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Cost of lost productivity from acute respiratory infections in South America

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ABSTRACT

Objectives. To estimate the burden of permanent productivity losses caused by acute respiratory infections in South American countries in 2019.

Methods. Mortality data from the Global Burden of Disease Study 2019 were analyzed to estimate the burden of disease attributable to acute respiratory infections. An approach based on the human capital method was used to estimate the cost of permanent productivity losses associated with respiratory diseases. To calculate this cost, the sum of the years of productive life lost for each death was multiplied by the proportion in the workforce and the employment rate, and then by the annual minimum wage or purchasing power parity in United States dollars (US$) for each country in the economically active age groups. Separate calculations were done for men and women.

Results. The total number of deaths from acute respiratory infections in 2019 was 30 684 and the years of productive life lost were 465 211 years. The total cost of permanent productivity loss was about US$ 835 million based on annual minimum wage and US$ 2 billion in purchasing power parity, representing 0.024% of the region's gross domestic product. The cost per death was US$ 33 226**.** The cost of productivity losses differed substantially between countries and by sex.

Conclusion. Acute respiratory infections impose a significant economic burden on South America in terms of health and productivity. Characterization of the economic costs of these infections can support governments in the allocation of resources to develop policies and interventions to reduce the burden of acute respiratory infections.

Keywords Cost of illness; respiratory tract infections; South America.

Acute respiratory infections (ARIs) are responsible for millions of episodes of illness and cases of premature deaths annually (1). The impact is greater in older adults and those with comorbidities (2). ARIs are among the most common conditions in primary care (3). Although ARIs are often not fatal, they affect quality of life and productivity (4, 5). Recognizing ARIs and implementing appropriate prevention measures and treatment protocols (1, 6) helps the health system and health workers provide better clinical and health management of these infections.

For low- and middle-income regions, such as Latin America and the Caribbean, the health burden of ARIs has not yet been precisely characterized, as reliable population and epidemiological estimates are lacking (2, 6). Some systematic reviews have assessed epidemiological data on ARIs and their social and economic impact in South America and the Caribbean (5, 7–9). Other studies have obtained data from countries, regions, or municipalities using secondary data on hospitalizations (10), or information from a single health facility (11). But no comprehensive assessment of the burden of ARIs in South American countries as a whole is available.

The burden of disease, based on disability-adjusted life years (DALYs), has been used to estimate the impact of respiratory

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infections (2, 4, 7, 12). However, the loss of productivity because of these diseases has not been explored as much (10, 11, 13), even though they result in direct and indirect economic costs for individuals and society. Indirect economic costs include losses in labor productivity attributable to morbidity and mortality. These productivity losses may be temporary, or permanent if they result in early death (4, 5, 11, 13, 14). Estimating this lost productivity and understanding its societal impact can provide additional useful information to identify health priorities and manage ARI prevention and control decisions (15, 16). Assessing productivity losses facilitates cross-country comparisons of the consequences of ARIs and approaches to address them (17).

For such evaluations, the human capital approach is often used, which presupposes a production potential throughout the working life of individuals. Loss of productivity is measured as the length of time that working life is reduced due to illness, using wages as the value of work to society, the labor force participation rate, and the unemployment rate (15, 18).

Given the need for a comprehensive and systematic analysis of the burden of ARIs in South America to guide future research and better inform health system managers about the use of resources (19), this study aimed to estimate the permanent productivity losses and costs caused by ARIs in South American countries in 2019.

METHODS

This was an exploratory, population-based, cross-sectional study that estimated permanent productivity losses associated with premature deaths from ARIs in people of working age in South America in 2019.

Information sources

In this study, which uses a quantitative approach, the metrics were generated by the Global Burden of Disease Study 2019 (12). The 2019 Global Burden of Disease Study estimated the sex disaggregated incidence, prevalence, mortality, years of life lost, years lived with disability, and DALYs caused by 369 diseases and injuries for 204 countries and territories (12). All measurements and variables are reported on the Institute for Health Metrics and Evaluation website (20), where the Global Health Data Exchange can be accessed (21). Deaths were collected by country (location), cause – lower and upper respiratory infections (codes A.2.2 and A.2.3, respectively) – age group, sex, year, measure in absolute numbers, rates (per 100 000 inhabitants), and percentages (20, 22).

Economic data on workforce participation, unemployment and employment rates, monthly minimum wage in United States dollars (US$), and purchasing power parity (PPP) of each country were obtained from the International Labour Organization (23), as was the working-age population, by sex and age group. The retirement age was obtained from different sources in different countries including: the International Social Security Association; the Economic Commission for Latin America and the Caribbean; and the Inter-American Development Bank with the Organization for Economic Cooperation and Development and the World Bank (24–27). The gross domestic product (GDP) per capita and health expenditures for the year 2019 for each country were obtained from the World Bank database (28).

Estimating productivity loss

Loss of productivity (economic burden) is an important measure of the burden of disease, not only from the clinical/epidemiological perspective, but also the economic and social burden of the disease (13).

An approach based on the human capital method (10, 14, 15, 17) was used to estimate the permanently lost productivity associated with respiratory diseases in South America in economically active age groups (15–69 years), by sex, for the year 2019. For each death caused by ARIs in people of working age, the years of productive life lost (YPLL) were calculated as the difference between the retirement age and age at time of death by ARI (based on the midpoint of the age range) (29). For example, if the retirement age is 65 years for men and women, for the first age group, 15–19-year-olds, 48 years are left before retirement (65 – 17 years); this value was determined for all age groups (15–19 years; 20–24 years, and so on up to the retirement age). These values were multiplied by the number of people who died within each age group to get the YPLL. In the World Bank (28) and International Labour Organization (23) databases, the number of people in the workforce and the number of people outside the workforce were obtained, by sex and age group, in each country. Persons outside of the labor force include all persons of working age who were not in the labor force (that is, nonemployed (not actively seeking work) or unemployed (actively seeking work)). The numbers of persons in and outside the workforce were added and used as the denominator to calculate the proportion in the workforce. The employment rate was calculated as 1 – the unemployment rate.

To calculate the total cost of permanent loss of productivity related to ARIs in South America, the sum of YPLL for each death was multiplied by the proportion in the workforce and the employment rate, and then by the annual minimum wage in US$ or PPP for each country in the economically active age groups. Calculations were also done for men and women separately. The use of PPP values, which consider the different salary purchasing powers in countries, allows for better income comparisons. A growth rate for minimum wages of 2% per year was incorporated (14). Table 1 and Table 2 show the data inputs for each country.

Data analysis

Microsoft Excel, version 365 (Microsoft, Redmond, WA, USA) was used for the analyses.

A 3% discount rate was applied. Results were converted to US$ (31) using the 2019 PPP exchange rates (14).

To assess the effect of methodological assumptions on the results, the following alternative scenarios were used to analyze the evolution of productivity losses for South American countries: (i) addition of 5 years to the retirement age; (ii) trend of epidemiological data on deaths, using the values of the confidence intervals produced by the GHDx (20); and (iii) changes in the discount rate (0% and 6%).

Ethical issues

This study used secondary data from a public domain database without names and respects the ethical principles in the resolution of the Brazilian National Health Council. No. 466, December 12, 2012 (32).

TABLE 1. Demographic baseline data, ARI mortality, and GDP for countries in South America, 2019

Country	Total population, n[a]	Total deaths from ARIs, n[b]	Life expectancy at birth, in years[a]	GDP × million US$[c]	Monthly minimum wage, in US$ (2019)[a]	Monthly minimum wage, in PPP US$ (2019)[a]
Argentina	44 938 712	36 267	76.6	452 819	350	813
Bolivia, Plurinational State of	11 513 102	6 588	71.5	40 895	307	786
Brazil	211 049 519	88 747	75.8	1 873 288	253	443
Chile	18 952 035	4 706	80.1	278 585	428	726
Colombia	50 339 443	7 918	77.2	323 110	252	602
Ecuador	17 373 657	5 448	77.0	108 108	394	755
Guyana	782 775	263	69.9	5 174	212	437
Paraguay	7 044 639	1 474	74.2	37 925	351	874
Peru	32 510 462	18 192	76.7	228 326	279	534
Suriname	581 363	164	71.6	4 221	234	634
Uruguay	3 461 731	1 596	77.9	61 231	444	616
Venezuela, Bolivarian Republic of	28 515 829	5 558	72.0	NAD	NAD	NAD
South America	**427 063 267**	**176 920**	**75.1**	**3 413 677**	NA	NA

ARI, acute respiratory infection; GDP, gross domestic product; PPP, purchasing power parity; NAD, no available data; NA, not applicable.
Notes: Total deaths included all age groups, except 0 to 1 year.
The Bolivarian Republic of Venezuela was not included in the calculation of total GDP.
Sources: [a]World Bank (28); [b]GHDx, Institute for Health Metrics and Evaluation (20); [c]Inter-American Development Bank.

TABLE 2. Economic data for countries in South America, 2019

Country	Sex	People outside the workforce × 1 000[a,b], n	People in the workforce × 1 000[a,b], n	Unemployment rate, %[c]	Retirement age, in years (2019)[c,d]
Argentina	F	8 737	8 796	10.7	65
	M	4 671	11 561	9.2	65
Bolivia, Plurinational State of	F	1 573	2 435	4.4	60
	M	768	3 209	3.4	60
Brazil	F	39 871	45 756	14.5	65
	M	22 461	58 620	10.1	65
Chile	F	3 938	3 858	8.0	65
	M	2 229	5 232	6.7	65
Colombia	F	8 827	11 234	12.8	54
	M	3 840	15 050	7.9	59
Ecuador	F	2 887	3 442	4.6	65
	M	1 361	4 869	3.3	65
Guyana	F	163	120	15.1	60
	M	95	186	12.5	60
Paraguay	F	981	1 477	8.3	65
	M	396	2 134	5.4	65
Peru	F	3 678	8 600	3.7	65
	M	1 823	10 198	3.1	65
Suriname	F	117	97	11.1	60
	M	70	141	5.7	60
Uruguay	F	636	807	10.5	70
	M	373	937	7.2	70
Venezuela, Bolivarian Republic of	F	6 794	3 849	NAD	55
	M	2 986	7 071	NAD	60
South America	NA	NA	NA	NA	NA

F: female; M: male; NAD: No available data. NA: not applicable.
Sources: [a]International Labour Organization (23); [b]World Bank (28); [c]Inter-American Development Bank; [d]Comisión Económica para América Latina y Caribe (26, 30).

RESULTS

Lost productivity due to ARIs

South America is a large, diverse subcontinent and home to 6% of the world's population. It had a GDP of about US$ 3.4 trillion in 2019 (28). In 2019, before the coronavirus disease 2019 (COVID-19) pandemic, about 1.4 billion new respiratory infections and 177 000 deaths in all ages were reported in South America, with significant differences between countries, age groups, and the sexes. Deaths, YPLL, workforce proportions, and employment rates by sex and economically

TABLE 3. Estimated YPLL and deaths due to ARIs, workforce proportion and employment rate in South American countries, by sex and age group, 2019

Country and age group in years	YPLL, in years		Deaths[a], n		Workforce proportion[b,c]		Employment rate[b,c,d]	
	F	M	F	M	F	M	F	M
Argentina			1 832	3 081				
15–24	4 013	5 251			0.32	0.46	0.71	0.76
≥25	21 168	34 645			0.55	0.78	0.92	0.93
Bolivia, Plurinational State of			473	572				
15–24	1 309	1 618			0.42	0.57	0.90	0.92
≥25	9 099	10 152			0.68	0.90	0.97	0.98
Brazil			6 522	11 603				
15–24	14 094	22 099			0.50	0.62	0.68	0.77
≥25	79 506	149 398			0.54	0.75	0.89	0.93
Chile			132	346				
15–24	247	310			0.29	0.34	0.80	0.81
≥25	1 424	4 122			0.54	0.78	0.93	0.94
Colombia			668	952				
15–24	1 702	3 015			0.43	0.58	0.75	0.84
≥25	3 721	8 054			0.59	0.86	0.90	0.94
Ecuador			376	624				
15–24	1 742	3 255			0.34	0.53	0.88	0.93
≥25	5 001	8 177			0.61	0.87	0.97	0.98
Guyana			30	55				
15–24	97	136			0.40	0.57	0.67	0.77
≥25	286	544			0.43	0.70	0.91	0.91
Paraguay			101	205				
15–24	417	688			0.58	0.66	0.80	0.88
≥25	1 366	2 673			0.73	0.90	0.95	0.97
Peru			1 099	1 758				
15–24	3 707	5 939			0.47	0.71	0.92	0.93
≥25	13 850	23 153			0.65	0.89	0.97	0.98
Suriname			37	70				
15–24	96	117			0.28	0.47	0.60	0.81
≥25	331	604			0.51	0.73	0.93	0.97
Uruguay			56	89				
15–24	139	149			0.42	0.52	0.68	0.76
≥25	956	1 541			0.59	0.76	0.93	0.96
Venezuela, Bolivarian Republic of			306	647				
15–24	1 895	1 955			0.19	0.51	0.83	0.88
≥25	3 542	7 908			0.41	0.76	0.93	0.93
South America	**169 708**	**295 503**	**11 327**	**19 357**	NA	NA	NA	NA

YPLL, years of productive life lost; ARI, acute respiratory infection; F, female; M: male; GDP, gross domestic product; NA, not applicable.
Sources: [a]GHDx, Institute for Health Metrics and Evaluation (20); [b]International Labour Organization (23); [c]Inter-American Development Bank; [d]Comisión Económica para América Latina y Caribe (26, 30).

active age group in South American countries are given in Table 3.

Table 4 and Table 5 present the estimated loss in productivity using the minimum wages in PPP and nominal wages, in US$, for both sexes, after applying the discount rate, the cost per death by ARI, the ratio of the cost of death between men and women, and the total cost as a percentage of GDP. In the absence of official data on income or wages for the Bolivarian Republic of Venezuela (23, 26, 27), the calculations for lost productivity due to ARIs for South America did not include the losses that occurred in this country.

In 2019, South America suffered just over 30 000 deaths in working-age groups (Table 3), and the productivity loss associated with ARIs was US$ 834 301 088 (Table 4). In PPP, this figure rose to more than US$ 2 billion.

Brazil had the highest YPLL (265 097 years) with the highest total productivity loss (US$ 438 090 274), and Guyana had the lowest YPLL (1 063 years) with the lowest productivity loss (US$ 1 655 181). The 12 South American countries lost 465 211 years of productive life in 2019 (Table 3), and Brazil accounted for almost 57% of this amount. In 2019, ARI-related deaths in the working-age population totaled 30 684. Brazil (18 125) and Argentina (4 913) accounted for about 60% and 16% of these deaths, respectively. They are also the countries with large populations on the subcontinent (Table 1).

TABLE 4. Estimated cost of lost productivity due to ARIs in South American countries, 2019

Country	Cost in PPP minimum wage 2019, US$			Cost in nominal minimum wage 2019, US$		
	Females	Males	Total	Females	Males	Total
Argentina	194 731 925	196 417 810	391 149 734	43 088 020	101 742 262	144 830 283
Bolivia, Plurinational State of	20 095 049	31 505 669	51 600 717	9 777 842	15 261 818	25 039 660
Brazil	484 122 478	441 548 816	925 671 294	118 519 931	319 570 342	438 090 274
Chile	14 611 200	60 032 077	74 643 277	4 177 557	14 719 615	18 897 172
Colombia	29 427 198	89 522 004	118 949 202	6 968 851	21 137 409	28 106 260
Ecuador	28 702 610	68 848 670	97 551 280	14 559 561	35 492 635	50 052 197
Guyana	1 342 046	3 964 779	5 306 824	428 398	1 226 783	1 655 181
Paraguay	10 594 427	25 473 405	36 067 832	4 261 545	10 176 494	14 438 039
Peru	96 037 060	221 242 534	317 279 594	30 867 010	71 782 997	102 650 007
Suriname	2 489 325	9 001 787	11 491 112	620 798	1 741 082	2 361 881
Uruguay	8 999 226	18 890 134	27 889 361	2 703 084	5 477 051	8 180 135
Venezuela, Bolivarian Republic of	NAD	NAD	NAD	NAD	NAD	NAD
South America	**891 152 545**	**1 166 447 684**	**2 057 600 228**	**235 972 599**	**598 328 489**	**834 301 088**

ARIs, acute respiratory infections; PPI, purchasing power parity; NAD, no available data.
Source: Prepared by authors from results of the study.

TABLE 5. Estimated cost per death from ARIs and total cost as a percentage of GDP in South American countries, 2019

Country	Cost per death from ARIs, US$ (2019)			Cost per death ratio (M/F ratio)	Total cost as % of GDP
	F	M	Total		
Argentina	23 516	33 006	29 468	1.40	0.032
Bolivia, Plurinational State of	20 677	26 680	23 963	1.29	0.061
Brazil	18 172	27 542	24 170	1.52	0.023
Chile	31 629	42 532	39 521	1.34	0.007
Colombia	10 426	22 195	17 341	2.13	0.009
Ecuador	38 687	56 870	50 030	1.47	0.046
Guyana	14 453	22 208	19 500	1.54	0.032
Paraguay	42 194	49 579	47 143	1.18	0.038
Peru	28 097	40 843	35 940	1.45	0.045
Suriname	16 666	24 898	22 037	1.49	0.056
Uruguay	48 183	61 526	56 368	1.28	0.013
Venezuela, Bolivarian Republic of	NAD	NAD	NAD	NAD	NAD
South America	26 609	37 080	33 226	1.40	0.024

ARIs, acute respiratory infections; GDP, gross domestic product; M, males; F, females; NAD, no available data.
Source: Prepared by authors from results of the study.

Brazil and Argentina reported the highest total cost of productivity losses (US$ 438 090 274 and US$ 144 830 283, respectively) and in PPP (US$ 925 671 294 and US$ 391 149 734, respectively) (Table 4). The countries with the lowest cost of losses were Guyana (US$ 1 655 181) and Suriname (US$ 2 361 881). In PPP, the lowest cost of losses occurred in Guyana (US$ 5 306 824) and Suriname (US$ 11 491 112), the countries with the smallest populations in the subcontinent.

The permanent loss of productivity in 11 of the 12 South American countries in 2019 represented 0.024% of their combined GDP. However, variations were seen between the countries: for example, the total cost of ARIs as a proportion of GDP was higher in the Plurinational State of Bolivia and Suriname (0.061% and 0.056%, respectively) while in Chile and Colombia the proportionate cost was lower, 0.007% and 0.009% of GDP, respectively. Costs per death in Uruguay (US$ 56 368/death) and Ecuador (US$ 50 030/death) were 3.3 times higher than in Colombia and Guyana (US$ 17 341/death and US$ 19 500/death, respectively). For South America overall, the cost per death was US$ 33 226.

Estimates of ARI deaths by sex indicate significant differences. In Chile, deaths caused by ARIs in working-age men were 2.6 times higher than in working-age women (346 and 132 deaths, respectively). The Bolivarian Republic of Venezuela also had a higher male:female death ratio of 2.1. The country with the least differences in deaths between the sexes was the Plurinational State of Bolivia – male:female death ratio of 1.2.

TABLE 6. Estimated percentage change in productivity losses from baseline using different discount rates, retirement age, and number of deaths in South American countries, 2019

Country	No discount, %	6% discount, %	Real retirement after 5 years of legal retirement, %	Absolute number of deaths (upper CI), %	Absolute number of deaths (lower CI), %
Argentina	38.2	–21.8	38.4	28.7	–24.4
Bolivia, Plurinational State of	40.8	–23.1	33.9	62.0	–45.8
Brazil	40.7	–23.0	33.3	10.9	–12.3
Chile	33.5	–20.0	42.2	29.3	–29.3
Colombia	13.9	–23.9	32.4	40.6	–28.4
Ecuador	51.0	–26.7	26.6	53.5	–31.4
Guyana	47.1	–25.4	28.0	50.3	–35.9
Paraguay	48.2	–25.6	28.8	51.9	–37.5
Peru	47.7	–25.4	29.1	55.8	–37.3
Suriname	40.7	–23.0	29.9	49.3	–37.3
Uruguay	39.6	–21.9	37.1	26.5	–32.8

CI, confidence interval.
Note: The Bolivarian Republic of Venezuela was excluded because it did not have data for productivity loss calculations.
Source: Prepared by authors from results of the study.

Productivity losses were also significantly different between men and women. In Suriname and Chile men's productivity losses were more than 3.6 times greater than women's. Argentina had almost no difference in productivity losses between men and women (Table 4). In addition, the cost per death caused by ARIs was higher in men than in women. Colombia and Guyana had the highest cost per death sex ratios (2.1 and 1.5, respectively), while Paraguay (1.2), Uruguay (1.3), and the Plurinational State of Bolivia (1.3) had lower ratios.

Changes in productivity losses were estimated by varying: (i) discount rate values; (ii) retirement age; and (iii) number of deaths (Table 6). First, labor losses caused by premature deaths were estimated with different discount rates in the year 2019. For example, in Argentina, the baseline productivity loss was US$ 144 830 283 (Table 4). Without the 3% discount used in the baseline estimates, this loss would be US$ 200 119 061. The absolute difference is US$ 55 288 694, corresponding to an increase of 38%. Overall, 0% discount resulted in an increase in productivity losses, while an increase in the discount rate to 6% reduced the productivity losses.

A second alternative scenario estimated the change in productivity losses with an older retirement age (70 years versus 65 years). This change resulted in an increase in the costs of permanent productivity losses, as the time working in the workforce is also longer.

Third, epidemiological changes were simulated using mortality. By using the upper confidence interval of the number of deaths from the GHDx (20), productivity losses increased, while using the lower confidence interval, with a lower number of deaths, productivity losses decreased.

DISCUSSION

The main results of this study show that the total cost of lost productivity in South America economies caused by ARIs in 2019 was around US$ 834 million (more than US$ 2 billion in PPP), representing 0.024% of the combined GDP of these countries (ranging between 0.007% and 0.0615.), and a cost per death of US$ 33 226. The labor markets, in terms of quantity (jobs and hours worked) and wages, differ considerably between South American countries. Therefore, this comparison between GDP and productivity losses helps to highlight the potential impact of these premature deaths from ARIs in economic terms and the social losses that can be caused by these deaths (10, 13, 14).

South American countries differ significantly by population and economic circumstances (GDP, workforce, unemployment, and retirement age) (23, 26–28), and these difference can explain the variability in YPLL and lost productivity estimates found in this study. Studies that explored very different regions and countries also reported heterogeneous findings (2, 10, 12, 14). Modifying the scenarios suggests that local factors such as age of retirement, changes in the workforce, and deaths related to ARIs are important in interpreting the results. As shown in a previous study (14), the variation observed when changing the discount rate is consistent with the variation in productivity.

The human capital approach has been widely used to understand the costs of premature mortality in several disease areas (especially in oncology) and regions, although our findings are not directly comparable with them, since cancer and ARIs are very different illnesses and regions differ considerably (14, 15). Our estimates are different from those observed in a study in Ecuador which calculated the burden of acute respiratory diseases between 2011 and 2015 (10). The results showed that 17 757 ARI-associated deaths occurred for all age groups with estimated average annual productivity losses of US$ 152 million (temporary and permanent losses), equivalent to 0.164% of Ecuador's GDP. The authors stated that most of the burden could be attributed to years of life lost due to premature mortality in the population younger than 5 years and older than 60 years (10). We estimated a cost per death related only to early deaths in the working-age population of US$ 50 030, equivalent to 0.046% of Ecuador's GDP. The databases, methodologies, and discount rates used may be responsible for the difference in the results of our study and the earlier study.

A study calculating permanent productivity losses due to cancer in Brazil, Russia, India, China, and South Africa (BRICS countries), reported 87 000 annual deaths for Brazil (2012), at a total cost of lost productivity of US$ 4 647 822 021 (US$

53 377/death), representing 0.2% of Brazil's GDP (14). Cancers kill five times more people than respiratory diseases and the authors used higher per capita incomes in their calculations than we did.

The average cost per death caused by ARIs for South America was US$ 33 226, equivalent to 0.024% of its GDP. The cost per death showed substantial differences between countries and between the sexes. Our estimated costs per death appear lower than those reported in other locations and regions (5, 10, 14). Because of the methodological, population, and economic differences between studies, caution is needed when comparing the findings.

This work has some limitations. First, the cost of temporary productivity losses related to ARIs was not calculated; only permanent productivity losses were considered because of the unavailability of data.

We used the human capital approach to estimate the costs of premature deaths derived from ARIs. This approach is the most used method to calculate productivity loss (14–16, 18). Critics of this approach point out that the values resulting from lost productivity are subject to biases in earning patterns. Women, young persons, and disadvantaged socioeconomic groups generally earn less, so their lost productivity is typically less valued with this approach. Furthermore, the human capital approach measures the potential productivity loss rather than the actual loss incurred by society (15).

Other approaches can be used such as the value of the statistical life. In this method, there are some difficulties in obtaining the data to estimate the values in low- and low-middle income countries, which is the case for several Latin American countries. Some indirect methods can be used to estimate the costs of premature deaths (33). After applying this alternative approach to different countries, Viscusi and Masterman found that the results yielded much higher values than the human capital approach, in the range of 2–4-fold higher. These values were highly dependent on the level of per capita income (the lower the per capita income of the country, the lower the value of the statistical life). Thus, the human capital method we used in our study likely gives conservative results for the analyzed countries. This potential underestimation of productivity losses should be taken into account if such information is to be used for policy-making.

Our assessment, as others (13), focused on lost productivity, enabling a quantitative description of the burden of ARIs, without considering other aspects such as direct health costs and time away from work which varies significantly from one person to another (5, 10, 13).

Another limitation of our study is related to using minimum wages and not average earnings in the calculations. Average wages and minimum wages for this region do not reveal much about how wages are distributed across different groups. Considerable informality exists in the economy in developing countries (10, 23, 25, 26, 34), and the "actual" average retirement age of each country is different from the legal retirement age. In these countries, it is not uncommon for individuals to retire and to continue working as a way of supplementing their income. Thus, the productivity losses may have been underestimated, as individuals have a longer productive life than that established by the retirement age (13, 34).

Our study is based on global data, both health, economic, and demographic (20, 21, 23, 26, 27). Although national or regional records are more consistent, under-reporting or lack of data were found, as seen for the Bolivarian Republic of Venezuela. The use of statistical models to estimate hospitalization and mortality rates associated with respiratory viruses is not agreed upon, as they may lack precision (9) and some studies used non-representative samples (11). In 2011, a study that estimated resource use and cost of treating acute cough and lower respiratory tract infections in 13 European countries showed substantial variation between mean treatment costs (US$ 25.1 to US$ 122.3) (35). The authors reported that the main difficulty in carrying out studies on the costs across different nations was the barriers associated with identifying reliable databases and data.

Despite these limitations, our study provides useful new information on the impact of mortality from ARIs. To the best of our knowledge, this is the first work to estimate potential productivity losses due to mortality from upper and lower respiratory infections (together) in all South American countries. Many ARIs that result in high productivity losses in South America countries are amenable to prevention, early detection, and/or treatment. Implementation of such programs, as has been in done in more developed countries, would lead to lower productivity losses and costs. An increasing number of South American countries have immunization programs and national ARI treatment guidelines (1, 2, 6).

Conclusion

Permanent loss of productivity due to ARIs is important and has a significant impact at an individual and societal level in South America. The average individual loss in persons of working age is about US$ 33 226 and the social loss is nearly US$ 840 million. The differences in the estimates of lost productivity values between the South American countries suggests the need for economic and social debate about gender inequalities, access to health services, prophylaxis (such as vaccination), and treatments, and also debate on the quality and transparency of data in low- and middle-income regions.

Characterization of the burden of these diseases using DALYs and productivity loss metrics can support governments in allocating resources for planning health policies and interventions for the prevention and control of ARIs. Multinational studies can be helpful in exploring variability in resource use and cost across and within countries.

Author contributions. FA conceived the original idea. GBGM collected the data. GBGM and CMMV analyzed the data and interpreted the results. GBGM wrote the paper. All authors reviewed the paper and approved the final version.

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Costo de la pérdida de productividad por infecciones respiratorias agudas en América del Sur

RESUMEN

Objetivos. Estimar la carga de la pérdida permanente de productividad causada por infecciones respiratorias agudas en países sudamericanos en el 2019.

Métodos. Se analizaron los datos de mortalidad del estudio sobre carga mundial de enfermedad del 2019 para estimar la carga de enfermedad atribuible a las infecciones respiratorias agudas. Se empleó un enfoque basado en el método del capital humano para estimar el costo de las pérdidas permanentes de productividad relacionadas con las enfermedades respiratorias. Para ello, la suma de los años perdidos de vida productiva por cada muerte se multiplicó por la proporción de la fuerza de trabajo y la tasa de empleo y, a continuación, por el salario mínimo anual o la paridad del poder adquisitivo en dólares estadounidenses en los grupos etarios económicamente activos de cada país. Se realizaron cálculos separados para hombres y mujeres.

Resultados. El número total de muertes por infecciones respiratorias agudas en el 2019 fue de 30 684 y se perdieron 465 211 años de vida productiva. El costo total de la pérdida permanente de productividad fue de aproximadamente US$ 835 millones según el salario mínimo anual y de US$ 2000 millones en cuanto a la paridad de poder adquisitivo, lo que representa el 0,024% del producto interno bruto de la región. El costo por muerte fue de US$ 33 226. El costo de la pérdida de productividad difirió sustancialmente entre los países y según el sexo.

Conclusión. Las infecciones respiratorias agudas suponen una carga económica significativa para América del Sur en términos de salud y productividad. La caracterización de los costos económicos de estas infecciones puede ayudar a los gobiernos en la asignación de recursos para elaborar políticas e intervenciones que permitan reducir la carga de las infecciones respiratorias agudas.

Palabras clave Costo de enfermedad; infecciones del sistema respiratorio; América del Sur.

Custo da perda de produtividade devido a infecções respiratórias agudas na América do Sul

RESUMO

Objetivos. Estimar a carga de perdas permanentes de produtividade causadas por infecções respiratórias agudas em países da América do Sul em 2019.

Métodos. Dados de mortalidade do estudo Carga Global de Doença 2019 foram analisados para estimar a carga de doença atribuível a infecções respiratórias agudas. Utilizou-se uma abordagem baseada no método do capital humano para estimar o custo das perdas permanentes de produtividade associadas às doenças respiratórias. Para calcular esse custo, a soma dos anos de vida produtiva perdidos devido a cada morte foi multiplicada pela proporção da força de trabalho e da taxa de emprego. Em seguida, esse valor foi multiplicado pelo salário mínimo anual ou pela paridade do poder de compra, em dólares dos Estados Unidos (US$), de cada país nas faixas etárias economicamente ativas. Foram feitos cálculos separados para homens e mulheres.

Resultados. O número total de mortes por infecções respiratórias agudas em 2019 foi de 30 684, com 465 211 anos de vida produtiva perdidos. O custo total da perda permanente de produtividade foi de cerca de US$ 835 milhões com base no salário mínimo anual e US$ 2 bilhões em paridade de poder de compra, o que representa 0,024% do produto interno bruto da região. O custo por morte foi US$ 33 226. O custo da perda de produtividade diferiu substancialmente entre os países e por sexo.

Conclusão. As infecções respiratórias agudas impõem uma carga econômica significativa à América do Sul em termos de saúde e produtividade. A caracterização dos custos econômicos dessas infecções pode fundamentar as decisões de alocação de recursos tomadas pelos governos para desenvolver políticas e intervenções com o intuito de reduzir a carga das infecções respiratórias agudas.

Palavras-chave Efeitos psicossociais da doença; infecções respiratórias; América do Sul.