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DAVID MAYER FOULKES AND CARLOS LARREA

Racial and Ethnic Health Inequities: Bolivia, Brazil, Guatemala and Peru

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Abstract

Afro-Indigenous health inequities are jointly estimated for Bolivia, Guatemala, Peru and Brazil. The concentration index for various health and health factor indices is decomposed according to two socio-geographic regionalizations. Ethnic health levels are systematically lower than corresponding non-ethnic levels for most Latin American regions, while within-group health differences are lower for ethnic populations. In order, factors explaining 85% of health inequity are household goods, education, followed by health service use and basic household quality. Otherwise, ethnic reality forms a complex mosaic. Pro-poor evaluated programs raising these factors would reduce ethnic disadvantage and provide an opportunity for studies including community variables.

Resumen

Estimamos en forma conjunta las inequidades en la salud afro-indígena para Bolivia, Guatemala, Perú y Brasil. Descomponemos, conforme a dos regionalizaciones socio-geográficas, el índice de concentración de varios índices de la salud y sus factores. La salud afro-indígena resulta menor en la mayoría de las regiones de América Latina, mientras que las diferencias son menores al interior de estos grupos étnicos. En orden de importancia, 85% de la inequidad en salud se explica por la provisión desigual de, primero, bienes del hogar y educación y, después, del uso de servicios de salud y de la calidad de la vivienda básica. Por lo demás, la realidad étnica conforma un complejo mosaico. Programas que mejoren estos factores en los pobres, y que incluyan una evaluación sistemática, reducirían la desventaja étnica y darían la oportunidad de entender mejor el aspecto comunitario.

Introduction

Health is a vital component of wealth and an essential component of its creation. Hence, it is an essential dimension for understanding and documenting racial and ethnic[1] inequities, particularly in Latin America. Yet, there are surprisingly few country, or continent-wide, quantitative evaluations of indigenous inequities, especially with regard to health. In this study, we evaluate these ethnic inequities jointly for four highly representative countries, Bolivia, Guatemala, Peru and Brazil. The first three have the highest proportions of indigenous populations in Latin America (50.5%, 48.0%, and 38.4% respectively),[2] while 45.0% of the population of Brazil is Mestizo or Black. Together, these countries hold 45.7% of the Latin American population and 54.6% of its indigenous population. They are also the only ones with adequate ethnicity indicators in their DHS surveys. For our analysis, we elaborate a serie of indices on health, education and household assets, applying a sophisticated principal components technique that uses most of the relevant information contained in these surveys. Then, we decompose overall concentration indices for health and its determinants by social and geographic regions. Our overriding finding is that 1) ethnic health levels are systematically lower than the corresponding non-ethnic levels for a wide spectrum of Latin American regions, and 2) within-group health differences are lower in the ethnic populations. The inequity decompositions also show that indigenous and ethnic realities are subject to considerable regional variation requiring specific attention. The factors most responsible for overall health inequities across the population are household goods (representing income) and education, followed by health service access, household quality and height for age.

In addition, we conduct a sensibility analysis showing that transfer programs for the lower 20% of the population will benefit the indigenous populations more than proportionally, implying that a policy tool for raising human capital levels perfected in recent years can be applied as a first step in reducing ethnic discrimination. Such programs can be associated with in-depth microeconomic studies of the individual, local and regional determinants of ethnic discrimination that can form the basis for further policy interventions addressing these issues.

[1] We shall refer to the Afro-Indigenous as the *ethnic* population, even though every race is ethnic.
[2] According to http://www.igeofcu.unam.mx/atlas/pobl_cultur/ame_hoy.htm.

The origins of ethnic discrimination

Racial and ethnic inequities in Latin America have deep historical roots. Colonial regimes were designed to complete the conquest of its indigenous people, leading to their degradation. Institutions such as the *Encomienda* were designed to destroy the indigenous communal land system, replacing it with large estate holdings served by a resident serf populations reduced to debt peonage. Land distribution in Bolivia was the worst in Latin America before the 1952 Revolution, with 4% of all landowners holding more than 82% of the land. In Peru, the system endured until it was abolished by the land reform of 1969. Latifundia persist in Guatemala to this day (CIDH, 1993).[3] In Brazil, the original native population numbered millions and exceeded that of Portugal itself. However, it was decimated by conflict and disease and reduced to about 150,000 by the early twentieth century, increasing to 330,000 by the mid-1990s. During the colonial period, when Indian slavery proved difficult to enforce, hundreds of thousands of slaves were imported from Africa to Brazil. The result was a highly stratified class structure.[4]

Ethnic polarization in Latin America was nevertheless mitigated by intermarriage. Racial and ethnic groups that arrived in Brazil intermingled and intermarried with few exceptions. Ethnic mixture was so strong in most of Latin America that in the present day there are no clear ethnic color distinctions. The result is a complex, multiethnic society and identity. For example, in Bolivia over 60% of the population identifies with an indigenous people, yet also considers itself mestizo and feels incorporated in a consensual national identity (2002 *Bolivian Human Rights Report*, chapter 3).[5] Throughout Latin America, there is a strong cultural tradition of tolerance and cordiality, as well as longstanding explicit laws against racial discrimination. Nevertheless, there is a strong correlation between light color and higher income, education, and social status. This "continuous" ethnic spectrum is so pervasive that recent econometric research in Peru uses surveys to construct multidimensional ethnic membership scores for Asiatic, White, Indigenous, and Black ethnic groups, finding racially related earnings in favor of predominantly White individuals (Ñopo, Saavedra and Torero, 2004).

In the case of Guatemala, the precarious multiethnic, pluricultural and multilingual social fabric was broken by internal armed confrontation in 1962. When the peace accord was signed in 1996, the Commission for Historical Clarification organized by the United Nations concluded that "the structure

[3] According to this report the latifundio system worsened in the 80's and 90's; 2.1% of the landowners now own 72% of cultivated lands and receive 90% of agricultural credit.

[4] This and the following paragraphs include quotes from: http://countrystudies.us/, sections for Peru, Bolivia, and Brazil. This page contains on-line versions of books previously published in hard copy by the Federal Research Division of the Library of Congress as part of the Country Studies/Area Handbook Series sponsored by the U.S. Department of the Army between 1986 and 1998.

[5] See http://idh.pnud.bo/drows/idh_informes/2002/todo.htm.

and nature of economic, cultural and social relations in Guatemala are marked by profound exclusion, antagonism and conflict, a reflection of its colonial history." The conflict involved ethnic issues. "…violence was fundamentally directed by the State against the excluded, the poor and above all, the Mayan people …" "Eighty-three percent of fully identified victims in this war were Mayan and seventeen percent were Ladino" (*ibid*).

To this day, throughout Latin America those regions with the largest native populations and the highest percentages of indigenous language speakers tend to be the most backward, poorest and least educated and developed. Although in the past these regions tended to be remote rural regions, over the years, as in Peru, many indians have moved from highlands and selva to coastal plantations and cities. One million peruvians of indian descent live in many "new towns" or "squatter communities", where they are the poorest of the poor. The living conditions of the indigenous population are generally abysmal, especially when compared to those of non-indigenous people. However, economic research on the topic has been limited until recently by a lack of quality micro-data including information on ethnic origin.

The state of ethnic inequities

There are surprisingly few quantitative economic studies documenting ethnic inequities in Latin America. We summarize here Psacharopoulos and Patrinos (1994), who provide one of the main earlier references for the socioeconomic conditions of indigenous peoples. According to them, indigenous people are a seriously disadvantaged group, and in areas such as education, even worse off than expected. There is a very strong correlation between indigenous origins and schooling attainment, and between schooling attainment and poverty category. Indigenous females may also be worse off than their male counterparts. Parental skills and educational attainment are reflected in the schooling and other human capital characteristics of their children. A greater percentage of all indigenous persons participate in the labor force compared with their non-indigenous counterparts, and a higher percentage of the indigenous population in the labor force is employed. Thus indigenous people, on average, work more and earn less; a high proportion of the indigenous poor are "working poor". The health problems of indigenous groups are severe. Access to medical care for pregnant women, which is essential for the preservation of the mother's life and the healthy development of her children, is limited at best. An important finding is that education has the strongest effect in reducing fertility levels in indigenous urban Bolivia. Moreover, ethnicity and household income levels are not significantly associated with fertility once education is controlled for. This means that access to education for the indigenous population should be increased.

Policies to reduce the educational gaps between indigenous and non-indigenous persons could make a very large dent in earnings differentials and lead to a considerable decline in poverty among indigenous people. Our findings confirm the important role of education in securing health assets for the indigenous populations.

Our paper provides a uniform evaluation of afro-indigenous inequities across social strata and across a fine regionalization of Bolivia, Brazil, Guatemala and Peru, covering health status, health access, and also health factors such as education, household goods (representing income) and household quality.

The dynamics of exclusion

In the Spanish ex-colonies, the institutions implanted in colonial life as part of the strategy for maintaining dominion over the conquered indigenous peoples continue to persist in indiscernible ways, as an "invisible wall" (Torero, Saavedra Escobal, and Ñopo, 2004) holding back an underlying, negated civilization (Bonfil, 1990). A similar statement can be made for Brazil. Although discrimination is not usually explicit, it appears in subtle forms: unwritten rules, unspoken attitudes, references to "good appearance" rather than color, or simply placing higher value on individuals who are white or nearly white.[6] Institutions whose original purpose was to appropriate indigenous lands and maintain domination over indigenous and black peoples have hardly evolved to become instruments for the protection of the property —including the homes— of the poor and indigenous poor. This absence of basic property rights (which could be used as collateral and thus become integrated with the system of capital accumulation) is a factor holding back economic growth (Hernando de Soto, 2003). Language and cultural differences in general also constitute important barriers. For example, in Peru, speaking quechua, the language of 19% of the population, carries a stigma. Lessons in schools tend to be taught almost exclusively in spanish. There are no television shows and very little radio or published writings in quechua. Indian cultural contributions, as may be the closeness of the family, are not fully valued. With new technologies come new exclusions. According to UNDP (1999), the new communication technologies are dividing the world into those connected and those in isolation, including much of the indigenous population.

To these institutional and cultural barriers are added intergenerational dynamics making poverty persistent. The evolution of the income, education and health of different strata of the population are based on their long-term human development. Human development results from an intergenerational

[6] Stated for the case of Brazil in http://countrystudies.us/brazil/.

cycle of essential investments in nutrition, health and education. In the long-term, these investments results in secular rises in height, weight, longevity and human capabilities in general having a strong impact on economic growth, as has been found for developed countries (Fogel, 2002). Investment failures characteristic of human capital accumulation affect the acquisition of health and education and imply that parental human capital levels are transmitted to the next generation, generating long-term persistence of human capital and income inequality. Early childhood nutrition and health are critical links in this process, forming the basis for the human capital investment that generates future adult education, health and income. The crucial role of early childhood health is documented for England in Case, Lubotsky and Paxson (2001) and Case, Fertig and Paxson (2003), who explain the origin of the 'gradient' of health along income, and for Mexico by Mayer-Foulkes (2004), who documents the presence of a human development trap and finds that early child development is an important determinant of the hold of the trap. Below, children's and mother's stature are used as indicators of early nutrition to measure their impact on health inequities.

Indigenous and other ethnic groups in Latin America and the Caribbean were placed at the lower end of the income distribution since colonial times, and therefore share with other poor people in the continent income, education and health dynamics that make poverty persistent. Health plays a substantial role in these dynamics, both as a causal factor and as one of the main dimensions of well-being. In addition, they face barriers related to successful insertion in the production of income, health and education for reasons of institutions, culture, language and discrimination.

Ethnic inequities in health

We have portrayed, in broad terms, the origins as well as the persistence of ethnic inequities in Latin America. The question we pose in the paper is: to what extent do these exist in the present day, particularly with regard to health? To answer it, we decompose the health concentration index, a measure of health inequity *relative* to income inequity (Wagstaff, van Doorslaer and Paci, 1989). The decomposition expresses overall health inequity as a sum of within-group inequities weighted by population and *per capita* asset holdings.

We address the following specific questions. What is the extent of afro-indigenous inequities in health? In what population groups are the health inequities located, geographically and according to socioeconomic status? How do inequities in health factors such as wealth, education and health service use impact ethnic health inequities? What are the intergenerational impacts on these dynamics? What would be the impact of programs making factor transfers on health inequities?

Amongst the answers, we find: afro-indigenous peoples suffer lower *per capita* levels of health, while their within-group inequities are lower. For the general population, health inequities are higher in urban regions and more educated social classes, while in the vast majority of these indigenous peoples are worse off. The most important factors affecting overall health inequities are household goods (representing income) and education followed by health service access, household quality and height for age as an indicator of direct intergenerational impacts. Although the direct intergenerational impacts are considerable, they are small enough that the poverty cycle can be broken by increasing income, education and health access and services. Finally, factor transfers to the poorest 20% of the population will benefit ethnic populations more than proportionally.

The remaining sections explain the measurement and analysis of health inequities and specify the decompositions that will be performed; describe the data and ethnicity indicators; detail the construction of multivariate socioeconomic status, health and other indices; discuss the health inequity decomposition methodology, and review the results of the health inequity decompositions according to the two socio-geographic population subdivisions and by factors, including a sensitivity analysis of ethnic disadvantage to the provision of health production factors. A summary of conclusions follows.

1.- Measurement and analysis of health inequities

We measure and decompose health inequities for the ethnic and non- ethnic populations of Bolivia, Brazil, Guatemala and Peru, using the health concentration index (Wagstaff, van Doorslaer and Paci, 1989), a measure of health inequity relative to income inequity. The data bases that will be used for this purpose are merged Demographic and Health Survey (DHS), which are quite comparable. The advantage of using an international database is to obtain complete comparability across countries, geographical regions and socioeconomic levels as measured by an education index.

Two socio-geographic subdivisions are used. Both are defined by combining a social and a geographic subdivision. In either case the social subdivision consists of six categories defined according to three educational levels and a binary variable for ethnic membership. Two geographic subdivisions are used. These were designed to capture the persistently high regional disparities in living conditions, human capital, nutrition and health. The first socio-geographic subdivision divides the sample into eight urban and rural regions in the four countries. The second adopts the much finer geographical subdivision embedded in the DHS surveys and also includes metropolitan areas in the cases of Peru and Guatemala, which concentrate an important portion of the national population, wealth and social services. Thus the first socio-geographic subdivision divides the joint database on Bolivia, Brazil, Guatemala and Peru into 6 × 8 = 48 regions, all of them with an adequate sample, while the finer socio-geographic subdivision divides it into 6 × 43 = 258 regions, out of which only 210 have indigenous observations.

To analyze health inequities we conduct two types of decomposition. The first decomposes health inequity across the two socio-geographic subdivisions just described, while the second decomposes health inequity by health production factors, namely indices for education, basic housing quality, household goods, and health service access.

Inequity decompositions across socio-geographic subdivisions are performed for several health indicators including height for age z-score, health status and health service access.[7] Health factors inequities are also decomposed. The purpose of these decompositions is to determine the social and geographical distribution of health and health factor inequities, and whether these originate in the *per capita* asset holdings of each socio-geographic group (reflecting between-group inequities) or in the inequity of asset holdings within these groups.

The main result is that in the vast majority of cases ethnic groups have lower *per capita* levels of these assets but also lower within-group inequity. The analysis also shows that indigenous reality otherwise forms a complex, non-uniform mosaic over the region. Other authors have also pointed out this reality is difficult to interpret (Handa, 2005), and is characterized by heterogeneous responses (Trujillo, 2005).

The second type of decomposition has the purpose of explaining inequities in health according to inequities in the health factors. First, a common decomposition is conducted over the joint four-country database. Health inequities arise from the following factors in order of magnitude: household goods (representing income), education, and, in approximately equal magnitudes, health service access, household quality and height for age as an indicator of direct intergenerational impacts. Thus to break the intergenerational cycle of poverty —especially health poverty— it is most urgent to achieve a rise in income and education, followed by improvements in sanitation and health service provision.

Next, a country-specific factor decomposition is performed, interacting each factor with the ethnic indicator. The results show, as elsewhere in the previous decompositions, that the underlying ethnic reality is a complex mosaic allowing for only a few generalizations. For example, the way some factors are provided contributes especially badly to inequity or ethnic inequity in some countries while contributing to equity in others.

2.- Data and Indicators

[7] Most of these indicators are constructed from the surveys using Categorical Principal Components Analysis, as explained further in the data section.

Demographic and Health Surveys (DHS) are the most reliable and internationally comparable empirical data source for analyzing ethnic and social inequality in Latin American countries. They include several countries with high indigenous population, namely Guatemala, Peru and Bolivia. Additionally, there is a DHS survey in Brazil, where ethnic inequalities affect the afro-descendant population.

DHS questionnaires became more comparable from the early 1990s (DHS III and Measure DHS + series). This article uses the following surveys: Peru 1996, Brazil 1996, Bolivia 1997 and Guatemala 1998. Each of these surveys has national coverage and detailed questionnaires including mother and child anthropometric measures, socioeconomic conditions, ethnicity, use of health services, and maternal and child health outcomes. All countries have complex multi-stage random sample designs, allowing for representative sub-national analysis at the regional level. Standardized questionnaires and codes allow for cross-country comparative studies. Sample sizes are reported in Table I.1.

Table I.1. Households included in DHS Surveys

Country	Year	Sample size	% Indigenous/Afro-descendant
Peru	1996	28,122	8.3
Bolivia	1997	12,109	14.8
Guatemala	1998	5,587	18.5
Brazil	1996	13,283	41.9

Source: DHS Surveys. (www.measuredhs.com).

2.1.- Ethnicity Indicators

Questions about ethnicity are not standardized across countries. In Peru and Bolivia, there is not a direct question about ethnicity, but all women aged 15 to 49 are asked about the language spoken at home. If the answer of at least one woman includes an indigenous language, the household is identified as indigenous. Although this procedure may underestimate the size of indigenous groups —given an expected underreporting of indigenous languages, and also the existence of indigenous communities which speak Spanish only— it is useful to identify ethnic differences.[8]

In Guatemala there are two ethnic questions, including the language spoken at home and ethnic self identification. According to the results, 30 % of women in fertile age identified themselves as indigenous, but only 72 % of indigenous women declared speaking an indigenous language. To maintain comparability across countries, we include only the question about language to identify indigenous households.

[8] For example, the documents cited in the introduction give higher percentages of indigenous population.

In Brazil, where language is not useful for ethnic identification, there is only a direct question on ethnic self-identification for women aged 15 to 49, including Asian descendant, White, Indigenous, Mixed and Black as options. To identify possible ethnic discrimination, we created a dummy variable including mixed (Pardos or Mulatos), Black and Indigenous answers. We defined a household as Indigenous, Black or mixed if at least one woman identifies herself as such. Table I.1 reports the percentages of indigenous or afro-descendant households.

2.2.- Multivariate Socioeconomic Status (SES) Index

To facilitate the analysis of the relationship between socioeconomic status (SES), health and ethnicity, we elaborated a set of multivariate indices, including most of the relevant variables from the surveys.

DHS surveys do not have information on household income or aggregate consumption, conventionally used to evaluate wellbeing. Nevertheless, they include detailed questions on housing, household assets and education, and some employment indicators. Filmer and Pritchett (2001) elaborate a wealth index from DHS surveys in India and other countries, applying principal components analysis to a set of basic housing and household asset indicators. They show that the method provides consistent and reliable results. The wealth index, based on stock indicators, must be regarded as a *proxy* for long term economic status, and not a substitute for *per capita* consumption or income, which are flow variables that are more sensitive to short term fluctuations.

We extend the application of this methodology in three significant ways. First, we apply the sophisticated C*ategorical Principal Components Analysis* (CATPCA), which is not restricted to numerical and dummy variables, and directly handles categorical variables. Most of the questions in DHS and other household surveys, as well as an important part of the social indicators, such as the household source of drinking water, or the type of childbirth, are categorical variables, either nominal or ordinal. Second, we include not only housing indicators, but also variables in education and employment, expanding the scope of the SES index, while maintaining their components in the dimensions of housing, education and employment. Third, we built health indices using the same methodology.

As a statistical procedure, CATPCA simultaneously provides optimal quantification of categorical variables, and reduces the dimensionality of the data (Van de Geer, 1993a, Van de Geer, 1993b, Meulman and Heiser, 1999, Meulman, 2000). CATPCA handles nominal, ordinal and numeric indicators. An index, estimated from the first principal component, can be interpreted as the linear combination of original indicators which captures the maximum possible amount of information by optimizing the explained proportion of total variance. A detailed explanation of the methodology applied in this research is available in Larrea (2002). All indices were transformed to a scale for 0 to 100 points, to facilitate interpretation and to allow the calculation of concentration indices.[9] Table I.2 contains a list of the variables used to construct the SES indicator and their components. All SES indices were elaborated at the household level, with the exception of the employment index, which was first estimated for each woman in reproductive age, and then averaged for each household.

Our housing indicators include most of the relevant information provided by DHS surveys. Education indicators balance information on adult education (illiteracy, years of schooling, access to higher education) and current enrolment at all levels (assistance ratios for all children and youngster in the corresponding age group). Unfortunately, there is no information on education quality in DHS surveys, somewhat limiting the reliability and comparability of data.

If a household does not have a child or youngster in a particular age group[10] the record is defined as missing. In the case of education, missing cases are replaced by the mean to calculate principal components. As all educational indicators are numerical, in this case we applied classical principal component analysis to construct the index.

The employment index includes years of schooling as a *proxy* for worker skills. Individual employment data is available for all women aged 15 to 49 and their partners. Occupational groups differentiate 11 cases of unskilled, agricultural and skilled jobs. Occupational categories include lack of employment, unremunerated employment, self-employment and salaried jobs.

The SES index was obtained from the education, housing and employment indices, using classical principal component analysis.

Mathematically, principal component indices are defined as the linear combination of indicators with weights that maximize their explained variance.

$$PCIndex = \sum_{i=1}^{n} w_i x_i \ ,$$

were w_i are the principal component weights and x_i are the indicators.

Because weights are specific to each particular survey or data base, we created a pooled data base, including all four surveys mentioned above. Weights in the integrated data base were defined as proportional to each country's population. Thus, original sampling weights were scaled to maintain

[9] To improve the comparability of Gini coefficients and concentration indices, all SES and health indices transformed to a scale of 0 to 100 points effectively range from 2 to 98 points, and are positively associated with wellbeing.
[10] Age groups are 6-11 for primary education, 12-17 for secondary and 18-29 for post-secondary.

the proportionality of the weighted national samples to the respective country populations.

2.3.- Multivariate Health Indices

DHS survey information focuses on maternal and child health and does not provide an overall perspective of household health. Analytically, three groups of indicators can be identified: a) health knowledge, b) use of health services, and c) health status.

A set of indicators was defined for each of these dimensions, taking most of the available information in the questionnaire. Indicators were also constructed combining the three indices, and a global health index was also estimated. Health indices were estimated for each woman in reproductive age, and then averaged for each household. In all cases, categorical principal components analysis was applied. Table I.3 contains health indices and variables.

There are only a few health knowledge questions in the questionnaire. From detailed questions on knowledge of 11 contraceptive methods we elaborated a numeric indicator. The remaining indicators are simple dichotomous variables.

Health service indicators are based on actual use. Nevertheless, in Latin America, they may be regarded as a fairly good *proxy* to access, given acute deficits in public health infrastructure. Some ordinal or numeric indicators were constructed combining different questions, as in the cases of contraceptives, prenatal health care, and childbirth.

Among health status variables, an age-controlled fertility indicator was elaborated. It can be defined as the heteroskedasticity-controlled residual of the cubic regression of the number of live births as a function of age. Heteroskedasticity is controlled by a predicted standard deviation also obtained through a cubic estimate of standard deviations by age.

As child stunting increases during the first 30 months of life, a similar procedure was applied to estimate an age-controlled indicator of stunting risk for all children younger than five years. In this case a Lowess non parametric regression was applied and no control for heteroskedasticity was necessary. The regression took child height for age *z* score as a function of age in months. *Z* scores were estimated using the program *Anthro*.

Last child birth weight was based on a five-category scale ranging from very small to very large. Weight in kilograms was not available for most children born at home (a common situation in Latin America). Morbility was estimated combining diarrhea, acute respiratory diseases and fever. The woman Body Mass Index (BMI) – defined as: $BMI = Weight_{(kgs)}/Height_{(mts)}^2$ – is a widely used anthropometric indicator of woman's current nutritional status.

In addition to the main indices, separate indices for health services and health status were estimated for women only, as well as a child health status index. Also, two additional health indices on Women's Health Services Use and Women's Health Status. The sets of variables defining each health index are shown in Table I.3.

Women's Health Services Use: Anti-tetanus vaccination in last pregnancy; Number, opportunity and quality of prenatal visits in last child; place of attention of last childbirth; type of attention of last childbirth; proportion of vaccinations received by last child out of total.

Women's Health Status: Proportion of dead children; BMI of non-pregnant woman; indicator of chronic malnutrition controlled by child's age group; type of weight at birth of last child; prevalence and intensity of diarrhea of last child in last two weeks.

3.- Health Inequity Decomposition: Method and Interpretation

The decomposition methodology for the Wagstaff, van Doorslaer (2002b) concentration index is well established; see for example Van Doorsaler and Jones (2002). It is described in Appendix 1. Usually, the decomposition is performed over a set of health factors, such as education, basic household quality, household goods, and health service use (which we shall use in what follows). The results are interpreted to mean that education inequity, say, explains some percentage of health inequity. Some error term for unexplained inequity remains.

Here we also decompose health inequity by socio-geographical regions. These decompositions are performed for two different joint socio-geographic subdivisions of the 4 countries in the study. The socio-geographic subdivisions consisted in choosing geographical regions and subdividing the population in each region according to educational and ethnic status. Three levels of educational status Ed1, Ed2, Ed3 were constructed according to the CATPCA Education index mentioned above, following the criteria shown in Table I.4.1. To situate these educations levels in terms of schooling and literacy, Table I.4.2 shows the mean levels of woman's schooling, husband's schooling, for each of these educational status levels, as well as women's de facto literacy according to the following categories: does not read, reads with difficulty, reads fluently. On the average, both women and their husbands have incomplete primary schooling in Ed1, primary schooling in Ed2, and lower secondary schooling in Ed3. A major portion of women in Ed1 in practice cannot read, while 70% read fluently in Ed2 and 90% in Ed3.

Table I.4.1 Definition of Household Educational Levels

Educational Level	Educational Index	Percent of full sample
Ed1	0 to 30	34.67
Ed2	30 to 50	53.42
Ed3	50 to 100	11.91

Table I.4.2 Descriptive Statistics for Household Educational Levels

	Schooling (yrs)		Women's De Facto Literacy (%)		
Educational Status	Woman's Schooling	Husband's Schooling	Does not Read	Reads with Difficulty	Reads Fluently
Ed1	2.28	3.26	0.45	0.26	0.29
Ed2	6.30	7.29	0.05	0.20	0.74
Ed3	11.79	12.98	0.01	0.03	0.97

By considering both educational level and ethnic status, the population in the joint four-country sample was divided into 6 population groups we shall refer to as social groups. As mentioned above, two geographic subdivisions were defined. The first simply divided the four countries into urban and rural. The second is a finer subdivision adding to the urban/rural distinction the regional subdivision adopted by the DHS surveys in each country, with 3 categories in Peru and Bolivia, 8 in Guatemala and 7 in Brazil. Because the metropolitan areas typically concentrate population, wealth and social services, these were added as regions in the case of Peru and Guatemala, the later including a "metropolitan rural" region. The full procedure resulted in a subdivision of Peru into 7, Bolivia into 6, Guatemala into 16 and Brazil into 14 regions. Taking also the social subdivision into account, we shall refer to the first as the *urban/rural* and the second as the *finer* socio-geographic subdivision. The two socio-geographic subdivisions of each country and their resulting inter- and intra- regional population distributions are shown in Tables I.5 and I.6.

The decomposition formulae used for the socio-geographic subdivisions of the population are described in Appendix 1. These decompositions are special in that there is no error term, since the dummies describing these regions add up to one. They are also unusual in that the decomposition of the concentration index according to population subgroups results in a *doubly* *weighted* sum of within-group inequities:[11]

$$C(y;z) = \sum_{j=1}^{J} \frac{N_j}{N} \frac{\bar{y}_j}{\bar{y}} C(y_j;z)$$

The overall concentration index $C(y;z)$ is the weighted average of the within-group inequities $C(y_j;z)$, weighted both in proportion to the population N_j / N and in proportion to the *per capita* holdings $\bar{y}_j / \bar{y}$ of the health assets. These reflect between group inequalities in health. Note that the sum can also be viewed as a population-weighted sum of the quantities $(\bar{y}_j / \bar{y})C(y_j;z)$, which accordingly represent *per capita inequity*. See Appendix 1 for the proof of the decomposition.

For each decomposition performed we report the following three quantities:

1) The *average relative per capita level*. This is the ratio $\bar{y}_j / \bar{y}$ between group *j*'s and the whole population's average *per capita* level (taken over the four-country sample). It gives a measure of between group inequalities in health.

2) The *within-group inequity* of group *j*. This is $C(y_j;z)$, which is analogous to the concentration index $C(y;z)$, but is defined for indicator y_j of population group *j* with respect to the socioeconomic status *z* of the *whole* population (rather than the subgroup population). It is independent of the scale of y_j and therefore of the relative *per capita* level of asset *y* held by each subgroup.

3) The *per capita inequity* of group *j*. To combine the within-group inequities $C(y_j;z)$ into the population-wide inequity $C(y;z)$, they must first be weighted by the relative *per capita* level $\bar{y}_j / \bar{y}$, yielding $(\bar{y}_j / \bar{y})C(y_j;z)$.

4.- Health Inequity Decomposition: Results

Health and factor inequity decompositions were carried out: 1) according to the two socio-geographic subdivisions; 2) according to health production factors; 3) after an 'experimental' factor augmentation, decomposing health benefits according to the socio-geographic subdivisions. Also, 4) inequity decompositions for the main health production factors were performed.

[11] The sum would be single weighted in terms of the total assets Ny_j of each group, but this is counter-intuitive without reference to population sizes.

Overall, 45 inequity decompositions were estimated for each of the socio-geographic subdivisions. These are listed in Table XII and are available in Appendix 2[12] (in future, on the web). The decompositions were calculated using robust estimators (see the discussion in Appendix 1). The results were extremely significant. In the case of the urban/rural subdivision, all of the decomposition coefficients were significant at better than 1%. Their average significance in each decomposition was better than 0.00026. In the case of the finer subdivision, out of the 210 regions with indigenous observations, at the most 2 obtained results less significant than 1% in each table, for a total of 11 out of the 9450 observations in the 45 tables. The average significance of each decomposition entry was better than 0.00039 for children and 0.003 for households.

In all, we ran the following sets of decompositions for the two socio-geographic subdivisions:

A. Three children's and seven household health indicators.[13]

B. Controlled health inequity indices for four children's or two household indicators.

C. Education, basic household quality, household goods and employment indicators in either database.

The health indices used in each set of decompositions were the following:

A. Three children's or seven household health indicators:

a) Children's height for age z-score, health status and health service use.

b) Women's height for age z-score, household health status, household health service use, women's health status, women's health service use, women's health knowledge and children's vaccinations (from the household data base).

These are the "10 health indicators" used.[14]

B. Controlled health status inequity indices for four children's or two household indicators.

What is the inequity in health status after controlling for education, basic household quality, household goods and employment indices as health factors? To answer this we regressed health status indicators against the health factors

[12] At http://www.cide.edu/investigador/doctos_publicacion.php?IdInvestigador=25&IdPublicacion=1638.

[13] The ten indicators mentioned above.

[14] All variables including z-scores were normalized from 0 to 100 before applying the inequity decomposition. Normalization to a positive index is necessary for the concentration index to make sense.

and decomposed the inequity of the normalized residual. The residual thus represents health status over and above what the factors would predict. The residuals were normalized to define an index between 0 and 100. The health status indicators used were the following:

a) In the case of children, besides health status, height for age z-score was analyzed in this way. Also, the controlling regressions were ran a second time including women's (mother's) height for age z-score as a control, representing an intergenerational health factor. Thus we obtained four "factor-controlled" inequity decompositions for children.

b) In the case of households, household and women's health status.

c) Education, basic household quality, household goods and employment indicators in either database.

For each of these indicators, which can be considered factors in the production of health, as well as women's (mother's) height for age z-score in the children's database, an inequity decomposition was performed.

The results are described and analyzed in the sections that follow.

4.1.- Health inequity decomposition for the main health indicators

We begin by presenting the decompositions of the main health status indicators, which reveal the main results. Recall that the decompositions represent the total concentration index as a population-weighted average of the *per capita inequity* $(\tilde{y}_j / \bar{y})C(y_j;z)$ of each subdivision of the population (presented in the first column of the Tables), and that this *per capita* inequity is the product of the *average relative per capita levels* $\tilde{y}_j / \bar{y}$ of endowments (second column) and the scale-free *within-group inequities* $C(y_j;z)$ (third column). Because the ethnic phenomenon is very diverse, we will stress both the general and the specific patterns of behavior found in the results. To do this, we shall use *graphically enhanced tables*. Each table or set of tables will be shaded to highlight its main features or patterns, according to criteria to be explained in the text below.

The average relative *per capita* levels $\tilde{y}_j / \bar{y}$ that intervene in the decomposition turn out to be important to distinguish between population differences in *equity* and differences in *levels*.

The overriding pattern of our results is that ethnic people turn out to have *lower per capita levels* of health but also *lower levels of inequity* (measured by either as *per capita* or within-group inequity).

This overriding pattern of the results becomes apparent when the decompositions for the main health indicators are examined. Table sets II.1 and II.2 report the decomposition results for the urban/rural subdivision for:

1) the three children's health variables and 2) women's height for age z-score, household health status and household health service use.

The *per capita* and within-group inequity sections of Tables II.1 (respectively Tables II.2) are shaded to represent the socio-geographic regions for which the inequity contribution is positive for all three children (respectively, household) health indicators. A common shading pattern occurs for the four countries examined and for all six Tables II. The shading pattern highlights: 1) educational level E3; 2) educational level E2 for the non-ethnic urban population; and in addition, 3) the urban ethnic population of Guatemala and Brazil and the rural non-ethnic population of Brazil.

Our interpretation is that larger differences in health occur for the richer population than occur for the poorer population, and for urban regions as compared to rural areas. This is also consistent with the lesser contribution of the ethnic population to inequity, since it is poorer and more rural.

Turning now to the section for average relative *per capita* levels in Tables II, the shading pattern now represents the socio geographic regions for which the ethnic population has lower *per capita* health levels. Here we find that *the ethnic population has consistently lower child and household health levels for most socio-geographical regions*, specifically all of Peru; rural Bolivia and Guatemala at educational levels Ed1 and Ed2, and urban Guatemala at educational level Ed1. Also, ethnic children in urban Bolivia, rural Bolivia at Ed3, rural Brazil at Ed1 and Ed2, and urban Brazil at Ed2 are at a disadvantage. Besides this, ethnic urban households in Guatemala at Ed3 and Brazil at Ed1 are at a disadvantage.

Summarizing, both general and specific patterns are present. The general pattern is that health inequities are higher in urban regions and in more educated strata, but not specifically for ethnic people; and that ethnic people, especially with lower educational levels, tend to have lower *per capita*l health assets. Specific regional patterns are nevertheless clearly present.

4.2.- Assessment of the results for health and health factor inequity decompositions

To examine the full set of decompositions (Tables in Appendix 2, see footnote 12) we asked 1) whether ethnic inequity (*per capita* or within-group) was worse than the corresponding non-ethnic inequity, and 2) whether ethnic *per capita* health or factor levels were worse or not. To answer this question we counted, for each socio-economic region, how many of the estimates of types A, B, C listed above reflected ethnic disadvantage. We find that the overriding pattern of our results is maintained. Ethnic people have lower *per capita* levels of health but also lower levels of inequity.

Tables III.1 and III.2, A, B and C present these counts for each type of estimate, for the urban/rural socio-geographic subdivision. The overriding pattern of results that was discussed above for the basic health indicators is confirmed. Ethnic populations show less *per capita* and within-group inequity, but they are at a disadvantage in *per capita* asset levels. Tables III.1.D and III.2.D show the addition of the respective tables A, B, C. In these tables, the shaded cells show when the majority of the inequity estimates or *per capita* asset levels in each socio-economic region indicated ethnic disadvantage. Only rural Peru at Ed1 and Ed2 and urban Peru at Ed3 showed ethnic disadvantage in inequity. However, the 24 regions throughout the four countries showed ethnic disadvantage in asset levels for most indicators, except for urban Guatemala Ed2 and rural Brazil Ed3.

The analogue of Table D for the finer socio-geographic subdivision for the ten health indicators is shown in Table IV, which counts for how many of these indicators there is ethnic disadvantage. The same pattern emerges. In 74 out of the 92 socio-geographic regions for which there are observations of ethnic people in the sample, ethnic people suffer a disadvantage in *per capita* asset levels. However, *per capita* inequity is usually less, with the notable exception of Peru and much of Guatemala at Ed1 and Ed2. Even so, it is clear that ethnic reality conforms a complex regional mosaic.

To have a point of comparison for the results on ethnic disadvantage, showing that the overriding pattern does not appear spuriously with the decomposition, we ask whether inequity levels are worse in urban than in rural areas. The results, based on the urban/rural subdivision, are shown in Tables V.1 and V.2, which are analogous to Tables III explained above. A different, specific pattern emerges, As can be seen in summary Tables V.1.D, V.2.D, most urban regions are at a disadvantage with their rural counterparts in *per capita* and within-group inequity, as well as in *per capita* asset levels.

4.3.- Sensitivity of ethnic disadvantage in health to health production factors

To conduct a rough sensitivity analysis of ethnic disadvantage, we suppose that health status depends linearly on the production factors mentioned above: education, basic household quality, household goods, health service use and women's height for age z-score. This last measure is included to take into account an intergenerational factor in health. It is a measure of women's life-long wealth and health that especially reflects early childhood malnutrition. Thus, both in the case of children and in the case of households, it represents an intergenerational channel through which low socioeconomic status and health is transmitted. Then, taking into consideration the success of conditional transfer programs such as Progresa, now Oportunidades, we considered the following transfer experiment for each factor. Raise, for the lower 20% of the whole population, its corresponding asset level up to the 20th percentile. What will the effect of this transfer on ethnic disadvantage be?[15]

This question allows answering the following one. Do asset transfer policies applied to the poor population as a whole diminish ethnic disadvantage, or is it necessary to apply specifically ethnic policies at this level? This question is important, because implementing discriminatory policies so as to reduce discrimination could be costly and problematic. Our results will show, roughly, that the non-ethnic-specific transfer policies mentioned above consistently lessen ethnic *per capita* disadvantage in *per capita* levels, but not *per capita* or within-group inequity levels, as is to be expected from the previous results. Tables VI show the results for the urban/rural subdivision. The shaded areas show that the regions for which the effects on children's and households ethnic disadvantage are strong generally coincide. The results in Tables VII, for the fine subdivision, are even more encouraging. Here the gray cells show those regions for which half or more of the factor-enhancing programs reduce both children's and household ethnic disadvantage, while results in bold show the few cases where only one or the other holds. In the vast majority of regions, health factor transfers to the poorer population reduce ethnic disadvantage.

4.4.- Decomposition of health inequity by health production factors

How much inequity is explained by the production factors? To answer this question we decompose inequity by factors, namely education, basic household quality, household goods, health service use and women's height for age z-score, following the methodology in Appendix 1, for the database as a whole. The inequity decomposition results in effect decompose the intergenerational transmission of wealth as represented by health.

Table VIII.1 shows the results for three children's health indicators: height for age z-score, health status and health status controlled by height for age z-score. The first indicators is well known to contain noisy information on nutrition (Glewwe, Jacoby and King, 2001) and cognitive ability (Rubalcava and Teruel, 2004), that is, on early child development in general. It is an important indicator, given the important role of secular rises in height (Fogel, 2002). Early child development plays an important role in determining lifelong achievements in health, education and income (Mayer-Foulkes, 2004). The second is an overall measure of health. The third is the content of this measure that is orthogonal to the first measure. Thus we have three health measures following a gradient along the early child development content reduces.

[15] Of course, women's stature cannot be improved. When we say "stature improved" what is meant is that the adverse effects correlated to low stature are counteracted.

The results consequently also follow a gradient.[16] The percentage of "explained" inequity diminishes from 87.2% to about 79.2%. In the estimates presented here, women's height for age z-score measures a mixture of direct effects on child height of maternal early child development and genetic information on height. The percentage of inequity accounted for by women's height for age z-score diminishes from 27.4% to 5.7%. The 16.5% of health status inequity is probably a reasonable measure of the direct intergenerational impact of parental on child health status. The next most important determinant of health is household goods, a measure of income, accounting for roughly 20% of inequity across the three health indicators. The importance of education increases as nutrition becomes less important, probably because nutrition depends more directly on income than health in general, which depends also on parental knowledge. Household quality, which contains sanitation indicators, also similarly grows in importance. Health service use accounts for roughly 15.5% of inequity. We interpret these decompositions as implying that the vicious cycle in the intergenerational transmission of wealth in the form of health can be broken if income, education, and health services and sanitation improve, in that order of importance. Studying ethnic health inequity in Colombia, Bernal (2005) obtains similar conclusions in that once socioeconomic characteristics (which may result from discrimination) are controlled for, remaining ethnic differences are small. These results are optimistic in that they imply policies reducing ethnic socioeconomic differences should be able to eliminate ethnic discrimination.

Table VIII.2 is a similar decomposition for several household health indicators, accounting for about 90% of inequity (significance in Table IX.2). The results for household and women's health are similar to those obtained for children's health, with household goods and education accounting for somewhat higher proportions of inequity. Health depends more on the benefits derived from socioeconomic status than on those obtained from health service use. When we turn to women's knowledge, the most important factor is education, with household goods and health service use also rising. The negative sign obtained for basic household quality probably compensates for a non-linear effect, for example decreasing knowledge returns to education and income. In the case of children's vaccinations it is health service use that rises in importance. Again the negative sign obtained for basic household quality probably compensates for decreasing vaccination returns to health service use. The results obtained for women's height for age z-score are interesting in that they state that this indicator of early child development affects long-term health but not knowledge or vaccinations.

[16] The regression on which the decomposition is based is reported in Table IX.1, showing almost all coefficients significant at 1%.

Table VIII.3 is a similar decomposition for household health indicators, but excluding women's height for age z-score and accounting for a smaller percentage of inequity (significance in Table IX.3). Again, around 30% of non-inherited health (as measured by women's height for age z-score, household health status, women's health status and household health status controlled by height for age z-score), is accounted for by household goods, a proxy for income, and about 20% by education (15% in the case of height). Basic household quality accounts for about 12% and health service use for between 12% and 22%, rising when height or its effects are excluded. In the case of women's health knowledge, education rises to about 50%; in the case of children's vaccinations health service use is most important; similarly when these indicators are controlled for by height for age z-score.

Summarizing, we can conclude that equity in income and education, followed by health service use and sanitation are, in that order, the most important determinants of health equity. Education is less important for nutrition than for health in general.

4.5.- Country-specific decomposition of health inequity by factors and ethnic membership

We now perform the same inequity decomposition but interact each of the factors with the ethnic membership dummy, independently for each country in the sample. The results are quite different from the average results. Each country has a characteristic pattern of inequity decomposition that is essentially common for the following four indicators: children's height for age z-score and children's, household and women's health status.

The results are shown in Tables X.1 for children and X.2 for household indicators. Each table has four panels showing results for two health indicators and decomposition percentages for factors and for factors interacted with the ethnic dummy. The corresponding regressions results are shown in Tables X.1 and X.2. The coefficients for the factors are almost all significant at better than 1%. The ethnic interactions are usually not significant individually, although their pattern of signs is.

The gray cells show a common pattern for which health factors (and factors interacted with the ethnic dummy) in which countries explain a relatively high proportion of health inequities. Exceptionally large or small impacts not fitting the general pattern are in bold. The green (or dark gray) table cells show cells for which ethnic membership is associated with *less* health inequity. The fact that the pattern repeats itself in the four panels lends significance to the obtained sign. The probability that a given coefficient has the same sign in the four panels is always better than 1%, as the multiplication of the four corresponding p-estimates shows.

Comparison should hopefully point out areas which policy should pay special attention to. Let us first consider overall health inequity, independently of ethnic membership. In Peru, health inequity is inordinately associated with inequities in basic household quality and health service use. In Brazil, inequities in household goods and mother's height for age (nutrition, cognitive ability, etc.) play a stronger than average role. Education inequities are also amiss in Guatemala. So are household good inequities affecting children's height in Bolivia, and basic household quality inequities affecting household and women's health in Brazil.

Factors specifically affecting ethnic populations adversely are: inequities in health service use in Peru and Bolivia (except here for children's health status), education in Bolivia and basic household quality in Guatemala and in Brazil for the case of household and women's health status. On the other hand, factors positively affecting ethnic populations are: inequities in education in Peru and Guatemala, and factors associated with mother's height in Guatemala. Ethnic reality forms a complex mosaic in which local and regional factors play an important role.

Conclusions

Our inequity decomposition of all health asset indicators essentially yielded the same results. Higher inequities are located at higher levels of education; in urban rather than rural areas, and for non-ethnic populations. In general, larger differences in health occur for the richer population than occur for the poorer population, and for urban regions as compared to rural areas.

Once ethnic and non-ethnic populations are specifically compared, the overriding result is that ethnic populations suffer lower *per capita* asset levels. All of the 24 regions in the urban/rural socio-geographic subdivision, and 74 out of the 92 regions in the finer subdivision showed ethnic disadvantage in *per capita* asset levels. However, ethnic *per capita* or within-group inequity within these regions is usually less, with the exception of some regions in Peru and Guatemala. This means that health inequities between ethnic and non-ethnic groups are strong, while within group inequities are usually lower in the ethnic populations. In contrast, most urban regions are at a disadvantage with their rural counterparts both in *per capita* and within-group inequity, and in *per capita* asset levels.

Other than this overriding pattern, ethnic reality across socio-geographical regions in the four countries that were examined in this study forms a complex, varied mosaic.

It is beyond the scope of this paper to explain why ethnic peoples have lower *per capita* holdings in health and health factors. It is of course likely that if long-term income dynamics are subject to equilibrium processes implying persistent inequality, then initial conditions —originating in the colonial era— as well as ethnic-specific barriers, are involved. Why inequities are smaller within ethnic groups for comparable educational levels also calls for an explanation. Family and community values may play a role.

Next, we ask what the effect on ethnic health of a pro-poor policy raising education, basic household quality, household goods, health service use or women's height for age z-score to the 20th percentile level. Do asset transfer policies applied to the lowest 20th percentile level diminish ethnic disadvantage, or is it necessary to apply specifically ethnic policies? Can non-discriminatory policies reduce discrimination? Our results show that non-ethnic-specific transfer policies to the poorest 20% consistently lessen ethnic per-capita disadvantage in per-capita levels, although not inequity levels. For the vast majority of regions the factor-enhancing programs reduce both children's and household ethnic disadvantage, mostly through eliminating disadvantages in per-capita levels but also through reducing per-capita inequity in many regions of Peru, Guatemala and Brazil. Thus policies based on non-discriminatory individual characteristics can be used at least to begin to reduce the impacts of discrimination and persistent poverty against the ethnic population. Of course, such policies will not address specific local and regional indigenous problems arising at the cultural, social and institutional levels. These may be important components of indigenous disadvantage.

Next, we asked how much inequity is explained by the same production factors. They explain about 85% of inequity in the case of children, and about 90% in the case of household and women's health. Here the presence of women's height for age z-score reflects a direct intergenerational effect, with indirect intergenerational effects working through other assets such as income, education and health services. This direct effect accounts for about 15% of inequity in the case of height, and less for other health indicators, implying that the intergenerational cycle of poverty can be broken if these other asset levels rise.

The most important of these assets is household goods, our best measure of income, accounting for roughly 20% of inequity for most health measures. The next is education, followed by health service use and basic household quality (an index including sanitation). Thus, basic health inequities depend more on socioeconomic inequity than on health service use inequity. 17 More specific indicators depend on more specific factors, for example women's knowledge on education and children's vaccinations on health service use. Also the impact of women's height for age z-score on these two indicators is small. Similarly, education is less important for nutrition than for health in general.

However, although these results may hold on average, once the decompositions are performed for each country individually and ethnic membership is interacted with the dummies, what emerges is a complex mosaic of specific results. Each country has a characteristic pattern of factor inequity decomposition that is essentially common for children's height for age z-score and children's, household and women's health status. Comparison point out areas policy should pay special attention to. The main ones are that in Peru, health inequity is inordinately associated with inequities in basic household quality and health service use; in Brazil, inequities in household goods and mother's height for age (nutrition, cognitive ability, etc.) play a stronger than average role. Education inequities are also strong in Guatemala. Factors specifically affecting ethnic populations adversely are: inequities in health service use in Peru and Bolivia (except here for children's health status), education in Bolivia and basic household quality in Guatemala and in Brazil for the case of household and women's health status. On the other hand, factors positively affecting ethnic populations are: education in Peru and Guatemala, and mother's height in Guatemala.

As we have already mentioned, implementing transfer programs such as Oportunidades in Mexico will tend to benefit the ethnic populations more than

[17] This is consistent with Psacharopoulos and Patrinos (1994) emphasis on the potential benefits of education.

proportionally. At the same time, the careful microeconomic evaluation associated with these programs can be expanded to study the dynamics of exclusion and the special needs of ethnic peoples, locally and regionally, including the institutional level. Such studies could be instrumental in defining effective community level policies addressing ethnic issues.

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Appendix 1

Measurement and Decomposition of Inequality[18]

We use the health concentration index (Wagstaff, van Doorslaer and Paci, 1989) as our measure of a health inequality *relative* to income inequality. Suppose we have a population of *N* individuals for which we have a continuous indicator of health y_i. Rank the population according to a measure of wealth z_i, so that $z_1 \leq \ldots \leq z_N$. Then the health concentration index $C(y; z)$ is defined as twice the area between the diagonal and the concentration curve L(y) plotting the cumulative proportion of the population against the cumulative proportion of health. For example, if L(y) lies below the diagonal then inequalities in health exist and favor the wealthy, and the health concentration index $C(y; z)$ will be positive. By construction, $C(y; z)$ lies between –1 and 1.

For weighted data, the computation formula for $C(y; z)$ given by Van Doorsaler and Jones (2002) (with a slight change of notation) is the following:

$$C(y;z) = \frac{2}{\bar{y}} \sum_{i=1}^{N} w_i y_i R_i - 1,$$

where

$$\bar{y} = \sum_{i=1}^{N} w_i y_i$$

is the weighted mean health of the sample, w_i is the sampling weight of individual *I*, (with the sum of w_i equal to *N*), and R_i is the weighted relative fractional rank of the *i*th individual according to wealth asset *z*,

$$R_i = \frac{1}{\bar{y}} \sum_{j=1}^{i-1} w_j + \frac{1}{2} w_i \quad \text{where } w_0 = 0.$$

As Kakwani *et al*. (1994) show, $C(y; z)$ can be derived as the estimate of γ in the following convenient WLS regression:

$$2\sigma_R^2 [y_i / \bar{y}] \sqrt{w_i} = \alpha \sqrt{w_i} + \gamma R_i \sqrt{w_i} + u_i,$$

[18] We follow Van Doorsaler and Jones (2002) in the following exposition. This article can be consulted for further references and explanations.

where $\sigma_R^2 = \frac{1}{N}\sum_{i=1}^{N} w_i (R_i - \frac{1}{2})^2$ is the weighted variance of R_i. The estimator of γ is equal to $C(y;\ z)$ and can also be estimated in terms of the weighted covariance of y_i and the weighted fractional rank, $C(y;z) = (2/\bar{y})w\text{cov}(y_i, R_i)$.

Standard errors for $C(y;\ z)$ can be obtained from the least square estimates of the WLS regression above. A more accurate standard error taking into account serial correlation in the errors and the dependence of the observations as a result of the presence of the relative rank variable on the RHS of this regression has been developed by Kakwani *et al.* (1994). But since this estimator does not correct for potential heteroskedasticity and for errors in the sampling of the data we have chosen here instead to use a robust estimator for the variance matrix, also following Van Doorsaler and Jones (2002).

The next step is to decompose inequality. Wagstaff, van Doorslaer and Watanabe (2002) show that, for a linear regression model

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i ,$$

the concentration index for *y* can be written

$$C(y;z) = \sum_k (\beta_k \bar{x}_k / \bar{y}) C(x_k;z) + GC(\varepsilon;z)/\bar{y}$$

where $\bar{x}_k$ is the weighted mean of x_k, $C(x_k)$ is the concentration index for x_k and $GC(\varepsilon;\ z)$ is the generalized concentration index for ε.

The decomposition of $C(y;\ z)$ shows that the concentration index can be thought of as consisting of two components. The first is an explained component, equal to the weighted sum of the concentration indices of the regressors, where the weights are simply the elasticities of *y* with respect to each x_k. The second is a residual component of inequality that cannot be explained by the systematic variation in the x_k across income groups.

Decomposition of Inequality into Population Subgroups

We now apply this decomposition methodology to the case of population subgroups. Consider a subdivision of the population into $j = 1 \ldots J$ population subgroups G_j. Let N_j be the population of each group *j*, so that $N = \sum_{j=1}^{J} N_j$. For health variable y_i define the corresponding group-specific health index y_j, where $y_{ji} = \delta_{ji}\ y_i$, writing δ_{ji} for the dummy variable equal to one if person *i* is in group G_j. The following equation is an identity:

$$y_i = \sum_{j=1}^{J} y_{ji}$$

Applying the decomposition formula just established above,

$$C(y;z) = \sum_{j=1}^{J} (\tilde{y}_j / \bar{y}) C(y_j; z) .$$

Here by definition

$$\tilde{y}_j = \frac{1}{N} \sum_{i=1}^{N} \delta_{ji} y_j = \frac{N_j}{N} \frac{1}{N_j} \sum_{i \in G_j} y = \frac{N_j}{N} \bar{y}_j ,$$

where $\bar{y}_j$ is the *per capita* endowment of health asset ***y*** in group G_j. Hence

$$C(y;z) = \sum_{j=1}^{J} \frac{N_j}{N} (\bar{y}_j / \bar{y}) C(y_j; z) ,$$

a population-weighted average of relative *per capita* endowment interacted with within-group inequalities $C(y_j;\, z)$. Note that $C(y_j;\, z)$ approximates, but is not equal to, the concentration index of health asset ***y*** in group G_j, because it is defined in relation to the population-wide wealth distribution of *z* rather than the group-specific wealth distribution of z_j.