ORIGINAL ARTICLE

Long-term Estimate of the Number of Doctors in Argentina

Estimación a largo plazo del número de médicos en la Argentina

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ABSTRACT

Background: Knowledge of the number of doctors qualified to practice medicine and its numerical relation with the population to care has strategic importance in order to coordinate healthcare workforce training. To date, there is no information about the expected growth trend of the number of doctors in Argentina for the near future.
Objective: The aim of this study was to estimate the progress of the number of doctors in Argentina over a 20-year period and to relate it, through a dynamic simulation model involving different scenarios, with the number of inhabitants as a demand index.
Methods: A conceptual model was designed to represent the growth of the number of doctors and its relationship with the number of inhabitants. The model was developed in 2007 and prospectively validated with real data in 2014.
Results: The estimation up to 2027 revealed 27% increase in the number of doctors, based on the historical trend of university graduates. The prospective validation at 7 years after simulation initiation showed model underestimation of 13.4%, possibly due to the incorporation of more foreign doctors.
Conclusions: The simulation of different scenarios allowed speculating on strategies to plan the introduction of new doctors to the healthcare system and the admission policies at medical schools, in order to accommodate the current number of professionals according to the country's human development index. The model also specified the necessary redistribution of doctors to reduce inequity between provinces.

Key words: Education, Medical - Health Manpower - Forecasting - Computer Simulation

RESUMEN

Introducción: Conocer la cantidad de médicos habilitados para ejercer y su relación numérica con la población a atender tiene importancia estratégica para coordinar la formación de recursos humanos en salud. Hasta el momento no se cuenta con información sobre las tendencias esperadas para el futuro inmediato con respecto al crecimiento del número de médicos en la Argentina.
Objetivo: Estimar la evolución del número de médicos en la Argentina en un período de 20 años y relacionarlo, a través de un modelo de simulación dinámica con diferentes escenarios, con la cantidad de habitantes como un índice de demanda.
Material y métodos: Se diseñó un modelo conceptual para representar el crecimiento del número de médicos y su relación con la cantidad de habitantes. En 2007 se desarrolló el modelo y en 2014 se validó con los datos reales.
Resultados: La estimación hasta 2027 reveló un crecimiento del 27% de acuerdo con la proyección histórica de egresados universitarios. La validación prospectiva a los 7 años del inicio de la simulación mostró una subestimación del modelo del 13,4%, posiblemente debido a la incorporación de más médicos extranjeros.
Conclusiones: La simulación de distintos escenarios permitió especular sobre las estrategias para planificar la incorporación de nuevos médicos al sistema de salud y las políticas de ingreso a la carrera, a fin de acomodar la actual proporción de profesionales de acuerdo con el índice de desarrollo humano del país. El modelo también precisó la redistribución necesaria de médicos para disminuir la inequidad entre las provincias.

Palabras clave: Educación médica - Recursos humanos en salud - Predicción - Simulación por computador

Abbreviations

HDI	Human development index	**SISA**	Argentine Integrated Healthcare Information System

Rev Argent Cardiol 2016;84:25-30. http://dx.doi.org/10.7775/rac.v84.i1.6957
SEE RELATED ARTICLE: Rev Argent Cardiol 2016;84:5-7. http://dx.doi.org/10.7775/rac.v84.i1.7883

Received: 07/27/2015 - *Accepted:* 09/02/2015

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INTRODUCTION

In order to coordinate healthcare manpower training at the universities with the health requirements of a country, it is necessary to know among other things, the number of doctors authorized to practice medicine and their numerical relationship with the population. (1) Another relevant approach is the correlation between doctor availability and job offer, which also requires close coordination between training institutions and employers. Historically, this relationship has not been well managed in Argentina, although today the magnitude of the problem is acknowledged. (2) No exception to this debate is the issue of the adequate regional distribution of doctors and the expected ratio of general practitioners and specialists. Estimates for Argentina revealed that in 2001 there was approximately one doctor per 300 inhabitants, but this proportion ranged from 90 to 677 according to the geographical area, (3) and in 2012 the estimate was one doctor per 256 inhabitants. (4)

Developed countries tend to make long-term projections in order to estimate the required manpower to meet the future demand resulting from population growth and healthcare reforms. The strategic issue is so important that publications from Academic Medicine of December 2013 and Health Affairs of November 2013 were exclusively devoted to the analysis of the number of doctors needed in the United States for the next 15 years. (5-6)

So far there is not enough information on the expected trends for the immediate future in Argentina, (7) or with validated models to guide mid- and long-term planning policies of medical resources. (4.8) Consequently, the aim of this study was to estimate the growth of the number of doctors in Argentina over a period of 20 years and to relate it to the number of inhabitants as an indicator of demand, using a simulation model with different possible scenarios.

METHODS

A model developed in 2007 to represent the growing number of doctors and their relationship with the number of inhabitants was validated with real data in 2014. This model considered the projected population growth and the increase in the number of doctors according to the trend of the previous 15 years and to the number of graduates per year since 1998. (3) The number of doctors was corrected according to the proportion of active professionals in 2001, the expected annual rate of departures or retirements (cut-off point of 65 years), mortality by age group and professional migration balance. (3, 8-12) The endpoints evaluated were the number of doctors in activity and the ratio of inhabitants per doctor. The simulation provided annual data from 2007 to 2027 and allowed the analysis of different scenarios, namely: number of doctors needed to keep the doctor/population ratio of 1/317 (ratio observed in 2006) and reduction in the number of doctors needed to achieve in 2027, a ratio of 1 doctor per 400 inhabitants [recommended ratio based on the Human Development Index (HDI) of the country. (13) In order to obtain an international standard of comparison, the relationship between HDI and the number of doctors per 1000 inhabitants for all countries with mid and high HDI (index >0.7) was plotted. Additionally, restricting the admission to study medicine necessary to meet the demands of different scenarios was analyzed. Finally, an optimization analysis was performed to estimate the number of new doctors each province should incorporate or exclude in a span of 20 years to reach a doctor/inhabitant ratio of 1/317 (2006 basis).

Statistical analysis

The STELLA® Research 5.1.1 dynamic simulation software was used to implement the model. Stochastic simulations were performed using the average value and the historical variable variation. To validate the model, the simulation estimated results until 2014 were compared with those reported by the Argentine Integrated Healthcare Information System (SISA). (4, 14)

SPSS Statistics 17.0 software package was used for statistical analysis and the values obtained in the simulation were expressed as mean and standard deviation (SD) or 95% confidence intervals (95% CI), or as percentages. Distribution normality was analyzed with the Kolmogorov-Smirnov goodness of fit test. The nonlinear correlation between HDI and the number of doctors per 1000 inhabitants was calculated with the determination coefficient R^2.

RESULTS

Figure 1A shows the ratio between HDI and the number of doctors per 1000 inhabitants across all countries, along with its nonlinear adjustment function (R^2=0.580, $y=10.6x^2-6.8x+0.97$). Figure 1B shows only results for countries with mid and high HDI. Based on the adjustment function, an ideal relationship of 2.4 doctors per 1000 inhabitants was determined for Argentina, i.e. a total of 98,000 doctors, or 1 per 417 inhabitants.

Scenario 1: After 100 simulations the evolution of the total number of doctors in activity was evaluated until 2027. The estimated number of doctors increased from 120,595 in 2007 to 153,806 (95% CI 153,237 to 154,375) in 2027, corresponding to an absolute increase of 27%. The doctor/inhabitant ratio dropped from 1/371 to 1/217 (95% CI 1/270-1/272) in the same period. Figure 2 plots the simulation trajectory compared with the total number of doctors, according to data provided by SISA in 2014. Up to that year, the simulation underestimated the number of doctors by 13.4%, according to the observed value. Since the simulation also underestimated the immigration of foreign doctors in this period, when the latter number of doctors was subtracted from the total, the underestimation of doctors was reduced to 5.4%. The simulation trajectory compared with the number of inhabitants per doctor ratio according to 2014 SISA data is plotted in Figure 3. Up to that year, the simulation estimated the existence of 1 doctor per 287 inhabitants, while the observed values were 1 doctor per 269 inhabitants. This difference disappeared when the group of foreign doctors was excluded.

Scenario 2: The evolution of the necessary number of doctors to maintain a medical/inhabitant ratio of about 1/317 (2006 basis) was estimated after 100

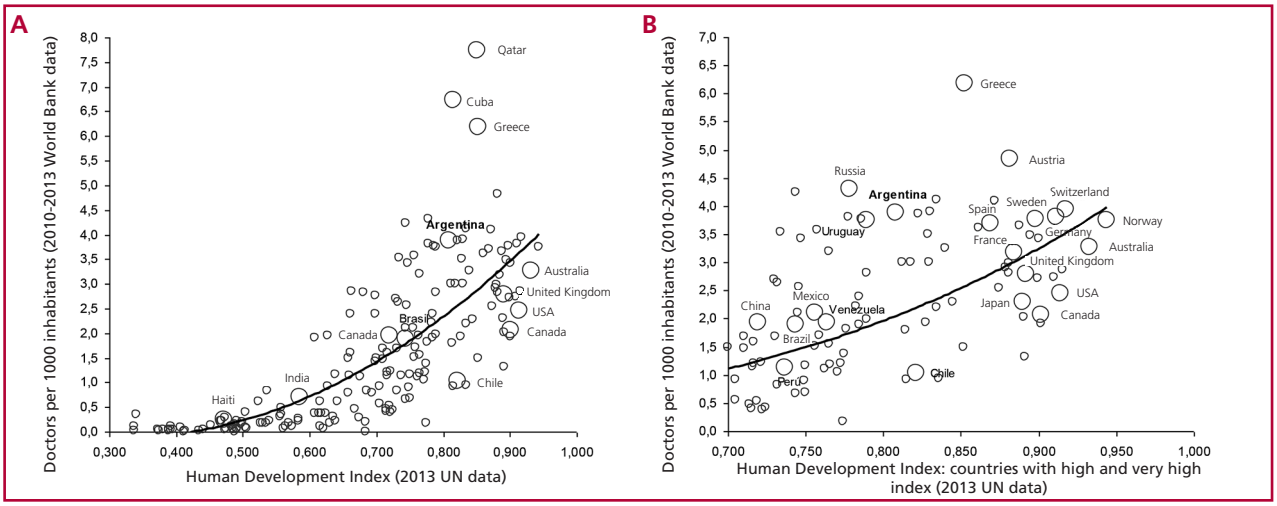

Fig. 1. A. Ratio of human development index and number of doctors per 1000 inhabitants per country. **B.** The same ratio only in countries with mid and high index (index >0.7).

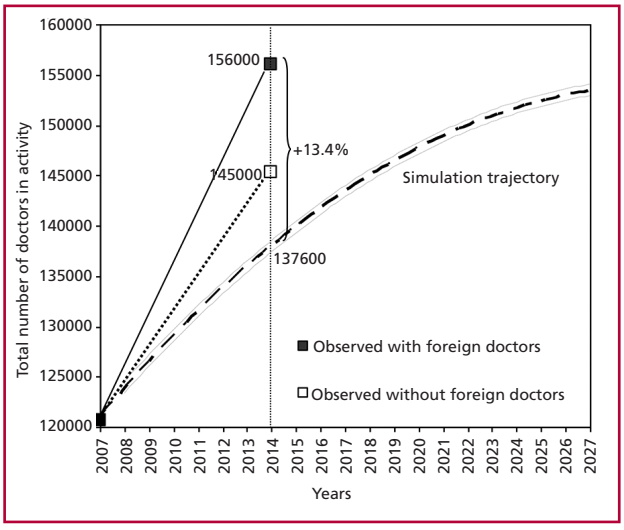

Fig. 2. Estimated evolution of the number of doctors in Argentina until 2027 and comparison with real data observed in 2014. The simulation trajectory is shown with its confidence band. The observed data do not necessarily follow a linear trajectory between 2007 and 2014 because intermediate values were not available. Note that the value on the y-axis does not start at zero, so that differences appear to be increased.

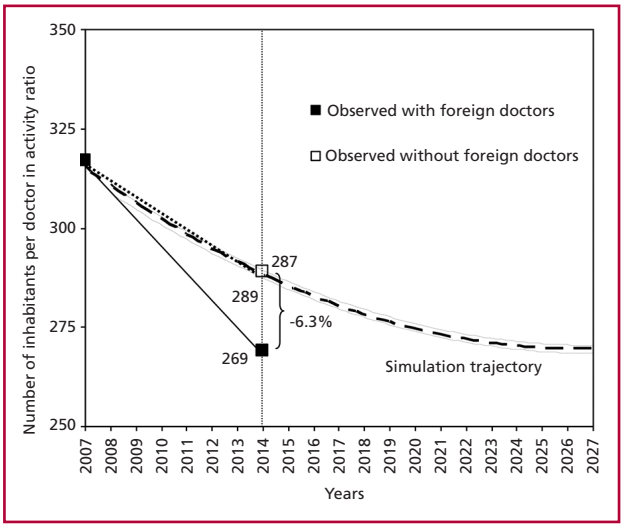

Fig. 3. Estimated number of inhabitants per doctor ratio in Argentina until 2027 and comparison with actual data observed in 2014. The simulation trajectory is shown with its confidence band. The observed data do not necessarily follow a linear trajectory between 2007 and 2014 because intermediate values were not available. Note that the value on the y-axis does not start at zero, so that the differences appear to be increased.

simulations. This situation occurred when the growth was subjected to a restriction which reduced the number of new doctors in about 30% throughout the simulation. In this case, the estimated number of practicing doctors increased from 120,595 in 2007 to 128,186 (95% CI 127,871 to 128,501) in 2027, corresponding to an absolute increase of 6.3%. With this restriction, the doctor/inhabitant ratio increased slightly up to 1/325 (95% CI 1/324-1/326) in the same period.

Scenario 3: When the simulation evolution was evaluated to estimate the required number of doctors to achieve in 2027 a doctor/inhabitant ratio of 1/400 (ratio recommended based on the 2005 HDI=0.758), we observed that it was necessary to reduce the number of new doctors in about 60%. In this case, the estimated number of active doctors decreased from 120,595 in 2007 to 102,415 (95% CI 102,277-102,556) in 2027, corresponding to an absolute decrease of 15%. With this restriction and according to the objective of this simulation, the doctor/inhabitant ratio increased to 1/407 (95%CI 1/406-1/408) in the same period.

Scenarios 2 and 3 analyzed the restriction levels for the incorporation of new doctors to the system, but did not consider what should be the limit or quota

for admission to medical school. After the simulation, we observed that in the case of scenario 2 it would require to reduce the average number of admissions across the country to 45% (from 11,400 to 5,100 students) to maintain in 2027 a doctor/inhabitant ratio of about 1/317 (2006 basis). In the case of scenario 3, the complete elimination of new student enrolment from 2008 to 2020 was needed to achieve in 2027 a doctor/inhabitant ratio of 1/400.

Finally, Figure 4 shows the estimated number of new doctors that each province should incorporate or exclude in a period of 20 years to reach a doctor/inhabitant ratio of 1/317 (2006 basis). Specifically, Buenos Aires and Córdoba should reduce the current number of active doctors by 6% and 11%, respectively.

DISCUSSION

The simulation conducted in 2007 to estimate the number of doctors in Argentina for the next 20 years allowed the analysis of the potential growth of that number according to the different scenarios in which the enrolment of new professionals to the system was maintained or restricted. Based on the unrestricted growth rate of the previous 15 years, the simulation until 2027 revealed that the increase in the number of doctors could reach 27%, with the consequent change in the doctor/inhabitant ratio. On the other hand, the necessary restrictions for the graduation of new doctors from the Schools of Medicine should be 30 % and 60%, respectively, to maintain the doctor/inhabitant ratio of 1/317, or to correct it to 1/400, which is the recommended ratio according to the country's HDI.

Fig. 4. New doctors needed between 2007 and 2027 to optimize the ratio of one doctor per 317 inhabitants in each Argentine province.

Model validation with data obtained in 2014 showed that the simulation underestimated by 13.4% the number of doctors for that year. This error may have occurred because the model did not adequately consider net migration of professionals between 2007 and 2014 (less migration and increased immigration from Latin American countries). Thus, the SISA registry reported that out of 156,000 active doctors in 2014, more than 7% were foreigners.

The approach of these hypothetical scenarios was based on the analysis of different degrees of restriction on the enrolment of new doctors to the healthcare system since 2007. However, considering that the new professionals to be added in the upcoming years are already in their formative undergraduate stage, any proposed admission restriction to the profession should consider that the flow of new doctors is already determined and will remain constant for the next 7 or 8 years as those who are already studying medicine graduate. The simulation that considered this delay showed that to achieve the goal of maintaining in 2027 the same doctor/inhabitant ratio of 2007, the number of students who entered the University after 2008 should be restricted by about 50%. On the other hand, to reach a doctor/inhabitant ratio of 1/400, it would be necessary to eliminate the complete enrolment of new students for 13 years. It is worth noting that the purpose of this work was not to propose a specific policy to regulate the number of doctors, but to provide the strategic information needed for decision-making on the provision of human resources.

In general, all Latin American countries show persistent disparity in the structure and composition of the healthcare workforce. Inadequate geographical distribution of professionals between urban and rural areas, and even between provinces and states as well as the disproportion between general practitioners and specialists, and the imbalance in the doctor/nurse ratio are a common feature in the region. (15) In the case of Argentina, the number of faculties or schools of medicine has tripled in the last 25 years and this growth has taken place almost exclusively at the expense of the private sector. Almost 60% of medical schools are private projects, although its student population reaches only 10% of the total enrolment. (15-16) On the other hand, medical school graduates increased 13.4% between 1998 and 2002. (16)

In addition, the analysis by jurisdiction shows the existing distortion in the geographic distribution of doctors. Thus, the City of Buenos Aires and its suburbs concentrate 55% of the total population of doc-

tors. (8) This concentration depends on the greater potential for occupational inclusion and professional development in specialization and training areas.

According to the scenarios proposed in the various simulations, a plausible target to achieve a slowdown in the growth of the population of doctors in Argentina could be to maintain the current doctor/inhabitant ratio, but with a better distribution throughout the country. Simulations performed in each province showed how the incorporation flow of new doctors to each healthcare system should be managed, although in this case the required profile of specialized professionals was not determined. The necessary redistribution of doctors throughout the country can only take place through local promotion policies and incentives, which will help to reverse the situation and ensure quality care for health problems. This framework should aim to encourage the enrolment of doctors from different specialties in underserved areas with the implementation of economic incentives, training scholarships and grants. (16-17)

The academic autonomy of universities that promote the development of human resources is one of the main strategies to ensure the continuity of educational projects beyond the political situation of a country. But in the case of the health area, this autonomy includes the responsibility to coordinate its actions according to the availability of professionals, the job offer and the country's sanitary needs.

For years Argentina has maintained a much larger number of doctors in activity than that observed in other countries with similar or higher HDI. When comparing the number of doctors per capita with some neighboring countries with similar HDI, such as Chile and Brazil, Argentina significantly surpasses the number of professionals. Likewise, our country also outnumbers the ratio of doctors per capita, compared with other more developed countries like England and Canada. The same relationship is observed with Japan, South Korea and Hong Kong which have a very low number of doctors per inhabitant compared with similar Western countries, despite a high human development level. (18)

This situation demonstrates the need to analyze human resources development policies, specially the regulation required for an eventual growth slowdown in the number of doctors, so that a balance can be found in the composition of healthcare teams. (19)

One of the study limitations is that the simulation strategies used to estimate the long-term number of doctors clearly depend on the validity of the data supplied by the model. Furthermore, the model was developed according to schemes already known in the field of simulation to determine the population growth, (20) and obviously the results can only be validated prospectively. This simulation was originally made in 2007 and could be validated with a first cut-off point in 2014. The data at the beginning of the simulation were based on different sources. Firstly, the information collected by the Ministry of Education provided the professional staff from newly enrolled students and graduate doctors; secondly, the quantitative information from the National Population Census 2001, which processed for the first time data on the number of professionals and its distribution by gender and age according to the jurisdiction; and finally, the National Registry of Health Resources and Services (1980-1998) that gave information of thirteen provinces. (3, 7-12) Abramzón (3, 8) has for years processed census data to estimate the number of doctors across the country. These resulted from adjusting medical graduate data provided by the Ministry of Education to the corresponding mortality and retirement indexes. These estimates used, in general, a fixed annual retirement rate of 0.5%. In our models, however, the number of doctors leaving the activity was calculated according to the progression over time of the distribution by age group obtained from the National Census, with a cut-off point of 65 years, at which time doctors generally retire from public services. If we consider that most professionals continue with their private activity until an older age, the simulation cut-off point chosen may underestimate the total number of doctors in activity for each period.

CONCLUSIONS

The long-term estimate of the number of doctors in Argentina revealed a steady increase in the number of professionals according to the unrestricted projection of the historical rate of university graduates. Prospective validation at 7 years from simulation initiation showed an underestimation of the model close to 13%, possibly due to the inclusion of more than expected foreign doctors.

The implementation of different scenarios through computer simulation allowed speculating on different strategies to plan the number of new doctors to be incorporated to the healthcare system and the medical school admission policies to accommodate the current number of professionals according to the country's HDI. The model also described the necessary redistribution of doctors across the country in order to reduce inequality among provinces. The data obtained are intended to serve as a basis to plan medical human resources in the country, and in turn, to provide strategic information to implement suitable measures within the framework of university autonomy policies.

Conflicts of interest

None declared
(See author´s conflicts of interest forms in the web / Supplementary Material)

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