Trends in relevant excess mortality in Peru and nine areas during the first wave of COVID-19 pandemic between January and May 2020: A descriptive study

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Trends in relevant excess mortality in Peru and nine areas during the first wave of COVID-19 pandemic between January and May 2020: A descriptive study

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Abbreviated title: Trends in relevant excess mortality in Peru and nine capitals during COVID-19 pandemic.

26

27 **ABSTRACT**

28 **Introduction:** COVID-19 has arrived the main capitals of Peru and caused direct and indirect
29 deaths. Though mortality data is reported through SINADEF, relevant excess mortality (REM)
30 remains unknown.

31 **Objective:** To estimate the monthly relevant excess mortality for all causes and non-related
32 with violent and COVID-19 causes between January and May 2020 in Peru and nine areas with
33 the highest absolute numbers of deaths by COVID-19.

34 **Material and Methods:** To estimate relevant excess mortality, we calculated the monthly
35 upper and lower limits of historical mortality (95% confidence interval) and the average for the
36 last 3 years (2017-2019). REM was considered when observed values exceed the estimated
37 upper limit plus corresponding 2 standard deviations. We also determined REM excluding non-
38 related with violent and COVID-19 causes.

39 **Findings:** Relevant excess mortality of 35 deaths per 100 000 population from all causes during
40 April and May 2020 were found in Peru with no difference when we excluded violent deaths.
41 In addition, Callao had the highest REM followed by Lima, Ucayali, Loreto, Piura, Ica, Ancash,
42 and La Libertad. In country and capitals analysis, male and individuals over 60 years were the
43 most affected groups.

44 **Discussion:** Relevant excess mortality determination is a needed, easy and low-cost approach
45 to monitor the progress of COVID pandemic and to evaluate the effectiveness of policy
46 measures. This surveillance method should expand to the 25 locations of Peru.

47 **Conclusion:** COVID-19 accounted for 45% of the relevant excess all-cause deaths, leaving
48 54.29% unattributed to COVID-19. Hence, it is necessary to rethink the policy measures in
49 order to avoid direct and indirect deaths attributed to the pandemic.

50 **Keywords:** Mortality, COVID-19, Public Health Surveillance, Peru (source: MeSH)

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) first emerged in December 2019 in Wuhan, China and rapidly spreads across most countries of the world(1). The Coronavirus Disease 2019 (COVID-19) was confirmed to have reached Latin America in February 2020 and Peru reported its first case on March 6, 2020(1,2). The World Health Organization (WHO) even recognized that COVID-19 was a pandemic on March 11(1). On March 15, the Peruvian government just declared a national state of emergency and meanwhile there had already reported 71 cases in the main cities of Peru(2).

The first death was reported on March 19 and at the end of the month there were already 66 deceases: 75.75% men and 66% over 60 years old(3). At the end of May, Peru was the tenth most affected country with 178 024 infected people and 4638 deaths(2,3). Although there was a considerable increase of molecular and serological testing for COVID-19, 11518 molecular tests were only performed between March 4 and March 30(4). With the limited availability of tests and imperfect sensitivity of the serological tests(5), there have indisputably been a number of deaths caused by COVID-19 that are not counted in official data. Indirect deaths are also common in a pandemic situation due to an overloaded health system or lack of healthcare access (6). Both types of death are described in specific risk groups.

A meta-analysis of thirteen studies found that male, older than 65 years, current smoking were risk factors for severe disease progression in patients with COVID-19(7). It can also aggravate and increase mortality burden especially affecting people with prior health conditions including diabetes, hypertension, cardiovascular disease, and respiratory disease (7). In particular, Peru has epidemiological features in relation to severe risk factors.

76
77 According to the last Peruvian national census in 2017, the population accounted for 29 381
78 884 inhabitants with almost one third of the nation's population living in its capital, Lima(8).
79 Moreover, 49.18% of individuals were male and only 11.9% were over 60 years old(8).
80 Comorbidities are common and it was reported that 3.6%, 9.5% and 22.7% of the population
81 over 15 years old were diagnosed with diabetes, hypertension and obesity respectively in
82 2018(9). Additionally, 11.2% of people smoke cigarettes currently in 2018(9). Indeed,
83 Peruvian data reported older than 60 years and patients with hypertension and obesity had a
84 greater risk of death(10,11).

85
86 On the other hand, secondary consequences of social distancing may increase suicides,
87 homicides and decrease motor vehicle accidents. For example, canceled public events and
88 closed businesses have been associated with higher suicide rates compared with times of
89 prosperity (12). Also, lockdown could interrupt the access to community and religious support
90 or mental health treatment and raise this kind of violent deaths(13). In order to concentrate on
91 biological causes of death, we excluded violent deaths.

92
93 Weekly excess deaths analysis could provide the most objective and comparable way of
94 assessing the total mortality effects of a pandemic (16). Unfortunately, most countries do not
95 publish such statistics. National Death Registry Information System (SINADEF) provides a
96 monthly number of deaths.

97
98 Therefore, to track the impact of COVID-19 in Peru, we estimated the monthly excess mortality
99 for all causes and non-related with violent and COVID-19 causes between January and May
100 2020 Peru and nine areas with the highest absolute numbers of deaths by COVID-19.

METHODS

This is a descriptive study based on official public data in which we analyzed the excess of deaths between January 1 and May 31 of 2020 by all causes and excluding the violent and COVID-19 deaths

Study locations

Peru's divisions are 25 areas: 24 departments and one constitutional province(Callao) of which we selected the areas with the highest absolute numbers of deaths by COVID-19 (>100 deaths) until May 31th, 2020 according a study that found the excess was greater in the regions most affected by COVID-19 in Italy (14). These were Lima, Lambayeque, Piura, Loreto, Callao, Ancash, Ica, La Libertad and Ucayali.

Data sources

We accessed the mortality database updated to Jun 6th, 2020 from SINADEF (15). The data included the monthly number of deaths by sex and age class. We also used data from violent deaths, namely those associated with traffic accidents, homicides, suicides, work-related deaths and other accidents. Data are available for the period January 1st to May 31th, 2020, and for the corresponding periods in 2017–2019.

Data from confirmed deaths by COVID-19 updated to Jun 6th, 2020 were collected from the National Open Data Platform (NODP) (3). The published data corresponds date of birth, date of death, sex, department, province and district. We did not use province and district data. Although, SINADEF and NODP have missing data on subtotal deaths (unknown age or gender). We did our best to mitigate the impact of these data quality issues.

Current population data was not available. Demographic data were collected from the 2017 Peruvian National Census (8). We only obtained general, sex and age groups population data to calculate the mortality rates.

Data analysis

To estimate the excess mortality (EM), we calculated the monthly upper and lower limits of historical mortality (95% confidence interval) and the average for the last 3 years (2017-2019) and the current year between January 1st and May 31th because the information was not available for earlier years.

The Relevant Excess Mortality (REM) calculation method has been considered when the observed values exceed the estimated average value plus corresponding 2 standard deviations (17,18). Our approach is more careful to not overestimate the excess of mortality. We consider REM when the observed values exceed the estimated upper limit value plus corresponding 2 SDs but we also show the REM related to the estimated average value. We calculated REMs using death absolute values and mortality rates to total deaths (TD), total deaths excluding violent deaths (TD-VD) and COVID-19 deaths (TD-VD-CD). The same process was done by sex and age class (0-11y,12-17y,18-29y,30-59y and $\geq 60y$).

Data were downloaded as tables and analyzed using Microsoft Excel 19. We developed a data extraction sheet. One author extracted data, the second author checked the extracted data and both analyzed the information. Figures were designed using STATA 16 licensed by Cayetano Heredia Peruvian University.

No information at the individual level or on the cause of death was used, therefore clearance from the Ethical Review Board was not necessary.

RESULTS

Peru

Our results were compatible with no REM between January-March 2020 and REM of 6 and 29 deaths per 100,000 population in April and May 2020 severally (Table 1 and fig. 1). During January and February, Peru did not informed COVID-19 deaths. This study did not find a difference in April and May REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 19 deaths per 100,000 population in May. Hence, COVID-19 deaths explained fully April REM and partially May REM.

We noted REM for men of 11 and 44 deaths per 100,000 population for April and May 2020 respectively (Table 2 and fig. 2). Additionally, this study did not find difference when we evaluated TD-VD and just 1 and 31 deaths per 100,000 population in April and May respectively for TD-VD-CD. On the other hand, this study manifested REM for women of 1 death per 100,000 population and 14 deaths per 100,000 population in April and May respectively (Table 2 and fig. 3). We observed the same REM when we evaluated TD-VD and just 9 deaths per 100,000 population in May for TD-VD-CD.

We did not find REM between January and March 2020 by age group (table 3 and Fig. 4-6). April REM was 5 deaths per 100,000 population for the 30-59y group and 21 deaths per 100,000 population for ≥ 60 y group (table 3 and Fig. 7). May REM was 30 deaths per 100,000 population for the 30-59y group and 188 deaths per 100,000 population for ≥ 60 y group (table 3 and Fig. 8). Note that when we assessed TD-VD, it did not represent a significant difference

in REM. Otherwise, we did not find REM if we evaluated TD-VD-CD in April. Instead, we found REM of 22 and 130 deaths per 100,000 for the 30-59y group and $\geq 60y$ group respectively in May.

Lima

Our results are compatible with REM of 4, 25 and 59 deaths per 100,000 population in March, April and May 2020 severally (Table 1 and Fig. 9). This study did not find difference in REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings indicated REM of 3, 17 and 48 deaths per 100,000 population in March, April and May respectively.

We found REM for men of 5, 35 and 86 deaths per 100,000 population in March, April and May 2020 respectively (Table 2 and Fig. 10). Additionally, this study found just a little difference in March and April when we evaluated TD-VD and just 3, 23 and 73 deaths per 100,000 population in March, April and May severely for TD-VD-CD. On the other hand, this study manifested REM for women of 4, 15 and 32 deaths per 100,000 population in March, April and May respectively (Table 2 and Fig. 11). We observed the same REM when we assessed TD-VD and just 3, 11 and 28 deaths per 100,000 population in March, April and May severally for TD-VD-CD.

We find REM in all the months by age group, except in February 2020 (Table 3 and Fig. 13). January REM was 1 death per 100,000 population for the 18 – 29y group (Table 3 and Fig. 12). In March we observed REM of 31 deaths per 100,000 population for $\geq 60y$ group (Table 3 and Fig. 14). April REM was 14 and 107 deaths per 100,000 population for the 30-59y group $\geq 60y$ group respectively (Table 3 and Fig. 15). May REM was 52 deaths per 100,000 population for the 30-59y group and 358 deaths per 100,000 population for $\geq 60y$ group (Table 3 and Fig. 16). Note that when we assessed TD-VD, it did not represent a significant difference in REM. If we

evaluated TD-VD-CD, March REM was 27 per 100 000 population for $\geq 60y$ group; April REM was 8 deaths and 66 deaths per 100 000 population for the 30-59y and $\geq 60y$ group severally. May REM was 44 deaths per 100,000 population for the 30-59y group and 298 deaths per 100 000 population for $\geq 60y$ group when we assessed TD-VD-CD.

Lambayeque

Our findings showed that all deceases were within the expected parameters from January to May 2020. Though, we could see a constant progression until March around 3.42 and 4.18 deaths per 100,000 population and a growing linear trend since April which passed from 22.8 to 54.04 deaths per 100,000 population in May (Fig. 17). Note that SD for 2017-2019 monthly values (20-26) was higher than other areas (<12) (Table 1).

Similar situation happened with sex, but male had a higher slope than women from March to May 2020 (Fig. 18 and 19). For age groups, we observed a constant tendency from January to March for all age groups (Fig. 20-22). In April and May, the three first groups had a constant tendency; but the 30-59y and $\geq 60y$ groups had an increasing linear tendency (Fig. 23 and 24). Note that individuals $\geq 60y$ was the most affected set.

Piura

Our results are only compatible with REM of 40 per 100,000 population in May (Table 1 and Fig. 25). This study did not find difference in REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings indicated REM of 21 deaths per 100,000 population in May.

We found REM for men of 3 and 62 deaths per 100,000 population in April and May 2020 respectively (Table 2 and Fig. 26). Additionally, this study found just a little difference in April

when we evaluated TD-VD and just 37 deaths per 100,000 population in May severely for TD-VD-CD. On the other hand, this study manifested REM for women of 18 deaths per 100,000 population in May (Table 2 and Fig. 27). We observed the same REM when we assessed TD-VD and just 7 deaths per 100,000 population in May for TD-VD-CD.

We did find REM between January and March 2020 by age group (Table 3 and Fig. 28-30). April REM was only 14 deaths per 100,000 population for the 30-59 years group (Table 3 and Fig. 31). In May, we observed REM of 1, 46 and 268 deaths per 100,000 population for the 18-29y, 30-59y and $\geq 60y$ group respectively (Table 3 and Fig. 32). Note that when we assessed TD-VD, it did not represent a significant difference in REM for April and May. If we evaluated TD-VD-CD, May REM was only 28 deaths per 100 000 population for the 30-59y group and 158 deaths per 100,000 population for $\geq 60y$ group.

Loreto

Our results are compatible with REM of 4, 8 and 45 deaths per 100,000 population in February, April and May 2020 severally (Table 1 and Fig. 33). This study found a little difference in February REM and no difference in April and May REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 3 and 24 deaths per 100,000 population in February and May respectively.

We found REM for men of 2, 15 and 64 deaths per 100,000 population in February, April and May 2020 respectively (Table 2 and Fig. 34). Additionally, this study found just a little difference when we evaluated TD-VD and just 1 and 34 deaths per 100,000 population in February and May severally for TD-VD-CD. On the other hand, this study manifested REM for women of 5 and 26 deaths per 100,000 population in February and respectively (Table 2 and

Fig. 35). We observed the same REM when assessed TD-VD and just 15 deaths per 100,000 population in May for TD-VD-CD.

We found REM in all months by age groups, except in March 2020 (Table 3 and Fig. 38). January REM was 4 deaths per 100 000 population for the 30-59y group (Table 3 and Fig. 36). In February we observed REM of 3 deaths per 100,000 population for ≥ 60 y group (Table 3 and Fig. 37). April REM was 13 and 74 deaths per 100,000 population for the 30-59y and ≥ 60 y group severally (Table 3 and Fig. 39). May REM was 62 and 418 deaths per 100,000 population for the 30-59y and ≥ 60 y group respectively (Table 3 and Fig. 40). Note that when we assessed TD-VD, it did not find REM in February; but a little difference in REM in the other months. IF we evaluated TD-VD-CD, it did not find REM in April. However, May REM was 43 and 252 deaths per 100,000 population for the 30-59y and ≥ 60 y group severally when we assessed TD-VD-CD.

Callao

Our results are compatible with REM of 25 and 94 deaths per 100,000 population in April and May 2020 severally (Table 1 and Fig. 38). This study found a little difference when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings indicated REM of 12 and 73 deaths per 100,000 population in April and May respectively.

We found REM for men of 39 and 127 deaths per 100 000 population in April and May 2020 severally (Table 2 and Fig. 39). Additionally, this study found just a little difference in April when we evaluated TD-VD and just 19 and 102 deaths per 100 000 population in April and May respectively for TD-VD-CD. On the other hand, this study manifested REM for women of 8 and 60 deaths per 100 000 population in April and May 2020 (Table 2 and Fig. 40). We

observed the same REM when we assessed TD-VD and just 2 and 49 deaths per 100 000 population in April and May severally for TD-VD-CD.

We did find REM between January and March 2020 by age group (Fig. 41-43). April REM was 20 and 119 deaths per 100 000 population for the 30-59y and ≥ 60 y group (Table 3 and Fig. 44). In May 2020 we observed REM of 68 and 603 deaths per 100 000 population for 30-59y and ≥ 60 y group respectively (Table 3 and Fig. 45). Note that when we assessed TD-VD, it did not represent a significant difference in REM. If we evaluated TD-VD-CD, April REM was 9 and 54 deaths per 100 000 population for the 30-59y and ≥ 60 y group; and May REM was 51 and 491 deaths per 100 000 population for the 30-59y and ≥ 60 y group respectively when we assessed TD-VD-CD.

Ancash

Our results are compatible with REM of 22 per 100,000 population in 2020 May (Table 1 and Fig. 46). This study found little difference in REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 3 deaths per 100,000 population were observed in May.

We found REM for men of 46 deaths per 100 000 population for 2020 May (Table 2 and Fig. 47). Additionally, this study found just a little difference in April when we evaluated TD-VD and just of 21 deaths per 100 000 population in May for TD-VD-CD. On the other hand, we did not observe REM for women.

We did find REM between 2020 January and April by age group (Figures 49-52). May REM was 22 and 137 deaths per 100 000 population for 30-59y and ≥ 60 y group respectively (Table

3 and Fig. 53). Note that when we assessed TD-VD, it did not represent a significant difference in REM for April and May. If we evaluated TD-VD-CD, May REM was of 7 and 42 deaths per 100 000 population for 30-59y and ≥ 60 y group severally.

Ica

Our results are compatible with REM of 34 per 100,000 population in May 2020 (Table 1 and Fig. 54). This study found a little difference when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 10 deaths per 100,000 population in May.

We found REM for men of 12 and 48 deaths per 100 000 population in April and May 2020 severally (Table 2 and Fig. 55). Additionally, this study found just a little difference in April and May when we evaluated TD-VD and just 20 deaths per 100 000 population in May for TD-VD-CD. On the other hand, this study manifested REM for women of 14 deaths per 100 000 population in May 2020 (Table 2 and Fig. 56). We observed the same REM when we assessed TD-VD. We did not find REM in May for TD-VD-CD

We found REM in all months by age groups, except in March 2020 (Table 3 and Fig. 59). January REM was 3 deaths per 100 000 population for 12-17y group (Table 3 and Fig. 57). In February we observed REM of 1 death per 100 000 population for the 18-29y group (Table 3 and Fig. 58). April REM was 1 death per 100 000 population for 12-17y group (Table 3 and Fig. 60). May REM was 33 and 180 deaths per 100 000 population for the 30-59y and ≥ 60 y group respectively (Table 3 and Figure 61). Note that when we assessed TD-VD, it did not find REM in February and April; but a little difference in REM for January and May. If we evaluated TD-VD-CD, January REM was 1 death per 100,000 population for 12-17y group; May REM

was 10 and 54 deaths per 100, 000 population for the 30-59y and $\geq 60y$ group respectively when we assessed TD-VD-CD.

La Libertad

Our results are compatible with REM of 11 deaths per 100,000 population in May 2020 (Table 1 and Fig. 62). This study found a little difference in REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 2 deaths per 100,000 population in May.

We found REM for men of 17 deaths per 100 000 population in May 2020 (Table 2 and Fig. 63). Additionally, this study found just a little difference in May REM when we evaluated TD-VD. In the evaluation of TD-VD-CD, our findings only indicated REM of 4 deaths per 100 000 population in May. On the other hand, this study manifested REM for women of 3 deaths per 100 000 population in May (Table 2 and Fig. 64). We observed little difference in REM when we assessed TD-VD and no REM for TD-VD-CD.

We did not find REM between January and April 2020 by age group (Table 3 and Fig. 65-68). May REM was 12 and 68 deaths per 100 000 population for 30-59y and $\geq 60y$ group respectively (Table 3 and Fig. 69). Note that when we assessed TD-VD, it did not represent a significant difference in REM for April and May. If we evaluated TD-VD-CD, May REM was 4 and 17 deaths per 100 000 population for the 30-59y and $\geq 60y$ group severally.

Ucayali

Our results are compatible with REM of 30 and 51 per 100,000 population in 2020 April and May severally (Table 1 and Fig. 73). This study did not difference in REM when we evaluated

TD-VD. In the evaluation of TD-CD-CD, our findings only indicated REM of 20 and 40 deaths per 100,000 population in April and May respectively.

We found REM for men of 80 deaths per 100,000 population in May 2020 (Table 2 and Fig. 74). This study did not difference in REM when we evaluated TD-VD and just 62 deaths per 100,000 population in May for TD-VD-CD. On the other hand, this study manifested REM for women of 28 and 19 deaths per 100 000 population in April and May respectively (Table 2 and Fig. 75). We observed the same REM when we assessed TD-VD and just 15 deaths per 100,000 population in May for TD-VD-CD.

We did not find REM between January and March 2020 by age group (Table 3 and Figures 76-78). Our results are compatible with REM in all the age group in April: 1,3,12,22 and 114 deaths per 1000,000 population for 0-11y,12-17y,18-29y,30-59y and $\geq 60y$ group severally (Table 3 and Fig. 79) .May REM was 56 and 619 deaths per 100 000 population for 30-59y and $\geq 60y$ group respectively (Table 3 and Fig. 80). Note that when we assessed TD-VD, it did not represent a significant difference in REM. If we excluded TD-CD-CD, April REM was 1,3,10,12 and 34 114 deaths per 1000,000 population for the 0-11y,12-17y,18-29y,30-59y and $\geq 60y$ group severally. May REM was 46 deaths per 100,000 population for the 30-59y group and 524 deaths per 100,000 population for $\geq 60y$ group when we assessed TD-VD-CD.

DISCUSSION

Our findings illustrate 35 deaths in excess per 100 000 population from all causes during April and May 2020 in Peru. Callao was the location with the highest excess mortality followed by Lima, Ucayali, Loreto, Piura, Ica, Ancash, and La Libertad (119, 88, 81, 53, 40, 34, 22 and 11 deaths per 100 000 population). Loreto was the only department with general excess mortality

of 35 deaths in February 2020 and it could be explained for an outbreak of Dengue fever (23). Furthermore, April excess mortality was observed for all age group in Ucayali, even excluding violent and COVID-19 deaths. That will require further investigation to establish the excess causes.

Social distancing interventions has potential adverse outcomes on suicide and homicide risk is high(13,21). Although, suicide, homicide and motor vehicle deaths presented a sudden drop after the lockdown in Peru (22). We found that violent deaths did not mean a matter modification in REM in accordance with the above. Otherwise, the proportion of excess deaths that were attributed to COVID-19 increased over time.

Micheloizzi and colleagues informed an excess mortality of 4,805 (+ 45%) between the first week of March until 18 April in Italy(25). In the case of Peru, we only reported 1752 excess deaths (+16.67%) in absolute numbers during April 2020. In England and Wales, the average of all-cause excess mortality was 79 per 100,000 population during 22 February to 08 May in 2020 while there was an excess of 35 Peruvian deaths per 100,000 population between 01 February and 31 May(26). The largest mortality ratios in European countries could be explained because the beginning of pandemic was earlier in February. Several researchers informed specific regions with increase in all-cause mortality in 2020 compared with historical mortality rate, especially in men and older people(27–29). Our data corroborate that national and locations excess was greater in men than women (55 and 15 deaths per 100 000 population respectively). Differently, we found a national excess mortality of 35 deaths per 100 000 population for 30-59 years group, but it was higher in individuals over 60 years (208 deaths per 100 000 population). Besides, there was no excess of deaths among children and young people under 30 years which is consistent because this group is less likely to have a severe or critical clinical presentation (30,31).

Media has also assessed the excess mortality for Peru. The British Broadcasting Corporation (BBC) estimated an excess of 87% higher than average between 16 March to 31 May with about 18,900 more people dying than usual(38). Meanwhile, the Financial Times(FT) found an excess of 17,956 deaths from 04 March to 27 May (39). Unlike it, we did not obtain the estimation for the same periods of time; however, we obtained an excess of 10,201 deaths from 1 March to 31 May. The media data could be alarming and the result of an overestimation given that any death above the average of historical period has been considered an excess. Similar situations have happened in other countries which have estimated excess mortality(29,40–42). Although, this raise could be expected.

One possible explanation for excess mortality is COVID-19 deaths without being diagnosed. On the other hand, deaths related to other causes could represent an important excess cause because individuals postponed treatment to avoid the infection in private or public health centers or COVID-19 patients were prioritized or do not access.

A study showed 150,132 5-year prevalent cases which will need medical or surgical management in the following years in Peru (33). Although, Peruvian health system has been featured by inefficient performance, discontinuity and lack of assessment(34) and had one of the lowest current health expenditure in Latin America and the Caribbean (35). Both conditions make it prone to not have suitable response in emergency situations. Even England and North Ireland informed significant falls of 45-66% in admissions for chemotherapy and 70-89% in urgent referrals for early cancer diagnosis to pre-emergency level. It also found 78% of excess deaths occur in cancer patients with ≥ 1 comorbidity during COVID-19 pandemic(36). Cardiovascular and Cancer excess deaths have been reported in Scotland and it may also happened in Peru(37).

The limitations of this study are related with the fact that data is changing each moment because of the epidemic is still growing. In addition, we have found a few missing data (sex, age) and

some inconsistent information for Lambayeque. Even with these limitations, the findings showed the most affected groups were male and individuals over 60 years old. We consider that investigation of relevant excess mortality is a necessary, low cost and easy method. It is important to compare the death toll of the first wave during pandemic and to evaluate the effectiveness of policy responses and possible modifications. Additionally, locations might differ in the distribution of its population, age, sex and comorbidities; so, some places could be more vulnerable and need other kind of interventions. Therefore, we suggest to expand its use to the 25 locations of Peru and to reanalyze responses due to 72% of Peruvian people do not belong to the formal sector of the economy and they need going outside to generate daily income(20) and it perpetuates transmission cycle and adverse outcomes.

Conclusion

Although, Peru was one of the first Latin American countries with the first restrictive measures, COVID-19 deaths were significant and accounted for 45% of the relevant excess all-cause deaths, leaving 54.29% unattributed to COVID-19. Hence, it is necessary to rethink the policy measures in order to avoid the direct and indirect impact of COVID-19 and to find the suitable way to reach population.

List of Abbreviations

- **SARS-CoV-2:** Severe acute respiratory syndrome coronavirus 2
- **COVID-19:** Coronavirus Disease 2019
- **WHO:** World Health Organization
- **SINADEF:** National Death Registry Information System
- **NODP:** National Open Data Platform
- **EM:** Excess mortality
- **REM:** Relevant Excess Mortality

- **TD:** Total deaths
- **TD-VD:** Total deaths excluding violent deaths
- **TD-VD-CD:** Total deaths excluding violent and COVID-19 deaths
- **BBC:** British Broadcasting Corporation
- **FT:** Financial Times

Declarations

Ethics approval and consent to participate: The data used were anonymous from a public source so ethics approval was not required.

Consent for publication: Not applicable

Availability of data and materials: The data used in this study are freely available online in Spanish.

National Death Registry Information System,

http://www.minsa.gob.pe/reunis/data/defunciones_registradas.asp

National Open Data Platform, <https://www.datosabiertos.gob.pe/dataset/fallecidos-por-covid-19-ministerio-de-salud-minsa>

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75 Table 1: Relevant excess mortality for general absolute deaths and mortality rates

Location	Month	Limits and deviation standard (DE) for absolute deaths			Limits and deviation standard (DE) for mortality rates			Total deaths (TD)				TD - VD (Violent deaths)				TD-VD-CD(COVID-19 Deaths)			
		5% CI	95% CI	DE	5% CI	95% CI	DE	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average
Peru	January	7420.67	9801.33	1051.89	25	33	4	-2279.11	-1088.78	-8	-4	-2474.11	-1283.78	-8	-4	-2474.11	-1283.78	-8	-4
	February	6966.91	9246.42	1007.20	24	31	3	-2112.82	-973.07	-7	-3	-2314.82	-1175.07	-8	-4	-2314.82	-1175.07	-8	-4
	March	8109.96	9805.38	749.12	28	33	3	-1943.62	-1095.91	-7	-4	-2049.62	-1201.91	-7	-4	-2115.62	-1267.91	-7	-4
	April	7495.14	9094.86	706.83	26	31	2	1751.48	2551.34	6	9	1713.48	2513.34	6	9	-56.52	743.34	0	3
	May	11530.01	13415.49	833.10	39	46	3	8449.31	9392.05	29	32	8389.31	9332.05	29	32	5587.31	6530.05	19	22
Lima	January	1911.43	2781.23	384.32	20	29	4	-355.87	79.03	-4	1	-552.87	-15.57	-6	-1	-552.87	-117.97	-6	-1
	February	1788.14	2800.52	447.32	19	30	5	-447.16	59.03	-5	1	-629.16	-17.03	-7	-1	-629.16	-122.97	-7	-1
	March	2387.44	2820.56	191.37	25	30	2	413.69	630.25	4	7	334.69	10.45	4	6	293.69	510.25	3	5
	April	2074.19	2709.14	280.55	22	29	3	2333.75	2651.23	25	28	2304.75	70.48	24	28	1573.75	1891.23	17	20
	May	4255.00	5049.00	350.83	45	53	4	5575.34	5972.34	59	63	5550.34	96.52	59	63	4536.34	4933.34	48	52
Lambeyeque	January	24	686	293	2	57	24	-1229.96	-898.86	-103	-75	-1239.96	-908.86	-104	-76	-1239.96	-908.86	-104	-76
	February	51	643	261	4	54	22	-1116.11	-820.24	-93	-69	-1125.11	-829.24	-94	-69	-1125.11	-829.24	-94	-69
	March	23	723	309	2	60	26	-1296.19	-945.97	-108	-79	-1301.19	-950.97	-109	-79	-1307.19	-956.97	-109	-80
	April	60	589	234	5	49	20	-784.00	-519.25	-65	-43	-788.00	-523.25	-66	-44	-1111.00	-846.25	-93	-71
	May	132	726	262	11	61	22	-603.82	-306.95	-50	-26	-608.82	-311.95	-51	-26	-895.82	-598.95	-75	-50
Piura	January	241	624	169	13	34	9	-631	-439	-34	-24	-647	-455	-35	-25	-647	-455	-35	-25
	February	243	645	178	13	35	10	-706	-505	-38	-27	-715	-514	-39	-28	-715	-514	-39	-28

	March	290	700	181	16	38	10	-785	-580	-42	-31	-797	-592	-43	-32	-799	-594	-43	-32
	April	392	519	56	21	28	3	-78	-14	-4	-1	-85	-21	-5	-1	-263	-199	-14	-11
	May	629	901	120	34	49	6	744	880	40	47	738	874	40	47	391	527	21	28
Loreto	January	180	198	8	20	22	1	-16	-7	-2	-1	-33	-24	-4	-3	-33	-24	-4	-3
	February	140	145	2	16	16	0	35	37	4	4	28	30	3	3	28	30	3	3
	March	137	186	22	16	21	2	-47	-23	-5	-3	-49	-25	-6	-3	-51	-27	-6	-3
	April	126	192	29	14	22	3	75	108	8	12	73	106	8	12	-37	-4	-4	0
	May	329	427	43	37	48	5	401	450	45	51	398	447	45	51	213	262	24	30
Callao	January	343	367	10	35	37	1	-49	-37	-5	-4	-68	-56	-7	-6	-68	-56	-7	-6
	February	270	391	54	27	39	5	-121	-60	-12	-6	-146	-85	-15	-9	-146	-85	-15	-9
	March	322	366	20	32	37	2	-22	1	-2	0	-30	-7	-3	-1	-34	-11	-3	-1
	April	286	346	26	29	35	3	244	273	25	27	242	271	24	27	118	147	12	15
	May	680	715	15	68	72	2	932	949	94	95	925	942	93	95	724	741	73	75
Ancash	January	288	559	120	27	52	11	-334	-198	-31	-18	-364	-228	-34	-21	-364	-46	-34	-21
	February	297	455	70	27	42	6	-145	-66	-13	-6	-169	-90	-16	-8	-169	-28	-16	-8
	March	306	509	90	28	47	8	-237	-136	-22	-13	-256	-155	-24	-14	-257	-37	-24	-14
	April	266	474	92	25	44	8	-166	-62	-15	-6	-174	-70	-16	-6	-255	-39	-24	-14
	May	513	626	50	47	58	5	233	290	22	27	223	280	21	26	35	5	3	9
Ica	January	296	377	36	35	44	4	-81	-40	-10	-5	-118	-77	-14	-9	-118	-77	-14	-9
	February	289	391	45	34	46	5	-97	-46	-11	-5	-128	-77	-15	-9	-128	-77	-15	-9
	March	321	429	48	38	50	6	-184	-130	-22	-15	-199	-145	-23	-17	-199	-145	-23	-17
	April	295	361	29	35	42	3	-21	12	-2	1	-29	4	-3	0	-92	-59	-11	-7
	May	452	489	16	53	57	2	285	304	34	36	272	291	32	34	83	102	10	12
La Libertad	January	582	717	60	33	40	3	-129	-62	-7	-3	-163	-96	-9	-5	-163	-96	-9	-5
	February	519	788	119	29	44	7	-469	-335	-26	-19	-504	-370	-28	-21	-504	-370	-28	-21
	March	550	838	127	31	47	7	-509	-365	-29	-21	-536	-392	-30	-22	-539	-395	-30	-22
	April	579	628	22	33	35	1	-131	-106	-7	-6	-139	-114	-8	-6	-186	-161	-10	-9

	May	705	718	6	40	40	0	202	209	11	12	182	189	10	11	33	40	2	2
Ucayali	January	125	170	20	25	34	4	-15	7	-3	1	-15	7	-3	1	-15	7	-3	1
	February	84	173	39	17	35	8	-107	-63	-22	-13	-109	-65	-22	-13	-109	-65	-22	-13
	March	58	152	42	12	31	8	-65	-18	-13	-4	-68	-21	-14	-4	-68	-21	-14	-4
	April	82	151	30	16	30	6	150	185	30	37	149	184	30	37	100	135	20	27
	May	219	347	57	44	70	11	255	319	51	64	255	319	51	64	198	262	40	53

TD: Total deaths, VD: Violent deaths, CV: COVID-19 deaths

Table 2: Relevant excess mortality for general absolute deaths and mortality rates by sex

Location	Sex	Month	Limits and deviation standard(DE) for absolute deaths			Limits and deviation standard(DE) for mortality rates			TD				TD - VD				TD-VD-CD			
			5% CI	95% CI	DE	5% CI	95% CI	DE	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average
Peru	Male	January	3,913	5,193	565	27	36	4	-1276.19	-636.29	-9	-4	-1780.19	-1140.29	-12	-8	-1780.19	-1140.29	-12	-8
		February	3,73	4,9	517	26	34	4	-1095.57	-510.34	-8	-4	-1591.57	-1006.34	-11	-7	-1591.57	-1006.34	-11	-7
		March	4,305	5,21	400	30	36	3	-1064.48	-612.01	-7	-4	-1379.48	-927.01	-10	-6	-1429.48	-977.01	-10	-7
		April	4,049	4,841	350	28	34	2	1606.08	2002.45	11	14	1488.08	1884.45	10	13	206.08	602.45	1	4
		May	6,825	7,702	387	47	53	3	6405.30	6843.33	44	47	6270.30	6708.33	43	46	4541.30	4979.33	31	34
	Female	January	3492.94	4621.06	498.46	23	31	3	-1035.98	-471.92	-7	-3	-1223.98	-659.92	-8	-4	-1223.98	-659.92	-8	-4
		February	3224.29	4357.04	500.50	22	29	3	-1036.05	-469.67	-7	-3	-1179.05	-612.67	-8	-4	-1179.05	-612.67	-8	-4
		March	3799.69	4600.98	354.05	25	31	2	-875.07	-474.43	-6	-3	-957.07	-556.43	-6	-4	-973.07	-572.43	-7	-4
		April	3442.55	4251.45	357.41	23	28	2	172.74	577.18	1	4	121.74	526.18	1	4	-386.26	18.18	-3	0
		May	4713.52	5723.48	446.25	32	38	3	2075.01	2580.00	14	17	2028.01	2533.00	14	17	1363.01	1868.00	9	13

Lima	Male	January	1022.44	1462.23	194.32	22	32	4	-260.88	-40.98	-6	-1	-400.88	-180.98	-9	-4	-400.88	-180.98	-9	-4
		February	954.05	1491.28	237.37	21	32	5	-239.03	29.59	-5	1	-391.03	-122.41	-8	-3	-391.03	-122.41	-8	-3
		March	1271.67	1470.99	88.07	27	32	2	215.87	315.53	5	7	155.87	255.53	3	6	124.87	224.53	3	5
		April	1116.97	1433.70	139.95	24	31	3	1605.41	1763.77	35	38	1585.41	1743.77	34	38	1057.41	1215.77	23	26
		May	2613.87	3000.13	170.67	57	65	4	3987.52	4180.65	86	90	3966.52	4159.65	86	90	3386.52	3579.65	73	77
	Female	January	882	1,323	195	18	27	4	-110.16	110.44	-2	2	-167.16	53.44	-3	1	-167.16	53.44	-3	1
		February	827	1,314	215	17	27	4	-220.81	22.43	-5	0	-252.81	-9.57	-5	0	-252.81	-9.57	-5	0
		March	1,109	1,351	107	23	28	2	190.48	311.48	4	6	171.48	292.48	4	6	161.48	282.48	3	6
		April	955	1,273	141	20	26	3	749.77	909.21	15	19	740.77	900.21	15	19	537.77	697.21	11	14
		May	1,636	2,05	183	34	42	4	1576.97	1783.67	32	37	1572.97	1779.67	32	37	1377.97	1584.67	28	33
Lambayeque	Male	January	14	328	139	2	56	24	-579	-422	-100	-73	-586	-429	-101	-74	-586	-429	-101	-74
		February	31	317	127	5	55	22	-544	-401	-94	-69	-552	-409	-95	-70	-552	-409	-95	-70
		March	5	377	165	1	65	28	-677	-491	-117	-85	-682	-496	-117	-85	-686	-500	-118	-86
		April	35	318	125	6	55	22	-382	-241	-66	-41	-386	-245	-66	-42	-599	-458	-103	-79
		May	105	404	132	18	70	23	-206	-57	-35	-10	-209	-60	-36	-10	-407	-258	-70	-44
	Female	January	9	357	154	2	58	25	-650	-476	-105	-77	-653	-479	-106	-78	-653	-479	-106	-78
		February	20	327	135	3	53	22	-574	-421	-93	-68	-575	-422	-93	-68	-575	-422	-93	-68
		March	17	347	145	3	56	24	-620	-456	-101	-74	-620	-456	-101	-74	-622	-458	-101	-74
		April	24	272	110	4	44	18	-404	-280	-66	-45	-404	-280	-66	-45	-514	-390	-83	-63
		May	26	323	131	4	52	21	-401	-252	-65	-41	-402	-253	-65	-41	-483	-334	-78	-54
Piura	Male	January	126	337	93	14	37	10	-331	-225	-36	-25	-343	-237	-37	-26	-343	-237	-37	-26
		February	134	362	101	15	39	11	-404	-290	-44	-32	-410	-296	-45	-32	-410	-296	-45	-32
		March	153	399	109	17	43	12	-483	-360	-53	-39	-494	-371	-54	-40	-496	-373	-54	-41
		April	201	269	30	22	29	3	23	57	3	6	17	51	2	6	-110	-76	-12	-8
		May	397	552	69	43	60	7	572	649	62	71	567	644	62	70	344	421	37	46
	Female	January	112	290	79	12	31	8	-308	-219	-33	-23	-312	-223	-33	-24	-312	-223	-33	-24
		February	108	284	77	12	30	8	-303	-216	-32	-23	-306	-219	-33	-23	-306	-219	-33	-23

		March	136	300	73	15	32	8	-298	-216	-32	-23	-299	-217	-32	-23	-299	-217	-32	-23
		April	189	251	28	20	27	3	-97	-66	-10	-7	-98	-67	-10	-7	-149	-118	-16	-13
		May	233	349	51	25	37	5	172	230	18	25	172	230	18	25	68	126	7	13
Loreto	Male	January	102	115	6	23	26	1	-20	-14	-4	-3	-24	-18	-5	-4	-24	-18	-5	-4
		February	71	83	5	16	19	1	7	13	2	3	2	8	1	2	2	8	1	2
		March	78	108	13	17	24	3	-31	-16	-7	-4	-32	-17	-7	-4	-34	-19	-8	-4
		April	67	119	23	15	27	5	65	91	15	20	64	90	14	20	-17	9	-4	2
		May	207	277	31	47	62	7	286	321	64	72	283	318	64	72	151	186	34	42
	Female	January	68	91	10	15	21	2	-29	-18	-7	-4	-30	-19	-7	-4	-30	-19	-7	-4
		February	59	72	6	13	16	1	1	8	0	2	-1	6	0	1	-1	6	0	1
		March	46	92	21	10	21	5	-52	-28	-12	-6	-53	-29	-12	-7	-53	-29	-12	-7
		April	56	74	8	13	17	2	24	33	5	8	23	32	5	7	-6	3	-1	1
		May	122	151	13	28	34	3	113	128	26	29	113	128	26	29	64	79	15	18
Callao	Male	January	192	198	3	40	41	1	-15	-12	-3	-3	-33	-30	-7	-6	-33	-30	-7	-6
		February	155	202	21	32	41	4	-49	-25	-10	-5	-70	-46	-14	-10	-70	-46	-14	-10
		March	178	210	14	37	43	3	-22	-6	-5	-1	-27	-11	-6	-2	-29	-13	-6	-3
		April	164	193	13	34	40	3	187	202	39	42	185	200	38	41	92	107	19	22
		May	420	435	7	87	90	1	618	626	127	129	613	621	126	128	495	503	102	104
	Female	January	151	169	8	30	33	2	-35	-26	-7	-5	-35	-26	-7	-5	-35	-26	-7	-5
		February	115	190	33	23	37	7	-72	-35	-14	-7	-76	-39	-15	-8	-76	-39	-15	-8
		March	147	177	13	29	35	3	-34	-19	-7	-4	-36	-21	-7	-4	-38	-23	-7	-5
		April	137	168	13	27	33	3	42	57	8	11	42	57	8	11	11	26	2	5
		May	256	284	12	50	56	2	304	317	60	62	304	317	60	62	252	265	49	52
Ancash	Male	January	145	278	59	27	52	11	-146	-80	-27	-15	-166	-100	-31	-19	-166	-100	-31	-19
		February	171	239	30	32	45	6	-59	-25	-11	-5	-77	-43	-14	-8	-77	-43	-14	-8
		March	171	262	40	32	49	7	-91	-46	-17	-9	-104	-59	-19	-11	-104	-59	-19	-11
		April	124	246	54	23	46	10	-83	-22	-16	-4	-88	-27	-17	-5	-146	-85	-27	-16

		May	306	339	15	57	63	3	245	261	46	49	236	252	44	47	112	128	21	24
	Female	January	140	282	62	26	51	11	-187	-117	-34	-21	-197	-127	-36	-23	-197	-127	-36	-23
		February	123	219	43	22	40	8	-83	-35	-15	-6	-89	-41	-16	-7	-89	-41	-16	-7
		March	137	247	49	25	45	9	-131	-76	-24	-14	-137	-82	-25	-15	-138	-83	-25	-15
		April	142	229	39	26	42	7	-71	-28	-13	-5	-74	-31	-14	-6	-97	-54	-18	-10
		May	199	294	42	36	54	8	-32	16	-6	3	-33	15	-6	3	-79	-31	-14	-6
Ica	Male	January	157	183	12	37	44	3	-2	11	0	3	-17	-4	-4	-1	-17	-4	-4	-1
		February	163	198	16	39	47	4	-26	-9	-6	-2	-48	-31	-12	-7	-48	-31	-12	-7
		March	174	206	14	42	49	3	-52	-36	-12	-9	-63	-47	-15	-11	-63	-47	-15	-11
		April	175	180	2	42	43	0	50	53	12	13	43	46	10	11	0	3	0	1
		May	254	271	8	60	65	2	203	212	48	50	191	200	46	48	85	94	20	22
	Female	January	137	194	25	32	45	6	-82	-53	-19	-12	-104	-75	-24	-17	-104	-75	-24	-17
		February	128	197	30	30	46	7	-77	-42	-18	-10	-86	-51	-20	-12	-86	-51	-20	-12
		March	138	224	38	32	52	9	-141	-98	-33	-23	-145	-102	-34	-24	-145	-102	-34	-24
		April	132	179	21	31	42	5	-56	-33	-13	-8	-57	-34	-13	-8	-77	-54	-18	-12
		May	185	223	17	43	52	4	60	80	14	19	59	79	14	18	0	20	0	5
La Libertad	Male	January	300	392	41	35	45	5	-106	-60	-12	-7	-143	-97	-16	-11	-143	-97	-16	-11
		February	288	405	52	33	47	6	-218	-159	-25	-18	-246	-187	-28	-22	-246	-187	-28	-22
		March	276	422	64	32	49	7	-250	-177	-29	-20	-274	-201	-32	-23	-276	-203	-32	-23
		April	290	356	29	33	41	3	-130	-97	-15	-11	-135	-102	-16	-12	-166	-133	-19	-15
		May	381	393	6	44	45	1	149	155	17	18	135	141	16	16	31	37	4	4
	Female	January	270	337	29	30	37	3	-57	-23	-6	-3	-63	-29	-7	-3	-63	-29	-7	-3
		February	232	362	58	26	40	6	-212	-147	-23	-16	-219	-154	-24	-17	-219	-154	-24	-17
		March	270	419	66	30	46	7	-269	-195	-30	-21	-272	-198	-30	-22	-273	-199	-30	-22
		April	271	289	8	30	32	1	-51	-41	-6	-5	-54	-44	-6	-5	-70	-60	-8	-7
		May	314	335	9	35	37	1	25	36	3	4	19	30	2	3	-6	5	-1	1
Ucayali	Male	January	69	95	11	28	38	4	-6	7	-2	3	-7	6	-3	2	-7	6	-3	2

		February	53	92	17	21	37	7	-49	-29	-19	-12	-51	-31	-20	-13	-51	-31	-20	-13
		March	36	86	22	15	34	9	-43	-18	-17	-7	-46	-21	-19	-9	-46	-21	-19	-9
		April	43	94	23	17	38	9	-118	-92	-47	-37	-119	-93	-47	-37	-156	-130	-62	-52
		May	145	216	32	58	86	13	200	235	80	94	200	235	80	94	155	190	62	76
	Female	January	53	79	11	21	32	5	-17	-4	-7	-2	-17	-4	-7	-2	-17	-4	-7	-2
		February	27	86	26	11	35	10	-70	-41	-28	-17	-71	-42	-29	-17	-71	-42	-29	-17
		March	21	67	20	9	27	8	-25	-2	-10	-1	-25	-2	-10	-1	-25	-2	-10	-1
		April	39	56	8	16	23	3	68	77	28	31	68	77	28	31	56	65	23	26
		May	71	128	25	29	52	10	48	76	19	31	48	76	19	31	37	65	15	27

TD: Total deaths, VD: Violent deaths, CV: COVID-19 deaths

Table 3: Relevant excess mortality for general absolute deaths and mortality rates by age group

Location	Age group	Month	Limits and deviation standard(DE) for absolute deaths			Limits and deviation standard(DE) for mortality rates			TD				TD - VD				TD-VD-CD			
			5% CI	95% CI	DE	5% CI	95% CI	DE	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average	Excess deaths from +2DE above upper limit	Excess deaths from +2DE above average	Excess mortality rate from +2DE above upper limit	Excess mortality rate from +2DE above average
Peru	0-11y	January	472	617	64	8	10	1	-151.61	-79.36	-2	-1	-202.61	-130.36	-3	-2	-202.61	-130.36	-3	-2
		February	457	555	43	7	9	1	-74	-25	-1	0	-126	-77	-2	-1	-126	-77	-2	-1
		March	518	603	37	8	10	1	-222	-180	-4	-3	-261	-219	-4	-4	-261	-219	-4	-4
		April	497	573	33	8	9	1	-267	-229	-4	-4	-288	-250	-5	-4	-294	-256	-5	-4
		May	541	603	27	9	10	0	-286	-255	-5	-4	-306	-275	-5	-4	-319	-288	-5	-5
	12-17y	January	82	108	12	3	4	0	-34.12	-21.07	-1	-1	-63.12	-50.07	-2	-2	-63.12	-50.07	-2	-2
		February	82	121	17	3	4	1	-50	-30	-2	-1	-86	-66	-3	-2	-86	-66	-3	-2

		March	90	99	4	3	3	0	-29	-25	-1	-1	-50	-46	-2	-2	-50	-46	-2	-2
		April	80	84	2	3	3	0	-8	-6	0	0	-22	-20	-1	-1	-25	-23	-1	-1
		May	81	110	13	3	4	0	-56	-41	-2	-1	-76	-61	-3	-2	-78	-63	-3	-2
	18-29y	January	351	415	28	6	7	0	-27.80	4.29	0	0	-223.80	-191.71	-4	-3	-223.80	-191.71	-4	-3
		February	324	404	35	6	7	1	-93	-53	-2	-1	-218	-178	-4	-3	-218	-178	-4	-3
		March	324	428	46	6	7	1	-225	-173	-4	-3	-294	-242	-5	-4	-296	-244	-5	-4
		April	309	397	39	5	7	1	-186	-142	-3	-2	-212	-168	-4	-3	-231	-187	-4	-3
		May	328	427	44	6	7	1	-143	-94	-2	-2	-174	-125	-3	-2	-192	-143	-3	-2
	30-59y	January	1548.16	1990.51	195.45	14	18	2	-398.42	-177.24	-4	-2	-699.42	-478.24	-6	-4	-699.42	-478.24	-6	-4
		February	1,453	1,823	163	13	17	2	-365	-180	-3	-2	-637	-452	-6	-4	-637	-452	-6	-4
		March	1,554	1,964	181	14	18	2	-590	-385	-5	-4	-770	-565	-7	-5	-790	-585	-7	-5
		April	1,504	1,838	148	14	17	1	560	727	5	7	491	658	5	6	-63	104	-1	1
		May	1,629	1,979	154	15	18	1	3,191	3,365	30	31	3,145	3,319	29	31	2,328	2,502	22	23
	≥60y	January	5115.41	6849.59	766.24	146	196	22	-1873.08	-1005.99	-54	-29	-1987.08	-1119.99	-57	-32	-1987.08	-1119.99	-57	-32
		February	4,843	6,554	756	138	187	22	-1,744	-888	-50	-25	-1,898	-1,042	-54	-30	-1,898	-1,042	-54	-30
		March	5,763	6,877	492	165	197	14	-1,048	-491	-30	-14	-1,136	-579	-32	-17	-1,18	-623	-34	-18
		April	5,841	7,05	534	167	202	15	732	1,336	21	38	693	1,297	20	37	-495	109	-14	3
		May	8,065	9,459	616	231	270	18	6,572	7,268	188	208	6,507	7,203	186	206	4,555	5,251	130	150
Lima	0-11y	January	96	153	25	6	9	1	-78	-49	-5	-3	-88	-59	-5	-3	-88	-59	-5	-3
		February	96	128	14	6	7	1	-12	4	-1	0	-21	-5	-1	0	-21	-5	-1	0
		March	128	160	14	8	9	1	-77	-61	-5	-4	-81	-65	-5	-4	-81	-65	-5	-4
		April	127	142	7	7	8	0	-60	-52	-3	-3	-46	-38	-4	-3	-63	-55	-4	-3
		May	91	162	32	5	10	2	-140	-104	-8	-6	-140	-104	-8	-6	-144	-108	-8	-6
	12-17y	January	14	19	2	2	2	0	4	6	0	1	-4	-2	0	0	-4	-2	0	0
		February	15	25	4	2	3	1	-9	-4	-1	0	-20	-15	-2	-2	-20	-15	-2	-2
		March	10	22	5	1	3	1	-15	-9	-2	-1	-17	-11	-2	-1	-17	-11	-2	-1
		April	6	21	7	1	3	1	-17	-9	-2	-1	-17	-9	-2	-1	-21	-13	-2	-2

		May	15	24	4	2	3	0	-16	-11	-2	-1	-17	-12	-2	-1	-18	-13	-2	-2
	18-29y	January	83	92	4	4	5	0	12	16	1	1	-41	-37	-2	-2	-41	-37	-2	-2
		February	77	106	13	4	5	1	-27	-12	-1	-1	-68	-53	-3	-3	-68	-53	-3	-3
		March	88	108	9	4	5	0	-57	-47	-3	-2	-75	-65	-4	-3	-76	-66	-4	-3
		April	77	106	13	4	5	1	-41	-27	-2	-1	-62	-48	-2	-2	-57	-43	-3	-2
		May	65	109	19	3	5	1	-19	3	-1	0	-23	-1	-1	0	-30	-8	-1	0
	30-59y	January	423	570	65	11	15	2	-106	-33	-3	-1	-190	-117	-5	-3	-190	-117	-5	-3
		February	403	525	54	11	14	1	-18	43	0	1	-98	-37	-3	-1	-98	-37	-3	-1
		March	460	577	52	12	15	1	-59	-1	-2	0	-100	-42	-3	-1	-109	-51	-3	-1
		April	434	569	60	12	15	2	525	593	14	16	-68	0	14	15	286	354	8	10
		May	422	575	67	11	15	2	1,924	2	52	54	1,91	1,986	51	53	1,63	1,706	44	46
	≥60y	January	423	570	65	121	176	25	-390	-54	-32	-5	-432	-96	-36	-8	-432	-96	-36	-8
		February	1,374	2,215	371	114	183	31	-596	-176	-49	-15	-639	-219	-53	-18	-639	-219	-53	-18
		March	1,935	2,196	115	160	182	10	373	503	31	42	359	489	30	40	328	458	27	38
		April	2,058	2,513	201	170	208	17	1,291	1,518	107	126	-115	112	107	125	793	1,02	66	84
		May	3,115	3,653	238	258	302	20	4,328	4,596	358	380	4,322	4,59	358	380	3,6	3,868	298	320
Lambayeque	0-11y	January	-2	45	21	-1	17	8	-86	-62	-33	-24	-86	-62	-33	-24	-86	-62	-33	-24
		February	4	39	15	2	15	6	-59	-41	-22	-16	-59	-41	-22	-16	-59	-41	-22	-16
		March	5	49	19	2	19	7	-81	-59	-31	-23	-82	-60	-31	-23	-82	-60	-31	-23
		April	10	30	9	4	11	3	-46	-36	-18	-14	-46	-36	-18	-14	-46	-36	-18	-14
		May	10	43	15	4	16	6	-70	-53	-27	-20	-71	-54	-27	-21	-71	-54	-27	-21
	12-17y	January	1	7	3	1	6	2	-11	-8	-9	-7	-11	-8	-9	-7	-11	-8	-9	-7
		February	-1	7	4	-1	6	3	-12	-8	-10	-7	-13	-9	-11	-7	-13	-9	-11	-7
		March	-4	13	7	-3	10	6	-26	-18	-21	-15	-26	-18	-21	-15	-26	-18	-21	-15
		April	1	6	2	1	5	2	-9	-7	-7	-6	-9	-7	-7	-6	-9	-7	-7	-6
		May	0	6	3	0	5	2	-11	-8	-9	-7	-11	-8	-9	-7	-11	-8	-9	-7
	18-29y	January	2	24	10	1	10	4	-43	-32	-18	-14	-44	-33	-19	-14	-44	-33	-19	-14

		February	2	20	8	1	8	3	-33	-24	-14	-10	-35	-26	-15	-11	-35	-26	-15	-11
		March	0	30	13	0	13	6	-53	-38	-23	-16	-54	-39	-23	-17	-54	-39	-23	-17
		April	4	22	8	2	9	3	-35	-26	-15	-11	-35	-26	-15	-11	-37	-28	-16	-12
		May	5	27	10	2	12	4	-41	-30	-18	-13	-42	-31	-18	-13	-42	-31	-18	-13
	30-59y	January	8	128	53	2	30	12	-217	-157	-51	-37	-222	-162	-52	-38	-222	-162	-52	-38
		February	18	101	37	4	24	9	-165	-124	-39	-29	-169	-128	-40	-30	-169	-128	-40	-30
		March	1	154	68	0	36	16	-278	-201	-65	-47	-278	-201	-65	-47	-282	-205	-66	-48
		April	11	114	46	2	27	11	-119	-67	-28	-16	-121	-69	-28	-16	-219	-167	-51	-39
		May	15	122	47	4	28	11	-27	27	-6	6	-29	25	-7	6	-105	-51	-25	-12
	≥60y	January	-43	425	207	-28	283	137	-818	-584	-544	-389	-822	-588	-547	-391	-822	-588	-547	-391
		February	-32	423	201	-21	281	134	-798	-571	-531	-380	-800	-573	-532	-381	-800	-573	-532	-381
		March	-83	536	273	-55	356	182	-1,059	-750	-705	-499	-1,062	-753	-707	-501	-1,064	-755	-708	-502
		April	20	407	171	14	271	114	-569	-375	-378	-250	-571	-377	-380	-251	-794	-600	-528	-400
		May	79	509	190	52	339	127	-441	-226	-293	-150	-441	-226	-293	-150	-652	-437	-434	-291
Piura	0-11y	January	19	27	4	4	6	1	-2	2	-1	0	-4	0	-1	0	-4	0	-1	0
		February	13	45	14	3	10	3	-47	-31	-11	-7	-47	-31	-11	-7	-47	-31	-11	-7
		March	18	35	8	4	8	2	-31	-22	-7	-5	-32	-23	-7	-5	-32	-23	-7	-5
		April	26	34	4	6	8	1	-26	-22	-6	-5	-26	-22	-6	-5	-28	-24	-6	-5
		May	23	23	0	5	5	0	-9	-9	-2	-2	-9	-9	-2	-2	-12	-12	-3	-3
	12-17y	January	1	7	3	1	4	1	-9	-6	-5	-3	-10	-7	-5	-4	-10	-7	-5	-4
		February	4	8	2	2	4	1	-9	-7	-5	-3	-9	-7	-5	-3	-9	-7	-5	-3
		March	2	5	1	1	2	1	-4	-3	-2	-1	-4	-3	-2	-1	-4	-3	-2	-1
		April	4	5	1	2	2	0	-2	-1	-1	-1	-2	-1	-1	-1	-2	-1	-1	-1
		May	4	6	1	2	3	0	-4	-3	-2	-1	-4	-3	-2	-1	-4	-3	-2	-1
	18-29y	January	2	34	14	1	10	4	-52	-36	-15	-10	-54	-38	-15	-11	-54	-38	-15	-11
		February	8	26	8	2	8	2	-29	-19	-8	-6	-32	-22	-9	-6	-32	-22	-9	-6
		March	6	30	11	2	9	3	-43	-31	-12	-9	-45	-33	-13	-9	-45	-33	-13	-9

		April	14	16	1	4	5	0	-7	-6	-2	-2	-8	-7	-2	-2	-9	-8	-3	-2
		May	13	16	2	4	5	0	2	4	1	1	-1	1	0	0	-4	-2	-1	-1
	30-59y	January	48	123	33	7	19	5	-139	-101	-21	-16	-149	-111	-23	-17	-149	-111	-23	-17
		February	45	130	37	7	20	6	-152	-110	-23	-17	-154	-112	-24	-17	-154	-112	-24	-17
		March	59	131	32	9	20	5	-145	-109	-22	-17	-153	-117	-23	-18	-153	-117	-23	-18
		April	77	91	6	12	14	1	43	50	7	8	39	46	6	7	-19	-12	-3	-2
		May	45	112	29	7	17	5	300	334	46	51	298	332	46	51	183	217	28	33
	≥60y	January	153	417	117	74	202	57	-415	-282	-200	-136	-416	-283	-201	-137	-416	-283	-201	-137
		February	140	415	121	68	200	59	-458	-321	-221	-155	-462	-325	-223	-157	-462	-325	-223	-157
		March	165	460	131	80	223	63	-522	-374	-252	-181	-523	-375	-253	-181	-525	-377	-254	-182
		April	280	397	52	135	192	25	-114	-56	-55	-27	-116	-58	-56	-28	-233	-175	-113	-84
		May	447	645	88	216	312	42	554	653	268	316	554	653	268	316	328	427	158	207
Loreto	0-11y	January	16	33	7	6	12	3	-19	-11	-7	-4	-20	-12	-8	-5	-20	-12	-8	-5
		February	20	25	2	8	10	1	-3	-1	-1	0	-3	-1	-1	0	-3	-1	-1	0
		March	14	32	8	5	12	3	-30	-20	-11	-8	-31	-21	-12	-8	-31	-21	-12	-8
		April	20	32	6	8	12	2	-32	-26	-12	-10	-32	-26	-12	-10	-32	-26	-12	-10
		May	11	43	14	4	16	5	-63	-47	-24	-18	-63	-47	-24	-18	-64	-48	-25	-19
	12-17y	January	1	7	3	1	6	2	-8	-5	-7	-5	-8	-5	-7	-5	-8	-5	-7	-5
		February	-1	6	3	-1	5	3	-8	-4	-7	-4	-8	-4	-7	-4	-8	-4	-7	-4
		March	2	3	1	2	3	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		April	2	4	1	2	4	1	-6	-5	-5	-4	-6	-5	-5	-4	-6	-5	-5	-4
		May	1	5	2	1	5	2	-5	-3	-5	-3	-6	-4	-6	-4	-7	-5	-6	-4
	18-29y	January	7	16	4	4	11	3	-13	-8	-8	-5	-13	-8	-8	-5	-13	-8	-8	-5
		February	5	9	2	3	6	1	0	2	0	1	-3	-1	-2	-1	-3	-1	-2	-1
		March	7	13	3	4	8	2	-12	-9	-7	-6	-12	-9	-7	-6	-12	-9	-7	-6
		April	12	17	2	8	11	1	-11	-8	-7	-5	-12	-9	-8	-6	-13	-10	-8	-7
		May	13	16	1	8	10	1	-4	-3	-3	-2	-5	-4	-3	-2	-8	-7	-5	-4

	30-59y	January	39	49	4	14	17	1	12	17	4	6	8	13	3	5	8	13	3	5
		February	37	46	4	13	17	1	-3	1	-1	0	-5	-1	-2	0	-5	-1	-2	0
		March	38	59	9	13	21	3	-31	-20	-11	-7	-31	-20	-11	-7	-32	-21	-11	-8
		April	36	53	8	13	19	3	36	45	13	16	36	45	13	16	-1	8	0	3
		May	45	69	11	16	25	4	174	186	62	67	173	185	62	66	121	133	43	48
	≥60y	January	87	106	8	113	137	11	-47	-38	-61	-49	-47	-38	-61	-49	-47	-38	-61	-49
		February	68	80	5	89	104	7	2	8	3	11	0	6	0	8	0	6	0	8
		March	75	97	10	97	125	12	-6	5	-7	7	-7	4	-8	6	-8	3	-10	4
		April	88	127	17	114	164	22	57	76	74	99	56	75	73	98	-16	3	-21	4
		May	203	256	23	264	332	30	322	348	418	452	322	348	418	452	194	220	252	286
Callao	0-11y	January	11	19	4	5	10	2	-11	-7	-5	-3	-12	-8	-6	-4	-12	-8	-6	-4
		February	7	23	7	4	12	4	-24	-16	-12	-8	-26	-18	-13	-9	-26	-18	-13	-9
		March	17	20	2	5	11	3	-14	-12	-12	-9	-16	-14	-13	-10	-16	-14	-13	-10
		April	10	19	4	8	11	1	-10	-5	-4	-3	-10	-5	-4	-3	-10	-5	-4	-3
		May	20	20	0	10	10	0	-7	-7	-4	-4	-7	-7	-4	-4	-7	-7	-4	-4
	12-17y	January	0	5	2	0	6	2	-9	-6	-10	-7	-10	-7	-11	-8	-10	-7	-11	-8
		February	1	5	2	1	5	2	-6	-4	-7	-5	-6	-4	-7	-5	-6	-4	-7	-5
		March	0	1	1	0	2	1	-1	0	-3	-2	-1	0	-3	-2	-1	0	-3	-2
		April	1	2	1	1	4	2	-1	-1	-5	-4	-1	-1	-5	-4	-1	-1	-5	-4
		May	1	4	2	1	4	2	-3	-1	-3	-1	-5	-3	-5	-4	-5	-3	-5	-4
	18-29y	January	13	18	2	7	9	1	-1	1	-1	1	-12	-10	-6	-5	-12	-10	-6	-5
		February	13	21	4	6	10	2	-8	-4	-4	-2	-16	-12	-8	-6	-16	-12	-8	-6
		March	8	13	2	4	7	1	-3	-1	-3	-2	-4	-2	-4	-2	-5	-3	-4	-3
		April	11	17	3	6	11	2	-16	-13	-13	-10	-16	-13	-13	-10	-17	-14	-14	-11
		May	14	23	4	7	11	2	-15	-10	-7	-5	-15	-10	-7	-5	-17	-12	-8	-6
	30-59y	January	69	75	3	18	20	1	-20	-17	-5	-5	-21	-18	-6	-5	-21	-18	-6	-5
		February	52	72	9	14	19	2	-18	-8	-5	-2	-30	-20	-8	-5	-30	-20	-8	-5

		March	63	78	7	16	19	2	-19	-11	-4	-2	-23	-15	-5	-3	-24	-16	-5	-3
		April	63	66	2	17	17	0	76	78	20	20	76	78	20	20	33	35	9	9
		May	65	83	8	17	22	2	258	267	68	70	256	265	67	69	193	202	51	53
	≥60y	January	222	262	18	180	213	15	-57	-37	-47	-30	-59	-39	-48	-32	-59	-39	-48	-32
		February	198	288	40	161	234	33	-97	-52	-79	-42	-100	-55	-82	-45	-100	-55	-82	-45
		March	241	287	20	192	228	16	150	159	-26	-8	-39	-16	-26	-8	-41	-18	-27	-9
		April	286	305	9	232	249	8	149	158	119	128	149	158	118	127	69	78	54	62
		May	503	525	10	408	427	8	742	754	603	612	740	752	601	610	604	616	491	500
	0-11y	January	13	27	6	6	11	3	-16	-9	-7	-4	-20	-13	-8	-6	-20	-13	-8	-6
		February	18	28	4	8	12	2	-18	-13	-8	-5	-20	-15	-8	-6	-20	-15	-8	-6
		March	16	31	7	7	13	3	-27	-19	-11	-8	-30	-22	-13	-9	-30	-22	-13	-9
		April	13	27	6	6	11	3	-20	-13	-8	-6	-22	-15	-9	-6	-22	-15	-9	-6
		May	19	27	4	8	12	2	-13	-9	-6	-4	-13	-9	-6	-4	-13	-9	-6	-4
Ancash	12-17y	January	2	3	1	2	3	1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-2
		February	3	4	1	3	4	1	-3	-3	-3	-2	-3	-3	-3	-2	-3	-3	-3	-2
		March	4	6	1	3	5	1	-3	-2	-3	-2	-4	-3	-4	-3	-4	-3	-4	-3
		April	3	6	2	2	5	1	-4	-2	-4	-2	-5	-3	-4	-3	-5	-3	-4	-3
		May	3	6	2	3	6	1	-6	-5	-6	-4	-6	-5	-6	-4	-6	-5	-6	-4
	18-29y	January	15	20	2	8	10	1	-8	-5	-4	-3	-15	-12	-8	-6	-15	-12	-8	-6
		February	9	20	5	5	10	3	-16	-11	-8	-5	-21	-16	-11	-8	-21	-16	-11	-8
		March	11	17	3	6	9	1	-11	-8	-6	-4	-15	-12	-8	-6	-15	-12	-8	-6
		April	12	17	2	6	9	1	-11	-8	-6	-4	-13	-10	-7	-5	-13	-10	-7	-5
		May	7	20	6	3	10	3	-16	-9	-8	-5	-19	-12	-9	-6	-19	-12	-9	-6
	30-59y	January	53	94	18	13	24	5	-42	-22	-11	-6	-55	-35	-14	-9	-55	-35	-14	-9
		February	49	73	11	12	19	3	-24	-12	-6	-3	-36	-24	-9	-6	-36	-24	-9	-6
		March	52	80	13	13	20	3	-43	-29	-11	-7	-47	-33	-12	-8	-47	-33	-12	-8
		April	51	76	11	13	19	3	-16	-4	-4	-1	-18	-6	-5	-1	-41	-29	-11	-7

		May	75	95	9	19	24	2	84	94	22	24	81	91	21	23	29	39	7	10
	≥60y	January	204	429	100	134	287	68	-291	-178	-197	-121	-296	-183	-201	-124	-296	-183	-201	-124
		February	198	335	61	134	228	41	-211	-142	-143	-96	-216	-147	-146	-100	-216	-147	-146	-100
		March	232	399	74	158	271	50	-179	-96	-122	-65	-186	-103	-126	-70	-187	-104	-127	-70
		April	209	387	79	142	263	53	-156	-67	-106	-45	-157	-68	-106	-46	-215	-126	-146	-85
		May	377	453	34	256	308	23	202	241	137	163	197	236	134	160	61	100	42	68
Ica	0-11y	January	11	20	4	6	11	2	-5	0	-2	0	-7	-2	-3	-1	-7	-2	-3	-1
		February	10	27	7	5	14	4	-25	-17	-13	-9	-26	-18	-14	-10	-26	-18	-14	-10
		March	17	26	4	9	14	2	-26	-22	-14	-12	-27	-23	-15	-12	-27	-23	-15	-12
		April	13	16	2	7	9	1	-7	-6	-4	-3	-7	-6	-4	-3	-8	-7	-4	-4
		May	10	20	5	5	10	2	-13	-8	-7	-4	-13	-8	-7	-4	-13	-8	-7	-4
	12-17y	January	1	2	1	1	2	1	3	4	3	4	1	2	1	2	1	2	1	2
		February	0	5	2	0	6	3	-7	-4	-8	-5	-7	-4	-8	-5	-7	-4	-8	-5
		March	1	5	2	1	6	2	-8	-6	-10	-8	-8	-6	-10	-8	-8	-6	-10	-8
		April	2	3	1	2	4	1	1	1	1	1	-1	-1	-2	-1	-1	-1	-2	-1
		May	1	3	1	1	4	1	-4	-3	-5	-4	-4	-3	-5	-4	-4	-3	-5	-4
	18-29y	January	8	14	3	5	8	2	0	3	0	2	-10	-7	-6	-4	-10	-7	-6	-4
		February	11	14	2	6	8	1	3	4	1	2	-6	-5	-4	-3	-6	-5	-4	-3
		March	12	17	2	7	10	1	-14	-12	-8	-7	-19	-17	-11	-10	-19	-17	-11	-10
		April	5	19	6	3	11	4	-23	-15	-13	-9	-24	-16	-14	-10	-25	-17	-14	-10
		May	11	16	2	6	9	1	-9	-6	-5	-3	-14	-11	-8	-6	-14	-11	-8	-6
	30-59y	January	42	74	15	13	24	5	-4	12	-1	4	-27	-11	-9	-4	-27	-11	-9	-4
		February	43	66	10	14	21	3	-8	4	-2	1	-24	-12	-8	-4	-24	-12	-8	-4
		March	57	77	9	18	25	3	-38	-27	-12	-9	-44	-33	-14	-11	-44	-33	-14	-11
		April	42	75	15	14	24	5	-19	-2	-6	-1	-22	-5	-7	-2	-45	-28	-15	-9
		May	54	76	10	18	25	3	102	113	33	36	96	107	31	35	30	41	10	13
	≥60y	January	219	267	22	221	270	22	-89	-65	-90	-66	-89	-65	-90	-66	-89	-65	-90	-66

		February	202	310	48	204	314	49	-139	-84	-140	-85	-144	-89	-145	-90	-144	-89	-145	-90
		March	229	306	34	232	310	34	-107	-69	-108	-69	-110	-72	-111	-72	-110	-72	-111	-72
		April	219	285	29	221	288	29	-56	-23	-57	-23	-58	-25	-59	-25	-96	-63	-97	-64
		May	321	364	19	324	368	19	179	200	180	202	177	198	178	200	54	75	54	76
La Libertad	0-11y	January	37	40	1	9	10	0	-1	0	0	0	-3	-2	-1	0	-3	-2	-1	0
		February	27	43	7	7	11	2	-29	-21	-7	-5	-33	-25	-8	-6	-33	-25	-8	-6
		March	34	47	6	9	12	1	-33	-27	-8	-7	-34	-28	-9	-7	-34	-28	-9	-7
		April	28	35	3	7	9	1	-15	-12	-4	-3	-16	-13	-4	-3	-16	-13	-4	-3
		May	27	51	11	7	13	3	-49	-37	-12	-9	-49	-37	-12	-9	-50	-38	-13	-10
	12-17y	January	7	10	2	4	5	1	-4	-2	-2	-1	-5	-3	-3	-2	-5	-3	-3	-2
		February	5	7	1	3	4	1	-1	0	-1	0	-5	-4	-3	-2	-5	-4	-3	-2
		March	6	13	3	3	7	2	-14	-11	-8	-6	-17	-14	-9	-7	-17	-14	-9	-7
		April	3	9	3	2	5	1	-10	-7	-6	-4	-10	-7	-6	-4	-11	-8	-6	-5
		May	3	9	3	2	5	1	-9	-6	-5	-3	-11	-8	-6	-5	-11	-8	-6	-5
	18-29y	January	22	37	7	6	10	2	-15	-8	-4	-2	-33	-26	-9	-7	-33	-26	-9	-7
		February	22	40	8	6	11	2	-36	-26	-10	-7	-42	-32	-12	-9	-42	-32	-12	-9
		March	25	35	5	7	10	1	-26	-21	-7	-6	-32	-27	-9	-8	-32	-27	-9	-8
		April	16	27	5	4	8	1	-25	-19	-7	-5	-27	-21	-8	-6	-27	-21	-8	-6
		May	23	31	4	6	9	1	-11	-7	-3	-2	-19	-15	-5	-4	-19	-15	-5	-4
	30-59y	January	108	135	12	17	22	2	-23	-10	-4	-2	-38	-25	-6	-4	-38	-25	-6	-4
		February	103	128	11	16	21	2	-56	-43	-9	-7	-73	-60	-12	-10	-73	-60	-12	-10
		March	95	154	26	15	25	4	-113	-84	-18	-13	-129	-100	-21	-16	-131	-102	-21	-16
		April	109	129	9	17	21	1	-38	-28	-6	-5	-42	-32	-7	-5	-55	-45	-9	-7
		May	108	125	7	17	20	1	74	82	12	13	67	75	11	12	25	33	4	5
	≥60y	January	398	523	55	187	245	26	-146	-84	-68	-39	-153	-91	-72	-43	-153	-91	-72	-43
		February	336	564	101	158	265	47	-362	-248	-170	-116	-366	-252	-172	-118	-366	-252	-172	-118
		March	376	578	89	176	271	42	-314	-213	-147	-100	-315	-214	-148	-100	-316	-215	-148	-101

		April	378	454	33	177	213	16	-132	-94	-62	-44	-133	-95	-62	-44	-166	-128	-78	-60
		May	497	509	5	233	238	2	144	150	68	70	141	147	66	69	35	41	17	19
Ucayali	0-11y	January	13	13	0	9	9	0	1	1	1	1	1	1	1	1	1	1	1	1
		February	4	13	4	3	9	3	-10	-6	-7	-4	-10	-6	-7	-4	-10	-6	-7	-4
		March	2	15	6	1	11	4	-11	-4	-8	-3	-11	-4	-8	-3	-11	-4	-8	-3
		April	8	10	1	6	7	1	1	2	1	1	1	2	1	1	1	2	1	1
		May	6	24	8	4	17	6	-29	-20	-21	-14	-29	-20	-21	-14	-31	-22	-22	-16
	12-17y	January	1	3	1	2	6	2	-3	-2	-6	-4	-3	-2	-6	-4	-3	-2	-6	-4
		February	1	2	1	2	4	1	-3	-3	-6	-5	-3	-3	-6	-5	-3	-3	-6	-5
		March	0	3	1	0	5	2	-1	0	-2	1	-1	0	-2	1	-1	0	-2	1
		April	0	1	1	-1	2	1	2	3	3	4	2	3	3	4	2	3	3	4
		May	0	6	3	0	10	4	-11	-8	-19	-14	-11	-8	-19	-14	-11	-8	-19	-14
	18-29y	January	3	18	7	3	19	7	-25	-18	-26	-18	-25	-18	-26	-18	-25	-18	-26	-18
		February	7	14	3	7	15	3	-8	-5	-9	-5	-8	-5	-9	-5	-8	-5	-9	-5
		March	3	10	3	3	10	3	-3	1	-3	1	-5	-1	-5	-1	-5	-1	-5	-1
		April	6	6	0	6	6	0	12	12	12	12	12	12	12	12	10	10	10	10
		May	7	17	5	7	18	5	-17	-12	-18	-13	-17	-12	-18	-13	-18	-13	-19	-14
	30-59y	January	37	51	6	22	31	4	-2	6	-1	3	-3	5	-2	3	-3	5	-2	3
		February	23	55	14	14	33	9	-47	-31	-29	-19	-50	-34	-30	-21	-50	-34	-30	-21
		March	13	37	11	8	23	6	-15	-3	-9	-2	-16	-4	-9	-2	-16	-4	-9	-2
		April	22	40	8	14	25	5	37	46	22	28	36	45	22	27	20	29	12	17
		May	13	48	16	8	29	10	92	110	56	67	92	110	56	67	75	93	46	56
	≥60y	January	46	75	13	118	194	34	-91	-76	-233	-195	-91	-76	-233	-195	-91	-76	-233	-195
		February	50	95	20	127	246	52	-51	-28	-131	-72	-51	-28	-131	-72	-51	-28	-131	-72
		March	44	99	24	113	255	63	-55	-27	-141	-70	-55	-27	-141	-70	-55	-27	-141	-70
		April	82	138	25	212	356	64	44	72	114	186	44	72	114	186	13	41	34	106
		May	156	219	28	402	565	72	240	272	619	700	240	272	619	700	203	235	524	605

80 TD: Total deaths, VD: Violent deaths, CV: COVID-19 deaths

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Figure 9: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Lima(95% CI)

Figure 18: Male 2020 deaths by month compared to the upper and lower limits of historical deaths for Lambayeque (95% CI)

Figure 19: Female 2020 deaths by month compared to the upper and lower limits of historical deaths for Lima (95% CI)

Figure 25: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Piura (95% CI)

Figure 26: Male 2020 deaths by month compared to the upper and lower limits of historical deaths for Piura (95% CI)

Figure 27: Female 2020 deaths by month compared to the upper and lower limits of historical deaths for Piura (95% CI)

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Figure 33: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Loreto(95% CI)

Figure 34: Male 2020 deaths by month compared to the upper and lower limits of historical deaths for Loreto (95% CI)

Figure 35: Female 2020 deaths by month compared to the upper and lower limits of historical deaths for Loreto (95% CI)

Figure 41: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Callao (95% CI)

Figure 42: Male 2020 deaths by month compared to the upper and lower limits of historical deaths for Callao (95% CI)

Figure 43: Female 2020 deaths by month compared to the upper and lower limits of historical deaths for Callao (95% CI)

Figure 49: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Ancash (95% CI)

Figure 57: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Ica (95% CI)

Figure 65: General 2020 deaths by month compared to the upper and lower limits of historical deaths for La Libertad (95% CI)

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Figure 73: General 2020 deaths by month compared to the upper and lower limits of historical deaths for Ucayali (95% CI)

REFERENCES

1. World Health Organization. Timeline of WHO's response to COVID-19 [Internet]. Available from: <https://www.who.int/news-room/detail/29-06-2020-covidtimeline>
2. Ministerio de Salud del Perú. Casos positivos por COVID-19 [Internet]. 2020. Available from: <https://www.datosabiertos.gob.pe/dataset/casos-positivos-por-covid-19-ministerio-de-salud-minsa>
3. Ministerio de Salud del Perú. Fallecidos por COVID-19 [Internet]. 2020. Available from: <https://www.datosabiertos.gob.pe/dataset/fallecidos-por-covid-19-ministerio-de-salud-minsa>
4. Munayco C V, Tariq A, Rothenberg R, Soto-Cabezas GG, Reyes MF, Valle A, et al. Early transmission dynamics of COVID-19 in a southern hemisphere setting: Lima-Peru: February 29th-March 30th, 2020. *Infect Dis Model* [Internet]. 2020 May 12;5:338–45. Available from: <https://pubmed.ncbi.nlm.nih.gov/32399507>
5. Lisboa Bastos M, Tavaziva G, Abidi SK, Campbell JR, Haraoui L-P, Johnston JC, et al. Diagnostic accuracy of serological tests for covid-19: systematic review and meta-analysis. *BMJ* [Internet]. 2020 Jul 1;370:m2516. Available from: <http://www.bmj.com/content/370/bmj.m2516.abstract>
6. Simonsen L, Spreeuwenberg P, Lustig R, Taylor RJ, Fleming DM, Kroneman M, et al. Global Mortality Estimates for the 2009 Influenza Pandemic from the GLaMOR Project: A Modeling Study. *PLOS Med* [Internet]. 2013 Nov 26;10(11):e1001558. Available from: <https://doi.org/10.1371/journal.pmed.1001558>
7. Zheng Z, Peng F, Xu B, Zhao J, Liu H, Peng J, et al. Risk factors of critical & mortal COVID-19 cases: A systematic literature review and meta-analysis. *J Infect* [Internet]. 2020; Available from: <http://www.sciencedirect.com/science/article/pii/S0163445320302346>

- 583 8. Instituto Nacional de Estadística e Informática. Censos Nacionales 2017: XII de
584 Población, VII de Vivienda y III de Comunidades Indígenas [Internet]. 2017. Available
585 from: <https://censos2017.inei.gob.pe/redatam/>
- 586 9. Instituto Nacional de Estadística e Informática. Perú: Enfermedades No Transmisibles y
587 Transmisibles, 2018 [Internet]. 2019. Available from:
588 [https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1657/li](https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1657/libro.pdf)
589 [bro.pdf](https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1657/libro.pdf)
- 590 10. Escobar G, Matta J, Ayala R, Amado J. Características clinicoepidemiológicas de
591 pacientes fallecidos por covid-19 en un hospital nacional de Lima, Perú . Vol. 20, Revista
592 de la Facultad de Medicina Humana . scielo ; 2020. p. 180–5.
- 593 11. Fernando Mejía, Carlos Medina, Enrique Cornejo, Enrique Morello, Sergio Vásquez,
594 Jorge Alave, Alvaro Schwalb GM. Características clínicas y factores asociados a
595 mortalidad en pacientes adultos hospitalizados por COVID-19 en un hospital público de
596 Lima, Perú. Prepr SciELO [Internet]. 2020; Available from:
597 <https://preprints.scielo.org/index.php/scielo/preprint/view/858>
- 598 12. Oyesanya M, Lopez-Morinigo J, Dutta R. Systematic review of suicide in economic
599 recession. World J psychiatry. 2015 Jun;5(2):243–54.
- 600 13. Reger MA, Stanley IH, Joiner TE. Suicide Mortality and Coronavirus Disease 2019—A
601 Perfect Storm? JAMA Psychiatry [Internet]. 2020 Apr 10; Available from:
602 <https://doi.org/10.1001/jamapsychiatry.2020.1060>
- 603 14. Magnani C, Azzolina D, Gallo E, Ferrante D, Gregori D. How Large Was the Mortality
604 Increase Directly and Indirectly Caused by the COVID-19 Epidemic? An Analysis on
605 All-Causes Mortality Data in Italy. Int J Environ Res Public Health [Internet]. 2020 May
606 15;17(10):3452. Available from: <https://pubmed.ncbi.nlm.nih.gov/32429172>
- 607 15. Ministerio de Salud del Perú. Sistema Informático Nacional de Defunciones [Internet].

- 608 2020. Available from:
609 http://www.minsa.gob.pe/reunis/data/defunciones_registradas.asp
- 610 16. Leon DA, Shkolnikov VM, Smeeth L, Magnus P, Pechholdová M, Jarvis CI. COVID-
611 19: a need for real-time monitoring of weekly excess deaths. *Lancet* [Internet].
612 2020/04/22. 2020 May 2;395(10234):e81–e81. Available from:
613 <https://pubmed.ncbi.nlm.nih.gov/32333839>
- 614 17. Green HK, Andrews NJ, Bickler G, Pebody RG. Rapid estimation of excess mortality:
615 nowcasting during the heatwave alert in England and Wales in June 2011. *J Epidemiol*
616 *Community Health*. 2012 Oct;66(10):866–8.
- 617 18. Vieira A, Peixoto VR, Aguiar P, Abrantes A. Rapid estimation of excess mortality in
618 times of COVID-19 in Portugal - Beyond reported deaths. *medRxiv* [Internet]. 2020 Jan
619 1;2020.05.14.20100909. Available from:
620 <http://medrxiv.org/content/early/2020/05/19/2020.05.14.20100909.abstract>
- 621 19. Instituto Nacional de Estadística e Informática. La población de Lima supera los nueve
622 millones y medio de habitantes [Internet]. Lima; 2020. Available from:
623 <http://m.inei.gob.pe/media/MenuRecursivo/noticias/notadeprensa006.pdf>
- 624 20. Defensoría del Pueblo. Estado de Emergencia Sanitaria: El problema de la informalidad
625 laboral en una economía confinada [Internet]. Lima; 2020. Available from:
626 [https://www.defensoria.gob.pe/wp-content/uploads/2020/04/Serie-de-Informes-](https://www.defensoria.gob.pe/wp-content/uploads/2020/04/Serie-de-Informes-Especiales-Nº-02-2020-DP-Problema-de-la-informalidad-laboral-en-una-economia-confinada.pdf)
627 [Especiales-Nº-02-2020-DP-Problema-de-la-informalidad-laboral-en-una-economia-](https://www.defensoria.gob.pe/wp-content/uploads/2020/04/Serie-de-Informes-Especiales-Nº-02-2020-DP-Problema-de-la-informalidad-laboral-en-una-economia-confinada.pdf)
628 [confinada.pdf](https://www.defensoria.gob.pe/wp-content/uploads/2020/04/Serie-de-Informes-Especiales-Nº-02-2020-DP-Problema-de-la-informalidad-laboral-en-una-economia-confinada.pdf)
- 629 21. Bradbury-Jones C, Isham L. The pandemic paradox: The consequences of COVID-19
630 on domestic violence. *J Clin Nurs* [Internet]. 2020/04/22. 2020 Jul;29(13–14):2047–9.
631 Available from: <https://pubmed.ncbi.nlm.nih.gov/32281158>
- 632 22. Calderon-Anyosa RJC, Kaufman JS. Impact of COVID-19 Lockdown Policy on

- Homicide, Suicide, and Motor Vehicle Deaths in Peru. medRxiv [Internet]. 2020 Jan 1;2020.07.11.20150193. Available from: <http://medrxiv.org/content/early/2020/07/14/2020.07.11.20150193.abstract>
23. Vasquez-Chavesta AZ, Morán-Mariños C, Rodrigo-Gallardo PK, Toro-Huamanchumo CJ. COVID-19 and dengue: Pushing the peruvian health care system over the edge. Travel Med Infect Dis [Internet]. 2020 Jun 26;36:101808. Available from: <https://pubmed.ncbi.nlm.nih.gov/32599174>
24. Centro Nacional de Epidemiología P y C de E. Sala situacional para el Análisis de Situación de Salud - SE 27- 2020 [Internet]. Lima; 2020. Available from: <https://www.dge.gob.pe/portal/docs/vigilancia/sala/2020/SE03/dengue.pdf>
25. Michelozzi P, de'Donato F, Scortichini M, de Sario M, Noccioli F, Rossi P, et al. Mortality impacts of the coronavirus disease (COVID-19) outbreak by sex and age: Rapid mortality surveillance system, Italy, 1 February to 18 April 2020. Eurosurveillance. 2020;25(19):1–5.
26. Kontopantelis E, Mamas MA, Deanfield J, Asaria M, Doran T. Excess mortality in England and Wales during the first wave of the COVID-19 pandemic. medRxiv. 2020;2020.05.26.20113357.
27. Piccininni M, Rohmann JL, Foresti L, Lurani C, Kurth T. Use of all cause mortality to quantify the consequences of covid-19 in Nembro, Lombardy: Descriptive study. BMJ. 2020;369.
28. Weinberger DM, Chen J, Cohen T, Crawford FW, Mostashari F, Olson D, et al. Estimation of Excess Deaths Associated With the COVID-19 Pandemic in the United States, March to May 2020. JAMA Intern Med [Internet]. 2020;06520(May):E1-9. Available from: <https://sci-hub.tw/downloads-ii/2020-07-02/3c/10.1001@jamainternmed.2020.3391.pdf>

- 658 29. Freitas ARR, Medeiros NM, Frutuoso L, Beckedorff OA, Martin LMA, Coelho MMM,
659 et al. Use of excess mortality associated with the COVID-19 epidemic as an
660 epidemiological surveillance strategy - preliminary results of the evaluation of six
661 Brazilian capitals. medRxiv [Internet]. 2020;2020.05.08.20093617. Available from:
662 <http://medrxiv.org/lookup/doi/10.1101/2020.05.08.20093617>
- 663 30. Liu Y, Mao B, Liang S, Yang J-W, Lu H-W, Chai Y-H, et al. Association between age
664 and clinical characteristics and outcomes of COVID-19. Eur Respir J [Internet]. 2020
665 May 27;55(5):2001112. Available from: <https://pubmed.ncbi.nlm.nih.gov/32312864>
- 666 31. DeBiasi RL, Song X, Delaney M, Bell M, Smith K, Pershad J, et al. Severe COVID-19
667 in Children and Young Adults in the Washington, DC Metropolitan Region. J Pediatr
668 [Internet]. 2020 May 13;223:199-203.e1. Available from:
669 <https://pubmed.ncbi.nlm.nih.gov/32405091>
- 670 32. Centers for Disease Control and Prevention. Coronavirus Disease 2019: People of Any
671 Age with Underlying Medical Conditions [Internet]. US; Available from:
672 [https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-](https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html)
673 [medical-conditions.html](https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html)
- 674 33. Bray F, Ferlay J, Soerjomataram I. Global Cancer Statistics 2018: GLOBOCAN
675 Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries.
676 2018;394–424.
- 677 34. Sánchez-Moreno F. The national health system in Peru. Rev Peru Med Exp Salud
678 Publica. 2014;31(4):747–53.
- 679 35. The World Bank. Current health expenditure (% of GDP) - Latin America & Caribbean
680 [Internet]. 2017. Available from:
681 <https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS?locations=ZJ>
- 682 36. Lai AG, Pasea L, Banerjee A, Denaxas S, Katsoulis M, Chang WH, et al. Estimating

- 683 excess mortality in people with cancer and multimorbidity in the COVID-19 emergency.
 684 medRxiv [Internet]. 2020;2020.05.27.20083287. Available from:
 685 <https://www.medrxiv.org/content/10.1101/2020.05.27.20083287v1>
- 686 37. Figueroa J, Brennan P, Theodoratou E, Poon M, Purshouse K, Din F, et al. Trends in
 687 excess cancer and cardiovascular deaths in Scotland during the COVID-19 pandemic 30
 688 December 2019 to 20 April 2020. medRxiv [Internet]. 2020 Jan 1;2020.05.02.20086231.
 689 Available from:
 690 <http://medrxiv.org/content/early/2020/05/06/2020.05.02.20086231.abstract>
- 691 38. Dale, B. ; Stylianou N. Coronavirus: What is the true death toll of the pandemic? British
 692 Broadcasting Corporation (BBC) [Internet]. Available from:
 693 <https://www.bbc.com/news/world-53073046>
- 694 39. Steven Bernard, David Blood, John Burn-Murdoch, Max Harlow, Caroline Nevitt, Alan
 695 Smith CT and AW. Coronavirus tracked: the latest figures as countries start to reopen.
 696 Financial times [Internet]. 2020; Available from:
 697 [https://raw.githubusercontent.com/Financial-Times/coronavirus-excess-mortality-](https://raw.githubusercontent.com/Financial-Times/coronavirus-excess-mortality-data/master/data/ft_excess_deaths.csv)
 698 [data/master/data/ft_excess_deaths.csv](https://raw.githubusercontent.com/Financial-Times/coronavirus-excess-mortality-data/master/data/ft_excess_deaths.csv)
- 699 40. Felix-Cardoso J, Vasconcelos H, Rodrigues P, Cruz-Correia R. Excess mortality during
 700 COVID-19 in five European countries and a critique of mortality analysis data. medRxiv
 701 [Internet]. 2020 Jan 1;2020.04.28.20083147. Available from:
 702 <http://medrxiv.org/content/early/2020/05/02/2020.04.28.20083147.abstract>
- 703 41. Docherty K, Butt J, de Boer R, Dewan P, Koeber L, Maggioni A, et al. Excess deaths
 704 during the Covid-19 pandemic: An international comparison. medRxiv [Internet]. 2020
 705 Jan 1;2020.04.21.20073114. Available from:
 706 <http://medrxiv.org/content/early/2020/05/13/2020.04.21.20073114.abstract>
- 707 42. Wetzler HP, Wetzler EA. COVID-19 Excess Deaths in the United States, New York

708 City, and Michigan During April 2020. medRxiv [Internet]. 2020;2020.04.02.20051532.
709 Available from:
710 <http://medrxiv.org/content/early/2020/05/19/2020.04.02.20051532.abstract>