Why Global Health Matters to North Carolina:

The economic impact of the global health sector on North Carolina's economy

Adrian Garcia-Mosqueira
Duke University Economics Department
Sui Tang
Duke University Economics Department
Kim Chapman Page
Duke Global Health Institute
Charles Becker
Duke University Economics Department

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[1] **Adrian Garcia-Mosqueira** and **Sui Tang** were the primary authors of this study. They designed the methodology, collected data, conducted the analysis, and drafted the report; **Kim Chapman Page** was the project manager, oversaw the completion of the study, and finalized the report; **Charles Becker** served as the main economic advisor to this study and provided direction for the methodology.

Executive Summary

Why Global Health Matters to North Carolina:
The Economic Impact of the Global Health Sector on North Carolina's Economy

The state of North Carolina has long been regarded as a leading research hub for innovation, policy and service. This distinction can be credited, in part, to its efforts relating to global health. Inspired by a study by the University of Washington, the Duke Global Health Institute assembled a team of researchers at Duke University to quantify the global health sector's impact on North Carolina's economy. This study provides estimates based on data from 2007, which is the latest year for which complete information is available.

In this report, Duke researchers use an inclusive approach to account for economic activity generated by North Carolina's labor market, including data from non-profit organizations, academic institutions, and industry output. Global health activity, for the purposes of this report, is limited to organizations based in North Carolina that actively seek to improve health conditions and eliminate health disparities in low- and lower-middle income countries. Therefore, the study's estimates are conservative, representing a reliable "floor" of the true economic impact of global health activity in the state. Moreover, there continues to be tremendous growth in global health activity in North Carolina, which is not reflective in this report, and we expect that the total economic impact has grown substantially over the past two years.

The data have been broken down into the following three sectors: (a) for-profit, which includes private and public businesses; (b) non-profit, which includes entities that are tax-exempt, such as charitable organiza-tions and research institutions; and (c) academic, which includes the economic impact of global health research at universities statewide. Within each of these groupings, the impact of global health was measured in terms of employment, income generated, output, and tax revenue. Economic impacts were divided between direct impacts and indirect impacts. Direct impacts are the immediate effects of global health activity on a given economic region, such as labor requirements or the value of a medical procedure produced by an entity engaged in global health. Indirect impacts are the effects of global health activities on supporting industries that are necessary for or enable global health activities, such as the construction of centers and laboratories that undertake global health research.

The main study findings were as follows:

(1) In 2007 North Carolina's global health sector supported more than 7,000 jobs and $508 million in salaries and wages annually. The impact of global health on the state's economy ranged from $1.7 to $2.0 billion.

(2) The strongest contributor to global health is North Carolina's non-profit sector. Non-profit organizations, charities, and research institutions together comprised 3,400 jobs, $267 million in wages, and more than $1 billion in total business activity. One of the largest contributors is RTI International, headquartered in the Research Triangle Park, which is one of the oldest and largest science parks in North America. In 2007, RTI International received more than $216 million in grants for ongoing projects related to women's reproductive health issues, neglected tropical diseases and malaria eradication. That figure jumped sharply from $165 million in 2006.

(3) North Carolina's academic community also contributes significantly to global health, with nearly $51 million in total business activity in 2007. Duke University and the University of North Carolina at Chapel Hill account for roughly 90 percent of this sector's total impact on global health. The most significant contributors within these institutions are the UNC Gillings School of Global Public Health and the Duke Global Health Institute.

(4) Other notable considerations include the impact of North Carolina's pharmaceutical and research industries on global health. These areas represent the top two contributors within the for-profit sector, followed by medical apparatus manufacturing. Most of these companies' exports go to South Africa, Mexico, Brazil, Russia, and Turkey. In 2007, the total for-profit sector supported 3,000 jobs in global health, generated $220 million in wages, and had an economic impact of $591 million.

In general, the report's findings verify that there is a strong relationship between the state of North Carolina and the global health sector, providing thousands of jobs and economic benefit to the state while improving lives around the world. North Carolina's commitment to improving health conditions and eliminating health disparities is marked by its significant and tangible impact on global health, which continues to grow over time, and provides meaningful and lasting results for underserved populations around the world, as well as the citizens of North Carolina.

I: Introduction

North Carolina's economy has transformed itself time and time again. A state once known for tobacco production, today North Carolina houses top universities and leading international research hubs, such as the Research Triangle Park. Global health is a field in which North Carolina excels through specialized institutions such as the Duke Global Health Institute, the UNC Gillings School of Global Public Health, and various non-profit organizations, including Family Health International, RTI International and IntraHealth. Each of these groups is known for their role in discovering, developing, and promoting innovations in global health research, education, policy, and service.

Global health has become a considerable driver of economic activity in North Carolina; measuring these impacts is the primary objective of this analysis. The businesses, organizations, and educational institutions that are involved in "producing" global health are generators of economic activity, and their activities have measurable and sizable impact on North Carolina's economy. This study is timely and relevant because it examines a sector that increases in importance as North Carolina continues to strengthen its relationship with the international community. The ability to quantify the size of a sector in a community is key to realizing its value. This information is of particular relevance to policymakers as they make decisions that will affect the investment priorities and globalization of North Carolina's economy.

This report seeks to measure the economic impact of global health activities in North Carolina. Applying a rigorous quantitative analysis to measure global health activities across the state proved particularly challenging. As a result, we adhere to a conservative standard throughout the study that establishes a reliable numerical "floor" of the true economic impact of global health activity throughout the state.[2] The report is limited by a lack of available sources for data, so multiple sources were used to triangulate information and generate accurate economic impact estimates. An alternate criterion was used to estimate the economic impact (explained below) that draws a clearer picture of the relationship between North Carolina and global health. Although the estimates presented here may seem modest, they are likely underestimated.

[2] It is worth noting that the true economic impact could be much larger. Wherever there was any question, we used assumptions that lowered our estimates, which yielded a lower bound on the actual contribution to economic impact. Most studies of this sort tend to be "booster" studies that overstate a sector's contribution. This is augmented by the multiplier impact approach, which is the methodology used here and elsewhere, which does not account for "crowding out" of activities in other sectors. However, by choosing both detailed and conservative assumptions, we believe that we have avoided a positive bias in our estimates of the sector's impact.

Definition of Global Health

A working definition of global health was necessary to establish a framework for the report. For the purposes of this study, global health in the North Carolina context **is any service, production process, or good originating from North Carolina that both promotes and generates better health conditions for low- and middle-income countries abroad.** This definition is broad enough to include the production of goods and services, research and education activities that seek to eliminate diseases and health disparities, but also address programmatic goals related to nutrition, access to safe drinking water, environmental hazards, and strengthening health systems. The remainder of this paper is organized as follows: section two details the methodology and the premise behind the input-output model, as well as the approach in measuring each of the different contributors to global health. Section three presents the results, and section four offers some concluding comments**.**

II: Methodology

Inspiration for this study comes from Beyers *et al* (2007) that estimated the economic impact of global health on Washington State's economy. However, the methodology and definition was adjusted to better suit the economic landscape in North Carolina, and to align with our working definition of global health.[3] We consider the impact of activities related to global health generated within North Carolina that benefit those countries whose income levels are considered "low" and "middle-low" (LML) according to the World Bank.[4] Beyers *et al* coined this **Developing-World Health**[5]**.** Because this classification does not capture the impact of global health activities on some countries that have significant health disparities, some countries within the "upper-middle" income category were included throughout the report. This augmented selection process will be referred to as *alternate* criteria. The relationship between North Carolina's global health sector and the international community is measured by exports of goods and services that promote the improvement of health conditions. These goods range from pharmaceuticals and surgical instruments to new information technologies, diagnostic tools, and methodologies. The value of "public" goods is not measured in this data, which may otherwise include academic and technical knowledge that is disseminated by researchers, scholars, and students who are engaged in global health.

Input-Output Model:

This study measures the impact of global health on North Carolina's economy, through the input-output model, which was developed by Wassily Leontief to measure the relationships

[3] Beyers et al 2007 was the first paper that sought to measure the impact of global health using a similar methodology to ours.

[4] These countries are listed in Appendix **III**

[5] For an explanation of why we chose this criteria as the target of our study, refer to Appendix **III**

between industries through the use of one industry's output as an input to another.[6] Input-output models are generally static and cross-sectional in nature, but can be used as a national accounting tool as well as for regional economic impact analysis. The most important contribution of this model is that it captures the indirect links between industries through multipliers. For example, an increase in the demand for automobiles leads to an increase in the demand for rubber, glass, and bolts used to manufacture it.

The input-output model has several variables of interest. The first is **direct effects**, which measure the first-order impacts of industry output in monetary terms, such as wages, labor required, production output and taxes. **Indirect effects** are the impacts that industries have on each other. Continuing with the automobile example, if the automobile industry increases its production by 50% for one year, the increased demand for inputs, such as steel, aluminum, labor and rubber, would lead to increased production by these industries in response to increased demand. The economic impact of this increased output is what we refer to as "indirect effects" in this context. In the context of global health, the indirect effects would be all production centers, organizations, or institutes that contribute to the production of global health goods or services. Finally, **induced effects** are the impacts on final demands as a result of the extra-generated household income due to increased labor demand.

That being said, the input-output model has limitations. Because the multipliers depend on the state of a region's economy at a point in time, it has limited ability to compare effects of a given industry across time. Furthermore, the model ignores scarcity in that an increase in one industry's demand for inputs does not raise the price of those inputs. Finally, the model assumes there are no substitution effects between inputs since increasing the demand for inputs in one industry leads to an increase in demand for other inputs, rather than the possibility that inputs can substitute each other. Refer to Appendix II for a technical description of the input-output model, as well as more information on limitations of the model.

The major contributors to global health in North Carolina were divided into three sectors: for-profit, not-for-profit and academic. This division provides readers with a better understanding of the ways in which operational and global health contributions differ from one sector to another. The authors of this report applied the same modeling methodology to all three sectors of the economy. Unlike the University of Washington study, a "domestic global health sector" was not included in our analysis. As a result, this report does not account for government initiatives that mainly seek to improve the living conditions of those living in North Carolina.[7]

[6] Leontief, 1986

[7] While this is a large component of the Beyers et al. study, we believe that in many cases these activities actually represents a cost to the taxpayers of North Carolina, and therefore should not be included.

Data Sources:

Given the broad nature of our working definition of global health, traditional data sources, classifications, and organizational structures do not fully accommodate our data needs. Thus, the authors of this report drew from several sources to complete their analysis:

North Carolina Employment Security Commission (NCESC):

The study's authors gathered a plethora of information from the Labor Market Information Dataset. Data on employment, average wages, total wages paid, and taxable income are organized by the North American Industry Classification System (NAICS). The NAICS codes classify economic activity based on the category of output or service a particular business entity provides. This dataset was used primarily for the analysis of the for-profit sector through the selection of six-digit NAICS codes that are characterized by contributions to global health.

IMPLAN Multipliers:

To obtain valid multipliers that capture the indirect effects of the global health sector, multiplier reports from IMPLAN were used. IMPLAN is a research center based at the University of Minnesota that specializes in social accounting and regional planning research.[8] Information from North Carolina's 2007 multiplier report was used to analyze the indirect impacts for both the non-profit and for-profit sectors. IMPLAN's per-sector output data was also used for direct effects analysis. The IMPLAN multipliers utilize an industry classification system that differs from NAICS, but IMPLAN codes can be assigned to NAICS codes, allowing for the utilization of IMPLAN multipliers in conjunction with the NCESC dataset and non-profit data.

USA Trade Online:

USA Trade Online is a partnership between the U.S. Census Bureau Foreign Trade Division and STAT-USA. Data on North Carolina's exports to low- and middle-low income countries was analyzed to determine the state's share of production in the selected NAICS codes that were destined for the **Developing-World Health** sector. The data from USA Trade Online was utilized to obtain the ratio of business output that is exported to low- and middle-low income economies. Given that state export data is only available at the four-digit NAICS code level, the study's authors estimate the contribution of these exports based on the wage/labor bill ratio of the six-digit NAICS codes contained within each four-digit code.

Internal Revenue Service/The Urban Institute/GuideStar:

In order to determine which non-profit entities contributed to global health in North Carolina, the authors analyzed Internal Revenue Service (IRS) data files for all tax-exempt

[8] http://implan.com/v3/

organizations and other charitable entities. The cumulative master file, which contains a list of all registered tax-exempt organizations in North Carolina, was the starting point from which the authors compiled a list of non-profit organizations engaged in global health. The data included the organization's founding date, mission statement, overhead expenses, and activities, such as grants and sources of revenue. The more research-friendly National Center for Charitable Statistics database, created and maintained by The Urban Institute, provided in-depth information about the activities of a particular tax-exempt entity. GuideStar was also a useful resource for verification of this data.

Sector Notes

For-Profit Sector:

The first step in analyzing the impact of North Carolina's global health sector was deciding which NAICS codes accurately capture the industries that contribute to global health. The NAICS codes that would likely contain for-profit business identities that contribute to global health are presented in **Table 1**. This sector is comprised mostly of private business and other ventures that sell their output to either consumers or other producers as intermediate goods. The NAICS codes are individually checked and selected. To determine whether companies within each category are involved in global health activities, the authors collected data based on the "Corresponding Index Entries" in the 2007 NAICS system. This study focuses on codes that are representative of the pharmaceutical and medicine manufacturing and medical equipment and supplies manufacturing industries. The final list of the for-profit sector consists of 16 six-digit NAICS codes, and they are described in more detail in **Table 1**.

Additional information was obtained from each NAICS code that pertained to the number of jobs generated, average wage, annual output, output share destined for exports, and export share destined for countries whose reception of this output would make a contribution to global health.[9] To achieve this, the authors of this report multiplied the output of each NAICS code by the percentage destined for export and in particular, to LML countries.[10] This calculation yielded the percentage of output in each particular NAICS code that would be exported to low and middle-low income countries. A similar process was used to determine the percentage of labor market shares that contribute to global health.

Finally, for NAICS codes 541710 and 541720, the authors estimated a global health contribution based on an extrapolation of exports to the countries of interest in this study, after analyzing a combination of North Carolina average share of exports and the total U.S. export quantities.

The approach used for this study has several limitations. First, there is little control over the distribution of goods once the trade flows leave North Carolina and arrive to the countries of

[9] These countries are listed in **Appendix III**

[10] These percentages were available by NAICS code in the Census Bureau Foreign Trade Division.

interest. For example, the export of pharmaceuticals to low- and middle-income countries are, in part, consumed by the upper class in these countries, and therefore do not reduce health disparities as it has been defined in this report. Secondly, it is difficult to account for domestic trade flows in that North Carolina's goods are intermediate goods and eventually benefit the countries of interest as exports. Similarly, the export of North Carolina's goods to high-income countries, which were destined for LML income countries, is also not captured in impact estimates.

Table 1: For-Profit NAICS Codes Contributing to Global Health

NAICS Code	NAICS Definition
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339114	Dental Equipment and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
541710	Research and Development in Biotechnology, Physical, Engineering, and Life Sciences
541720	Research and Development in the Social Sciences and Humanities

Non-Profit Sector:

Data on North Carolina's non-profit organizations was compiled primarily from the IRS's website. The authors secured a comprehensive list of approximately 41,000 tax-exempt organizations that operate within North Carolina. From this point, the authors were able to identify which charitable entities contribute to global health, and the share of their global health-related activities.

The raw IRS database had differing degrees of information regarding each charitable entity. Several different strategies were used to identify those entities that contribute to global health. The authors of this report used codes from the National Taxonomy of Exempt Entity (NTEE), which classify non-profits by their overall purpose, in an effort to list only those that are relevant to global health. The prefixes that were used most often include E, F, G, Q, T, V and X.[11] When a particular non-profit did not have an NTEE code, another activity code was used, but this classification system is no longer being used. In the instances that a non-profit organization was classified by multiple codes, the NTEE code was used since it is considered to be more accurate, relevant, and up-to-date classification. For those non-profits that had neither an activity code nor a NTEE code, the organization's mission statement provided the author's with the information that could determine any impact on global health, if any.

One of the most formidable aspects of this task was determining how to characterize non-profits that are classified with the T prefix. These organizations include trusts, funds, and endowments, which all generate revenue through investments and other financial means and then use these capital gains to make charitable donations. There are several thousand organizations in this classification across North Carolina. This study investigates whether these particular organizations engage in any other charitable activities apart from monetary contributions that may contribute to global health activity. The authors also reviewed tax returns to determine where contributions were made. If it was determined that charitable contributions were directed at an organization that promotes global health either within or outside North Carolina, then it was included in the estimate.

Following this analysis, it was necessary to assess the magnitude of each contribution. This was particularly important for those entities that had multiple objectives in their mission statement. For example, many humanitarian organizations contribute to global health, but as part of their mission they also include educational or economic goals, which are not explicitly part of global health. For the purposes of this report, activities were only included if they obviously related to global health. For those organizations whose primary focus is global health, all revenues and operation expenses (including wages, taxes, and other expenses) were

[11] The prefixes E, F and G refer to health services. Q refers to institutions that deal with international affairs. T refers to trusts and funds with a wide variety of purposes and X refers to charitable institutions that are related to religious services. Religious non-profits generally were involved with missions abroad that sought to improve the health conditions of residents in our countries of interest.

included as economic benefits of global health. For those entities in which global health is only a part of their overall mission, those expenses were isolated from monetary contributions that were destined as global health activities, and used them to calculate the overall share of global health activities. The authors applied this share to other economic variables such as number of jobs, wages paid and taxes. This method was used most often on the global health-related monetary contributions of trusts, funds, and charities.[12]

Many organizations do not need to file tax returns. This is the case for most religious organizations, as well as for those that have less than $25,000 in gross receipts. Religious organizations were included in the list of contributors to global health, but do not contribute to the financial estimates of economic impact. Due to the underreporting of financial information, it is likely that the contribution of North Carolina's non-profit sector to global health is underestimated. This is especially true in the case of the numerous religious organizations that establish or support medical missions to developing countries. The authors attempted to include as many of these organizations as possible, given the limitations of the data. A further limitation of the data arose as a result of the inability to determine whether the expenditures on global health activities were monetary transfers abroad. This was problematic since these transfers do not generate productive economic activity in North Carolina, and likely inflate the final numbers. A complete list of non-profits is included in **Appendix IV.**

Academic Sector:

Given that global health is an interdisciplinary industry, the authors of the study encountered a lack of datasets conducive to the purpose and methodology of the research. As a result, the authors manually searched for research centers and academic units whose main research agenda pertained to global health. Data was gathered and analyzed for this section of the report based on various criteria, including research related to global health, global health courses, and initiatives of either an academic or applied nature that contribute to global health, as well as their support staff.

TABLE 2: Examples of Global Health Non-Profits in North Carolina

Charitable Institution	Activities
Research Triangle Institute Global Health Technologies Group	Malaria and HIV Research; Neglected Tropical Diseases Research; Contraceptives
Samaritan's Purse	Disaster Relief; Medical Missions
IntraHealth International	Increase Access to quality healthcare
Family Health International	Large Scale Public Health Initiatives Abroad
Ipas	Female Reproductive Rights Abroad; Sexual Health

[12] The methodology in determining which multiplier was applied, and how we classified "output" for each charitable entity is in Appendix **IV**.

Examples of such centers are the Carolina Population Center and the Duke Global Health Institute. Finally, the value of research initiatives was quantified based on the value of grants supporting them and other financial information available. Because of the limited information available in this respect, it is likely that the academic sector's contribution to global health is underreported and mainly reflects labor market impacts.

In this case, the input-output model is limited by the fact that it treats academic and research centers as it would of any other business. In this way, this model only captures the economic impact of the initial investment to create the research center, as well as operational costs such as maintenance, salaries, and capital costs. The input-output model fails to capture the "spillover effects" of academia and its output. Spillover effects are the concentrations of knowledge and research institutes that lead to other economic impacts, such as the establishments of business and entities that apply research findings produced in the geographical proximity. Silicon Valley is an example of these spillover effects. Knowledge tends to be a public good in this context, and the input-output model also fails to capture the value of this knowledge, except through the wages paid to professors and other researchers. Nevertheless, the input-output model is an adequate tool to analyze the impacts of the academic sector.

Furthermore, there is much research done in the academic sector pertaining to technologies or medical procedures that likely will contribute to global health in the future. For example, clean water technologies or medical procedures will likely benefit many people, including our population of interest in LML countries. Unfortunately, unless this research was specifically targeted at reducing the gap of access to health services in our countries of interest, we did not include these in order to maintain consistency in our approach.

Table 3: Examples of Universities Contributing to Global Health

University	Institute or Department	Sample Global Health Course
Duke University	Duke Global Health Institute	Poverty, Inequality and Health
UNC- Chapel Hill	Gillings School of Global Public Health	Globalization and Health
NCCU	Department of Nursing	Transcultural Health
Wake Forest University	WFU Baptist Medical Center	Global Bioethics
East Carolina University	Department of Public Health	Global Public Health

III: Results

For Profit Sector:

The for-profit sector in North Carolina is comprised of companies that contribute to improvements in health, reduction of health disparities, and protection against global threats that transcend national borders. The figures presented below represent the private sector's contribution to global health in the selected categories. The selected NAICS codes are arranged in Table 1 according to the following categories: Pharmaceutical Manufacturing, Diagnostic and Laboratory Instruments Manufacturing, Medical Apparatus and Instruments Manufacturing, and Research and Development.

Table 4: Global Health For-Profit Economic Impact
(Millions 2007 USD; Jobs in Units; Alternative criteria in parenthesis)

	Direct Impact	Indirect Impact	Induced Impact	Total
Output	**342.50** (392.09)	**150.10** (171.93)	**98.75** (112.56)	**591.90** (676.30)
Employment	**1,233** (1,399)	**871** (992)	**961** (1,029)	**3,066** (3,419)
Labor Income	**96.31** (108.73)	**93.40** (104.13)	**30.62** (34.73)	**220.34** (247.61)
Tax Revenue	**8.86** (9.05)	N/A	N/A	**8.86** (9.05)
Value Added	**145.49** (165.45)	**73.23** (84.05)	**56.06** (63.75)	**274.98** (313.25)

Table 5 below separates economic impacts based on several classifications of business activities, which have been separated into columns. Variables of interest are included in the first column, such as "Direct Jobs," which is the number of jobs directly generated by any particular industry in the table. As it suggests, the "Total Jobs" entry is the sum of direct, indirect and induced impacts of a particular business activity on employment. Finally, the sum of economic impacts across all business activities appears in the far right column. Based on the study's findings in Table 5, the two largest contributions are Pharmaceutical Manufacturing exports and the economic impacts of Research and Development given their large direct output and labor requirements relative to other industries. This global health sector generates $342 million in direct output and $591 million in total output, which includes both direct and indirect impacts. Tax revenue from the sales of goods as well as taxes generated through labor wages total $8.86 million. In sum, the for-profit industry generates 3,064 global health-related jobs directly, with over half from pharmaceutical manufacturing and research and development activities. These employment figures generate an estimated $96 million in wages directly to the North Carolina labor market. If the indirect and induced impacts are accounted for, North Carolina's for-profit global health sector generates $220 million in wages and an average wage of $78,000.

Table 5: Global Health For-Profit Economic Impact by Activity
(Millions 2007 USD; Jobs in units; Alternative criteria in parenthesis)

	Pharmaceutical Manufacturing	Diagnostic and Laboratory Instruments	Medical Apparatus and Instruments Manufacturing	Research and Development	Total
Direct Output	**195.25** (217.63)	**2.42** (3.66)	**47.18** (65.42)	**97.65** (105.38)	**342.50** (392.09)
Indirect Output	**97.39** (108.56)	**1.1** (1.65)	**19.05** (26.58)	**32.56** (35.14)	**150.10** (171.93)
Induced Output	**44.30** (49.39)	**0.56** (0.84)	**12.25** (16.86)	**42.14** (45.47)	**98.75** (112.56)
Total Output	**336.97** (375.60)	**4.08** (6.17)	**78.49** (108.87)	**172.35** (185.99)	**591.90** **(676.63)**
Tax Revenue	**3.76** (3.86)	**0.06** (0.07)	**1.03** (1.09)	**4.00** (4.03)	**8.86** **(9.05)**
Direct Jobs	**301** (336)	**6** (9)	**184** (253)	**742** (800)	**1,233** (1,398)
Indirect Jobs	**468** (522)	**7** (10)	**112** (154)	**284** (306)	**871** (995)
Induced Jobs	**462** (455)	**6** (8)	**111** (153)	**382** (413)	**961** (1,029)
Total Jobs	**1,232** (1,313)	**19** (27)	**407** (560)	**1,408** (1,519)	**3,066** **(3,422)**
Direct Labor Income	**37.43** (41.72)	**0.52** (0.79)	**11.10** (15.21)	**47.27** (51.01)	**96.31** (108.73)
Indirect Labor Income	**30.34** (33.82)	**0.04** (0.56)	**6.80** (9.45)	**55.88** (60.30)	**93.40** (104.13)
Induced Labor Income	**13.67** (15.24)	**0.17** (0.26)	**3.45** (5.20)	**13.00** (14.03)	**30.62** (34.73)
Total Labor Income	**81.44** (90.78)	**1.07** (1.62)	**21.67** (29.87)	**116.15** (125.34)	**220.34** **(247.61)**
Direct Value Added	**75.45** (84.10)	**0.50** (0.85)	**18.49** (25.40)	**51.05** (55.10)	**145.49** (165.45)
Indirect Value Added	**45.88** (51.14)	**0.49** (0.82)	**8.99** (12.81)	**17.86** (19.22)	**73.23** (84.05)
Induced Value Added	**25.09** (27.97)	**0.28** (0.48)	**6.85** (9.55)	**23.86** (25.75)	**56.09** (63.75)
Total Value Added	**146.42** (163.21)	**1.27** (2.15)	**34.33** (47.76)	**92.77** (100.07)	**274.98** **(313.25)**

In this case, the indirect impacts follow the same pattern as direct impacts relative to the extent that various business activities contribute to global health. The only exception is the manufacturing of Medical Apparatus and Instruments, which surpasses the research industry as

the second-largest contributor. In terms of value added, which includes employment compensation, proprietary income and indirect business taxes of supporting industries, global health generates $145 million. This leads to a total of $275 million in value added across direct, indirect, and induced impacts.

If the alternate criteria are used, the same patterns are present. Research and pharmaceuticals are the driving force behind global health impacts, followed by medical apparatus manufacturing. One trend to note is that in the alternative criteria, the economic impacts of surgery and other medical manufactures rise dramatically, suggesting a high demand in these alternate countries for these products. The largest global health products manufactured or originated in North Carolina are exported to Brazil, Mexico, South Africa, Russia and Turkey.

Non-Profit Sector:

The data indicates there are at least 125 North Carolina-based non-profit and charitable institutions that contribute to global health, or 137 organizations if an alternate criterion is also included in the estimate. The variance in size and type of activity between organizations is vast. The study analyzed financial data on 99 (110) non-profit organizations, in which 33 (38) of them have paid employees as direct contributors to the organization. The remainder of these institutions have labor requirements, and are either largely volunteer-run, or satisfy their labor requirements through contractors or affiliated organizations. As a result, these organizations contribute to the economy through overhead expenditures and other inputs required to operate. These impacts are summarized in the following table:

Table 6: Global Health Non-Profit Economic Impact
(Millions 2007 USD; Jobs in Units; Alternative criteria in parenthesis)

	Direct Impact	Indirect Impact	Induced Impact	Total
Output	**587.63** (725.89)	**203.45** (249.70)	**250.12** (309.73)	**1041.20** (1,285.32)
Employment	**1,640** (1,783)	**1,398** (1,499)	**458** (499)	**3,496** (3,791)
Labor Income	**120.24** (130.28)	**70.08** (86.00)	**77.16** (95.55)	**267.48** (311.68)
Tax Revenue	7.66 (8.42)	N/A	N/A	**7.66** (8.42)
Value Added	**298.35** (370.54)	**112.58** (137.95)	**141.64** (175.40)	**552.57** (683.90)

The economic activity that is directly generated by non-profit global health activity is estimated to be $587 million. Furthermore, the non-profit sector generates an additional $453 million in output through its indirect impact on supporting industries. Non-profit global health activities account directly for 1,640 jobs in North Carolina, and an additional 1,856 jobs if indirect and induced effects are considered. Non-profit global health activities pay a total of

$120 million in wages, with an average wage of $73,298. This, however, excludes monetary equivalents of other benefits associated with employment. Alternative impacts follow a similar pattern and are included in parentheses in the table above. The high average wage is largely driven by the composition of our sample.

The largest contributors to global health are RTI International, Family Health International, Ipas, and IntraHealth, which all demand skilled labor, and therefore have higher average wages. In the case of non-profit organizations whose wages are lower, the data are limited or absent, and therefore, have a small impact on measures of the average. This includes mission groups, committees and grassroots-level organizations. Nevertheless, this suggests that North Carolina's global health sector has extensive skilled labor requirements. Global health activity within this sector generates $552.57 million through value added impacts, which include employment compensation, proprietary income, and indirect business taxes of supporting industries. Global health non-profits generate tax revenue through two sources: payroll taxation and excise taxes. Payroll taxation accounts for about 60% of non-profit tax revenue, which in 2007, was an estimated $7.6 million in total tax revenue for North Carolina that originated from non-profit global health organizations.

In Table 7, charitable organizations are divided by the nature of their activity. The *Funding and Organizational Support* category includes charitable organizations that provide financial support to other organizations. *Global Health Research* refers to those non-profits that research global health through scientific and social science approaches. The *Religious Organizations* category is comprised of denominational organizations that generally fund and organize health missions abroad, providing short-term medical relief or infrastructure development related to global health. *International Development* contains those non-profits that focus their efforts on making a long-term impact on global health through the establishment of health clinics or community-run projects. Finally, the *International Relief* category is composed of grass-roots organizations that are engaged in medical missions or other health relief efforts that are non-religious in nature and are mainly short-term (although recurring) projects.

When the impacts of nonprofit organizations are broken down by activity, as in Table 7, it is clear that global health research activities dominate the non-profit sector. Research activities account for a large majority of both direct and indirect output, with roughly 85% of direct output and 75% of direct jobs. The second largest contributors are *International Development* and *International Relief Efforts*, which account for about 12% of direct output and 23% of direct jobs. Religious organizations represent a remarkably small segment of this economic sector, but this is largely because these organizations are not required to file taxes. Therefore, it is likely the *Religious Organizations* category is grossly underestimated.

Table 7: Global Health Non-Profit Economic Impact by Activity
(Millions 2007 USD; Jobs in Units; Alternative criteria in parenthesis)

	Funding & Monetary Support	Global Health Research	Religious Organization	International Development	International Relief	Total
Direct	1.66	510.40	0.46	33.70	41.40	**587.91**
Output	(1.66)	(647.30)	(0.96)	(34.00)	(41.95)	(725.80)
Indirect	0.62	170.20	0.18	14.57	17.91	**203.48**
Output	(0.62)	(212.00)	(0.38)	(14.70)	(18.15)	(245.85)
Induced	0.69	220.27	0.18	13.00	15.98	**250.12**
Output	(0.69)	(264.61)	(0.37)	(13.11)	(16.19)	(294.97)
Total	2.97	900.88	0.83	61.28	75.28	**1,041.24**
Output	(2.97)	(1,123.91)	(1.72)	(61.82)	(76.29)	**(1,266.65)**
Tax	0.20	6.06	.05	.70	0.69	**7.70**
Revenue	(0.20)	(6.81)	(.10)	(.70)	(.69)	(8.50)
Direct	5	1,246	5	184	200	**1,640**
Jobs	(5)	(1,384)	(9)	(185)	(201)	(1,785)
Indirect	7	1,181	1	127	82	**1,398**
Jobs	(7)	(1,275)	(3)	(128)	(84)	(1,496)
Induced	1	378	1	35	43	**458**
Jobs	(1)	(417)	(1)	(36)	(44)	(498)
	13	2,805	7	345	325	**3,496**
Total Jobs	(13)	(3,076)	(12)	(349)	(328)	**(3,778)**
Direct						
Labor	0.25	97.50	0.08	10.01	12.35	**120.19**
Income	(0.25)	(107.44)	(0.15)	(10.03)	(12.45)	(130.32)
Indirect						
Labor	0.21	58.65	0.06	5.00	6.15	**70.07**
Income	(0.21)	(72.63)	(0.13)	(5.04)	(6.24)	(84.25)
Induced						
Labor	0.21	67.96	0.05	4.01	4.93	**77.16**
Income	(0.21)	(81.64)	(0.12)	(4.05)	(5.00)	(91.02)
Total						
Labor	0.67	224.11	0.19	19.02	23.48	**267.48**
Income	(0.67)	(261.70)	(0.41)	(19.12)	(23.68)	**(305.58)**
Direct						
Value	0.80	266.88	0.23	13.68	16.77	**298.36**
Added	(0.80)	(347.90)	(0.44)	(13.80)	(17.00)	(379.94)
Indirect						
Value	0.35	93.37	0.10	8.42	10.34	**112.58**
Added	(0.35)	(116.40)	(0.23)	(8.50)	(10.48)	(135.96)
Induced						
Value	0.39	124.73	0.10	7.36	9.05	**141.63**
Added	(0.39)	(149.82)	(0.21)	(7.43)	(9.17)	(167.02)
Total						
Value	1.53	484.99	0.44	29.46	36.17	**552.59**
Added	(1.53)	(614.13)	(0.89)	(29.73)	(36.65)	**(682.92)**

The additional economic impact associated with select upper-middle income countries, based on alternative criteria, is attributable to global health research and international

development activities. Similar to the for-profit sector, Mexico, Brazil, South Africa and Russia are the main drivers of economic impact in North Carolina, representing over 60% of the total impacts.

Academic Sector:

The labor market represents the primary source of economic impact in the academic sector through faculty and staff positions which directly support global health activities. Due to limited information that clearly defines which academic institutions contribute to global health, the research team collected data based on public information, which included faculty websites, departmental information, curriculum vitas and other methods. Table 8 indicates that 411 people were employed by several universities in North Carolina, and were actively contributing to global health. From those 411 jobs, 202 were academic in nature, and the other 209 positions represented support staff from departments or research institutes that work in global health. The indirect and induced impacts of the academic sector support an additional 170 jobs across the state.

Global health academic activities generate an estimated $29 million in output. The overhead required to run these institutes generates another $10 million in support industries, as well as $11 million in demands generated by the wages of these support industries. This totals an estimated $51 million in output. In all, the academic sector's global health activity generates an estimated $21 million in wages. The average wage in supporting industries is $36,042. Finally, global health academic activities stimulate North Carolina's economy through value added impacts of $15.3 million in direct effects, and $12 million in indirect and induced impacts. When applying the alternate criteria, global health impacts rise by roughly $4 million, which generate an additional 46 jobs. The increased economic impact is moderate, due in part, to country overlap. Many faculty members work in multiple countries, and therefore, the economic impact of some global health research was counted in the initial country-selection standard.

Table 8: Global Health Academic Economic Impact
(Millions 2007 USD; Jobs in Units; Alternative criteria in parenthesis)

	Direct Impact	Indirect Impact	Induced Impact	Total
Output	**29.55** (31.92)	**10.43** (11.27)	**10.97** (11.85)	**50.95** (54.01)
Employment	**411** (444)	**70** (75)	**100** (108)	**581** (627)
Labor Income	**14.92** (16.12)	**2.68** (2.90)	**3.38** (3.65)	**20.99** (22.68)
Tax Revenue	**1.68** (1.83)	N/A	N/A	**1.68** (1.83)
Value Added	**15.38** (16.62)	**5.81** (6.27)	**6.21** (6.71)	**27.40** (29.61)

Global health impacts are not exclusive to employment and output. Courses taught in several universities across North Carolina generate sizable sources of revenue for these universities, and serve to increase the interest and awareness of global health.[13] There are at least 112 courses related to global health (as identified by the course title alone) across all universities in North Carolina. There are likely many more courses that contain global health content or curricula. These figures are noteworthy and the related economic impacts are captured in the data above as direct academic global health output.

IV: Concluding Remarks

In 2007, economic output generated by global health across all sectors (for-profit, non-profit, and academic) is approximately $1.7 billion (or $2 billion using the alternative criteria). These figures are more modest that those found by Beyers *et al*., which found global health activity in Washington State to be $4.1 billion. This result is surprising, given that North Carolina is a larger state in both economy and population (9 million versus 6.5 million people and $390 versus $310 billion in 2007) than Washington State.[14] The authors attribute this difference to the "domestic global health sector" that was not part of this study. If we only consider Beyers *et al*'s "Developing World Health" sector, the impact on North Carolina's economy is comparable with Washington State (see Appendix VII for a more detailed explanation). This is important to note given that the methodology in this study takes a much more conservative approach in its economic estimates. Aside from the "domestic global health sector," the pattern of economic impact is similar for both states across the profit, non-profit, and academic sectors, as well as in labor market variables.

North Carolina's exports to low and middle-low income countries account for 19.5% of all state exports. To put this into perspective, North Carolina's exports to Canada are 24.4% of exports. Low and middle-low income countries represent only 8 of North Carolina's top 25 trading partners. This fact highlights the impressive contributions of the non-profit global health sector, given that North Carolina's commercial exports are limited in quantity and value.

One of the most impressive results from this study is the impact of the non-profit sector on global health. The largest contributor is RTI International, housed in the Research Triangle Park, which is one of the countries' largest science parks. RTI International has ongoing projects such as women's reproductive health issues, neglected tropical diseases and malaria eradication, which collectively received over $216 million in grants (representing 35% of their total revenue) from USAID in 2007. That figure is up from $165 million in 2006. Following RTI International's lead, Family Health International and Ipas are the second largest non-profit contributors to global health.

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[13] For a complete list of courses taught in universities across North Carolina, please refer to appendix V

[14] Populations estimate based on the Census Bureau. Nominal GDP figures provided by the Bureau of Economic Analysis

Academic institutions across North Carolina also have a significant economic impact on global health. Duke University and University of North Carolina at Chapel Hill represent roughly 90% of the state's global health activity in this sector. The Gillings School of Global Public Health at UNC and the Duke Global Health Institute are the two most significant contributors. The estimates in this study, however, fail to identify faculty members whose research addresses domestic health. The data also does not reflect academic institutions that contribute to global health today, but had not done so in 2007, or do not identify global health as their primary research agenda on public documents. Therefore, the numerical impacts of the academic sector are likely understated due to data limitations and measuring constraints.

The global health sector is a significant and growing industry in North Carolina, and it continues to increase in relevance and economic impact. The report's findings verify that the global health sector provides thousands of jobs and economic benefit to the state while working to address critical health challenges around the world. North Carolina's commitment to improving health conditions and eliminating health disparities is marked by its significant and tangible investment in global health, improving the lives of underserved populations around the world, as well as the citizens of North Carolina. The results of this economic impact analysis demonstrate the prominence – and promise – of the global health sector and suggest that North Carolina is once again transforming its economic landscape to reflect the importance of our global connections worldwide.

How do these impacts compare to North Carolina's economy as a whole? Global health is a modest, but growing, sector of the state economy. In 2007, North Carolina was the ninth largest economy in the United States, with a state GDP of $400 billion and exports to LML countries of 4.6 billion dollars. Exports to LML countries accounted for about 20% of North Carolina's total exports across all goods and services. North Carolina's labor force is composed of approximately 5.4 million workers out of a total population of 9.06 million people. The income per capita in North Carolina is an estimated $34,952, thus making global health employment a higher-paying sector on average.

In our NAICS codes of interest within the for-profit sector, North Carolina employs approximately 55 thousand people, with approximately 21 billion dollars of direct output. Within these, global health contributes over 3,000 jobs and $590 million dollars of output. The non-profit sector presents a different story, as it is composed by some of the largest entities in the state, as has been mentioned above. Finally, global health contributes approximately 600 jobs in the academic sector, out of a total of 44,000 jobs, but this last figure includes teaching jobs in junior colleges and universities, and thus does not reflect the smaller number of academic jobs in the state. This sector contributes 3 billion dollars to North Carolina's economy, out of which we only attribute $50 million to global health using our conservative standard. Thus, global health is a modest subset of these industries within North Carolina. This is not surprising, as our approach throughout this paper has been a conservative one, and there is

evidence that the trend of growth in global health activities has since grown.

V: Appendix and References

Appendix I: Global Health NAICS codes

Total List of NAICS Codes Used in For-Profit and Non-Profit Sectors (Base Criteria)

NAICS Code	Description	Amount of Activities in GH
325411	Medicinal and Botanical Manufacturing	1.58%
325412	Pharmaceutical Preparation Manufacturing	1.58%
325413	In-Vitro Diagnostic Substance Manufacturing	1.58%
325414	Biological Product (except Diagnostic) Manufacturing	1.58%
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	1.41%
334516	Analytical Laboratory Instrument Manufacturing	1.41%
334517	Irradiation Apparatus Manufacturing	1.41%
339112	Surgical and Medical Instrument Manufacturing	2.07%
339113	Surgical Appliance and Supplies Manufacturing	2.07%
339114	Dental Equipment and Supplies Manufacturing	2.07%
339115	Ophthalmic Goods Manufacturing	2.07%
339116	Dental Laboratories	2.07%
541710	Research and Development in Biotechnology, Physical, Engineering, and Life Sciences	2.78%
541720	Research and Development in the Social Sciences and Humanities	2.78%
813211	Grantmaking Foundations	Individually Selected
813212	Voluntary Health Organizations	Individually Selected
813219	Other Grantmaking and Giving Services	Individually Selected
813311	Human Rights Organizations	Individually Selected
813312	Environment, Conservation and Wildlife Organizations	Individually Selected
813319	Other Social Advocacy Organizations	Individually Selected
813410	Civic and Social Organizations	Individually Selected

Appendix II: Input-Output Model Technical Notes

Input-Output Model:

The input-output model is based on the linkages between industries in a given context. The model can represent a municipality, economic region, or an entire nation. The model's main elements include transaction tables, direct requirement tables and total requirement tables. Transaction tables measure (in monetary value) the transactions between industries. These transactions are the purchasing of industry *j's* output as an input of production for industry *i*. Direct requirement tables contain the amount of inputs (measured in monetary values) from industry *i* to industry *j,* divided by the total value of inputs for industry *j*. Thus, element a_{ij} of the table measures the value of inputs of the ratio of industry *i's* output for each extra monetary unit of output industry *j* produces. The sum of all the column elements (all inputs from other industries into industry *j*) will be equal to one. Finally, the total requirements table is composed of a series of coefficients that measure the direct and indirect (and in some cases the induced) effects of an extra dollar of production by industrial sector, depending on the type of multiplier used.

The basic model has two balance equations that satisfy a given level of output:

(1) N=AY

where N is the vector that contains intermediate demand for each industry's output. A is the matrix of coefficients from the direct requirements table, and Y is the vector of total output by industry.

(2) Y=N+D

where D is the vector of final demand per industry. We can substitute (1) into (2), resulting in (after some re-arranging):

Y = AY+D
D = Y-AY
D = Y(I-A)

(3) Y =D (I-A)-1

the element (I-A)-1 is known as the Leontief Inverse matrix, which is composed of the total requirements multipliers. These multipliers, when added by columns, represent the economic

impact of an additional monetary unit of output in that specific industry.

The finalized identity is as follows:

$$(4)\ \Delta Y=\Delta D\ (I-A)^{-1}$$

Some of the limitations of the I-O model are the following:

1. The model assumes perfect supply elasticity. Changes in demand for inputs have no effect on prices of inputs, and thus do not take into account scarcity or demand effects on price. Thus, the model does not accommodate market power or the ability to substitute between inputs when prices change.
2. The coefficients lose explanatory power when used for years that are distant from the modeled year. This generates the need for constant re-estimation of coefficients, a task that tends to be arduous.
3. Generally, I-O models include induced effects, which are the impacts of labor income, but they do not include government expenditures.
4. The I-O model gives us an estimate for changes in demand based on the state of a region's economy at a particular point in time, and therefore, is limited to inter-temporal comparisons.

Appendix III: Definition and List of "Developing-World Health" Countries

List of Countries Included in Global Health

Afghanistan	Congo, Dem Rep	Iran	Mozambique	Swaziland
Albania	Congo, Rep	Iraq	Myanmar	Syrian Arab Rep.
Algeria	Cote D'Ivoire	Jordan	Namibia	Tajikistan
Angola	Djibouti	Kenya	Nepal	Tanzania
Armenia	Dominican Rep	Kiribati	Nicaragua	Thailand
Azerbaijan	Ecuador	Korea, Dem Rep	Niger	Timor-Leste
Bangladesh	Egypt	Kyrgyz	Nigeria	Togo
Benin	El Salvador	Lao PDR	Pakistan	Tonga
Bhutan	Eritrea	Lesotho	Papua N. Guinea	Tunisia
Bolivia	Ethiopia	Liberia	Paraguay	Turkmenistan
Bosnia Herzegovina	Gambia	Macedonia	Peru	Uganda
Burkina Faso	Georgia	Madagascar	Philippines	Ukraine
Burundi	Ghana	Malawi	Rwanda	Uzbekistan
Cambodia	Guatemala	Maldives	Sao Tome and Principe	Vanuatu
Cameroon	Guinea	Mali	Samoa	Vietnam
Cape Verde	Guinea-Bissau	Marshall Islands	Senegal	West Bank/Gaza
Central African Rep	Guyana	Mauritania	Sierra Leon	Yemen
Chad	Haiti	Micronesia	Solomon Islands	Zambia
China	Honduras	Moldova	Somalia	Zimbabwe
Colombia	India	Mongolia	Sri Lanka	
Comoros	Indonesia	Morocco	Sudan	

The research team considered other methods that establish the countries that would be the target of the study. The Human Development Index (HDI) and the IMF country classification were alternatives, but the team chose the World Bank's definition and classification. HDI was not used because it is difficult to interpret due to the factors that influence the index and their weights. The authors decided against IMF's classification because there are fewer thresholds of classification, and the majority of countries are in the middle category of "Emerging and Developing" economies (not least developed). Therefore, this method would not have accounted for certain countries that are developing, but are industrialized. The method chosen for this study, the World Bank Country Classification, avoids those issues because of its four categories of income.

The authors of this study also compiled several indicator statistics from the World Health Organization related to health, such as infant mortality rate, access to health care, wealth inequality, HIV prevalence and life expectancy at birth to determine which upper-middle income countries face severe health issues. The assumption is that global health economic activity produced in North Carolina will also benefit these specific countries in much the same way as LML countries.

The countries selected are:

Alternative Criteria Countries:

Belize	Botswana	Brazil	Dominica	Fiji
Gabon	Grenada	Jamaica	Lebanon	Mexico
Russia	South Africa	Suriname	Turkey	

Appendix IV: Non-Profit Technical Notes

Treatment of Non-Profit Output

The vast majority of the non-profits in the study do not have "traditional output." When applying output multipliers, researchers use the value of a production unit as measured by its monetary value, which is derived from the manufacturers' price or the market price. Non-profit institutes generally do not have revenue in this sense; revenue comes from charitable donations, membership dues or fund-raising activities. Therefore, a non-profit's revenue is not an accurate measure of its "output," especially when revenue is utilized in other ways that do not contribute to global health. Most of these charitable entities can be divided into one or more of the following categories:

Research Institutes: Examples include RTI, Ipas and Family Health International

Financial Support: Funds designated to generate income through investment activity, which are then distributed as charitable contributions. Most of these funds have guidelines for how to use them, but they tend to donate to a wide variety of institutions.

Missions: These are groups that primarily travel abroad on voluntary medical missions to underdeveloped countries.

While it is possible to quantify the cost of producing research, it is very difficult to quantify the value of research produced. A similar problem arises when valuing the services provided by the non-profits of interest. There is simply no information on the value of each service in each location where the service is provided. If there were reasonable estimates for value, it wouldn't be necessary to calculate the number of procedures or services provided.

Therefore, the expenditures on global health-contributing activities were measured as a non-profit's output. This approach, while limited, is the most reasonable one to use, given the severe limitations of data. The monetary expenditures of each non-profit can help determine the impact of the global health sector in North Carolina by applying the appropriate multiplier to each organization. Note that pure "pass-throughs" (fund-raising activities to support health efforts overseas – both funds raised and expenditures) are not included in this study's measure of global health.

Appendix V: List of Global Health Charitable Organizations

Table: Global Health Charitable Organizations in North Carolina

Name	Activity	Name	Activity
African Aids Prevention And Medical Assistance Foundation	AIDS Research	**Hope For Haiti Foundation**	International Development
African Community Economic Development Corporation	Economic Development	**Hope For You International Ministries**	International Relief
African Medical Mission Inc	International Development	**Hope International Ministries**	Emergency Assistance
Alodo Alome Inc	International Relief	**Horizon International Services**	Malnutrition Elimination
Amani Children's Foundation	Aids Research	**International Services Assistance Fund**	International Health Development
Bangladesh Medical Association Of North America	Medical Disciplines	**Ipas**	International Development
Barry Charitable Foundation Inc	Private Grantmaking Foundation	**Jamkhed International North America**	Professional Society
Bin Charitable Foundation	Private Independent Foundation	**Jarrell Snipes Foundation**	Private Grantmaking Foundation
Bonjour Africa Projects Inc	Humanitarian Service	**Jerry R. Licari Foundation**	Private Grantmaking Foundation
Boundless Hope USA Inc	International Relief	**Joan and Robert Huntley Charitable Foundation**	Named Trust
Branches Of The Vine	International Relief	**Kate B Reynolds Charitable Trust**	Private Independent Foundation
Bridge To The Nations	International Relief	**Kurtz Family Foundation**	Private Grantmaking Foundation
Bukavu Foundation	International Development	**Kybele Inc**	Reproductive Health Care
Burroughs Welcome Fund	Private Grantmaking Foundation	**Lake Norman Children's Relief Inc**	International Relief
Carolina For Kibera Inc	Advocacy/Humanitarian Service	**Latin America Mission Project Inc**	International Development
Cary Oil Foundation Inc	Private Independent Foundation	**Lawrence and Sandra Davis Family Foundation Inc**	Private Independent Foundation
Center For Health Economics Research Inc	Social Science Research	**Life For Africa Inc**	International Development
Chara Inc	Public Foundation	**Lifewater Medical Ministries**	International Relief
Children Of Vietnam	International Relief	**Lomax Family Foundation**	Private Independent Foundation
Chilonga Health Care Foundation	Single-Organization Support -Healthcare	**Lumiere Medical Ministries Inc**	International Development
Christian Mission Of Central Honduras Inc	Christian-Based Relief Organization	**Mark Muirhead Ministries Inc**	Christian-Based Relief Organization
Chromosome 22 Central	Birth Defects And Genetic Diseases	**Marrow Match Foundation Inc**	Health Support
Compassion For Africa Ministries	International Relief	**Mercy International**	International Development

Compassion Med International Inc	International Relief	**Mercy Mission Teams Inc**	International Relief
Concern For Humanity	Humanitarian Service	**Ministry Of Hope Inc**	International Development
Concord Baptist Church	Protestant-Based Relief Organization	**Mission Haiti Inc**	International Relief
Cooperacion Ortopedica Americano Nicaraguense	International Relief	**Mission Manna**	International Development
Cross Link Mission	International Relief	**Mission Ukraine Children's Hope**	Primary Health Care
Crutchfield Family Foundation	Private Independent Foundation	**Missions 4 Jesus Inc**	Christian-Based Relief Organization
Curamericas Global Inc	International Development	**Natural Products & Glycotechnology Research Institute**	Biological Research
Donald D. Lynch Family Foundation	Named Trust	**North Carolina Biotechnology Center**	Biological Research
DW And Ruth Brooks Foundation	Private Independent Foundation	**North Carolina GlaxoSmithKline Foundation**	Private Grantmaking Foundation
Equip Inc	Protestant-Based Relief Organization	**Open Door Missions International**	International Development
Family Health International	International Health Development	**Organization Of Christian Ministries Inc**	Christian-Based Relief Organization
First Assembly Of God	Protestant-Based Relief Organization	**Paramedics For Children Inc**	International Relief
First Haitian Wesleyan Church	Protestant-Based Relief Organization	**Pathway Ministry**	Christian-Based Relief Organization
Freedom Christian Center	Christian-Based Relief Organization	**Pathways International NC Inc**	International Relief
From Hunger To Harvest Inc	International Relief	**Project Health For Leon**	International Development
Front Street Christian Church	Christian-Based Relief Organization	**Purposeful Path**	International Relief
Full Belly Project Ltd	International Agricultural Development	**Research Triangle Institute**	General Scientific Research
Gail And Harry Grim Foundation	Private Grantmaking Foundation	**Samaritans Purse**	International Relief
George And Jane Pfaff Family Foundation	Federated Giving Program	**Seed Programs Inc**	International Agricultural Development
Glimpse Of Hope Inc	International Development	**Servants International Inc**	International Development
Global Children Outreach	International Development	**Small World Foundation Inc**	International Development
Global Church Mission Inc	Christian-Based Relief Organization	**Softly International Inc**	Humanitarian Service
Global Hope Peace & Health Inc	International Relief	**Sol International Foundation Inc**	International Relief
Global Ministries	International Relief	**Stop Hunger Now Inc**	International Relief
Global Vaccines Inc	Voluntary Health Association	**Support Africa Organization**	International Relief
Haiti Fund Inc	International Development	**The Center For Conflict Relief And Reconstruction**	International Development
Halifax Organization For Economic Development	Economic Development	**The Family Health International Foundation**	International Development
Hands Of Compassion Inc	Humanitarian Service	**The National Cancer Coalition Inc**	International Health Development
Hands Of Compassion International	International Health Development	**The Nyanya Project**	International Agricultural Development

Hannah's Hands International Inc	Humanitarian Service	**Touch The World Ministries Inc**	Christian-Based Relief Organization
Hasten International Inc	International Relief	**Triangle Results**	Malnutrition Elimination
Health Guidance Center Foundation	Single-Organization Support -Healthcare	**Trinity Children Inc**	International Development
Health Research Foundation Inc	Research Institute And Public Policy Analysis	**Ukraine Challenge International Inc**	Christian-Based Relief Organization
Hearts And Hands For Haiti	Heart And Circulatory Diseases	**Vision Nicaragua**	International Relief
Hearts With Haiti Inc	International Development	**Voice Of Love Foundation**	International Relief
Helping Hands Ministry Inc	International Development	**Workers In The Harvest International**	Malnutrition Elimination
Hi-Cap Nepal Inc	International Development	**World Harvest Missions Inc**	International Relief
Highlands Bolivian Mission Inc	International Relief	**Yeshua Medical Ministries Inc**	International Relief
Hope Community Church Inc	Christian-Based Relief Organization	**Z Smith Reynolds Foundation Inc**	Private Grantmaking Foundation
Correll Ministries	Christian-Based Relief Organization	**Renewed Hope Medical Mission**	Christian-Based Relief Organization
Global Baptist Gospel Project Mission	Baptist-Based Relief Organization	**African Rising**	Private Grantmaking Foundation
Staff of Hope	International Relief	**The Water Project**	International Development
Help Africa Fund	International Relief	**Gethsemane International**	Private Grantmaking Foundation
Light of Stanley Foundation	International Relief	**Children of Chernobyl**	International Relief
International Partnerships	International Development	**Bridge to Turkiye Fund**	International Relief
American Belarussian Relief Foundation	International Relief	**Intrahealth International**	International Development

Appendix VI: Global Health Courses

Table: Sample Courses and Curricula in Global Health

Name of Course/Research Project	Department
Duke University:	
Ethnicity, Culture, and Family Processes	African and African American Studies
Poverty, Inequality and Health	African and African American Studies
Darfur	African and African American Studies
AIDS and other Emerging Diseases	Biology
AIDS and other Emerging Diseases: Focus on Kenya	Biology
Global Diseases	Biology
General Microbiology	Biology
Design for People With Disabilities	Biomedical Engineering
Electronic Design for the Developing World	Biomedical Engineering
Design for the Developing World	Biomedical Engineering
Comparative Approaches to Global Issues	Cultural Anthropology
Medical Anthropology	Cultural Anthropology
Anthropology and Psychology	Cultural Anthropology
Global Health and Human Rights: Perspectives on Suffering	Cultural Anthropology
Global Health, Human Rights & the Ethics of Engagement	Cultural Anthropology
Economic Growth and Development Policy	Economics
Development Economics	Economics
Economics and Policy of International Health	Economics
Economics of Global Health	Economics
Applied Methods in Health Care	Economics
Environmental Chemistry and Toxicology	Environment
Science and Politics of Natural Catastrophes	Environment
Natural Catastrophes: Rebuilding from Ruin	Environment
Health/Ecology Risk Assessment	Environment
Environmental Health	Environment
Resource Environmental Policy	Environment
Environmental Toxicology	Environment
Interventions in Global health	Global Health
Special Topics in Global health	Global Health
Chubby History: Obesity and Public Health	History
Epidemic Disease in the 20th Century	History
Cross-Cultural Challenges to Medicine in the 21st Century	Interdisciplinary Studies
Issues of Healing in the Developing World and the Care of the Underserved: A Medical and Theological Perspective	Interdisciplinary Studies
Virology and Viral Oncology	Molecular Genetics and Microbiology
Microbial Pathogenesis	Molecular Genetics and Microbiology
Human Rights at Home and Abroad	Political Science
Comparative Approaches to Global Issues	Political Science
Comparative Health Care Systems	Political Science
Gender and International Relations	Political Science

Science and Politics of Natural Catastrophes	Public Policy Studies
Natural Catastrophes: Rebuilding from Ruin	Public Policy Studies
Comparative Health Care Systems	Public Policy Studies
Health, Science, and Human Rights	Public Policy Studies
Social Dynamics of Global Health	Public Policy Studies
Globalization and Health Equity	Public Policy Studies
Understanding and Assisting Development in the Third World	Public Policy Studies
Gender and Globalization	Public Policy Studies
Health Policy in Developing Countries	Public Policy Studies
Gender and Globalization	Public Policy Studies
Economic Analysis of Development	Public Policy Studies
Nation, Region and Global Economy	Sociology

University of North Carolina Chapel Hill	
West Africa: Society and Economy in the Twentieth Century	African American Studies
The Anthropology of Gender, Health and Illness	Anthropology
Medicine and Anthropology	Anthropology
Kinship, Reproduction, Reproductive Technologies and the New Genetics	Anthropology
Seminar in Medical Anthropology	Anthropology
Seminar on the Anthropological Contributions to the Understanding of Medical Systems	Anthropology
Transcultural Psychiatry	Anthropology
Global health	Anthropology
Gender, Sickness and Society	Anthropology
Seminar on Anthropological Perspectives on Latin America	Anthropology
Health Economics for Developing Countries	Economics
Emerging and Re-Emerging Infectious Diseases	Epidemiology
Methods in Infectious Disease Epidemiology	Epidemiology
Mathematical Modeling of Infectious Diseases	Epidemiology
Control of Infectious Diseases in Developing Countries	Epidemiology
Epidemiology of HIV/AIDS in Developing Countries	Epidemiology
Environmental Epidemiology	Epidemiology
Infection/Inequality	Epidemiology
Global Health Ethics Seminar	Epidemiology
Water and Sanitation: Planning and Policy in Developing Countries	Environment
Water Policy in Lesser Developed Countries	Environment
Global Water, Sanitation and Hygiene	Environment
Medical Geography	Geology
Geography of Health Care Delivery	Geology
Global Health and Community Solutions	Health Policy and Administration
Health Policy and Practice in Latino Populations	Health Policy and Administration

Global Perspectives on Ethical Issues in Health Policy and Management	Health Policy and Management
Theory and Practice of Health Policy and Administration	Health Policy and Management
Public Health Issues in Community Preparedness and Disaster Management	Health Policy and Management
Economics and Behavior of the International Pharmaceutical Industry	Health Policy and Management
International and Comparative Health Systems	Health Policy and Management
Management of Foreign Aid in Health and Population	Health Policy and Management
International Cooperation in Health and Population	Health Policy and Management
Globalization and Health	Health Policy and Management
Health Economics for Policy and Administration	Health Policy and Management
Health Economics Laboratory	Health Policy and Management
Evaluation & Planning of Primary Care Interventions in Developing Countries	Maternal and Child Health
International Family Planning and Reproductive Health	Maternal and Child Health
Maternal and Child Health Issues for Immigrant Populations	Maternal and Child Health
Survey Course on Optimal Infant and Young Child Feed	Maternal and Child Health
Issues in International Maternal and Child Health	Maternal and Child Health
Global health Service Learning to Increase Understanding of Migrant Latino Health	Nursing
International Nutrition	Nutrition
Interdisciplinary Perspectives in Global Health	Public Health Leadership
AIDS: Principles, Practice and Politics	Public Health Leadership
Global Health Discussion Series	Public Health Leadership
Interdisciplinary Perspectives in Global Health	Public Health Leadership
Cultural Competencies of Health Organizations	Public Health Leadership
Environment and Work in the Global Economy	Public Policy
Sociology of Mental Health Illness	Sociology
Medicine and Society	Sociology
Medical Sociology: Health, Illness and Healing	Sociology
The International Politics of Sexual and Reproductive Health	Women's Studies
North Carolina Central University	
Community Health	Health Education
Foundations for Public Health	Health Education
Foundations for Public Health II	Health Education
University of North Carolina A&T	
Global Health and Socio-Economic Development	University Studies
Wake Forest University	
Medical Anthropology	Anthropology

Global Bioethics	Bioethics
East Carolina University	
Public Health: Global Course	Public Health

Appendix VII: Deviations and Comparison with Beyers et al.

A key finding in this study is North Carolina's economic impact on global health relative to Washington State and the *Beyers et al* study from the University of Washington. Washington State's global health activity represents a larger portion of its economy, yet North Carolina is more populous and has a larger economy. The research team attributes this difference to the following three factors of this report: 1) it does not include a "Domestic Global Health" sector; 2) a more conservative methodology was used; and 3) there were a considerable amount of limitations with regards to data sources.

The most notable difference between the studies is the "Domestic Global health" sector. Beyers *et al* includes this sector in their methodology because they consider the international immigrants who reside in Washington State to directly benefit the state's health standard. The authors of this study did not include this sector for various reasons. First, it is difficult to estimate the reduction or elimination of a health disparity as a result of immigrants who move to North Carolina. The standard is elusive given that immigrants travel from many different countries with many different kinds of health systems. Also, there are many unknown factors that would otherwise be influential, including the quality of health services that were available to immigrants prior to their migration, their current access to health services, and the monetary value of their individual consumption of health services. These values are challenging to measure using the input-output model, while also taking into consideration further complications like illegal immigration.

A more appropriate comparison is the results of this study compared to the Beyer *et al* "Developing World Health" sector. This report examines the impact of global health activity in North Carolina that result from economic activities such as medical goods exports, academic research and relief missions that promote global health abroad. If these findings are compared with those of the "Developing World Health" sector in Washington State, the results are very similar. Approximately 65% percent of the global health economic impact in total business activity and 75% of the estimated impact on labor markets in Washington State depends on "domestic global health." This comparison (not including alternative criteria countries) is presented in aggregate terms in the following table:

Global Health Impact Cross-State Comparisons: Washington State and North Carolina

	North Carolina	Washington State
Total Output	1,688.02	1,464.81
Total Jobs	7,139	14,124
Total Income	508.81	614.66
Tax Revenue	18.2	46.99

Based on the table above, economic output impacts are similar for those states, while

there is a large divergence in employment figures. This difference comes in the form of indirect jobs created. In the analysis of this report, the jobs directly generated by global health in the for-profit, non-profit and academic sectors closely match those generated directly in Washington State. The major differences between North Carolina and Washington State are a result of the indirect and induced employment impacts. This also contributes to the smaller income and tax revenue figures, although North Carolina has a significantly larger average income. This is likely due to economic impacts in the for-profit and non-profit sectors that are driven by global health research activities, which require skilled labor, and therefore, yield higher wages.

Finally, the modest reporting of the results of this study is due, in large part, to the availability of data sources. As mentioned, a major challenge was to obtain viable data for estimation in the input-output model. In particular, the academic sector suffers from a lack of availability of labor market data. The research team was unable to determine an exact figure for the number of people or employees who contributes to global health through their research. The findings are largely based on information that is readily available to the public. The non-profit sector suffers from this problem as well; it is likely that there is considerable underreporting of business activity, especially within religious organizations. Furthermore, the selection of NAICS codes for this report were used across all sectors, which is considered to be a much more conservative approach relative to Beyers *et al*. The modest reporting of data in this report, therefore, resulted in a smaller number of industries and smaller estimates.

Appendix VIII: Multipliers

Impact Type	NAICS Code	Direct	Indirect	Induced
Output	325411	1.00	0.52	0.25
Output	325412	1.00	0.44	0.23
Output	325413	1.00	0.64	0.25
Output	325414	1.00	0.65	0.22
Output	334510	1.00	0.53	0.18
Output	334516	1.00	0.44	0.23
Output	334517	1.00	0.49	0.15
Output	339112	1.00	0.44	0.29
Output	339113	1.00	0.35	0.24
Output	339114	1.00	0.21	0.25
Output	339115	1.00	0.30	0.27
Output	339116	1.00	0.19	0.44
Output	541710	1.00	0.33	0.43
Output	541720	1.00	0.33	0.43
Employment	325411	1.00	1.25	1.20
Employment	325412	1.00	1.33	1.30
Employment	325413	1.00	1.55	1.12
Employment	325414	1.00	2.26	1.52
Employment	334510	1.00	1.15	0.69
Employment	334516	1.00	1.01	0.81
Employment	334517	1.00	1.65	0.91
Employment	339112	1.00	0.76	0.75
Employment	339113	1.00	0.52	0.55
Employment	339114	1.00	0.34	0.53
Employment	339115	1.00	0.47	0.62
Employment	339116	1.00	0.11	0.32
Employment	541710	1.00	0.38	0.52
Employment	541720	1.00	0.38	0.52
Labor Income	325411	1.00	0.15	0.08
Labor Income	325412	1.00	0.14	0.07
Labor Income	325413	1.00	0.21	0.07
Labor Income	325414	1.00	0.20	0.06
Labor Income	334510	1.00	0.16	0.05
Labor Income	334516	1.00	0.15	0.07

Labor Income	334517	1.00	0.16	0.04
Labor Income	339112	1.00	0.16	0.08
Labor Income	339113	1.00	0.11	0.07
Labor Income	339114	1.00	0.12	0.07
Labor Income	339115	1.00	0.15	0.08
Labor Income	339116	1.00	0.09	0.13
Labor Income	541710	1.00	0.57	0.13
Labor Income	541720	1.00	0.57	0.13
Value Added	325411	0.39	0.24	0.14
Value Added	325412	0.41	0.21	0.13
Value Added	325413	0.23	0.38	0.14
Value Added	325414	0.32	0.31	0.12
Value Added	334510	0.14	0.23	0.10
Value Added	334516	0.23	0.22	0.13
Value Added	334517	0.09	0.22	0.08
Value Added	339112	0.41	0.22	0.16
Value Added	339113	0.44	0.17	0.14
Value Added	339114	0.46	0.11	0.14
Value Added	339115	0.52	0.15	0.15
Value Added	339116	0.64	0.11	0.25
Value Added	541710	0.52	0.18	0.24
Value Added	541720	0.53	0.18	0.24

Appendix IX: References and Bibliography

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