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Municipal Health Index: Monitoring Changes in Health Inequalities in Bolivia

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Abstract

Summary indexes are frequently used to identify the magnitude and to evaluate changes in social, economic and other conditions. These kinds of measures are now used more frequently in the analysis of health conditions, especially for determining inequalities in these areas. Using the Municipal Health Index (MHI), which assesses the overall health conditions of a municipality, we tried to determine how large health inequalities are among Bolivian municipalities and how they may have changed between the years 2000 and 2005. The MHI is composed of ten indicators representing diverse factors, which were calculated using data from The National Institute of Statistics and The National Health Information System.

Results indicate that in Bolivia there still exist profound health inequalities among municipalities and socioeconomic regions, with the impoverished and the indigenous populations having the lowest MHI. Nevertheless, between 2000 and 2005 there have been notable improvements: firstly, there was a significant national rise in the median value of the index and secondly, a sensible reduction of the municipalities with significantly low values of the MHI, was observed.

Furthermore the gap between the highest and the lowest values of the index was reduced by approximately 50%. These improvements have been observed in all regions of the country. However, Potosi and Pando, two of the poorest departments of the country, continue to be among the regions with the lowest MHI, the Department of Chuquisaca had the most significant improvement in health conditions during the same time.

Introduction

The measurement of health inequalities has become a frequent and necessary procedure in the last 20 years as it is an essential step to identify problems which can lead to interventions (1, 2). There have been numerous proposals for ways to carry out the measurement of health inequalities (3, 4). These range from the simplest — absolute or relative differences— to more complex measures such as compound or synthetic indexes (2). However, the analysis of the average figures to identify and monitor health inequalities are no longer sufficient. Therefore, the search for more powerful procedures to attain a more comprehensive understanding of health problems and their distribution in the population continues.

Compound indexes try to achieve this purpose by summarizing information on a general topic (e.g. health) using indicators from different dimensions (e.g. demographic, social, cultural, economic, etc.). Despite its limitations (6), this type of analysis has been a fundamental tool for the search of health equity in recent years. Many researchers have been working on developing summary measures, such as synthetic indexes, to analyze the results of different aspects of human progress: social, economic, human development, etc. For example in the Americas, the Index of Unsatisfied Health Needs has been developed by the Pan-American Health Organization and used in several countries to analyze and evaluate the progress in the attainment of health goals (7). To carry out this type of analysis, also other methods have been used to identify differences and inequalities in health situations.

Based on those considerations a synthetic health index was developed by a group of experts supported by the PAHO/WHO office in Bolivia following principles that integrate information from different dimensions related to health. Like other similar indexes, the MHI intends to measures the entire health condition of a population within a given community (8).

The MHI includes relevant indicators that are not only related to the health status of a population but also related the determinants of a population's health. The MHI can vary between the values of 0 and 1, with higher values reflecting better health conditions. The impact in the population's health that have the determinants incorporated in the index (through its indicators), can evidences the existence and evolution of health inequalities at the municipal level and consequently it can helpful in proposing and implementing more effective interventions.

This study presents an analysis of health inequalities in Bolivian municipalities and how they have changed, as indicated by the Municipal Health Index (MHI).

Methodology

The methodology for the construction of the MHI is based on procedures suggested by PAHO Bolivia (8). The index is calculated for each territorial unit (municipality) and the relative achievement reached in each indicator is calculated, starting from the distance of the best and worse reached result. The selection of the indicators was carried out by identifying, according to experts' approach, a tracer indicator for each component, dimension or sphere. Keeping low correlations among them was a desirable characteristic in the indicators included in a synthetic index. In the construction of the MHI for, the following indicators were used:

Selected indicators, date and data source

Dimension	Indicator	Date	Data source
Mortality	Infant mortality rate per 1000 live births (IMR)	2001	INE
Morbidity	Number of cases of ADD in children per 1000 children under 5 (ADD)	2005	SNIS
Health Resources	Health personnel per 1000 inhabitants (HPER)	2005	SNIS
Health Services	Pregnant women's percentage with 4 prenatal controls (PC4)	2005	SNIS
Economic Situation	Annual income per capita in Bs: annual municipal income /total population (INCOME)	2005	DGP
Education resources	Students per teacher in initial, primary and secondary education (SpT)	2003	INE
Education outcomes	Medium of escolarity in adults: average years of studies (SCOL)	2001	INE
Access to energy	Percentage of homes with access to electricity (ELECT)	2001	INE
Household	House crowdedness: number of people per rooms in the house (CROW)	2001	INE
Physical environment	Percentage of homes with access to drinkable water (WATER)	2001	INE

- ○ *Calculation of the relative achievements*

For a municipality the relative achievements for each indicator come in particular, given by the relationships:

$$(X_{municipality} - \min X)/(\max X - \min X)$$ if a high value of the indicator is the desirable

or

$$(\max X - X_{municipality})/(\max X - \min X)$$ if a low value of the indicator is the desirable

where:

$X_{municipality}$: value of the indicator for the municipality
$\min X$: minimum value observed for the indicator among the municipalities
$\max X$: maximum value observed for the indicator among the municipalities

- ○ *Expression for the calculation of the index*

According to the indicators selected to integrate the Municipal Health Index (MHI), the calculation expression was the following:

$$\textbf{MHI} = 0.085607\ \textbf{\textit{IMR}} + 0.247726\ \textbf{\textit{ADD}} + 0.057318\ \textbf{\textit{HPER}} + 0.121967\ \textbf{\textit{PC4}} + 0.019851\ \textbf{\textit{INCOME}} + 0.052020\ \textbf{\textit{SpT}} + 0.067360\ \textbf{\textit{SCOL}} + 0.143822\ \textbf{\textit{ELECT}} + 0.077649\ \textbf{\textit{CROW}} + 0.126680\ \textbf{\textit{WATER}}$$

where the expressions in italic represent the relative achievements for each one of the indicators according to the expressions given in the respective paragraph and the numeric constants represent the established weighs.

Summary statistics for each MHI indicator used in the MHI

Indicator	Lowest value	Higher value	Desirable value	Variance of achievements	Weight
Infant mortality rate per 1000 live births	38,0	170,4	Low	0,026552	0.085607
Number of cases of ADD in children per 1000 children under 5	57,0	1000	Low	0.076836	0.247726
Health personnel per 1000 inhabitants	0,0	4,3	High	0,028276	0,057318
Pregnant women's percentage with 4 prenatal controls	0,0	100,0	High	0,060167	0,121967
Annual income per capita in Bs (annual municipal income /total population)	89,7	581,5	High	0,009793	0,019851
Students per teacher in initial, primary and secondary education	5,6	39,0	Low	0,025662	0,052020
Medium of escolarity in adults (average years of studies)	1,5	10,6	High	0,033229	0,067360
Percentage of homes with access to electricity	0,0	95,3	High	0,070949	0,143822
House crowdedness (number of people per rooms in the house)	1,3	4,1	Low	0,038305	0,077649
Percentage of homes with access to drinkable water	0,0	96,2	High	0,062492	0,126680

To classify the municipalities according to the value of the MHI, the following ranges were used:

High: $0,75000 < MHI \leq 1,00000$
Medium: $0,50000 < MHI \leq 0,75000$
Low: $0,25000 < MHI \leq 0,50000$
Very low: $0,00000 \leq MHI \leq 0,25000$

Using the MHI results for each municipality, the data was analyzed by calculating the departmental average and corresponding variations, with the goal to provide useful information to regional authorities and also to determine the progress of health achievements as compared to other departments. Finally an analysis of the evolution of the MHI was carried out comparing the 2005 values with those calculated for 2000 (8).

The elaboration of the maps was carried out using the SIGEpi software.

Results

Considering that the average MHI of a department is indicative of the health situation of the entire territory, we can then establish a hierarchical structure of the global health situation of the country. According to this structure, Tarija has the best health situation, whereas Potosí has the worst (Table 1). The national MHI average was 0,547998 with the highest value registered in the municipality of La Paz (0,761734) of the department of La Paz. The lowest values corresponded to the municipality of San Pedro de Buenavista (0,192003) in the Department of Potosí.

Table 1. Results of the MHI 2005, by departments. Bolivia, 2005

Department	Number of Municipalities	Departmental average	Maximum value	Minimum value	Ratio Max/Min	Dif. from Max (0,761734)
Tarija	11	0,530415	0,692094	0,354343	1,95	0,231319
Santa Cruz	56	0,523086	0,708766	0,290643	2,43	0,238648
Cochabamba	45	0,519603	0,717313	0,316672	2,26	0,242131
La Paz	80	0,517833	0,761734	0,365201	2,08	0,243901
Oruro	35	0,493844	0,705361	0,375900	1,87	0,267890
Beni	19	0,476503	0,604222	0,314488	1,92	0,285231
Potosí	38	0,410311	0,608668	0,192003	3,17	0,351423
Chuquisaca	28	0,385595	0,676587	0,199784	3,38	0,376139
Pando	15	0,381880	0,662483	0,194566	3,40	0,379854
National	**327**	**0.484376**	**0,68191**	**0,28929**	**2.36**	**0,29073**

The variation of the intradepartmental MHI indicates that in La Paz and Oruro, the individual MHI values of their respective municipalities were closer to the department average. On the contrary, the biggest dispersion of the values was observed in Potosí and Cochabamba (see Figure 1).

Figure 1. Distribution of the MHI values for 2005

○ Outliers
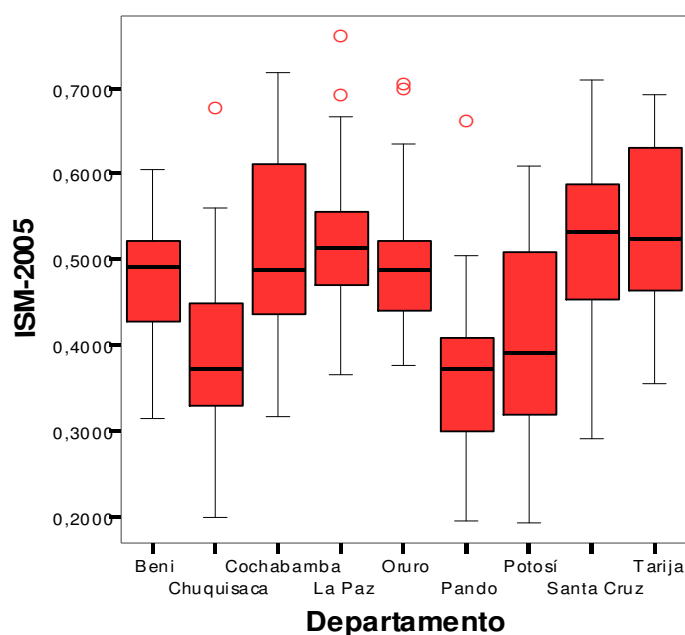
Of the 327 municipalities included in the analysis, a large proportion (55.3%) had a low or very low MHI (0 - 0,5), whereas a significant portion of the municipalities (44.3%) had a medium value of index (0,5 - 0,75). Only one municipality had a high index (over 0,75).

The distribution of the municipalities by category indicates that those in the department of Santa Cruz have the most favorable situation with 62,5% of its municipalities having medium MHI and 11% (6 municipalities) having a high index. The next best situation is observed La Paz where the 57.5% and 1,3% of its municipalities are in the categories of medium and high MHI values respectively.

Table 2. Distribution of municipalities according to category of MHI, by departments. Bolivia 2005

| Department | Municipal health index | | | | | | | | Total of Municipalities |
| | High | | Medium | | Low | | Very low | | |
	Total	%	Total	%	Total	%	Total	%	
Chuquisaca	0	0,0	2	7,1	25	89,3	1	3,6	28
La Paz	1	1,3	46	57,5	33	41,3	0	0,0	80
Cochabamba	0	0,0	21	46,7	24	53,3	0	0,0	45
Oruro	0	0,0	13	37,1	22	62,9	0	0,0	35
Potosí	0	0,0	11	28,9	25	65,8	2	5,3	38
Tarija	0	0,0	6	54,5	5	45,5	0	0,0	11
Santa Cruz	0	0,0	35	62,5	21	37,5	0	0,0	56
Beni	0	0,0	9	47,4	10	52,6	0	0,0	19
Pando	0	0,0	2	13,3	12	80,0	1	6,7	15
National	**1**	**0,3**	**145**	**44,3**	**177**	**54,1**	**4**	**1,2**	**327**

The worse situation, according with the percentage of municipalities with low index, is observed in the departments of Chuquisaca (89.3%), Pando (80%), Potosí (65.8%) and Oruro (62.9%).

Analyzing the gap between the departmental average and the maximum value of the MHI (0,761734 in La Paz), it becomes evident that the largest discrepancy is observed in Pando (2 times). This can be interpreted as meaning Pando's department health is the worst in the country. In contrast, the most favorable health conditions were observed in the department of Tarija, whose MHI value was approaching the maximum value (see figure 2).

Figure 2. Departmental Average of MHI. Bolivia 2005
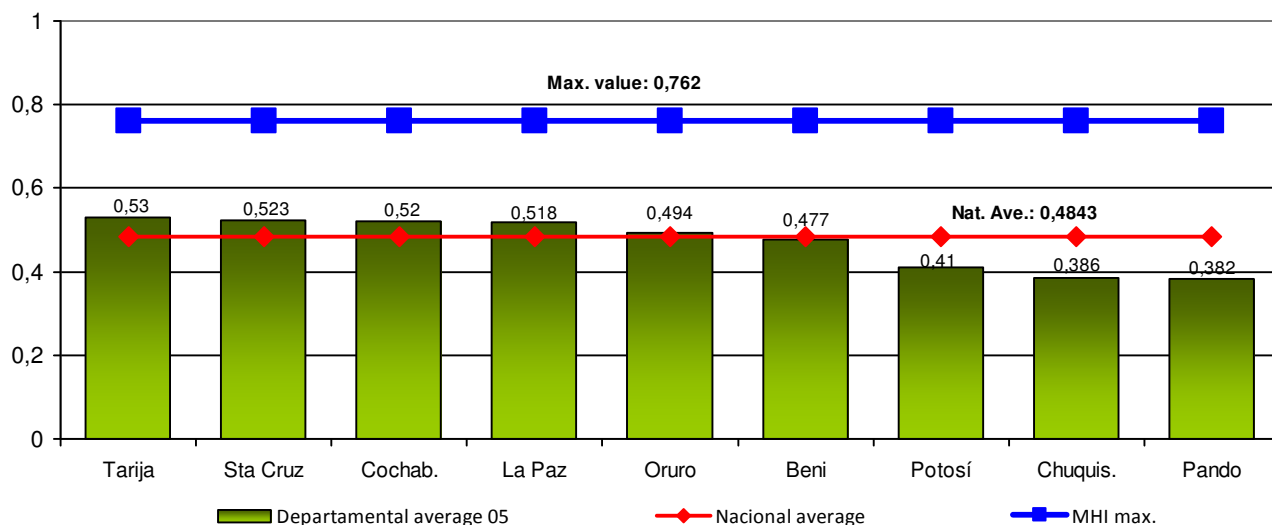
To determine the relative distance between each municipal score of MHI and the maximum value calculated (by MHI_mun/MHI_max ratio), it becomes evident that near 75% of the municipalities of Pando are more than three times below the best MHI in the country. In Chuquisaca two thirds of municipalities are also similarly lower from the best value of the index (see table 2). This confirms that these departments present the worst health situation of health in 2005.

Table 2. Number of municipalities in each quartile of the distribution of the ratio MHI_max/MHI_mun.

Department.	Quartile 1 (1,3700)		Quartile 2 (1,5689)		Quartile 3 (1,8331)		Quartile 4 (3,9673)		Total
	No.	%	No.	%	No.	%	No.	%	
Beni	4	21,1	6	31,6	4	21,1	5	26,3	19
Chuquisaca	2	7,1	0	0,0	7	25,0	19	67,9	28
Cochabamba	17	37,8	6	13,3	16	35,6	6	13,3	45
La Paz	19	23,8	34	42,5	21	26,3	6	7,5	80
Oruro	6	17,1	12	34,3	12	34,3	5	14,3	35
Pando	1	6,7	2	13,3	1	6,7	11	73,3	15
Potosí	8	21,1	3	7,9	6	15,8	21	55,3	38
Santa Cruz	21	37,5	16	28,6	11	19,6	8	14,3	56
Tarija	4	36,4	2	18,2	4	36,4	1	9,1	11
Total	82	25,1	81	24,8	82	25,1	82	25,1	327

The following figure illustrates that the departments of Pando and Chuquisaca have the largest proportions of municipalities with the poorest health condition in the country, more than three times distant from the maximum value of the index (see Figure 3). This is particularly true in the municipalities San Pedro of Buenavista in Potosi and Villa Nueva in Pando which are four times away.

Figure 3. Porcentual distribution of quartile of the ratio of MHI in relation to the maximum value. Bolivia 2005
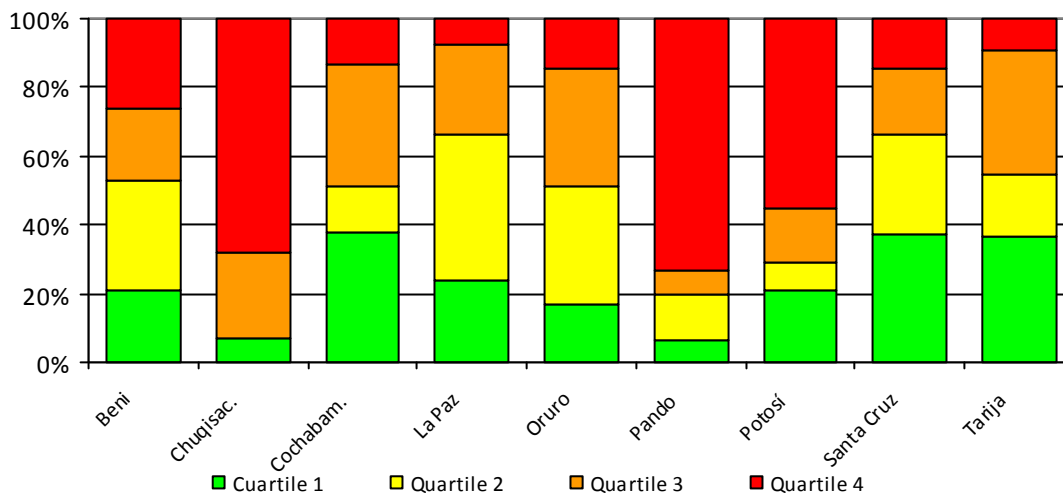

Evolution of the MHI between 2000 and 2005

Comparing the results of the MHI between 2000 and 2005, an increase of the national average is appreciated: from 0,465707 to 0,484376. This was also observed at a departmental level, as well as at the municipal level, as many municipalities improved to medium and high levels from previously low levels of index (see figure 4).

Figure 4. Variation in number of municipalities in each category of the MHI. Bolivia 2000-2005
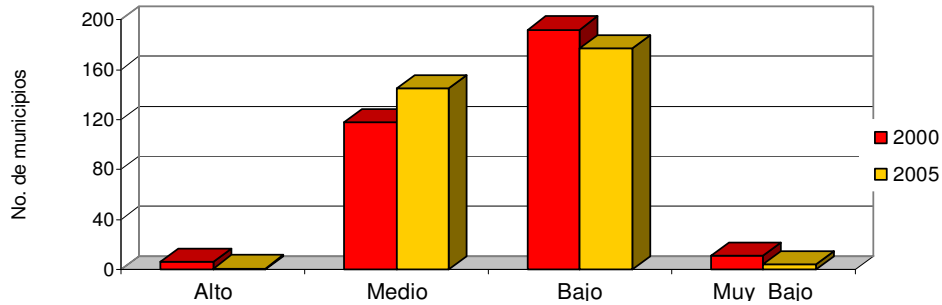
Another important change associated with this improvement is the decrease of the gap between the value of the index and the maximum figure at national level. The ratio between the MHI values of the municipalities with the highest and lowest values in the 2000 was 5,7 times (0.825392 in Santa Cruz de la Sierra and 0.143532 in Pocoata), while in the 2005 this value decreased to 3,9 times (0.761734 in La Paz and 0.192003 in San Pedro de Buenavista).
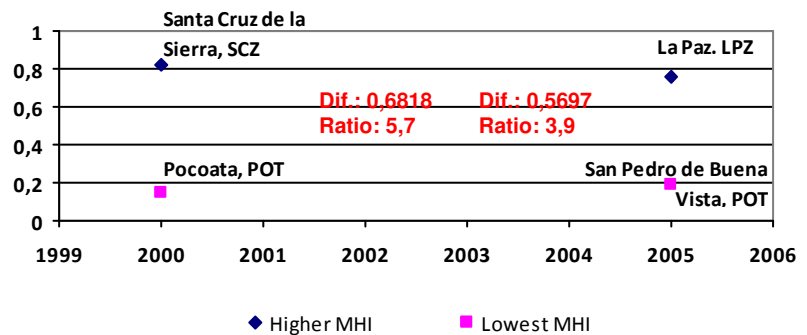
At the regional level an improvement in most the departmental MHI averages were observed as all departmental averages improved except that of Santa Cruz, which was reduced by 0,0107 units. The best improvement was seen in Chuquisaca who experienced an increase in 0,069 units, although it is still low (see Figure 5). In general, the highest score was reduced from 2000 to 2005 (-0,0033), whereas the lowest value was improved (0,0656)
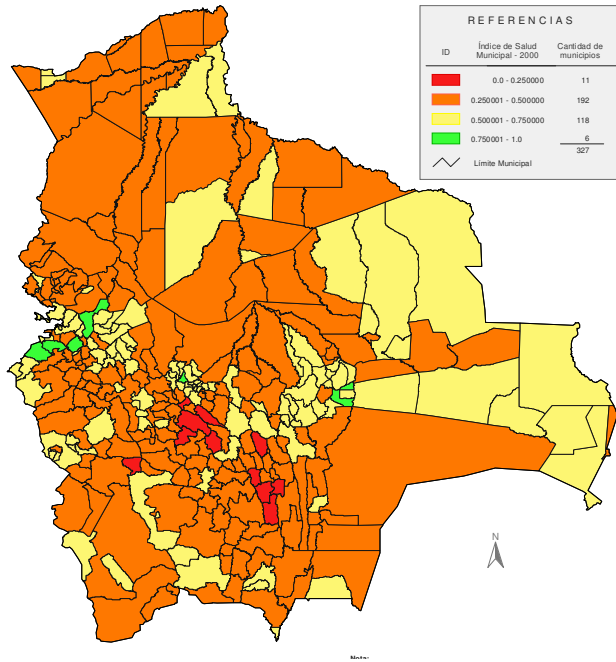
Figure 5. Variation of the Departmental Average of MHI. Bolivia 2000-2005
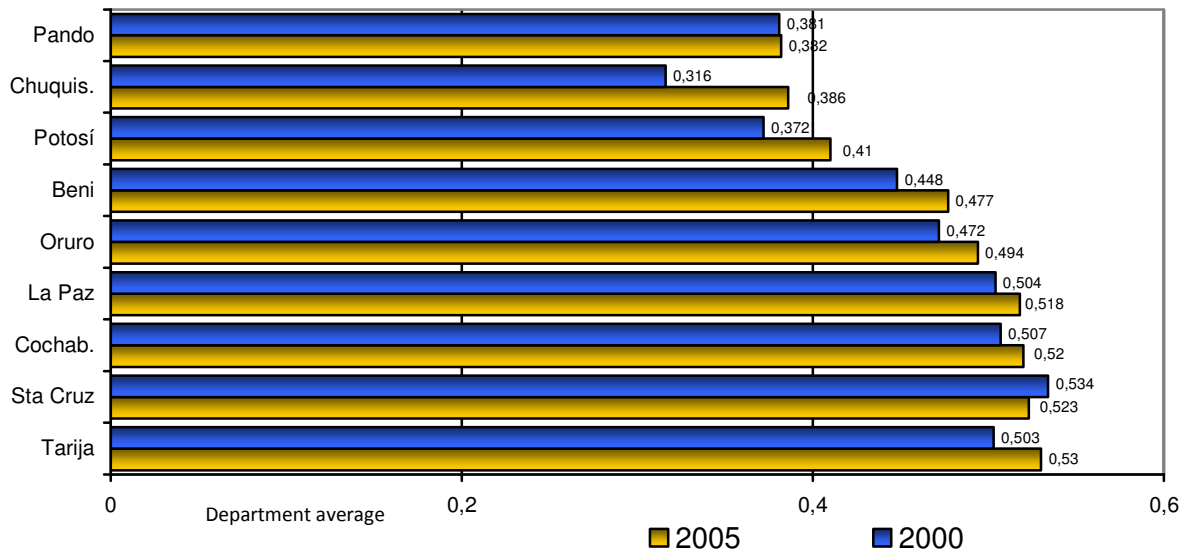
Taking a look to the spatial distribution of the index we can appreciate that the areas of low or very low scores got a significant reduction from 2000 to 2005 (see Figure 6).

Figure 6. Municipal Health Index. Bolivia 2000 y 2005

MHI 2000

At the municipal level, the most significant change was that in 2005 there were no municipalities with very low values of the MHI. Nevertheless the pattern of concentration of municipalities with worse MHI stayed in the region where the municipalities of the north of Potosí converge, occident of Chuquisaca and southeast of Oruro; as well as the regions of the south of La Paz and their frontier with the northwest of Cochabamba.

MHI 2005
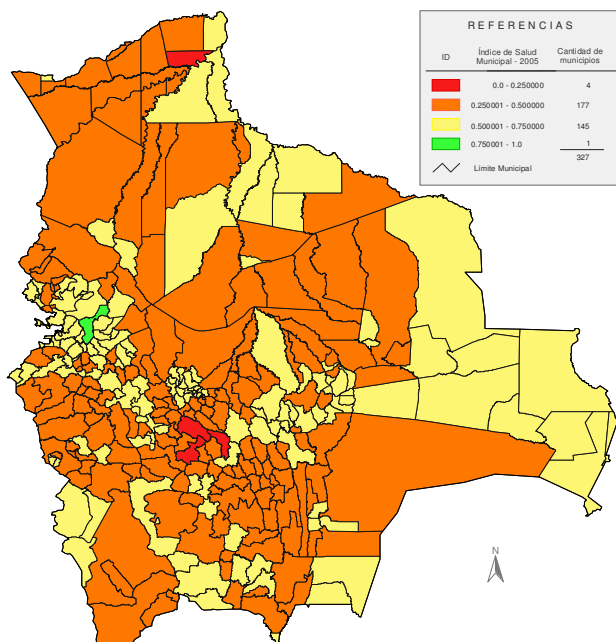
Discussion

Although the measurements of the health situation using synthetic indexes is still in development, their use can provide useful information about the global state of the health improvements and breaches that are yet to be reduced. Since the MHI calculations were done using the same sources of information and the same approaches during the years of 2000 and 2005, we can infer that there have been advances in this period regarding situation of general health. Nevertheless, there still exists a wide range of inequalities between the different regions of the country and an even wider breach among municipalities of Bolivia.

This global improvement could be attributed to the interventions and the implementation of strategies and projects of health in some regions of the country, but these interventions have still not reached to the municipalities and communities that are most vulnerable, such as in the departments of Chuquisaca, Potosí, Oruro and Pando that stay but far from the regions with better global situation of health such as Tarija and Santa Cruz.

The spatial distribution of the HMI is very consistent with the pattern of poverty and human development in Bolivia. It means that is showed a high correlation between the MHI and the level of poverty of the municipalities, the higher level of poverty the lower value of the MHI.

Acknowledgements

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