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# Resource distribution, accessibility, and health equity: from global analyses to the Cuban case

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**Resource distribution, accessibility, and health equity: from global analyses to the**

**Cuban case**

by

**Isaac Zvi Christiansen**

A dissertation submitted to the graduate faculty  
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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**ABSTRACT**

This dissertation examines interrelated questions concerning distribution of healthcare financing and human resource for health (HRH), access to healthcare services, and health outcomes on international and national levels of analysis. The dissertation is comprised of three papers, addressing the following questions: What is the relationship between the government's share of total health spending and infant mortality? How do developing countries cluster along the lines of critical health and development indicators? How successful has Cuba been, a country with a highly public health and development model, in reducing inequality in human resource for health distribution? While this study does not ignore the relationships among inequality, per capita gross national income, food security and health outcomes, the central focus is on key dimensions of healthcare accessibility - the distribution of human resources for healthcare services and the extent to which governments reduce financial barriers to care.

Although previous research has examined the relationship between public health spending and the infant mortality rate (IMR), few if any studies have examined the impact of government expenditure on healthcare services as a percentage of total expenditure on health (GEHPTEH) on the IMR. In the first paper, I employ additive and interactive multivariate regression models with cross-sectional data gathered from the World Health Organization and the World Bank to examine the relationship between GEHPTEH and IMR while controlling for gross national income, doctor density, the percentage of children under 1 year vaccinated for polio, and the percentage of the population with access to improved water sources. The findings of the additive models

indicate a non-trivial inverse association between GEHPTEH and IMR, while the interactive model indicates that the level of GEHPTEH makes a greater difference among poorer nations.

The second paper contributes to the social science literature on health and development by creating a typology of primarily non-Organization for Economic Cooperation and Development (OECD) countries to more precisely understand the nature of the challenges facing them. Using cluster analysis to classify developing nations on the basis of eight health and development variables, I find that a tier of countries in above-average and below average situations of health and development subdivides into a tier of Mild, Moderate, Severe, and Critical situations, which then further subdivide into nine relatively distinct groupings. These results indicate the importance of designing development strategies that address particular configurations of per capita gross national income level, inequality, food insecurity, healthcare financing and vaccination coverage.

Though much past research has examined developments and transformations in Cuba's healthcare system, national IMR trends, and the government's commitment to universal healthcare access in the face of economic difficulties, the reduction of HRH and IMR spatial inequality among and within Cuban provinces has received less attention. Drawing from Cuban Ministry of Health data, the third paper examines the changes in absolute and relative inequality in HRH distribution by personnel type and IMR among Cuban provinces over time, and contrasts these distributions with the global, OECD, and developing country distributions using formal and informal inequality measures. Using municipal level data from Cuba's National Statistical Office, the paper also examines the levels of absolute and relative inequality in HRH distribution and IMR within Cuban

provinces in 2010. This paper's contribution to the broader literature lies in the significance of the measurable strides towards greater within country equality of HRH within a global context of high between and within country disparities of HRH. Cuba's experience in this regard is especially salient when taking into consideration the high levels of spatial inequality in HRH prior to 1959 as well as a set of particularly adverse economic circumstances, particularly during the 'special period' of the 1990s, characterized by material and financial resource scarcity.

## CHAPTER 1: GENERAL INTRODUCTION

In spite of reduction in infant and child mortality in previous decades, large disparities remain in health resources and outcomes both between and within countries. These inequalities reflect significant structural threats to the attainment of a world characterized by equitable and sustainable development. A person's life chances tend to vary considerably depending on where he/she is born. For example, children born in Sierra Leone in 2012 were fifty-three times more likely to die before their first birthday than children in Norway. Even within the same geographical region, we still observe acute disparities in health outcomes. In 2012, a child born in Guatemala was six times more likely to die before his/her first birthday than a child born in Cuba. These disparities in infant mortality are largely seen as the result of other acute dissimilarities in development, including inequalities in gross domestic product (GDP) per capita (Filmer and Pritchett 1999; Rajan, Kennedy, and King 2013), education, (Song and Burgard 2011) poverty (Rajan, Kennedy, and King 2013; Houweling *et al.* 2005), human resources for health (Anand and Bäringhausen 2004) income inequality (Wilkinson and Pickett 2006) and improved sanitation (VanDerslice, Popkin, and Briscoe 1994).

While all of the aforementioned variables exert an important influence on health outcomes and many are included as variables in different papers in this study, the primary focus of this dissertation is the government's share of a country's total health expenditure (GEHPTEH) and human resources for health. This dissertation is comprised of three papers that focus on different aspects of health and development. The first two papers are international cross-sectional analyses using country level data from the World Health Organization (WHO) and World Bank. The third paper is a case study of Cuba based on

data from Cuba's Ministry of Health (MINSAP) and the Cuban National Statistics Office (ONE).

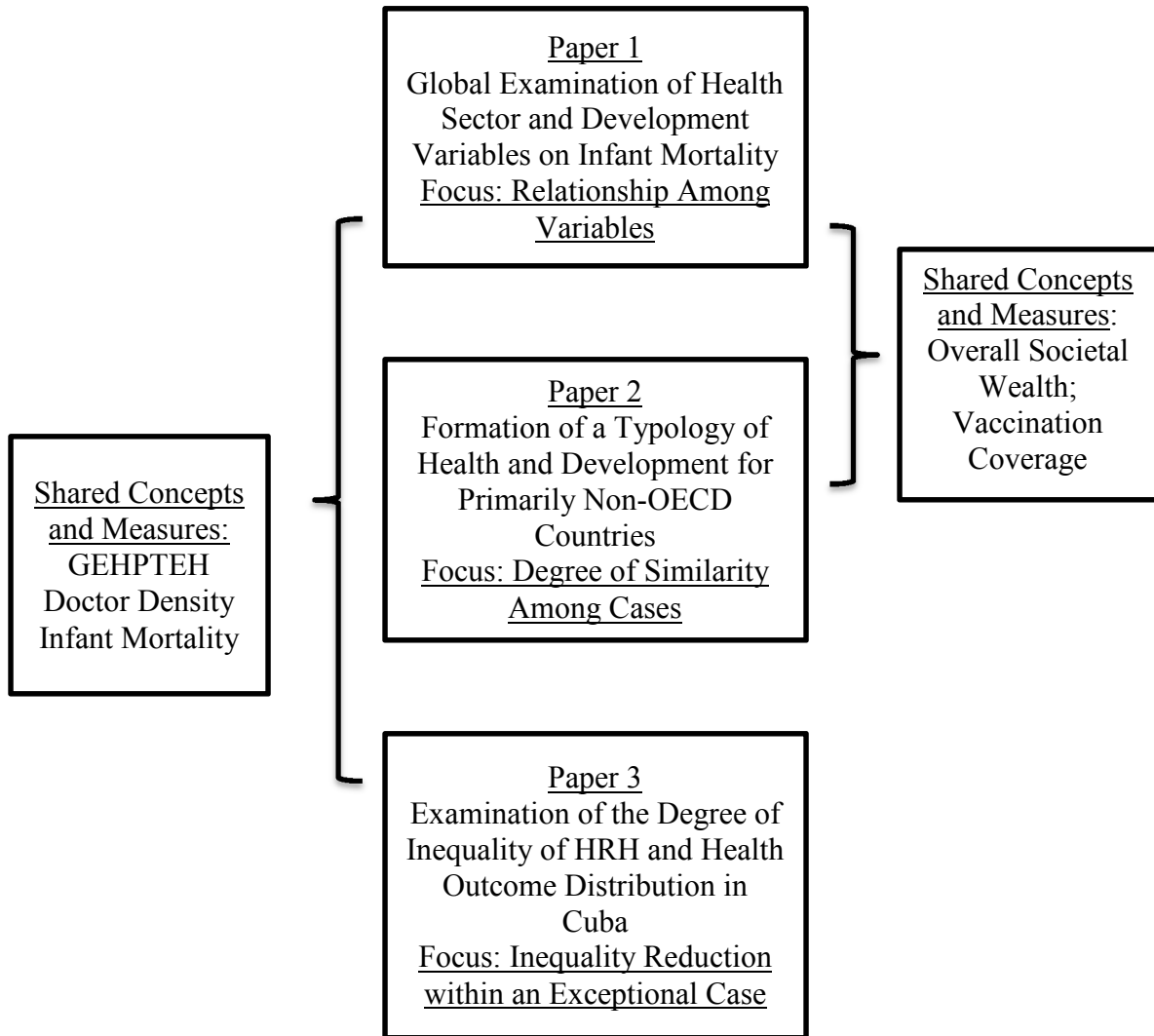
The first paper focuses on the relationship between GEHPTEH and the infant mortality rate (IMR) using multivariate ordinary least squared (OLS) regression techniques for 186 countries. The second paper constructs a nested typology of 123 primarily non-OECD countries using hierarchical agglomerative cluster analysis. The third paper is a case study of Cuba and uses provincial level data from MINSAP to look at changes in human resource for health and health outcomes over time. The paper also looks at distributions of these variables within Cuban provinces for 2010 using municipal level data from ONE.

As shown in Figure 1, these papers share central concepts and measures. GEHPTEH reflects the government's share of healthcare financing and is an important component of treating healthcare as a human right and/or public good rather than as a commodity. GEHPTEH is the predictor variable of most interest in the first paper and is one of the variables based on which countries cluster in paper two. While paper three does not analyze variance of Cuba's GEHPTEH over time, it should be noted that according to the data gathered for this dissertation and using GEHPTEH as a measure of the level of publicly financed healthcare financing, Cuba has one of the most publicly financed healthcare systems in the world.

The number of doctors per 1000 people (hereafter referred to as doctor or physician density) is another central variable in this dissertation. Doctor density is a key predictor in the regressions in the first paper, an important variable in the cluster analysis of the third. The third paper involves examination of the degree of human resource for

health (HRH) inequality in a country that, next to the tiny and extremely wealthy Monaco, has the highest doctor density of the 186 countries examined in paper 1. All of the papers conceptualize and utilize the infant mortality rate (IMR) as a key health and development outcome.

The dissertation's focus progressively sharpens. It begins with a study about the relationship between various predictor variables and the IMR in a cross-sectional analysis. Although this paper highlights some salient cases in regards to these variables, its primary focus lies on the relationship between GEHPTEH and the IMR while controlling for other socioeconomic and health related variables. The goal of the second paper is to construct a typology of health and development using eight socioeconomic and health related variables by conducting a cluster analysis that maximizes homogeneity within county groupings and maximizes heterogeneity among them. The final paper uses several mathematical techniques to estimate the degree of inequality in the provincial and municipal distribution of HRH and IMR in Cuba.



**Figure 1:** Dissertation Structure

The first paper “The Case for Government Funded Healthcare: An International Analysis of Government Expenditure, Socioeconomic Development and Infant Mortality” examines the relationship between GEHPTEH and the IMR. Existing studies that look at the relationship between government expenditure and the IMR or similar health outcomes focus either on government expenditure on health as a percentage of GDP (Ssozi and Amlani 2015; Filmer and Pritchett 1999), or government expenditure on health per capita (May and Smith 2011; Farag 2010; Schell *et al.* 2007). Although these measures are useful in understanding the relationship between spending and the IMR, they do not capture the government’s *share* of total healthcare financing.

The results of previous studies have tended to be mixed. Farag (2010) and May and Smith (2011) found a significant inverse relationship between government health spending and the IMR, while Filmer and Pritchett (1999) and Schell and company (2007) did not. It should be noted that most of these studies did not utilize any variable that captured any aspect of the relationship between accessibility and health spending. Ssozi and Amlani’s found that government expenditure as a percentage of GDP was significantly inversely associated with CMR but not IMR. Although, the theoretical discussion of Ssozi and Amlani (2015: 172) correctly captures the danger of increased out of pocket expenditure leading to delayed care or increased poverty, they do not use a measure of its percentage of the total expenditure on health and only used its aggregate as a percentage of GDP.

I selected GEHPTEH because it is a measure of the private/public split as a percentage of the total amount the society spends on health, and because a higher GEHPTEH connotes lower out of pocket expenditure (since the WHO correctly classifies



out of pocket as part of private expenditure). As indicated above, a high GEHPTEH reflects a more public and less commodified healthcare system while a low GEHPTEH reflects a more commodified privatized healthcare system. The central hypothesis ( $H_1$ ) of the research is that countries with higher GEHPTEH will have lower IMR.

Doctor density is also a variable of special interest, as it is another important component of accessibility. If healthcare is free, but there are no physicians near the populations that need them due to outmigration or insufficient efforts to bring them to populations that have historically not had access to physicians, then accessing healthcare is understandably compromised. While it is important to note that there is much within country variation in doctor density that is not captured at our level of analysis (due in part to the absence of a doctor distribution GINI variable by country), physicians tend to migrate from poorer countries to wealthier ones, leaving poorer countries with less HRH to address disease and/or promote population health (WHO 2006; Dussault and Franeschini 2006). The second hypothesis postulated in this research ( $H_2$ ) is that countries with a higher doctor density will have a lower IMR. A third hypothesis ( $H_3$ ) is the presence of an interaction between GEHPTEH and  $\log_{10}$  GNI per capita (GNIPC), indicating that the lower the GNIPC the greater the effect of GEHPTEH on IMR.

A bivariate analysis examines correlations among GEHPTEH, doctor density, GNIPC, the percentage of children under one year of age who have received the polio vaccine, the percentage of the population with access to improved water supplies, total expenditure on health as a percentage of GDP (TEHPGDP) and IMR. Eleven centered OLS regression models are run using SPSS. Lastly, I test for the presence of an interaction between GEHPTEH and GNIPC when regressed on IMR.

The second paper “Health and Development Challenges: A Nested Typology of 123 Non-OECD Countries” divides 123 countries into a three-tiered nested classification system. This paper lists Dr. David Peters, Associate Professor of Sociology at Iowa State University as a co-author in recognition of his assistance in SAS coding, input on diagnostic interpretation and discussions with me concerning naming clusters. In this paper, we seek to establish a health and development typology for predominately non-OECD countries based on eight important health and development indicators.

With the exception of Wood and Gough (2006), all the previous health typology research reviewed (Karim, Eikemo and Bambra 2010; Chung and Muntaner 2007; Navarro and Shi 2001) focused on wealthier nations, often using a predetermined political-welfare regime typology as a predictor of health outcomes. Navarro and Shi (2001) found that social-democratic regime types tended to have less income inequality, higher taxes and public employment than other political-welfare regime types, and better health outcomes than the other types examined (Christian Democratic, Liberal, or Fascist). Chung and Muntaner (2007) used multilevel models to analyze panel data for 18 countries over 38 years. They used welfare type as fixed effects predictors and controlled for (log) GDP per capita to explain annual variation in IMR and low birth weight. Like Navarro and Shi (2001), they found that Social Democratic countries had better health outcomes than other welfare types (Christian Democratic, Liberal or Wage Earner Welfare States). Like the studies of Palma-Solis *et al.* (2009), Coburn (2004) and Field Kotz and Bukham (2000), the typology work of Chung and Muntaner (2007) and Navarro and Shi (2001) provide evidence that neo-liberal policies are deleterious to population health.

Wood and Gough (2006) used k-means cluster analysis to group 61 developing countries from Asia, Eastern Europe, Latin America and Africa based on human development index, aid and remittance inflow, public expenditure on health and education. They found four distinct ‘types’ or groupings: actual or potential welfare regimes, more effective informal security regimes, less effective informal security regimes and insecurity regimes. Higher social spending and socio-economic development outcomes characterized actual or potential welfare regime types, while low public spending, a high dependency on remittances and a low level of social-development characterized the ‘insecurity regimes’.

The research presents a model of virtuous circle of equitable health and development where strong political-economic, health and educational structural and infrastructural, and human resource inputs contribute to positive economic and health outcomes that feed back into a ‘virtuous circle’. The model’s development is based on previous research (including paper 1) which indicates that a higher government’s share of healthcare financing, lower inequality, higher GNIPc, higher rates of social investment, higher human resources for health leads to better health outcomes (Palma-Solis *et al.* 2009; Wilkinson and Pickett 2006; Navarro and Shi 2001; Field, Kotz and Bukham 2000; Navarro 1993; Wilkinson 1992).

The standardized z-scores for GNIPC, GEHPTEH, doctor density, TEHPGDP, the percentage of children under the age of five underweight, the percentage of children under one year of age who have received the diphtheria, pertussis, and tetanus (3 dose) vaccine (DPT3), the GINI coefficient and the IMR are used to classify 123 countries using a Wards method cluster analysis. Traditional tools such as dendrograms, and

agglomeration schedules of fusion coefficients as well as statistical plots of the pseudo  $R^2$  and the pseudo  $t^2$  are used to determine the number of clusters. We name clusters according to their countries' mean z-scores on the variables used to conduct the analysis.

The third paper “Human Resources for Health and Health Outcomes: An Analysis of their Distributions over Time and Space” measures the changes in the levels of inequality in the distribution of HRH in Cuba among provinces from 1989 to 2014, and measures inequality in the distribution of HRH within Cuban provinces using municipal level data for 2010. The paper also examines changes in IMR by province over time and looks at the variation of IMR within provinces using municipal level data.

One reason to focus on an equitable geographic distribution of health system inputs, like HRH, is that one would expect that greater equality in the distribution of health system inputs would lead to greater equality in health system utilization and ultimately in health outcomes. For this general model to maintain validity, one would expect to find a relationship between higher HRH density and better health outcomes. Previous studies have tended to find such associations (Anand and Bärnighausen 2004; Hanmer, Lensink and White 2003). It would then logically follow that rural populations that have to overcome greater geographic barriers for healthcare would tend to experience worse health outcomes. In this regard, a recent study by Dare *et al.* (2015) showed that increased distance between population and access to surgical care led to increased probability of being in a cluster that exhibited higher rates of mortality resulting from acute abdominal conditions.

Previous research has documented the evolution of Cuba's healthcare system (Feinsilver 1993; Danielson 1981; Danielson 1979; Ochoa and Serrano 2000), its

emphasis on primary care (Whiteford and Branch 2008), and other variables influencing its success in achieving health outcomes comparable to those of the wealthiest nations in spite of the island's lower GNIPC (Franco *et al.* 2007; Speigel and Yassi 2004). Other studies have examined trends in infant mortality (Corteguera and Henriquez 2001; Corteguera 2000) or how the Cuban government responded to the crisis that followed the collapse of the Soviet Union and the Eastern European socialist economies in terms of healthcare financing, planning and organization (Nayari and López-Pardo 2005; Borowy 2011, 2013).

This research is distinct from these previous studies in that the emphasis is on changes in the distribution of HRH and IMR over time and space in Cuba. I examine changes in the level of inequality beginning with the distribution of physicians by province in Cuba from MINSAP data provided by Danielson in 1958, to their distribution by province on the eve of the crisis in 1989, up through the recent transformations of the health sector emanating from the 'Guidelines for the Economic and Social Policy of the Party and the Revolution'. Due to the difficulties in obtaining sufficient data on variables such as the number of physicians, family doctors or nurses serving on international missions by province (and municipality), the research is limited in terms of causal inference regarding fluctuations in annual HRH inequality. Therefore, causal inferences regarding changes in HRH inequality are limited to comparing health policy goals and shifts to changes in HRH distributional patterns.

I use descriptive and formal inequality measures (GINI and Theil coefficients) to examine trends in HRH distribution by personnel type in Cuba across provinces over time, and I hypothesize a general decline in the level of inequality in these distributions

over time. I also examine provincial variation in IMR over time and uses box plots to help the reader visualize this variation. Choropleth maps generated in ArcGIS are provided to display the geographic variation in provincial HRH and IMR over time.

In this paper, I also examine variation at the municipal level, and hypothesize that inequality in HRH distribution will be greater within provinces than among them. As on the provincial level of analysis, descriptive and inequality measures are used to capture the level of inequality of HRH distribution among municipalities within provinces. In addition, box plots and choropleth maps display variation in IMR at the municipal level.

The broader theoretical argument is that within a national health care system it is far easier to address disparities in HRH distribution than in a system characterized by private financing and providers since privatized healthcare tends to lead to greater HRH concentrations in wealthier areas. In part, imbalance in privatized healthcare systems would be due to the influence of economic push and pull factors. Physicians will be more likely to open up a practice in areas where people are wealthy enough to afford their services or private insurance and less likely to practice in areas where people are too impoverished to acquire insurance or pay for services. In a state controlled system, where HRH are essentially state employees, the state will have more control in deciding placement. This is largely the case in Cuba, where private practice was largely eliminated by 1965 (Feinsilver 1993).

This research may be of value to those who are interested in Cuba's health system and to those who are interested in health equity. Equitable distributions of material and human inputs are essential elements for an equitable distribution of health outcomes. Cuba's experience shows that an equitable distribution of HRH personnel is possible,

even in times of economic crisis. Furthermore, these results show that over time, disparities in health outcomes have narrowed. While this research does not permit much in the way of making causal inferences regarding these distributions, it is the view of the author that Cuba's socialist healthcare organization and political commitment to treating health as a right and not a commodity are essential elements to achieving equity in HRH distribution.

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**CHAPTER 2: THE CASE FOR GOVERNMENT FUNDED HEALTHCARE: AN  
INTERNATIONAL ANALYSIS OF GOVERNMENT EXPENDITURE,  
SOCIOECONOMIC DEVELOPMENT AND INFANT MORTALITY**

**A paper to be submitted to *Sociology of Development***

Isaac Christiansen

**Abstract**

Public funding of healthcare is a critical component of ensuring access to care for the poor. It varies considerably among countries and its relationship with healthcare outcomes deserves attention. This paper examines the relationship between public funding of health care, doctor density and the infant mortality rate (IMR). While previous research has examined the role of public health spending on the IMR, few if any studies have examined the impact of government expenditure on health as a percentage of total expenditure on health (GEHPTEH) on the IMR. Using World Health Organization data for 186 countries, I find a statistically significant and non-trivial relationship between GEHPTEH and the IMR, while controlling for gross national income, doctor density, percent of the population with access to improved water sources, and the percentage of children under 1 year who have received the polio vaccine. An interactive model is run, which suggests that although GEHPTEH has an impact on IMR reduction across nations, the effect is greater in poorer nations than in wealthier ones. These findings may be pertinent to strategies to reduce infant mortality and improve healthcare outcomes, particularly among low-income nations.

## Introduction

Despite the significant progress made globally in reducing infant and under-five mortality, high infant and child mortality rates remain a significant problem in many developing nations, particularly within the WHO Eastern Mediterranean and African regions. A glance at these regions' averages is sufficient to highlight the global disparity in life chances. So, for example, while in the WHO Americas region infant and child mortality averaged 13 and 16 per 1000 live births in 2011, respectively, the WHO African region endured average infant and under-five mortality at 63 and 97 per 1000 live births, and the Eastern Mediterranean had an infant mortality rate (IMR) and a CMR of 45 and 59 per 1000 live births, respectively.<sup>1</sup>

Researchers have documented relationships between various socio-economic and public health variables and the infant mortality rate (IMR), including education (e.g., Rajan, Kennedy, and King 2013; Song and Burgard 2011; Pamuk, Fuchs, and Lutz 2011; Arik and Arik 2009), quality of housing/living conditions (e.g., Urdiola 2011), poverty (e.g., Rajan *et al.* 2013; Houweling, Kunst, Looman, and Mackenbach 2013), social class (e.g., Antonovsky and Bernstein 1977) vaccination rates (Breiman *et al.* 2004) and aspects of clean water and sanitation (e.g., VanDerslice, Popkin and Briscoe 1994). Since many of these variables, in turn, vary among countries depending on the quantity of income and the resources the country has at its disposal, the relationship between income and the IMR has a prominent place in the literature. In this regard, there is ample evidence in support of the hypothesis that a country's per capita income is inversely causally related to infant mortality (Arik and Arik 2009; Schell *et al.* 2007; Filmer and

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<sup>1</sup> These 2011 regional estimates of infant and child mortality are from the WHO Global Health Observatory Data Repository accessed on 10/31/2014. The national figures are from the WHO data gathered on 11/2013.

Prichett 1999; Prichett and Summers 1996; Wilkinson 1992). The importance of income as a predictor of IMR has led to much research examining the impact of inequality in general on the IMR (e.g., Avendano 2012; Arik and Arik 2009).

Although there is relative consensus regarding the correlation between income and the IMR, the research regarding the causal role of the level of inequality in income distribution within a society in general (as opposed to the overall level of income of a society) in determining the IMR has led to somewhat mixed results. Though Schell *et al.* (2007), Hosseinpoor *et al.* (2005), Lynch *et al.* (1998) demonstrated that the income inequality *itself* was an important determinant of IMR, other studies (Rajan *et al.* 2013; Avendano 2012; Chung and Muntaner 2006) indicated that the impact of inequality alone on the IMR was insignificant when controlling for income level or poverty rates. Furthermore, in a meta-analysis of studies of IMR determinants, Kim and Saada (2013) observed that nine of 14 cross-country studies focusing on the relationship between inequality and infant mortality found that inequality controlling for average income exacerbated the IMR but the remaining five studies found no significant relationship when controlling for income. In another review study, Wilkinson and Pickett (2006) found that of 168 studies examining inequality and healthcare outcomes, 78% found that inequality significantly exacerbated population health.

Schell *et al.* (2007) reported that of five independent variables, GNP per capita had the largest independent inverse effect on the IMR with the female illiteracy rate and the GINI index (an important measure of inequality) having the second and third strongest independent effect on the IMR, respectively.<sup>2</sup> In a study using a dichotomous hierarchical probit model to analyze the impact of inequality on the IMR in Iran's

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<sup>2</sup> Poverty rate and public health spending were insignificant in Schell *et al.*'s multivariate regression analysis.

provinces while controlling for health service availability and a province's overall IMR, Hosseinpoor *et al.* (2005) showed that socioeconomic inequality helped to explain within province IMR variation. Arik and Arik (2009: 41-42) showed that while both income *and* its distribution were robust indicators of IMR, when income is controlled for inequality, income's coefficient declined significantly.

Conversely, although Rajan *et al.* (2013) showed in a logistic regression that the GINI coefficient was significantly related to an increase in reports of illness/ailments while controlling for average income, individual income and educational level, they rejected the hypothesis that inequality was significantly related to under-five mortality rates across Indian states and districts. Avendano (2012) found in a cross-sectional longitudinal study over a 48-year period that inequality often correlated with the IMR, but the impact disappeared when controlling for country fixed effects or for economic variables (e.g. unemployment). Therefore, although inequality among those who have sufficient resources to ensure life's necessities may in itself be insufficient to explain IMR variation, there is less doubt that the greater the portion of the population that suffers from poverty and absolute deprivation, the higher the IMR.

The above-reviewed literature on the relationship between income, the level of within country inequality and the IMR indicates that there is a need for research that focuses specifically on what measures or policies will likely reduce the IMR among poorer populations. Tying together the issue of inequality and societal measures that may protect more impoverished populations, Avendano (2012: 759) reasoned that "strong social protection policies such as universal access to care and favorable maternity leave benefits may reduce infant mortality directly and may at the same time cluster in

countries with strong redistribution policies, without necessarily having an impact through reducing income inequality”. Thus, social spending that increases access to care may serve as a countervailing force protecting poorer populations by buffering the impact of inequality on the IMR.

Still other studies have examined the relationship between neoliberal policies and population health (Laurell 2014; Palma-Solis *et al.* 2009; Shoepf *et al.* 2000). For example, while Wilkinson and Pickett (2006; 1992) argue that higher income inequality leads to worse population healthcare outcomes through reducing social cohesion, Coburn (2000) argues that both increased inequality and the decline in social cohesion are caused by neoliberal policies. Exploring the implications of dependency on the IMR, Shandra *et al.* (2004) analyzed the impact of commodity concentration, multinational penetration, and International Monetary Fund conditionality on the IMR. In a series of interactive panel regressions they found that the aforementioned explanatory variables had more harmful impacts on the IMR at lower levels of political democracy than at higher ones.

Navarro and Shi (2001) examined the impact of socio-political and economic variables on health outcomes. They identified that among OECD nations those countries classified as social democratic that had higher union density, public employment, larger public health and social security expenditures had lower IMR than countries classified as Christian democratic, ex-fascist or liberal where these predictor variables were progressively lower. Consistent with Navarro and Shi, other research has shown an inverse relationship between neoliberal cuts in government expenditure and better population health (Palma-Solis *et al.* 2009; Shoepf *et al.* 2000).

Breiman and colleagues (2004) found that polio and diphtheria, pertussis and tetanus (DTP3) vaccination were associated with lower mortality for babies between 6 weeks and nine months of age. Although some studies have documented (e.g. Aaby *et al.* 2004) increased mortality associated with the DTP3 vaccine children young infants (potentially due to a Th2 immune response from the vaccine leading to atopy or allergic hypersensitivity), it is critical to emphasize the importance of the DTP3 vaccine in eliminating high mortality from these diseases (Sadoh and Oladokun 2012; Soares 2007: 268-269). Sadoh and Oladokun (2012) express concern for Nigeria in the context of a global resurgence of both diphtheria and pertussis and argue for a strengthening of vaccination coverage.

Insufficient human resources for health and prohibitive costs of healthcare services may constitute barriers to poor populations that ultimately affect the IMR. Governments may potentially mitigate the effect that low income has on the IMR by increasing public health expenditure and by encouraging health professionals to practice in areas where they are relatively scarce. While some research has focused on or included human resources for health (Arik and Arik 2009; Anand and Bärnighausen 2004; Gbessemete and Jonnson 1993) and aspects of health financing (Houweling *et al.* 2013; Mays and Smith 2011; Flimer and Prichett 1999; Gbessemete and Jonnson 1993) into their models, few (e.g., Khun 2010) have accounted for the relationship between the public/private split in health care spending and the IMR. My research seeks to fill these gaps by examining the relationship of physician density and the government's share of total health expenditure to IMR variation across countries.



Regarding the relationship between public spending on health and the IMR, the results have varied. Mays and Smith (2011) found a robust inverse relationship between public health spending and the IMR in a time series multivariate analysis of U.S. city and county data. Conversely, Schell *et al.* (2007) observed that public spending on health was ultimately insignificant when examining the IMR as a function of inequality, GNP per capita, public health expenditure, and female literacy. Like Filmer and Pritchett (1999), these researchers also found that, even though public spending on health care in a simple regression had a significant effect on the IMR, once GDP per capita and female illiteracy rate were entered into the model the significance of their public spending variable disappeared.

Schell and colleagues (2007) concluded that increased public health spending alone is not sufficient and needs to be coupled with effective strategies to better use health care dollars and to address other factors such as female illiteracy, income levels, and inequality. Farag (2010) used fixed-effect regression models and found that both total spending on health as a share of GDP and government health spending as a percentage of GDP (in separate models) had statistically significant impacts towards reducing IMR on data from 131 and 133 countries. In another key study, Houweling *et al.* (2005) showed that although the level of public spending on health was an insignificant predictor of IMR across income levels when controlling for income, literacy and region; they did find that public spending reduced infant mortality more dramatically among poorer population quintiles than among wealthy ones.

*Underlying theory and research design*

The aforementioned studies examined the contribution of the level of public (*i.e.*, government) spending on health to IMR variation. However, a problem lies in the concept they sought to operationalize. Their chosen predictor variable to represent public expenditure was simply the absolute value of public spending on health *irrespective of its proportion to the society's total spending on health*. I feel that this overlooks a central function of public health care spending, since the greater the portion of the total health care bill covered by the government the lower the portion of the total cost is incurred by individuals and families.

Hence, while their chosen measure of public spending may provide a measure of government commitment to health care and absolute financial resources poured into the health sector, it does not measure the degree to which government spending reduces financial barriers to healthcare. If the costs of accessing care are prohibitive, these financial barriers could lead to adverse health effects among the population, particularly among its most vulnerable and poorest members. Emanating from this logic, this research's primary focus is to examine the impact of general government expenditure on health as a percentage of total expenditure on health (GEHPTEH) on the IMR.

The model for examining the impact of public health spending on the IMR presented here is distinct from the aforementioned studies. Drawing upon WHO data, I select GEHPTEH to help explain variation in the IMR while controlling for doctor density, gross national income per capita, the percentage of children under one year of age who received the polio vaccine, and the percentage of the population with access to improved water sources. I expect that financial barriers emanating from low GEHPTEH

(and thus higher out of pocket or insurance costs) would lead people to postpone or abandon care leading to worse health care outcomes reflected in higher IMR and that this will be more acute for poorer nations. It is my hope that this research will provide a scientific contribution to understanding the importance of the government's role in the reduction of financial and human resource barriers to care.

Underlying this research is a philosophy in favor of a rights-based approach to healthcare provision. A rights-based approach to health implies that the state has the responsibility to provide healthcare services regardless of the residing population's ability to pay (Farmer 2005; Alma Ata 1978; UN 1948). This is fundamentally at odds with the trend in growing commodification of health services through increased privatization. When healthcare is commodified, the gap between absolute need for healthcare among a population and its demand backed by the ability to pay leads to inequality among the population in healthcare outcomes, and to distortions in which services are provided and where.<sup>3</sup> Although GEHPTEH does not capture all of the elements of a rights-based approach, it does provide a measure to the degree of socialization of healthcare financing.

Reflecting on the inequality debate, most discussions regarding the impact of inequality and income on the IMR seems to overlook the point that income is unequally distributed between countries as well as within them. Nevertheless, since GNI per capita is often noted as a significant predictor of IMR (and in my findings as well), I ask, how unequal is the international distribution of GNI per capita? As a minor contribution to this discussion, I calculate the GINI index of GNI per capita (PPP) dollars to address this

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<sup>3</sup> For example, Rodelis Therapeutics, a private pharmaceutical company, recently increased the price of cycloserine more than 21-fold, a drug that treats multiple drug resistant tuberculosis and Turning Pharmaceuticals increased the price of Daraprim, (pyrimethamine) a drug that is used to treat parasitical infections like malaria, from \$13.50 a tablet to \$850.00 a tablet (Pollack 2015). These increases in price are sure to reduce the availability of medication for more vulnerable populations who have greater need for them.

question. I hope that this research will provide a scientific contribution to understanding the importance of the government's role in the reduction of financial and human resource barriers to health care.

## Methods

I used both additive and interactive multivariate linear regression models to measure the impact of the explanatory variables on the IMR. This method is standard and the same or similar methods have been used in similar studies (Rajan *et al.* 2013; Schell *et al.* 2007; Filmer and Pritchett 1999). Multivariate regression provides a way of examining the direct effect of each of the explanatory variables while controlling for other predictors (Cohen *et al.* 2003: 75-80).

### *Data sources*

All the data for the 186 countries used in this study came from the World Health Organization Global Health Observatory Data Repository with the exception of Gross National Income (GNI) per capita, which came primarily from the World Bank.<sup>4</sup> GNI per capita data for 173 of 186 countries are from the World Bank's "World Development Indicators Size of the Economy" table for 2013 (or most recent year) values updated on

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<sup>4</sup> Data for four missing countries (Bosnia and Herzegovina, Iraq, Serbia and Macedonia) for doctor density came from the World Bank. The few countries for which no information on doctor density could be gathered were excluded from the sample.

<sup>5</sup> Purchasing-power parity gross national income (GNI) per capita was gathered from the World Bank for the year 2013 with the exception of Andorra and Argentina, which were from 2008 and 2011, respectively. I used stand-in measures as estimates for missing cases when the World Bank did not report the data. In the cases of Djibouti and Libya GNP per capita was used and drawn from the Google public data explorer. In the cases of Monaco and Myanmar their (2011) GNI per capita figures were gathered from the United Nations. For the Cook Islands, I was unable to find the GNI per capita figure so the most recent (2005) GDP per capita figure was used and came from the CIA World Factbook. The figure for Brunnei Darressalam is the GDP per capita in US dollars for 2013 reported by Knoema that cited the IMF World Economic Outlook 2014.

April 9<sup>th</sup> 2014.<sup>5</sup> Data for the IMR were for the year 2012, data for general government expenditure on health as a percentage of total expenditure on health (GEHPTEH) were from 2011, data for percent population with access to improved water sources were from 2012 (or most recent year) while data for doctor density, was from the most recent year reported.<sup>6</sup> The percent population with access to improved sanitation was excluded from the analysis to avoid multicollinearity.

### *Variables*

Table 1 provides the descriptive statistics for the 186 countries included in this study. The dependent variable, the IMR, is the number of infants born that die before reaching one year of age per 1000 live births. The high standard deviation indicates that the chances of a child surviving to his/her first birthday fluctuate considerably based upon where he or she is born. Infant mortality ranges from 1.7 per 1000 live births in Luxembourg to 117.4 in Sierra Leone.

**Table 1:** Descriptive Statistics\*

Variable	Min.	Max.	Mean	Standard Deviation
GEHPTEH	15.90	99.90	59.43	19.60
Doctor Density	0.01	7.06	1.59	1.49
GNI per Cap	600.00	167,021.00	17,394.40	21,254.47
LogGNIpc	2.78	5.22	3.97	0.52
TEHPGDP	1.65	19.48	6.98	3.11
LogTEHPGDP	0.22	1.29	0.80	0.19
PolioVac	30.00	99.00	89.75	11.34

<sup>6</sup> The reported doctor density ranges from 1998-2012; only one (Haiti) is from 1998, three are from 2000, and the majority of cases are between 2004-2011.

**Table 1:** Continued

Variable	Min.	Max.	Mean	Standard Deviation
ImprWater	40.00	100.00	88.13	15.00
IMR 2012	1.70	117.40	25.99	24.38

\*N=186

GEHPTEH refers to the government's portion of the total health care bill. This indicator could thus be viewed as a measure of how 'socialized' a country's total health care system is, in that it provides a numerical measure of the public/private mix.

Furthermore this variable provides me with an operationalized measure of how much governments reduce financial barriers to care. One way this is reflected is in GEHPTEH's strong inverse correlation (-0.87) to out of pocket expenditure on health. The numerator of GEHPTEH measures the total amount of government expenditure on health of pooled government funds including government funds budgeted for health services, "expenditure on health by parastatals, extra-budgetary entities and notably compulsory health insurance payments" (WHO 2011). The denominator is the sum of governmental and private expenditures on health.<sup>7</sup>

Doctor density is the number of physicians per 1000 people in the population. This provides a simple, albeit imperfect, operationalized measure of human resources for health. The inclusion of doctor density with GEHPTEH in the model allows me to capture another important dimension of healthcare accessibility. Physician density ranged from .01 for Tanzania to 7.05 for Monaco.

<sup>7</sup> Private expenditure on health includes "expenditure from pooled resources with no government control, such as voluntary health insurance, and the direct payments for health by corporations (profit, non-for-profit and NGOs) and households. As a financing agent classification, it includes all sources of funding passing through these entities, including any donor (funding) they use to pay for health" (WHO 2011a).

Since the negative relationship between access to safe drinking water and the IMR has been amply documented (McKinlay and McKinlay 1977; Van DerSlice *et al.* 1994) I included this variable in the study. The WHO indicates that increasing the percentage of the population with access to improved drinking water sources is a key means to reduce population exposure to drinking water contaminated by fecal material. The WHO (2014c) classifies “piped water into dwelling, plot or yard, public tap/stand pipe, tube well/borehole, protected dug well, protected spring and rainwater collection” as improved drinking water sources. Countries ranged from 40% of the population with access in Papua New Guinea to 100% in much of Europe, Japan, the US and the UAE.

GNI per capita (PPP) helps provide a standardized measure of purchasing power between countries (World Bank 2014). GNI per capita ranged from \$600 in Central African Republic to \$167,021 in Monaco. GNI per capita was also the variable that most significantly violated the assumption of normality. Its kurtosis score was 16.10 with a skewness score of 3.24.<sup>8</sup> For this reason, I transformed the variable to log base 10. This corrected the kurtosis to -0.65 and the skewness to -0.23.

It is important to note that GNI per capita in PPP dollars (as opposed to in U.S. dollars) may reflect the value of state subsidies on population living expenses. For instance, Cuba, which provides ample state subsidies to various basic needs of the population (a fact that partially reflected in its high GEHPTEH), had a GNI per capita of \$5,890 in 2011 (the most recent year available) in US dollars using the Atlas Method reported by the World Bank, while the GNI per capita for PPP reported by the World Bank for the same year was \$18,520. This 3:1 ratio can be contrasted to the

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<sup>8</sup> The next highest score of kurtosis was 1.3 for percentage of the population with improved water with a negative skew of -1.47. Only GNI per capita was the only variable log transformed.

corresponding U.S. figures of \$50,660 and \$53,960, respectively. It is for this reason that the PPP version was selected, as I thought it would provide a more accurate reflection of a country's overall economic level.

The percentage of children under one year of age covered by the polio vaccine provides a good measure of overall vaccination coverage. It is correlated in our sample with the percentage of children under one year of age who receive the diphtheria, pertussis and tetanus 3-dose (DTP3) vaccine at 0.97. This variable was chosen over DTP3 largely because its kurtosis (5.32) and skewness (-2.04) were lower than those of DTP3 (9.22 and -2.63, respectively). This variable was not log transformed since the transformation (as in the case of DTP3) exacerbated the abnormality. The percentage of vaccination coverage ran from 30% in Equatorial Guinea to 99% in 30 different countries around the globe.

Total expenditure on health as a percentage of GDP (TEHPGDP) is the WHO estimate sum of all public and private expenditures as a percentage of purchasing power parity GDP (WHO 2011b). The variable had some kurtosis and skewness (2.74 and 1.27, respectively), which was reduced by the  $\log_{10}$  transformation to 0.342 and -0.267, respectively.

### *Hypotheses*

**H<sub>1</sub>:** The higher the proportion of government expenditure on health as a percentage of total expenditure on health, the lower the infant mortality. I expected there to be a significant inverse relationship between these two variables in a simple regression model as more people will have access to healthcare when the government helps in



reducing or eliminating financial barriers to care. I anticipated that the relationship would be sufficiently robust to remain significant in a multivariate additive regression models that control for the other variables included in this study.

**H<sub>2</sub>:** I expected that the higher the doctor density, the lower the IMR and I expect this relationship to be quite strong especially in a simple regression model. I anticipated that this relationship would remain significant when the other variables are added to the model. This reflects the importance of human resources for health as a central component of making health services and care available to the population (WHO 2006; Dussault and Franceschini 2006; Schrecker and Labonte 2004; Chen *et al.* 2004; Padarath *et al.* 2003). Additionally, I expect that a review of the scatterplot will reflect a relationship in which the effect tapers off after doctor density gets beyond a certain point and where it becomes more difficult to affect infant mortality.

**H<sub>3</sub>:** I expected there to be a significant interaction effect between GEHPTEH and GNI per capita. I hypothesized that there is a greater importance for GEHPTEH at lower levels of GNI than at higher levels. I suspect this because previously cited research has indicated an inverse relationship between GNI and the IMR. Thus, because the IMR cannot fall below zero and since high levels of GNI tend to indicate a low IMR, I expect the impact of GEHPTEH on the IMR to diminish at higher levels of GNI per capita.

### *Analysis and procedures*

SPSS was used for all statistical analysis. First, I examined simple regressions between each of the independent variables and the IMR. This provided some preliminary evidence toward evaluating H1 and H2. Scatterplots were examined to ascertain the

nature of the relationship between the IVs and the IMR. Here it became apparent that quadratic terms needed to be added to the models for GNI and doctor density. A cubic term was also added to doctor density, largely due to the particular spread of this data that led to too strong a quadratic pull. This had created a strong U-shape curve that implied a total reversal in the relationship between doctor density and IMR rather than a mere tapering off of its effect as we approach IMR's lower bound. The addition of the cubic term corrected that problem (see Figures 1a-1c). Following Cohen *et al.* (2003: 204) all independent variables were centered to avoid nonessential multicollinearity that results from the inclusion of polynomial or interaction terms. Although doctor density, and its quadratic and cubic terms will all be interrelated leading to higher multicollinearity among these terms even when centered, this phenomenon can be safely ignored (Cohen *et al.* 2003: 208).

Next, I conducted a bivariate analysis to examine relations among predictors. Here, it was noted that several variables were approaching 0.7 collinearity with GNI. Therefore, variance inflation factors (VIF) and the condition index were monitored throughout the process. However, even in models where the VIF is somewhat augmented among correlated control variables, this does not affect the reliability of the coefficients of the other independent variables (Cohen *et al.* 2003: 422). Since the primary purpose is to test the impact of GEHPTEH on the IMR while controlling for other predictors, the models were run and presented. Furthermore, when variables represent different concepts, researchers may proceed with caution depending on the level of multicollinearity. It should be noted that Cohen *et al.* (2003) reject the 'rules of thumb' (VIF  $\geq 10$  or condition index  $\geq 30$ ) regarding multicollinearity as too lenient for social

science research, demonstrating that it reduces the estimate's precision by increasing the standard error, no variable in any model in this research has VIFs or a collinearity index that even remotely approach the 'rule of thumb' values. Additionally, no changes in predictor signs were observed.

After the bivariate analysis, I added each of the other IVs in two-predictor models before developing more complex regression models. This allowed me to examine the effect of each IV in improving the model's predictive capacity and to analyze the effect of the controls on GEHPTEH's predictive power. The results of 11 regression models are shown. I report R-squares, unstandardized and standardized beta coefficients, standard error and significance of the predictors in all models.

Due to the importance of GNI per capita reflected both in my own study and in the literature, I calculated the GINI index for GNI (PPP) relative to the population. The

GINI was calculated using the formula  $G = \left| 1 - \sum_{i=0}^N (\sigma Y_i + \sigma Y_{i-1})(\sigma X_i + \sigma X_{i-1}) \right|$ . The GINI

was obtained by multiplying the per capita values by the population. A GINI score provides a number between 0 and 1 with 0 representing maximum inequality and 1 representing maximum inequality. This measure roughly captures between-country inequality in GNI per capita and does not capture within country inequality, contrasting each countries share of the total GNI (PPP) with its share of the population.

To prepare the interaction model, the centered  $\log_{10}$  of GNI per capita and GEHPTEH were multiplied together to create the centered cross product.

$\hat{IMR} = \beta_0 + \beta_1 GEHPTEH + \beta_2 \text{LogGNIpcap} + \beta_3 XPGNIGE H$  was the interactive model

used to test H<sub>3</sub>. Next, I provided a table with the relevant results and interpreted the

coefficients at low, mean and high levels of GNI. Finally, I provided two tables of the 15 countries with the highest and the lowest GEHPTEH to facilitate discussion.

### *Study limitations*

Ideally, this research would demonstrate the connections between GEHPTEH and IMR more clearly by accounting for country estimates of forgone care rates. These provide a measure for the amount of needed healthcare services that were needed but not obtained by a given population. According to the theory that GEHPTEH reduces financial barriers to care, there should be a strong inverse correlation between GEHPTEH and the forgone care rate, which in turn leads to worse health outcomes. Unfortunately, data for forgone care rates are presently unavailable at the international level.

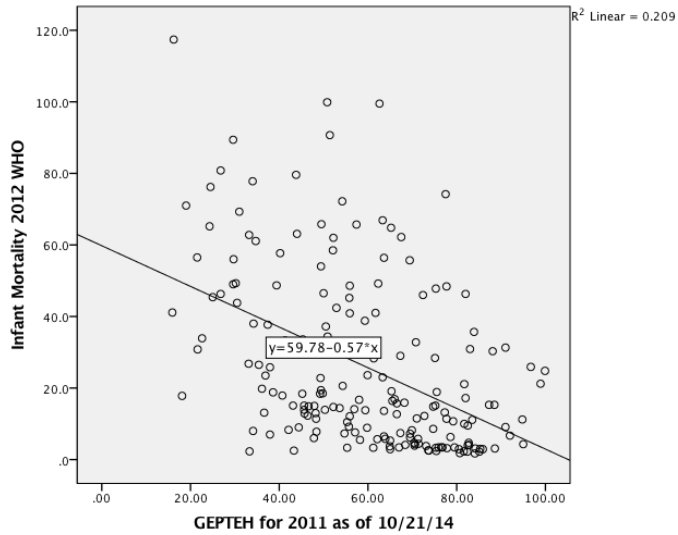
This study was also limited by the regularity of data reported for some variables. Initially, I wished to control for inequality while simultaneously examining its impact on the IMR. Unfortunately, many countries do not report their GINI coefficient, and for those who do, they are often for the most recent year available- data that is at times more than twenty years out of date. Similar problems affect data on union density. Also, both doctor density and GNI per capita are most recent year data, since in many cases those data were all that was available. In order to provide a longitudinal analysis, solid panel data needs to be available for each of the variables of interest. Since this study was limited in this way, it only provides a cross-sectional analysis of country characteristics using recent data. Finally, the data do not account for how public health spending is actually used, therefore the research could not identify which allocation strategies are most effective towards reducing IMR.

## RESULTS

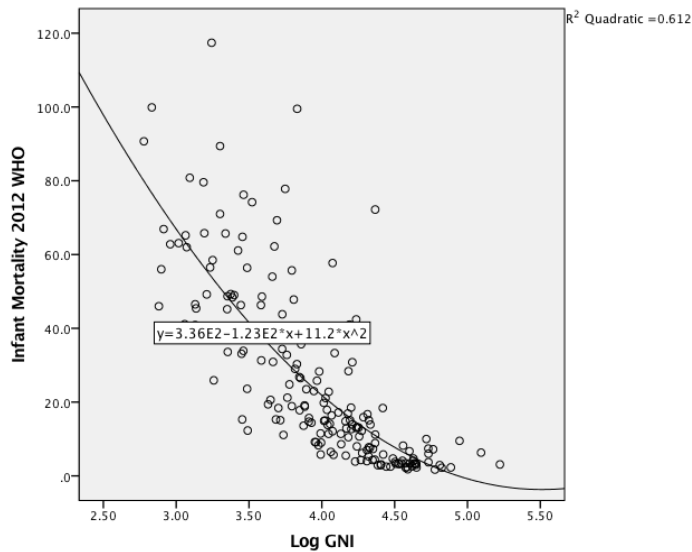
Using multiple regression analysis, I examined the specific contribution of each of public health and socioeconomic variable on variation in the IMR. Similar results were obtained (not shown) using the under-five mortality rate as the dependent variable in all tests. In this section I provide the simple regression coefficients of each of the explanatory variables regressed on IMR, bivariate correlations among predictors, additive regression models and lastly, I test for an interaction between GEHPTEH and log of GNI per capita.

Examining the simple regression coefficients regressed on the IMR, I observed that the largest negative effect (standardized) results from population with access to improved drinking water (-0.79) followed closely by GNI (-0.77), doctor density (-0.66), polio vaccination coverage (-0.58), GEHPTEH (-0.46) and lastly TEHPGDP (-0.13). Since TEHPGDP did not even produce a significant correlation with the IMR it was dropped at this point. The relatively low  $R^2$  for GEHPTEH (0.209) is not entirely surprising, given that IMR is a function of a plethora of proximate and distal factors. Nevertheless, the significant coefficients and critical theoretical and practical importance imply that this is still an important variable to include. By comparison, GNI and  $GNI^2$  produced an  $R^2$  of 0.612. Figure 1a illustrates the scatter of the countries and provides the simple regression equation and line for IMR as a function of GEHPTEH and the  $\log_{10}$  of GNI, respectively. Figure 1b indicates that as doctor density reaches 1 per 1000, there is a significant drop in the IMR, with a more modest impact after 2 per 1000, with the particular scatter in the data best explained with a downward S distribution and the

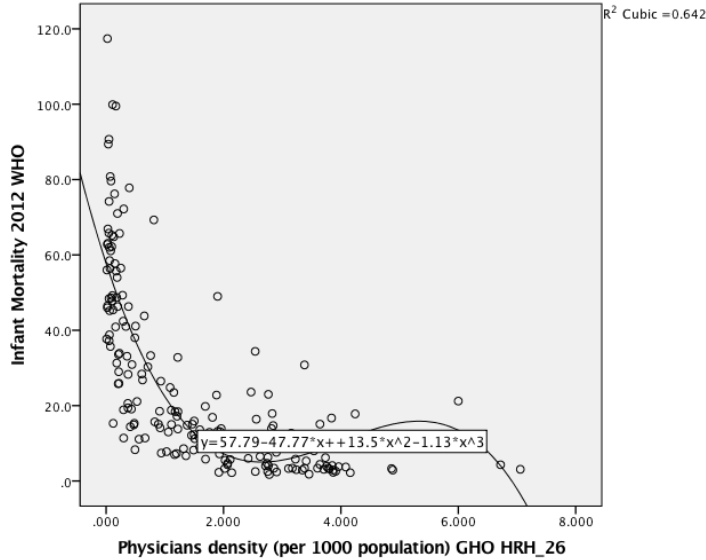
inclusion of a cubic term. This suggests that training and retaining an adequate number of physicians is of greater importance for countries with a doctor density score under one.



**Figure 1a:** Infant mortality rate as a function of GEHPTEH.



**Figure 1b:** Infant mortality rate as a function of LogGNIpc and LogGNIpc<sup>2</sup>.



**Figure 1c:** Infant mortality rate as a function of doctor density, doctor density<sup>2</sup> and doctor density<sup>3</sup>.

Reviewing Table 2, the strong inverse correlation observed between GNI and IMR reflects the well-documented inverse relationship between these two variables (Schell *et al.* 2007; Arik and Arik 2009; Filmer and Pritchett 1999). The simple regression coefficient for GEHPTEH provides some initial evidence in support of H<sub>1</sub> while the strong negative correlation between doctor density and IMR provides some support for H<sub>2</sub>.

**Table 2:** Correlation Coefficients

	GEHP- TEH	Doc Den	LogGNI pc	Polio Vac	LogTEH PGDP	Impr. Water	IMR 2012
GEHPTEH	1						
Doc. Density	0.37**	1					
LogGNIpc	0.44**	0.69**	1				
Polio	0.29**	0.40**	0.43**	1			

**Table 2:** continued

	GEHP- TEH	Doc Den	LogGNI pc	Polio Vac	LogTEH PGDP	Impr. Water	IMR 2012
LogTEHP GDP	0.16*	0.28**	0.03	0.23**	1		
Impr. Water	0.37**	0.57**	0.70**	0.55**	0.17*	1	
IMR2012	-0.46**	-0.66**	-0.77**	-0.58**	-0.13	-0.79**	1

Note: N=186 \*\* correlation significant at 0.01 \* significant at .05 level (two tailed test).

### *Relations among predictors*

Table 2 shows strong correlations of GNI with access to improved drinking water (0.70) and doctor density (0.69) indicating that variance inflation factors and other signs of collinearity need to be monitored when these variables are included in the same model. It must be noted that some other variables could not be included directly in the study to avoid multicollinearity. For example, for the 163 countries for which I had data on female literacy, the correlation between log of GNI and female adult literacy rate was 0.75. Also, the percent population with access to improved sanitation was correlated with the percent population with access to improved water sources at 0.76, and with GNI at 0.81. Thus, by controlling for GNI, we are in a loose way controlling for these other variables.



**Table 3a** Centered Predictor Additive Regression Models with IMR as Dependent Variable

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	25.99 (1.60)***	11.93 (1.74)***	22.79 (1.46)***	26.00 (1.36)***	26.15 (1.08)***	14.52 (1.90)
GEHPTEH	-0.57 (0.08)*** [-0.46]	-0.29 (0.06)*** [-0.23]	-0.19 (0.06)** [-0.15]	-0.39 (0.07)*** [-.31]	-0.23 (0.06)*** [-0.19]	-0.22 (0.06)*** [-0.18]
Doc. Density		-12.21 (0.93)*** [-0.75]				-8.50 (1.22)*** [-0.52]
Doc. Density <sup>2</sup>		7.80 (0.86)*** [1.12]				5.26 (0.98)*** [0.75]
Doc Density <sup>3</sup>		-1.04 (0.18)*** [-0.75]				-0.70 (0.19)*** [-0.50]
LogGNlpc			-31.34 (2.40)*** [-0.67]			-12.97 (3.19) *** [-0.28] 7.26 (3.32) * [0.09]
LogGNlpc <sup>2</sup>			11.75 (3.56)** [0.15]			
Polio vac.				-1.04 (0.13)*** [-0.49)		
Impr. water					-1.17 (0.8)*** [-0.72]	
R <sup>2</sup>	0.209	0.689	0.630	0.424	0.645	0.722
DF	1	4	3	2	2	7

Note: N = 186. Unstandardized coefficients with standard error in parenthesis. Standardized coefficients reported in brackets. \*P < .05 1 \*\*P < .01 \*\*\* P < .001

**Table 3b** Centered Predictor Additive Regression Models with IMR as Dependent Variable

	Model 7	Model 8	Model 9	Model 10	Model 11
Intercept	13.70 (1.67)***	17.30 (1.66)***	23.28 (1.34)***	24.66 (1.25)***	18.40 (1.81)***
GEHPTEH	-0.25 (0.05)*** [-0.20]	-0.19 (0.05)*** [-0.15]	-0.14 (0.06)* [-0.12]	-0.12 (0.05)* [-0.10]	-0.16 (0.05)** [-0.12]
Doc. Density	-10.68 (0.92)*** [-0.65]	-7.67 (0.98)*** [-0.47]			-5.96 (1.15)*** [-0.36]
Doc. Density <sup>2</sup>	6.80 (0.83)*** [0.98]	4.86 (0.85)*** [0.69]			3.71 (0.92)*** [0.53]
Doc Density <sup>3</sup>	-0.90 (0.17)*** [-0.65]	-0.64 (0.17)*** [-0.46]			-0.48 (0.17)** [-0.35]
LogGNlpc			-26.77 (2.32)*** [-0.57]	-17.99 (2.57)*** [-0.38]	-8.07 (2.98)** [-0.17]
LogGNlpc <sup>2</sup>			9.99 (3.27) ** [0.13]	5.09 (3.12) [0.07]	3.41 (3.03) [0.04]
Polio vac.	-0.48 (0.10)*** [-0.23]	-0.30 (0.09)** [-0.14]	-0.60 (0.10)*** [-0.28]	-0.38 (0.10)*** [-0.18]	-0.31 (0.09)** [-0.15]
Impr. Water		-0.54 (0.09)*** [-0.33]		-0.59 (0.10)*** [-0.36]	-0.45 (0.09)*** [-0.28]
R <sup>2</sup>	0.727	0.773	0.692	0.744	0.784
DF	5	6	4	5	8

Note: N = 186. Unstandardized coefficients with standard error in parenthesis. Standardized coefficients reported in brackets. \*P < .05 \*\*P < .01 \*\*\* P < .001

*Additive regression models*

As reported in Tables 3a and 3b, with the exception of LogGNIpc's quadratic term that lost significance in models 10 and 11, all variables maintained statistical significance in these models. The intercept is the predicted IMR when all variables are at their mean (for descriptive statistics see Table 1 above). Model 1 is the simple regression model using GEHPTEH as the sole predictor of IMR. Models 2-5 estimate the IMR as the function of GEHPTEH with one other variable (and if necessary their power polynomials). Of the first five models, Models 2 and 5 do the best job of predicting IMR.

GEHPTEH retains significance in all of these models and the  $R^2$  of these models improved significantly as compared to Model 1. However, a drop in the size of GEHPTEH's coefficient is largest when it is in the same model as GNI, likely as a result of the correlation between these two variables and/or as an artifact of the logarithmic transformation of GNI per capita. Even here, however, GEHPTEH's unique contribution to explaining IMR (it's  $pr^2$ ) is -.22. The standardized coefficients reflect that doctor density has a relatively larger impact upon the IMR than does GEHPTEH, while the quadratic term's positive value indicates that the negative impact of increasing doctor density of the IMR wanes as IMR approaches its lower bound which is in turn tempered by the cubic term. Thus, as we increase from a score of 1.59 (the mean) to 2.59 doctors per 1000 people the predicted IMR drops from 11.93 to 6.48.

In Model 3, the GEHPTEH was regressed on IMR controlling for GNI and its quadratic term, the standardized coefficient of GEHPTEH dropped to -0.152 but retained significance at 0.003. In this model,  $R^2$  increased modestly to 0.630 from 0.612 when GNI and the quadratic term are the sole predictors of IMR (not shown). Models 4 and 5

show that the percentage of children under 1 year who received the polio vaccine and the percentage of population with access to improved water both make significant contributions to the explanation of the variance of IMR when added to the model.

Models 6 through 11 combine the operationalized central concepts analyzed in this study. In model six we see that some of the effect of GNI's quadratic term is weakened, but remains significant. Estimating the net effect of the unstandardized beta for GNI on Model 6's intercept, a one-unit increase in the log of GNI per capita (the equivalent of country going from low average income to very high income, in our example, from a GNI of  $10^{3.97}$  or \$9332.54 to a GNI of  $10^{4.97}$  or \$93,325.43) would reduce the IMR by 5.71 deaths per 1000 live births ( $-12.97 + 7.26$ ). Some caution should be taken as doctor density's VIF is raised to 3.6 and GNI is raised to 3.0. Nevertheless, both coefficients remain largely interpretable since the confidence intervals for the beta coefficients never approach zero. Contrary to expectations, in this model doctor density ( $pr^2 = -.461$ ) and not GNI ( $pr^2 = -.29$ ) was the strongest predictor of IMR. In this model GEHPTEH's original contribution ( $pr^2 = -.28$ ) and to the model and its effect size approximate those of GNI.

Models 7 and 8 are both very strong, with Model 8 having a high  $R^2$  and low VIFs for doctor density and percent population with improved access to water (2.7 and 2.3, respectively). GEHPTEH's  $pr^2$  remains high in model 8 (-.27), although it drops somewhat in Models 9 and 10 to -.18 and -.17 respectively. Nevertheless, even in these models with reduced significance ( $p = 0.27$ ), GEHPTEH's upper bound of the confidence interval does not cross the zero point, allowing us to safely reject  $H_1$ 's null hypothesis. If, using model 8, we were to increase GEHPTEH's value ten points above the mean (to

69.43) and hold doctor density, access to better water sources and polio vaccinations at their mean, we would observe a 1.88 drop in the IMR from 17.30 to 15.42.

In model 11, due to doctor density being added to a model with GNI, we see that both GEHPTEH's significance and unique contribution improved to  $p = .003$  and  $pr^2 = .25$ , respectively. Although this model contains the highest multicollinearity, GEHPTEH's coefficients remain unaffected. GEHPTEH's VIF is low in all models, its highest value at 1.32 in model 11. Since doctor density and GNI's coefficients become somewhat unstable here, their precise beta values should be interpreted with greater caution (VIFs of 3.9 and 3.3, respectively). Also, GNI's confidence interval widens considerably here (-13.95 to -2.19) and its polynomial's confidence interval crosses the zero point but the beta does not change signs. The improved water variable's VIF increased only to 2.6, and retains a narrower confidence interval (-0.64 to -0.27).

Models 2, 6, 8 and 11 provide support for  $H_2$  (that doctor density adds to the explanation of IMR controlling for the study's other variables). These findings are consistent with Anand and Bärnighausen's (2004) study, which found that doctor density significantly added to the explanation of IMR while controlling for GNI, female adult illiteracy and income poverty. GNI's importance, in terms of its predictive power of the IMR and in its relation to other variables in this study, is reflected in all models in which it is included. Thus, I calculated the GINI coefficient for GNI (against its cumulative population) as 0.55, reflecting substantial inequality in GNI among countries. Finally, while GEHPTEH is not the strongest predictor, it contributed significantly to the explanation of IMR in all models, and in the expected direction leading to the rejection of

H<sub>0</sub> for H<sub>1</sub>. These models suggest that countries tend to experience lower IMR when governments cover a greater portion of the total health care bill.

*An Interactive model*

Next, I check for an interaction between GEHPTEH and GNI with IMR as the dependent variable to test whether GEHPTEH has a greater effect on reducing the IMR in poorer nations than in wealthier ones. Table 3 and the regression equations below provide evidence for the presence of an interaction effect between these predictors, indicating that GEHPTEH matters more in reducing infant mortality in poorer nations than in wealthier ones. Calculating GEHPTEH's effect at a given level of GNI, one observes that as income increases the effect of GEHPTEH becomes weaker until the effect in the model disappears around GNI per capita \$20,000. To illustrate, I ran a few cases through the interaction model. Examples of low, medium, and high values are given within the range of observed data and are presented in their natural (not logged) form to facilitate interpretation.

**Table 4:** Centered interactive model with IMR as dependent variable

Model	Unstandardized Coefficients		Standardized Coefficients		Collinearity
	B	Std. Error	Beta	Sig.	VIF
(Constant)	24.562	1.214		.000	
GEHPTEH	-.140	.065	-.113	.031	1.304
LogGNIpc	-33.230	2.366	-.713	.000	1.249
XPGNIGEHE	.316	.111	.132	.005	1.049

For low (2.97) GNI or -1.0 in centered model:

$$I\hat{M}R = [-0.14 + 0.316(-1)]GEHPTEH + [-33.23(-1) + 24.562]$$

$$I\hat{M}R = -0.456GEHPTEH + 57.792$$

For the mean GNI (3.97) represented as 0 in centered model:

$$I\hat{M}R = [-0.14 + .316(0)]GEHPTEH + [-33.23(0) + 24.562]$$

$$I\hat{M}R = -0.14GEHPTEH + 24.562$$

For high (4.30) or -.33 GNI per capita:

$$IMR = [-0.14 + .316(0.33)]\widehat{GEHPTEH} + [-33.23(.33) + 24.562]$$

$$I\hat{M}R = -0.036GEHPTEH + 13.926$$

So, in the case of low GNI (\$933) a country with a high GEHPTEH, say 89.43 or 30 points above the mean, would have a predicted IMR of 44.11, or a 13.68 reduction in the IMR as compared to a case where the country's GEHPTEH was at the mean (predicted IMR of 57.79). Likewise, if one reduces GEHPTEH when GNI is low, to 29.43 or 30 percentage points below the mean, an increase in the IMR by 13.68 to 71.47 would be observed. Given an average GNI (\$9,332) and a high GEHPTEH, the predicted IMR would be 20.36, or 4.2 fewer deaths per 1000 live births as compared to the mean GEHPTEH. In the case of high GNI (\$21,378) the impact of a high GEHPTEH versus the mean is minimal, with a reduction of 1.08 in the IMR and a predicted IMR of 12.85.

### *Implications of results*

One should keep in mind that while according to this study's models moving up one doctor per 1000 population leads to a significant drop in infant mortality, many physicians need to be trained and retained to achieve that. Furthermore, the curvilinear

relationship suggests that, as there is an increase in doctor density the impact on the IMR decreases. Similarly, the vast gulf between rich and poor nations reflects that it is difficult for a country to increase its GNI per capita sufficiently. Finally, increasing GEHPTEH, while important in its own right as a reflection of the government's role in reducing financial barriers to care, helps reduce infant mortality. Results of the interactive model indicate that GEHPTEH plays a much larger role in reducing infant mortality among poorer nations than among wealthy ones. These results support the importance placed on human resources for health and access to health care emphasized by the World Health Organization (2006, 2010).

Nevertheless, while all these variables are important, and a holistic approach would be ideal given abundant resources, many countries must be selective in designing strategies to reduce the IMR. These models and the bivariate correlation tables also suggest that many of these variables are interrelated. More human resources for health and increased GEHPTEH may help increase vaccine coverage, while higher GNI attracts more physicians and enables governments to invest in infrastructure that helps provide water to vulnerable populations. Ultimately, each country will have to decide how to allocate its resources in order to maximize the short and long term health impacts of those allocation decisions.

## **Discussion**

In this study, I found that all of the study's variables - except TEHPGDP - contributed significantly to the explanation of IMR. Below, I provide a discussion of countries with the 15 highest and lowest percentages of GEHPTEH followed by a



discussion of results of each variable in the context of other pertinent studies. I conclude the paper by providing suggestions for future research and by positioning the results within the present and historical contexts of austerity measures that tend to cut public health care spending.

**Table 5a:** Characteristics of the 15 countries with the highest GEHPTEH in 2011

Country	GEHPTEH	Doc. Density	GNI pc	Impr. Water	Polio Vac.	IMR
Tuvalu	99.9	1.09	5,990	98	97	24.8
Niue	99.8	6.00	5,800	99	98	21.2
Solomon Is.	96.7	0.22	1,810	81	86	25.9
Cuba	95.0	6.72	18,520	94	98	4.3
Seychelles	94.8	1.51	23,270	96	98	11.2
Brunei	92.0	1.36	39,943	...	90	6.7
Daruss						
Micronesia	91.0	0.18	3,840	89	98	31.3
Cook Islands	91.0	2.89	9,100	100	81	9.1
Monaco	88.6	7.06	167,021	100	99	3.1
Samoa	88.5	0.48	4,840	99	95	15.3
Nauru	88.1	0.71	6,746	96	79	30.3
Vanuatu	87.3	0.12	2,840	91	67	15.3
San Marino	85.9	4.89	64,480	...	96	2.9
Denmark	85.3	3.24	44,440	100	94	3.0
Norway	85.1	4.16	66,520	100	95	2.2

**Table 5b:** Characteristics of the 15 countries with the lowest GEHPTEH in 2011

Country	GEHPTEH	Doc. Density	GNI pc	Impr. Water	Polio Vac.	IMR
Liberia	29.7	0.01	790	75	93	56.0
Tajikistan	29.6	1.90	2,500	72	56	49.0
Chad	29.6	0.04	2,000	51	96	89.4
Yemen	26.8	0.20	3,820	55	78	46.3
Guinea-Bissau	26.8	0.07	1,240	74	89	80.8
Uganda	25.0	0.12	1,370	75	82	45.4
Côte d'Ivoire	24.5	0.14	2,900	80	83	76.2
Guinea	24.3	0.10	1,160	75	64	65.2
Cambodia	22.6	0.23	2,890	71	95	33.9
Azerbaijan	21.6	3.38	16,180	80	92	30.8
Haiti	21.5	0.25	1,710	62	67	56.5
Afganistan	19.0	0.19	2,000	64	71	71.0
Georgia	18.1	4.24	7,040	99	93	17.8
Sierra Leone	16.2	0.02	1,750	60	91	117.4
Myanmar	15.9	0.50	1,144	86	87	41.1

### *A look at the extremes*

Tables 5a and 5b show the scores of key variables<sup>9</sup> for the countries whose government expenditure accounted for the most and the least of the total health care bill, respectively. It is noteworthy that the majority of the 15 countries in Table 4a are small island nations. While some of the countries in Table 4a have high GNI per capita, nine have GNI under \$20,000, and eight have GNI under \$10,000 in PPP dollars. Among the countries with the highest GEHPTEH, those with the highest IMR (Micronesia, Nauru and Solomon Islands) have very low doctor density, indicating serious problems in sufficient human resources for health, while 19% of the population of the Solomon

<sup>9</sup> GNI is presented in its natural (not logged) form to facilitate interpretation.

Islands lack access to improved drinking water sources and 14% of children under 1 year of age have not received their polio vaccine.

Though each of these three countries also had a low GNI, some interesting exceptions (Cuba, Cook Islands, Vanuatu, and Samoa) seem to reflect that an increased portion of public healthcare spending has helped some poor countries overcome a low GNI when accompanied by high access to clean water, high doctor density, and/or vaccination coverage. This suggests that although improving access to clean water is highly correlated with GNI, it may be among the more feasible steps that countries with low income can take to reduce IMR.

Nevertheless, increasing GEHPTEH and improving access to clean water alone is not enough. Based on model 11, the Solomon Islands' *predicted* IMR would be 40.6 (14.7 infant deaths more than the actual figure), and while their high GEHPTEH reduced the predicted IMR by 6 infant deaths, increasing doctor density to the mean value of 1.49 from 0.22 would decrease the predicted value by 16.3 deaths per 1000 live births. If Solomon Islands increased access to clean water supplies to our sample mean of 88.13, the predicted IMR would drop by 3.2 infant deaths. Thus, model 11 suggests that the most important step to improve health outcomes in the Solomon islands is to train and retain more physicians.

Table 5b examines the opposite side of the spectrum regarding public health expenditure. Here I note the deviant case<sup>10</sup> of Georgia as a country that has a highly privatized health care system with relatively medium income and moderately low infant mortality. Nevertheless, Georgia has high doctor density, and all of its population has

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<sup>10</sup> Singapore and Lebanon are other exceptions, 21<sup>st</sup> and 24<sup>th</sup> lowest GEHPTEH, respectively. They both had very low IMRs of 4.56 and 6.28 in 2012, respectively. Singapore's high income per capita, however, partially helps explain its success at 76,850 for 2013, which is higher than the GNIs of Norway, Denmark and the Netherlands.

access to clean water. Most concerning, however, are the cases of Sierra Leone, Chad, Guinea Bissau, and Afghanistan. These countries suffer from low physician density, high poverty, and poor access to clean water. Furthermore, when residents of these countries do have access to a physician, the bill or cost of insurance is the individual's responsibility. The IMR for these countries suggests that this combination is devastating.

For example, Guinea Bissau's predicted IMR using model 11 is 62.5 (18.3 fewer than the reported figure) if increasing its GEHPTEH from 26.8 to the mean of 59.4, the predicted IMR would drop to 57.3. However, according to model 11, if Guinea Bissau increased its doctor density to the mean of 1.49, this would reduce the county's IMR by 19.3. In addition, Guinea Bissau's lower than average percent population with access to improved water supplies contributes 6.4 infant deaths to the predicted value.

### *GNI per capita*

My results show that the GNI has the second largest effect on reducing the IMR in our linear multivariate models. This finding is generally consistent with the results of previous research (Arik and Arik 2009; Schell *et al.* 2007; Filmer and Pritchett 1999; Pritchett and Summers 1996). Consistent with our results, Arik and Arik (2009) found that the effect of GNI per capita on the IMR tapers off as IMR approaches its lower bound.

Although I did not have sufficient data to include measures of within country inequality in the study, due to the importance of this variable in predicting IMR (both directly and indirectly) I asked in the introduction how unequal is the distribution of GNI per capita between countries. Considering each country as an individual case (since I am

already dealing with income *per capita*), I calculated the GINI coefficient as 0.55. This means that the between country income distribution is highly unequal, and this study's findings suggest, that this translates into highly unequal life chances.

### *Doctor density*

Similar to Anand and Bärninghusen's (2004) cross-country study, my findings show doctor density contributes to the overall explanation of IMR (and CMR) in the expected direction. These findings differ from Arik and Arik's (2005) results that did not find doctor density to be a significant predictor of IMR in their provincial level study of IMR in Turkey. Arik and Arik offer the reduced variation of physician density resulting from Turkey's policy requiring physicians to serve in rural areas as a possible explanation.

Gbesemete and Jonsson (1993) found mixed results concerning the significance of physician density in their cross-country study of 28 countries in Africa. My results are consistent with their second OLS model that found a statistically significant inverse relationship for physician density while controlling for seven other variables including GDP. I speculate that the lower coefficients and statistical power obtained for this variable in Gbesemete and Jonsson's study could have resulted from the small sample size imposed by their specific research question. My study's finding that showed that increasing doctor density had the largest effect in reducing the IMR provides further support for the WHO's (2006) emphasis on addressing global disparities in human resources for health.

*GEHPTEH*

Since I am unaware of other studies that have used this particular variable as a predictor of IMR, I can only compare these findings with research on the impact of public health care expenditure in general. An increase in GEHPTEH is not the same as an increase in government spending per se, but is an increase in the government's share of spending *relative to* the share of private insurance and out of pocket expenditure. Despite the distinction between GEHPTEH and aggregate government/public health care spending one may reasonably expect that the relationship between each of these variables and the IMR to be similar. In this regard, these findings are consistent with May and Smith (2011) that found a robust inverse relationship between public health care spending and the IMR using U.S. county and city data.

My results appear somewhat inconsistent with Filmer and Pritchett's (1999) results. They found a small but significant correlation for public spending on health with the CMR and an insignificant relationship with the IMR when accounting for eight other variables including GDP per capita. My findings are also relatively inconsistent with Schell *et al.* (2007). As in these studies, the inclusion of GNI did reduce GEHPTEH's effect size in the overall model, but in the case of using the log of GNI (PPP), GEHPTEH retained significance. This could be attributable to the inclusion of smaller island countries that have relatively small GNI per capita but high GEHPTEH, or to my choice of expenditure measure. The choice of measures was theoretically informed as GEHPTEH approximates the levels to which a government reduces financial barriers to health care access through increased expenditure.

The results of the interaction model tends to support the findings of Houweling *et al.*'s (2005) study which found that public health spending had a stronger impact in reducing the IMR in poorer countries than in wealthier ones.<sup>11</sup> This model suggests that a 10-percentage point increase in GEHPTEH would result in 4.56 fewer deaths per 1000 live births for poorer countries. Thus, although there are many high-income countries (Monaco, Norway, Denmark) that have both high GEHPTEH and very low IMR, this model indicates that the more significant partial effect of GEHPTEH originates from poorer countries whose scores on IMR are lower than GNI alone would predict.

While in part the limited impact in wealthier countries may be related to the fact that they are closer to IMR's lower bound, it may also be overshadowed by these nations' accumulation of other advances in public health care and education (i.e., greater portion of population with access to better sanitation and water supplies, higher female literacy rates etc.). Although higher GEHPTEH is associated with lower IMR, increasing GEHPTEH should not be construed as sufficient to address the challenges in improving health outcomes nor as a succinct and inclusive measure of public health. Other measures, such as the percentage of the population with access to clean water and sanitation are central to public health and IMR reduction.

These results provide empirical support for the hypothesis that the greater the GEHPTEH the lower the IMR. I suggest that this is likely the case for two reasons. First, GEHPTEH is strongly inversely correlated with out of pocket expenditure on health as a percentage of total expenditure on health (-0.858), indicating that the higher the GEHPTEH the lower the financial barriers to care. Secondly, poorer populations are

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<sup>11</sup>It should be noted, however, that a strong inverse bivariate correlation exists between GEHPTEH and IMR (-.549  $p < .001$ ) for the 33 OECD countries that comprise a sub-sample of this research.

poor sources of effective demand despite having an abundance of health care needs, and thus would likely not attract the necessary health services when the bulk of the financing of these services is relegated to the private sector.

### *Research and policy implications*

This research opens up potential directions for future research. The importance of income on the IMR suggests that policies should be examined not only regarding overall national growth but also on their ability to reduce between-country inequality. Further research should also be pursued on the relationship between within-country human resource for health density and health care outcomes. Another potential avenue for future research would be to analyze the impact of GEHPTEH on IMR over time both among and within countries. Finally, future research could examine the connection between GEHPTEH and the forgone care rate given reliable estimates of the latter.

These findings reinforce the importance of a rights-based approach to health care financing and are pertinent to the international, and potentially national, efforts to reduce infant and child mortality. One of the central arguments of proponents of neo-liberal policies is that governments are inherently inefficient and, in terms of health care, private sector control, provision and financing would lead to better health outcomes. If this were true, however, one would expect a positive (rather than an inverse) association between GEHPTEH and IMR. The results of this research are thus wholly inconsistent with the neoliberal paradigm.

The focus on GEHPTEH is particularly pertinent given that many countries feel pressured to pursue austerity policies in the wake of ongoing economic difficulties.



Many of these austerity measures are aimed at decreasing the role of government in health care provision and finance (Kentikelenis *et al.* 2014; Hermann 2009) and more recent neo-liberal policies have been detrimental to health care outcomes, by increasing inequality and creating more barriers to health care services (Palma-Solis *et al.* 2009; SAPRIN 2004; Schoepf *et al.* 2000;). Likewise, according to my research, governments that cover more of the total financial healthcare burden tend to have lower IMR particularly among poor counties. This research thus suggests that reductions in GEHPTEH may be harmful to the goal of improving healthcare outcomes, particularly among poorer countries.

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### CHAPTER 3: HEALTH AND DEVELOPMENT CHALLENGES: A NESTED TYPOLOGY OF 123 DEVELOPING COUNTRIES

A paper to be submitted to *International Journal of Health Services*

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#### **Abstract**

Although previous researchers have analyzed development dynamics and theories as well as the relationship between societal level health outcomes and various indicators of development, relatively few have provided typologies of health and development. Health and development typologies enhance understanding of which countries are most similar in terms of the key variables that serve as the basis for clustering. These classifications can then facilitate comparisons of the various health and development types identified in the analysis and assist in the generation of appropriate policy strategies. Due largely to problems of insufficient data, previous studies have focused on wealthier nations' political, developmental and health indicators.

This study contributes to the social science literature on health and development by creating a nested typology of non-OECD countries to more precisely understand the nature of the challenges facing them. Developing nations are classified using cluster analysis based on eight key health and development factors: income inequality, GNI per capita, under-nutrition, government share of total expenditure on health, total expenditure on health as a percentage of GDP, DPT3 vaccination coverage, number of physicians per 1000 people and infant mortality. We find tiers of country clusters characterized by above average health and development, high inequality, and below-average health and

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development. These tiers then subdivide into nine relatively distinct groupings. By identifying groupings of countries that share in particular arrangements of health and development challenges this research may assist policymakers, and health and development scholars to identify broad but appropriate strategies for country clusters.

## **Introduction**

Theoretical and empirical research on health and development has focused on dynamics of socioeconomic development relationships between societal level health outcomes and indicators of development. Development has been seen by some to be largely a product of policies that favor foreign investment and economic growth, often measured in terms of GNP (e.g., Marquardt 2005; Dollar 2001) while others (e.g., Krutzman 2008:679; Gershman and Irwin 2000; Jaffe 1998:8) have argued that economic growth by itself is an inadequate measure of development, since the costs and benefits of that growth may be very unequally distributed. Other measures such as whether production is geared towards internal and/or external markets, access to adequate productive technology, the degree of income and wealth inequality, the nature of class relations, infrastructural development, political and socioeconomic independence, population health, educational and nutritional indicators, diversity of exports, governmental redistributive policies and ecological sustainability are considered important components of development (Amin 2013; Gershman and Irwan 2000:17-18; Foster 1999; Jaffe 1998; Rodney 1972). Other significant bodies of research (e.g., De Vos and Van der Stuyft 2015; Arik and Arik 2009; Palma Solís *et al.* 2009; Leys 2009; Shandra *et al* 2004; Millen and Holtz 2000) have focused on the relationships among aspects of political economy, development indicators and population health.

The goal of this paper is to construct a typology of health and development for developing, primarily non-OECD countries. There have been relatively few studies leading to taxonomies of health and development, with the majority of studies focused on the developed world, due in part, to the greater availability of data. This research adds to the existing health and development literature by creating a nested taxonomy of primarily non-OECD countries that cluster around particular scores on key health, health system and socioeconomic development variables.

These variables include gross national income per capita (GNIPC), the government's share of total health expenditure (GEHPTEH), income inequality (GINI), physician density (number of doctors per 1000 people), the percentage of children under age five that are underweight (U5UW), the percentage of children under age one that have received the diphtheria, pertussis and tetanus (DPT3) vaccine, total expenditure on health as a percentage of GDP (TEHPGDP), and the infant mortality rate (IMR). GNIPC provides an overall measure of a country's economic level and is a known determinant of cross-national variation in health outcomes. The GINI measures how unequal a nation's income is distributed and is also considered a determinant of health outcomes. GEHPTEH measures the degree of government's share of health financing in a given country. TEHPGDP furnishes an idea of how costly care is in a particular country. Physician density is an important element in health systems, since a health system cannot function effectively without sufficient doctors or other health professionals. U5UW provides a measure of the degree of hunger in a country, and by extension, of food security. The level of DPT3 vaccination coverage imparts a measure of the level of epidemic and illness prevention. Finally, in addition to being a direct measure of infant



survival, the infant mortality rate (IMR) is a good general indicator of health outcomes in a society. By clustering developing countries based on these variables we are sure to obtain a typology that captures vital facets of health and development.

Below, we provide a brief review of the health and development literature focusing primarily on relationships among various socioeconomic variables and health outcomes, with an emphasis on variables that are included in this study followed by a review of key studies that have provided health and development typologies and/or ‘welfare regime’ typologies linked to health outcomes. Immediately following the typologies in health and development research sub-section, we highlight the unique contribution of this research and introduce a conceptual model for health and development that reflects relations among variables. This is then followed by a discussion of methods and presentation of the research findings. This paper concludes with a discussion of the implications of the findings and suggestions for future research.

### *Development and health*

Much research has indicated links between important aspects of development and population health. Higher GNIPC and/or gross domestic product (GDP) per capita are related to better population health indicators up until a level after which, other variables explain remaining variation (Arik and Arik 2009; Schell *et al.* 2007; Prichitt and Summers 1996). Many researchers (e.g., Wilkinson and Pickett 2006; Wilkinson 1992; Schell *et al.* 2009; Lynch *et al.* 1998) have also conducted studies indicating that income inequality leads to worse health outcomes, although others (Rajan *et al.* 2013; Avendano 2012) did not find significant relationships when controlling for other economic

variables. Taken together, however, the research suggests that inequality (in addition to poverty) is deleterious to population health outcomes. This may occur either through a relationship with increased poverty for the many or indirectly through psychological stresses that result from a decline in social cohesion originating from increased relative deprivation, as Wilkinson (2006) suggests. Other socioeconomic determinants of population health outcomes, such as infant and child mortality rates, include the average educational level of the population and female literacy rates (Song and Burgard 2011; Filmer and Pritchett 1999), percentage of the population with access to clean water and sanitation (Urdinola 2011; VanDerslice, Popkin, and Briscoe 1994) and quality of housing (Urdinola 2011).

Another key socioeconomic determinant of health outcomes is the nature of the healthcare system itself. The WHO (2010) has argued that universal health coverage is a central element in reducing barriers to care and that reducing direct out of pocket payments for services is especially important. In a previous cross-sectional study, Christiansen and Mazur (unpublished) showed how GEHPTEH was inversely related to the IMR while controlling for GNI per capita (PPP), doctor density, percentage of children under one year of age vaccinated for polio, and percentage of the population with access to improved water sources. A higher GEHPTEH reflects a lesser degree of privatization of health care financing, an important element of healthcare systems.

Navarro (1993) showed that in advanced capitalist countries, whether healthcare system financing is primarily linked to employment with non-comprehensive means tested programs targeting poorer populations, or whether there is a universal public healthcare system in place, is largely determined by the balance of class forces. It is thus

not surprising that neoliberal policies, consisting of privatization and shrinking roles of the state have had detrimental effects on health in many countries (Laurell 2015; Rao 2009; Coburn 2009; Mohan 2009; Farmer 2005; Field, Kotz and Bukham 2000).

Neoliberal policies lead directly to a reduction in the role of state services, reduced tax revenue, erosion of social, environmental and worker protections, and to increased global and domestic inequality. A downward spiral intensifies through intense interstate competition for foreign direct investment often to gain access to critical technologies or through pressures, or as part of austerity packages imposed by international financial institutions, as more countries choose an export oriented industrialization strategy based on foreign capital investment (Harvey 2005). Ultimately, the higher rates of surplus value extracted and held on to by multinational corporations are linked to both poorer health and lower social cohesion (Coburn 2004).

#### *Typologies in health and development research*

With few exceptions (e.g., Wood and Gough 2006), most of the research that has either developed a typology of countries for studies in health and development or utilized a typology as a predictor variable for population health outcomes has focused on wealthier countries (Karim, Eikemo and Bambra 2010; Chung and Muntaner 2007; Navarro and Shi 2001; Epsing-Anderson 1990). Navarro and Shi (2001) adapted a four-class typology from Huber and Stephens (1998) that divided developed capitalist countries according to welfare governance type as defined by the political orientation of the party that governed the country (social democratic, Christian democratic, liberal and fascist) for the greatest portion of the 1946-1980 period. They found that the social

democratic countries had considerably greater working class power (measured by higher union density), higher taxes as a percentage of GDP, lower inequality, higher percentage of the population publically employed in health, education and welfare, a higher proportion of women in the labor force, and more universal coverage. Their results also showed that Social Democratic countries exhibited lower average IMR for each decade during 1960-1996 than each of the other governance types.

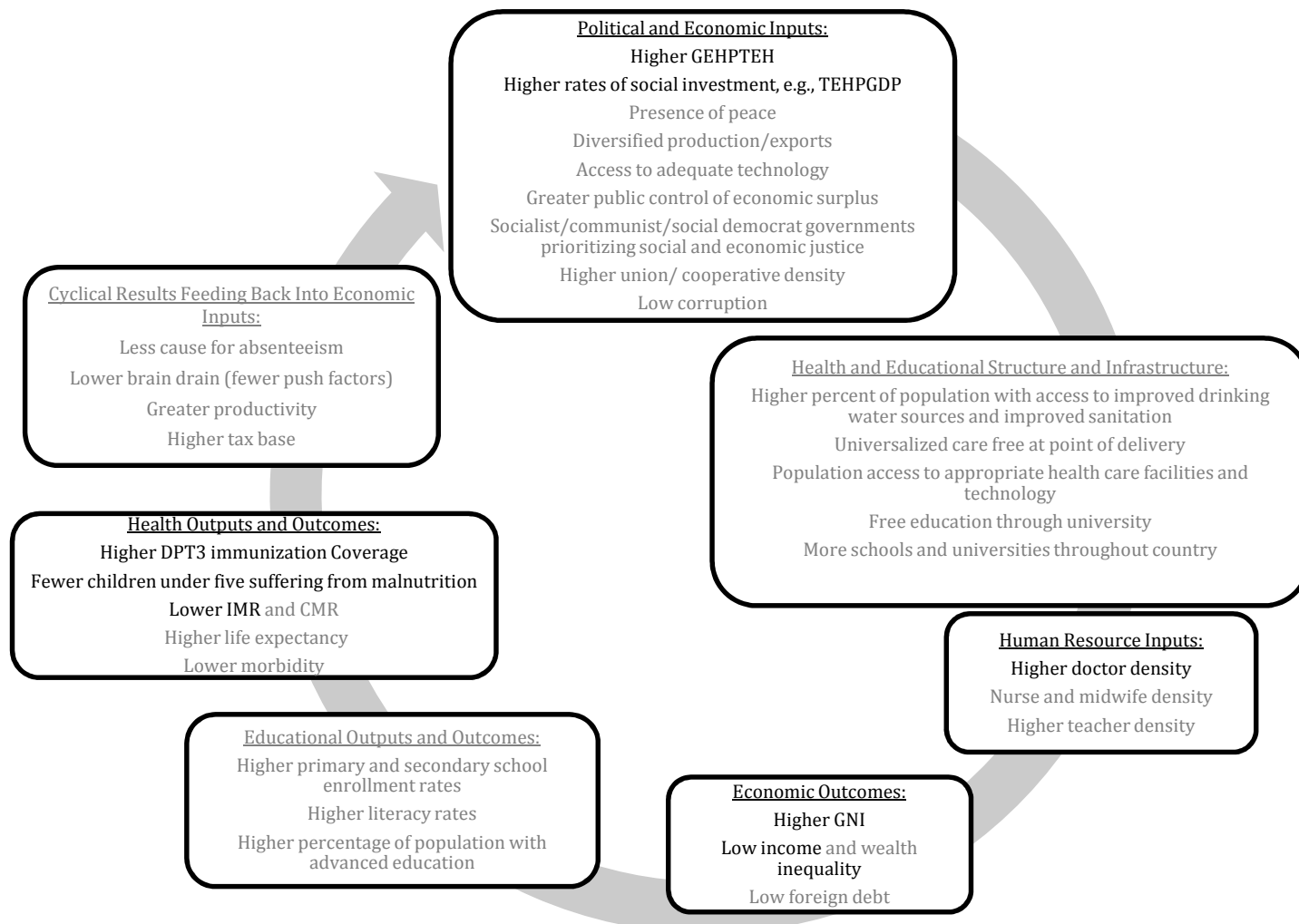
Chung and Muntaner (2007) provided further support for Navarro and Shi's (2001) findings that welfare regime type was significantly related to better health outcomes in longitudinal multilevel models controlling for (log) GDP per capita. They showed that the populations of social democracies (Sweden, Norway, Denmark and Finland) had better health indicators (measured by infant mortality and low birth weight) than other welfare regime types. Karim *et al.* (2010) used a one-way ANOVA to test whether significant differences existed in terms of life expectancy, IMR, GDP per capita, social expenditure as a percentage of GDP, and TEHPGDP between regime types. They used a six-class regionalized typology based on geographic region and specifically incorporated an East Asian welfare state type into the model. The welfare-regime types that they used were Scandinavian, Anglo-Saxon, Bismarkian, Southern, Eastern European, and East Asian. They found significant differences in each of the variables by welfare state type. They further showed that the East Asian welfare state type performed much better than would be expected based on GDP per capita, and social and health expenditures in health outcome indicators. They suggest that this may be due to different cultural dietary patterns and lower rates of smoking.

Still, few researchers have sought to establish typologies of health and development among poorer countries. In one such study, Wood and Gough (2006) created a global typology of security regimes focusing on developing/underdeveloped countries. The crux of their argument is that for poor countries to improve their social-development outcomes they need to undo ‘clientelist’ political-economic forms and establish formalized rights structures. Using a k-means cluster analysis, Wood and Gough (2006) divided 61 countries into four distinct clusters, based on human development index (HDI) score, public expenditure on education and health as a percentage of GDP, and the total remittance flow of émigrés plus international aid as a percentage of GDP. Their typology was divided as follows: “Actual or potential welfare regimes” were predominately Eastern European countries but also included Kenya, Thailand and several Latin American countries that exhibited high social spending with generally positive social development outcomes. “More effective informal security regimes” were a mix of Asian, Middle-Eastern and Latin American countries that had relatively positive social development outcomes but displayed low average state spending and aid/remittance inflow. “Less effective informal security regimes” were South Asian and a few sub-Saharan African countries and were characterized by “poor levels of welfare coupled with low public commitments and moderate international flows” while “insecurity regimes” were comprised of only sub-Saharan African nations that depend on aid/remittances almost entirely and exhibited very poor social development outcomes (Wood and Gough 2006: 1703-1704).

*Direction of this research*

This research is distinct from the previous typologies that have predicted particular health and development results from a variant of a welfare-state typology. In this research we used eight socioeconomic health and development indicators with a hierarchical agglomerative cluster analysis for 123 non-OECD countries to construct a nested taxonomy of health and development. The goal of this research is not to replicate Human Development Index rankings, but rather to examine country groupings based on the variables listed below in Table 1. From there, the salient characteristics of each cluster are identified reflecting more specifically the particular health and development challenges faced by countries in each grouping.

Figure 1 provides a model for a virtuous circle of health and development. Elements in black are variables used in the cluster analysis, while the elements in grey are considered important, but were excluded from the clustering process due either to insufficient data or excessive multicollinearity with other variables used in the cluster analysis. Starting at the top of Figure 1, the first two boxes represent a high degree of political-economic sovereignty and greater workers' power, which are necessary to gain greater public control of the social surplus and decommodification of social benefits, such as health and education provision. These factors would ideally lead to a greater capacity to develop human resources (which then are fed back into the cycle as inputs) and to better and more equitable economic, educational and health outcomes that, in turn, feed back into the system completing the virtuous circle of equitable health and development.



**Figure 1: Virtuous circle of equitable health and development**

### *Research limitations*

This cluster analysis uses variables that capture particular characteristics of nation-states but does not encapsulate the relations between these countries and the wealthier nations, or between these countries and industry, transnational corporations or international financial institutions. Likewise, between country capital, import and export flow dynamics are not evaluated. This study also does not reflect within country inequalities (by province or district) in doctor density, vaccination rates or IMR. These are important considerations because physicians tend to be concentrated in more developed/ urban areas, leading to salient geographic variations in vaccination rates and IMR between a country's urban and rural areas (Dussault and Franeschini 2006). Finally, this typology is derived from cross-sectional data and is not based on change over time, and therefore cannot measure the level of potential dynamism between typological categories.

### **Data and Methods**

The goal of this research is to construct a typology of health and development among non-OECD countries. The primary way to create an empirically based classification of cases is cluster analysis. Here we used Ward's Method, a form of hierarchical agglomerative cluster analysis, to group cases into clusters. The variables were standardized and the analysis was run in SAS. The number of clusters was determined by a variety of traditional and statistical diagnostic criteria, and the clusters were named based on an examination of the mean scores, standard deviations and ranges of the variables in each cluster.



*Data Sources*

Data for 123 developing countries were obtained primarily from the World Bank (WB) and the World Health Organization (WHO) Global Health Observatory Data Repository. The goal for the data gathering stage was to acquire recent data for as complete a set of countries as possible within close temporal proximity to obtain an accurate snapshot of the countries health and development profile. Data for purchasing power parity gross national income (GNI) per capita and the GINI coefficient for 2012 or most recent year available were obtained primarily from the WB, while data on infant and child mortality rates (2012), the percentage of children under one year of age that have been vaccinated by the diphtheria, pertussis and tetanus (DPT3) vaccine (2012), physician density per 1000 (most recent year), the TEHPGDP (2011) and GEHPTEH (2011) all come from the WHO. Some estimates for the GINI coefficient were gathered from Global Peace Index when they were not available from WB. Data on the 2008-2012 estimates for the percentage of children under-five that are underweight were gathered from the International Food Policy Research Institute (IFPRI).

*Variables and Assumptions*

Table 1 provides a list of variables used in this research, their description, and the source of the data. Table 2 provides descriptive statistics for each of the variables used in the study. In Table 2, the values are for the raw (non-standardized) scores of the variables over the data set. Table 3 provides a correlation table for the study's variables.

**Table 1: Variables and their Descriptions**

Variable Abbreviation*	Description	Source
ZGNIPC	The log <sub>10</sub> of gross national income in purchasing power parity dollar per capita in 2013	World Bank
ZGINI	GINI coefficient for 2012 or most recent year	World Bank/GPI
ZU5UW	2008-2012 estimates of the percentage of children under the age of five that are classified as underweight	IFPRI
ZDocDen	Number of doctors per 1000 population in 2012 or most recent year	WHO
ZDPT3	Percentage of infants under the age of one year that have received the diphtheria, pertussis, and tetanus vaccine in 2012	WHO
ZTEHPGDP	The log <sub>10</sub> of total expenditure on health as a percentage of gross domestic product in 2011	WHO
ZGEHPTEH	Government expenditure on health as a percentage of total expenditure on health in 2011	WHO
ZIMR	Number of children per 1000 live births that die before reaching their first birthday in 2012	WHO

\*Z indicates that the variable is presented in standardized Z-score values.

Table 2 shows that GNI per capita among our non-OECD countries is relatively modest, but with considerable variance. The GINI coefficient measures inequality of the distribution of an asset (a score of 100 indicates perfect inequality while a score of 0 indicates perfect equality). Average inequality among these countries was relatively high and varies considerably. While the average level of doctor density does not appear to be a major problem, the high standard deviation and minimum scores indicates that physicians are concentrated in some nations. The percentage of children under the age of five underweight reflects, “wasting, stunted growth or both” (Grebmer *et al.* 2013: 7). Roughly 12% of the non-OECD world’s children are underweight and almost 90%

receive the DPT3 vaccination. TEHPGDP varies considerably, while the governments' share of total health care spending averages just over half. Most concerning, however, is that the average IMR for the countries is quite high with significant variation, with one country, Sierra Leone, having an infant mortality rate (IMR) of 117.4.

**Table 2:** Descriptive Statistics for 123 Countries

Variable	Mean	Standard Deviation	Min	Max
GNIPC	11,179.67	15,361.26	600.00	123860.00
GINI	41.71	9.05	26.00	64.00
U5UW	12.16	10.54	0.30	45.30
DocDen	1.20	1.30	< 0.01	6.72
DPT3	87.54	12.83	26.00	99.00
TEHPGDP	6.26	2.77	1.65	19.48
GEHPTEH	53.03	17.84	15.90	95.00
IMR	33.44	25.50	2.90	117.40

The first assumption of cluster analysis is that all of the variables are on the same scale. If they are not, standardization is recommended (Aldenderfer and Blashfield 1984: 20). Since the variables gathered were on different scales, the variables were transformed to their Z-scores to conduct the cluster analysis.

Although avoiding multicollinearity is not a crucial requirement of cluster analysis, variables that are collinear act as an implicit weight on the concept measured. For this reason, certain variables that were gathered initially for the research could not prudently be included in the cluster analysis. These include the female literacy rate, the percentage of the population with access to improved water supply and the percentage of the population with access to improved sanitation. These are all highly interrelated and each is highly negatively correlated with the IMR at -0.79, -0.73, and -0.81, respectively.

Since IMR is highly correlated with other essential variables included in this cluster analysis (DocDen, GNI per capita), there is already an implicit weight on IMR in

this study; while the argument could be made that these variables measure unique concepts, their inclusion would apply excessive weight on IMR. While the inclusion of doctor density as a measure of human resources for health (HRH) and GNI per capita as a measure of a country's overall level of wealth relative to population size is deliberate, adding even more weight to the concept represented by IMR by including female literacy rate or the percentage of the population with improved water supply would have created too strong bias in the analysis. Nevertheless, the presence of correlated variables implies causal relationships among elements influencing cluster formation. As Table 3 shows, GNI per capita and IMR are the only included variables included that have a correlation over 0.7.

Another requirement of cluster analysis is to address outliers. Four of the variables had no outliers and ZU5UW and ZIMR had one case each over three standard deviations from the mean (Timor-Leste and Sierra Leone, respectively). ZDocDen had one outlier (Cuba) at 4.23 standard deviations above the mean while ZDPT3 had four outliers (in part due to its left skew) one of which (Nigeria) was 4.80 standard deviations from the mean. A potential solution is to winsorize the data, by reducing all extreme values to roughly no more than a value of three standard deviations away from the mean. A winsorized nine-cluster solution was run; and while slightly different mean values were obtained on these variables, cluster membership was identical to the non-winsorized version. Since these cases represent actual values and not errors of data entry, we use the non-winsorized results.

Although normality is not an assumption of cluster analysis directly, it is a requirement for some of the verification procedures (such as logistic regression). For this

reason, we used a  $\log_{10}$  transformation of ZGNIPC and ZTEHPGDP. Kurtosis in ZGNIPC was reduced by the transformation from 28.37 to -0.48 and its skewness from 4.66 to -0.21, while kurtosis in ZTEHPGDP was reduced from 6.33 to 0.87 and its skewness from 1.80 to -0.21. ZDPT3 was also non-normal, but it was not log-transformed after we observed that the kurtosis was greatly exacerbated by the transformation, going from 5.18 to 15.28.

**Table 3: Health and Development Correlations\***

<i>Variable</i>	ZlogGNIPC	ZGINI	ZU5UW	ZDocDen	ZDTP3	ZlogTEHPGDP	ZGEHPTEH	ZIMR
ZlogGNIPC	1							
ZGINI	-.121 (.181)	1						
ZU5UW	-.646 (.000)	.032 (.725)	1					
ZDocDen	.602 (.000)	-.359 (.000)	-.634 (.000)	1				
ZDTP3	.418 (.000)	-.203 (.024)	-.460 (.000)	.324 (.000)	1			
ZlogTEHPGDP	-.235 (.009)	.044 (.626)	-.170 (.060)	.110 (.224)	.178 (.049)	1		
ZGEHPTEH	.452 (.000)	-.113 (.215)	-.377 (.000)	.254 (.005)	.314 (.000)	-.069 (.449)	1	
ZIMR	-.752 (.000)	.243 (.007)	.670 (.000)	-.647 (.000)	-.524 (.000)	.053 (.561)	-.376 (.000)	1

\*N = 123. Significance for two-tailed test in parenthesis.

### *Clustering Method*

Ward's method differs from the average squared Euclidean distance method by joining cases to clusters "that result in the minimum increase to the ESS" (error of the sum of squares) of Euclidean distance until all cases and clusters have been nested under a single cluster (Aldenderdorf and Blashfield 1984:43). Ward's method tends to avoid the production of elongated chained clusters often produced by the average squared Euclidean distance method, and for this reason is preferred for the purpose of this research. The equation for Ward's method is:

$$D_{KL} = B_{KL} = \frac{\| \overline{X_K} - \overline{X_L} \|^2}{\frac{1}{N_K} + \frac{1}{N_L}} \quad D_{JM} = \frac{(N_J + N_K)D_{JK} + (N_J + N_L)D_{JL} - N_J D_{KL}}{N_J + N_M}$$

where N is the number of cases,  $D_{KL}$  is the distance between existing clusters K and L and  $D_{JM}$  is the distance between M, the merger of clusters K and L and any new cluster J, and  $N_K$  refers to the number of cases in cluster K.

### *Clustering Criteria and Verification*

The goal of cluster analysis is to minimize distance between elements within clusters, while maximizing distance between them. The optimal solution is to minimize the amount of variance lost while keeping the number of clusters relatively small. This research uses a combination of traditional techniques (agglomeration schedules of fusion coefficients and dendrograms) and statistical techniques (semi-partial  $R^2$ , pseudo F statistic, pseudo  $t^2$  and  $R^2$  compared with expected  $R^2$ ) to determine the number of

clusters. In traditional techniques, one looks for ‘jumps’ in the agglomeration schedule or long lines in the dendrogram that signify a significant loss of information or variance explained by the joining of clusters and the quantity of clusters. A potential solution is to select the number of clusters just before the ‘jump’ or longer lines in the dendrogram. Statistical techniques and their plots work in a somewhat similar way. Plots are examined to see where the jumps are in the graph indicating a loss of data, with the number of clusters before the jump recommended as a potential solution to identify the number of clusters (Aldenderfer and Blashfield 1984: 57).

The three cluster solutions were then ‘checked’ with a logistic regression using the cluster solution as a dependent variable in SPSS. Lastly, clusters were named based on the mean z-scores of the variables for the cases in each cluster. Means, standard deviations and minimum-maximum z-scores are presented in tables for each cluster, while the actual (non-z) values are discussed within the text. The z-scores allow the reader to assess the comparative value of clusters while the ‘natural’ values discussed within the text allow the reader to accurately assess the characteristics of each cluster.

## **Results**

This research constructs a typology of health and development using Ward’s method, a form of hierarchical agglomerative cluster analysis. ZGNIPC, ZU5UW, ZGEHPTEH, ZTEHPGDP, ZGINI, ZDocDen, ZDTP3 and ZIMR were used to cluster the countries. Although initially we expected the diagnostic instruments to suggest a single solution, both traditional and statistical indicators suggested three to four distinct solutions. The dendrogram suggested solutions of two, three, six and nine clusters, the pseudo  $t^2$  suggested three, five, six and nine, the pseudo-F plot five and eight, the semi-



partial  $R^2$  plot indicated three, six, and nine and the plot of  $R^2$  over the approximate expected  $R^2$  indicated three, six and nine clusters. Separate multinomial logistic regression with the cluster solutions as dependent variables ‘confirmed’ the solutions. The convergence of diagnostic techniques coupled with the logistic regression validation *suggests* that the cluster divisions are genuinely present in the data rather than reflecting a mere product of method. Based on the examination of the diagnostic plots, a three-tiered nested cluster solution of three, six and nine clusters was selected and developed based on the mean scores of the variables within each cluster.

Figure 2 shows how these solutions are nested within one another. As indicated by the diagnostic tests, the largest single loss of variance results from joining the last three clusters into one. This reflects major division between countries with severe health and development challenges, those that have average to above average health and development and those characterized by extremely high inequality (semi-partial  $R^2$  goes from 0.054 to 0.301, while the  $R^2$  drops from 0.403 to 0). This is then followed by a further subdivision into six clusters, named for their most salient characteristics as: High HRH, High Income, Divided Fortunes (high inequality), Hungry (food insecure), Critical Condition, and Extremely Critical Condition. Zooming in to a breakdown of nine clusters, we examined the specific areas of success or acute challenges faced by member countries. Tables 4, 5, 6a and 6b provide the z-means, standard deviations and ranges for each of the variables used to classify cluster membership for each of the cluster solution levels. Table 7 shows which countries belong to which cluster. Clusters at this level are named in terms of overall health and development as either Mild (Type 1), Mild (Type

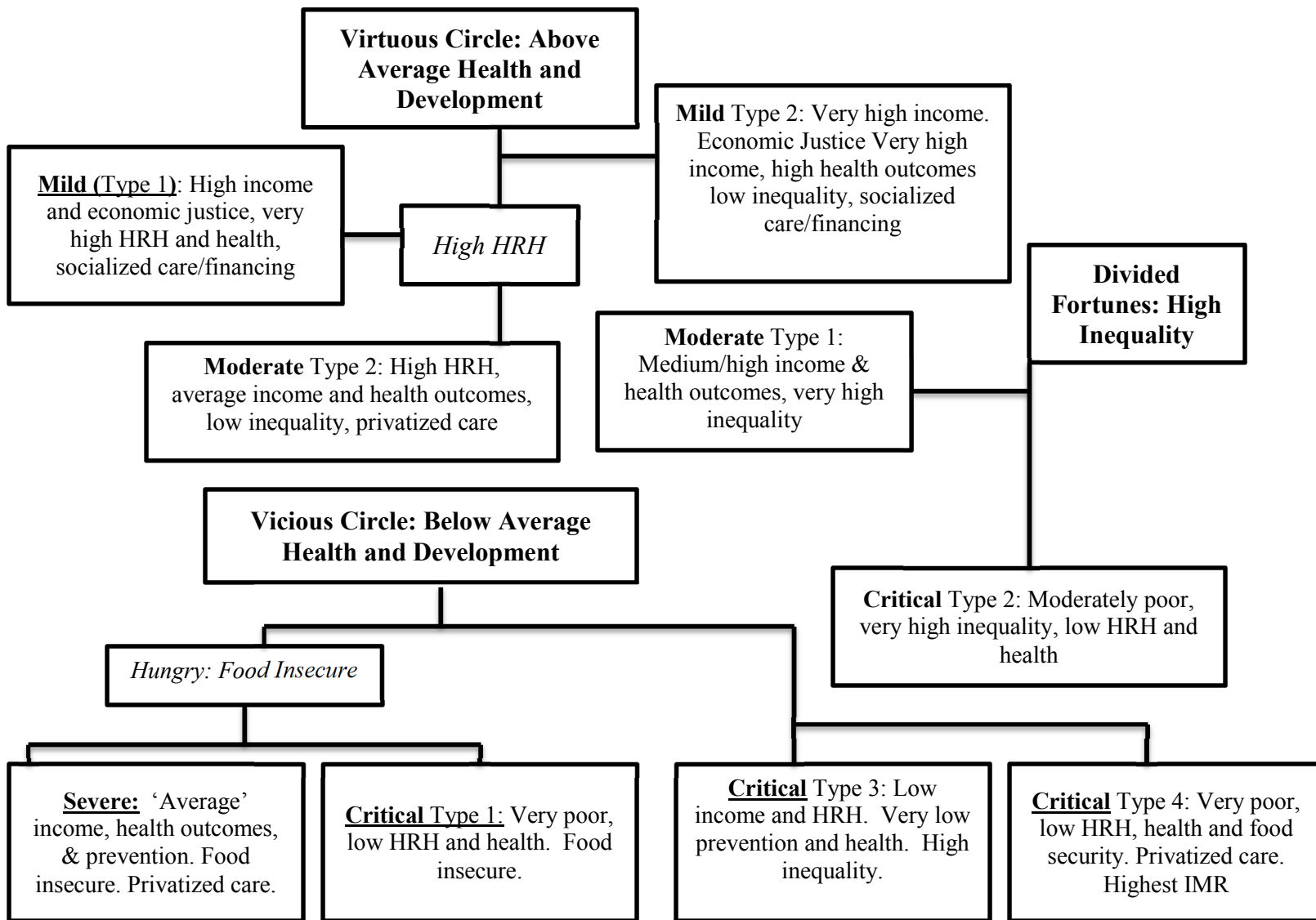
2), Moderate (Type 1), Mild (Type 2), Severe or Critical (Types 1-4), with a higher level of type relating to a worse health and development scenario.

### *Three-cluster Tier*

An examination of Table 4 shows that members of the Virtuous Circle cluster tend to have higher GNI per capita, doctor density, proportion of children receiving vaccines, lower inequality, proportion of children under age five underweight, and infant mortality. Their healthcare systems are more publically funded and this grouping spends the average on health as a percentage of GDP. In real terms, this cluster averages a little over two doctors for every one thousand people with a standard deviation (SD) of 1.32 physicians. It has a mean GNI per capita of \$19,146 (SD 21,287) but a median of \$14,900, reflecting that the mean is strongly pulled upwards by high values for the wealthy oil exporting countries of Oman, Saudi Arabia, Qatar and Kuwait. Inequality is much lower than the average (GINI 35.6, SD 5.2) while GEHPTEH (60.6, SD 17.9) tends to be higher but varies considerably.<sup>14</sup> People residing in countries within this cluster tend to live longer with an average life expectancy of 73.2 years and experience lower average IMR and under-5 child mortality rate (CMR) of 14.4 (SD 9.5) and 16.8 (SD 11.3), respectively.

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<sup>14</sup> These data are averages of the country values for the GINI, doctor density, and IMR that treats countries as individuals- they are not separate calculations based on the total populations of the combined countries in a cluster. It should be noted that this is a limitation as it gives equal weight to disparate populations.



**Figure 2:** Nested cluster health and development typology

**Table 4: Three-cluster Solution\***

Cluster Name	N	ZGNIPC	ZGINI	ZU5UW	ZDocDen	ZDPT3	ZTEHPGDP	ZGEHPTEH	ZIMR
Virtuous Circle Above Average Health and Development	48	0.71 (0.69) [-0.84 to 2.69]	-0.68 (0.57) [-1.74 to 0.36]	-0.75 (0.30) [-1.13 to [0.06]	0.87 (1.02) [-0.87 to 4.23]	0.54 (0.46) [-1.45 to 0.89]	0.05 (0.92) [-2.60 to 1.62]	0.42 (1.00) [-1.96 to 2.35]	-0.75 (0.37) [-1.20 to 0.61]
Divided Fortunes: Average health and high inequality	27	0.23 (0.73) [-1.92 to 1.09]	1.21 (0.63) [0.25 to 2.46]	-0.40 (0.56) [-1.11 to 1.01]	-0.25 (0.52) [-0.91 to 0.58]	0.30 (0.49) [-0.74 to 0.89]	0.35 (0.72) [-1.18 to 1.89]	0.24 (0.72) [-0.99 to 1.37]	-0.13 (0.87) [-1.01 to 2.59]
Vicious Circle: Below Average Health and Development	48	-0.84 (0.75) [-2.13 to 1.15]	-0.00 (0.86) [-1.29 to 2.35]	0.98 (0.83) [-0.34 to 3.14]	-0.73 (0.25) [-0.92 to 0.23]	-0.71 (1.18) [-4.80 to 0.89]	-0.24 (1.15) [-2.95 to 2.89]	-0.56 (0.88) [-2.08 to 1.38]	0.82 (0.87) [-1.03 to 3.23]

\*Note: Mean scores with standard deviations in parentheses. Minimum and maximum scores provided in brackets.

**Table 5: Six-cluster Solution\***

Cluster Name	N	ZGNIPC	ZGINI	ZU5UW	ZDocDen	ZDPT3	ZTEHPGDP	ZGEHPTEH	ZIMR
High HRH	38	0.55 (0.52) [-0.84 to 1.22]	-0.70 (0.60) [-1.72 to 0.36]	-0.81 (0.26) [-1.137 to 0.038]	1.08 (0.99) [-0.63 to 4.23]	0.49 (0.50) [-1.45 to 0.89]	0.39 (0.61) [-0.90 to 1.62]	0.19 (0.98) [-1.96 to 2.35]	-0.74 (0.38) [-1.20 to 0.61]
High income Mild (Type 2)	10	1.30 (0.92) [0.12 to 2.69]	-0.60 (0.47) [-1.29 to 0.14]	-0.53 (0.34) [-1.09 to 0.06]	0.07 (0.66) [-0.87 to 1.19]	0.76 (0.17) 0.35 to 0.89]	-1.26 (0.67) [-2.60 to - 0.63]	1.32 (0.38) [0.69 to 1.73]	-0.77 (0.34) [-1.06 to 0.09]
Divided Fortunes	27	0.23 (0.73) [-1.92 to 1.09]	1.21 (0.63) [0.25 to 2.46]	-0.40 (0.56) [-1.11 to 1.01]	0.25 (0.52) [-0.91 to 0.58]	0.30 (0.46) [-0.74 to 0.89]	0.35 (0.72) [-1.18 to 1.89]	0.24 (0.72) [-0.99 to 1.37]	-0.13 (0.87) [-1.01 to 2.59]
Hungry: Food insecure	26	-0.59 (0.75) [-1.85 to 1.15]	-0.35 (0.53) [-1.29 to 0.70]	1.20 (0.90) [-0.34 to 3.14]	-0.69 (0.25) [-0.90 to - 0.00]	-0.19 (0.70) [-1.45 to 0.89]	-0.64 (0.81) [-2.49 to 0.99]	-0.28 (0.80) [-2.08 to 1.25]	0.46 (0.65) [-1.03 to 1.41]
Critical Type 3	7	-0.64 (0.86) [-2.13 to 0.60]	0.88 (0.88) [-0.19 to 2.35]	0.55 (0.77) [-0.33 to 1.72]	-0.61 (0.42) [-0.89 to 0.23]	-2.78 (1.22) [-4.80 to -1.45]	-1.22 (0.95) [-2.95 to -0.18]	-0.21 (0.98) [-1.31 to 1.38]	1.01 (1.16) [-0.83 to 2.25]
Extremely Critical Type 4	15	-1.38 (0.37) [-2.02 to - 0.71]	0.18 (0.99) [-0.96 to 2.02]	0.78 (0.61) [0.18 to 2.23]	-0.85 (0.07) [-0.92 to - 0.71]	-0.64 (0.74) [-1.91 to 0.43]	0.89 (0.89) (-0.18 to 2.89)	-1.19 (0.64) [-2.07 to - 0.05]	1.36 (0.81) [0.17 to 3.29]

\*Note: Mean scores with standard deviations in parentheses. Minimum and maximum scores provided in brackets.

**Table 6a: Nine-cluster Solution\***

Cluster Name	N	ZGNIPC	ZGINI	ZU5UW	ZDocDen	ZDPT3	ZTEHPGDP	ZGEHPTEH	ZIMR
Mild Type 1: High income, health inputs, outcomes, and economic justice	21	0.84 (0.27) [-0.31 to 1.22]	-0.83 (0.67) [-1.74 to 0.36]	-0.94 (0.16) [-1.13 to -0.35]	1.35 (0.99) [-0.46 to 4.23]	0.39 (0.57) [-1.45 to 0.89]	0.53 (0.57) [-0.90 to 1.41]	0.84 (0.58) [0.12 to 2.35]	-0.94 (0.24) [-1.20 to -0.20]
Mild Type 2: Very high income, high health and economic justice	10	1.30 (0.92) [0.12 to 2.69]	-0.60 (0.47) [-1.29 to 0.14]	-0.53 (0.34) [-1.09 to 0.06]	0.07 (0.66) [-0.87 to 1.19]	0.76 (0.17) [0.35 to 0.89]	-1.27 (0.67) [-2.60 to -0.63]	1.32 (0.38) [0.69 to 1.73]	-0.77 (0.34) [-1.06 to 0.09]
Moderate Type 1: Medium-high income & health, very high inequality	18	0.50 (0.44) [-0.36 to 1.09]	1.01 (0.45) [0.36 to 1.69]	-0.69 (0.34) [-1.11 to 0.08]	0.03 (0.42) [-0.76 to 0.58]	0.30 (0.43) [-0.51 to 0.89]	0.34 (0.60) [-0.42 to 1.51]	0.07 (0.74) [-0.99 to 1.24]	-0.62 (0.26) [-1.01 to 0.03]
Moderate Type 2: Average income and health, low inequality, privatized care	17	0.20 (0.54) [-0.84 to 0.92]	-0.55 (0.48) [-1.18 to 0.36]	-0.66 (0.28) [-1.05 to -0.02]	0.74 (0.91) [-0.64 to 2.33]	0.60 (0.38) [-0.51 to 0.89]	0.22 (0.63) [-0.67 to 1.62]	-0.62 (0.74) [-1.96 to 0.56]	-0.49 (0.39) [-1.00 to 0.61]

\*Note: Mean scores with standard deviations in parentheses. Minimum and maximum scores provided in brackets.

**Table 6b: Nine-cluster Solution\***

Cluster Name	N	ZGNIPC	ZGINI	ZU5UW	ZDocDen	ZDPT3	ZTEHPGDP	ZGEHPTE H	ZIMR
Severe: Average income, health, & prevention. Food insecure. Privatized care.	13	-0.16 (0.75) [-1.55 to 1.15]	-0.49 (0.50) [-1.29 to 0.47]	1.28 (0.92) [-0.34 to 2.66]	-0.54 (0.27) [-0.78 to -0.00]	-0.12 (0.71) [-1.21 to 0.89]	-1.12 (0.75) [-2.49 to -0.02]	-0.83 (0.61) [-2.08 to 0.09]	0.08 (0.67) [-1.03 to 1.41]
Critical Type 1 Very poor, low HRH and health. Food insecure.	13	-1.01 (0.47) [-1.85 to 0.01]	-0.20 (0.54) [-1.08 to 0.70]	1.13 (0.92) [0.12 to 3.14]	-0.85 (0.05) [-0.90 to -0.75]	-0.26 (0.71) [-1.44 to 0.82]	-0.15 (0.67) [-2.6 to -0.63]	0.27 (0.53) [-0.76 to 1.25]	0.83 (0.37) [0.29 to 1.31]
Critical Type 2 Low HRH, health outcomes. High Inequality.	9	-0.30 (0.91) [-1.92 to 0.81]	1.62 (0.77) [0.25 to 2.46]	0.18 (0.44) [-0.91 to 1.01]	-0.80 (0.10) [-0.91 to -0.64]	0.28 (0.54) [-0.74 to 0.82]	0.37 (0.97) [-1.18 to 1.89]	0.57 (0.59) [-0.72 to 1.37]	0.86 (0.83) [-0.20 to 2.59]
Critical Type 3: Low income and HRH. Very low prevention and health. High inequality.	7	-0.64 (0.86) [-2.13 to 0.60]	0.88 (0.88) [-0.19 to 2.35]	0.55 (0.77) [-0.33 to 1.72]	-0.61 (0.42) [-0.89 to 0.23]	-2.78 (1.22) [-4.80 to -1.45]	-1.22 (0.95) [-2.95 to -0.18]	-0.21 (0.98) [-1.31 to 1.38]	1.01 (1.16) [-0.83 to 2.25]
Critical Type 4: Poor, low HRH, and food security. Highest IMR Privatized care.	15	-1.38 (0.37) [-2.02 to -0.71]	0.18 (0.99) [-0.96 to 2.02]	0.78 (0.61) [0.18 to 2.23]	-0.85 (0.07) [-0.92 to -0.71]	-0.64 (0.74) [-1.91 to 0.43]	0.89 (0.89) [-0.18 to 2.89]	-1.19 (0.64) [-2.07 to -0.05]	1.36 (0.81) [0.17 to 3.29]

\*Note: Mean scores with standard deviations in parentheses. Minimum and maximum scores provided in brackets.

**Table 7: Countries by Cluster Membership\***

Cluster Name and Description	Country
<b>Virtuous Circle Cluster Countries</b>	
Mild Type 1: High income, very high health inputs, outcomes, and economic justice.	Argentina, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cuba, Estonia, <i>Iraq</i> , Jordan, Kazakhstan, Latvia, Lithuania, Montenegro, Romania, Russian Federation, Serbia, Macedonia (FYR), Tunisia, Turkey, Ukraine and Uruguay
Mild Type 2: Very high income, high health and economic justice.	Algeria, Bahrain, <i>Bhutan</i> , Fiji, Kuwait, Libya (prior to war), Oman, Qatar, Saudi Arabia, Thailand
Moderate Type 2: Average income and health, low inequality, privatized care.	Albania, Armenia, Azerbaijan, China, Egypt, Georgia, Iran, Kyrgyzstan, Lebanon, Mauritius, Moldova, Mongolia, Morocco, Nicaragua, Tajikistan, Uzbekistan, Vietnam
<b>Disparate Fortune Cluster Countries</b>	
Moderate Type II: Medium-high income & health, very high inequality.	Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, Suriname, Venezuela
Critical Type II: Low HRH and health. High Inequality.	Angola, Botswana, Comoros, Lesotho, Malawi, Namibia, Rwanda, Swaziland, Zambia
<b>Vicious Circle Cluster Countries</b>	
Severe: Average income, health. and prevention. Food Insecure. Privatized care.	Bangladesh, Cambodia, Gabon, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Yemen
Critical Type 1: Very poor, low HRH and health. Food insecure.	Benin, Burkina Faso, Burundi, Cameroon, Djibouti, Ethiopia, The Gambia, Ghana, Kenya, Madagascar, Mauritania, Senegal, Timor-Leste
Critical Type 3: Low income, HRH, prevention and health.	Central African Republic, Chad, Congo (Brazzaville), Nigeria, Papua New Guinea, South Africa, <i>Syrian Arab Republic</i>
Critical Type 4: Very poor, low HRH, health outputs and food security. Privatized, expensive care.	Afghanistan, Côte d'Ivoire, Democratic Republic of the Congo (DRC), Guinea, Guinea-Bissau, Haiti, Liberia, Mali, Mozambique, Niger, Sierra Leone, Sudan, Togo, Uganda, United Republic of Tanzania

\*Countries in italics appear not to fit well in their assigned grouping



‘Divided Fortunes’ is the next cluster in the three-cluster solution. This cluster is characterized by relatively average values (based on our sample of developing countries) of health and development, but with extraordinary levels of inequality. We named this cluster the Divided Fortunes cluster firstly because of its high inequality, and secondly because this cluster is the result of the uniting of two clusters that although they were similar in inequality levels and ZTEHPGDP, were quite different in terms of other key indicators such as ZGNIPC, ZHRH, ZU5UW, and ZIMR. In real terms, countries in this group have an average GNI per capita of \$10,302 (SD 5,867), an average GINI coefficient of 52.7 (SD 5.7), an average doctor density of 0.87 (SD 0.68), a little above average GEHPTEH (57.2 SD 12.9) and a relatively average IMR of 30.2 deaths (SD 9.5).

As seen in Table 4, the Vicious Circle cluster exhibits below average health and development appears as an inversion of the above-average health and development cluster. GNI per capita averages \$4,281 (SD 4,449) and ranges from \$600 in Central African Republic to \$22,460 in Malaysia with a median value of \$2,245. Roughly 21 percent of children were underweight in this cluster (SD 9.00) and just over 20% of children under a year of age had not received their DTP3 vaccine in 2012. Physicians are scarcer in this cluster with only one for every 3,909 inhabitants (doctor density 0.26 SD 0.32). There are worse healthcare outcomes here with an average IMR of 53.54 (SD 22.22), CMR 77.41 (SD 36.43), and life expectancy 59.03 (SD 9.53). The relatively large standard deviations in this first cluster solution further strengthened the indications of the clustering criteria to examine the next set of clusters.

### *Six-cluster Tier*

In the six-cluster tier, a High Income cluster breaks off from the Virtuous Circle cluster leaving a High HRH cluster, the Divided Fortune cluster remains as before, and the Vicious Circle is divided into Hungry, Critical Type 3 and Critical Type 4 clusters. Here, we will only describe the High HRH and Hungry clusters that are unique to this tier.<sup>15</sup> Table 5 provides the Z-means, standard deviations and ranges of the ‘middle nest’ of clusters.

The High HRH grouping performs well on health and economic justice indicators. It has a high average doctor density of 2.61 per 1000 inhabitants (SD 1.29) a relatively average GNI per capita of \$13,319 (SD 6,041): GEHPTEH is just above average at 56.35% (SD 17.53). This cluster also has the lowest income inequality of the four clusters at this stage, with an average GINI of 35.37 (SD 5.41). Early childhood vaccination is high in both this cluster with absolute percentages of children under one year receiving DPT3 at 93.73 (SD 6.35). The High HRH cluster has good health outcomes: the percentage of children underweight and the IMR are low at 3.62 (SD 2.75) and 14.52 (SD 9.81), respectively.

The Hungry cluster’s average GNI per capita is significantly lower than the High HRH cluster or the Divided Fortunes cluster at \$4,802 and a little more compact than those clusters (SD 5,088). Doctor density is extremely low at 0.30 (SD 0.32), second only to the Critical Type 4 cluster (discussed below). Health financing is, on average, lower as a percentage of GDP and a little more private, with TEHPGDP at 4.63% (SD 1.56) and GEHPTEH at 48.03 (SD 14.20). What makes this cluster stand out, however,

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<sup>15</sup> The Divided Fortunes Cluster is described in the three cluster tier above and the High Income, Critical and Extremely Critical clusters are described in the nine cluster tier below

are the very high percentage of children under five that are underweight (24.86, SD 9.51) and the troublesomely elevated IMR and CMR at 45.08 (SD 16.65) and 61.77 (25.52), respectively.

### *Nine-cluster Tier*

Tables 6a and 6b show the average z-scores, standard deviations and ranges for each of the variables in the third tier of our nested typology. In the nine-cluster tier each cluster is given a name representing the relative severity of the health and development situation facing the country grouping. Here, the Virtuous Circle that at the previous stage had divided into a High Income cluster and a High HRH cluster breaks down into three clusters. The High HRH grouping subdivides into Mild Type 1 and Moderate Type 2. The Divided Fortunes cluster breaks down into Moderate Type 1 noted for medium/high income and health outcomes with average physician density and Critical Type 2 with very low physician density, soaring inequality, and elevated IMR. Lastly, the Vicious Circle cluster ultimately subdivides into four distinct country agglomerations. At the previous stage the Vicious Circle cluster separated into a Food Insecure cluster and a Critical Type 3 and 4 clusters, at this stage the Critical Types 3 and 4 clusters remain as before, while the Hungry cluster subdivides into a Severe and a Critical Type 1 cluster.

Mild Type 1 is characterized by high income, low inequality, very high HRH and health outcomes while the Mild Type 2 cluster displays very high income, high health outcomes, public health spending and low inequality. Many countries in Mild Type 1, such as Cuba, Kazakhstan, Russia and Bulgaria, come from the former Soviet bloc or otherwise have had some connection to socialist economies. This type has the highest

average doctor density at 2.97 for every 1000 people (SD 1.30), a low percentage of children underweight at 2.30 (SD 1.71), the lowest inequality with an average GINI of 34.24 (6.02), the second highest GEHPTEH at 68.04 (SD 10.38) and the lowest IMR of the cluster typology at 9.34 (SD 6.02). Twenty of the 21 countries that were allocated here by the cluster analysis have an IMR below 16.7 and doctor density over 1.22.

Belarus is typical of the Mild Type 1 cluster. Its GNI is just above the cluster average, at \$16,940, and it has 3.8 doctors for every 1000 people. Its healthcare is largely publically financed (GEHPTEH 70.5) and it has a very low IMR (3.9). Iraq, in contrast, is an outlier in this regard, with an IMR at 28.4 and physician density of 0.607 or 1 doctor for every 1,647 people. Iraq's higher IMR is likely a product of the disruption and brutality caused by the history of U.S. sanctions, the 2003 invasion and ongoing sectarian violence.

Mild Type 2 is characterized by high income and economic justice and consists primarily of wealthy Middle Eastern oil exporting nations. It differs from the above cluster principally in that it is far wealthier with an average GNI per capita of \$41,287 (SD 39,092) compared to \$16,664 (SD 4,627.42) and far lower doctor density 1.29 (SD 0.86). It should be noted, however, that the high SD indicates that this cluster still contains a considerable amount of variance within it. Countries such as Qatar, Oman, Kuwait and Bahrain are all wealthy with sufficient doctor density and low IMR. Saudi Arabia also exhibits the characteristic features of this cluster. It has a GNI per capita of \$53,780, a GEHPTEH of 67.3, just less than one doctor for every one thousand people and an IMR of 7.4. By comparison, Bhutan is a relative outlier with a GNI per capita of \$7,210, a doctor density of 0.074 or one doctor for every 13,513 people and an IMR of

35.7. The factors that appear to keep Bhutan in this cluster are its high scores on GEHPTEH, DPT3 and similar TEHPGDP. Nevertheless, it would appear that Bhutan perhaps would fit better in the Severe grouping.

The moderate clusters come from the Virtuous Circle and Divided Fortunes Clusters. Moderate Type 1 comes from the Divided Fortunes cluster<sup>16</sup> with medium-high income and health and very high inequality and Moderate Type 2 with average income and health, low inequality and more privatized care. Moderate Type 1 is a thoroughly Latin American cluster; the only Latin American nations outside of this cluster are Argentina, Cuba, Nicaragua and Uruguay. It is characterized by relatively low (but still worrisome) IMR at 17.6 (SD 6.68) and very high inequality with the average GINI coefficient at 50.83 (SD 4.09). This contrasts with Moderate Type 2 (from the Virtuous Circle cluster) that is characterized by a slightly higher IMR at 20.9 (SD 9.96) and much lower inequality (GINI 36.76, SD 4.31). This is in spite of Moderate Type 2's doctor density (2.16 SD 1.18) that is higher than both that of Mild Type 2 (1.29, SD 0.86) and that of Moderate Type 1 (1.24, SD 0.54) clusters.

Moderate Type 2 consists primarily of European, Central and Eastern Asian countries with the notable exceptions of Nicaragua, Morocco and Mauritius. Mongolia is typical of Moderate Type 2. Mongolia's GNI per capita is close to the cluster's mean at 8810, it has a doctor density just above the cluster's average at 2.8, its GINI coefficient is 37, and its IMR is 23. In a few places in both Moderate types (notably in Honduras, Guyana, Tajikistan and Vietnam) we see greater than 10% of children under-five underweight.

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<sup>16</sup> Moderate (level 1) is ranked as level 1 largely because of its lower IMR as compared to the Moderate (level 2) although in other ways it performs more poorly than the Level 2 cluster.

It is interesting to note that many countries with socialist-oriented governments in Latin America (Bolivia, Ecuador, El Salvador and Venezuela) were in Moderate Type 1, with the other Latin American nations. This suggests that either a more profound transformation has yet to be completed in these countries that would place them in a more egalitarian grouping, or that the indicators used in this study do not accurately capture the social transformation that is taking place. For instance, Bolivia and El Salvador have relatively high GEHPTEH but also high income inequality, indicating that although the working class has been powerful enough to achieve greater public financing of health care, it has been thus far unsuccessful at reducing levels of inequality- a difficult task given the entrenched economic power of the wealthy classes.

The World Bank reported that Ecuador and Venezuela have both high levels of income inequality, with GINI coefficients of 49 and 45 respectively, and very low GEHPTEH at 36.1% and 36.6%, respectively. Contrast this with Cuba where the GINI for 2014 given by Global Peace Index was 30 and GEHPTEH is 95%, reflecting the profound social transformation that began over 50 years ago. Why might this be so? Looking at Venezuela, given that the Partido Socialista Unido de Venezuela (PSUV) has led the country since 1998, the country's low GEHPTEH and relatively high inequality may seem surprising.

The persistently high inequality may reflect the importunate power of the wealthy Venezuelans, the low GEHPTEH can be partially explained by the 1990s era International Monetary Fund and World Bank mandated neoliberal austerity measures that drastically cut public health expenditure, encouraged privatization and decentralization of health services. This was followed by a 'comprehensive health care

strategy' under the PSUV that has sought to strengthen the public health care system and provide free access to health services, most famously through the Barrio Adentro's four-tiered program for the poor and uninsured (Alvarado *et al.* 2008). Still, the public system continues to exist alongside a private one in which wealthier segments obtain access to private providers paid for directly or through private insurance (Bonvechio *et al.* 2011).

Nevertheless, there have been significant changes benefiting the most disadvantaged sectors of the populations in Venezuela, Bolivia and Ecuador, including significant reductions of poverty and inequality and increased democratic participation (de la Torre 2013). Between 2002 and 2011, CEPAL (2012:18) reported that Venezuela's poverty rate dropped 19.1%, Ecuador's 16.6% and Bolivia's dropped 20% between 2002 and 2009. Of the Latin American region covered by CEPAL, only Argentina and Peru appeared to experience larger drops in their poverty rates. Furthermore, inequality, while still high, has also declined. According to data tables published by CEPAL that accompanied the 2012 report, in 1997 the richest 10% of Venezuela received 32.8 percent of the country's income while the poorest 10% received only 1.8%. By 2011, the wealthiest ten percent's share of Venezuelan income had fallen to 22.9% and the poorest share had risen modestly to 2.4%.

CEPAL also reports improvements in Bolivia and Ecuador. The wealthiest ten percent's share fell by 10.2% and 4.4% in Bolivia and Ecuador, respectively, while the bottom 10% increased its share modestly from 0.7% to 1.0% in Bolivia and from 1.7 to 1.9% in Ecuador. This is also reflected in formal inequality measures. According to CEPAL (whose figures differ from the World Bank used in this research), Venezuela's

GINI has dropped from 50.7 in 1997 to 39.7 in 2011, Bolivia's GINI fell from 59.5 in 1997 to 50.8 in 2009 and Ecuador's fell modestly from 51.3 to 46.0.

The Hungry cluster breaks down into Severe and Critical Type 1, both with a very high percentage of children under the age of 5 underweight. The Severe cluster is made up of predominately South Asian countries and exhibits income and health outcomes close to the sample's average and Critical Type 1 consists of predominately sub-Saharan African countries that experience very low income, HRH levels and health outcomes. The Severe cluster is noteworthy in that it spends less on health as a percentage of GDP (3.75%, SD 1.18) and has lower GEHPTEH (38.18%, SD 10.92) than the critical cluster (TEHPGDP 5.52%, SD 1.41; GEHPTEH 57.88%, SD 9.50). Both the Severe and Critical Type 1 clusters had similar percentages of children under the age of one year in need of vaccinations with respective DPT3 vaccination percentages of 86.00% (SD 9.10) and 84.15% (SD 9.14).

The Severe cluster has the highest U5UW (25.68%, SD 9.74) of all clusters while Critical Type 1 has the second highest (24.04%, SD 9.6). Nevertheless, the Critical Type 1 cluster is much worse off than the Severe cluster. Severe has a much higher average GNIPC (\$7,230, SD 6,251) and a slightly lower level of inequality (GINI 37.23, SD 4.51) than the Critical Type 1 cluster (GNIPC \$2,374.61, SD 1,445; GINI 39.9 SD 4.9). In addition, Critical Type 1 has lower physician density (0.10 SD 0.06) than the Severe cluster that has a doctor density of 0.50 (SD 0.36). This lack of critical health inputs is reflected in worse health outcomes: Critical Type 1's IMR (54.59, SD 9.35) and CMR (78.2, SD 16.11) are far more elevated than those of the Severe cluster (IMR 37.23, SD



17.16; CMR 45.3 SD 22.64) while life expectancy is far lower in Critical Type 1 (59.15 SD 4.00) than in the Severe grouping (67.77 SD 3.77).

India is typical of the Severe grouping. In 2013, India had a GNI per capita of \$5,350, one doctor for every 1,538 people, and 40.2 percent of children under 5 underweight. India's IMR for 2012 was 43.8. By contrast, Benin typifies the Critical Type 1 cluster. Its GNI per capita is lower at \$1,780, and although its percentage of children underweight is lower than India's at 21.2, its doctor density is incredibly low at 0.06 or one doctor for every 16,667 people. Benin also reported a 2012 IMR of 58.5, 14.7 more infant deaths per 1000 live births than India reported for 2012.

The countries in the next most difficult situation of health and development are those of Critical Type 2. This grouping is composed of 9 largely Southern African countries and exhibits the highest inequality of our typology (GINI 56.33, SD 7.00). In spite of this cluster's significantly<sup>17</sup> higher overall income than Critical Type 1, it is very similar to Type 1 in terms of doctor density (0.15 SD 0.13), IMR (55.28 SD 21.24) and CMR (80.76, SD 36.32). Although this grouping has the highest GEHPTEH of the Vicious Circle and Divided Fortune clusters at 63.11 (SD 10.48), public financing of care is insufficient by itself to address the cluster's challenges. Thus, in spite of its relatively higher GNIPC, this cluster displays comparably worrisome health outcomes. Typical of this cluster is Swaziland, which has a GNI per capita of \$6,220, but a GINI coefficient of 51. Swaziland has a doctor density of 0.17, and a 2012 IMR of 55.7.

Critical Type 3 is a small cluster consisting of just seven countries: Central African Republic, Chad, Congo (Brazzaville), Nigeria, Papua New Guinea, South Africa

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<sup>17</sup> This difference is significant at  $p < .001$  according to a t-test comparing the two clusters' means resulted in a t-value of 169.8. The critical value for a t-test with 8 degrees of freedom is 4.501.

and Syria (prior to the war). Many of these countries are currently experiencing some form of civil conflict. Only 52% (SD 15.63) of children under the age of one have received the DPT3 vaccine, by far the lowest rate of vaccination coverage of our typology. Critical Type 3 has the third highest U5UW (17.9%, SD 8.12), and income inequality (GINI 49.71, 7.95) of our typology. Health care spending in this cluster tends to be mixed but varies wildly (GEHPTEH 49.27 SD 17.48). With the exception of Syria, which in 2012 reported an IMR of 12.3, these countries have very poor health indicators (including South Africa in spite of its higher GNI per capita). IMR and CMR are the second highest of all clusters at 59.16 (SD 29.57), and 88.68 (SD 49.37), respectively. As would be expected based on these indicators, life expectancy is also relatively short here (58 SD 9.02). Congo (Brazzaville) is a prime example of Critical Type 3. Congo's GNI pc is \$4,720 with a GINI coefficient of 47. Fourteen percent of children under five in Congo are underweight,) doctors are scarce (doctor density 0.1) and IMR is high at 62.2.

Lastly, Critical Type 4 is made up almost entirely of African nations, with the exceptions of Afghanistan and Haiti. We note that many of these nations (Afghanistan, Côte d'Ivoire, DRC, Liberia, Sierra Leone, Sudan and Uganda) have recent histories of war or civil conflict. This cluster is the poorest with an average GNI per capita \$1492.67 (SD 608) and the little income they have is poorly distributed (GINI 43.33, SD 8.95). Physicians are scarce with an average of one doctor for every 10,040 inhabitants (doctor density 0.0996, SD 0.086) and healthcare spending is almost entirely private (GEHPTEH 31.78, SD 11.45). These data imply significant human resource and financial barriers to care for those who can least afford it. The health-related outcomes are devastating: IMR

68.19 (SD 20.67), CMR 102.45 (SD 34.48) and life expectancy 55.47 (SD 4.75). Mali exemplifies Critical Type 4. Its GNI per capita is low at \$1,540, it has low doctor density 0.08, 18.9 percent of children are underweight, 26% percent of children under one year did not receive the DPT3 vaccine and 79.6 infants out of every thousand born did not live to their first birthday in 2012.

## **Discussion**

The purpose of this research was to establish a taxonomy of health and development of primarily non-OECD countries. Using Ward's method cluster analysis, we grouped 123 countries with eight health and development variables. A three-tiered nested typology resulted from this process, with a large divide between Virtuous Circle countries characterized by above average health and development, Divided Fortune countries noted for very high inequality and Vicious Circle countries characterized by below average health and development. In the intermediate six-cluster stage, the Virtuous Circle countries divided into a High Income (Mild Type II) cluster and a High HRH country cluster, the Divided Fortunes cluster remained as before, and the Vicious Circle cluster divided into a Hungry cluster and Critical Type 3 and 4 Clusters. These subdivisions reflect distinct patterns around the chosen set of health and development indicators, particularly ZGINI, ZU5UW, ZIMR and ZGNIPC. Finally, the third tier of nine clusters shows that many of these clusters are further distinguished by physician density, GEHPTEH, and vaccination coverage, in addition to the predictable clustering around GNIPC and IMR.

As mentioned in the introduction, while there is recognition of the importance of GDP and/or GNI per capita leading to better health and development, there is also a concern among development scholars that this particular variable is used as a substitute for a more holistic and nuanced approach. GDP and GNIPC are limited measures that do not capture the nature of a society's economy, i.e., whether the guiding force of a society's economy is oriented towards the production and distribution of use values for the fulfillment of human needs or is simply concerned with exchange value and the logic of capital accumulation. It also does not reflect the distribution of the costs and benefits of a society's economic activity, and while a powerful predictor of other health and development outcomes, it does not account for all clustering placements in our analysis. In this regard, it is noteworthy that the Mild Type 1 has a lower IMR, and higher doctor density than Mild Type 2, in spite of Mild Type 2's greater GNIPC. Furthermore, although the Severe Cluster has only a slightly higher average GNIPC than the Critical Type 2 cluster, Critical Type 2 has far greater income inequality and loses on average 20 children per 1000 live births more than the Severe cluster.

A notable but worrisome observation is the strong influence of geographic region. Algeria, Mauritius, Morocco, Egypt and Tunisia were the only African countries to fall into the Virtuous Circle cluster, which was largely populated by Eastern European, and (other) Middle Eastern countries. The Divided Fortune cluster consists of Latin American and Southern African nations. The Vicious Circle cluster was almost entirely composed of African and Southeast Asian countries. Once we proceed to the third tier, the regional dynamics of under-/mal-development become even more pronounced. The Divided Fortune subdivides almost entirely by region into Moderate Type 1, which

almost entirely consists of Latin American countries, and Critical Type II, which consists of eight Southern African countries and one Central African country (Rwanda). The high inequality in the Moderate Type 1 reflects the continuing challenge in that region to reduce inequality in spite of the rise to power of many left-wing governments that have tried to address it. Critical Types 1, 3 and 4 are entirely composed of sub-Saharan African countries with the exception of Afghanistan, while the Severe cluster is almost entirely South Asian, with the exception of Yemen and Gabon.

Relating the nested typology to the virtuous circle of health and development in Figure 1, it appears that countries in the Mild Type 1 cluster best approximate that dynamic, while the Critical and Severe clusters approximate the inverse. Mild Type 2 also roughly approximates it, but it should be noted that many of the countries in this Type depend heavily on either oil or tourism, leaving the cluster vulnerable to shifts in oil price and economic crises that could negatively impact tourism revenues.

The crux of our findings is consistent with the spirit of previous health and development typologies. While our research did not develop a set of welfare state typologies to predict health outcomes and is thus not strictly comparable, like Navarro and Shi (2001) and Chung and Muntaner (2007) we found that clusters with better health and development tended to have higher GEHPTEH (indicating a lower degree of commodification of healthcare services). Additionally, the characteristics of the Critical clusters appear consistent with Wood and Gough's (2006) Insecurity Regime cluster.

A central concern arising from this paper is how to best improve the situations of countries in the Severe and Critical clusters. These groupings exhibit higher IMR, U5UW, low GNI per capita, fewer doctors, lower vaccination rates, slightly greater

reported inequality and more privatized care. The extent and depth of these problems will not likely be alleviated without a holistic plan that addresses the specific health and development challenges faced by countries in each cluster.

Countries in Severe and Critical Type 1 clusters should develop a strategy to improve food security. If they address this problem, there would likely be positive repercussions in health outcomes, moving them out of the Vicious Circle. Governments in the Severe and Critical Type 4 clusters should take on a greater portion of health financing or seek other methods to improve access to healthcare. Efforts to train and retain physicians are essential for all of the Vicious Circle clusters, but are especially important for all Critical Types. Critical Types 2 and 3 need to urgently address the severe economic inequalities present in their societies, either by implementing redistributive taxation or by more fundamental changes to production relations in their economic systems. Doing this may increase social cohesion and lead to an improvement in health outcomes. Critical Type 3 should prepare thorough vaccination campaigns. Finally, Critical Types 1, 3, and 4 need to take measures that will improve GNI but that don't increase inequality substantially. National and international strategies and stakeholder collaboration are necessary to help these nations achieve improved economic status, sustained food security, improved reach of preventative care and vaccination drives, reduced inequality, and progress towards a universal system of national health care.

Interpretation of the underlying causes of the disparities in health and development outcomes and what should be done to address them will likely vary according to theoretical orientation. Modernization theorists would tend to argue that the

Severe and Critical countries need to continue to prepare the way for ‘takeoff’ by further reducing the role of the state in economic affairs and competing for foreign investment. They would likely argue for greater private investment and a reduction of the role of the state in healthcare financing and provision. However, as seen in both the cluster typology and in the correlations presented in Table 3, those countries with higher inequality and greater privatization of healthcare financing tend to have greater health and development challenges.

Marxists, dependency, and world system theorists, in contrast, would tend to emphasize that genuine development cannot occur without sufficient national control over the economy, food security, diversification away from reliance on extractive industries, technological development, sufficient management of the country’s place in the global capitalist economy, and an internal market orientation (Amin 2013: 43-45). The challenges faced by these countries are magnified by the context of a global capitalist economy dominated by powerful multinational corporations and international financial institutions that seek to limit national sovereignty in determining economic and social policies while orienting productive and distributive economic arrangements to the logic of capital accumulation rather than towards human need.

The limitations of this work point to many areas of potential future research. For example, due to the importance of doctor density in this study, further research could measure the inequality of physician distribution *within* countries and examine its relationship with other health and development outcomes. Additionally, more work is needed that not only examines country characteristics but integrates the socio-economic relational dynamics between countries, i.e., flows of surplus value, raw materials,

consumer goods, and waste, into explanatory and typological models of health and development. Further research with sufficient longitudinal data could study the trends of health and development by examining country movement through the typology over time. Finally, future research could remove the health outcome variable from the socioeconomic and health system variables around which countries are clustered and then test the solution's predictive power on key health outcome variables.



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## **CHAPTER 4: HUMAN RESOURCES FOR HEALTH AND HEALTH OUTCOMES IN CUBA: AN ANALYSIS OF THEIR DISTRIBUTIONS OVER TIME AND SPACE**

A paper to be submitted to International Journal of Health Services

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### **Abstract**

Past research has examined developments and transformations in Cuba's healthcare system, national infant mortality rate (IMR) trends, and the government's commitment to universal healthcare access in the face of economic difficulties. Nevertheless, the reduction of spatial inequality among and within Cuban provinces regarding human resources for health (HRH) and IMR has received less attention. Drawing on Cuban Ministry of Health data, this paper examines changes in the distribution of HRH by personnel type and IMRs among Cuban provinces over time, emphasizing the period since 1990. The author contrasts these with global, OECD, and developing country distributions. Using municipal level data from Cuba's National Statistical Office, the paper examines levels of absolute and relative inequality of HRH within Cuban provinces in 2010. The research shows support for declining inequality in HRH and IMR across provinces in Cuba over time and provides evidence that inequality is greater within provinces than among them. The contribution to the broader literature lies in placing the research within a global context of high between and within country disparities. Cuba's experience is especially salient given high levels of spatial inequality prior to 1959 and material resource scarcity during the 'special period' of the 1990s.

## Introduction

Severe inequality in the distribution of physicians, nurses, and health workers in the health sector known as human resources for health (HRH) remains pronounced both among and within countries, often in inverse relation to populations' needs (Dussault and Franceschini 2006; WHO 2006:8; Chen *et al.* 2004; Paradath *et al.* 2003; Hart 1971). For example, in 2006 the World Health Organization (WHO) indicated that while the Americas region had half of the world's health financing, 10% of the disease and 37% of global HRH.

HRH disparities remain acute. By way of illustration, in 2010 according to WHO data, Sierra Leone had only one physician for every 45,455 people while Austria had one physician for every 206 people. Within countries, too, there is ample documentation of highly unequal distributions of HRH. These are exacerbated by migratory patterns in which physicians tend to be concentrated in urban centers, move from the public to the private sector, and ultimately migrate from poorer 'less developed' countries to more wealthy 'more developed' ones (Tandi *et al.* 2015; WHO 2006:8; Dussault and Franceschini 2006; Pfeiffer 2003; Schoepff *et al.* 2000).

Cuba is noted for its achievements in improving health outcomes and its high level of physician and HRH density (Souers 2012; Whiteford and Branch 2008). In light of the global and national challenges in HRH imbalances, this research examines changes in the degree of inequality in HRH distribution by personnel type among Cuban provinces over time, and among municipalities within provinces for 2010. Has Cuba been able to continue to reduce internal HRH imbalances in spite of the economic crisis of the 1990s? Have the current transformations in Cuba's healthcare system that began

around 2010 had a positive, or negative impact on HRH distribution? These questions are answered to the degree possible by examining the level of inequality in HRH distributions, particularly since 1989 when Cuba was on the eve of a severe economic crisis, through 2014. This paper also depicts across-province trends over time in IMR disparities in Cuba.

### *Cuba and the broader context of HRH imbalances*

A central rationale for correcting HRH imbalances is that an unequal distribution of HRH and other health inputs may foster unequal access to care, and ultimately lead to unequal health outcomes. It is pertinent, then, that HRH density is identified as a determinant of health outcomes. In a cross-sectional study of 119 countries, Anand and Bärnighausen (2004) found a significant inverse association between HRH density and infant, child and maternal mortality while controlling for other socioeconomic mortality determinants. These results are consistent with Hanmer, Lensink and White (2003) which showed that the higher the population per physician, the higher the IMR.

Distance between the population and health facilities and personnel is also an important factor. A recent study in India used spatial clustering analysis of deaths in 4,064 postal codes resulting from time-critical acute abdominal conditions (such as appendicitis or peptic ulcer disease) revealed that “the odds of living in a high acute abdominal mortality cluster increased with increasing distance from surgical care” (Dare *et al.* 2015: e651). Vandenbroucke (1990) used a central place theory framework to examine the distribution of public and private higher and lower order health facilities and travel distance to various healthcare facilities in Quetzaltenango, Guatemala. He found

that of 914 ‘places’ analyzed, 725 did not have any health facility, and that travel patterns to obtain health services conformed “to the hierarchy of political capitals, rather than to central place hierarchy” (Vandenbroucke 1990: 199).

There are various factors that influence HRH inequality and migration patterns. Regarding migration patterns, ‘push factors’ tend to compel HRH out of areas of greater need, ‘pull factors’ attract HRH to areas of *lesser need*, ‘stay factors’ influence HRH to remain in areas of *lesser need*, and ‘stick factors’ influence HRH to remain in communities where they are needed. Medical professional out-migration may be stimulated by factors both endogenous and exogenous to the health system. Endogenous push factors include low salaries, lack of technology, unsafe working environments, and insufficient opportunity for career advancement. Exogenous push factors include poverty, inadequate housing or unsafe living environment. Endogenous and exogenous pull factors tend to be the inverse of push factors (WHO 2006; Zurn *et al.* 2004; Paradath *et al.* 2003).

Zurn and colleagues (2004) indicate that inequality in HRH distribution occurs as a result of socio-demographic, cultural, economic and geographical factors that influence the supply and demand of HRH personnel. Specifically, Zurd *et al.* indicate HRH imbalance results from a combination of fluctuation in the supply of HRH (influenced by their perceived economic and cultural costs and benefits of pursuing a career as a health professional), and the prominence of ‘market failure’ defined as a violation of the neo-classical assumption of perfect competition. Other factors influencing migration of professionals include insecurity, civil conflict and low pay in the public sector (Akokpari 2006).



A market driven orientation to healthcare (in which production, distribution and resource allocation are oriented to fulfilling effective demand) may also have a negative influence on HRH distribution (Deppe 2009; Navarro 1976). In a privatized healthcare system, physicians will go where they have jobs, and these will generally be concentrated closer to populations with greater ability to pay. This contrasts with a rights-based approach to health which emphasizes that society (usually states) has a duty to provide universal preventative *and* curative care (generally funded through taxation) based on need (Farmer 2005; 1999). A market orientation of healthcare services leaves a service gap between a population's effective demand and its absolute needs. This gap is reflected in the severe global HRH and disease burden imbalance (WHO 2006).

In this vein, in a systematic review of the World Bank led health reforms in Latin America, Homedes and Ugalde (2005) found that the move towards greater privatization and decentralization did little to address urban/rural inequalities in HRH distribution. In addition, these neo-liberal oriented reforms exacerbated the outflow of HRH from the public to private sector or to wealthier countries, undermined HRH wages, and did not result in productivity increases. Likewise, Tandi *et al.* (2015: 9) indicate that in Cameroon, neo-liberal reforms imposed by the International Monetary Fund “saw the shrinkage of public health sector recruitment and the development of other health resources and may have accounted for the shortage and distributional inequalities of the health workforce as well as led to the proliferation of the private sector.”

In light of the salience of push and pull factors on HRH migratory patterns, it is understandable that a country's or region's overall level of wealth and development is highly correlated to doctor density. Out-migration of physicians from poorer to wealthier

regions is common, and this out-migration of professionals is exacerbated by economic shocks or falls in per capita gross domestic product (GDP) (Okeke 2013). Nevertheless, there are some notable cases of countries which have higher physician density than would be expected based on gross national income (GNI) per capita, even when taking into account purchasing power parity which in Cuba's case is a more than three times the value than its GNI per capita measured in U.S. dollars.

One reason to look at Cuba's HRH distribution is that unlike other societies in which the distribution of HRH is largely determined by market forces, in Cuba it is primarily determined by government planning and health care financing is almost entirely public. Another reason why Cuba has been selected as a case study for examination of its internal HRH distribution is its high physician density. In this regard, it is useful to examine the difference between the predicted physician density and the actual physician density for the Cuban case determined by a simple OLS regression. Relevant regression equations are included in an appendix. Data for both variables are for 186 countries and the most recent year available at the time of collection.

Using  $\text{Log}_{10}$  of GNI per capita purchasing power parity (PPP) data gathered from the World Bank as the independent variable and physician density per 1000 population data from the World Health Organization (WHO) as the dependent variable for 186 countries, I ran a simple OLS regression on SPSS. GNI correlated significantly ( $p < .001$ ) with doctor density at .69. Specifically, the predicted value for doctor density in Cuba based on its GNI in this simple model was 2.18 physicians per 1000. However, Cuba's *actual* value for 2010 was 6.78, thus 4.6 doctors per 1000 people *greater* than its predicted value.

Similarly, Cuba's 2012 IMR was far lower than a quadratic ( $\log_{10}$ ) GNI per capita model would predict. Using the same GNI data with the 2010 IMR of these 186 countries gathered from the WHO's Global Health Observatory, the centered regression equation predicts that Cuba's IMR would be 13.6 deaths per 1000 live births. However, the actual value for 2012 (the year of IMR data used) reported by the WHO was only 4.3. Cuba's better than expected performance on both of these indicators based on its GNI per capita PPP indicates that much could be learned from a closer look at both the development of its healthcare system and its internal HRH distribution.

#### *Historical context and development of Cuba's health provision model*

The history of the Cuban revolution generally, but particularly from 1959 to 1970 and again during the 1990s, highlights the possibilities and limits of socially transformative agency within a context of inherited underdevelopment, resource scarcity, U.S. directed invasions, covert war and far-reaching economic sanctions (Perez 2011; Parenti 2005; Chomsky 2005). Prior to 1959, the U.S. largely dominated the Cuban economy: U.S. companies owned or controlled the majority of Cuba's sugar, tobacco, coffee, lead, hotels, oil refineries, and trains, and Cuba remained dependent on the U.S. to import the majority of its goods (Perez 2011; DeFronzo 1996). U.S. hostility towards Cuba largely originated from measures that the Cuban government took to address inequality, underdevelopment and economic independence, most notably agrarian reform and nationalizations. Although these measures took place within international law, U.S. animosity and actions hostile towards the island grew (Lamrani 2013).

A fundamental goal of the Cuban revolution has been to reduce and/or eliminate the severe regional, land, class, racial, gender, educational, and health inequalities that existed prior to 1959 (Perez 2011; Frank 1999; Huberman and Sweezy 1969). Regarding unequal education, 24 percent of Cuba's population was illiterate in 1960, with the great majority of those located in rural areas. In 1961, the new revolutionary government mobilized large portions of the population to teach people to read and write in a massive literacy campaign focused primarily on rural areas. By December that year, the national illiteracy rate had been reduced to a mere 3.9% (Huberman and Sweezy 1969). Measures continued thereafter to consistently raise the population's educational level (ibid; Franc 1999).

Since the revolutionary government in Cuba acquired power in January 1959, eliminating inequalities in access to healthcare has been of paramount importance and has been explicitly stated in government policy. While health policy has evolved over time, throughout each period the goals have clearly been to improve both the overall health of the population as well as to improve equity in health inputs, outputs and outcomes. The Cuban Constitution, voted on by 98% of the electorate and approved by 97.7% of said vote in 1976 and with modifications approved in 1978, 1992 and 2002, is explicit in this regard. Article 50 states:<sup>18</sup>

Everyone has the right to be attended to and to have his/her health protected. The state guarantees this right.

- With the provision of free medical and hospital assistance, through the network of rural medical service installations, polyclinics, hospitals, preventative and specialized treatment centers
- The provision of free dental service
- With the development of the plan for sanitary dissemination and health education, periodic medical examinations, general vaccination, and other disease prevention

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<sup>18</sup> Author's own translation

measures. The population cooperates with these plans and activities through the mass and social organizations (Asamblea Nacional del Poder Popular 2003).

It is clear that this policy is intended to do three things: first, to eliminate or greatly reduce financial barriers to medical care access; second, to promote an equitable distribution of human and infrastructural health resources; and third to generate both good health care indicators as well as non-disparate health care outcomes. Due to Cuba's investment in health care and focus on developing human resources for health, (according to WHO data on physician density) the island as of 2010 had one doctor for every 149 people with roughly 99.7% of the population covered by family doctors. In 2011, Cuba registered infant and child mortality rates of 4.9 and 6.0 per 1000 live births, respectively. Those figures were lower than the corresponding rates in the United States.<sup>19</sup>

#### *The development of Cuba's healthcare system*

Cuba's aggregate health care situation prior to 1959 left much to be desired. Cuba's IMR, maternal mortality rate and life expectancy in 1958 were 60 per 1000 live births, 125.3 per 100,000 live births, and 58.8 years, respectively (Whiteford and Branch 2008; Nayari 1995)<sup>20</sup>. Healthcare in pre-revolutionary Cuba was divided between an "under-funded and understaffed" health care system for the less advantaged and private clinics for the wealthy, with roughly 34% of people in Havana covered by forms of

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<sup>19</sup> Infant and child mortality in the U.S. in 2011 were 6 and 7.1, respectively. It is thus ironic that many in the U.S. attempt to present Cuba as an example of a failed development model while at the same time the U.S. historically has done that all it can to disrupt their development (Feinsilver 2009; Chomsky 2005). U.S. sanctions against Cuba coupled with the fall of the Soviet Union and the socialist block of Eastern Europe took a heavy toll on Cuba's economy and health care system. Many aspects of the health care system have been impacted, including the physical maintenance of medical facilities and the amount medical equipment and medicines available. In direct costs to the health care system, it was estimated that the US 'embargo' or more aptly termed 'economic blockade' had cost the Cuban health care system \$1.75M (Alfonso 2003). Cuba's permanent mission to the UN estimated that in one year, from May 2011 to April 2012, the US blockade cost Cuba's medical system \$10M (Diario Granma 2012).

<sup>20</sup> It is important to note the debate that exists regarding pre-Revolutionary and early revolutionary measures of infant mortality. For more on this matter see the works of Dr. Raúl L. Riverón Corteguera (2000) and Abel Losada Álvarez (1999).

mutual insurance (Whiteford and Branch 2008; Danielson 1979). Rural areas typically had poorer sanitation systems and a greater risk of infectious disease (Whiteford and Branch 2008; Fields 2006; Warman 2001). While the wealthy had good access to private medical care including cosmetic surgery, rural areas suffered among the highest infant and maternal mortality rates in Latin America (Warman 2001:313). Even though other estimations of the IMR in the early period are quite lower (34.8 reported for 1959), the downward trend in infant mortality in post-revolutionary Cuba, particularly from the 1970s forward, is strongly supported (MINSAP 2014; Whiteford and Branch 2008; Corteguera and Henríquez 2001).

Danielson (1979) indicates that inequality in healthcare resource distribution was acute during this period; while the city of Havana had one doctor for every 450 people, Oriente province had only one for every 3155 people. Access to medical care prior to the revolution was also impacted by one's racial category in the old mutualist system (Danielson 1979). Due to racial discrimination and the racialized economic stratification that characterized Cuban society prior to the 1959 revolution, Black Cubans were excluded from the mutualist health associations with the notable exception of Centro Benéfico.

The new revolutionary government immediately took steps to abolish racial discrimination in employment and access to public spaces and services. Articles 41 through 43 of Cuba's constitution criminalize racial discrimination and protect equal access to the country's health institutions "without distinction of race, skin color, sex, religious beliefs, national origin or any other harm to human dignity" (Asamblea Nacional de Poder Popular 2003).

Although these early successes in fighting for equality reflected the government's willingness to reduce inequality, many structural factors complicated the task in addressing the country's health challenges. Roughly half of Cuba's then 3000 physicians feared the political and socio-economic changes and migrated to Miami, initially hindering Cuba's efforts to universalize and expand care in rural areas. Nevertheless, in 1960 the Cuban government established the Rural Health Service and the Rural Dental Service in 1961. The Rural Health Service built health care facilities, worked to provide clean water and adequate sanitation, placed health care personnel in rural areas, and improved prenatal, maternal and infant care (Franco *et al.* 2007; Whiteford and Branch 2008; Feinsilver 1993). During the revolution's early period, Cuba also formally identified the state as having the responsibility to provide free healthcare, signaling that the country was going to follow a rights-based approach to healthcare provision. By 1965, the country had largely abandoned private medical practice and the socialized nature of health care was codified into law (Feinsilver 1993).<sup>21</sup>

Over the next few decades, Cuba expanded services and reformulated healthcare delivery models. In the 1960s and 1970s, as part of a community approach to medicine, a polyclinic-based model was developed in Cuba. Interdisciplinary teams comprised of a nurse, general physician, internist, pediatrician, and an obstetrician staffed polyclinics. These facilities attended to 25,000 to 30,000 people, and had the primary responsibility of providing primary care to the community. In addition, polyclinics engaged in vaccination

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<sup>21</sup> Under the Principles of Socialist Public Health health care "is a right of the population," health care provision is the states responsibility, services must be equitable and have a scientific base, and health care has a "preventative orientation" with high community involvement together with international solidarity and medical collaboration with other countries (Ochoa and Serrano 2000).

drives, epidemiological surveillance and postgraduate medical training (Whiteford and Branch 2008; Novás and Fernández-Sacasas 1989).

Nevertheless, this model was unable to fulfill all primary care needs and many people were still turning to hospitals for primary care. The family doctor program developed in the 1980s deepened the community approach to healthcare provision. Physician-nurse teams were responsible for providing care to 120-150 families, living directly above the family doctor clinics in government provided apartments (Whiteford and Branch 2008). This led to increased medical surveillance of the community, a focus on environmental factors, early disease detection and rehabilitation (Feinsilver 1993). This program is a central component of Cuba's human resource based approach to health care delivery; by 1991, Cuba had over 15,000 family doctors, that number growing to 36,478 in 2010. These efforts to strengthen primary care likely improved efficiency by decreasing the number of hospital and emergency visits relative to cases seen by family doctors, while simultaneously contributing to a reduction in the IMR (Feinsilver 1993).

By 1990, the IMR stood at 10.7 per 1000 life births and life expectancy was 75.2 years for the 1985-1990 period. Disparities between town and country had been drastically reduced. Geographically equitable construction of medical facilities had eliminated 'regional imbalances' when allowing for additional capacity for referral centers (Feinsilver 1993). Coverage of rural areas was complete, and coordination of primary, secondary and tertiary care was improved.<sup>22</sup> Feinsilver (1993) presented data from Cuba's Ministry of Health which showed that the range of IMR among Cuba's provinces narrowed from 17.9 in 1979 to 5.0 in 1989, indicating a trend towards

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<sup>22</sup> The commitment of the government to improving health care was also reflected in the rapid expansion of health care infrastructure. By 1983 Cuba had built 256 hospitals, 397 polyclinic, 21 blood banks, and 81 maternity homes (Burns 1986).



improved and more equal health outcomes (a trend that will be examined below in greater detail). By this time, Cuba had led successful vaccination campaigns, eliminating or virtually eradicating polio, tuberculosis, DPT, typhoid, congenital rubella syndrome, hepatitis B and other diseases with an immunization coverage higher than “that of many developed countries” (Whiteford and Branch 2008:28-30). Cuba has continued to make impressive strides in fighting disease; an example is the recent recognition by the WHO of its elimination of mother-to-child transmission of HIV and syphilis (WHO 2015).

The fall of Eastern Europe and the Soviet Union during 1989-1991 plunged Cuba into a time of hardship known as the Special Period. Cuba suffered a sudden collapse of GDP by more than 35%, a precipitous fall in real wages, and a 90% decline in energy imports from the former Soviet Union and the end of imports of essential spare parts for Cuban industry, affecting virtually all areas of the Cuban economy (Perez 2011; Brenner *et al.* 2008). Cuba’s surprisingly resilience to the crisis, particularly in terms of health outcomes has led to interest regarding how countries may be able to adjust to potential economic contraction (Borowy 2013). In response, Cuba introduced some market-style reforms, legalized the dollar, and turned to tourism to increase access to hard currency.

While these reforms contributed to economic recovery, they also led to increased economic inequality; the GINI index grew from 0.24 during the 1980s to 0.38 by the end of the 1990s (Borowy 2013; Espina 2008; Saney 2004). These new inequalities also tended to be racially correlated as Afro-Cubans often worked outside the tourist sector and were less likely to receive remittances due to historic demographics of emigration (De la Fuente 2008; Espina 2008). Other research suggests that increased economic inequality exacerbates health outcomes, with those who are most disadvantaged placed in

the greatest risk (Wilkinson and Pickett 2006; Hosseinpoor 2005). This may occur even in the context of relatively socialized health care systems as in the UK (Marmot Review 2010; DHSS 1980; Hart 1971).

It is noteworthy in this regard that in spite of the tremendous economic difficulty during the 1990s, Cuba did not institute any IMF style austerity measures. Cuba did not privatize any portion of its health care sector, nor reduce its commitment to free and universal health care provision. According to WHO data, in 2011, Cuba's private expenditure on health was a mere 5.3% of the total expenditure on health. During the 'Special Period', Cuba actually *increased* its peso budget for health care, although the dollar budget (from which the country imports medical equipment) fell following the pattern of the Cuban economy and gradual recovery (Nayari 2005:809-810; Franco *et al.* 2007: 243; Uriarte 2008; Chomsky 2000).

Furthermore, Cuba has continued not only to attend to its own population but has sent health care personnel to serve in 103 countries, and currently provides health cooperation with 68 countries, including 25 in the Americas, 30 in Africa, 3 in the Middle East, 8 in Asia and 2 in Eastern and Central Europe (MINSAP 2011:141; Feinsilver 2009). Aspects of Cuba's international medical assistance include providing physicians to remote underserved areas, emergency disaster assistance, and training of thousands of physicians through collaboratively building new medical schools in these nations or having students from poor nations and backgrounds study under full scholarships in Cuba (Fields 2006; Christiansen 2010; Feinsilver 2009; Brouwer 2011). These international commitments should be kept in mind when looking at quantitative data of HRH in Cuba.

Still, the island has had fewer funds for hospital maintenance, water infrastructure and even some healthcare programs (Williams 2008). Nevertheless, the Cuban government actively pursues strategies to correct problems as they appear. For instance, there was a measurable decline in surgical operations performed between 2005 and 2006 with 58,043 fewer surgeries in 2006 than in 2005 (936,212 to 878,169)<sup>23</sup>. These numbers have since recovered; by 2012 there were 108,575 more surgeries performed in 2012 than in 2005 in the context of a small population drop (MINSAP 2012: 157). While per capita annual outpatient doctor visits declined from 5.5 in 1999 to 3.5 in 2005 due to family doctor office consolidation, by 2010 that figure recovered to 5.1 annual visits through a temporary reorganizing of primary care services based on service hours (Iñiguez 2013; MINSAP 2010). Iñiguez (2013) documents similar patterns in the fluctuations of per capita pediatric visits for children less than one year of age and maternal home residencies. While not suggesting a causal relationship between the difficulties in this period and the IMR, it is relevant that while the overall trend of this period in the IMR was downward (from 7.2 in 2000 to 5.3 in 2006), increases were reported in 2002 and 2005 compared to the preceding years (MINSAP 2011).

Since Raúl Castro became president in 2008, and particularly since the passage of the ‘Guidelines for the Economic and Social Policy of the Party and the Revolution’ in 2011, Cuba has been undergoing a restructuring of its socioeconomic model. The changes also seek to address challenges regarding the complexities of funding healthcare, renovating polyclinics and hospitals, and making healthcare services more efficient within a context of general economic difficulties and obstacles in acquiring medical

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<sup>23</sup> Iñiguez (2013:46) argues that this was due to a loss of surgical capacity characterized by “limited surgical resources” during hospital renovations.

technologies due to U.S. sanctions.<sup>24</sup> In spite of the Cuban government's efforts to prevent these circumstances from causing harm to the population and the healthcare system, the sanctions and economic difficulties have taken a measurable toll.

The balancing of local needs with large international health commitments is necessary for Cuba to maintain/improve health equity. The need for equilibrium was recognized in the policy guidelines adopted by the Sixth Communist Party Congress on April 18<sup>th</sup> 2011. Guideline 160 states that the country's health policy needs to "guarantee that the formation of medical specialists responds to the country's needs and to those generated by international commitments." Relevant changes occurring in Cuba's health sector include the consolidation of services where too many HRH were concentrated relative to need, promotion of efficient use of staffing, and regionalization of services.<sup>25</sup> Polyclinics that the Ministry of Health deems to be underutilized by the population will be transformed into family doctor offices (Iñiguez 2013).

### *Research Questions, Implications, and Particular Contribution to the Literature*

Past research has examined developments and transformations in Cuba's healthcare system (Feinsilver 1993; Iñiguez 2013; Ochoa and Serrano 2000), national trends in infant mortality (Corteguera 2000; Corteguera and Henríquez 2001; Álvarez 1999), and the government's commitment to universal access to care in the face of

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<sup>24</sup> Measures taken by the U.S. against the island include fining companies that sell medical equipment to Cuba, banning subsidiaries of U.S. companies from trading with Cuba, not allowing any ship that enters a Cuban port to enter a U.S. port for a period of six months and creating onerous licensing restrictions on the sale of food and medicine (American Association for World Health 1997). These restrictions, (combined with the dissolution of the socialist block countries) led in the early 1990s to "the disappearance of more than 300 medicines from local pharmacies" that "together with food shortages, threatened the very health of all sectors of the population" (Perez 2011: 296).

<sup>25</sup> One example of this "involves 24% of municipalities in the country with only one health area, meaning a single polyclinic reporting to the municipal health department. The two administrations are now being merged, with the polyclinic assuming management of the municipal health system, avoiding duplication of functions" (Iñiguez 2013: 49).

economic difficulties (Borowy 2013; Nayari and Lopez-Pardo 2005; Chomsky 2000). Also, current research is examining the impact of the socio-economic changes taking place on the nature of Cuba's evolving socialist model (Piñeiro Harneker 2014; Rodríguez 2014). However, little has been done to examine the government's goal of reducing spatial inequality in general, and the various shifts in healthcare strategies in particular, looking at change over time in the spatial distribution of healthcare human resources and outcomes. No article was found that examined the degree of inequality in HRH distribution at the municipal level. This research contributes to the analysis of changes in Cuba's health system by examining HRH distribution both among and within Cuba's provinces.

Has the provincial distribution of HRH and outcomes in Cuba become more equal over time particularly since the economic crisis of the 1990s? If so, to what degree? Have the recent changes instituted in Cuba's health sector led to an increase in inequality in healthcare personal distribution among provinces? Are Cuban health personnel more equally distributed among provinces or within them? Have provincial differences in the IMR continued to narrow since 1989? Which provinces are those with the greatest inequality in HRH distribution and IMR?

The question of whether Cuba has been able to maintain or deepen health equity amid various economic pressures and certain adjustments to the Cuban economic model (including a greater prominence of cooperatives, and more foreign investment) are relevant beyond Cuba's borders. Understanding Cuba's successes and challenges of establishing a public health care system with a rights-based approach to healthcare is also of special interest for those who wish to research further on how this has proceeded

within a context of resource scarcity. This work informs the larger debate between those who advocate a distribution of healthcare services by market logic and those who wish to promote healthcare as an inalienable human right.

## **METHODS**

This research uses descriptive and formal inequality measures to examine the degree to which Cuba has reduced inequality in the spatial distribution in HRH by personnel type relative to the population both over time across provinces (from 1958 to 2014, but with the greatest focus on 1989–2014) and within provinces in a cross-sectional analysis at the municipal level. Cuba has 16 provinces with each province containing several municipalities. I also use basic measures (box plots) and GIS mapping to portray the provincial and municipal level distributions in health care personnel and IMR. As can be gleaned from the earlier discussion, Cuba's experience reflects several highly relevant 'natural experiments': the revolution in 1959 and subsequent transformation of the health care system, the economic crisis of the 1990s, and the changes initiated by the Cuban government headed by President Raul Castro as reflected in the Guidelines approved by the Sixth Congress of the Communist Party in April 2011.

### *Data Sources, Data Quality and Research Limitations*

The majority of the provincial level data for this research were acquired from Cuba's Ministry of Public Health (MINSAP) statistical yearbooks. MINSAP's website INFOMED provides yearbooks dating back to 1995. Doctor density data for Cuba's provinces in 1958 was taken from Danielson (1979: 232). Doctor and family doctor data

by province as well as provincial population data for 1989 comes from the MINSAP data provided in Feinsilver (1993). Provincial mortality data from 1970 to 1990 comes from MINSAP data reported by Corteguera and Henríquez (2001). Country level population and total doctor and nurse data used to provide the global, OECD and non-OECD country comparisons come from the World Health Organization. Data on Cuba's annual GDP growth were gathered from the World Bank.

Data for the municipal level analysis were gathered from the Cuban National Office of Statistics (ONE) that publishes data from MINSAP. The National Statistic System (SEN) coordinates the national, territorial and complementary statistics for the country. ONE then approves and integrates these statistics that originate from all the “organs, organisms and entities that produce statistics in the country” (ONE 2012). Unfortunately, the types of data provided by ONE vary in terms of completeness by province, year, municipality, and measures gathered, limiting the number of variables and provinces available for analysis. This problem is significantly more pronounced at the municipal level than at the provincial level. This makes a countrywide analysis on the municipal level impossible without ONE or other official Cuban entities providing the missing data. Nevertheless, a significant number of provinces provide adequate municipal data for a variety of central indicators used in the study at the municipal level. Ten provinces were selected for analysis at the municipal level according to the following two criteria:

1. Publication of relevant indicators on the municipal level for all of a province's municipalities (or at least a great majority of the municipalities in question).

2. Greater apparent consistency of reported indicators with data provided on the provincial level.

For these reasons municipal data regarding the number of doctors for Scanti Espirtú and Ciego de Ávila were not included in the municipal analysis since summation of the numbers provided in the municipal yearbooks available in ONE did not match the numbers provided at the provincial level. This could have been due to some municipalities not reporting doctors, or reporting only family doctors, different times in reporting, or different definitions. When I used data despite observed discrepancies between municipal summation of total family physicians and provincial figures given within ONE (Cienfuegos and Las Tunas), the summation of the municipal figures were used, which was always lower. In addition, I sent e-mails to the respective provincial heads of the statistical section of ONE. While responses were received from members of ONE's staff, I was usually referred to MINSAP, but received no response from them.<sup>26</sup> According to the Ministry of Health's Statistical Yearbook (2010), MINSAP provincial data regarding the number of physicians comes from a registry of medical personnel and is used for provincial comparisons over time.

The largest threats to internal validity associated with data collection in this research relates to the different definitions used and potentially different methods utilized in acquiring data for a single indicator. For instance, MINSAP presents the number of doctors and family doctors in a province as listed on the registry through 2014. This number likely includes physicians who are away serving on missions abroad. While this is a useful measure of how many doctors the state has the ability to summon to a

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<sup>26</sup> The most helpful of the responses were received from the section of ONE working with Granma province, although this was a province with no observed discrepancies. The difference could be attributable to doctors actually serving vs. those merely registered but serving abroad.



particular area, it does not provide a precise measure for the number of doctors *actually serving* in the community. While Cuba's high levels of doctor density may allow for this to occur without any given locale suffering severe shortages, more precise and consistent categories would have helped the present effort considerably.

In this regard, it is noteworthy that since 2011 the MINSAP statistical yearbooks have used the category titled 'Family Doctors Serving in the Community'. During the 1990s, MINSAP provided a breakdown of the distribution of family doctors in their statistical yearbooks that included this category among others, but during the decade of the 2000s these breakdowns did not appear. The numbers for this measure were roughly 30-40% of those listed as family doctors in 2010, likely reflecting the high number of general practitioners serving abroad.

This research's primary limitation lies in its ability to make causal inferences regarding fluctuations in HRH inequality, due to scarcity of available data. Causal inferences for explaining variation in HRH inequality at the provincial level are thus limited primarily to a comparison of the stated intent of recent policy changes and the observed changes in the distribution of HRH. Neither MINSAP nor ONE makes available certain potentially interesting explanatory variables for explaining the variation in HRH density (such as poverty levels, racial demographics, or the number of physicians, family doctors and nurses by province and municipality serving on foreign missions). Other potential interesting variables such as the number of medical school graduates are only available on the national level, further reducing the ability to make causal inferences. This study is also limited in terms of spatial analysis; i.e., data on distances traveled to see a care provider or a specialist were not available. Rather than

analyzing access based on central places as in central place theory, this research looks at HRH distribution among administrative units (provinces and municipalities).

### *Hypotheses*

**H<sub>1</sub>:** I hypothesize that the GINI and Theil index for the distribution of each category of HRH to be moving closer to zero over time, reflecting a reduction HRH imbalance relative to the population since 1989. Although Cuba has experienced greater economic inequality since the opening up to tourism forced by the economic crisis of the 1990s, as noted by Espina (2008), I hypothesize that the island nation has been able to continue to advance in terms equity of health inputs (operationalized as doctor, family doctor and nurse density, where possible) and in outcomes (operationalized as infant mortality). Since GDP has fluctuated significantly in the last two and a half decades, I do not expect any significant correlations between the HRH GINIs for the years calculated and the corresponding GDP growth level. This hypothesis builds upon previous research that reflects Cuba's determination to implement universal healthcare provision across the island since the Cuban revolutionary government came to power in 1959 (Whiteford and Branch 2008; Nayari and López-Pardo 2005; Feinsilver 1993).

**H<sub>2</sub>:** I hypothesize that there is greater inequality within provinces than among provinces regarding doctor density generally. In part, this would likely reflect natural unevenness of distributions in those municipalities with tertiary sectors that require a greater number of physicians and specialists. I anticipate that the level of inequality will be lower for the distribution of family doctors as measured by the GINI index than the distribution of total

doctors. Some level of inequality among these total physicians is intentional. Those provinces that have municipalities with major metropolitan centers where tertiary services tend to be concentrated will have greater inequality reflecting the higher number of specialists concentrated there. In theory, this problem is addressed by calculating the GINI of the spatial distribution of family doctors and to a lesser degree by examining nurses relative to the population. Unfortunately, even for those provinces in which the numbers of total doctors were provided, some municipalities did not provide the number of total family doctors or total nurses. In those cases only the GINIs for the total doctors relative to the population are calculated.

#### *Measuring inequality in HRH*

This paper uses descriptive and inequality measures (such as the GINI coefficient) to capture the degree of inequality in the Cuba's HRH distribution. Regidor (2004), Schneider *et al.* (2002) and The Pan American Health Organization (2001) present the GINI coefficient as a useful way to measure various health inequalities. This method has also been used in previous studies (e.g., Munga and Maestad 2009; Tandi *et al.* 2015).

I calculated the GINI and the Theil coefficients for the distribution of doctors, family doctors and nurses relative to the population using Microsoft Excel. I used Brown's formula (multiplied by 100) for the GINI coefficient recommended by the Pan American Health Organization (2001):  $G = 100 * [1 - \sum_{i=0}^{n-1} (Y_{i+1} + Y_i) (X_{i+1} - X_i)]$  where G is the GINI coefficient, Y is the cumulated proportion of health care personnel in category i, X is the cumulated proportion of the population in category i, and n is the

number of geopolitical units. I used the Theil formula  $T = \sum_{i=1}^N H_i \ln \left( \frac{H_i}{P_i} \right)$  where  $H_i$  is the share of health workers in category  $i$ , and  $P_i$  is the share of population in category  $i$ .

Dussault and Franceschini (2006) indicate that a normative approach, which focuses on doctors relative to population, may not capture need or productivity.

Although I did not analyze morbidity data, I did gather data on productivity as measured by medical consultations per inhabitant. Medical consultations per capita correlated positively at the provincial level with total doctor density in every year for which I had gathered relevant data: in 1989 (0.84  $p < .001$ ), in 1995 (0.81,  $p < .001$ ), in 1999/2000<sup>27</sup> (0.681  $p = .005$ ) in 2005 (0.75,  $p = .001$ ), in 2010 (0.72  $p = .002$ ), in 2011 (0.83  $p < .001$ ), in 2012 (0.78  $p < .001$ ) and in 2014 (0.54  $p = .029$ ).

Regarding the measure of inequality in health outcomes, the research does not use concentration indices due to the interpretational problem associated with the worst-case scenario when discussing the distribution of a ‘bad thing’ i.e., infant mortality vs. an asset.<sup>28</sup> In its place, I have chosen a far more simple but eloquent measure: box plots. The box plot correctly captures the reduction in IMR and provides an accurate visual depiction of the spread. It has the additional attribute of singling out outliers. I also calculate the population attributable proportion (PAP) as explained by Schneider *et al.* (2002), with the sole difference that instead of basing the comparison on the difference between the overall IMR and the province with the best socioeconomic indicator’s IMR, I

<sup>27</sup> Total doctor data for 2000 was unavailable, so I used the 1999 provincial distribution.

<sup>28</sup> Initially it may appear that the reversal of the sorting order is sufficient to account for the necessary difference in interpretation, but I would argue, that this fails to truly invert the scenario of perfect inequality of the distribution of something desirable (like human resources for health, wealth or income). Take for example a case of perfect inequality where all geopolitical units lost every child that was born prior to their first birthday save one unit that lost none. If there were 16 geopolitical units and 1000 babies born in each, and we measured the above situation with a concentration index, we would have an absolute value of 6.25 as opposed to 100. Yet this is a situation most parallel to absolute inequality of the GINI coefficient in which one person owns all the wealth and everyone else has nothing. True, this reflects low concentration, but it does not measure the inequality in life chances. The concentration index is thus aptly named and measures if one province bears undue weight, but this summary measure does not capture the concept that is the focus of this research.

contrast the overall IMR with the province with the lowest IMR. This provides an answer to the question of what would have been the percent reduction in the IMR if every sub-unit had achieved an IMR equal to that of the unit that had the lowest IMR. The calculation is from Schneider *et al.* (2002) and is as follows:  $PAP =$

$$\frac{\text{General IMR} - \text{Lowest IMR}}{\text{General IMR}}$$

GIS mapping was used to display the geographic dimensions of HRH density and health outcome variation. At the provincial level, choropleth maps were generated using ArcGIS to reflect spatial changes in IMR over time and to contrast the spatial variation in IMR with population per doctor in 2012. The municipal level maps contrast population per doctor with IMR and percent rural with the population per family doctor.

Some correlations were run at the provincial, municipal and national levels to explore potential relationships between the variables explored (including year) and other variables of interest provided by MINSAP and ONE at various levels of analysis. They include the percent of the population classified as rural (provincial and municipal levels), and the annual health budget (national level). In spite of the limited number of years, I ran national level correlations to explore *potential* relationships over time with the GINI and Theil coefficients. Inferences about the relationships originating from correlations here beyond the years analyzed should be made with caution, and these inferences should not be extended beyond the Cuban case.

## RESULTS

The goal of this research is to ascertain the change in the degree of inequality in the distribution of HRH and IMR among Cuban provinces since the beginning of the

Cuban revolution with the focus predominantly on distributional changes that have occurred since the fall of the Soviet Union and Eastern European Council for Mutual Economic Assistance in 1989 and the period covering the recent changes in the Cuban health sector. Where data permits some exploration of potential explanations for these shifts, they are provided.

The period evaluated extends through the socioeconomic changes outlined in the ‘Guidelines for the Economic and Social Policy of the Party and the Revolution’ that were approved by the Sixth Congress of the Cuban Communist Party in April of 2011. Among the recently approved guidelines is Guideline 155, whose purpose is to “Reorganize and concentrate the health-care services, including emergency care and transportation, on a regional basis and consistent with the needs in each province and municipality. The health care system must see to it that each patient receives appropriate and quality assistance” (Sixth Congress of the Communist Party of Cuba 2011). This research also examines the level of inequality in these distributions within ten of Cuba’s provinces in 2010.

#### *Change in HRH distribution among Cuban Provinces*

Table 1 presents data on the spread of physicians among Cuban provinces by year. Taking a look at Table 1 (below) as both the median and national figures indicate, the number of doctors proportionate to the population among Cuban provinces has increased dramatically in the time period examined. National doctor density across the island nation increased more than seven-fold since the beginning of the revolution in 1959. Pooling all of the provinces, there is further evidence of the strong upward trend in

physician density. This revealed a strong positive correlation in a two-tailed test between year and provincial level doctor density at .763 (n=93 p < .01). It is also notable that this trend did not ebb over the ‘special period’ of the 1990s nor did the overall trend subside after the passing of the Guidelines in 2010.

**Table 1:** Physician (density) distribution in Cuba among provinces

Country/ Year	N	Min.-Max. Doctor Density per 1000	Median Doctor Density	National/ overall Doctor Density	GINI	Theil
1958*	7	0.38 – 4.00	0.60	0.90	NA	NA
1989	15	1.76 – 6.85	2.42	3.31	27.0	13.1
1995	15	3.43 – 8.73	4.54	5.18	18.4	6.0
1999	15	3.98 – 9.14	5.09	5.79	15.6	4.2
2005	15	4.04 – 9.86	5.49	6.28	15.3	4.1
2010	16	4.24 – 9.68	6.32	6.81	12.0	2.5
2012	16	4.64 – 9.99	6.88	7.35	11.3	2.1
2014	16	5.12 – 9.60	7.29	7.62	9.4	1.4
World 2013 or most recent year**	157	0.01 – 6.78	1.23	1.39	40.0	27.3
OECD 2012	28	1.73-4.96	3.21	2.73	15.0	3.8
Non-OECD 2013 or most recent year	129	0.1 – 6.78	1,613	1.07	38.2	26.6

Note: N refers to the number of provinces. Doctor density is the number of doctors per 1000 people. GINIs and Theils are calculated by comparing the cumulative doctors against cumulative population with values ranging from 0 to 100. Absolute equality is 0 and absolute inequality is 100. \*Data from a MINSAP table of doctor density by province, reported in Danielson 2012 \*\*Years range from 2007-2013.

Although there were insufficient data available to calculate the GINI and Theil coefficients for 1958, both the size of the absolute range and the fact the provinces were aggregated and much larger, suggests that inequality was very high and doctor density particularly low in some areas. For instance, Oriente province was later divided into Las Tunas, Granma, Holguin, Guantánamo, and Santiago de Cuba, while Las Villas (also known as Santa Clara) was later divided into Villa Clara, Sancti Spíritus and Cienfuegos. So, although we may always expect a higher concentration of physicians in urban areas (where more secondary and tertiary health services are located), the inequality in the distribution of physicians in 1959 Cuba appears stark. For example, in Oriente and Pinar del Rio provinces there was roughly only one doctor for every 2,632 and 2,174 people, respectively, but in the capital city there was roughly one physician for every 250 people.

By 1989, it was clear that the situation of the overall distribution of physicians had improved dramatically, especially in those areas with historically the low doctor density. Aggregating the estimates for the five provinces that once formed Oriente province, the combined '1989 Oriente province' would have had a doctor density of 2.27 compared to the 1958 figure of 0.38. Still, taking into account the level of inequality as measured by the GINI and Theil, there was still significant inequality in Cuba across provinces in 1989. This was, however, considerably less than the between-country estimates observed in the world and non-OECD countries in the past decade. By 2014, there was less inequality in the reported distribution of Cuban physicians among provinces than there was among OECD countries.

From 1989 to 2014 the distribution of total physicians among provinces became more equal and the total number of physicians relative to the population has become



much higher, providing support for H<sub>1</sub>. While there are very few years presented in Table 1 with which to analyze national level data (n = 7 years- excluding 1958), these numbers generate a significant inverse correlation between year and the GINI coefficient (-.948, p < .01). While quantitative data is insufficient to fully analyze other variables that may explain the dynamics of physician placement, we see that doctor density correlated negatively with the percentage of the population defined as living in rural areas in 2010 (n = 16) on the provincial level at (-.552 p < .05). However, by 2012 this correlation lost significance (-.352 p = .18). In this limited sample, Cuba's GDP growth did not approach a significant correlation with either its doctor density or any of the HRH related GINI or Theil coefficients.

It is critical to remember, however, that many of these physicians are serving in important internationalist missions. For instance, although MINSAP does not provide information regarding the number of physicians serving abroad (only the countries in which they serve) in their statistical yearbooks, the Cuban News Agency reported on March 26<sup>th</sup> of 2015 that there were over 25,000 physicians serving in Cuba's various internationalist programs (Padrino 2015). In 2014, MINSAP reported that the island had 85,563 physicians, thus subtracting 25,000 leaves roughly 60,000 for domestic service.<sup>29</sup> Given Cuba's high physician density this may not pose a significant problem to the provision of health care in Cuba as according to Fransisco Rojas Ochoa, "We can have thousands abroad because 80,000 here would bump heads" (Edith and Terrero 2008).

Since these numbers include specialists, family physicians, generalists as well as those serving abroad, one may suspect that the distribution of hospitals and hospital beds

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<sup>29</sup> MINSAP does not report the number of physicians that each province provides to internationalist missions. This would have been beneficial for keeping track of any impact it may have on the equity of HRH distribution and for the this research.

relative to the population would have become more equal as well. Nevertheless, over this period there has been a decrease in the number of total hospitals (from 263 in 1989 to 215 in 2010 and then further to 152 in 2014). In the period from 1989 to 2012,<sup>30</sup> there was a decrease in the number of total hospital beds from 63,068 to 45,649. Thus, I observed a slight increase when calculating the GINI for the total hospitals (relative to the cumulative population) between 1989 and 2010 from 14.3 to 18.0, respectively, but a decrease in the GINI for hospital beds between 1989 and 2012 (in spite of a reduction in total hospital beds) from 23.9 to 13.8, respectively.

The decrease in the number of hospitals and hospital beds reflects a continued emphasis to shift services and technology away from hospitals and towards the polyclinic (Iñiguez 2013: 45). However, while the number of polyclinics increased from 440 polyclinics in 1995 to 563 in 2010, by 2014 they dropped to 451, likely reflecting consolidation of services as specified in Guideline 155. In spite of the reduction of total polyclinics in 2014, the provincial distribution of polyclinics relative to the population measured by the GINI coefficient has followed a trend of reducing an already low level of inequality - going from 13.8 in 1995 to 12.1 in 2010 to 7.4 in 2014.

Since one would necessarily expect a greater concentration of overall physicians (particularly specialists) in or near the tertiary facilities, one would expect greater inequality in the distribution of total physicians than of family doctors. Due to the importance placed on primary care both in Cuba and in the literature, it is important to examine the change in the distribution of family physicians in Cuba as well during this period. It should be emphasized that family doctors are the center of Cuba's community medicine model whose primary duty is "to aggressively investigate and monitor the

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<sup>30</sup> The MINSAP yearbook of 2010 did not report totals on provincial hospital beds.

health of the entire population, not just the diseased” (Feinsilver 1993: 40). Tables 2a and 2b provide data regarding the distribution of family doctors and family doctors listed in the community over time.

As in the case with total physicians, there was a steady increase over time in ‘overall’ family doctor density. However, those classified as family doctors *in the community* decreased slightly during the same period. In 1989, Cuba’s family doctor program was very young, having only been piloted in 1984, so some disparities among provinces would be expected. The virtual disappearance of these disparities by the year 2000, as indicated in Table 2a, is thus quite remarkable. However, although the 2010 level of inequality remained minimal and was less than half of what it was in 1989, it did increase during 2000-2010. Nevertheless, since many Cuban physicians spend an extended time in international missions, Table 2b likely provides a more precise picture of those physicians actually serving in the community.<sup>31</sup>

It should be noted that consultation per inhabitant correlates more strongly with total doctor density than with either family doctor density or family doctor in community density in every year for which I ran correlations with consultations per inhabitant except for 1995. Family doctor density correlated significantly with total medical consultations per capita in 1989, 1995, and 2005. These variables did not correlate significantly in 2000 or 2010. Density of family doctors listed in the community did not correlate with medical consultations per capita in any year analyzed.

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<sup>31</sup> It is important to note that in 1995 ‘community’ was only one of several localized family physician placement categories. Other placement categories included ‘schools’, ‘infant circles’, ‘work centers’, ‘tourism’, ‘agro-industrial complex’, ‘agricultural cooperatives’, ‘on reserve’ and ‘other’. In 2012 and 2014, however, the Cuban Ministry of Health (MINSAP) reported only a single category: family doctors located in the community.

**Table 2a:** Family doctor (density) distribution among provinces in Cuba

Year	N	Min.-Max.	Median	National	GINI	Theil
1989	15	0.48 – 2.90	2.44	1.12	22.7	8.9
1995	15	1.89 – 3.01	2.44	2.47	9.1	1.3
2000	15	1.98 – 3.15	2.74	2.69	5.7	0.6
2005	15	2.27 – 3.44	2.83	3.00	6.7	0.7
2010	16	2.25 – 4.49	3.41	3.24	10.6	1.8

Note: All GINIs and Theils are multiplied by 100. Absolute equality is 0 and absolute inequality is a 100.

**Table 2b:** Family doctors listed in community (density) distribution among provinces in Cuba

Year	N	Min.- Max.	Median	National	GINI	Theil
1995	15	1.22 - 1.63	1.46	1.48	3.9	0.3
2000	15	1.26 - 1.73	1.50	1.53	3.9	0.3
2011	16	0.58 - 2.53	1.13	1.19	14.1	4.0
2012	16	0.98 - 1.53	1.18	1.20	6.2	0.6
2013	16	1.05 - 1.45	1.18	1.19	4.8	0.4
2014	16	1.01 - 1.29	1.14	1.14	3.4	0.2

Note: All GINIs are multiplied by 100. Absolute equality is 0 and absolute inequality is 100.

MINSAP's human resources director, Dr. Marcos del Risco del Rio, reported on March 27, 2014 on Mesa Redonda (a Cuban news analysis television program) that a reorganization of HRH began in 2010 to increase efficiency within the health sector while maintaining universal coverage. The reorganization of much of the health sector was based on a countrywide study that provided an analysis of health facilities that examined economic and epidemiological factors in every municipality. One component of this reorganization is the reduction the total number of health workers, and according to Dr. Risco del Rio, were reduced by 109,000. This has helped to achieve the goal of reducing the total number of health workers on the government's payroll and to increase

salaries for those remaining within the health sector. Dr. Risco del Rio reports that 27,257 excess health sector trained professionals relocated based on existing needs and a portion was placed on reserve (Mesa Redonda 2014).

Table 2b shows a decrease in the number of family physicians in the community between 2000 and 2011. The data for 2011 reflects some of the problems discussed by Iñiguez (2013). In 2011, the number of family doctors located in the community density overall was roughly the same as in 2012 and 2014, but the distribution was far more skewed in 2011, with Villa Clara and Artemisa had very low family doctors in the community density (by Cuban standards) at 0.58 and 0.89, respectively. By the following year, however, these had increased to 1.32 and 0.98, respectively.

The decrease in family doctor density in 2011 (which has remained relatively stable since) reflects the consolidation of family doctors' offices as well as the continued efforts to correct the balance between family doctor distribution and caseloads. While according to Edith and Terrero (2008) and Iñiguez (2013), this decrease did not lead to a drop in the rate of coverage, it did lead to longer wait times, a reduction in per capita doctor visits, increased caseloads and some people turning to the hospital for primary care. The current target is for each family nurse-physicians office to have a caseload of 300 to 400 families (Iñiguez 2013: 49). Table 2a thus provides some support for  $H_1$ , due to the difference between the 1989 and 2010 GINIs, while Table 2b indicates that the level of equality in the distribution of family physicians spiked in 2011 and decreased in each of the following years. This suggests that the reorganization of this part of the health system is leading to greater equality in the distribution of physicians in the community relative to the population.

Table 3 reflects an overall increase in nurse density with a slight decrease in 2014. The inequality in nurse distribution increased in 2012 but reverted to its 1995 level in 2014. Nevertheless, as both the GINI and Theil indicate, inequality in the distribution of nurses has been minimal even during the years with most inequality. Overall, it is clear that neither the Special Period nor the changes approved by the Sixth Congress of the Communist Party have upset a commitment to equality in the distribution of HRH in Cuba among provinces.

**Table 3:** Nurse (density) distribution among provinces in Cuba

Year	N	Min.-Max.	Median	National /overall	GINI	Theil
1995	15	5.21 – 8.78	6.79	7.04	8.1	1.1
2000	15	5.63 – 9.09	7.07	7.43	7.7	1.0
2005	15	6.93 – 9.79	7.99	7.96	5.5	0.5
2012	16	4.47 – 13.25	8.49	8.25	12.5	2.7
2014	16	6.37 – 11.33	7.72	8.09	8.1	1.2
World 2012*	147	0.14 – 23.74	2.36	2.52	45.8	41.1
OECD 2012**	25	0.16 – 23.74	6.46	6.08	39.6	27.9
Non-OECD 2012*	121	0.14 – 11.72	1.74	1.99	37.6	30.7

Note: Nurse density per 1000 people. GINIs and Theils are run plotting the cumulative doctors against cumulative population and range from 0 to 100. Absolute equality is 0 and absolute inequality is a 100. \* Or most recent year. \*\*Chile is a big outlier in the OECD regarding nurse density.

#### *Change in absolute inequality of infant mortality rates among provinces*

Although a national health system has a greater ability to provide relatively equal access to quality prevention and care through a managed distribution of HRH and facilities (ideally varying solely by need), if those services are distributed and tailored to population needs ideally we would see both improving overall trends and a growing

degree of equality in health outcomes. As Table 4 and Figures 1, 2a, and 2b reflect, the average of the provincial IMR has improved and there has been a significant reduction in the range of the IMR over the period examined.

Although no province has obtained a lower IMR than Villa Clara (2.5) in 2010, average IMR tended to decline. Nevertheless, 2012 registered a slight increase as well as a wider spread in IMR among provinces. By 2014, the national and median IMR had improved, but the provinces Artemisa and Ciego de Avila registered IMRs 1.9 and 2.0 deaths per 1000 live births above the national average, respectively. According to the population-attributable-proportion (PAP) for 2014, if every province had done as well as Cienfuegos and Isla de Juventud (IMR = 3.0 for both provinces), then Cuba's IMR would have been 28.6% lower. It is important to mention that large increases in the PAP are likely mathematical artifacts of the IMR decreasing as opposed to a given province's relative position being exacerbated. This is why PAP may increase regardless of significant decreases in the average IMR of the series or of large decreases in the range of IMR (compare the years 1970 and 2010). Overall, there was an 88.4% reduction in the national IMR over the period examined.

**Table 4:** IMR distribution among provinces in Cuba

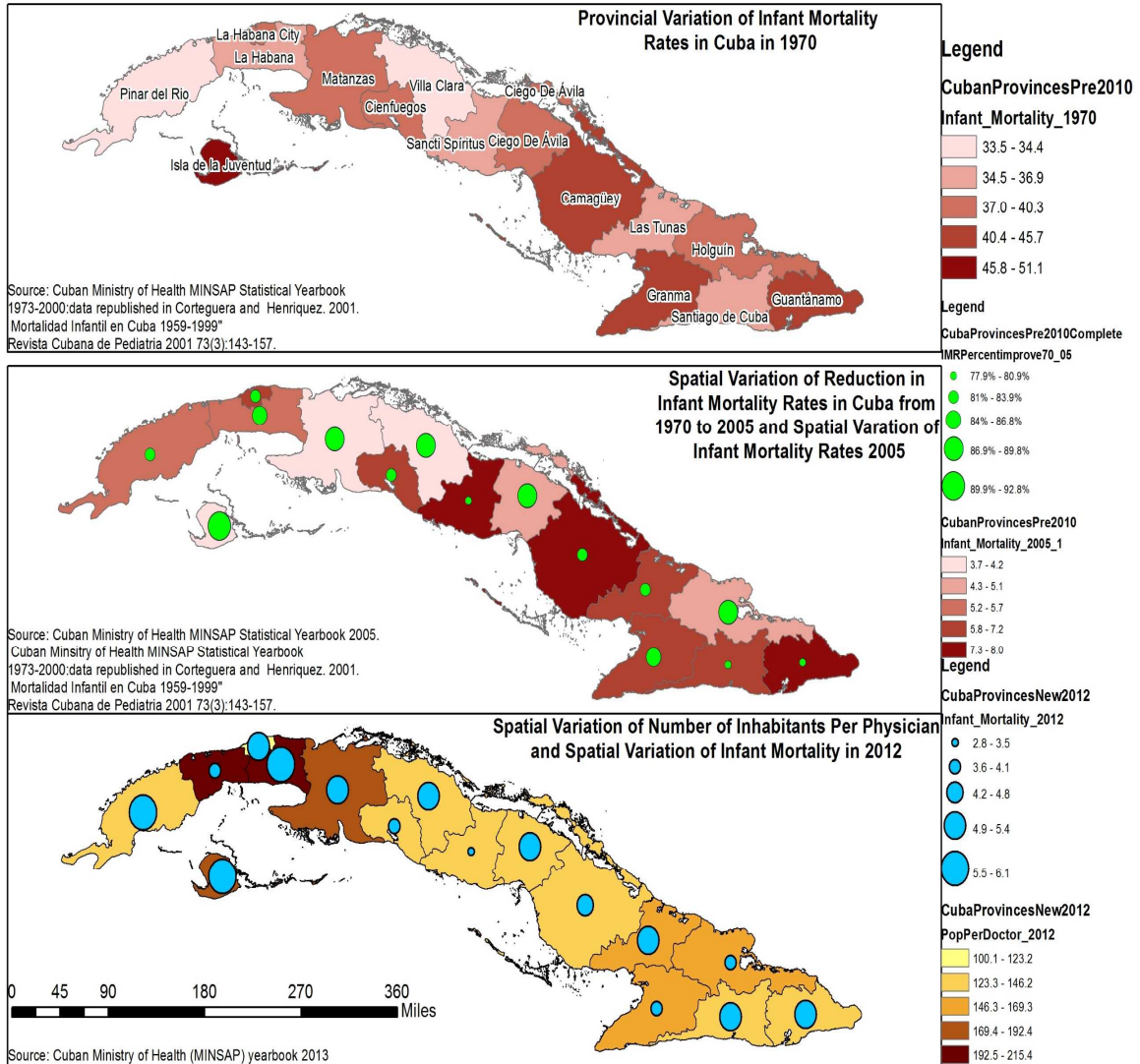
Year	N	Min.-Max.	Median	National	PAP
1970	15	33.5 - 51.1	38.3	38.7	13.4
1975	15	18.8 - 35.1	28.9	27.5	31.6
1980	15	14.4 - 24.2	19.8	19.6	19.6
1985	15	14.0 - 23.7	16.4	16.5	15.2
1990	15	7.6 - 13.6	10.8	9.9	23.2
1995	15	6.5 - 10.9	9.7	9.4	30.9
2000	15	4.9 - 9.1	6.9	7.2	31.9

**Table 4:** Continued

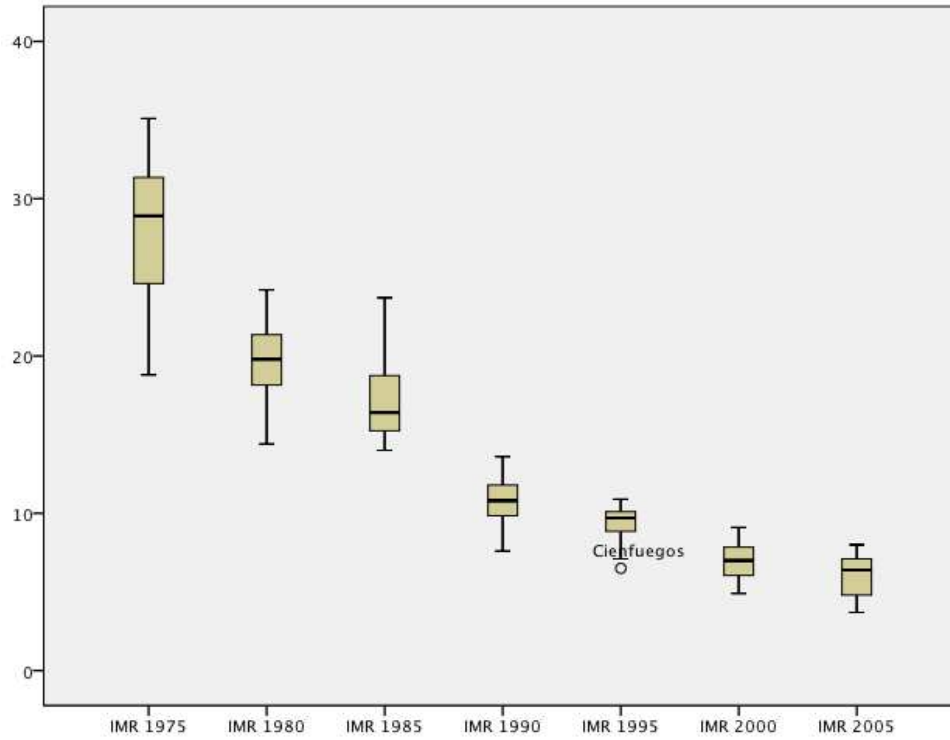
Year	N	Min.-Max.	Median	National	PAP
2005	15	3.7 - 8.0	6.4	6.2	40.3
2010	16	2.5 - 5.7	4.8	4.5	44.4
2012	16	2.8 - 7.1	4.8	4.6	39.1
2014	16	3.0 - 6.2	4.1	4.2	28.6
World 2012	187	1.7 -117.4	15.9	NA	NA
OECD 2012	32	1.7 - 13.9	3.4	NA	NA
Non-OECD 2012	121	3.9 - 117.4	26.8	NA	NA

Figure 1 includes three GIS generated maps, the first of which shows the provincial rates of IMR in 1970, the second displays provincial IMR in 2005 and the percent reduction in the IMR between 1970 and 2005, and the third shows the number of inhabitants per physician with provincial IMRs for 2012. The box plots in Figures 2a and 2b indicate that provincial IMRs are becoming much more similar, portraying much greater equality in the IMR among provinces. Figure 2a shows a strong downward trend in IMR across virtually all provinces, with the median, third and fourth quartiles becoming lower and tending towards closer scores. Figure 2b shows a continuation of the trend, although due to the lower bound of the IMR it is difficult to push it much lower.

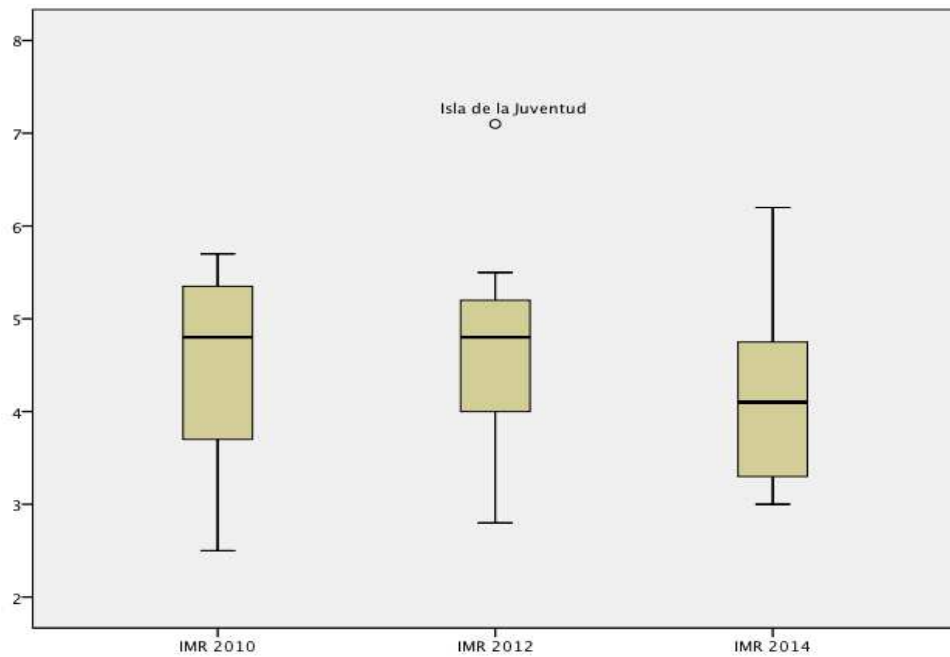




**Figure 1:** Infant mortality rates across time and space in Cuba



**Figure 2a:** Box plots of IMR among Cuban provinces 1975-2005



**Figure 2b:** Box plots of IMR among Cuban provinces 2010-2014

*HRH distribution among Cuban municipalities*

To delve deeper into understanding the level of inequality in HRH distribution in Cuba, I examined the number of physicians relative to the population in municipalities in ten Cuban provinces for 2010.<sup>32</sup> In the bivariate correlation analysis of the 2010 cross-section of municipalities, doctor density negatively correlates with percent rural at -0.39 ( $p < .01$ ,  $n = 117$ ). Nurse density also negatively correlates with percent rural at -0.23 ( $p < .05$ ,  $n = 82$ ). Family doctor density does not correlate significantly (.21,  $p = .13$ ,  $n = 44$ ) with the percentage of the population that lives in areas designated as rural. The various HRH categories evaluated in this study are all positively inter-correlated. Physician density correlates with nurse density (0.51  $p < .01$ ,  $n = 82$ ), nurse density correlates with family physician density (0.35  $p < .01$ ,  $n = 54$ ) and physician density correlates with family physician density (0.44  $p < .01$ ,  $n = 67$ ) as expected, considering that the latter is a component of the former. Neither the HRH density variables nor the percentage of the population residing in rural areas correlated with IMR at this level.

Table 5 shows the range of the distribution of physicians per 1000 population within each of the provinces, with the GINI and Theil coefficients providing summary measures of the degree of inequality in their distribution relative to the population. From Table 5 one can observe that Cienfuegos province had the most unequal distribution of doctors (but the second highest provincial average) while Santiago de Cuba province reported both the highest provincial average and the municipality with the greatest concentration of physicians. Cienfuegos's population is predominately urban with the

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<sup>32</sup> It should be noted that the reporting municipalities of La Habana province do not include the city of La Habana, which has always been reported separately and that this province was divided into Artemisa and Mayabeque in 2011.

lowest percentage of population living in rural areas of the ten provinces compared in Table 5. Cienfuegos municipality had by far the largest concentration of physicians at roughly twelve doctors per 1000 population in 2010, and has one of the province’s two general hospitals and the province’s pediatric hospital Paquito Gómez. In contrast, Rodas municipality in 2010 had a doctor density of ‘only’ 1.9. Guantánamo, which reported the third highest overall doctor density, had the most egalitarian distribution. Figure 3 (below) includes a map of the number of inhabitants per doctor by municipality.

Comparing the 2010 GINIs and Theils in Table 1 with the overall GINI and Theil in Table 5, it appears that the level of inequality within provinces is greater than the level of inequality between them, providing support for H<sub>2</sub>. However, the calculation in Table 1 includes provincial figures for provinces (and a few municipalities) not included in Table 5. Nevertheless, calculating the between provincial GINIs and Thiels for the data in Table 5 (by summing the doctors and population by the municipalities of the provinces used in Table 5 and then calculating the GINIs and Thiels of those summations), the between provincial GINI is 8.5 with a Theil of 1.3, as compared to within provincial coefficients of 27.3 and 11.8, respectively, clearly indicating greater within provincial inequality. This finding is unsurprising, as one would expect there to be a greater concentration of physicians in municipalities where there are more secondary and tertiary institutions.

**Table 5:** Physician (density) distribution within Cuban provinces

Province	N	Min.–Max.	Median	Prov./ overall	GINI	Theil
Camagüey	13	1.75 – 9.87	3.64	6.21	27.1	13.2
Cienfuegos	8	1.88 – 11.99	3.63	7.05	31.1	18.6

**Table 5: Continued**

Province	N	Min.–Max.	Median	Prov./ overall	GINI	Theil
Granma	13	3.55 - 9.45	4.01	5.77	19.5	6.5
Guantanamo	10	3.65 – 8.24	5.45	6.59	13.9	3.4
La Habana*	15	2.15 – 6.71	2.95	4.42	19.1	5.7
Holguin	14	2.62 – 8.20	3.45	5.18	22.7	8.7
Las Tunas	8	2.45 – 7.65	3.17	4.88	22.8	9.4
Pinar Del Rio	14	2.93 – 11.03	3.46	5.67	28.7	14.9
Santiago de Cuba	9	3.01 – 15.95	4.70	7.20	24.2	10.6
Villa Clara	13	3.61 – 11.45	4.28	6.56	26.0	11.8
<b>Total</b>	<b>117</b>	<b>1.75 – 15.95</b>	<b>3.91</b>	<b>5.91</b>	<b>27.3</b>	<b>11.8</b>

\* The Habana municipalities Santa Cruz del Norte, Batabano, Bauta and Güira de Melena did not report and are thus excluded.

Table 6 shows that the distribution of family doctors, as reported by Cuba's National Statistical Office (ONE) for six Cuban provinces, is more equal than that of overall physicians. Las Tunas's GINI and the Theil coefficients for family doctor distribution reflect a degree of inequality similar to that displayed by the province for doctor distribution. As in the case of the overall distribution of physicians, in 2010 Cienfuegos had the most unequal distribution of family physicians. Guantánamo and Granma provinces reported the most even distribution of family physicians relative to their populations in 2010. Comparing the overall within province GINI (19.3) and Theil (7.4) to the 2010 among province family doctor GINI (10.6) and Theil (1.8), I find further support for H<sub>2</sub>

The municipalities of Rodas, Cienfuegos and Jesús Menéndez, Las Tunas reported the lowest family physician density of the municipalities in the study with only

16 family doctors for a population of 33,546 people and 34 family physicians for a population of 50,460 people, respectively. Rodas is the second most rural municipality in Cienfuegos, and although Cumanayagua is the most rural of the province's municipalities, it reported highest family doctor density of the province at 2.8. In the bottom map of Figure 3, Cienfuegos is enlarged so the spatial inequality can be more fully appreciated. It should be noted that since 2010, according to ONE, Jesús Menéndez, Las Tunas has increased its number of family doctors to 55 (2013 population 49,165) improving the family doctor density to 1.12 and Rodas, Cienfuegos increased the number of family physicians slightly to 41 for a decreased population of 34,278, increasing family doctor density to 1.20. This may indicate efforts on part of MINSAP to continually manage and improve levels of equality in HRH distribution.

**Table 6:** Family physician (density) distribution within Cuban Provinces

Province	N	Min.-Max.	Median	Prov./ Overall	GINI	Theil
Camagüey	13	1.00 – 3.96	2.22	2.88	18.83	6.3
Cienfuegos	8	0.48 - 2.83	1.00	1.23	23.8	11.4
Granma	13	2.78 – 4.28	3.37	3.54	6.6	0.7
Guantanamo	10	3.03 – 4.46	3.78	3.60	3.6	0.3
Las Tunas	8	0.67 – 3.82	1.97	2.63	21.5	8.5
Villa Clara	13	1.90 – 4.76	3.58	3.73	12.0	2.4
<b>Total</b>	<b>65</b>	<b>0.48 – 4.76</b>	<b>3.12</b>	<b>3.09</b>	<b>19.3</b>	<b>7.4</b>

Table 7 presents the distribution of nurses within six Cuban provinces among their respective municipalities. With the exception of Camagüey and Guantánamo provinces, nurses tend to be more evenly distributed within Cuban provinces than

physicians overall, although not quite as evenly as family doctors. Manzanillo and Bayamo municipalities of Granma province both reported exceptionally high nurse density with 23.16 and 13.13, nurses per 1000 population, respectively. Pinar del Rio municipality of Pinar del Rio province and Guantánamo municipality of Guantánamo province are both quite high at 15.65 and 15.03 respectively. Camagüey, while not appearing to suffer a shortage of nurses, had the lowest nurse density in 2010 and the most uneven distribution of nurses of the provinces analyzed. Total within-province GINI (26.9) and Theil (12.7) were higher than the among-province GINI (12.5) and Theil (2.7) for 2012 (no nurse density data was reported for 2010) indicating further support for H<sub>2</sub>.

**Table 7:** Nurse (density) distribution within Cuban provinces

Province	N	Min.-Max.	Median	Prov./ Overall	GINI	Theil
Camagüey	13	1.36 – 9.00	3.12	3.20	35.8	21.3
Granma	13	6.33 – 23.16	9.72	12.51	19.3	6.9
Guantánamo	10	1.25 - 15.03	10.09	12.00	14.6	2.3
Holguin	14	5.21 - 14.90	8.70	8.73	14.4	3.5
Pinar Del Río	14	6.12 – 15.65	7.88	10.45	19.1	5.9
Villa Clara	13	5.67 -13.68	7.75	9.24	18.4	5.5
<b>Total</b>	<b>77</b>	<b>1.25 – 23.16</b>	<b>8.36</b>	<b>9.19</b>	<b>26.9</b>	<b>12.7</b>

\* Includes nurse assistants.

*Absolute inequality of infant mortality rates within provinces*

Table 8 provides the range, median and overall IMR of the municipalities within five Cuban provinces. The highest IMRs among these five provinces were in Guines, La Habana and Caimanera, Guantánamo at 11.6 and 11.2 respectively. Granma province had the lowest overall and median IMR, although Amancio, Las Tunas was the

municipality with the lowest IMR, where not a single infant death was reported for 2010. Here we can also see the hypothetical percentage reduction in the overall IMR of the provinces listed if all municipalities would have achieved the IMR of the municipality with the lowest IMR. A map of the distribution of IMR is provided (Figure 3) which includes reported IMRs for municipalities that are not included in Table 8.

**Table 8:** IMR Distribution within Cuban Provinces

Province	N	Min.–Max.	Median	Prov./ overall	PAP
Granma	13	1.4 – 9.7	4.7	4.7	70.2
Guantánamo	10	3.1 – 11.2	4.9	5.7	45.6
La Habana*	16	1.6 – 11.6	6.2	5.1	68.6
Las Tunas	8	0 – 8.9	5.4	5.5	100.0
Santiago de Cuba	9	1.9 - 8.9	5.6	5.3	64.2
<b>Total</b>	<b>56</b>	<b>0 – 11.6</b>	<b>5.1</b>	<b>NA</b>	<b>NA</b>

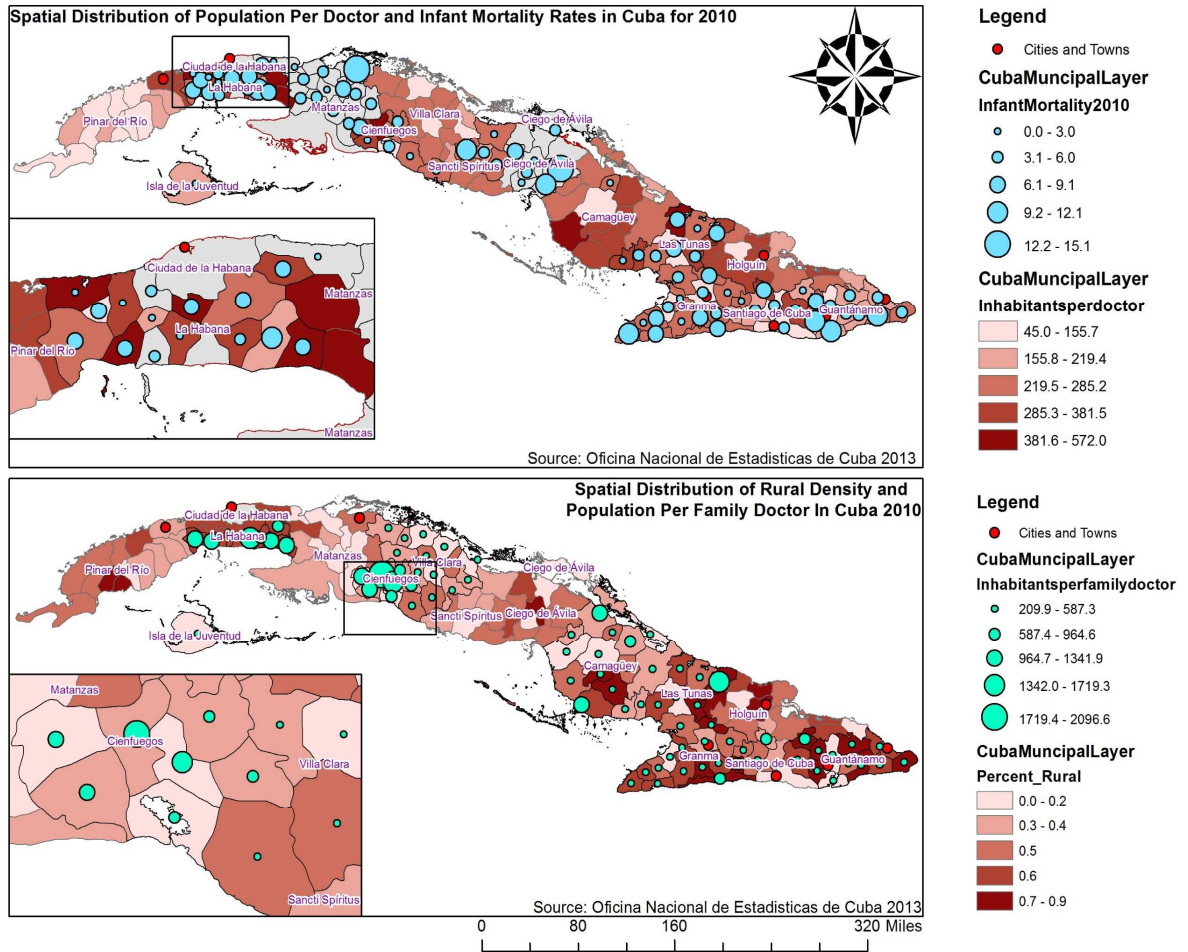
\* The municipalities Madruga, Nueva Paz, Batabano, Bahía Honda, Candelaria and San Cristobal did not report the IMR to ONE for 2010. They are excluded from the Min-Maz and Median calculations. The overall figure is what ONE reported for the province in 2010.

Figure 4 provides the box plots of the municipal IMR of the five provinces analyzed. It is apparent when comparing Figure 2b with Figure 4 that the spread of infant deaths tends to be greater within provinces than among them. For example, the provincial range of IMR in 2012 was 3.2 per 1000 lives births for Cuba as a whole, whereas Santiago de Cuba, the province with the lowest range of IMR among its municipalities of the provinces examined, had an IMR range of 7.0 for the same year.

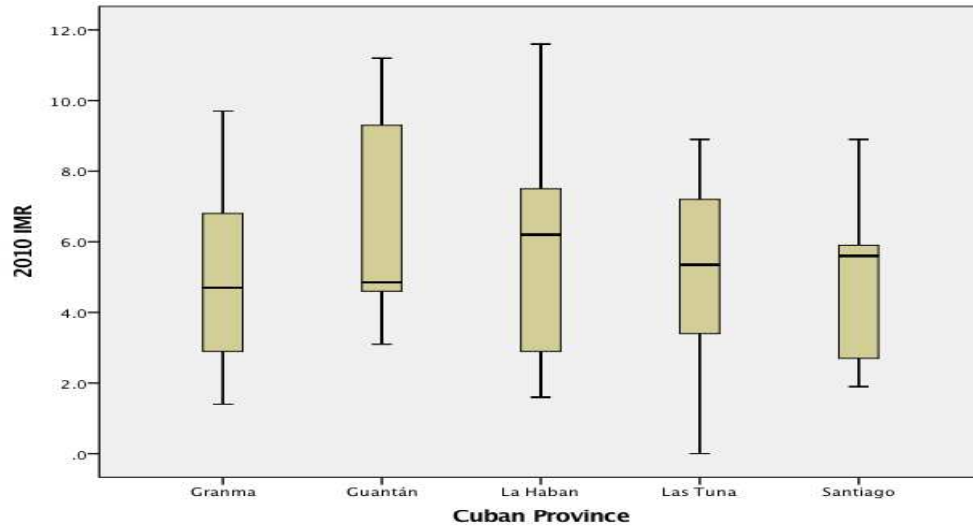
While there are no salient outliers identified by the plots, it is clear that Guantánamo has a strong right skew with lower half of the data points between 3.1 and 4.9, and the fourth quadrant is rather stretched indicating that the greater IMR raised the



provincial average significantly above its median. La Habana had the widest range of IMR (10.0 per 1000) and the widest gap between the median and its provincial average, suggesting that this province had the greatest variance in IMR of the provinces examined.



**Figure 3:** HRH and IMR distribution at the municipal level in Cuba



**Figure 4:** Box plots of IMR within Cuban provinces

## SUMMARY AND CONCLUSION

The primary goal of this research was to measure changes in the degree of inequality in HRH distribution in Cuba over time, with particular interest in the changes occurring over the ‘Special Period’ and the period under Raul Castro’s leadership. I found that inequality in physician distribution relative to the population among provinces has declined steadily over time, as doctor density increased. Inequality in the distribution of family doctors and nurses is very low and has remained fairly stable, although inequality in family doctors spiked in 2011, falling significantly in 2012 and 2014. Inequality in both doctor and nurse distributions relative to the population is more egalitarian among Cuban provinces than among countries of the OECD. While this is a comparison across different levels of analysis, logic suggests that inequality would be higher at more disaggregated levels. This was the case in this research as inequality of HRH distribution within provinces was greater than inequality among provinces. Further

research that gathers data on the distribution of physicians within countries of the OECD would allow for more precise comparisons.

This research was also examined the trajectory of provincial IMR over time. A steady decline in IMR and in the range of the rates was generally observed with a leveling out of the rates in recent years as Cuba's provinces approach the IMR's lower bound. Of the provinces examined at the municipal level, Santiago de Cuba had the most compact distribution of IMR, although here too, it appears that the IMRs vary more within provinces than among them.

For some comparisons to other within-country distributions of HRH, Munga and Maestad (2009) calculated the GINI coefficient of the spatial distribution of 46,896 health workers (nurses, physicians, clinical and assistant medical officers, physicians make up just a small fraction of the total) among 22 Tanzanian districts at 22.3. While this figure obscures the highly unequal access to physicians in Tanzania, the figure remains significantly higher than the GINIs for any of the recent HRH categories in Cuba among provinces examined here (except 1989). Nevertheless, there are some Cuban provinces on the municipal level that registered higher internal disparities for particular categories of HRH workers than the overall score for health workers in Tanzania.

A more methodologically similar comparison can be gleaned from Tandi and colleagues (2015) on HRH distribution in Cameroon. They calculated GINI coefficients for ten regions in Cameroon with an overall HRH GINI of 35.4 and a GINI of physician distribution of 52.8. Cameroonian nurses were far more equitably distributed than their physician counterparts at 30.8. While these numbers are far more elevated than the provincial Cuban numbers and convey well the crisis in HRH distribution faced in

Cameroon, a more apt comparison would be with the HRH distribution of Latin American and Caribbean nations.

The Cuban experience has relevance beyond its borders. As shown in the introduction of this article, severely unequal distribution of HRH both among and within countries remains an area of serious concern. Many nations suffer severe HRH imbalances, which in turn accentuate inequities in healthcare outcomes. While these imbalances are driven by a combination of push, pull, stay and stick factors, when healthcare is treated as a commodity, HRH distribution tends to serve effective demand over the population's absolute needs (WHO 2006:8; Navarro 1976:14-29). The Cuban government's commitment to non-commodified and preventive care, (as reflected in the Cuban constitution and in their extremely low share of private expenditure of total health expenditure as reported by the WHO), and the country's long-term commitment to general and health education has helped Cuba overcome the challenge of achieving greater equality in HRH distribution. Furthermore, they have not only overcome this challenge on their own soil, but since 1963 the Cuban government has assisted other nations with their own HRH distribution and shortage challenges (Brouwer 2011; Feinsilver 2009; Chaple 2006).

While the development of Cuba's socioeconomic and healthcare models were greatly facilitated by a relatively unique set of historical circumstances and would therefore be difficult to replicate, there are measures that could be taken by other countries, provided there is sufficient political will and stakeholder collaboration. Many Latin American countries including Venezuela, Ecuador, El Salvador and Bolivia have sought to emulate Cuba's investment in healthcare and collaborate with Cuba in terms of

healthcare provision and training of future physicians. Nevertheless, according to WHO data, 63.9% of Ecuador's health care financing in 2011 was private (either private insurance or out-of-pocket), and their income inequality is far more acute than Cuba's, indicating that more can be gained by following Cuba's example. Other countries in Latin America (particularly Guatemala, Honduras and Panama), but also many Southern African countries, exhibit very high inequality and low doctor density. These countries have much to learn from Cuba's rights-based approach to healthcare, its efforts to train health professionals, and the low level of imbalance in distribution of HRH personnel present in Cuba.

Even the United States could learn from various aspects of Cuban healthcare organization. According to Petterson *et al.* (2013), the U.S. experiences unequal HRH distribution, particularly among primary care physicians. In the U.S., the average primary care physician density is .80, with .84 per 1000 in urban areas and .68 in rural ones. Comparing this to our municipal level findings on Cuban family doctor distributions, there were only two municipalities of those examined with lower family doctor densities in 2010, both of which increased their family doctor densities the following year to more than one per one thousand.

Likewise, according to a 2014 Commonwealth international survey of health professionals' and patients' views of their country's healthcare system, seventy percent of those surveyed in the U.S. said it was difficult to obtain after hours care and 31% of U.S. respondents forwent recommended care due to its cost (Davis *et al.* 2014). This latter datum encapsulates the moral and public health danger of a healthcare system that treats health as a commodity and not a right. While there may be opposition to learning from

the Cuban experience in the U.S., significant progress has been recently made in improving bilateral relations, symbolized by the reopening of embassies in the countries' respective capitals on July 20, 2015.

Cuba's commendable progress towards achieving greater overall health equity results from a genuine social and political commitment to a rights-based approach to healthcare provision. The island's capacity to overcome insufficient and inequitable HRH distribution is the result of more than 50 years of struggle and metamorphoses of Cuba's national health care system. According to the results from this research, Cuba has been largely able to prevent the growth of economic inequality in the 1990s (due largely to circumstances beyond its control) from eroding its achievements in health equity. This is notable in light of Okeke's (2013) findings that economic crises tend to 'push' out physicians from developing countries. While Okeke's research did not examine the effects of economic crises on poorer areas within countries, it seems likely based on other work (e.g., WHO 2006) that economic crises would exacerbate internal HRH imbalances.

Today's achievements in universal access to care trace back to early efforts to overcome urban-rural disparities through the establishment of the Rural Health Service, the development of the polyclinic and family doctor model. It would not have been possible without a parallel vision to elevate the population's educational level that guaranteed free access to higher education. These achievements have depended as well on the political will not to sacrifice the rights (listed above) established in Cuba's constitution, a vision that is consistent with Article 25 of the United Nations' Universal Declaration of Human Rights.

Further research examining within-country levels of inequality in HRH distribution, and change over time as it relates to political-economic policy changes and country comparison studies would be particularly interesting. It would also be advantageous to be able to include a continuous measure of HRH distribution inequality (like the GINI coefficient) as a predictor variable in cross-national and panel studies of health care outcomes. Future studies of HRH distribution in Cuba could be improved if there were greater consistency in variables reported by municipalities across the island, and if clear numbers were provided regarding the numbers of physicians from a given province on missions were reported vs. those presently serving in their local communities. Finally, future studies could take a central place approach to analyze the relations among location of various levels of health facilities, maximum distance and health outcomes.

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## APPENDIX

Referenced regression equations:

Physician density per 1000 = dependent variable

Model	Unstandardize d Coefficients	Standard Error	Standardized Coefficients	T	P value
Constant	-6.238	.610		-10.233	.000
Log <sub>10</sub> GNI per cap (PPP)	1.972	.152	.69	12.947	.000
R <sup>2</sup>	.477				
N	186				

Thus, Cuba's predicted doctor density is  $2.18 = -0.6238 + 1.972(4.27)$ .

Mean of log<sub>10</sub> GNI per capita = 3.968

Cuba's centered log<sub>10</sub> GNI per capita value = .3 and log<sub>10</sub> GNI per capita<sup>2</sup> = .09

Centered quadratic model with IMR 2012 as dependent variable

Model	Unstandardized Coefficients	Standard Error	Standardized Coefficients	T	P value
Constant	22.947	1.494		15.36	.000
CenLogGNIPC	-34.554	2.189	-.741	-15.78	.000
CenlogGNIPC <sup>2</sup>	11.204	3.633	.145	3.08	.002
R <sup>2</sup>	.612				
N	186				

In this model, Cuba's predicted IMR is  $13.589 = 22.947 - 34.554(0.3) + 11.204(0.09)$ .

## CHAPTER 5: DISSERTATION CONCLUSIONS

This dissertation examined interrelated questions concerning healthcare financing, human resources for health (HRH) distribution, and health outcomes on international and national levels of analysis. This dissertation is comprised of three interrelated papers. The first paper examined the relationship between government expenditure on health as a percentage of total expenditure on health (GEHPTEH) and the infant mortality rate (IMR) using World Health Organization and World Bank data. The second paper clustered cases based on eight health and development variables to create a typology of 123 primarily non-OECD countries. The final paper examined recent trends in the level of inequality in the distribution of human resources for health and infant mortality among Cuban provinces.

Although previous findings regarding government health spending and health outcomes such as infant and child mortality have been mixed, these studies used health-spending measures that did not capture whether health financing was predominately public or private. By contrast, GEHPTEH was selected to capture the impact of the government's share of total health financing on IMR. The central hypothesis ( $H_1$ ) of this research was that countries with higher GEHPTEH would have lower IMR. A second hypothesis ( $H_2$ ) was that the higher the doctor density the lower the IMR, although the effects would tend to taper off as IMR reached its lower bound. A cubic term was also needed as the quadratic term created a strong U-shape effect, indicating that further increases in doctor density would eventually lead to a sharp increase in the IMR instead of simply tapering off. A third hypothesis ( $H_3$ ) was that there is an interaction between GEHPTEH and  $\log_{10}$  GNI per capita (GNIPC), indicating that the poorer the country the

greater the effect of GEHPTEH. The study utilized multivariate ordinary least squares regression to analyze data for these variables acquired from the World Health Organization and the World Bank.

I found a significant inverse association with the IMR in a cross sectional analysis of 186 countries while controlling for GNIPC (purchasing power parity dollars), doctor density (the number of doctors per 1000 population), the percentage of children under one year of age who received the polio vaccine and the percentage of the population with access to improved water sources. GEHPTEH and all controls remained significant in the expected directions in all models, although the effect size of GEHPTEH was most reduced (along with the significance level) in models that included GNIPC. Thus, the null hypotheses of  $H_1$  and  $H_2$  were rejected.

Regarding  $H_3$ , a significant positive interaction term was found that shows that the effect size of GEHPTEH is larger when GNIPC is lower, suggesting that the government's share of total healthcare financing makes a larger impact in poorer countries than in wealthy ones in terms of improving societal level health outcomes. The article concludes by placing these findings within the context of a push towards austerity measures and cuts in public health spending. It is my view that in light of these findings, privatization of healthcare services may lead to undesirable health impacts among the population.

The second paper created a 3-tiered nested typology of health and development for 123 primarily non-OECD countries. Countries were clustered based on their values on GEHPTEH, doctor density, LogGNIPC, the percentage of children under age 5 underweight (U5UW), inequality (GINI), the percentage of children under age 1 who

received the DPT3 vaccine, total expenditure on health as a percentage of GDP (TEHPDGP), and the IMR. The result was a three-tiered nested solution with three, six and nine clusters. The first tier differentiated the 123 countries into a Virtuous Circle classification with above-average health and development outcomes (average is in reference to the mean of our 123 country sample), a Divided Fortunes cluster of highly unequal countries, and a Vicious Circle cluster generally characterized by low GNI, average inequality, high food insecurity, low doctor density, low vaccination coverage, and more privatized care with high IMR.

The analysis breaks down in the middle tier to six clusters with only two clusters that are unique to this level: a cluster from the Virtuous Circle characterized by high doctor density and another from the Vicious Circle that is characterized by a high percentage of children under the age of five who are underweight. The final tier consists of nine country groupings. Nested within the Virtuous Circle were Mild Type 1 (with low inequality, high HRH, health outcomes and publicly financed care), Mild Type 2 (a wealthy predominately Arab country grouping with very high GNIPC, low inequality, and high vaccination coverage and GEHPTEH), and Moderate Type 2 (a cluster of diverse geographic composition, low inequality, high HRH and DPTS coverage, but more privatized care with an IMR higher than Mild Types 1 and 2 and Moderate Type 1.

Nested within the Divided Fortunes cluster were two disparate groupings, the Moderate Type 1 grouping of Latin American countries with high inequality, average health inputs and relatively low IMR, and a Critical Type 2 cluster of Southern African nations with extremely high inequality levels, very low HRH, average vaccination coverage, and very high IMR. The Vicious Circle cluster ultimately subdivided into one

severe cluster (predominately South Asian, the most food insecure, low HRH, GEHPTEH, and average IMR), a Critical Type 1 cluster (overwhelmingly sub-Saharan, food insecure, very poor, with low HRH and health outcomes), a Critical Type 3 cluster (low income, TEHPGDP and health outcomes, and high inequality) and a Critical Type 4 cluster (most poor, lowest HRH, lowest GEHPTEH and the worst health outcomes of the typology).

The contribution of this research is that it identifies relatively distinct country groupings that have a common set of health and development challenges. Unlike a regression, which attempts to parcel out the impact of a particular set of independent variables on a dependent variable, cluster analysis allows the researcher to view groupings of countries that share similar values across a range of variables. Strategies to address health and development challenges should be specific enough to address these particular combinations and health challenges. For example, while Critical Types 1 and 2 share many challenges in common, countries in Critical Type 1 face particularly acute food security challenges while Type 2 has extreme inequality. Thus, countries within a particular cluster type may wish to work together to jointly address challenges that they face together.

Cuba was selected as a case study for the final paper for several reasons. First, Cuba has both a much higher doctor density and a much lower IMR than simple regression models with GNIPC as the independent variable would predict. Secondly, Cuba's health financing is almost entirely public and its HRH distribution will be far less influenced by market forces than in societies in which health financing is predominately private. Previous research on Cuba's healthcare system has focused on trends in infant

mortality (e.g., Corteguera and Henriquez 2001; Corteguera 2000) or the health system's evolution and growing focus on primary care (Whiteford and Branch 2008; Feinsilver 1993).

I found a steady decline in inequality in the distribution of total doctors relative to population among provinces from 1989 to 2014. It is noteworthy that the level of inequality in HRH distribution continued to be reduced during Cuba's economic crisis in the 1990s, known as the 'special period'. Additionally, inequality in HRH distribution appeared much more extreme based on descriptive measures among provinces in Cuba in 1958 provided by Danielson (1979). Cuba's distribution of physicians among provinces is slightly more equal than the distribution of physicians among OECD countries and much more equal than the global and non-OECD distributions.

Regarding other HRH measures, inequality in family doctors and family doctors 'located in the community' have generally been very low, although the latter spiked in 2011. There has been an ongoing transformation of the health sector and much of the variation in family doctors in the community distribution seems to correspond with challenges identified by MINSAP and with policy shifts. Nurse density among Cuban provinces has remained low since 1995 (the earliest year for which I had data) and fluctuated somewhat. What is notable is that its distribution in any of the years is far more equal than the distribution of nurses among countries on a global level, among OECD countries or among non-OECD countries.

Regarding IMR, I observed a general decline in the range of values among provinces over time, as well as a strong reduction in the provincial median and national IMRs in Cuba from 1970 to 2014. Cuba's median IMR remains slightly above the

OECD median, but far above the median IMR on a global level. I also provided the population-attributable-proportion (PAP) for the IMR of each year that estimates the potential percentage reduction in the IMR if every province would have had an IMR of the province with the lowest IMR.

Within province inequality in physician distribution based on municipal data for 2010 in HRH distribution was much higher than inequality among provinces, but was still relatively low. Family doctor distribution tended to be less unequally distributed than total physician distribution, while the levels of inequality in nurse distributions was somewhere between the two. Particular municipalities and provinces that face more extreme challenges regarding HRH distribution were identified. Ranges in IMR within provinces also tend to be fairly narrow but are wider than the ranges among provinces, with the widest ranges observed in Guantánamo and La Habana provinces.

Each of these papers has, at least in some way, challenged my initial assumptions. In the first paper, while GEHPTEH retained significance with the logged form of GNI per capita in the model, I did not expect the inclusion of GNIPC to erode the effect size of GEHPTEH on the IMR to the degree that it did. The bulk of this phenomenon I attribute to the radical and accelerated increase in the size of GNI per capita that is inherent in a log transformation.

In the second paper, while I was not surprised that many countries clustered along regional lines, I did not expect them to do so as much as they did. This may have been due in part to the inclusion of GNIPC among the variables based on which countries were clustered. I also did not expect Iraq to cluster with Mild Type 1, nor did I expect Nigeria and South Africa to cluster with Central African Republic and Chad in Critical Type 3.

Rather, I expected that they would fall into the cluster with the highest inequality, Critical Type 2. I also expected the largely South Asian Severe cluster to reflect a much higher level of inequality than it did. Regarding the third paper, I did not expect to find any large increase in inequality in the distribution of family doctors in the community, as was registered in 2011. I was also surprised to see the high levels of inequality in HRH in Cienfuegos and Camaguey provinces.

### *Policy implications*

This research has several important policy implications. Perhaps the most overriding and pertinent implication for our times is that governments should do their best to eschew pressure from international financial institutions (IFIs) and others to privatize more and more government services and financing. Much of this type of external pressure from IFIs amounts to a loss of sovereignty by poorer countries in terms of economic and health policy (Waitzkin and Jasso Aguilar 2015; Mangala 2008). The trend towards greater privatization of health services and financing - a clear move away from treating healthcare as a human right - were notably seen across the Global South with generally negative consequences for population health as a result of structural adjustment programs (SAPRIN 2004; Schoepf *et al.* 2000), and the push for privatization of health financing continues in the Global South and has expanded to Europe (Kentikelenis *et al.* 2014; Palma Solis *et al.* 2009; Bretton Woods Project 2009; Hermann 2009).

Another clear policy implication is both obvious and difficult. Both paper 1 and paper 2 show that health and socioeconomic development variables are closely linked. It



is clear from this (and other) research, that to obtain better population health outcomes it behooves developing countries to train and retain more health professionals, improve population access to clean water sources, reach 100% polio and DPT3 vaccination coverage and reduce income inequality. Nevertheless, many of these and other critical socioeconomic development indicators such as literacy rates, and percentage of the population with access to improved sanitation, are highly interrelated and connected with overall economic standing as represented by GNI per capita. Thus, much of the potential success in improving health and development and overcoming the legacy of what Samir Amin terms ‘lumpen development’ may ultimately depend on strengthening economic sovereignty as well as and productive capacity.

There can be no emergence without state politics resting comfortably on a social bloc, a social force that gives it legitimacy and the capability of constructing a coherent project, an inward-looking national productive system. This must at the same time ensure the participation of the great majority of social classes and see to it that these social classes receive the benefits of growth (Amin 2013: 46).

Nevertheless, my research suggests that countries fall into groups, which face different combinations of health and development challenges. Countries of a particular type may seek to align with each other to overcome their specific set of difficulties. For example, countries in the Moderate Type 1 cluster tend to have moderately high income and average health outcomes (IMR in 2012 ranged from 7.8 in Chile to 32.8 in Bolivia) but all experience very high inequality. Only the countries of Critical Type 2 exceed this high level of inequality. However, not only is the average inequality for Critical Type 2 more acute, but also it has very low doctor density. These countries have a common interest in overcoming the challenges presented by acute income inequality; since they tend to be more similar in other health and development characteristics, they may benefit

from sharing experiences in trying to overcome their particular health and development challenges.

A final policy recommendation emanating from the third paper is for governments to try to remove the influence of market forces on internal HRH distribution and to prioritize the formation of HRH personnel. While the third paper did not provide much in the way of an international comparative analysis, it did examine the shifts in HRH distribution within Cuba, a country in which private medical practice virtually ceased to exist in 1965. The overriding finding was that even in periods of crisis, that according to Okeke (2013) stimulate HRH outmigration, Cuba was able to both increase aggregate numbers of physicians and maintain and/or reduce inequality levels in their distributions relative to the population (depending on whether we are referring to doctors, family doctors or nurses).

#### *Implications for future research*

This research has led to several potential avenues for future research. A major challenge in conducting research for any of these directions is going to be accessing sufficient data. One particular path indicated at the end of the first paper would be to obtain panel data to examine the impact of shifts in GEHPTEH over time on the IMR, and to look at the relationship among GEHPTEH, the forgone healthcare rate and health outcomes. It would also be useful in this regard to have ample time series data for physician density, inequality, and other interesting socioeconomic variables such as union density, total debt owed to IFIs, and an HRH GINI that indicated the level of spatial inequality of HRH within a given country.

Future research regarding typologies could include political variables, as well as use panel data to monitor movement of countries between clusters over time. As mentioned at the end of paper two, research is necessary that captures “the relational dynamics between countries, i.e., flows of surplus value, raw materials, consumer goods, and waste, into explanatory and typological models of health and development”. To this I add the importance of a variable, such as HRH GINI, which captures the level of inequality of HRH distribution within a country. Finally, future studies could cluster cases around socioeconomic development and health system variables minus the health outcome variable, and examine the relationship between clusters and key health outcome variables.

The third paper points in a few new directions, as well. First, it is my view that the study could have benefited from a detailed comparison of HRH distribution in different countries. While that would have made the study potentially too long for publication, it would have facilitated making relevant comparisons. Another potential avenue for future research would be to examine change over time in the municipal level in Cuba, but to make that worthwhile, it would be essential to have some basic economic data (median income and perhaps even the percentage of residents who receive income from abroad) regarding the number of physicians from a given area serving on international missions, and for the data to be uniformly gathered across provinces.

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