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Towards a comprehensive measurement of the health system in Latin America: presentation of the multidimensional performance index

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Abstract

An innovative methodology for measuring health system performance in Latin America using a multidimensional approach is presented. The methodology is based on the weighting of four key sub-indices: coverage, quality, socioeconomic health, and population perception, which together form the Multidimensional Performance Index (MDI). The main objective is to provide a comprehensive view of health system performance in the region and to identify potential areas for improvement. The research is aligned with the World Health Organization's (WHO) definitions of health as a holistic state of well-being and recognizes its multidimensional nature. In this framework, the health system is understood as an integral structure of organizations, institutions, and resources dedicated to improving health in general. The proposed methodology includes three main approaches: comparative, predictive, and evaluative, essentially aimed at improving the performance of the health system by facilitating international and national comparisons, predicting future behavior and identifying the variables that influence the main indexes. Finally, the methodology is applied to evaluate the performance of 18 Latin American countries, with a specific comparative analysis in three of them: Colombia, Costa Rica, and Dominican Republic.

Keywords: health; welfare; health statistics; social security; health service; health policy

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Hacia una medición integral del sistema de salud en América Latina: presentación del índice de desempeño multidimensional

Resumen

Se presenta una metodología innovadora para medir el desempeño del sistema de salud en América Latina mediante un enfoque multidimensional. La metodología se basa en la ponderación de cuatro subíndices clave: cobertura, calidad, salud socioeconómica y percepción de la población, que en conjunto conforman el índice de desempeño multidimensional (IDM). El objetivo principal es proporcionar una visión integral del desempeño del sistema de salud en la región e identificar áreas potenciales de mejora. La investigación está alineada con las definiciones de la Organización Mundial de la Salud (OMS), que concibe la salud como un estado de bienestar holístico y reconoce su naturaleza multidimensional. En este marco, el sistema de salud se entiende como una estructura integral que abarca organizaciones, instituciones y recursos dedicados a la mejora de la salud en general. La metodología propuesta abarca tres enfoques principales: comparativo, predictivo y evaluativo. Estos enfoques tienen como objetivo mejorar el desempeño del sistema de salud al facilitar la comparación internacional y nacional, prever el comportamiento futuro e identificar las variables que influyen en los índices principales. Finalmente, la metodología se aplica para evaluar el desempeño de 18 países latinoamericanos, con un análisis comparativo específico en tres países: Colombia, Costa Rica y República Dominicana.

Palabras clave: salud; bienestar; estadísticas sanitarias; seguridad social; servicio de salud; política de la salud

Rumo a uma medição abrangente do sistema de saúde na América Latina: apresentação do índice de desempenho multidimensional

Resumo

É apresentada uma metodologia inovadora para medir o desempenho do sistema de saúde na América Latina usando uma abordagem multidimensional. A metodologia é baseada na ponderação de quatro subíndices principais: cobertura, qualidade, saúde socioeconômica e percepção da população, que formam o Índice de Desempenho Multidimensional. O principal objetivo é fornecer uma visão abrangente do desempenho do sistema de saúde na região e identificar possíveis áreas de melhoria. A pesquisa está alinhada com as definições de

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saúde da Organização Mundial da Saúde (OMS) como um estado holístico de bem-estar e reconhece sua natureza multidimensional. Nessa estrutura, o sistema de saúde é entendido como uma estrutura integral de organizações, instituições e recursos dedicados à melhoria da saúde em geral. A metodologia proposta inclui três abordagens principais: comparativa, preditiva e avaliativa. Essas abordagens têm como objetivo melhorar o desempenho do sistema de saúde, facilitando as comparações internacionais e nacionais, prevendo o comportamento futuro e identificando as variáveis que influenciam os principais índices. Finalmente, a metodologia é aplicada para avaliar o desempenho de 18 países latino-americanos, com uma análise comparativa específica em três deles: Colômbia, Costa Rica e República Dominicana.

Palavras-chave: saúde; bem-estar; estatísticas de saúde; seguridade social; serviço de saúde; política de saúde

Introduction

The right to health encompasses not only the absence of disease, but also the conditions necessary for a dignified life. To guarantee this right, states establish institutions to administer and manage the health system. The World Health Organization (WHO) defines this system as the set of organizations, institutions, and resources that aim to improve the health of the population and that require for their operation adequate financial, human, and material resources to provide treatments and services that meet the needs of the population (Ocampo-Rodríguez et al., 2013). Therefore, although the health system is managed by government entities, it is composed of a series of organizations with the common objective of improving the health of the population.

The collective effort of these organizations shapes the health system and determines its characteristics according to the needs of the population, which vary from country to country and have general characteristics such as coverage, quality of services, socioeconomic factors and public perception. In this sense, it is essential to identify its shortcomings in order to improve its efficiency (Bernal and Gutiérrez, 2012; Rodríguez, 2019). Likewise, recognizing the qualities of an efficient health system makes it possible to replicate them to provide standards that meet the needs of the population.

In this context, on July 22, 1946, the Constitution of the World Health Organization (WHO, 2022) was signed by 61 States, introducing a multidimensional approach to health, defined as a complete state of physical, mental and social well-being, and establishing global health as essential for peace and security. Achieving this requires the cooperation of individuals and states through the adoption of appropriate health and social policies. Under this premise, the concept of health has evolved over time, reflecting different approaches. To provide a comprehensive understanding, two perspectives are explored: historical and evolutionary.

From a historical perspective, health has had three different conceptions: traditional, modern and postmodern (Marín et al., 2020; Serrano et al., 2019; Vergara, 2007). The first moved from the health-disease dichotomy to Hippocratic naturalism, moving away from supernatural perceptions and focusing on the biological study of diseases and the human body. Over time, economic, political, and social aspects and their relationship to health gained importance, giving rise to the modern conception that incorporated health studies into social representations. Postmodern conceptions, in turn, emphasized the dynamic nature of health, integrating biological advances and other knowledge systems and recognizing the need for health to adapt to social agreements about its content.

From an evolutionary perspective, the concept of health initially focused on the health-disease polarity, defined as the absence of disease. Health then came to be understood as a state of normality of organic and psychic functions, i.e. a state of harmony and balance with the organism. This evolution culminated in a concept of health as complete well-being in its physical, psychological, and spiritual aspects.

Based on these concepts, health has adopted an integrative approach that emphasizes the individual's capacity to develop his or her

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personality and functioning. Thus, health is understood as an integral and holistic state in which individuals can experience free and complete development. It thus recognizes the interrelationship with the social environment and emphasizes the importance of an adequate environment, access to appropriate health services, and favorable social and cultural conditions to ensure the integral development of the individual.

The ability to guarantee this comprehensive nature of health depends to a large extent on the social security system, which includes the measures and mechanisms implemented by a State to protect its citizens against various risks. Therefore, social security is a component of a public right that is closely linked to the constitutional principles of each State (Álvarez et al., 2021), whose main objective is to enable people within its jurisdiction to claim their rights in the best way possible, while ensuring the efficiency and effectiveness of its procedures (Bernal and Gutiérrez, 2012).

This study focused on the health aspect of the general social security system, in which the method of financing the system is an essential factor in determining its functioning and characteristics. According to Bernal and Gutiérrez (2012), there have traditionally been three health financing systems: the private, which includes formal or informal insurance arrangements; the public, which depends on resources from the national budget; and finally, the contributory social security systems, which generally receive contributions from individuals, often linked to their employment status.

On the other hand, several studies have analyzed how socioeconomic inequalities can affect the management of health systems. For example, poverty and social marginalization may limit people's access to health services and their ability to meet minimum quality of life needs. This concept is known as the social determinants of health (Avilés, 2017; Buitrago et al., 2023; Fernández et al., 2019; Gil de Miguel and Campuzano, 2014; London et al., 2009; Sinchi, 2020). According to this idea, health promotion is responsible for studying and intervening in these social, environmental and economic conditions to mitigate their impact on public and individual health, as well as the positive determinants of health that contribute to improving people's quality of life (De la Guardia and Ruvalcaba, 2020).

In summary, the analysis and study of the health system has often been approached from economic, social security, inequality, and clinical perspectives. However, these perspectives are often studied in isolation, neglecting the links and influences between them. Consequently, there is a need for an integrative analysis that incorporates multiple variables and perspectives to provide a comprehensive understanding of health system behavior. This holistic approach would provide insight into the complex dynamics of the system, which in turn would lead to more effective policies and interventions. Therefore, it is decided to address this issue from the perspective of system performance.

Some contemporary approaches suggest that performance measurement serves multiple purposes, such as evaluation, monitoring, budgeting, motivation, promotion, celebration, learning, and improvement (Agasisti et al., 2020; Behn, 2003). In this sense, stakeholders can improve accountability and transparency by adopting a holistic approach to performance measurement. Moreover, in the public sector, it allows citizens to evaluate the effectiveness of government and make informed judgments, as well as empowering officials by providing them with the necessary information to improve performance and allocate resources effectively (Carrillo et al., 2021). Therefore, measuring performance allows understanding its behavior, promotes accountability and transparency, facilitates decision-making, and promotes continuous improvement (Behn, 2003; Vera et al., 2022).

Accordingly, a methodology has been developed to measure the performance of the health system in Latin America from a multidimensional perspective, based on an approach that considers the main perspectives of the study of health, through four sub-indices that are integrated into a main tool that has been called the Multidimensional Performance Index (MDI).

Thus, this study not only contributes to a better understanding of the functioning and impact of health systems in Latin America, but also highlights the importance of measuring their performance. By examining the strengths, weaknesses, and characteristics of health

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systems and their operating contexts, the objective is to shed light on how they influence service delivery and impact on the well-being of the population, specifically in terms of coverage, quality, socioeconomic health, and perception.

Based on the information provided, the hypothesis proposed is that the sub-indices that make up the multidimensional performance index can be used to explore the future behavior of health systems, compare systems at the national or regional level, and identify the factors that influence each system.

Methodology

A mixed methodology was used, integrating follow-up techniques such as document review and bibliographic searches in databases such as Dialnet, Scielo and Elsevier, as well as tracking bibliographic similarities between references using Litmaps and searching international and regional statistical repositories of organizations such as ECLAC, WHO, PAHO and Latinobarómetro.

The objective was to select indicators with at least three or more observations in 18 Latin American countries[4] during the period 2011-2019. In cases where data were missing, Multivariate Imputation by Chained Equations (MICE) techniques and sensitivity measures[5] were used to estimate missing values. It was also decided to standardize the data on a scale from 0 to 1, using the min-max method, in order to ensure a uniform scale and guarantee the equal contribution of each indicator.

The analysis included the collection of 30 indicators in different areas, ranging from demographic variables such as total population, to socio-economic variables such as the proportion of people living in poverty, the net enrollment rate in high school, and the employed population. It also included economic aspects such as gross domestic product (GDP), health expenditures, epidemiological indicators (malnutrition rate, incidence of communicable and non-communicable diseases, morbidity rates by specific groups), and coverage of maternal, neonatal, and reproductive health services.

[4] Cuba and Haiti were not included due to lack of information. Neither were Guyana, Suriname and French Guiana.

[5] Relative bias, root mean square error (RMSE), R^2R^2.

Based on these aspects, four additional indicators were created to complement the analysis. These 34 indicators were used to construct four sub-indices representing different dimensions of the health system.

Then, by weighting the four sub-indices using the geometric mean, due to its effectiveness in handling percentages and its lower sensitivity to extreme values than the arithmetic mean, the Multidimensional Performance Index (MDI) was developed, which provides a comprehensive measure of the health system.

In the results section, an evaluative approach to the methodology was applied, analyzing the relationship between the exogenous variables and the MDI through regression models with a 5% ($\alpha = 0{,}05\alpha = 0{,}05$) significance level.

Interpretation of the Multidimensional Performance Index

The methodology is designed in such a way that values close to 1 indicate a high level in the respective dimension, while values close to 0 indicate the opposite.

The first index ($\alpha\alpha$) represents the health coverage of the country's population. Its measurement is based on SDG 3.8.1 on Universal Health Coverage (WHO, 2022), except that *Capacité* is replaced by PCS in the weighting. This provides an overview of health coverage in a country, considering the following variables:

- Insured population (PCS) represents the proportion of the population with some form of health insurance in the country.
- INF: The coverage of infectious diseases in the country.
- NCDs: Coverage of non-communicable diseases, which are chronic conditions that often require long-term treatment and care.
- RMNCH: Coverage of reproductive, maternal, newborn and child health. Focuses on critical areas of women's and children's health.

$$\alpha = (PCS \times INF \times NCD \times RMNCH)^{1/4} \quad (1)$$

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The second index ($\beta\beta$) focuses on modeling the quality of a health system by assessing its capacity to respond to and effectively control adverse health factors, considering the availability of human[6] ($d_s d_s$) and physical[7] ($c_h c_h$) resources. Both are multiplied by the percentage of gross domestic product invested in health ($GTSGTS$). To invert the scale, 1 is subtracted from each negative factor, i.e.:

- Adjusted mortality rate (AMR): the differences in mortality rates between populations of different ages and sexes relative to the crude mortality rate (CMR).
- Undernutrition (SoU): the proportion of the population that does not have sufficient access to nutritious food or regularly consumes inadequate amounts of food.
- Morbidity (IT): The incidence of diseases and health problems affecting the population, such as tuberculosis, malaria, HIV, tropical diseases, and stunted and overweight children.

$$\beta = (1 - TMA)(1 - SoU)(1 - TI) + (d_s GTS) + (c_h GTS) \quad (2)$$

The third index ($\gamma\gamma$) focuses on the health and well-being of the population by incorporating factors related to the social determinants of health. The components are as follows:

- Net secondary school enrollment (Ab): The percentage of the school-age population enrolled at this level.
- Population with health insurance (PCS).
- Labor force participation rate (LFP): The percentage of the working-age population (WAP) that is in the labor force.
- Impact of poverty on health (POB or TBM): The negative impact of poverty on health, considering the population living in poverty and the crude mortality rate.
- Adjusted life expectancy (ALE): the number of years a person can expect to live (LE), bearing in mind the impact of poverty on health.

[6] Summing the available data for four types of professionals: medical, dental, nursing, and pharmacy staff.

[7] Number of hospital beds per thousand inhabitants.

The choice of the net enrolment rate in secondary education instead of the often-used literacy rate is due to the fact that it guarantees a basic education in science, mathematics and social sciences, while the literacy rate considers the population that can read and write after a certain age, but not the fields of knowledge in which they have been educated. On the other hand, it is significant to note that the employment rate does not distinguish between formal and informal employment conditions. Despite these limitations, the rate provides valuable information on the labor market and its possible impact on the health system.

$$\gamma = \frac{1}{4}(\mathrm{Ab} + \mathrm{PCS} + \mathrm{TO} + \mathrm{EVA}) \quad (3)$$

The fourth index ($\delta\delta$) measures the population's perception of health and related issues through the question: What do you consider to be the most important problem in the country? from the Latinobarómetro regional survey, representing 100% of the total population[8]. The relative frequency of responses is analyzed for the following answers: Health Problems ($\mathrm{Fr_s}$ $\mathrm{Fr_s}$), Poverty ($\mathrm{Fr_p Fr_p}$), Crime - Public Safety ($\mathrm{Fr_i}$ $\mathrm{Fr_i}$) and Unemployment - Joblessness ($\mathrm{Fr_d Fr_d}$).

It is important to note that most countries do not have their own public opinion surveys on health, and when they do exist, they are usually not conducted annually; therefore, the Latinobarómetro is the closest available tool for consultation. It is also noteworthy that the percentage of respondents choosing *Health problems* as the most significant issue does not exceed 5%[9]. It is so necessary to include other perceptions related to general well-being.

In the index, the highest weight is given to $\mathrm{Fr_s Fr_s}$, as this is the most direct indicator of the population's perception of health. It also reflects the insured population, whose perceptions may be influenced by availability and accessibility. The inclusion of the three additional perception categories provides a more complete understanding of how the population perceives health. This integration is crucial because health cannot be separated from other aspects of an individual's life (De La Guardia and Ruvalcaba, 2020; Peres et al.,

[8] Except Panama, which is between 98% and 100%.

[9] Except in Brazil, where it is the main problem in most years

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2023). It is worth noting that even if people do not predominantly choose *Health problems*, this does not mean that they do not consider them to be a problem. Rather, they may perceive other issues to be of greater concern.

$$\delta = 0.5 \times (1 - \mathrm{Fr_s}) + 0.2 \times (\mathrm{PCS}) + 0.1 \times \mathrm{Fr_p} + 0.1 \times \mathrm{Fr_i} + 0.1 \times \mathrm{Fr_d} \quad (4)$$

The main index ($\varsigma_n\varsigma_n$) is the health system performance or MDI. It combines the four sub-indices discussed above and weights them equally using the geometric mean to reduce sensitivity to extreme values and maintain relationships of magnitude. A value close to 1 would indicate that the health system performance is optimal, with high coverage, high quality of health services, healthy population and positive public opinion about the system.

$$\varsigma(\alpha,\beta,\gamma,\delta) = (\alpha \times \beta \times \gamma \times \delta)^{1/4} \quad (5)$$

Results

The WDI was used to analyze the performance of 18 countries for the period 2011-2019, which allowed the identification of the country with the highest and lowest performance, as well as the average WDI, as an approximation of the performance of the Latin American region and, consequently, as a threshold to define the best performing countries and those that could improve. In this context, Table 1 shows the simple average WDI of the 18 countries over a nine-year period:

Table 1

Simple average of the Multidimensional Performance Index of the 18 countries (2011-2019)

Country	$E(\varsigma_n)$
Costa Rica	73,43 %
Chile	70,89 %
Uruguay	70,42 %
Colombia	69,05 %
Panamá	63,52 %
Ecuador	63,40 %
Nicaragua	62,82 %
Perú	61,89 %
Argentina	61,62 %
México	61,48 %
Brasil	61,14 %
Latin America	59,04 %
Paraguay	58,05 %
Guatemala	56,44 %
El Salvador	56,31 %
Honduras	52,14 %
Venezuela	51,81 %
Bolivia	46,22 %
Dominican Republic	44,02 %

Note. The yellow color refers to the average for the region; and, the green and red colors are, respectively, the countries above and below the average.

The results showed that the regional average was 59%, which implies a large margin for improvement in the different dimensions of the population health index. The country with the highest MDI was Costa Rica with 73.4%, followed by Chile with 70.9% and Uruguay with 70.4%. Conversely, the Dominican Republic was the country with the lowest score on the index, with 44%, a large percentage difference from Costa Rica. Finally, Colombia was in the group of countries with a medium performance; it was even close to Chile and Uruguay by about two percentage points.

Against this background, it was interesting to compare the WDIs of Costa Rica, Colombia and the Dominican Republic in order to identify the contributions of different variables or factors to their performance and to examine individual trends over the period. However, as in this work it was essential to recognize the need for a multidimensional analysis when assessing the performance of these health systems, it was necessary to show that a single factor analysis was insufficient, even when seeing an aggravating factor common to the region, such as poverty, which acts as a barrier preventing access to essential services and ultimately affects overall well-being (Fernandez et al., 2019).

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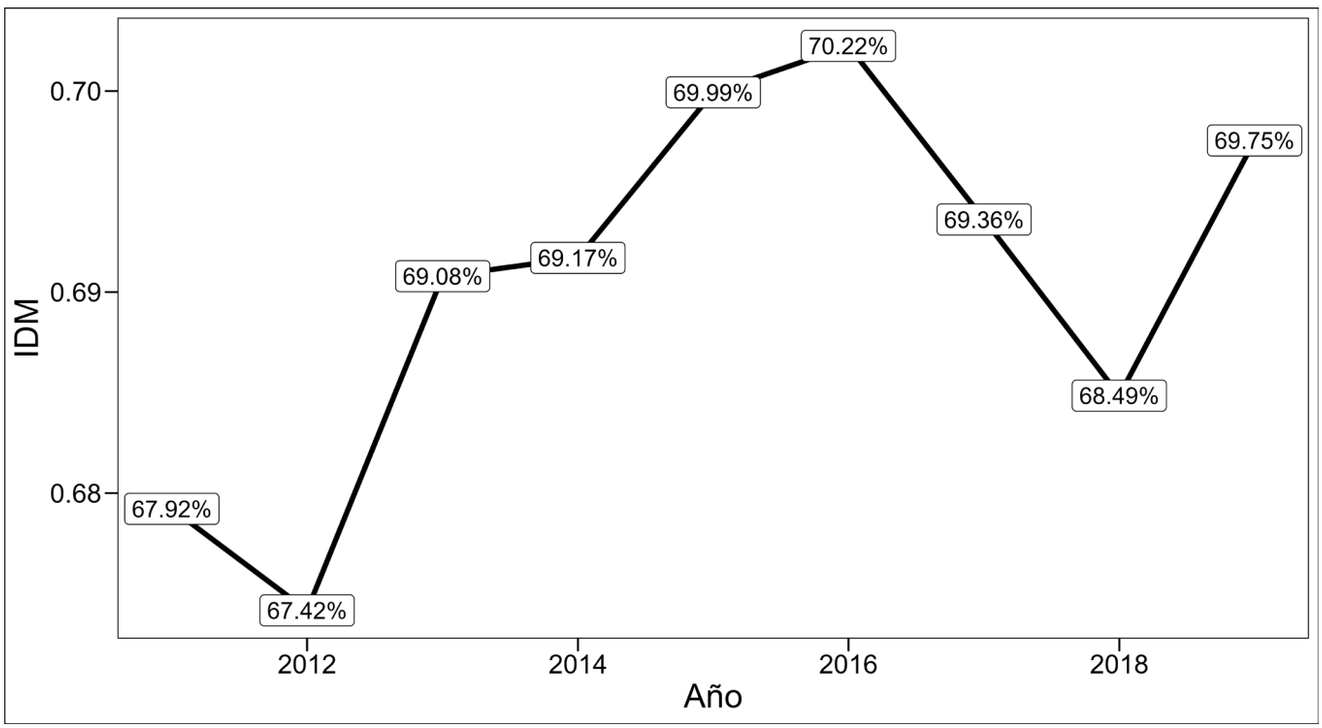
In Colombia, it was vital to highlight the alarming rates of poverty and extreme poverty that prevailed during the first decade of the century. In 2002, 74.6% of the national population lived in such conditions. However, there was a gradual decline throughout the decade, reaching a rate of 57% in 2010. Despite this 17.6% reduction, it was crucial to recognize that more than half of the population remained in conditions of vulnerability. This reality significantly impeded their access to basic services such as basic sanitation, reliable energy and drinking water services, sufficient food, adequate security and quality education. As a result, these challenges made it almost impossible to achieve full well-being, including optimal health outcomes (Avilés, 2017; Buitrago et al., 2023; Fernández et al., 2019).

In Figure 1, the WDI for Colombia showed a performance ranging from 67.4% to 70.2%, with the lowest point in 2012 and the highest point in 2016. It is worth noting that over the years, performance has shown an upward trend relative to the baseline. This suggests that, although the peak performance was not reached in 2019, the level of performance did not decline sufficiently to return to the baseline. This indicates that there has been a sustained improvement in basic service coverage, system quality, socio-economic health and population perceptions in Colombia.

Figure 1

Colombia WDI time series



It is worth noting that Colombia's better performance, despite having a higher proportion of people living in poverty than Latin America, can be explained within the WDI framework, as it integrates multiple dimensions and provides a comprehensive perspective that recognizes the influence of different approaches. In order to identify the factors influencing performance, a regression analysis was carried out to examine the relationship between a set of explanatory variables and the dependent variable.

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Table 2

Regression results using MDI as criterion for Colombia

Predictor	*b*	*b* IC of 95%	*SR^2*	*(>|t|)*	Fit
(Intercept)	0.49*	[0.30, 0.68]		0.00385*	R^2 = 0,967*
Poly (PCS, 2)1	0.02	[-0.00, 0.04]	.11	0.05153	IC 95% [.09,.97]
Poly (PCS, 2)2	-0.01	[-0.02, 0.00]	.07	0.08481	
Ab	0.25	[-0.02, 0.53]	.10	0.06049	
d_s^2	-0.00	[-0.00, 0.00]	.10	0.05862	
GTS	0.07	[-2.03, 2.17]	.00	0.9263	

Note. b represents unstandardized regression weights. SR^2, the squared semi partial correlation. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * indicates p < .05.

The regression model used included four predictor variables together with the intercept, which represents the possible value of the dependent variable if there is no influence from the predictor variables, which was found to be statistically significant. However, three variables had p-values close to 0.05.

An interesting aspect to consider is the joint effect of these variables on the WDI. The coefficients of GTS, Ab and PCS were positive, suggesting that an increase in their magnitudes contributes to an increase in WDI. However, a significant increase in $d_s d_s$ and PCS can lead to a decrease in WDI. This can be explained by the assumption that an excessive increase in the number of insured persons may affect the ability of the system to provide health services. Similarly, a significant increase in the health workforce without the necessary funding and infrastructure to support a larger workforce may have negative consequences.

On the other hand, Ab was found to be beneficial, indicating that there is room for improvement in this area. Finally, the regression model showed a high and significant level of explanatory power: 96.7%, and when adjusted, it explains 91.2% of the variation.

In contrast, Costa Rica did not have such high levels of poverty and extreme poverty in the 2000s. In 2002, for example, the percentage of the population living in these conditions was 33.4%, a figure that fell to 23.1% in 2010. It should be noted that Costa Rica's population living in poverty was lower than the regional average: in 2002, the regional average was 57.5%, while in 2010 it was 40.2% (Economic Commission for Latin America and the Caribbean [ECLAC], 2022).

Figure 2 shows the WDI for Costa Rica, which fluctuated between 74.7% and 72.6%, with the highest point observed in 2011 and the lowest in 2014. It is worth noting that during the period analyzed, the WDI experienced a slight decline of around 1 percentage point compared to the baseline.

To understand the reasons for this decline, it was necessary to examine the four sub-indices. The analysis showed that the quality index decreased by 8% and the perception index by 2%. Despite these declines, both sub-indices were relatively high compared to other Latin American countries. Consequently, the question arises as to which factors can explain the variation in the WDI for Costa Rica, using regression analysis.

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Figure 2

Time series of the WDI for Costa Rica

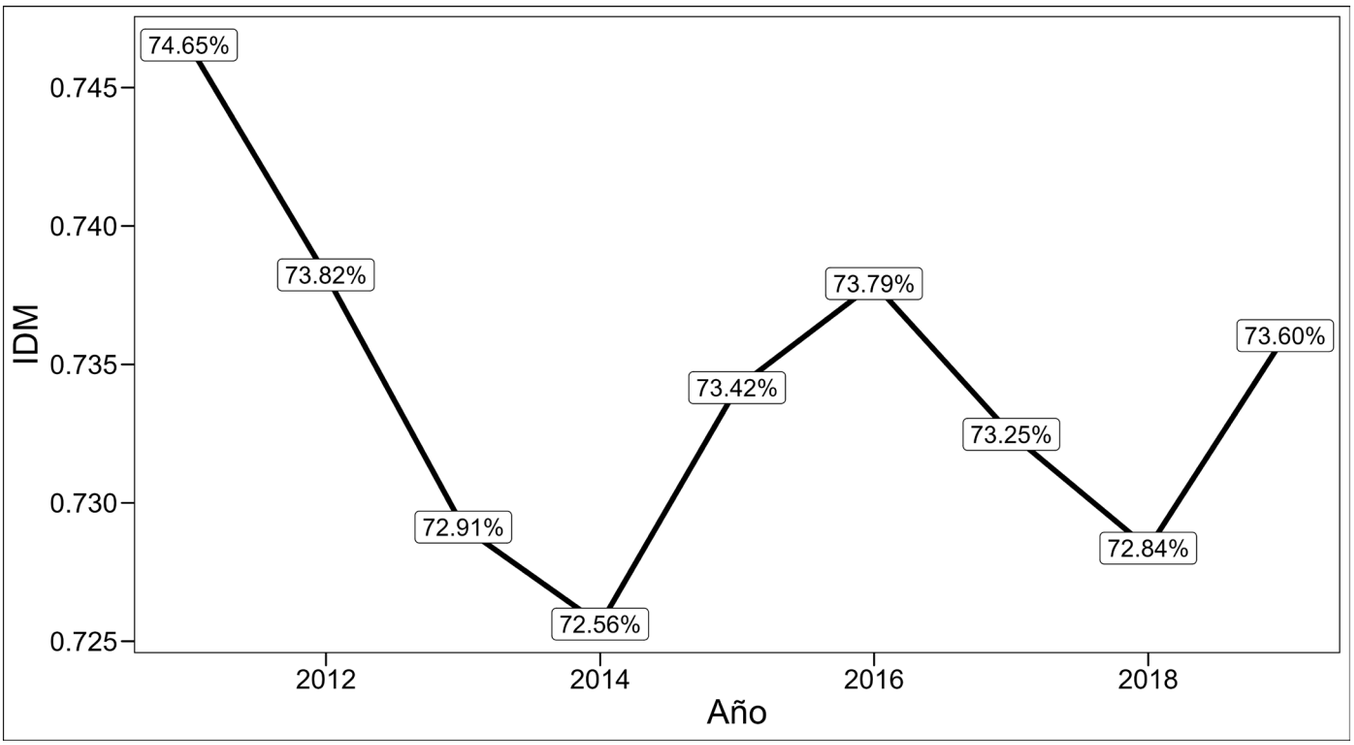

Table 3

Regression results using MDI as a criterion for Costa Rica

Predictor	*b*	*b* IC of 95%	*SR^2*	*(>|t|)*	Fit
(Intercept)	0.21	[-0.03, 0.46]		0.06888	R^2 = 0,953*
EV	0.42*	[0.17, 0.67]	.27	0.00896*	IC del 95 % [.34,.96]
Poly (GTS, 2)1	0.01*	[0.01, 0.02]	.49	0.00296*	
Poly (GTS, 2)2	0.00	[-0.00, 0.01]	.02	0.22656	
NCD	0.32*	[0.15, 0.49]	.33	0.00601*	

Note. b represents unstandardized regression weights. SR^2 signifies the squared semi-partial correlation. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * specifies p < .05.

The regression model for Costa Rica included three significant predictor variables with positive coefficients. To better understand these results, the following explanation was proposed: first, the decline in the fertility rate associated with the ageing of the population had an impact on the health status of the population. It was therefore reasonable to assume that an increase in life expectancy would have a positive impact on the performance of the health system.

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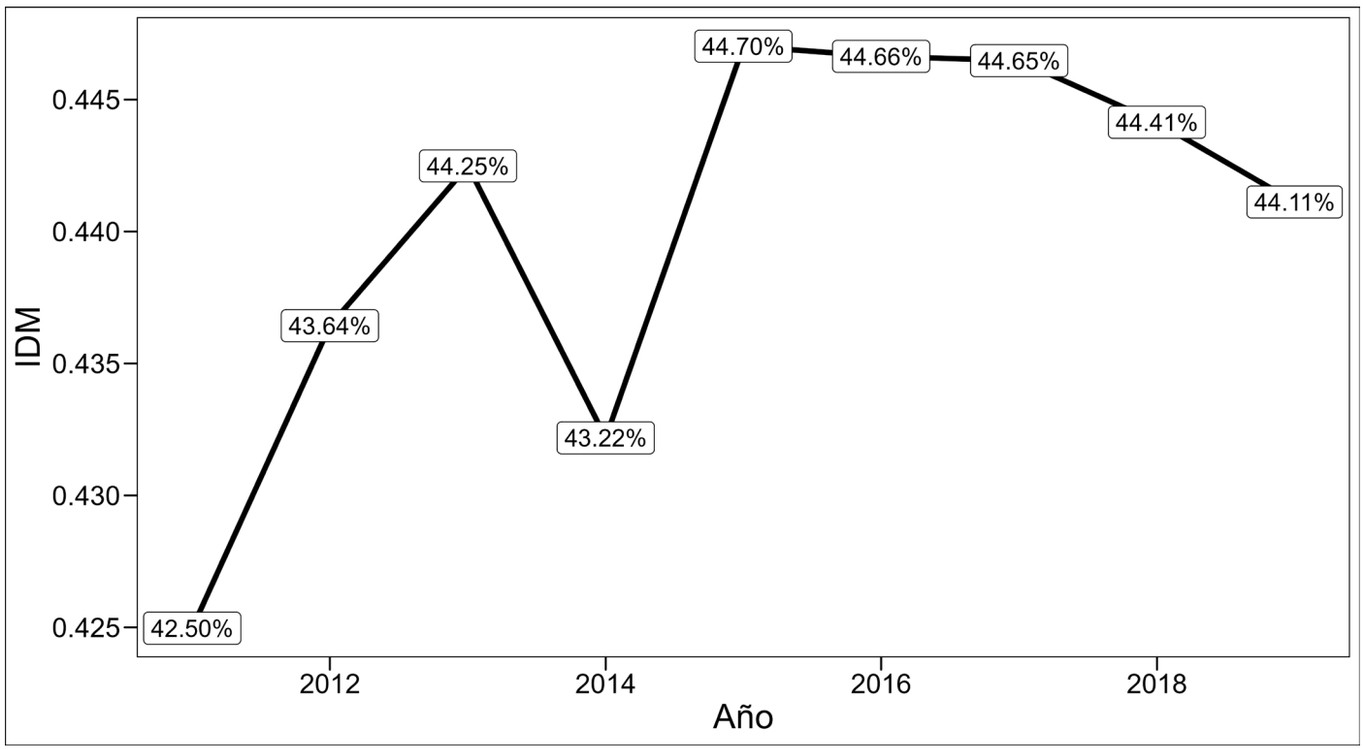
Second, performance was expected to improve as NCD coverage increased, but it was interesting to note that an increase in STG had only a modest impact on performance. Moreover, even when spending increased substantially, the improvement in performance was comparatively less than when spending was lower. This suggests that the management and administration of public resources for health in the country was sufficiently optimized that a significant increase in spending would not necessarily result in an equivalent increase in welfare.

In terms of variation, the regression model explained 95.3% of the total variation and, when adjusted, 90.5% of the variation.

The Dominican Republic experienced a significant increase in the proportion of its population living in poverty and extreme poverty over the period analyzed. In 2002, 45.1% of the population lived in these conditions, a figure lower than that for Latin America, which was 57.5%. By 2010, however, the proportion of the population living in these conditions had increased significantly to 53.2 per cent, compared with the regional average of 40.2 per cent.

Figure 3

Dominican Republic, WDI time series



In the case of the Dominican Republic, the WDI values fluctuated between 42.5% and 44.7%, with a high in 2011 and a low in 2015. However, these fluctuations were relatively small, differing by only a few decimal points. What is worrying is that the peak is around 15 percentage points below the average, indicating a significant divergence with the region. Interestingly, the decline in the population living in poverty between 2011 (50.8%) and 2019 (22.9%) did not correspond to a significant improvement in the WDI. This raises questions about the factors influencing the overall performance.

When analyzing the sub-indices, three of them were in the range of 50% to 74%, indicating a moderate level of performance. Nevertheless, the quality index showed worryingly low values of between 14% and 16%. This was mainly due to the constant lack of observations for two variables: $d_s d_s$ and $c_h c_h$, which required the use of imputation methods. It should be noted that these methods have also been used in other countries without having a significant impact on the sub-indices. In addition, sensitivity tests were carried out for all countries and the results were within

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acceptable limits for all three measures. Therefore, in order to fully understand the cross-country variation in the WDI, further analysis was needed to investigate and explore the factors contributing to these results.

Table 4

Regression results using MDI as the criterion for Dominican Republic

Predictor	***b***	***b IC of 95%***	***SR^2***	***(>|t|)***	***Fit***
(Intercept)	1.23*	[0.32, 2.13]		0.0196*	R^2 = 0,915*
TMA	-0.54*	[-1.03, -0.06]	.20	0.03625*	IC 95% [.05,.93]
Poly (PNS, 2)1	-0.03*	[-0.04, -0.01]	.55	0.00713*	
Poly (PNS, 2)2	-0.00	[-0.01, 0.01]	.03	0.31639	
Log (GTS)	0.12	[-0.13, 0.38]	.04	0.25127	

Note. b represents unstandardized regression weights. SR^2, the squared semi partial correlation. LL and UL, the lower and upper limits of a confidence interval, respectively. * indicates p < .05.

Table 4 shows the regression model with three variables, two of which were statistically significant with p-values less than 0.05. In addition, the intercept term in the model was also found to be significant. A possible explanation for these effects is as follows: an increase in the proportion of the uninsured population implies less access to health services, resulting in a decrease in the overall performance of the health system. The adjusted mortality rate, which is part of the quality index, had a significant negative coefficient, indicating that higher mortality rates were associated with a decrease in the MDI. This provides an explanation for the low values observed in the Quality index, given that the calculation of this indicator does not consider the variables $d_s d_s$ and $c_h c_h$. Finally, the regression model explained 91.5% of the variation in the WDI and, when adjusted, 83% of the variation.

Tests of the statistical assumptions of the regression models were also carried out, including linearity, normality, homoscedasticity, non-autocorrelation and multicollinearity (Gujarati and Porter, 2009; Mendenhall et al., 2010). The results are shown in Table 5.

Table 5

Statistical tests

Country	**Average Residues**	**Durbin-Watson**	**Breusch–Pagan**	**Shapiro–Wilk**	**GVIF**
Acceptance criteria	$n \approx 0$	$1,5 < DL < 2,5$	$p > 0,05$	$p > 0,05$	$GVIF < 5$
Colombia	-5,118667E-20	1,93	0,59	0,275	$poly(PCS, 2) = 1,4928$ $Ab = 1,3378$ $d_s^2 = 1,1972$ $GTS = 2,5605$

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Country	Average Residues	Durbin-Watson	Breusch–Pagan	Shapiro–Wilk	GVIF
Costa Rica	6,024816E-21	2,481	0,54	0,31	EV = 1,225 poly(GTS, 2) = 1,135 NCD = 1,128
Dominican Republic	-3,0116773E-21	2,31	0,20	0,919	poly(GTS, 2) = 3,317

Note. The tests were performed using the R language. The acceptance criteria are established with a confidence level of 95 %.

Discussion

The results of this research have relevant implications for policy-making and resource allocation in the health sector by identifying areas for improvement in the performance of the system, such as the low coverage of health services. The MDI methodology can guide investment strategies to improve accessibility and equity in service delivery, as well as in the infrastructure of the sector, which can have a positive impact on the population's access to primary health care services, not only in terms of cost reduction, but also in reducing the distance to nearby health centers, especially in rural areas, which is often a barrier to accessing the health system, as highlighted by Bran et al. (2020).

Based on the above, the research findings highlight the importance of improving the quality of care and delivery of health services as a determinant of the performance of the system, to address the shortcomings of the infrastructure, as well as the availability of human resources and the rationalization of process management (Álvarez et al., 2021). This reinforces the need to optimize the training of human talent in the health sector and the availability of resources to ensure optimal standards of care in order to effectively reduce mortality, morbidity and malnutrition rates, thereby improving the quality of life of the population.

Challenges are also identified in the implementation of information and communication technologies, in the handling of information, and in the processing of information for databases in the management of health data. This represents an opportunity to improve the efficiency of medical care and the management of clinical information, which could translate into tangible benefits for all actors in the system, such as a reduction in processing time.

However, this must go hand in hand with the strengthening of public health, so that the implementation of public programs and policies can improve the population's perception of the quality of health services and strengthen confidence and legitimacy in the system, thus encouraging greater community participation. In this sense, it is vital to emphasize that the limitations of the study are due to these challenges, which result in a lack of information on some variables and therefore hinder the evaluation of countries such as Cuba and Haiti.

It is clear, consequently, that the study of health system performance is linked to various aspects that may vary depending on the space and time in which they are assessed; it is therefore essential to approach performance measurement in a comprehensive manner, bearing in mind multiple dimensions and determinants in order to promote significant improvements in the well-being of the population.

From this point of view, the Multidimensional Performance Index methodology makes it possible to identify, from a set of different variables and factors, those that can have the greatest impact on the health system of the

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country, region or city concerned, and also to compare different territorial units on the basis of the MDI or the dimensions that make it up.

Conclusions

The initial objective was to develop a methodology that considers the multidimensional nature of health when measuring the performance of systems in Latin America. This objective has been fully achieved through the use of integrative methods, which show that the multidimensional measurement methodology provides relevant information on the behavior of the health system, which in turn supports informed decision-making, monitoring of health indicators and facilitates international comparisons.

In this sense, the research points to the need to study the health system from a multidimensional perspective, with different approaches other than the clinical one. Likewise, it is necessary to study each country in its uniqueness, since it can be affected by different factors, as seen in the regression analyses. These reveal the complexity and diversity of the variables that influence the functioning of these systems, going beyond the cause-and-effect relationship, for example, between poverty or resources and health.

However, it should be noted that it is impossible to capture all of these factors due to the transversal nature of the object of study and the stochastic component, although it is necessary to seek their relationship with other variables; for example, out-of-pocket spending on health services or the technological capacity of clinics and hospitals, while it is true that the limitation lies precisely in the lack of indicators and observations for the region.

The importance of the quality of care, investment in infrastructure, training of human talent, design and implementation of public policies, and implementation of information and communication technologies stand out as fundamental pillars for strengthening health systems in Latin America, and it is therefore imperative that governments and health institutions continue to work on the implementation of policies and actions that address the deficiencies identified by various measurement tools, including the IDM.

In conclusion, the methodology of the Multidimensional Index of Health System Performance for Latin America, although still in a process of improvement, can help ensure a health system with equitable access, quality care and comprehensive coverage, with the goal of improving the health and well-being of the population.

Conflict of interest

The authors of this article declare that they have no competing interests that might affect the reliability of this publication.

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Contribution

Nicolás Rubio García: Statistical data processing, writing materials and methods, and obtaining results. Elaboration of the methodology. Analysis and interpretation of results. Contribute to the bibliographic review and draft the introduction, discussion, and conclusions.

Jairo Alfredo Ortiz Pacheco: Review and analysis of the different bibliographic sources, elaboration of the state of the art and contribution of the introduction, methods, discussion and conclusions.

Andrés Mateo Gómez Franco: Literature review and contribution to the drafting of the introduction, discussion, and conclusions.

All authors participated in the preparation of the manuscript, read it, and approved it.