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Original Article

Doctors for the people? The problematic distribution of rural service doctors in Ecuador

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Abstract

Primary health care is at the core of health systems that aim to ensure equitable health outcomes. With an estimated 36% of rural population, Ecuador has a service year programme (created in 1970) for recently graduated doctors to provide primary care services in rural and remote communities. However, little has been done to monitor or evaluate the programme since its inception. The aim of this study was to assess Ecuador's rural medical service implementation with a focus on equitable distribution of doctors across the country. For this purpose, we analysed the distribution of all doctors, including rural service doctors, in health-care facilities across rural and remote areas of Ecuador in the public sector at the canton level for 2015 and 2019, by level of care (primary, secondary and tertiary). We used publicly available data from the Ministry of Public Health, the Ecuadorian Institute of Social Security and the Peasant Social Security. Our analyses show that two of every three rural service doctors are concentrated at the secondary level, while almost one in five rural service doctors, at the tertiary level. Moreover, cantons concentrating most rural service doctors were in the country's major urban centres (Quito, Guayaquil, Cuenca). To our knowledge, this is the first quantitative assessment of the mandatory rural service year in Ecuador in its five-decade existence. We provide evidence of gaps and inequities impacting rural communities and present decision makers with a methodology for placement, monitoring and support of the rural service doctors programme, provided that legal and programmatic reforms come into place. Changing the programme's approach would be more likely to fulfill the intended goals of rural service and contribute to strengthening primary health care.

Keywords: Primary health care, rural health, needs, inequality, health facilities, physicians, health services, personnel

Key messages

- There are clear distortions and disparities in the distribution of rural service doctors in Ecuador, with some being assigned to cantons without rural population and cantons with rural population lacking doctors in general.
- The high number of rural service doctors working in hospitals in urban areas points towards the need to find the right incentives for doctors to work in rural and remote areas.
- Optimally, distribution should be based on an improved categorization of urban and rural areas in the country, an objective assessment of travel distance and conditions, and timely data on human resources based on payroll information.
- A paradigm shift is needed so that rural and remote areas are not seen just as 'training grounds' for new medical doctors, but a professional development opportunity, concurrently with a reform in regulations to guarantee this.

Introduction

Primary health care (PHC) is at the core of health systems that aim to ensure equitable health outcomes, by focusing on people's needs and preferences as early and as close as possible to people's everyday environments (WHO, 2018). Following this principle, primary care providers should be distributed equitably across a region or country, but on the ground, reality varies and is particularly challenging for rural communities. A long-standing suggestion for the Latin American region, and elsewhere, has been to create rural health corps (Cavender and Albán, 1998; Ugalde and Homedes, 2008; Torres *et al.*, 2020) to consolidate human health resources, allowing us to strengthen the work of local teams and improve their performance at the primary care level. Such a strategy could help rural health care into becoming one of the main pillars of integrated networks in Ecuador, as outlined in the new Regional Compact on Primary Health Care for Universal Health (PAHO, 2019).

Ecuador has a largely fragmented and segmented health-care system, consisting of both private and public health providers, and is heavily dependent on individual's ability to

pay for services or follow-up care; consequently, access to health care varies greatly by socio-economic status, gender and urban/rural residency. The public health sector serves a vast majority of the Ecuadorian population in a system split between (1) health-care services for the uninsured, provided by the Ministry of Public Health (MoH) at the primary, secondary and tertiary levels, and (2) health-care services for the publicly insured, provided by the Ecuadorian Institute of Social Security (IESS), largely at the secondary and tertiary levels for adult workers and their families and rural peasants. In addition, research shows that there is a disconnect between the administrative and operational branches of health-care provision (Ortiz-Prado *et al.*, 2019). In 2014, as Ecuador's government health funding gradually began to decline, poverty and inequality begun to see an increase in the country. The poverty rate in rural and peri-urban areas rose 6% points between 2014 and 2017, with 58% of the poor living in rural areas and 70% of these, in extreme poverty. In contrast to only 15% of urban indigenous households living in poverty, almost 60% of rural indigenous households live in poverty (World Bank, 2018). Further highlighting these inequities, the rate of excess deaths in indigenous Ecuadorians in 2020, at the peak of the coronavirus disease 2019 (COVID-19) pandemic, far surpassed the excess death rate in the majority ethnic group (i.e. *mestizos*; Cuéllar *et al.*, 2021). Today, similar to the rest of the region, Ecuador is undergoing a severe economic crisis (ECLAC, 2021). In this context, the sustainability of Ecuadorian health-care services confronts fundamental challenges.

In Ecuador, PHC is largely provided by the MoH; there were only 653 IESS facilities (dispensaries of the Peasant Social Security subsystem) compared to 1980 MoH facilities in 2019. Since 1970, the backbone of PHC in rural Ecuador has been the medical service year, which is a requirement for professional qualification and, according to the law, may not be completed at the secondary or tertiary level of care (MSP, 2006). However, the strategy of filling personnel gaps with temporary (and fairly inexperienced, since they are fresh out of medical school) staff impedes establishing longer-term capabilities that may lead to improved health outcomes (Frehywot *et al.*, 2010). Furthermore, across the MoH system, career pathways for all health personnel are neither formalized nor made clear in regulations. This disconnect between career pathways and needs of the Ecuadorian population can make the system vulnerable to decisions based on rather personal, political or bureaucratic leverage. The consequences can be more critical for rural areas, usually isolated from other health/social services and support systems. Reports on the difficulties faced by rural service doctors and the inequities in rural health abound (Troya, 2016; Karáth, 2022). Ecuador is divided into 221 cantons (municipalities), which are secondary political administrative units including urban and rural areas that allow us to compare within and between provinces, which are larger units ($n = 24$). Cantons vary in physical and population size. With an estimated 36% of rural population (INEC, 2022a), and some cantons having more than 80% of rural population, it is imperative to consider changes in the conception, organization and functioning of Ecuador's rural health workforce.

Between 2007 and 2014, the Ecuadorian public health sector experienced a significant increase in investments, including in human resources (Torres and López-Cevallos, 2018), which, in turn, seemed to improve the coverage and quality of rural health care, gaining community trust and strengthening the right to free health care (Eckhardt *et al.*, 2019). Unfortunately, during this period, emphasis was placed on curative rather than preventive approaches, and over time, the system has become inefficient, among other reasons, due to poor administration and corruption (Izquierdo *et al.*, 2018; Torres and López-Cevallos, 2018). Continuing turnover of high- and mid-level authorities, and mass layoffs of health workers and budget restrictions in recent years, has further weakened the Ecuadorian health system.

Fifty years of rural health care in Ecuador

While the MoH rural primary care in Ecuador has focused on serving the uninsured, limited coverage by IESS of smallholder farmers and artisanal fishers through its Peasant Social Security (SSC, for its acronym in Spanish, established in 1968) means that the MoH filled the gaps of public insurance in rural and remote areas. Some local initiatives with the support of the MoH were possible through foreign funding channelled by international and local non-governmental organizations, including religious orders, in places such as remote coastal (Eloy Alfaro and Esmeraldas; Guderian *et al.*, 1997), tropical rainforest (Nuevo Rocafuerte, Orellana; Aguirre, 2016) and subtropical (Pedro Vicente Maldonado, Pichincha; Gaus *et al.*, 2008) communities.

The main goal of the MoH rural service programme has been to distribute human resources in a more equitable manner to provide health care in remote and rural areas (MSP, 1970). As a way to provide coverage in the short term until longer-term solutions were implemented, the mandatory rural service in Ecuador has continued over the years in a state of inertia. The first official rules and regulations for the programme were published in 1991 (21 years after the programme's inception) and have remained largely unchanged for more than three decades (MSP, 2019). Far from its promising beginnings, there is no evidence that the programme has been linked to a national health plan or health career pathway, and to our knowledge, no evaluations of its performance have been conducted apart from the one carried out in 1982 (Suárez-Torres *et al.*, 1982).

Ecuador's mandatory rural service year was established as a requirement for professional practice, similar to other initiatives that continue to this day in countries around the world (Frehywot *et al.*, 2010). The obligations and duties are limited to complying with a mandatory requirement for professional practice (MSP, 2019), at least in principle, serving rural areas. Since 2001, the programme expanded from medical doctors to include nurses, dentists, obstetricians and nutritionists and provides a salary and a travelling bonus, although not a compensation for additional administrative responsibilities (e.g. acting as a director of a health facility). The base salary of $986 per month for doctors was equivalent to 2.80 and 2.5 times the minimum wage in 2015 and 2019, respectively. Together with dentists, doctors earn the highest for all the professions.

Supported primarily by mandatory rural service health personnel, primary care had a significant boost at the end of the last century. The Family and Community Health Plan added ~1500 new doctors and other professionals between 1988 and 1992 (Sacoto, 2002) and synergized efforts with

the mandatory service year programme to establish small primary care facilities in Ecuador. In 2012, the MoH established a Comprehensive Health Care Model (MAIS, in Spanish) by which primary health care technicians (TAPS, in Spanish) are expected to work in extramural health prevention and promotion, and the identification of potential risks (MSP, 2012) with a family and community, and considering an intercultural approach focusing on 'populations with problems of access to health services' (MSP, 2012). However, there is limited evidence that its execution has been guided by PHC goals. In 2017, the MoH created a variation—the 'neighbourhood doctor' [Médico del Barrio]—to 'reorganize the provision of services beginning at the primary level' focusing on health-care services for at-risk populations (i.e. disabled, malnourished children, pregnant women and elderly people with noncommunicable diseases; MSP, 2017).

Planning and accountability in the distribution of health personnel in Ecuador are challenging by several different factors. As the trend to urbanization continues, the geographic classification for rural health provision does not reflect the country's reality. Parishes with seemingly rural characteristics are classified as urban, while parishes that are part of the suburban area of metropolitan cities are classified as rural. Also, there are loopholes in rural health personnel distribution that formally and informally allow selective relocation (MSP, 2019). First, doctors have preference to choose their location because of their grades, health conditions, pregnancy, parental and marital status. Second, doctors may delay fulfilling the requirement until completing a higher degree (specialization or master's degree), upon which they may work at a hospital instead of a primary-level health facility.

Impact on rural health provision

In the limited number of studies available, the experience of the mandatory medical service year in Ecuador is reported as rewarding, but has serious limitations when it comes to improving the health status of rural communities (Cavender and Albán, 1998), especially due to gaps in resources within health-care facilities (e.g. medical supplies) and the community (e.g. potable water and sanitation; Torres and López-Cevallos, 2018), which condition the persistence of preventable pathologies such as infectious and vector-borne diseases. Furthermore, in a health system such as Ecuador's, that prioritized hospital hyper-specialization in the early 2000s, primary care continues to be relegated to a secondary role (Torres and López-Cevallos, 2018).

One of the few studies on the provision of health services in Ecuador shows that, despite the concentration of health providers in urban areas, the presence of health personnel (except doctors) in rural public units increased the probability of using health services (López-Cevallos *et al.*, 2014). An exceptional evaluation of the national rural health plan in 1982 shows that, at least in its beginnings, a positive correlation was found between mandatory rural medical service and the improvement of morbidity and mortality indicators in Ecuador (Suárez-Torres *et al.*, 1982). Adequate distribution of primary care–level facilities and skilled health workers is essential to health system planning and evaluation; therefore, it is crucial to determine how doctors are distributed in rural areas at the primary care level and propose mechanisms for a more evidence-informed distribution of health-care providers across the country.

To the best of our knowledge, the latest report of the medical service year by the MoH does not include an analysis of personnel distribution, which could have shed light on whether the programme fulfils its purported objective to improve health-care coverage (MSP, 2023). Also, we have not found any assessment of health-care services availability in Ecuador after the 2015 MoH-mandated nationwide reform in the number and types of health-care facilities, ordering that some close or open and others change in category (MSP, 2015). In this context, the present study explored the distribution of rural service doctors in primary care facilities across rural and remote areas of Ecuador, compared to non-rural doctors and other health-care facilities at the canton level for 2015 and 2019, by level of care (primary, secondary and tertiary) in the main public health sector (i.e. Ministry of Public Health or MSP, IESS and SSC). The aim was to assess Ecuador's rural medical service implementation with a focus on equitable distribution of doctors in the programme.

Methods

In Ecuador, 'rural medical service' (*medicatura rural*, in Spanish) is the term used in government documents to refer to the 'Social Service Rural Health Year' for doctors, as defined in the law (MSP, 1970). For the purposes of this manuscript, all medical doctors are labelled as 'doctors'. 'Rural service doctors' are the subset of doctors completing the mandatory service year in MoH facilities, regardless of their placement in a rural or urban facility. The study period begins in 2015, to compare the distribution of doctors and rural service doctors immediately before the MoH health-care facility planning reform (MSP, 2015) with the last year for which public data were available at the time of the study, which was 2019. Data were obtained from the Statistical Registry of Health Resources and Activities (Recursos y Actividades de Salud or RAS in Spanish) for 2015 and 2019 (INEC, 2022b). The National Institute of Statistics and Census (INEC) collects the data for RAS directly from health facilities, ensuring full coverage and validation of the data released to the public. INEC is considered the national gold standard for providing reliable data, following international quality standards that census bureaus in the region including Ecuador are held accountable (INEC, 2022c). We filtered data to obtain the total number of health-care facilities and doctors, including rural service doctors, in 2015 and 2019. Data corresponded to facilities belonging to the Ministry of Public Health, the IESS and the Peasant Social Security (SSC). We analysed the data for Galapagos separately because this province has unique geographical characteristics and is governed under a special regime—which includes different residence and work permit requirements than continental Ecuador.

Analysing the distribution of facilities is relevant to doctor availability because all doctors, including those at the primary care level, work only based out of a health-care facility. To analyse the distribution of health-care facilities, all doctors and, more specifically, rural service doctors for 2015 and 2019, we used seven different metrics following international and national standards (Table 1). Ecuador's MoH does not pre-define the distribution of rural service doctors; it only defines minimum or maximum thresholds for doctors overall. According to Ecuadorian government guidelines (i.e. MAIS), primary care teams should include a minimum of one

Table 1. Metrics analysed to characterize the spatial distribution of doctors, rural service doctors, and health care facilities in the MoH and IESS/SSC system of Ecuador

Index	Calculation	Source
Doctors for urban populations	(Medical doctors/urban population) × 4000	MSP, 2012 (MAIS)
Doctors for rural populations—minimum	(Medical doctors/rural population) × 1500	MSP, 2012 (MAIS)
Doctors for rural populations—maximum	(Medical doctors/rural population) × 2500	MSP, 2012 (MAIS)
Doctors for total population	(Medical doctors/total population) × 10 000	WHO, 2012
Count of rural service doctors	Number of rural service doctors per canton	INEC, 2022b (RAS)
Rural service doctors for rural populations (ER)	(Rural service doctors/rural population) × 10 000	This study
Health-care facilities per population	(Health-care facilities/total population) × 10 000	WHO, 2012

Raw counts of doctors, rural service doctors, and health care facilities were obtained through the Statistical Registry of Resources and Health Activities (RAS in Spanish) for 2015 and 2019. We used a total of 7 indexes to analyze the distribution of health services across the country. MAIS = Spanish for 'Comprehensive Health Care Model'. ER = Enough Rurals index developed in this study.

doctor per 4000 people in urban areas and one doctor per 1500 (minimum) to 2500 (maximum) people in rural regions (MSP, 2012).

We used the rural and urban population proportions and projections per canton of the INEC (in Spanish) in the 'Population by area, according to province, canton and parish of residence' database (INEC, 2008) to obtain a proxy of total urban and rural population in each Ecuadorian canton. We assumed that, despite the potential for uneven population growth and internal mobility creating differences, the proportion of urban/rural population has remained constant for both 2015 and 2019.

Equation 1 is an indicator to estimate rural service doctor availability in cantons according to their rural population.

$$ER = \frac{RAS\ rural\ service\ doctors\ (year)}{Rural\ population\ (year)} \times 10{,}000 \qquad (1)$$

in which ER (*Enough Rurals*) in a canton represents the rate of rural service doctors per 10 000 rural people. The numerator corresponds to the number of rural service doctors, and the denominator corresponds to the total rural population in a canton.

Other indexes used in this study include counts of rural service doctors per canton, the rate of doctors per total canton population and the rate of health-care facilities per population (Table 1). Results are presented in counts, proportions and rates in tables and maps in this manuscript, the Supplementary Material and Databases 1 to 3. We used Pearson correlations to identify variations in the distribution of total doctors and rural service doctors among levels of care. While density thresholds should consider local baseline conditions and needs, we include an index of doctors and facilities per 10 000 people to allow for comparison with other countries (Table 1). We used R for all statistical analyses (R Core Team, 2020).

Results

Where are the rural service doctors in Ecuador?

In 2015, there were a total of 17 867 doctors and, among these, 910 rural service doctors were in Ecuador. For 2019, the total number of doctors increased to 26 405 and, among these, 1237 are rural service doctors (Table 2). The distribution of rural service doctors across health facilities was similar to the distribution of other doctors, in both 2015 and 2019 (Pearson correlation for 2015 = 0.83 and Pearson correlation for 2019 = 0.81; Figure 1). In 2015, only 19.5% of rural service doctors worked in the primary care level; in 2019, this proportion dropped to 12.4% (Figure 1, Table 2). Across PHC facilities, Type A Health Centers (Centro de Salud Tipo A in Spanish) had the highest number of rural service doctors (Figure 1 and Supplementary Material Table S1). Many rural service doctors (63.4% in 2015 and 67.9% in 2019) concentrate in General and Basic hospitals, which belong to the secondary level of care (Figure 1, Supplementary Material Table S1). We also found that 17.1% ($n = 156$) in 2015 and 19.7% ($n = 244$) in 2019 of rural service doctors worked at the tertiary level (Figure 1, Table 2 and Supplementary Material Table S1).

Indexes and geographic distribution of doctors and rural service doctors in 2015

Considering the threshold of one medical doctor per 4000 people as established in MAIS for urban regions (Table 1), with only two exceptions, the country has sufficient medical doctors per canton. Exceptions include Jaramijó in Manabí province (0.74 doctors per 4000 people) and San Pedro de Huaca in Carchi province (0.93 doctors per 4000 people; Figure 2a). Concurrently, several cantons appear as having an excess of doctors for their respective urban populations (Figure 2a), as exemplified by the case of Aguarico (155.8 per 4000 people) in Orellana province and Taisha (131.1 per 4000 people) in Morona Santiago province.

For rural populations, we used the minimum (one rural doctor per 1500 people) and maximum (one rural doctor per 2500 people) MAIS thresholds to identify cantons without enough doctors to meet Ecuadorian standards (Table 1). For 2015, there are 13 cantons below the minimum threshold (Figure 2b, Table 3); from these, six cantons are below the maximum threshold (Table 3 and Supplementary Material Fig. S1).

Rural service doctors were concentrated in the main metropolitan hubs of Ecuador: Quito ($n = 205$) in Pichincha province, Guayaquil ($n = 162$) in Guayas province and Cuenca ($n = 40$) in Azuay province; they are absent in 102 cantons (Figure 2c). In the 13 cantons not meeting the minimum rate of doctors by rural population, only three had rural service doctors: Chambo ($n = 1$) at Chimborazo province and Santa Lucía ($n = 1$) and Daule ($n = 5$) at Guayas province (Figure 2c, Table 3).

According to the amount of rural service doctors by rural population per canton (Eq. 1), 52 cantons distributed across the three Ecuadorian regions had fewer than one rural service doctor per 10 000 people living in rural areas (Figure 2d);

Table 2. Doctors, rural service doctors, and health care facilities in the MoH and IESS/SSC system of Ecuador according to the level of health care for 2015 and 2019

Level of health care	Doctors 2015 (%)	Doctors 2019 (%)	Rural service doctors 2015 (%)	Rural service doctors 2019 (%)	Health-care facilities 2015 (%)	Health-care facilities 2019 (%)
Primary	8245 (46.1)	10 222 (38.7)	177 (19.5)	153 (12.4)	2690 (93.9)	2699 (93.8)
Secondary	8007 (44.8)	11 625 (44)	577 (63.4)	840 (67.9)	161 (5.6)	158 (5.5)
Tertiary	1615 (9)	4558 (17.3)	156 (17.1)	244 (19.7)	14 (0.5)	19 (0.7)
Total	17 867 (100)	26 405 (100)	910 (100)	1237 (100)	2865 (100)	2876 (100)

Classification of level of care were determined using the classification of MAIS-2012 (see methods; MSP, 2012) and follows the categories depicted in Figure 1. Raw counts can be found in the Supplementary material.

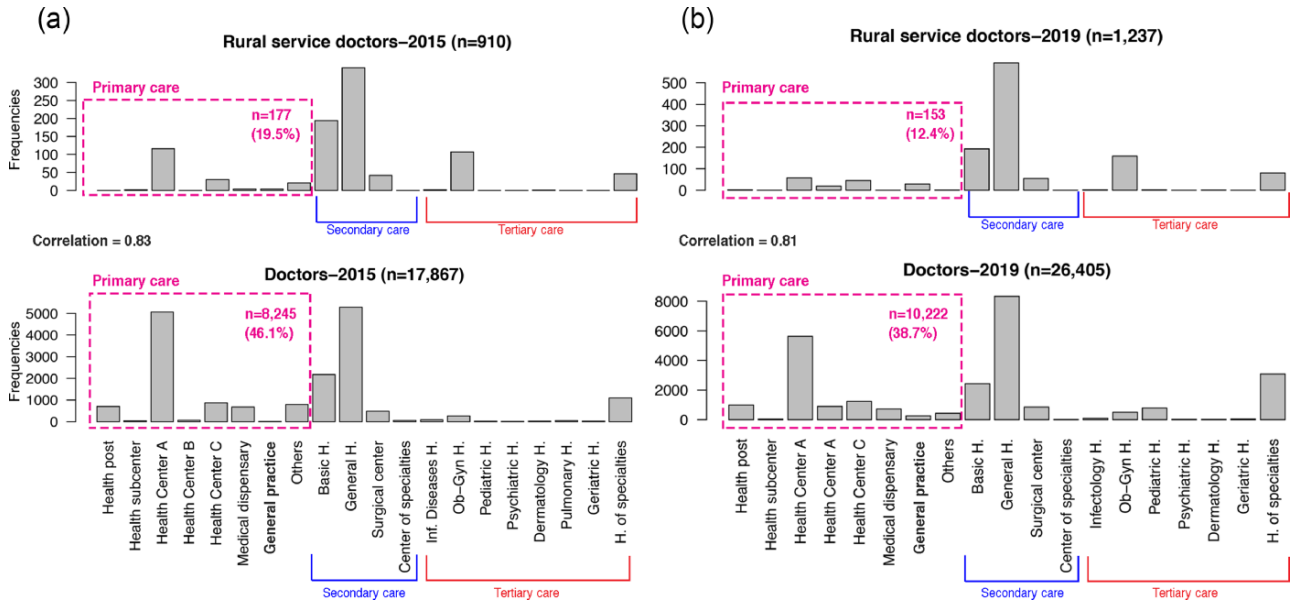

Figure 1. Distribution of doctors and rural service doctors per health facilities in Ecuador. Rural service doctors (superior panels) represent approximately one-third of the total amount of doctors across the country. The same pattern can be observed for 2015 (A) and 2019 (B) despite the increment of doctors for 2019. Pearson correlation between doctors and rural service doctors (0.85 for 2015 and 0.81 for 2019) indicates that these health personnel are distributed across similar health-care facilities

therefore, adding the 102 cantons without rural service doctors, a total of 154 cantons have a deficit of rural service doctors (Supplementary database 3). Chambo at the province of Chimborazo is the only canton where a rural service doctor ($n = 1$) compensates for the lack of doctors (1.24 per 10 000 versus 0.93 per 1500; Figure 2d, Supplementary database 3). Via our proposed rate (Eq.1), we showed that the highest rates of rural doctors per population are in Huaquillas ($n = 45.2$ per 10 000) in El Oro province, Guayaquil ($n = 20.4$ per 10 000) in Guayas province and Manta ($n = 20.3$ per 10 000) in Manabí province, cantons with a proportion of rural populations of 1.2%, 3.1% and 3.9%, respectively (Figure 2d, Supplementary database 1). Conversely, from the 30 first cantons with >80% of rural populations (Table 4), 18 had zero (60%), 10 had one (33.3%) and two had two rural doctors (6.7%) in 2015, with doctors in rural settings ranging from 0.5 to 6.1 per 1500 people.

Indexes and geographic distribution of doctors and rural service doctors in 2019

According to the MAIS threshold, the deficit of doctors across urban populations per canton in 2019 is null, meaning that urban areas in Ecuador have enough doctors (1 doctor per 4000 people; Figure 3a). In rural areas, we identified three cantons that are under the minimum MAIS threshold (1 doctor per 1500 people): Mocache at Los Ríos province (0.84 per 1500 people), and Colimes (0.78 per 1500 people) and Balao (0.95 per 1500 people) at Guayas province (Table 3 and Figure 3b).

Using the maximum threshold for doctors in rural populations (i.e. 1 doctor per 2500 rural people), we identified no deficit of doctors across the country (Supplementary Material Fig. S2) and an apparent excess in cantons such as Manta in Manabí province (129.2 per 2500 population), Guayaquil (127.2 per 2500) and Durán (64.81 per 2500) in Guayas province, and Machala (74.8 medical doctors per 2500) and Huaquillas (217.5 medical doctors per 2500) in El Oro province (Figure 3b and Supplementary database 1).

Overall, 2019 data on rural service doctors showed a similar pattern as in 2015 (Figures 2c and 3c). In 2019, 100 cantons lacked rural service doctors (Figure 3c), while the cantons concentrating most rural service doctors were Quito ($n = 304$), Guayaquil ($n = 228$) and Cuenca ($n = 60$). The three cantons without enough doctors for rural populations (Figure 3c) also lacked rural service doctors (Table 3).

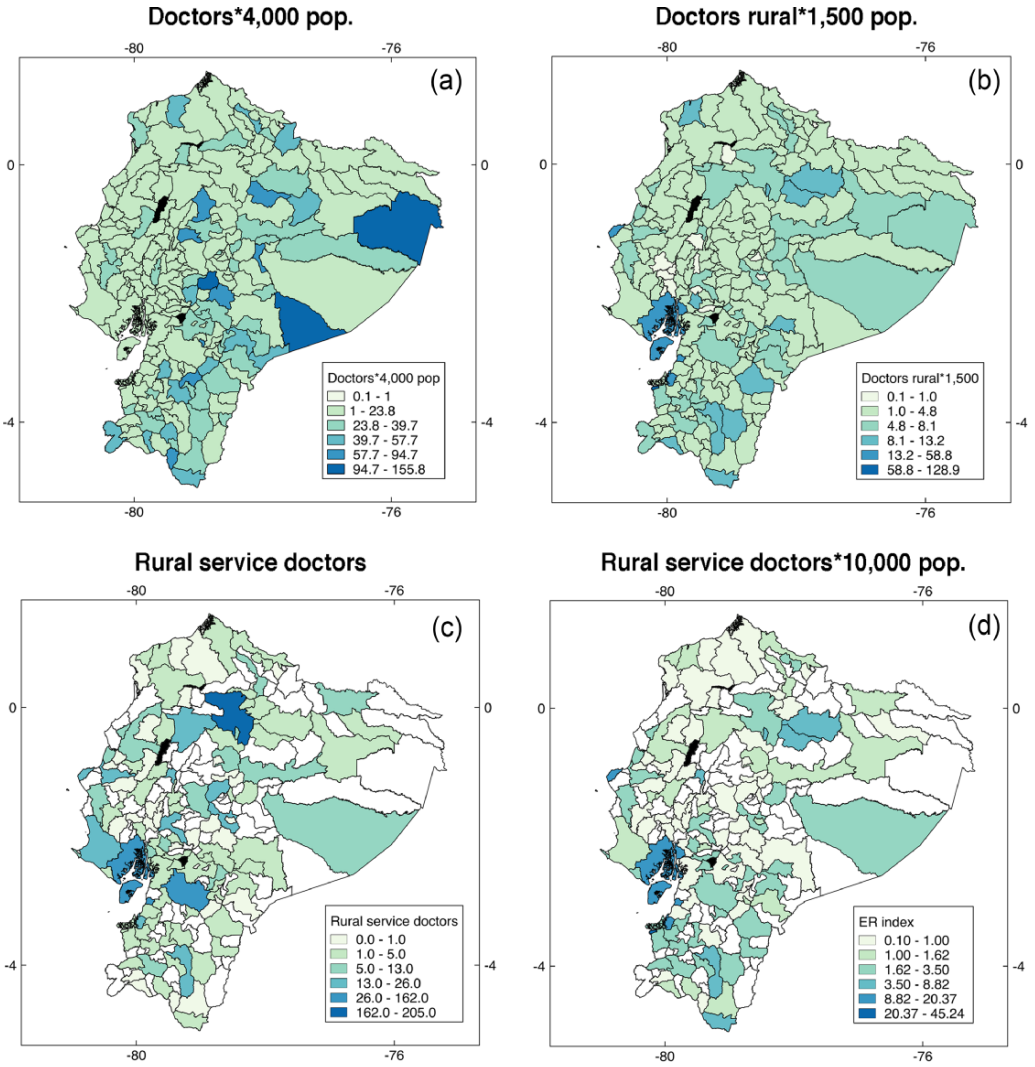

Figure 2. Spatial distribution of doctors and rural service doctors per canton in Ecuador, 2015. (A) Total doctors per urban population. (B) Total doctors per rural population using the minimum official range (the Methods section). (C) Raw counts of rural service doctors. (D) An index of rural service doctors per rural population developed for this study (ER, Eq.1). Colour categories determined with Natural Breaks (Jenks) via QGIS 2.18 'Las Palmas'. Dynamic maps are available as supplementary data.

By analysing the number of rural service doctors by rural population (Eq.1), we identified 57 cantons with less than one rural service doctor per 10 000 people; together with the 100 cantons with zero rural service doctors, we found a total of 157 cantons at deficit for 2019 (Figure 3d, Supplementary database 3). For 2019, from the 30 cantons with higher rural populations, 14 had zero rural service doctors (46.7%), 11 had one rural doctor (36.7%) and 5 had two or more rural service doctors (16.7%; Table 4). Together with the 2015 findings, these results suggest that rural service doctors are not being deployed to areas with high concentrations of rural population.

Distribution of doctors and rural service doctors in Galápagos, 2015 and 2019

The Galápagos archipelago is in the Pacific Ocean at ~1600 km from mainland Ecuador. According to the indexes explored in this manuscript (Table 1), the three cantons in Galápagos province—San Cristóbal, Isabela and Santa Cruz—have enough doctors across all categories in 2019 (Supplementary database 2). With respect to rural service doctors, there were a total of three rural service doctors in the Galápagos, except for San Cristóbal in 2015; using our 'ER' index, there was a deficit of rural service doctors for San Cristóbal for this year. In 2019, there were a total of five rural service doctors in Galápagos, showing a lack of deficit of rural service doctors for this year and potentially an excess for San Cristobal and Isabela (Supplementary database 2).

Distribution of primary care facilities, 2015 and 2019

In Ecuador, the distribution of facilities is relevant to doctor availability in the public sector given that they work only based out of a public health-care facility. For 2019, there were 11 new health facilities in the public sector (Table 2). There was almost no difference in the proportion of primary care facilities between 2015 (93.9%) and 2019 (93.8%; Table 2).

For 2015 and 2019, health-care facilities in the public sector were distributed heterogeneously across the country (Figure 4). When correcting the number of these facilities by the total population per canton for 2015 and 2019, we see that highly populated cantons like Quito, Guayaquil or Cuenca have lower counts of facilities considering the total

Table 3. Cantons without the minimum requirement of doctors per rural population in 2015 and 2019

Province	Canton (number of rural service doctors)	Year	Rate at lower threshold	Rate at higher threshold
Guayas	Nobol (0)	2015	0.33	**0.56**
Carchi	San Pedro de Huaca (0)	2015	0.36	**0.60**
Los Ríos	Mocache (0)	2015	0.50	**0.83**
Tungurahua	Quero (0)	2015	0.51	**0.86**
Guayas	Santa Lucía (1)	2015	0.54	**0.91**
Guayas	Colimes (0)	2015	0.56	**0.94**
Guayas	Alfredo Baquerizo Moreno (0)	2015	0.70	1.16
Guayas	Palestina (0)	2015	0.72	1.20
Los rios	Puebloviejo (0)	2015	0.79	1.31
Guayas	Coronel Marcelino Maridueña (0)	2015	0.86	1.44
Pichincha	Pedro Vicente Maldonado (0)	2015	0.87	1.44
Chimborazo	Chambo (1)	2015	0.93	1.55
Guayas	Daule (5)	2015	0.98	1.63
Los Ríos	Mocache (0)	2019	0.84	1.4
Guayas	Colimes (0)	2019	0.78	1.31
Guayas	Balao (0)	2019	0.95	1.58

Thresholds to identify the minimum number of doctors were obtained from official Ecuadorian rules (1 doctor*1,500-2,500 people, see Methods section). In 2015, a total of 13 cantons did not meet the lower threshold. Using the higher threshold, 6 cantons lacked the minimum number of doctors for rural populations (bold). In 2019, a total of 3 cantons did not meet the lower threshold of minimum number of doctors.

Table 4. Thirty cantons with >80% of rural populations in 2015 and 2019

Province	Canton	Rural population (%)	Minimum requirement of doctors for rural population—2015 (Number of rural service doctors)	Minimum requirement of doctors for rural population—2019 (Number of rural service doctors)
Chimborazo	Colta	94.9	2.6 (1)	2.3 (1)
Morona Santiago	Taisha	94.4	2.9 (0)	3.6 (0)
Chimborazo	Guamote	94.1	1.6 (1)	1.5 (1)
Pastaza	Mera	93.5	1.9 (0)	4.2 (0)
Cotopaxi	Pangua	92.5	2.5 (0)	2.9 (1)
Azuay	Nabon	92.3	2.6 (0)	3.6 (1)
Cotopaxi	Sigchos	91.1	3.1 (0)	3.0 (1)
Azuay	Pucara	90.9	1.9 (0)	1.9 (0)
Cañar	Deleg	90.5	3.5 (0)	3.4 (0)
Orellana	Aguarico	90.5	6.1 (0)	24.2 (0)
Tungurahua	Tisaleo	89.5	1.2 (0)	1.4 (0)
Loja	Espindola	89.4	3.4 (1)	3.9 (1)
Morona Santiago	Huamboya	89.4	1.3 (0)	2.5 (0)
Loja	Gonzanama	88.9	2.5 (0)	3.2 (0)
Esmeraldas	Rioverde	88.2	2.2 (1)	4.0 (1)
Loja	Sozoranga	87.6	3.0 (0)	2.6 (0)
Manabí	Pichincha	87.3	2.1 (1)	3.5 (2)
Loja	Olmedo	87.2	1.8 (0)	2.8 (0)
Esmeraldas	Eloy Alfaro	86.7	1.2 (1)	3.3 (2)
Loja	Saraguro	86.6	2.7 (2)	3.5 (1)
Los Ríos	Baba	86.5	1.6 (1)	1.6 (3)
Azuay	Sigsig	86.3	2.7 (1)	3.4 (1)
Tungurahua	Quero	86.1	0.5 (0)	2.5 (0)
Azuay	Sevilla de Oro	85.8	2.1 (0)	1.3 (0)
Chimborazo	Alausi	85.6	2.3 (2)	3.5 (2)
Cotopaxi	Pujili	85.4	2.1 (0)	1.8 (2)
Pichincha	Puerto Quito	84.9	1.6 (1)	1.9 (1)
Loja	Chaguarpamba	84.8	2.2 (0)	3.4 (0)
Orellana	Loreto	84.6	3.6 (0)	2.8 (0)
Bolívar	Chillanes	84.6	3.1 (1)	4.4 (1)

In general, for 2015, 18 cantons had zero (60%), 10 had one (33.3%), and two had 2 rural doctors (6.7%). For 2019, 14 had zero (46.7%), 11 had one (36.7%), and 5 had more than two rural doctors (16.7%). No. = numbers; Min. req. = minimum requirement according to the official guidelines of MAIS (MSP, 2012).

population, with 0.7, 0.47 and 1.1 health centres per 10 000 in 2015 and 0.6, 0.48 and 1 in 2019, respectively (Figure 4, Supplementary database 1). In contrast, cantons with low population density have a higher number of health facilities for their respective population [e.g. Mira at Carchi province (12.9 per 10 000) in 2015 or Aguarico at Orellana province (15.9 per 10 000) in 2019; Supplementary database 1]. Dynamic maps with data by canton for continental Ecuador for 2015 and 2019 can be found as supplementary data.

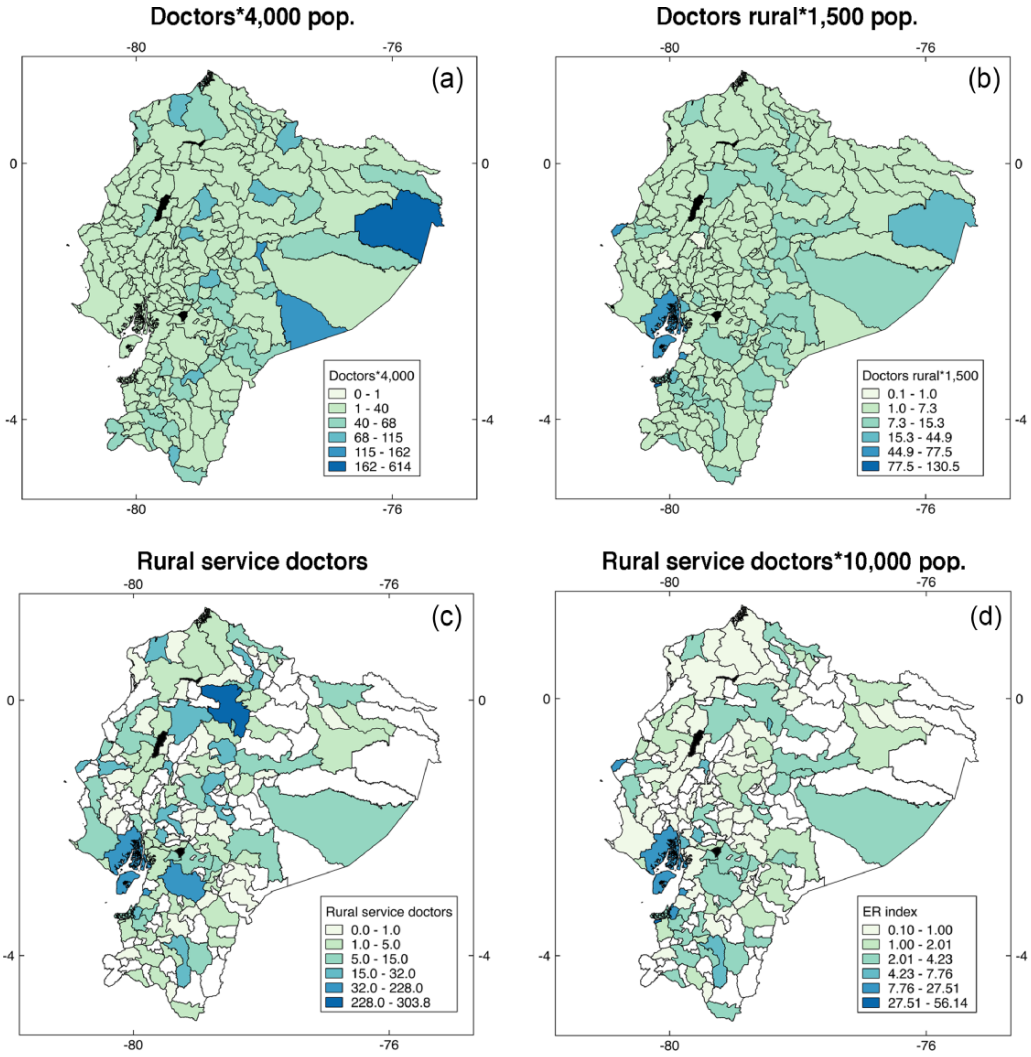

Figure 3. Spatial distribution of doctors and rural service doctors per canton in Ecuador, 2019. (A) Total doctors per urban population. (B) Total doctors per rural population using the minimum official range (the Methods section). (C) Raw counts of rural service doctors. (D) An index of rural service doctors per rural population developed for this manuscript (ER, Eq.1). Colour categories determined using Natural Breaks (Jenks) via QGIS 2.18 'Las Palmas'. Dynamic maps are available as supplementary data.

Discussion

To the best of our knowledge, this is the first quantitative assessment of the implementation of the mandatory service year in Ecuador since it was established in 1970. Our results challenge common beliefs of the role of rural service doctors in the country in multiple levels.

First, while the total number of doctors in the public health sector increased by almost 47%, the number of rural service doctors grew only by 36%, between 2015 and 2019. Second, although according to the Organic Law of Health rural service, doctors should be deployed at the primary care level (MSP, 2006), our findings show that for both 2015 and 2019, the vast majority of rural service doctors are working at the secondary level and an important share of them is deployed at the tertiary level of care, which are located in urban areas (Table 2). Third, and as a consequence of the first two, cantons with the highest percentage of rural population may not have any rural service doctors at all, even in cantons that lack doctors in general (Table 4 and Supplementary database 3).

The distribution of doctors (overall) and rural service doctors (specifically) across health-care facilities in Ecuadorian cantons is highly correlated for 2015 and 2019 (i.e. Pearson = 0.83 and 0.81, respectively; Figure 1), demonstrating that rural service doctors are less likely to work in cantons with a deficit of doctors for rural populations according to the minimum threshold established by MAIS (Figs. 2b and 3b, Table 3). Furthermore, even if a canton may have rural service doctors, this type of personnel frequently concentrates in hospitals, leaving the target population potentially unattended. Consequently, more than 65% of the cantons in continental Ecuador are lacking enough rural service doctors when the indicator we propose in this study, as a potential benchmark, is applied.

Arbitrary distribution of rural service doctors is clearly exemplified by La Libertad canton at Santa Elena province. Although 100% of the population of La Libertad canton is categorized as urban, three rural service doctors were assigned to this canton in 2019. Moreover, the doctor rate in La Libertad increased from 1.73 per 10 000 people in 2015, to 2.83 per 10 000 people in 2019 (Supplementary database 1).

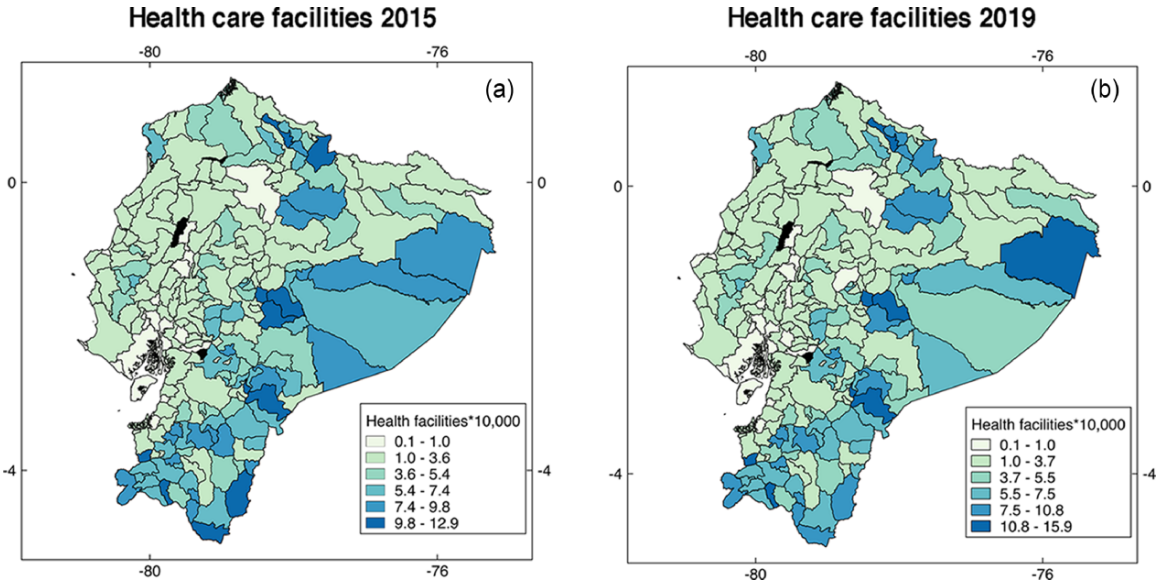

Figure 4. Spatial distribution of health centres per canton in Ecuador for 2015 and 2019. Health facilities raw counts were obtained from the RAS database. While correcting for population, we can see that areas with larger populations have a low amount of health centres. The pattern is similar for 2015 (A) and 2019 (B). Colour categories determined using Natural Breaks (Jenks) via QGIS 2.18 'Las Palmas'. Dynamic maps are available as supplementary data.

It is possible that the vicinity of Santa Elena province to Guayaquil, one of the two largest metropolitan hubs of Ecuador, made it a coveted location, but the question remains as to who decided to assign that many rural service doctors or any at all to that canton. In contrast, the case of Ambato canton at Tungurahua province shows that rural doctors and rural service doctors at the primary care level can be adequately assigned. According to all the indexes explored in this study, Ambato has enough doctors (Supplementary database 1). With a total of 17 rural service doctors for 2015 (0.93 of rural service doctors per 10 000) and 25 for 2019 (1.31 per 10 000), enough rural service doctors were assigned to that canton (Supplementary database 1). Ambato canton has roughly the same proportion of rural population as the proportion of rural service doctors in 2015 and 2019 or 1.87% (17/910) or 2% (25/1237) of all rural service doctors, respectively.

There are different reasons for why so many rural service doctors are largely located in or near the three major urban centres of the country (i.e. Quito, Guayaquil and Cuenca, Figures 2c and 3c). Practicing medicine as a recent graduate in remote or rural areas may be more challenging than doing so in an urban health facility since facilities may lack more senior doctors providing supervision and mentorship (Gaus *et al.*, 2008). Distance from major urban areas, where other vital elements such as adequate living conditions, day care and schools, and higher-level medical care, in addition to potential issues of safety in remote and rural areas, add to the disincentives. Finally, the lack of a career pathway in the public sector to serve in rural and remote areas, including a salary commensurate to the challenges they may face, renders it rather unattractive to gain experience at the primary level in these areas or even consider staying in those communities after the year of rural service concludes.

Interestingly, our analyses shed light on the concentration of doctors in hospitals in Quito, Guayaquil and Cuenca, where health-care facilities were similarly distributed by canton population density in 2015 and 2019 (Figure 4). The most densely populated cantons of Ecuador—Quito and Guayaquil—have less than one health-care facility per 10 000 people (Figure 4). Even if a reform were to allow for rural service doctors to provide care to underserved urban populations, there may not be enough or well-distributed PHC facilities.

Ecuador was devastated by the COVID-19 pandemic in 2020; the country had one of the highest excess death rates in the world (Cuéllar *et al.*, 2021). In 2021, the incoming government planned on using primary care facilities and staff for massive immunization. Limited knowledge on the heterogeneous distribution of primary care facilities (Figure 4), general personnel gaps and the role of PHC had the potential to create yet a new crisis caused by unnecessary pressure on understaffed facilities serving large populations (Torres *et al.*, 2021). The plan was fortunately cancelled, and the vaccination programme was successful without the need to use primary care facilities (Bortman and Mohpal, 2021), which highlights the importance of making a reform to guarantee health-care services at this level.

A final concern that our study raises is on the minimum and maximum thresholds for the number of doctors in the MAIS guidelines. For example, cantons with low population density have a higher number of health facilities for their respective population than others, for example: Mira in Carchi province (12.9 per 10 000) in 2015 and Aguarico in Orellana province (15.9 per 10 000) in 2019 (Supplementary database 1). There are cantons with an astounding number of doctors per population, such as Taisha in Morona Santiago province (131 doctors per 4000 people) and Aguarico (155.8 per 4000 people) in Orellana province. Presumably, these higher densities of facilities and doctors could respond to travel distances, which would entail that the MAIS guidelines probably should not be used to assess medical personnel

distribution and should be revised to consider other parameters such as cost of travel and distance from a health-care facility.

Limitations

The present study uses official survey-based data. Hence, some information may be missing that would be captured if databases corresponded to a source such as the MoH human resources department or payroll systems. A second limitation is that we only focus on medical doctors, while other skilled health workers such as nurses, dentists or midwives, and resources including equipment, are equally relevant to PHC services. A third limitation is the assumption that all doctors at the primary care level see patients, when the fact is that several of them have additional administrative responsibilities. Fourth, our study focused on a relatively limited timeframe (2015–2019). Future studies should expand the scope of the programme to better monitor changes in the distribution of rural service doctors across the country.

Conclusion

We conducted this study to contribute with an examination of the rural medical service programme as a basis for making recommendations for health policy and planning reform towards achieving greater health equity in Ecuador. This study leads to three main conclusions. First, we found distortions and disparities in the distribution of doctors and rural service doctors in particular, which call for an in-depth evaluation of both personnel distribution and the very design of the rural medical service year, including changes to legal and policy frameworks. Optimally, distribution of medical personnel should be based on an improved categorization of urban and rural areas in the country and an objective assessment of the relation between population size and parameters such as travel conditions (cost, frequency and mode of transportation) and distance from the nearest primary-level facility. Second, the high number of rural service doctors working in hospitals while cantons are lacking doctors in rural areas points towards the need to address the limitations in career pathways and incentives for doctors to work in rural and remote areas, for which the recently approved Organic Law of Health Careers (Asamblea Nacional del Ecuador, 2022) provides an opportunity of change. Of course, such a reform should consider the minimum conditions for medical doctors to practice their profession related to safety and living conditions. Third, a paradigm shift is needed so that rural and remote areas are not considered solely 'training grounds' for recently graduated medical doctors and, therefore, more experienced personnel should be deployed and maintained concurrently. Recent graduates need monitoring and mentoring, and, therefore, rural service doctors should be matched with facilities that have at least one permanent full-time doctor. Thus, rural service doctors could be supplemental to other more consistent human resources in rural and remote areas.

Contrary to the original intent of the programme, we provide evidence of the gaps in provision of service doctors in rural communities, biased towards placing them in urban areas and in secondary and tertiary care facilities. In doing so, we also provide Ecuadorian authorities (and decision makers in other countries with similar programmes) with an improved methodology for assigning rural service doctors. Such an approach would be more likely to fulfill the intended goals of the rural service programme and contribute to strengthening the provision of PHC.

Supplementary data

Supplementary data are available at *Health Policy and Planning* Journal online.

Data availability

All data are publicly available from the following sources. Population Projections: https://www.ecuadorencifras.gob.ec/proyecciones-poblacionales and https://sni.gob.ec/proyecciones-y-estudios-demograficos; Statistical Registry of Health Resources and Activities: https://www.ecuadorencifras.gob.ec/actividades-y-recursos-de-salud.

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Author contributions

All authors contributed equally. Daniel Romero-Alvarez, Daniel Lopez-Cevallos and Irene Torres contributed to conception or design of the work; Daniel Romero-Alvarez, Daniel Lopez-Cevallos and Irene Torres contributed to data collection; Daniel Romero-Alvarez, Daniel Lopez-Cevallos and Irene Torres contributed to data analysis and interpretation; Daniel Romero-Alvarez, Daniel Lopez-Cevallos and Irene Torres contributed to drafting the article; Daniel Romero-Alvarez, Daniel Lopez-Cevallos and Irene Torres contributed to critical revision of the article; Final approval of the version is to be submitted. All named authors have approved the final version.

Reflexivity statement

The authors include one woman and two men and span different levels of seniority. One author focuses on ecology of diseases, and two authors have expertise in inequalities in health systems and health policy. The three authors have extensive experience in conducting research in Ecuador.

Ethical approval. Ethical approval for this type of study is not required by our institute or local regulations.

Conflict of interest statement. None declared.

References

Aguirre M. *Límites de la salud intercultural. Estudio de caso en la provincia de Orellana*. http://saludyderechos.fundaciondonum.org/wp-content/uploads/2016/05/salud_intercultural_baja.pdf, accessed 4 April 2023.

Asamblea Nacional del Ecuador. *Ley Orgánica de Carrera Sanitaria*. Registro Oficial Suplemento No 139. https://www.registroficial.gob.ec/index.php/registro-oficial-web/publicaciones/suplementos/item/17246-suplemento-al-registro-oficial-no-139, accessed 4 April 2023.

Bortman M, Mohpal A 2021. Why Ecuador vaccinates its population faster than the rest of the world. https://blogs.worldbank.org/latinamerica/why-ecuador-vaccinates-its-population-faster-rest-world, accessed 11 June 2023.

Cavender A, Albán M. 1998. Compulsory medical service in Ecuador: the physician's perspective. *Social Science & Medicine* **47**: 1937–46.

Cuéllar L, Torres I, Romero-Severson E *et al.* 2021. Excess deaths reveal unequal impact of COVID-19 in Ecuador. *BMJ Global Health* **6**: e006446.

Eckhardt M *et al.* 2019. Universal health coverage in marginalized populations: a qualitative evaluation of a health reform implementation in rural Ecuador. *Inquiry* **56**: 0046958019880699.

ECLAC. *Fiscal Panorama of Latin America and the Caribbean, 2021*. Fiscal policy challenges for transformative recovery post-COVID-19. Economic Commission for Latin America and the Caribbean. https://www.cepal.org/en/publications/46809-fiscal-panorama-latin-america-and-caribbean-2021-fiscal-policy-challenges, accessed 4 April 2023.

Frehywot S, Mullan F, Payne PW *et al.* 2010. Compulsory service programmes for recruiting health workers in remote and rural areas: do they work?. *Bulletin of the World Health Organization* **88**: 364–70.

Gaus D, Herrera D, Heisler M *et al.* 2008. Making secondary care a primary concern: the rural hospital in Ecuador. *Pan American Journal of Public Health* **23**: 212–7.

Guderian RH, Anselmi M, Espinel M *et al.* 1997. Successful control of onchocerciasis with community-based ivermectin distribution in the Río Santiago focus in Ecuador. *Tropical Medicine and International Health* **2**: 982–8.

INEC. *Población por área, según provincia, cantón y parroquia de empadronamiento*. Instituto Nacional de Estadísticas y Censos. https://www.ecuadorencifras.gob.ec/wp-content/plugins/download-monitor/download.php?id=310&force=1, accessed 4 April 2023.

INEC. *Proyección de la población Ecuatoriana, por años calendario, según cantones 2010-2020. Instituto Nacional de Estadísticas y Censos*. https://www.ecuadorencifras.gob.ec/proyecciones-poblacionales. accessed 4 April 2023.

INEC. *Registro estadístico de recursos y actividades de salud*. Banco de datos abiertos. Instituto Nacional de Estadísticas y Censos. https://aplicaciones3.ecuadorencifras.gob.ec/BIINEC-war/index.xhtml, accessed 4 April 2023.

INEC. *Registro Estadístico de Recursos y Actividades de Salud 2019*. Instituto Nacional de Estadísticas y Censos. https://www.ecuadorencifras.gob.ec/documentos/web-inec/Estadisticas_Sociales/Recursos_Actividades_de_Salud/RAS_2019/Metodolog%C3%ADa_RAS_2019.pdf, accessed 11 June 2023.

Izquierdo A, Pessino C, Vuletin G (Eds). 2018. *Mejor Gasto Para Mejores Vidas: Cómo América Latina Y El Caribe Pueden Hacer Más Con Menos*. Washington DC: Inter-American Development Bank, pp. 1–465.

Karáth K. *Young doctors spend a year caring for rural folks in Ecuador*. Here's what they find. Goats and Soda: NPR. https://www.npr.org/sections/goatsandsoda/2022/06/13/1103957109/young-doctors-spend-a-year-caring-for-rural-folks-in-ecuador-heres-what-they-fin, accessed 4 April 2023.

López-Cevallos D, Chi C, Ortega F. 2014. Equity-based considerations for transforming the ecuadorian health system. *Revista de Salud Pública* **16**: 346–59.

MSP. *Acuerdo 0005320-2015*. 9 November 2015. https://aplicaciones.msp.gob.ec/salud/archivosdigitales/documentosDirecciones/dnn/archivos/ac%2000005320%202015%2009%20nov.pdf, accessed 4 April 2023.

MSP. *Decreto Supremo 44 (Registro Oficial 13, 8-VII-1970) [Organic Law of Health]*. http://www.acess.gob.ec/wp-content/uploads/2022/Documentos/DECRETOS/DECRETO%20SUPREMO%2044%20REQUISITO%C2%A0DE%C2%A0HABER%C2%A0CUMPLIDO%C2%A0UN%C2%A0AN%CC%83O%C2%A0DE%C2%A0SERVICIO%C2%A0DE%C2%A0MEDICINA%C2%A0RURAL%C2%A0PARA%C2%A0LA%C2%A0INSCRIPCIO%CC%81N%C2%A0DE%C2%A0TI%CC%81TULOS.pdf, accessed 4 April 2023.

MSP. *Informe sobre el año de salud rural desde el año 2018 al 2023*. https://www.ministeriodegobierno.gob.ec/wp-content/uploads/2023/02/136.INFORME-SOBRE-EL-ANO-DE-SALUD-RURAL-DESDE-EL-ANO-2018-AL-2023.pdf, accessed 4 April 2023.

MSP. *Ley orgánica de salud (Ley No. 2006-67) [Organic Law of Health]*. https://biblioteca.defensoria.gob.ec/bitstream/37000/3426/1/Ley%20Org%c3%a1nica%20de%20Salud.pdf, accessed 4 April 2023.

MSP. *Manual del Modelo de Atención Integral de Salud-MAIS*. Ministerio de Salud Pública del Ecuador. https://www.kimirina.org/images/kimirina/documentos/publicaciones/Manual_Modelo_Atencion_Integral_Salud_Ecuador_2012-Logrado-ver-amarillo.pdf, accessed 11 June 2023.

MSP. *Médico del Barrio*. Ministerio de Salud Pública del Ecuador. https://www.salud.gob.ec/manual-del-medico-del-barrio/, accessed 4 April 2023.

MSP. *Norma para la práctica del año de salud rural de servicio social en la Red Pública Integral de Salud*. Ministerio de Salud Pública del Ecuador. https://www.gob.ec/sites/default/files/regulations/2022-04/Norma_para_practica_salud_rural_servicio_social_en_RPIS_20191.pdf, accessed 4 April 2023.

Ortiz-Prado E, Fors M, Henriquez-Trujillo AR *et al.* 2019. Attitudes and perceptions of medical doctors towards the local health system: a questionnaire survey in Ecuador. *BMC Health Services Research* **19**: 1–13.

PAHO. *Compact 30.30.30 PHC for Universal Health*. Pan American Health Organization. https://www.paho.org/en/documents/brochure-compact-303030-phc-universal-health, accessed 4 April 2023.

R Core Team. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/, accessed 4 April 2023.

Sacoto F. 2002. Experiencias y proyecciones del modelo SAFYC en los años 80 y 90. *Correo Poblacional de Salud Reproductiva Y Gerencia En Salud* **11**: 2–4.

Suárez-Torres J *et al.* 1982. *Evaluación Del Plan Nacional de Salud Rural*. Quito: Instituto de Investigaciones Nutricionales y Médico Sociales, Ministerio de Salud Pública del Ecuador.

Torres I, López-Cevallos DF. 2018. Institutional challenges to achieving health equity in Ecuador. *The Lancet Global Health* **6**: e832–3.

Torres I, López-Cevallos DF, Sacoto F. 2020. Incentivized public service response to COVID-19 in rural and marginalized urban communities. *American Journal of Public Health* **110**: 1344–5.

Torres I, Romero-Alvarez D, López-Cevallos D, Cañizares B. *Time for a Health Check: the Reality of Vaccine Rollout in Ecuador*. Think Global Health. https://www.thinkglobalhealth.org/article/time-health-check-reality-vaccine-rollout-ecuador, accessed 04 April 2023.

Troya C 2016. Problemas emergentes en medicina de zonas rurales. Práctica Familiar Rural 1. https://practicafamiliarrural.org/index.php/pfr/article/view/64.

Ugalde A, Homedes N. 2008. Toward a rural health corps concept: lessons from the Dominican Republic. *The Journal of Rural Health*, **4**: 41–58.

WHO. *Health facilities per 10000 population. World Health Organization*. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3120, accessed 4 April 2023.

WHO. *A vision for primary health care in the 21st century: towards universal health coverage and the Sustainable Development Goals*. World Health Organization. https://apps.who.int/iris/handle/10665/328065, accessed 4 April 2023.

World Bank. 2018. *Systematic Country Diagnostic*. Bolivia, Chile, Ecuador, Peru and Venezuela: Country Management Unit.