



What Will Happen to Biomedical Research in Low-and-Middle Income Countries in the PostCOVID-19 World?

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Abstract

Scientific research is essential for a nation's development and is vital for generating solutions to population's health. Individual country's capacities to prevent and respond to public health issues, including health crises, is built with long-term investment in highly qualified professionals, infrastructure, and uninterrupted operating funding. Most Latin American countries, especially those at the bottom of the human development list, have limited capacity even though they are hot spots for tropical and other emerging infectious diseases. This weakness deepens these countries' dependence on nations with higher development and corresponding scientific capacity. The current COVID-19 pandemic has wreaked havoc on the health of the world's population and the global economy. Countries that lagged behind prior to the pandemic now face a myriad of additional challenges. On a more optimistic note, the pandemic could serve as a wake-up call for governments and funding agencies to strengthen scientific capacity around the world, so that we are better prepared to address the public health issues caused by current and prevalent diseases and by future diseases of pandemic potential.

Keywords Biomedical research · Tropical diseases · Latin America · Honduras · COVID-19

Scientific research is one of the most solid foundations of contemporary society. Both scientific knowledge and technological advances continue to shape human civilization. Increasingly, societies are enjoying a quality of life that many visionaries from the past would have considered impossible. Among scientific advances, those made in biomedical sciences are demonstrably essential for humans as a species. Immunizations continue to save countless lives and biotechnological advances are making possible to provide safe and nutritious foods to traditionally neglected communities. There are treatments, medical

interventions, pharmaceuticals, and diagnostic technology—to name a few—to address a variety of conditions.

Simply put, research activity's ultimate objective is to produce new knowledge. However, due to large variations of resources availability, infrastructure, and governance, not all countries are equally equipped to accomplish this goal. Variability of inputs into the research process will be naturally translated into variable outputs, which in turn, are used to gage countries' scientific productivity. The latter is often measured using indicators that can be counted, for instance: publications, journals, patents, technological impact, societal factors, as well as others such as research awards and prizes, conference presentations, databases, provenance and size of research grants, and the linkage between academia and the industry [1]. Among these, publication in scientific journals is a metric—that even though vastly imperfect—can be used as proxy of research performance, particularly in the so-called hard sciences as well as in biomedical sciences.

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Factors Influencing Publication Productivity

According to the number of publications, the USA and China have contributed to more than one-third of the global

publications between 1996 and 2019. The remaining 238 countries have made varying degrees of contributions to the global body of scientific literature, ranging from adequate to negligible [2]. The single most important reason for these differences in scientific productivity among countries is economic development and investment in science [3]. Presently, two countries (South Korea and Israel) are making great investments in science: they each assign 4.5% of their gross domestic product (GDP) to research and development, while the USA and China, invest 2.83% and 2.14% of their GDPs, respectively. On the other hand, most governments in the Central American region give little consideration to investing in science, if any at all [4]. For example, in the last 20 years, with a production of 1.75% of the global publications and 1.26% of their GDP invested in research and development, Brazil, the most prolific Latin American country, ranks 15th among 240 countries in the world. Conversely, the contribution of Central American countries—all in the group of low-and-middle income countries (LMICs)—ranges from 0.024% (Costa Rica) to 0.002% (El Salvador and Honduras) [2]. According to De-Moya-Anegón et al. [5•], SCImago lab categorizes Honduras as a “Group 3 country” (those with < 1000 publications for the period between 2014 and 2018; accounting for $\leq 0.1\%$ of the Iberoamerican region’s scientific productivity).

Figure 1 shows the number of scientific publications of five high income countries (USA, China, Brazil, Israel, South Korea) and one LMIC (Honduras), and the direct relationship between research and development expenditure and number of publications for those countries.

Many LMICs suffer from profound structural poverty and societal inequality, and because knowledge production is not a national priority, most of them have serious deficiencies in scientific capacity. One such country is Honduras; a small

nation situated in the heart of the Central American region. The objective of this review is to present Honduras as a case study of a LMIC where research capacity is lacking and the impact of the COVID-19 pandemic is having in the country. A few suggestions are offered for the strengthening of Honduras’s research capacity in a postCovid-19 world.

Research Capacity in Biomedical Sciences in Honduras

There is no national research system in Honduras. The country lacks national research ethics and biosafety guidelines, and there are no national funding agencies for research, development, and innovation. Private-public partnerships to support research are an unheard concept. Not surprisingly, there is no recognition of scientific research as a profession [6, 7••]. With the exception of the Honduran Medical Journal established in 1930, publication of scientific peer-review journals is a relatively recent way of communicating research findings in Honduras. Several medical and graduate associations publish their own journals, most of which are freely accessible online and do not charge article processing fees. At present, however, none of them is indexed in Scopus, which limits the visibility of Honduras-produced research.

There are 20 higher education institutions in the country (6 public and 14 private). Compared to other countries in Central America, Honduras’s higher education system is relatively small and mainly devoted to undergraduate teaching. In Honduras, the National Autonomous University of Honduras (Universidad Nacional Autónoma de Honduras, UNAH) is the institution legally mandated to oversee the higher education system [8•]; it is the largest university in the country, leading in all national indicators [5••]. However,

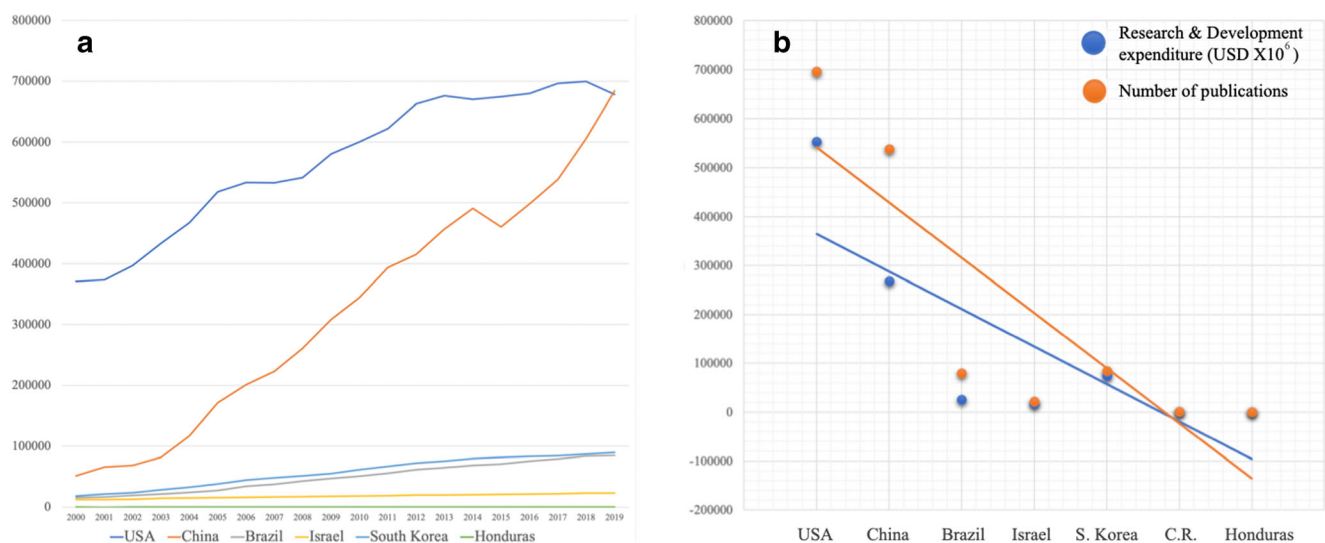


Fig. 1 **a** Number of scientific documents registered in Scimago Journal and Country Rank, **b** Expenditure on research and development and number of publications by country in 2017 (data published by the World Bank [2])

UNAH offers barely 27 masters degrees programs and two PhD programs: one in social sciences and one in communication and development (in partnership with Universidad Complutense de Madrid) [9]. Aside from the Master's program in Infectious and Zoonotic Diseases (MEIZ) offered by the School of Microbiology at UNAH, there are no graduate programs in biomedical sciences in the country.

A Glimmer of Hope

Despite this discouraging backdrop, there have been instances when the country—by way of one of its academic institutions—experiences a period of enhanced research activity in biomedical sciences brought about by international research cooperation. One such case is the period from 2007 to 2012, when the Teasdale-Corti (T-C) program financed through a Canadian consortium led by the Global Health Research Initiative (GHRI) had the vital mission to strengthen research capacity in this small nation [10]. The Teasdale-Corti in Honduras had two main partners, UNAH, the local partner, and Brock University, in Canada, the international partner. Its main objective was to strengthen research capacity in infectious diseases, and, by all indicators and metrics, the project was a success [7••]. Other international contributions, such as the Swedish cooperation (SIDA/SAREC) and the German academic exchange program (DAAD), have for a long time contributed to building capacities and training highly qualified personnel in biomedical research in the region, in particular with regard to infectious diseases of public health importance.

Altogether, these cooperative endeavors have resulted in an increased number of peer-reviewed publications. Between 2007 and 2020, two small research groups at UNAH engaged in these collaborative efforts and published more than 70 articles indexed in Scopus. Although small by international comparison, this number amounts to 14% of all articles authored by UNAH. Publications topics include dengue, chikungunya and zika, malaria, leishmaniasis, and soil-transmitted helminthiasis, among others. Beyond publication metrics, research findings from these investigations have had a positive impact in the populations' health. Their works have provided insight into the epidemiology and impact of HIV/AIDS [11–13], and vector-borne viral diseases [14–16]. As well, laboratory technology from UNAH to laboratories in the public health system has been transferred regularly [17–19]. Moreover, work from these research groups have contributed to the understanding of antimicrobial resistance and to malaria elimination in the country [20–22]. Very importantly, after these short- and medium-lived research cooperation initiatives have run their course, these research groups have continued active and welcomed junior colleagues, who inspired by their mentors, completed UNAH's only master of science degree in infectious and zoonotic diseases, or are now

pursuing graduate studies abroad. Moreover, faced with UNAH's ongoing institutional reform that has halted all direct funding for research, some researchers have begun to seek international funding to continue their work. These few examples bear witness not only to what can be achieved with a little support and investment in science, but also to the positive impact of research findings on issues of national and international concern.

COVID-19

While diligently conducting their investigations, researchers in Honduras and elsewhere experienced the unthinkable: a complete shutdown of institutions and research laboratories. At the time of this writing, the world continues to struggle with the SARS-CoV-2 pandemic. This public health emergency has revealed much in terms of societal inequalities within and between countries. COVID-19 has exposed nations' lack of preparedness, public health systems weakness, and leaders' inadequacy. It has also brought to light how many LMICs lacking a minimum of scientific and technical capacity have been unable to run clinical trials or implement and validate diagnostic tests that would have helped to monitor and control viral spread. Further, in responding to the emergency, LMICs as any other country around the globe had divert their already scarce resources and personnel to deal with the pandemic. Overall, the costs of the pandemic are immeasurable. The economic impact in LMICs will be probably catastrophic for their overall economy and well-being. As aptly stated by Molyneux et al. [23••] “the most vulnerable in society will be driven into deeper poverty”.

As the world emerges from the pandemic, high income countries will reopen their research laboratories and, in a short period of time, may be back where they left off. Some countries may even decide to increase investments in scientific research due to a renewed recognition of its societal importance. In fact, from early in the pandemic, experts have noted how COVID-19 has raised the profile of scientific research highlighting the essential role of infectious disease research for global health security [24, 25]. In LMICs, however, without leadership and clear vision, the most likely scenario will be a science recession.

What Can Honduras Do to Strengthen Its Research Capacity in the PostCovid-19 World

The following are a series of essential commitments at the national and institutional level to bring up research capacity in the country. Suggestions of particular importance in infectious diseases are marked with a (*) (Table 1).

Table 1 Essential commitments needed at the national and institutional level to enhance research capacity in biomedical sciences in Honduras

At the country-level	<ul style="list-style-type: none"> • Allocate at least 2% of the GDP. • Create a National Health Research System and a National Health Research Policy. • Create national standards for research ethics with human or animal participants (*). • Establish capacity for clinical trials (*). • Create national standards for biosafety and biosecurity (*). • Create fluid administrative mechanisms to fund scientific research. • Bring together governmental and academic units dedicated to infectious disease research to share knowledge and resources and develop collaborations. (*). • Promote long-term international cooperation programs (bilateral or multilateral). • Seek guidance from the international cooperation, and international organizations such as PAHO's Advisory Committee on Health Research (ACHR), the Council on Health Research for Development (COHRED), among others.
At the institutional level	<ul style="list-style-type: none"> • Encourage research beyond national priorities of the moment. • Create (or revitalize) and provide stable funding to scientific research administrative units. • Establish incentives for scientific research and publications. • Promote and support training of young researchers within and outside the country. • Create tenure-stream academic positions with significant dedication to research. • Create PhD programs at either institutional or regional level (as appropriate or feasible), or both. • Offer continuing education opportunities in biostatistics, molecular biology, biosafety, and scientific writing (*). • Strengthen South-South collaborations. • Promote alliances between government, academia, and industry (*). • Link institutions in the higher education system to share knowledge and resources and develop collaborations (*).

Conclusion

Contemplating this postCOVID-19 grim scenario, LMICs researchers as well as the institutions and governments that support them have two choices. The first, to accept what seems the inevitable fact of perpetual underdevelopment and dependence on international cooperation. The second and more difficult is to find opportunity in the challenge, to learn from the crisis and emerge stronger. This was the case of nineteenth century France when inspired by the success of the first rabies antiserum created the Pasteur Institute [26]. More recently after the 2009 H1N1 pandemic, Mexico decided to build laboratories across the nation and invested in the modern Institute of Diagnostic and Epidemiologic Reference (InDRE) [27] to cite just a couple of examples. Clearly, scientific knowledge is a global public good, and scientific research as a main generator of knowledge deserves an elevated place in society [28].

Under proper leadership, with permanent governance and research structures, as well as with sustainable financial support, countries can advance their scientific productivity and make meaningful contributions to their own citizens in particular and to the rest of the world in general. The time to decide what choice to make is now.

Authors' Contributions Both authors have contributed equally.

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Compliance with Ethical Standards

Conflicts of Interest The authors declare that they have no conflict of interest.

Ethics Approval Ethical approval was not necessary for this manuscript.

Consent to Participate N/A.

Consent for Publication The authors consent to the publication of the information contained in this manuscript.

Code Availability N/A

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- Of importance
- Of major importance

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