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Profile and funding of health research triggered by the COVID-19 pandemic in Brazil

Perfil e financiamento da pesquisa em saúde desencadeada pela pandemia da COVID-19 no Brasil

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ABSTRACT

Introduction: Facing COVID-19 pandemic challenges Brazil on taking actions to deal with the installed health crisis, and to choose which interventions are more efficient and effective with the problems arising from the new disease. This picture of uncertainties has led to health research financing actions, which aim at scientific and technological improvement, supporting evidence-based decision making. **Objective:** To map the health research funding opportunities to face the COVID-19 in Brazil, in terms of priority areas, funding sources and financial volumes. Methods: We search public sources to map documents related to the promotion of research and innovation in health, with public and private sectors. We conducted a survey directly on the websites of public research institutions and an unsystematic search to identify private financing, and categorized objects of the financing notice and calls identified in large areas and specific topics. **Results:** We found 23 financing opportunities focusing on the combat of COVID-19 pandemic, covering 20 different financing agents in a total amount of BRL 337,460,612.00. Five public institutions finance 75.0% of the resources. **Conclusions:** Despite the small amount of resources, there was an effort to promote health R&D in a timely manner, mainly by federal public agencies, with emphasis on CAPES and CNPq. The most contemplated areas were the inputs needed to face COVID-19 (diagnostic tests, medical equipment and devices, medicines, vaccines and biological products) and telecommunication and information technologies. However, the contributions covered practically all the important areas for knowledge, prevention and treatment of the disease. It is noteworthy that health R&D in Brazil has had its resources significantly reduced since 2015.

KEYWORDS: Research Financing Systems; Health Research Policy; COVID-19; 2019-nCoV Epidemic; Pandemics

RESUMO

Introdução: O enfrentamento da pandemia COVID-19 desafia o Brasil sobre as medidas a tomar com a crise sanitária instalada e quais intervenções são mais eficientes e efetivas frente aos problemas decorrentes da nova doença. Esse quadro de incertezas tem levado a ações de financiamento de pesquisa em saúde, que visam o aprimoramento científico e tecnológico, subsidiando a tomada de decisões baseada em evidências. **Objetivo:** Mapear as oportunidades de financiamento de pesquisa em saúde para o enfrentamento da COVID-19 no Brasil, em termos das áreas priorizadas, fontes financiadoras e volumes financeiros. **Método:** Fontes públicas foram utilizadas para mapear documentos relativos ao fomento à pesquisa e à inovação em saúde, junto às instâncias públicas e privadas. Realizou-se levantamento diretamente nos sítios eletrônicos das instituições públicas de pesquisa e busca assistemática para identificar financiamentos privados. Os objetos de financiamentos dos editais e chamadas identificados foram categorizados segundo grandes áreas e temáticas específicas. **Resultados:** Foram identificadas 23 oportunidades de financiamento para o enfrentamento à COVID-19, cobrindo 20 diferentes agentes de financiamento, totalizando R$ 337.460.612,00. Cinco instâncias públicas responderam

aproximadamente por 75,0% dos recursos. **Conclusões:** Apesar do pequeno montante de recursos, houve esforço de fomento à P&D/S em tempo oportuno, principalmente por parte de órgãos públicos federais, com destaque para CAPES e CNPq. As áreas mais contempladas foram os insumos necessários ao enfrentamento da COVID-19 (testes diagnósticos, equipamentos e dispositivos médicos, medicamentos, vacinas e produtos biológicos) e a tecnologias de telecomunicação e informação. Entretanto, os aportes atenderam praticamente todas as áreas importantes para o conhecimento, prevenção e tratamento da doença. Destaca-se que a P&D/S no Brasil tem tido seus recursos significativamente reduzidos desde 2015.

PALAVRAS-CHAVE: Sistemas de Financiamento da Pesquisa; Política de Pesquisa em Saúde; COVID-19; Epidemia por 2019-nCoV; Pandemias

INTRODUCTION

The pandemic caused by the SARS-CoV-2 virus, the etiological agent of COVID-19, since the beginning of 2020 as a totally new disease, represents a threat of magnitude not previously faced in this last century[1]. According to data from the World Health Organization (WHO), until May 6 there were 3,588,773 confirmed cases worldwide, with 247,503 deaths[2]. Brazil reported the first case of disease by the new coronavirus on February 26 and, on May 6, had 125,218 confirmed cases and 8,536 deaths, but with recognized underreporting of cases and deaths due to insufficient and restricted to symptomatic and severe cases testing, the large number of cases in which deaths occur at home, and the strangulation put to health services[3].

Added to the rapid speed of expansion of the virus, there are difficulties in establishing responses given the unknown and the urgent need to make efforts, especially in scientific research, as a powerful instrument in elucidating the numerous emerging issues regarding the disease, with measures capable of bringing evidence concerning more efficient and effective public policies and interventions given the problems arising from the pandemic. In this little-unveiled scenario, there are still countless uncertainties regarding the natural history of the disease and its evolution, its economic and health impacts on people and society, effective and safe treatment and prevention measures, etc. In addition to seeking emergency assistance reinforcement actions to prepare the health system to deal with the health crisis already in place.

Health research plays a central role in responding to public health emergencies and in the impact on the generation of new knowledge, especially those potentially applicable in new products that can be used to cope with it and prevent future risks. As a result, initiatives to stimulate and foster Health Research and Development (health R&D) related to COVID-19 have multiplied around the world since the beginning of the pandemic, even led by WHO.

Regardless of the presence of the current pandemic, health R&D is an important tool for improving the health situation of populations, which allows, among others, to support decision-making in the definition of policies and health planning, contributing to promotion, protection, recovery, and rehabilitation of health actions and for the reduction of social and health inequalities, widely observed in the Brazilian socio-sanitary scenario[4]. In overcoming these inequalities, Guimarães[5] stated that it is imperative to include in the debate on scientific research policies in general - and, in particular, in the field of health - the commitment of not dissociating between the scientific practice and the health reality that surrounds them.

The concept of health R&D used in this article has an expanded perspective, in which scientific and technological development in health ranges from basic to operational and translational research, including the development of strategic health inputs. In addition to generating knowledge, it involves transforming it into technologies, realized in the form of finished products and processes that meet the needs of the market. In short, health R&D integrated with innovation[5,6].

Health R&D is the main sectorial component of research in the country, although the funding for research related to this social area is still insufficient, especially when compared to the benefits it provides[7]. In addition, health research efforts can often occur without coherence with the National Health Policy. Guidance for this integration was already expressed in the Federal Constitution of 1988, which, among the competencies of the Unified Health System (SUS), adds the increase of scientific and technological development in its area of operation[8]. Another complicating factor stems from the fact that, in addition to insufficient funding, the past few years have been times of divestment and scrapping by development agencies.

Considering the central role of health R&D in the current pandemic context, this work aimed to map the health research financing opportunities triggered to cope with COVID-19 in Brazil, in terms of the priority areas, funding sources, and financial volumes.

METHOD

This is an exploratory cross-sectional study, based on public data sources with unrestricted access on the internet, adapted according to the work of Silva and Caetano[9] focusing specifically on the financing of health research related to COVID- 19.

The data search included multiple sources. Carried out between April 20 and 23, 2020, it involved direct searches and identification of public documents, mainly calls and/or funding notices.

Financial and scientific support actions given the COVID-19 pandemic were raised on the websites of Brazilian federal bodies linked to the promotion of Science and Technology (S&T): Financier of Studies and Projects (Finep), National Council for Scientific and Technological Development (CNPq) and Coordination for the Improvement of Higher Education Personnel (CAPES). Another health research public source also examined was the Oswaldo Cruz Foundation (Fiocruz), which traditionally has its own funding for health R&D, as part of its institutional budget.

In addition, a search was carried out on the portal of the National Council of State Research and Innovation Support Foundations (CONFAP) at https://confap.org.br/pt/faps, which allows accessing and identifying initiatives to promote research and development (R&D) on the websites of each of the twenty-six Research Support Foundations (FAP) of the country's federative units.

In addition, initiatives to support research funding on the internet were also mapped, which include some specific actions from the private or public sectors, identified on the Google search engine. An unsystematic search was performed, using as keywords a combination of the terms: "research and development financing", "research and innovation", "coronavirus epidemic", "SARS-CoV-2", "coronavirus", and "COVID-19".

All public documents were systematized and organized in an electronic spreadsheet using the Microsoft Excel® application. This step involved the calculation of the figures financed. When in foreign currency, the conversion was made using the Central Bank of Brazil converter, available at https://www.bcb.gov.br/. The analyzes were performed using descriptive statistics.

The objects of financing for the notices were categorized according to large areas and specific thematic lines contemplated in Chart 1, elaborated based on the adaptation of the international research platform The Global Health Network[10] *and constructed a posteri*, from the careful examination of each bid/call identified.

Chart 1. Categories of thematic areas identified in the notices and/or public calls for financing scientific-technological research and innovation in health in the fight against COVID-19.

Great thematic areas	Specific themes	Approaches involved
Inputs for coping with COVID-19	Diagnostic tests	New serological or molecular tests. Construction of serology and respiratory secretion database to evaluate new tests. Includes accuracy studies.
	Medical equipment and devices	Development of ventilators/respirators, parts, monitors, other inputs for the manufacture of medical equipment, and devices.
	Medicines, vaccines, and immunobiological products	New medicines, vaccines, and immunobiological products. It covers studies of existing therapies for other indications. Includes clinical research.
	Other inputs and new materials	Products for antisepsis, nanotechnology, automation systems, among others.
Health prevention and safety	Preventing and reducing contagion	Studies on the development and use of personal and collective protective equipment, other instruments or equipment for the protection, treatment, and isolation of patients, disinfection techniques.
Information and communication technology (ICT)	ICT application	It includes digital solutions involving artificial intelligence, the internet of things, application development, and software, among others.
	Telemedicine	New applications and studies encompassing teleconsulting, telediagnosis, telemonitoring, remote regulation, tele-education, second training opinion, and teleconsultation.
Health systems	Infrastructure	Activities related to research and adaptation in the improvement of laboratory facilities, health services, supply chain, and in the logistics of materials and patients.
	Health policies, network systems, and services	Studies on access and organization of the health network, assistance and diagnostic protocols, planning and management, care process.
Epidemiological knowledge of the disease	Development of scenarios and modeling	Research on mathematical modeling of transmission dynamics, georeferenced medical data, and prediction models for control, monitoring, and prediction of viral spread. Projections of need and the installed capacity of the health system.
	Epidemiology	It includes studies on disease burden, risks, and information systems. Evaluation of the spatio-temporal distribution of the epidemic, estimates of incubation time, rates of transmission and lethality of the disease. Epidemiological surveillance of the disease
Characterization of the disease and its natural history	Virology, immunity and inflammation, experimental models, clinical aspects	Pathogenesis, the pathophysiology of the disease to assess the clinical spectrum, severity and risk factors, worsening factors, immune response, clinical handling and treatment strategies, cure criteria and long-term effects.
Socioeconomic impacts	Social science, economic and behavioral research	Research based on social and behavioral data. Ethics and social engagement. It includes economic studies and forecasting the impact of measures to deal with the epidemic.
Other research areas with application in health	Incentives that do not fit into the above categories	Includes grants for the payment of scholarships and other unspecified situations, making classification impossible.

Source: Elaborated by the authors, 2020.

RESULTS

23 health R&D financing opportunities were identified to combat COVID-19, many of them treated as emergency actions in the pandemic context, which involved 20 different financing agents. The total amount determined for this financing was R$ 337,460,612.00, of which 29.0% came from state public institutions (FAP) and 9.6% from private bodies, while the rest refer to public bodies in the federal sphere.

CAPES alone accounted for just over 1/3 of the financial volumes (R$ 110,425,600.00), which added to four other institutions - CNPq, Fiocruz, Rio de Janeiro Carlos Chagas Filho Research Support Foundation (FAPERJ), and Federal District Research Foundation (FAPDF) - corresponded to almost 75% of the total values (Table 1).

CAPES, an agency linked to the Ministry of Education, launched the "Strategic Emergency Program to Combat Outbreaks, Endemics, Epidemics, and Pandemics", intending to increase the training of qualified human resources and financing research projects in the face of COVID-19. The program is structured in two strands, of which the first, the "Immediate Emergency Strategic Actions", for the emergency granting of masters and doctoral scholarships within the scope of *stricto sensu* graduate programs for research strictly related to the epidemic. The second, "Emergency Strategic Actions Induced in Specific Areas", consists of the launch of three calls for proposals for thematic projects: Emergency Selection Notice nº 09/2020 - Epidemics; Emergency Selection Notice nº 11/2020 - Pharmaceuticals and Immunology, and Emergency Selection Notice nº 12/2020 - Telemedicine and Medical Data Analysis[11,12,13].

CNPq, linked to the Ministry of Science, Technology, Innovations and Communications (MCTIC) and a traditional institution in promoting research in Brazil, offered the [14] MCTIC/CNPq/FNDCT/MS/SCTIE/Decit call nº 07/2020. The total resources were R$ 50,000,000.00, having MCTIC as source (with R$ 30,000,000.00), and the difference provided by the Ministry of Health (MS). The joint call involved seven themes or lines of research that, in addition to addressing COVID-19, included in its scope research on other severe acute respiratory syndromes.

Table 1. Values foreseen by the funding agencies for scientific research, technological development, and innovation to cope with COVID-19, Brazil, until April 23, 2020.

Sphere	Funding agency	Value	%	% Accumulated
Federal public	CAPES	110,425,600.00	32.7	32.7
Federal public	CNPq	50,000,000.00	14.8	47.5
State public	FAPDF	30,000,000.00	8.9	56.4
State public	FAPERJ	30,000,000.00	8.9	65.3
Federal public	Fiocruz	30,000,000.00	8.9	74.2
State public	FAPESP	20,000,000.00	5.9	80.1
Federal public	Finep	15,000,00.000	4.4	84.6
Private	SENAI	15,000,00.000	4.4	89.0
State public	FA	8,000,000.00	2.4	91.4
Private	Vale S.A.*	5,446,100.00	1.6	93.0
Private	ABDI	5,000,000.00	1.5	94.5
State public	FAPERGS	5,000,000.00	1.5	96.0
Private	EMBRAPII	4,000,000.00	1.2	97.2
State public	FAPEMIG	2,000,000.00	0.6	97.8
Private	Sebrae	2,000,000.00	0.6	98.3
Federal public	Enap	1,750,000.00	0.5	98.9
State public	FAPEAM	1,618,912.00	0.5	99.3
State public	FAPESQ	1,000,000.00	0.3	99.6
Private	Serrapilheira Institute**	1,000,000.00	0.3	99.9
State public	FAPESB	220,000.00	0.1	100.0
Grand Total		**337,460,612.00**	**100.0**	-

Source: Elaborated by the authors, 2020.
CAPES: Coordination for the Improvement of Higher Education Personnel; CNPq: National Council for Scientific and Technological Development; FAPDF: Federal District Research Foundation; FAPERJ: Rio de Janeiro Carlos Chagas Filho Research Support Foundation; Fiocruz: Oswaldo Cruz Foundation; FAPESP: São Paulo Research Foundation; Finep: Financier of Studies and Projects; SENAI: National Service of Industrial Training; FA: Araucaria Foundation for Supporting Scientific and Technological Development of Paraná; ABDI: Brazilian Agency for Industrial Development; FAPERGS: Foundation Support of Research the State of Rio Grande do Sul; EMBRAPII: Brazilian Company for Research and Industrial Innovation; FAPEMIG: Minas Gerais Research Funding Foundation; Sebrae: Brazilian Micro and Small Business Support Service; Enap: Brazilian National School of Public Administration; FAPEAM: Foundation Support of Research the State of Amazonas; FAPESQ: Foundation for Research Support of Paraíba State; FAPESB: Bahia State Research Support Foundation.
* The values of the company Vale S.A were USD 1,000,000.00, converted into reais on 04/23/2020 in the Central Bank of Brazil converter (1 USD = R$ 5.4461), available at https://www.bcb.gov.br/.
** Promotion identification carried out through a survey on the institution's portal based on information verified after searching on Google.

It is also worth mentioning Fiocruz, a federal autarchy that is part of the Ministry of Health, which launched, through the Fiocruz Program to Promote Innovation "Inova Fiocruz", two thematic notices for emergencies, one that seeks to bring actions, decisions and quick responses and the other for selecting proposals for the generation of knowledge aiming at understanding the disease.

In addition, the Brazilian National School of Public Administration (Enap), linked to the Ministry of Economy, launched a funding notice in the form of "Challenges to confront COVID-19", aiming to lead innovative solutions to fight the new disease.

Finep, also linked to the MCTIC, launched, together with the São Paulo Research Foundation (FAPESP), a research notice for the development of technologies for products, services, and processes to combat COVID-19, with values of approximately R$ 20,000,000.00 (50% for each)[15]. The funds are for companies in the state of São Paulo that intend to develop innovative processes and services to make products available on the market in an emergency and fast manner. In addition, FINEP launched a Public Selection of economic subsidy to innovation for the development of innovative solutions related to personal protective equipment and systems (PPE) and collective protection equipment (CPE), aiming at biological safety and protection of teams in the medical and hospital care chain.

Of the 26 Research Support Foundations present in the states and the Federal District (except Roraima), nine made efforts with the contribution of financial resources to promote the health R&D related to COVID-19 Some FAPs, such as the one in Pernambuco, despite not having resorted to new resources, published a notice to redirect contracted projects, prior to the pandemic. FAPERJ and FAPESP promoted supplementation so that ongoing research could also be redirected to confront the new coronavirus.

FAPERJ published the call "Emergency Action COVID-19 / SARS-COV-2 FAPERJ / SES", divided into three parts that encompass several themes aimed at strengthening research networks and encouraging companies, such as startups, micro, small, and medium-sized private companies[16].

The participation of some companies was also observed in the promotion of research, with a strong incentive for technological development and innovation. The company Vale S.A. and other entities with private legal personality, but not for profit, such as the Brazilian Company of Research and Industrial Innovation (EMBRAPPI), Brazilian Agency for Industrial Development (ABDI), Brazilian Micro and Small Business Support Service (Sebrae), and the National Service of Industrial Training (SENAI), in partnerships with each other, played an important role (Chart 2).

It was not possible to distribute the total amount of resources identified in the promotions by specific themes, except in particular situations when the notice and / or call had defined, from the beginning, the focus of the financing, for example: Finep's public selection, which was exclusive for PPE and CPE financing[17]. This is because the vast majority of the selection processes are ongoing and still do not have results of the research that will be effectively financed, whose information would be a condition for the distribution in question.

Regarding the thematic categories found in the notices and/or public calls for financing scientific-technological research and health innovation in the fight against COVID-19, it was observed that all eight major areas had the presence of financing.

The following thematic lines stand out, in order of predominance: application of information and communications technologies (ICT); diagnostic tests; prevention and reduction of contagion and telemedicine; medicines, vaccines, and immunobiological products; epidemiology; and health policies, network systems and services. The "others" category involved massively notices and / or calls for the payment of scholarships, which also contributes to the health R&D effort (Table 2).

Several FAPs (Amazonas, Bahia, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Sul, and São Paulo) stimulated promotion opportunities related to scientific and technological research on ICT, which allows the development of actions to support health services. Many involved developing applications and educational methodologies or equipment, with a view to develop technologies to improve training and health care. It also highlighted: actions for digital solutions involving artificial intelligence; internet of things; applications for police, firefighters, doctors, and nurses; applications for public health support services, intricately linked to technological development. This specific theme was also strongly present in private financing, which through "challenges" (such as Enap and Vale S.A.) sought to develop technological solutions for monitoring (including behavioral), control, and prevention during the pandemic context.

The topic of telemedicine was also underlined. CAPES published a specific emergency notice (Notice nº 12/2020) directly related to telemedicine applications, such as radiology and medical data analysis for diagnosis and decision-making assistance. The financing agents indicated the promotion of improvements in remote health services aimed at expanding diagnosis, treatment, prevention, and other activities that lead to the scalability of care; involving remote operation of magnetic resonance and computed tomography and support mechanisms for patients in home confinement or hospital quarantine, among others.

As expected, inputs for coping with COVID-19 - diagnostic tests, drugs (new and others with new therapeutic indications), and new vaccines and immunobiologicals - were quite prominent. Fiocruz, CNPq, several FAPs (Amazonas, Bahia, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Sul, São Paulo), and other private bodies have mobilized in this regard (Vale S.A., SENAI, ABDI, EMBRAPII, and Sebrae). In general, the development is intended to promote efforts to expand the offer of new diagnostic tests. In addition, actions were taken to streamline technical capacity in production, including reducing the time between material collection and test results, and studies of diagnostic accuracy.

Chart 2. Funding agencies for scientific research, technological development, and innovation aimed at facing COVID-19 according to the instrument and objective of the call, Brazil, until April 23, 2020.

Funding agencies	Legal instrument	Core objective
CNPq	MCTIC/CNPq/FNDCT/MS/SCTIE/Decit call nº 07/2020	Support the development of scientific and/or technological research related to COVID-19 and other severe acute respiratory syndromes.
CAPES	Notice nº 9/2020 - Epidemics	Support scientific and technological research and training of human resources with a focus on preventing and combating outbreaks, endemics, epidemics, and pandemics.
	Notice nº 11/2020 – Drugs and immunology	Support scientific and technological research and training of human resources with a focus on the study of vaccine drugs, immunobiological products, and related topics.
	Notice nº 12/2020 – Telemedicine and medical data analysis	Support scientific and technological research and training of human resources exclusively for the development of studies, procedures, and technological innovations in telemedicine and analysis of medical data and related topics.
Enap	Public call notice nº 26/2020	Selection of proposals for innovative solutions to solve public challenges.
Finep	Public Selection MCTIC/FINEP/FNDCT Economic Subsidy for Innovation – nº 01/2020	Development of innovative solutions, with technological risk, for the development of personal and collective protective equipment and systems, aiming at biological safety and the protection of teams in the medical and hospital care chain.
Finep FAPESP	FAPESP call nº 11/2020 - FAPESP + Finep collaboration	Technological research projects for small companies in the state of São Paulo with technologies for innovative products, services, and processes.
Fiocruz	Call nº 02/2020 – Inova Fiocruz Program	Bring quick actions, decisions, and responses. Strategic Orders Ideas and Innovative Products.
	Call nº 03/2020 – Inova Fiocruz Program	Select proposals to generate knowledge in order to accumulate knowledge necessary to understand the disease.
FA	Public Call nº 09/2020	Granting of Scholarships - extension projects primarily for graduates and students of Health courses.
FAPERJ	COVID-19/SARS-CoV-2 FAPERJ/SES Emergency Action	Three calls: research of networks in emerging and reemerging viruses, contribution to ongoing projects, and constitution of research networks for new projects involving startups, micro, small, and medium companies.
FAPESB	FAPESB notice nº 01/2020	Support for scientific, technological and/or innovation research.
FAPEMIG	FAPEMIG call nº 01/2020	Strengthen innovative actions in Scientific, Technological, and Public Innovation Institutions in Minas Gerais.
FAPESP	FAPESP call nº 12/2020	Supplementation for ongoing research to be redirected to cope with the coronavirus and/or possible ways for its management or prevention, in the modalities: thematic, young researcher, Research, Innovation and Dissemination Centers, or Engineering Research Center.
FAPEAM	Notice nº 005/2020	Promote research and/or strategic services that support the public health policy in Amazonas.
FAPERGS	FAPERGS Emergency Notice nº 06/2020	Support scientific, technological or innovation research projects by selecting proposals for financial support.
FAPDF	Agreement nº 03/2020	Technical-scientific cooperation between FAPDF and the Foundation for Scientific and Technological Development to support research, innovation, and extension projects and actions related to COVID-19.
FAPESQ	Notice nº 003/2020	Contribute to the rapid implementation of monitoring, analysis, and recommendations solutions by promoting socially referenced research.
EMBRAPII Sebrae	EMBRAPII and SEBRAE contract (number not identified)	For projects of startups and small companies, associated or not to medium and large companies, to create solutions related to software, intelligent systems, hardware, parts and medical equipment, among others.
ABDI SENAI	Innovation Notice for Industry: mission against COVID-19 - ABDI + SENAI	Support projects composed of consultancy, metrology/tests/analyzes, and/or research, development, and innovation that develop impact solutions.
Serrapilheira Institute	Unidentified instrument*	To analyze the evolution of the prevalence of COVID-19 infection in the population of Rio Grande do Sul, with prospects for reproduction in the entire country, at the request of the Ministry of Health. Also sponsored by Unimed Porto Alegre and Cultural Forest Institute.
Vale S.A.	Vale call challenge COVID-19	Select initiatives on the themes: "risk prevention and tracking", "screening and diagnosis" and "monitoring of patients", "intensive care". Solutions with maturity for fast implementation and low or zero cost for the end-user.

Source: Elaborated by the authors, 2020.
CNPq: National Council for Scientific and Technological Development; CAPES: Coordination for the Improvement of Higher Education Personnel; Enap: Brazilian National School of Public Administration; Finep: Financier of Studies and Projects; FAPESP: São Paulo Research Foundation; Fiocruz: Oswaldo Cruz Foundation; FA: Araucaria Foundation for Supporting Scientific and Technological Development of Paraná; FAPERJ: Rio de Janeiro Carlos Chagas Filho Research Support Foundation; FAPESB: Bahia State Research Support Foundation; FAPEMIG: Minas Gerais Research Funding Foundation; FAPEAM: Foundation Support of Research the State of Amazonas; FAPERGS: Foundation Support of Research the State of Rio Grande do Sul; FAPDF: Federal District Research Foundation; FAPESQ: Foundation for Research Support of Paraíba State; EMBRAPII: Brazilian Company for Research and Industrial Innovation; Sebrae: Brazilian Micro and Small Business Support Service; ABDI: Brazilian Agency for Industrial Development; SENAI: National Service of Industrial Training.
* Promotion identification carried out through a survey on the institution's portal based on information verified after searching on Google.

Table 2. Large areas and thematic lines in public notices and/or calls for financing health scientific-technological research and innovation for coping with COVID-19, Brazil, until April 23, 2020.

Great thematic areas	Thematic lines	N	%*
Inputs for coping with COVID-19	Diagnostic tests	14	60.9
	Medical equipment and devices	9	39.1
	Medicines, vaccines, and immunobiological products	11	47.8
	Other inputs and new materials	3	13.0
Health prevention and safety	Preventing and reducing contagion	12	52.2
Information and communication technology (ICT)	ICT application	16	69.6
	Telemedicine	12	52.2
Health systems	Infrastructure	3	13.0
	Health policies, network systems, and services	10	43.5
Epidemiological knowledge of the disease	Development of scenarios and modeling	6	26.1
	Epidemiology	11	47.8
Characterization of the disease and its natural history	Virology, immunity and inflammation, experimental models, clinical aspects	8	34.8
Socioeconomic impacts	Social science, economic and behavioral research	7	30.4
Other areas of health R&D with application in the health area	Incentives that do not fit into the above categories	12	52.2

Source: Elaborated by the authors, 2020.
ICT: Information and communication technology.
* Percentage calculated in relation to the total of 23 occurrences of funding for health research and technological development.

The challenge of developing drugs and immunobiological products (vaccines) involves identifying therapeutic candidates, either by repositioning existing drugs and schemes against COVID-19 (for example: chloroquine, hydroxychloroquine, nitazoxanide, etc.) or by developing new prototypes of antiviral drugs and other formulations. Preventive and/or therapeutic vaccines also represented a field of a great investment, being considered another strategic tool. Pre-clinical and/or clinical studies involved in the development of vaccines and drugs were part of this theme. Several instances have formulated notices and calls with this focus, such as CNPq, Fiocruz, FAPESP. CAPES[12] launched Emergency Call 11/2020, focusing on the study of drugs, vaccines, and immunobiological products for COVID-19, on the amount of R$ 25,844,000.00. It is interesting to highlight that no promotion from the private sector specifically mentioning medicines and vaccines was identified, although the object of some are generic and may, in the analysis and decision, come to contemplate this theme.

Medical equipment, such as mechanical ventilators, is extremely necessary for coping with the disease, given its use in health emergencies. Financing possibilities, such as those of the company Vale S.A. (called the COVID-19 challenge)[18] and the partnership between FAPESP and Finep, made it possible to subsidize innovative research for medical products and equipment, as long as these were in maturity stage for rapid market entry.

Actions for the development of personal and collective protective equipment and systems, aiming at biological safety and protection of teams in the medical-hospital care chain, focused on the development of innovative solutions. Finep made direct efforts on this topic, through public selection, with a specific economic grant of R$ 5,000,000.00 for companies. Other agents, such as FAPERJ, CNPq, Enap, and the private sector, also sought to allocate resources.

Expansion of epidemiological knowledge about COVID-19 was the funding target from all federal public agents and some FAPs. The notices are intended to support epidemiological studies capable of monitoring the spread of the disease and its containment and relevant actions for health surveillance. Another highlight was the initiative of the state government of Rio Grande do Sul and other agents, intermediated by the Serrapilheira Institute, with values of R$ 1,000,000.00, which commissioned a study from the Federal University of Pelotas (with other state universities) to research on the prevalence of SARS-CoV2 infection[19].

Coping with the epidemic has challenged health systems at all levels, given the unknown environment that healthcare networks, in their various dimensions, face. The Rio Grande do Sul state FAP, FAPESP, CNPq, and Fiocruz were public institutions that invested resources in this theme. Access issues, assistance service networks, health care, both for patients and professionals in the service line were listed as a focus for the development of studies, as well as management elements, such as efficiency and effectiveness of the health care system.

DISCUSSION

The word “crisis”, when written in Chinese, consists of two characters, one representing danger and the other, opportunity. Although this perception is considered wrong, in the case of the current pandemic, investments in health R&D can make such an analogy less unrealistic.

Certainly, the character of a new disease that did not exist before, its extent, which has already reached 214 countries, magnitude in terms of cases and deaths, and the great difficulty encountered by all health systems in dealing with it contribute to the relevance that health R&D related to COVID-19 has been receiving in terms of financial stimulus and

incentive all over the world, since the beginning of the pandemic. In this effort, WHO stands out, from the mobilization of the *R&D Blueprint*, a global strategy and preparation plan, initiated with the Ebola epidemic in Africa and then with the Zika virus. This plan allows for the rapid activation of R&D activities during epidemics and aims to improve coordination between scientists and health professionals from around the world, accelerating the process and developing new norms and standards to learn and improve the global response[20]. In this sense and considering the impact that the epidemic has caused (and is still expected to cause), in the national context, it appears that national health R&D initiatives are beginning to multiply, even considering the short time since the beginning of the pandemic.

Regarding the volume of health R&D funding for COVID 19 - R$ 337,460,612.00 -, some aspects deserve to be brought up for discussion, for its better contextualization. Expenditures (federal, state, and corporate) in R&D in Brazil accounted, according to the MICTC, for amounts of R$ 82.8 billion in 2017 (0.82% of gross domestic product), however, with a downward trend since 2015. Public expenditures totaled R$ 41.2 billion, of which R$ 25.7 billion were of federal origin, being 55.8% from the Ministry of Education and 17.7% from MCTIC. MS accounted for R$ 2.165 billion (8.4% of federal expenditures)[21].

Among health R&D financiers in Brazil, the Ministry of Health has played an increasing role as a policymaker and financier in this sector since 2005. Searches carried out in the Health Research Platform on direct global financing in health research show that there was a global investment (in the form of direct contracting, decentralized funding: Research Program for SUS - PPSUS, and national funding) of R$ 1,340,329,324, 49 between 2005 and 2019 in current values. However, there has been a declining trend over time both in the number of research funded and in the promotion - R$ 635,429,763.28 (2,703 researches) from 2005 to 2009, R$ 390,212,471.51 (1,746 researches) from 2010 to 2014, and R$ 314,687,089.70 (937 researches) from 2015 to 2019[22]. Although they may seem small, the amounts invested in health R&D in Brazil related to COVID-19, by all financing agents, including private ones, from the beginning of the epidemic until April 23 represent six times all the amount invested in health R&D by the MS in 2019 (R$ 55,815,609.24) identified on this basis.

The vast majority of resources directed to this health R&D come from public sources, especially Capes and CNPq, which together accounted for 47.5% of total investments and are historically important funders of sectorial research. The MS, however, was responsible for very small amounts: R$ 20,000,000.00 in the MCTIC/CNPq/FNDCT/MS/SCTIE/Decit Call nº 07/2020[14] and other R$ 30,000,000.00 by Fiocruz notices.

An important aspect to be highlighted about this participation is an article published in the Valor Econômico newspaper of March 9, 2020, in which the Minister of Health at the time, Luiz Henrique Mandetta, declared that "without resources, the country will be out of the researches against the virus" and it would not participate in "the race for the development of a vaccine or retroviral, in which other countries are already at the forefront ". The former minister argued that several agents and countries (World Bank, USA, and European Community) had been investing resources of billions of dollars in this research, and argued that it would be of little value for the country to use its limited science resources to act "in redundancy" with mega-laboratories, having to "prepare its technology park so that, at the moment the vaccine is developed, it will have the capacity to produce it"[23]. Certainly, a complicated position to be defended, as pointed out by Reinaldo Guimarães, former secretary of Science and Technology of the MS between 2007 and 2010, that it would be unreasonable to expect Brazil to have the right to commercialize new patented products that reach the market to face the epidemic or that a country not involved in the global R&D effort for diagnostic, therapeutic, or vaccine inputs may be able to produce them industrially[24].

It is also interesting that this posture of the MS is quite different from that present at the time of the Zika virus outbreak, which occurred in 2015, when a large intersectoral effort was organized, with the participation of several portfolios from different spheres of government, academic community, industry, and civil society. At that moment, the efforts of the research institutes were aligned. This provides for optimization of financial resources and reduces duplication in emergency situations, thus strengthening the confrontation and implementation of public policies.

In response to this manifestation of the MS, a group of scientific entities (Brazilian Society for the Advancement of Science, Brazilian Association of Collective Health, Federation of Experimental Biology Societies, Brazilian Society of Clinical Pathology, and Brazilian Society for Bioethics) requested in a letter to the Secretary of Science, Technology and Strategic Health Inputs, that the Ministry of Health incorporate and finance actions in the field of health R&D among the priorities in the application of the extraordinary financial resources announced to face the epidemic, suggesting values (R$ 100,000,000) to be distributed in rapid response projects and translational research[25].

Translating knowledge into action is not trivial and requires the development of collaborative measures to build knowledge among agents of interest that involve the interface between researchers, policymakers, and communities[26].

The position of abdicating the research effort related to COVID-19 stated by the MS may have had unfavorable repercussions outside national borders. The pandemic has reinforced the need to accelerate the development of vaccines against SARS-CoV-2, considered essential for the future control of this disease, and WHO has mobilized a wide coalition of scientists, researchers, and industrial partners to develop and evaluate immunobiological. Seven vaccines, out of more than 120 candidates, are already under clinical evaluation and 82 under preclinical evaluation. In late April, the WHO held a meeting to discuss that the vaccine to be developed

should be distributed equally, in order to ensure that all people have access to affordable prices, avoiding financial speculation. However, Brazil was not invited to participate and did not sign the public declaration of collaboration in the development of the COVID-19 vaccine[27]. Even so, some of the public notices/calls that come only from the public spheres include health R&D related to the vaccine as one of its objects of interest[12,14].

Eight immediate action priorities in terms of health R&DS for COVID-19 have been established, taking into account the existing knowledge gaps and the needs to address them[28]. All thematic areas that are the subject of notices and calls identified in this work are among them, with emphasis on some specific lines.

There is a profusion of funding directed to inputs to combat COVID-19, which is certainly based on the fact that diagnostic tests, lack of effective therapies, and a vaccine for SARS-CoV-2 have been one of the biggest obstacles in the pandemic scenario. It should be noted that these interventions have a direct impact, with more effective responses in the morbidity and mortality rates. Furthermore, they represent products that can result in the strengthening of national production capacity, which is related to their presence in calls from agents such as Finep and Vale S.A.

Another topic that is widely addressed in the health crisis is PPE and CPE - strategic for the protection of health professionals, patients, cleaning staff, public security agents, patient transport, essential workers, and the general public -, which includes the disinfection of environments and utensils and which were the subject of public notices such as Finep, Enap, SENAI, Fiocruz, etc.

In the days of COVID-19, the promotion of the use of ICT was predominant in financing issues, which, in addition to telemedicine, are areas that provide innovative solutions for the provision of health services. Both, through their technological scope, can promote benefits, such as: integration of computational tools for analyzing medical data for diagnostics; image processing and pattern recognition for the interpretation of remote medical examinations, especially radiological; diagnostic tools, using modern data analysis techniques and artificial intelligence; support for the modeling of georeferenced medical data; patient teleconsultations for monitoring health and/or disease parameters; support in health education. This is urgent in circumstances of social isolation and forced quarantine, measures adopted worldwide during the pandemic[29].

Some limitations are present, as there may be other public and, above all, private funders that are not identified or that may still promote new incentives for health R&D. Thus, the results do not reproduce nor necessarily reflect the framework for all investment in health research related to COVID-19 in the country. The notices/calls were the data sources used in the research, which dictate restrictions in terms of available information. In addition, the vast majority have not yet had their selection results announced, which makes it impossible to examine the effective distribution of expenditures by thematic area, which could be the best indication of what will actually be prioritized in terms of health R&D and COVID in Brazil.

CONCLUSIONS

The new coronavirus pandemic highlighted the value of science, medicine, and health. The implementation of research in the context of this social tragedy is essential both to understand how to fight this disease, as well as to learn how to deal with future outbreaks of this or other infectious agents. It is necessary to ask different questions in different contexts and carry out the different types of studies capable of addressing priority aspects for facing them and mitigating their effects.

It was relevant to identify that some efforts in health R&D in this area could be triggered in the short term in the national context, despite the small expenses, given the challenges posed.

On the other hand, it is important to keep in mind that COVID-19 arrived in Brazil after successive cuts in science and universal health, strongly attacked in recent years. Investments in research on this topic can help increase the national response capacity and save lives, but the country must resume and expand its investments in S&T and, more specifically, in health R&D, as a way of not distancing itself more of the more developed countries and reduce the national and SUS dependence. Not an easy task in a government context that is strongly restrained and that systematically, and since before the appearance of COVID-19, attacks science, education, and health. Therefore, there is an urgent need to reinforce the struggle for adequate resources for the development of science and technology and health and education in Brazil.

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Authors' Contributions

Silva RM, Caetano R, Silva AB – Conception, planning (study design), and writing of the work. Guedes ACCM, Santos DL, Nepomuceno CC, Ribeiro GR - Data acquisition, analysis, and interpretation. All authors approved the final version of the work.

Conflict of Interest

Authors have no potential conflict of interest to declare, related to this study's political or financial peers and institutions.