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# The Cost of Lost Productivity due to Premature Chagas Disease-Related Mortality: Evidence from Colombia (2010-2017)

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## Abstract:

Economic burden due to premature mortality has a negative impact not only in health system even though in the society. The aim of this study was to estimate the potential years of work tenure lost (PYWL) due to Chagas disease in Colombia from 2010-2017. National data on mortality by sex and ages between 15 and 62 due to Chagas from 2010 to 2017. The PYWL methodology was applied to assess the impact of Chagas disease in workers who suffer from them. In total, 1,261 deaths were analyzed in the study, of which 60% corresponded to males. The loss of labor productivity caused by Chagas disease was estimated at \$29 million. Overall, 48,621 PYWL were lost, and there was an average of 21 years for all subjects with Chagas. Throughout the analyzed period, PYWL increased substantially, and it is necessary to continue with early detection programs to avoid premature death in working age population.

**Keywords:** Chagas disease; Cost of Illness; Mortality Premature; Efficiency; Organizational; Life Expectancy.

## 1. Introduction

Chagas disease remains a serious public health problem worldwide, where its economic and social repercussions are of great magnitude [1]. The infection is endemic in South America and emergent in Europe and the United States [2]. This parasitic disease affects 6–7 million people worldwide, causing more than 7,000 deaths each year [3]. The calculate cost of program to diagnosis Chagas disease was US 13.1 million on 2017 [4].

Chagas disease not only imposes a significant health burden on individuals but also a large economic burden in low- and middle-income countries in the Americas, and in some high-income countries, over recent decades [4]. Among the working-age population, the economic cost of illness-related productivity losses as a result of lower productivity at work, lost workdays, and mortality can far exceed Chagas-related medical cost [5].

It is important to quantify the value of labor productivity loss due to premature mortality in measuring the economic burden of disease. Specially, communicable diseases that affects low- and middle-income countries. To quantify social and economic loss owing to premature death in working population age, is used the indicator of years of potential productive life lost [6,7]. Furthermore, Chagas disease has been associated with excess mortality [8]. The most frequently used measures to quantify social and economic loss due to premature death are years of potential life lost (YPLL) and potential years of work tenure lost (PYWL) [6,9–11].

Chagas disease is a clear threat not only to human health, but also affects the level of family income and economic growth in a country, particularly in rural areas [4]. It is estimated that about 752,000 of working years per year are lost due to premature deaths caused by diseases in the seven southernmost countries of America, which corresponds to 1,208.5 US\$ million/year [5].

Despite the high prevalence of Chagas disease estimated in Colombia [12], there are few studies that have estimated the productivity losses associated with premature deaths from this infection in the country [4]. Therefore, the study was aimed to estimate the PYWL associated with premature deaths caused by Chagas disease during the period 2010-2017 in Colombia.

## 2. Materials and Methods

This study was developed based on the human capital approach to estimate the costs of productivity lost derived from premature mortality due to Chagas disease in Colombia. Premature mortality was defined as deaths from Chagas before the age of 65 years old. The human capital approach equates productivity lost to an individual's wage rate and assumes that an individual produces a stream of output over a working lifetime which is cut short by premature death. All expenses were reported as Colombian pesos (COP) and were converted to US dollars (1 USD [US\$] = 2.984 COP) from year 2017 [13].

### Data Source

Numbers of deaths during 2010-2017 by 5-year age group and sex between the ages of 15 and 64 were obtained from the mortality database of the National Administrative Department of Statistics (DANE) using the International Classification of Diseases (ICD) code B57 [14]. The database contains number of

deaths due to all causes by sex and 5-year age- groups. Economic data, including wages, unemployment rates, labor force participation rates and gross domestic product (GDP), were derived from Bank of the Republic of Colombia.

**Estimation Methods**

To calculate PYWL the number of deaths that could be attributed to Chagas from 2010 to 2017 by sex was extracted and, from these, PYWL for men and women across productive age groups (between 15 and 64) were calculated, thereby assuming all those working will retire at 62 (for men) or 57 (for women), the official pensionable age in Colombia in 2017 [15]. Valuation of premature mortality costs involved multiplying, for each death, PYWL by age- and gender-stratified gross wages from age of death until to the official pensionable age. Estimates were adjusted for probability of being occupied. Wage growth was calculated at 2.5% per annum and a discount rate of 3% annually was applied. The scenario that assessed the 2017 minimum annual salary (3,301 USD per year) was modeled. Statistical analysis was performed using Stata version 14.0 (Stata Corporation LP, College Station, TX, USA). All the variables included in the study were described using the appropriate univariate statistics.

**Sensitivity analyses**

One-way sensitivity analysis was conducted to assess the effects of varying the parameters: the wage growth rate was varied to 1.5% and 3.5% to account for uncertainty over future growth in the Colombian economy, the discount rate was varied to 2% and 5% and, the minimum annual salary to 2,715 and 4,000. In addition, the effect of extending the retirement age to 65 was explored.

**3. Results**

From 2010 to 2017, 1,446 deaths caused by Chagas disease were recorded. Of these, 185 deaths occurred in people under 18 years of age for which reason they were excluded. In total, 1,261 deaths were analyzed in the study, of which 60% corresponded to males. The mean age at death was 21 years. Table 1 presents the number of deaths of all ages for males and females. Total PYWL was lower in women than men (18,384 vs 30,237). Total PYWL were 48,621. It is noticed that the deaths are increasing each year of the analysis period.

**Table 1.** The number of deaths and estimated PYWL by sex during 2010-2017

Year	2010	2011	2012	2013	2014	2015	2016	2017	Total
Number of deaths									
Males	102	87	101	110	113	93	132	128	866
Females	58	51	59	71	79	85	92	85	580
Total	160	138	160	181	192	178	224	213	1,446

Deaths at working age									
Males	84	69	88	95	93	83	117	112	741
Females	52	45	51	64	72	76	84	76	520
Total	136	114	139	159	165	159	201	188	1,261
PYWL									
Males	3,441	2,822	3,594	3,900	3,777	3,348	4,772	4,583	30,237
Females	1,854	1,593	1,824	2,263	2,521	2,682	2,968	2,679	18,384
Total	5,295	4,415	5,418	6,163	6,298	6,030	7,740	7,262	48,621

Table 2 demonstrates the average premature mortality cost per PYWL by sex from 2010 to 2017. The cost per PYWL for both sexes combined was \$29,683,913 in the study period, and it was \$17.3 for males and \$12.3 for females from 2010 to 2017.

The total cost of lost productivity due to premature mortality was 39, 7% higher in males than female, although the cost per PYWL its higher in females.

**Table 2.** Premature mortality cost by sex (USD 2017)

	<b>Total premature mortality cost</b>	<b>% of the total</b>	<b>Premature mortality cost per death</b>	<b>Premature mortality cost per PYWL</b>
Males	17,301,237	58	23,348	572
Females	12,382,676	42	23,813	674
Total	29,683,913	100	23,540	611

Table 3 show the cost of premature mortality cost for sex, for male is higher in each year of this period.

**Table 3.** Premature mortality cost per sex 2010 - 2017 (USD 2017)

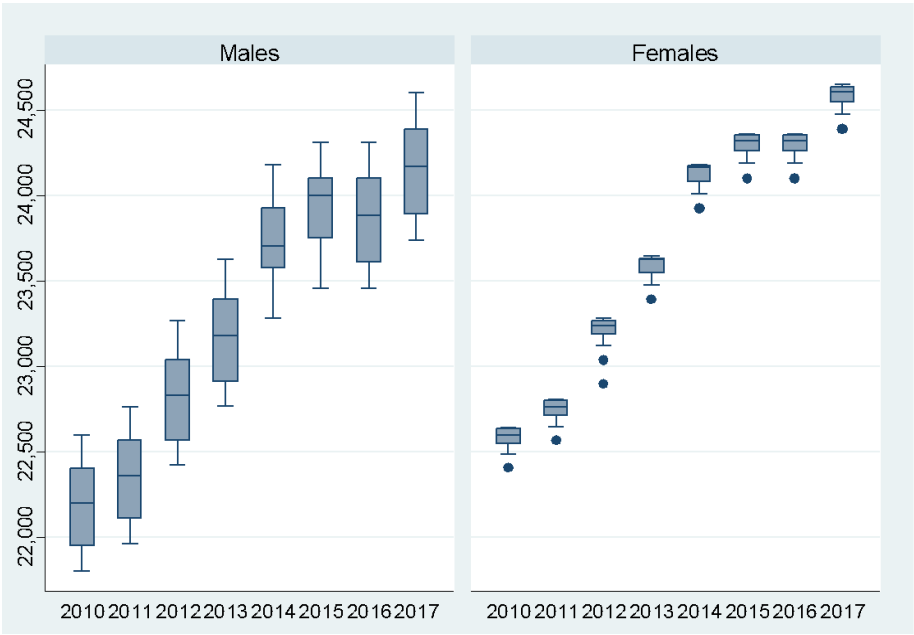
<b>Year</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
Males	1,862,873	1,541,799	2,008,175	2,198,782	2,206,153	1,986,068	2,793,321	2,704,067
Females	1,174,136	1,023,484	1,183,187	1,509,232	1,736,916	1,846,584	2,040,400	1,868,737
Total	3,037,009	2,565,283	3,191,362	3,708,014	3,943,069	3,832,652	4,833,722	4,572,803

We classified people included according to age in two groups. People who died between 18-25 are categorized as younger and people above 25 years old are classified as adults. Therefore, the Table 4 show the impact the cost is bigger in the youngest.

**Table 4.** Premature mortality cost per group of age 2010 - 2017 (USD 2017)

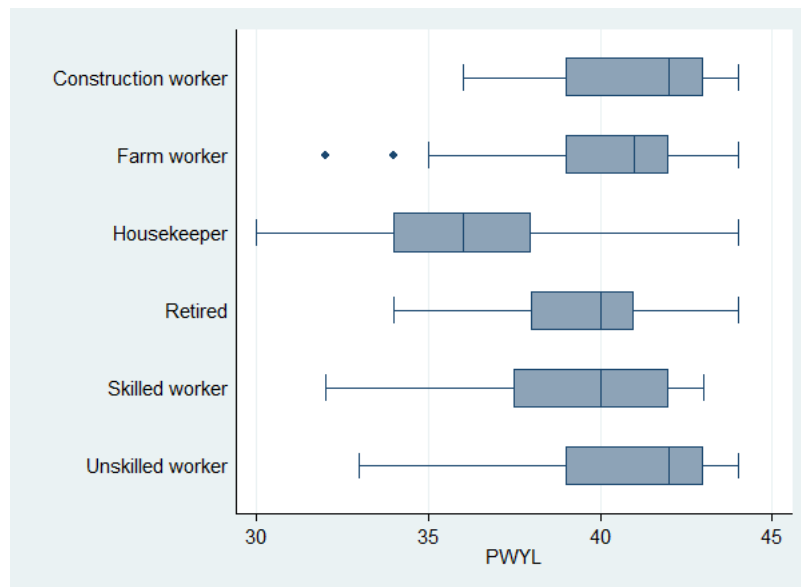
Year	2010	2011	2012	2013	2014	2015	2016	2017
Adults	22,597	68,203	46,165	47,106	96,491	72,932	170,012	98,320
Young	3,014,412	2,497,081	3,145,197	3,660,908	3,846,578	3,759,719	4,663,710	4,474,483

The figure 1 shows up a boxplot of cost of premature mortality by sex, this is bigger for men per death in comparison with women.



**Figure 1.** Productivity cost lost due to premature mortality by sex (US2017)

The Figure 2 evidence the PYWL per occupational group where construction workers, farm worker and unskilled worker are the third group with the most year of productivity life lost.



**Figure 2.** PYWL per occupation

#### 4. Discussion

The main result of this study is the estimation of the monetary value of the accumulated labor productivity losses during the 2010-2017 period due to deaths caused by Chagas disease in Colombia. This cost amounted to \$29 million. Despite the magnitude of the estimated cost, the trend observed throughout the period is clearly upward.

In recent years, Colombia has had great social, demographic, environmental and technological transformations in a sustained manner, and despite the innumerable situations of social injustice caused by world economies, the living conditions of the populations improved significantly [16,17]. However, diseases associated with contexts of social vulnerability and neglect, such as Chagas disease, still affect a considerable part of the population [12].

It is also worrying that the percentage of deaths from preventable Chagas disease continues to be high in the younger population. This is probably associated with the barriers to timely diagnosis that persist in the country and the difficulties associated with treatment [1,18,19]. This implies maintaining the early detection programs based on the evidence generated by the system [20,21].

Interestingly, 60% of the estimated losses in labor productivity fall on men. This can be explained by the higher risk of death in this group, and on the other hand, by the fact that employment rates and wages are higher for men than for women. It could also be related to the difference between men and women retirement age. These results are consistent with previous studies that have consistently reported that men have a higher risk of death compared to women [22,23].

Previous studies have tried to estimate the social impact of premature deaths on workers suffering from Chagas disease, but in a time horizon of one year [4]. On the other hand, some research has delved into the consequences on the loss of health-related quality of life caused by the consequences of the disease [24,25].

It is important to note that the theoretical approach used in the present study is the theory of human capital [26]. The main alternative approach is the so-called friction period method [27]. Although the methodological discussion on the strengths and weaknesses of both approaches has been intense, there is still no agreement on which is the best [26]. In this study, the human capital approach was chosen due to its greater anchorage with economic theory and for being the most widely used method in the scientific literature of disease cost studies.

The main limitations include, first, the real wages of people who died from Chagas disease are not considered (they are estimated from the average wage in Colombia). Second, there was also no information on whether the deceased worked or not (the average employment rates adjusted for age and sex apply). Third, the mortality database may have an underreporting death associated with Chagas disease.

## 5. Conclusions

Reducing premature and preventable deaths from Chagas disease are key health goals in the ten-year plan Colombian public health. The size of the economic impact and the burden borne by society due to premature deaths from Chagas reinforce the need to continue investing in early detection programs, in particularly because the cost of program of diagnosis is lower than the cost of PWLY in the analyzed time period, as well as initiatives that promote prosperity and well-being for all.

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