Estimation of all-cause excess mortality by age-specific mortality patterns of COVID-19 pandemic in Peru in 2020

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# Summary

## Background

All-cause excess mortality is a comprehensive measure of the combined direct and indirect effects of COVID-19 on mortality. Estimates are usually derived from Civil Registration and Vital Statistics (CRVS) systems, but these do not include non-registered deaths, which may be affected by changes in vital registration coverage over time.

## Methods

We use population and crude mortality rate projections from Peru’s National Institute of Statistics and Information (INEI, for its acronym in Spanish), individual-level registered COVID-19 deaths from the Ministry of Health (MoH) and individual-level registered deaths by region and age since 2017 from the National electronic registration of deaths system (SINADEF, for its acronym in Spanish).

We develop a framework that combines different estimations to find total excess mortality across regions and age groups. We use quasi-Poisson models to estimate excess registered mortality in Peru during the first wave of the COVID-19 pandemic during 2020. We use logistic mixed-effects models to estimate the completeness of the recent online registration system (SINADEF) at this time.

## Findings

We estimate that registered mortality nationally underestimates mortality by 24.6% (95% CI 48.1% - 20.9%) across 26 regions and 9 age groups. We estimate total all-cause excess mortality during the period of analysis at 117,574 (95% CI 114,101 - 139,810) of which 94,373 (95% CI 79,139 - 105,767) were captured by the vital registration system. Deaths at age 60 and over accounted for 75.4% (95% CI 75.7% - 75.4%) of total excess deaths, while there were fewer deaths than expected in younger age groups. Lima region, on the Pacific coast and including the national capital, accounts for the highest share of excess deaths, 61,986 (95% CI 61,918 - 69,672), while in the opposite side regions of Madre De Dios and Pasco account for less than 100 excess deaths.

## Interpretation

Estimating excess mortality in low- and middle-income countries (LMICs) such as Peru must take under-registration of mortality into account. Combining demographic trends with data from administrative registries reduces uncertainty and measurement errors. In countries like Peru, this is likely to produce significantly higher estimates of excess mortality than studies that do not take these effects into account.

## Funding

None.

# Research in context

## Evidence before this study

We searched PubMed, Google Scholar, medRxiv, and SocArXiv for studies published up to May 27, 2020, using the key words “excess mortality” and “under-registration” or “subregistration,” combined with “coronavirus” or “SARS-CoV-2” or “COVID-19.” We found studies estimating cumulative mortality in high-income countries in Europe and North America solely based on official death counts. We found studies computing overall COVID-19 mortality for a small number of LMICs. Prior research shows a significant percentage of under-registration of deaths in LMICs.

## Added value of this study

To our knowledge, we provide the first estimate of excess mortality associated with COVID-19 in a LMIC accounting for both registered and unregistered deaths. We develop an analytical strategy to address common challenges faced by LMICs, such as low completion rates of death certificates, missing data, vital registration growth, and inconsistency and variability of data across regions and age groups.

## Implications of all the available evidence

Our approach shows the importance of accounting for unregistered deaths based on demographic trends to generate robust estimates of excess mortality associated with COVID-19. It suggests that previous reports of COVID-19 related mortality in Peru were substantial underestimates.

# Introduction

Monitoring mortality is an essential part of the public health response to the COVID-19 pandemic. In many countries, accurate COVID-19 mortality monitoring has been hindered by failure to capture all deaths and to attribute causes of deaths to those that are recorded.1 Disentangling the contribution of COVID-19 to overall mortality is especially challenging, as many people who die from COVID-19 have other conditions, such as cardiovascular disease and diabetes.2 A further complication is the decision of some countries to apply an arbitrary maximum cut-off time between a positive COVID-19 test and death when deciding whether to attribute mortality to this cause.3 Also, it is widely documented that the pandemic has led to large numbers of deaths not directly attributable to COVID-19 (either exclusively or in part), due to the wider impacts of responses, including reduced access to treatment for other conditions.4,5 Conversely, there is evidence that the pandemic has, to a limited extent, reduced expected rates of mortality from causes such as road traffic injuries and homicides during lockdowns.6

In the absence of good data on these different mortality effects, robust estimation of all-cause excess mortality offers the most complete and reliable approach for gauging the overall impact of the pandemic on mortality in a defined population over a fixed period of time.7 Excess mortality refers to the number of additional deaths occurring over a time period when specific conditions apply (in this case, the presence of COVID-19), compared to the number of deaths we might reasonably expect over the same period based on historical data. It captures deaths directly and indirectly attributed to COVID-19 and corresponding responses, to provide an estimate of the overall mortality effect of the pandemic as it unfolds.8

Excess mortality estimates have been computed for high-income countries based on registered deaths by surveillance agencies9,10, academia11–14 and news agencies.15–18 However, these types of data are often incomplete or inaccurate, especially in many low and middle-income countries (LMICs). The Global Burden Disease (GBD) project estimates that only 64% of global deaths were registered in 2015.19 In most LMICs, responsibility for mortality data is often divided between different national and subnational agencies.20 This can cause extended delays in national reporting and discrepancies between different sources.12,21 Disaggregation of summary data by different geographical areas or demographic groups is usually very limited.22 These shortcomings in mortality data explain a lack of published studies of excess mortality in LMICs.23,24

We analyse excess mortality associated with the COVID-19 pandemic in Peru during 2020. This country is well-suited to our analytical approach. Like much of Latin America, Peru has experienced high levels of COVID-19 mortality. Official sources report 37,723 deaths directly caused by COVID-19 between 18 March and December 31 2020. However, these only include cases with positive COVID-19 test results and rates of testing in Peru have been low compared to other Latin American countries.25 Also, many tests have used low sensitivity devices, potentially generating false negatives.26 On the other hand, Peru does place anonymised individual level data on mortality and COVID-19 in the public domain.27 Other studies show that unregistered mortality tends to be more prevalent among older people and in poorer regions.28,29 However, as in many LMICs, Peru does not report under registration for sub-national data or disaggregated by age.

Potentially, our analytical design could be applied to other countries where mortality registration and cause of death data are incomplete. It may offer a valuable contribution towards assessing the true global impact of the COVID-19 pandemic.

# Data and methods

## Data

***The data sources in the Methods section should be described in more detail. For example, who manages these databases, what is the evidence about the validity and accuracy of these data? What data is contained in the databases? The INEI is projection data rather than real data, is this correct? If yes, what are the assumptions of these projections? Is the likely under-registration related to regions, age groups, socio-economic status or what exactly? This section should describe the dataset created from these databases in terms of the variables. For example, how is the mortality data represented in the dataset? Is it based on death rate per week over the study period? Are the data aggregated by age group and region only? In total how many rows of data, the dataset consisted of?***

We combine several demographic data sources to forecast mortality rates. These sources are (i) population projections from Peru’s National Institute of Statistics and Information (INEI, for its acronym in Spanish) for 2020 disaggregated by region and age group (the most recent census was in 2017);

1. crude mortality rate estimates disaggregated by region and year from 2015 to 2020 from INEI;
2. individual-level registered COVID-19 deaths by region and age in 2020 from the Ministry of Health (MoH);

and, (iv) individual-level registered deaths by region and age since 2017 from the National electronic registration of deaths system (SINADEF, for its acronym in Spanish). SINADEF registers individual-level data since 2017 with a progressive although still unequal among regions,27 which enables comparisons of spatial and temporal trends in death registration in the country.

## Excess mortality methods

Figure 1 represents our approach to estimate excess mortality, which can be decomposed into four terms: (i) SINADEF registration growth rateS (ii) excess registered deaths; (iii) excess unregistered deaths; and, (iv) unregistered COVID-19 deaths. While the terms (ii)-(iv) add counts towards the final estimation of total excess deaths, the first term adjusts downwards the final estimation. Although terms (i) and (iii) could be understood as a similar phenomeno, they are distingued based on post and pre pandemic wave, respectively.

Figure 2 summarises data sources used (squares), analysis performed (diamonds) and different outputs (circles), which will be explained below.

The first term, SINADEF registration growth rate, is computed for each region by comparing the average mortality during the period previous and post first wave. We determine the starting and ending points calculating the increment in the percentage from one weeks to the next one30 fixing 0.60% as criterion of change and assuming a linear registration growth rate during the first wave, as follows:

To estimate the second term, excess SINADEF registered deaths, we fit quasi-Poisson regressions to weekly deaths by age-groups and region due to the overdispersed and count nature of data, as follows:

where we fit a natural cubic B-spline function on weeks to address long-term trends and seasonality.31 Additionally, we use lagged residuals and the log of population in 2020, as an offset. Finally, we compute a dichotomous variable starting in the week corresponding to March 15 2020 as the first registered death of COVID-19 in the country.Then we compute the excess registered mortality as a population attributable fraction (PAF)32 based on the relative risk from parameter in equation (2), as follows:

where is the weekly number of deaths,33 and represents a fraction of the total mortality of the period where in equation (2).

The third term, excess unregistered deaths, estimates mortality delayed or absent in official registers. and is computed as a fraction of . We start by predicting SINADEF completeness by modelling random-effects logistic regressions for each region $\text\_{j}$ using data from 2017 and 2019.29 We exploit variability in INEI mortality rates, population aged 60 years and over and rurality to address potential differences in terms of registration completeness, using the equation:

where and are the Crude Death Rates, is the completeness registration rate for infants, is the logarithm under-five mortality rate and represents the fraction of the population at 60 years and over based on INEI projections. is the share of households that use liquefied petroleum gas (LPG) for cooking, which is an acceptable proxy for rurality in Peru, where 81.8% of rural households primarily use solid fuel compared to 9.8% of urban households, who typically cook with LPG.34 Rurality is an important factor to explain delays and under registration of deaths as the system requires access to internet and computers. Additionally, in the error term and is the region-level random effect. is computed using the inverse logit of the predicted values, which provides a regional adjusted SINADEF completeness rate.

Finally, excess unregistered deaths, , is computed based on from equation (4) and from equation (1), as follows:

The last term, unregistered COVID-19 deaths, is computed to correct for situations where the proportion of cumulative cases of officially COVID-19 exceeds registered deaths on MoH for that period exceeds SINADEF values. This occurs mostly in younger age groups. The computation follows a deterministic approach conditional on excess registered deaths being lower than officially registered COVID-19 deaths for each region and specific age-group as follows:

Finally, we estimate total excess deaths for different scenarios.

A first scenario is when there is no solid evidence suggesting under-registration of deaths for some regions or age groups and, therefore, no scope to expand registration over time. This usually occurs in areas and age groups with very small populations. In those cases is set to 0 as, if not, they would add negative values to the sum. A second scenario is related to younger age groups in some regions that have not be significantly affected by COVID-19 mortality. This case corresponds to when in equation (2) is not statistically significant and therefore we set . A third scenario is when some groups have fewer deaths than expected, due to effects such as reduced road traffic injuries caused by lockdowns. In these groups and are taken account of in our final estimation. A fourth scenario is when models underestimate the official number of deaths such as . In this case, we use the first as registered deaths. Equation (7) summarises the estimation of as follows:

Finally, we estimate total mortality during 2020 by adding from equation (7) and SINADEF deaths below the excess mortality during 2020, , adjusted by as follows:

To address the relative magnitude of mortality in 2020, we compute all cause age-standardised death rates per 1,000 people derived from the estimated total excess deaths. We use the direct standardization methods35 based on population INEI population estimates by region and age-group for 2020 as the standard population.36

As a robustness check for excess mortality estimates, we estimated a mortality baseline for each age group fitting a Generalised Linear Model with Poisson or Negative binomial distributions, depending on the data’s overdispersion. The model includes natural splines and sinusoidal components to account for secular changes and seasonality in mortality, as well as interpolated weekly exposures to control for changes in age structure over time. 95% prediction intervals were estimated using 2,000 bootstrapping iterations. Excess mortality is computed as the difference between observed mortality and the baseline, only including weeks in which observed mortality was above the upper prediction interval.

# Results

Figure 3 shows weekly deaths registered during years 2017-2020 where dotted vertical lines signaling start and end estimated points of the first pandemic wave. Those thresholds were used to compute the excess mortality period and the registration growth rate.

Figure 6 shows predicted values for excess registered mortality for the age group over 80. The line fit

Estimates of completeness of registration derived from our logistic regression model fit the data according to marginal and conditional and Root Mean Square of Errors parameters. Model fit and goodness-of-fit are presented in Appendix 1. Figure 4 shows important variations in regional completeness rates: Amazonas and Loreto (in Amazonia), Lambayeque (on the coast), and Cajamarca and Pasco (in the Andes) show estimated completion at below 40%, while Ica (coast) and Madre De Dios (Peru’s least populated regions in Amazonia) appear to have complete registration (see Appendix 1).

Figure 5

Table 1 summarises our estimates of excess mortality. The quasi-Poisson models show a good fit for our first term (weekly excess registered deaths) across models. Excess registered mortality is estimated to be 94,373 ( 95% CI 79,139 - 105,767 ), of which 37,725 are reported as COVID-19 deaths. This represents an increase of 150 % ( 95% CI 110 % - 180 %) compared to MoH data. See Appendix 2 for results and comparison with robustness analysis.

Table 2 shows estimates by region. Lima, which includes the capital, accounts for 61986 ( 95% CI 61918 - 69672 ) total excess deaths, and Madre De Dios and Pasco show the lowest numbers. Table 3 shows excess mortality estimates by age group. Deaths among people aged 60 years and over accounts for 75.4% of total excess mortality. There was negative excess registered mortality for the youngest three age groups: under 10, 10 to 19 and 20 to 29. Reasons to explain that phenomena are linked to lockdown measures that avoid car accidents, violent crime and other risk behaviours in younger age groups as well as potential registration delays of deaths occurred by other causes rather than COVID-19, which is predominant among older people, due to higher administrative workload.

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Our second term, excess unregistered deaths, is estimated to be 14,780 deaths ( 95% CI 25,622 - 26,541 ). This represents 19.7 % ( 95% CI 10 % - 32.7 %) of our estimate of the total registered and unregistered deaths. Coastal regions show the highest values where Lima accounts for 11,054 additional deaths, followed by Piura (4,631) and Lambayeque (1,512). Our third term adds 8,421 deaths corresponding to cases when reported COVID-19 deaths exceed our estimate of adjusted excess registered mortality. This mainly occurs for some smaller groups at younger ages. The regions with the highest under reported COVID-19 values are the Andean regions of Ayacucho (4,631), Cusco (794) and Puno (556).

Combining all these terms, our estimate of total excess deaths during 2020 is 117,574 ( 95% CI 114,101 - 139,810 ) and our estimate of total deaths for 2020 is 378,139 ( 95% CI 346,655 - 437,662 ). This is 0.3 % ( 95% CI -11.3 % - 11 %) more than the number of deaths projected by INEI for 2020.

Figure 7 shows all cause age-standardised death rates. We find that Lambayeque, Moquegua, and Tumbes (CI 95% ranging from NaN to NaN) present the highest rates, ranging from NaN to NaN, while regions of Cusco, Amazonas, and Ayacucho show the lowest rates ranging from NaN to NaN (CI 95% ranging from NaN to NaN) (left). Figure 7 (right) shows differences deaths per 1000 in comparison to INEI’s projections for 2020. We find excess mortality rates in all cases but Amazonas, which shows -1.26 suggesting that INEI overestimates mortality rates projections for 2020 and there is lower use of the CRVS system than expected.

# Discussion

The COVID-19 pandemic has underscored the need for methodological advances in population health measurement, research, critical data quality assessment and improvement of health information systems to obtain reliable information on the impact of the pandemic from multiple data sources linked to COVID-19. In this regards, our study provides a framework, tools and analytical strategy to estimate the excess mortality caused by the COVID-19 pandemic in Peru and, potentially, other countries where the quality of mortality data is medium to low.37 The scope for applying a similar approach will vary between countries. In countries such as India, where mortality and cause of death data are of considerably lower quality than in Peru, achieving robust estimates by any method will be hugely challenging.38 In other countries, such as Colombia, data quality is similar to Peru’s and a recent reform of its CRVS system is likely to have boosted registration rates in the past recent years.39

Other published studies of excess COVID-19 mortality fall into two categories. Some studies provide estimates for countries where mortality data are relatively complete and reliable.40–43 As such, they do not apply specific methods to address data gaps. Studies of excess COVID-19 mortality for countries with less complete data do not take account of unregistered deaths.44–47

We estimate that overall excess mortality in Peru was 212 % ( 95% CI 202 % - 271 %) higher than the level officially attributed to COVID-19. Registered excess mortality was 150 % ( 95% CI 110 % - 180 %) higher. This is a larger differential than reported by studies for high-income countries. For example, separate studies of the USA show differentials of between 28 and 33%.11,12 Our estimates are higher than those previously published for Peru, which are only based on registered deaths, and which apply simpler methods.48,49 Our estimates of regional variations in excess mortality are in line with,48 who speculate that they may be in part attributable to the effect of altitude of COVID-19 case fatality.

Despite making up a relatively low share of Peru’s population (12.5% in 2020), people aged 60 or more accounted for 75.4% of excess mortality. No other published study in Peru provides data disaggregated by age groups. A study of registered excess mortality in six Brazilian cities reports that people aged 60 and over accounted for 71.1% of the total.45 An analysis of European countries reports that 91% of excess COVID-19 deaths occurred among people aged 65 or more.42 This reflects a higher proportion of population aged 60 or more in Europe (25.5% in 2020) than in Peru.

# Limitations

Our analysis assumes that comparison between years is not invalidated by specific time-bound mortality events such as additional disease outbreaks or other major external shocks. Our estimates of registration completeness assume no variation across age groups, which may not be the case. We do not take into account changes in registration over time as our estimates are based on provisional data, which are incomplete and continue to be fatalities due to COVID-19. Finally, we present a conservative scenario, allowing for the existence of negative as well as positive excess deaths.

assuming a linear registration growth rate during the first wave

# Conclusion

There is an evident need for robust estimates of the direct and indirect mortality effects of the COVID-19 pandemic. To date, much of the data for LMICs in the public domain rely on officially-registered deaths. Inaccurate attribution of cause of death can, to some degree, be resolved by generating excess mortality estimates based on temporal comparisons of all-cause mortality. Also, these approaches do not include deaths that are not officially registered. This paper develops and applies a method to obtain robust estimates of excess mortality for both registered and unregistered deaths.

Our study indicates that official data under-represent the overall mortality impact of the COVID-19 pandemic in Peru. This gap is considerably greater than those reported for high-income countries. It is plausible that under-estimation of excess mortality in other countries with low quality mortality data will be comparable to Peru. In that case, LMICs would account for a much larger share of the global distribution of excess mortality associated with the COVID-19 pandemic than indicated by official data sources.

# Contributors

LS conceived and initiated the study, did the statistical analysis and visualisations and drafted the manuscript.

PLS conceived and supervised the study, drafted the manuscript and led the editing process of the manuscript.

MM and SE supervised the study and engaged in the draft review & editing

RM contributed in the data curation and methodology process and reviewed & edited the draft.

EA contributed in data curation, methodology and statistical analysis.

LS and EA had access to all the data. All authors approved the manuscript and are responsible for the decision to submit for publication.

# Declaration of interests

RM is a staff member of the Pan American Health Organization. The author alone is responsible for the views expressed in this publication, and they do not necessarily represent the decisions or policies of the Pan American Health Organization.

All other authors declare no competing interests.

# Data sharing

Data presented in this manuscript are made publicly available at <https://github.com/lsempe77/excess>

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Any?

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# Figures and tables

## Figure 1

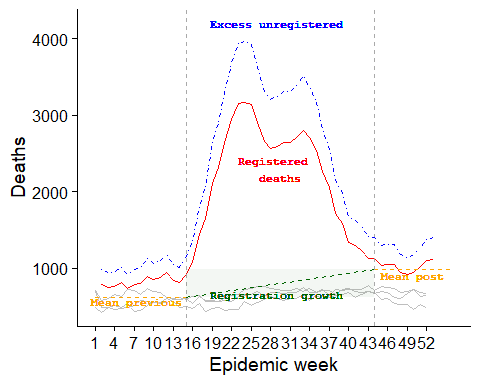


Figure 1: Conceptual representation of empirical strategy

## Figure 2

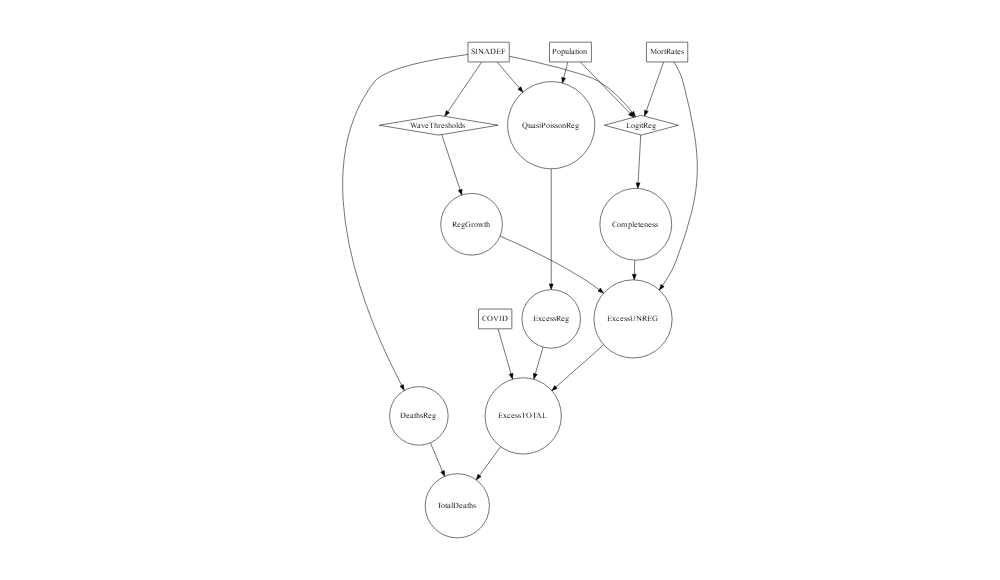


Figure 2: Flowchart: Data, analysis and outputs

## Figure 3

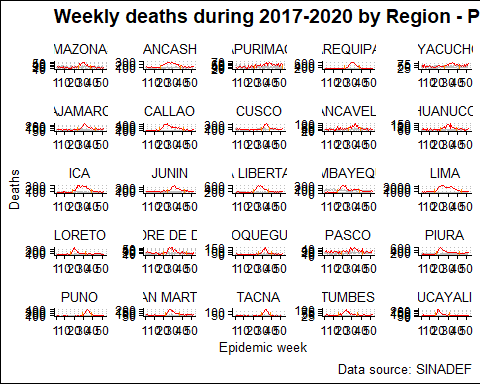


Figure 3: Weekly deaths during 2017-2020 by Region - Peru

## Figure 4

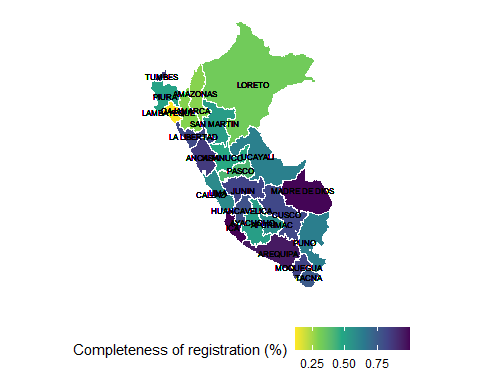


Figure 4: Completeness of registration

## Figure 5

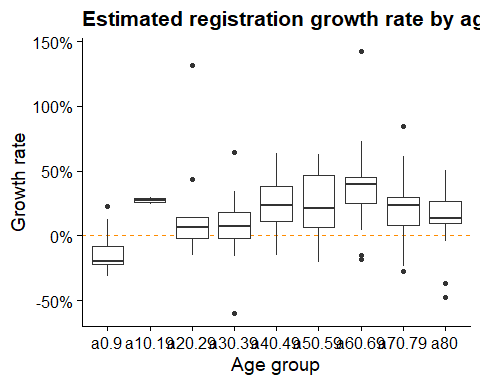


Figure 5: Estimated registration growth rate by age-groups

## Figure 6

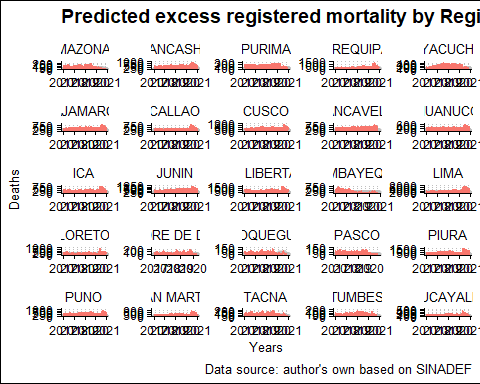


Figure 6: Predicted excess registered mortality

## Figure 7

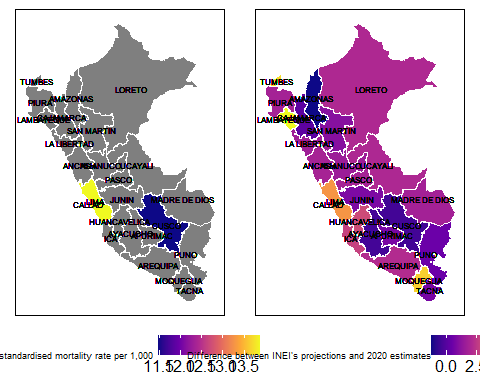


Figure 7: Age-standardised mortality rates

## Table 1

Table 1: Summary of estimations, Peru, 2020.

|  |  |
| --- | --- |
| Terms | Estimates (95% CI) |
| Excess registered deaths | 94373 ( 79139 - 105767 ) |
| Completeness of CRVS deaths registration | 19.7 % ( 24.3 % - 30.6 %) |
| Excess TOTAL mortality | 117574 ( 114101 - 139810 ) |
| Counterfactual estimated deaths in 2020 | 117276 ( 105882 - 132510 ) |
| Total estimated deaths in 2020 | 378139 ( 346655 - 437662 ) |

## Table 2

Table 2: Estimated total excess deaths by region

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Region | Total excess (TE) | TE - Lower 95% CI | TE - Upper 95% CI | Excess registered (ER) | ER - Lower 95% CI | ER - Upper 95% CI | Excess Covid-19 |
| AMAZONAS | 179 | 179 | 179 | 0 | 0 | 0 | 179 |
| ANCASH | 3524 | 3241 | 4545 | 3470 | 2829 | 3980 | 54 |
| APURIMAC | 109 | 134 | 109 | 62.05 | 0.3284 | 99.3 | 109 |
| AREQUIPA | 5338 | 4812 | 6199 | 5322 | 4564 | 5912 | 16 |
| AYACUCHO | 422.5 | 333 | 794 | 355 | 132.2 | 520.1 | 67 |
| CAJAMARCA | 2151 | 2151 | 3253 | 1614 | 1113 | 1974 | 147 |
| CALLAO | 6759 | 6722 | 7830 | 6174 | 5643 | 6574 | 18 |
| CUSCO | 1800 | 1486 | 2624 | 1767 | 1225 | 2189 | 33 |
| HUANCAVELICA | 201.7 | 131.7 | 297.8 | 33.44 | -121.2 | 138.2 | 168 |
| HUANUCO | 963.1 | 596.9 | 1938 | 935.1 | 450.7 | 1289 | 28 |
| ICA | 4149 | 3637 | 4553 | 4081 | 3560 | 4474 | 68 |
| JUNIN | 2524 | 2120 | 3567 | 2498 | 1796 | 3040 | 26 |
| LA LIBERTAD | 6766 | 6690 | 8193 | 6452 | 5709 | 7026 | 5 |
| LAMBAYEQUE | 2096 | 1872 | 2827 | -2535 | -4967 | -909.5 | 4631 |
| LIMA | 61986 | 61918 | 69672 | 50932 | 47745 | 53674 | 83 |
| LORETO | 2607 | 2442 | 3496 | 1664 | 922 | 2152 | 451 |
| MADRE DE DIOS | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MOQUEGUA | 363 | 320.6 | 453.1 | -147.8 | -441.1 | 52.94 | 511 |
| PASCO | 53 | 53 | 53 | 0 | 0 | 0 | 53 |
| PIURA | 8832 | 8727 | 10075 | 7320 | 6737 | 7754 | 35 |
| PUNO | 2787 | 2744 | 3802 | 2476 | 2030 | 2812 | 16 |
| SAN MARTIN | 2061 | 2010 | 2921 | 1558 | 967.9 | 1957 | 254 |
| TACNA | 368.5 | 309.4 | 536.4 | 250.5 | 146.4 | 321 | 118 |
| TUMBES | 450.4 | 388.7 | 537.6 | -343.7 | -866.3 | -0.5774 | 794 |
| UCAYALI | 1084 | 1084 | 1357 | 436.1 | -35.47 | 739.7 | 556 |
| Total | 117574 | 114101 | 139810 | 94373 | 79139 | 105767 | 8420 |

## Table 3

Table 3: Estimated total excess deaths by age-group

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Age range | Total excess (TE) | TE - Lower 95% CI | TE - Upper 95% CI | Excess registered (ER) | ER - Lower 95% CI | ER - Upper 95% CI | Excess Covid-19 |
| < 9 | 128 | 128.4 | 128.4 | -131.7 | -345.8 | -2.199 | 260 |
| 10-19 | 46 | 46 | 46 | 28.1 | 10.56 | 38.56 | 46 |
| 20-29 | 647 | 530.8 | 1071 | 483 | 250.6 | 654.6 | 164 |
| 30-39 | 2352 | 2094 | 3251 | 1594 | 762.7 | 2162 | 591 |
| 40-49 | 8021 | 7620 | 9533 | 6136 | 4617 | 7148 | 879 |
| 50-59 | 17707 | 17360 | 20365 | 13624 | 11530 | 15094 | 1565 |
| 60-69 | 28776 | 28292 | 32619 | 22401 | 19154 | 24752 | 2885 |
| 70-79 | 29888 | 29320 | 34582 | 23925 | 20718 | 26399 | 1881 |
| > 80 | 30009 | 28710 | 38214 | 26314 | 22441 | 29521 | 150 |
| Total | 117574 | 114101 | 139810 | 94373 | 79139 | 105767 | 8421 |

# Appendices

## Appendix 1: Model fit registration completeness

Table 4: Model fit Mixed-effect logistic regression

|  |  |  |  |
| --- | --- | --- | --- |
| R2m | R2c | RMSE.normalised | RMSE |
| 0.7438 | 0.8694 | 0.05282 | 0.2403 |

### Quasi-Poisson models

Table 5: Model fit Quasi-Poisson

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Departamento | range | null.deviance | df.null | logLik | AIC | BIC | deviance | df.residual | nobs | fit | dif.dev | df | p |
| AMAZONAS | a0.9 | 62.27 | 135 | NA | NA | NA | 52.23 | 119 | 136 | 0.1612 | 10.03 | 16 | 0.8648 |
| AMAZONAS | a10.19 | 23.19 | 76 | NA | NA | NA | 18.3 | 60 | 77 | 0.2112 | 4.898 | 16 | 0.9962 |
| AMAZONAS | a20.29 | 26.94 | 109 | NA | NA | NA | 20.89 | 93 | 110 | 0.2245 | 6.046 | 16 | 0.9876 |
| AMAZONAS | a30.39 | 42.37 | 122 | NA | NA | NA | 30.92 | 106 | 123 | 0.2703 | 11.45 | 16 | 0.7806 |
| AMAZONAS | a40.49 | 73.94 | 154 | NA | NA | NA | 65.59 | 138 | 155 | 0.1131 | 8.359 | 16 | 0.9374 |
| AMAZONAS | a50.59 | 135.5 | 173 | NA | NA | NA | 110.4 | 157 | 174 | 0.1855 | 25.15 | 16 | 0.06728 |
| AMAZONAS | a60.69 | 266.4 | 181 | NA | NA | NA | 166.3 | 164 | 182 | 0.3757 | 100.1 | 17 | 8.531e-14 |
| AMAZONAS | a70.79 | 229.6 | 198 | NA | NA | NA | 206.2 | 181 | 199 | 0.102 | 23.43 | 17 | 0.1359 |
| AMAZONAS | a80 | 256.4 | 203 | NA | NA | NA | 210.3 | 186 | 204 | 0.1796 | 46.04 | 17 | 0.0001702 |
| ANCASH | a0.9 | 220.7 | 204 | NA | NA | NA | 187.9 | 187 | 205 | 0.1487 | 32.81 | 17 | 0.0119 |
| ANCASH | a10.19 | 101.8 | 176 | NA | NA | NA | 93.9 | 159 | 177 | 0.07762 | 7.902 | 17 | 0.9686 |
| ANCASH | a20.29 | 159.5 | 196 | NA | NA | NA | 141.5 | 179 | 197 | 0.1128 | 18 | 17 | 0.3891 |
| ANCASH | a30.39 | 191.9 | 200 | NA | NA | NA | 159 | 183 | 201 | 0.1716 | 32.93 | 17 | 0.01151 |
| ANCASH | a40.49 | 357.4 | 205 | NA | NA | NA | 216.4 | 188 | 206 | 0.3946 | 141 | 17 | 1.393e-21 |
| ANCASH | a50.59 | 767.2 | 206 | NA | NA | NA | 243.7 | 189 | 207 | 0.6824 | 523.5 | 17 | 2.107e-100 |
| ANCASH | a60.69 | 1100 | 206 | NA | NA | NA | 248.5 | 189 | 207 | 0.774 | 851.1 | 17 | 5.733e-170 |
| ANCASH | a70.79 | 1088 | 206 | NA | NA | NA | 267.9 | 189 | 207 | 0.7537 | 819.8 | 17 | 2.723e-163 |
| ANCASH | a80 | 748.4 | 206 | NA | NA | NA | 250.5 | 189 | 207 | 0.6653 | 497.9 | 17 | 5.227e-95 |
| APURIMAC | a0.9 | 102.6 | 170 | NA | NA | NA | 90.44 | 154 | 171 | 0.1184 | 12.15 | 16 | 0.7339 |
| APURIMAC | a10.19 | 20.66 | 99 | NA | NA | NA | 16.27 | 83 | 100 | 0.2124 | 4.389 | 16 | 0.9981 |
| APURIMAC | a20.29 | 50.37 | 128 | NA | NA | NA | 40.86 | 112 | 129 | 0.1887 | 9.505 | 16 | 0.8912 |
| APURIMAC | a30.39 | 76.68 | 148 | NA | NA | NA | 67.06 | 132 | 149 | 0.1255 | 9.623 | 16 | 0.8856 |
| APURIMAC | a40.49 | 114.6 | 164 | NA | NA | NA | 104.8 | 148 | 165 | 0.08579 | 9.832 | 16 | 0.8752 |
| APURIMAC | a50.59 | 185.8 | 190 | NA | NA | NA | 142.9 | 173 | 191 | 0.2311 | 42.93 | 17 | 0.0004916 |
| APURIMAC | a60.69 | 292 | 199 | NA | NA | NA | 221.3 | 182 | 200 | 0.2424 | 70.79 | 17 | 1.578e-08 |
| APURIMAC | a70.79 | 263.7 | 206 | NA | NA | NA | 196 | 189 | 207 | 0.2568 | 67.73 | 17 | 5.28e-08 |
| APURIMAC | a80 | 372.9 | 206 | NA | NA | NA | 212.2 | 189 | 207 | 0.4311 | 160.7 | 17 | 1.901e-25 |
| AREQUIPA | a0.9 | 242.8 | 202 | NA | NA | NA | 213.4 | 185 | 203 | 0.1211 | 29.41 | 17 | 0.03095 |
| AREQUIPA | a10.19 | 106.2 | 167 | NA | NA | NA | 99.85 | 151 | 168 | 0.05988 | 6.36 | 16 | 0.9837 |
| AREQUIPA | a20.29 | 171.4 | 199 | NA | NA | NA | 153.1 | 182 | 200 | 0.107 | 18.33 | 17 | 0.3681 |
| AREQUIPA | a30.39 | 236.7 | 202 | NA | NA | NA | 186.4 | 185 | 203 | 0.2127 | 50.34 | 17 | 0.00003744 |
| AREQUIPA | a40.49 | 599.7 | 204 | NA | NA | NA | 250.6 | 187 | 205 | 0.5822 | 349.1 | 17 | 7.466e-64 |
| AREQUIPA | a50.59 | 1486 | 206 | NA | NA | NA | 325.6 | 189 | 207 | 0.7809 | 1160 | 17 | 4.311e-236 |
| AREQUIPA | a60.69 | 2417 | 206 | NA | NA | NA | 344.6 | 189 | 207 | 0.8574 | 2072 | 17 | 0 |
| AREQUIPA | a70.79 | 2435 | 206 | NA | NA | NA | 333.7 | 189 | 207 | 0.8629 | 2101 | 17 | 0 |
| AREQUIPA | a80 | 2587 | 206 | NA | NA | NA | 320.1 | 189 | 207 | 0.8763 | 2267 | 17 | 0 |
| AYACUCHO | a0.9 | 165.6 | 170 | NA | NA | NA | 123 | 154 | 171 | 0.2574 | 42.62 | 16 | 0.0003185 |
| AYACUCHO | a10.19 | 55.2 | 124 | NA | NA | NA | 49.19 | 108 | 125 | 0.1089 | 6.013 | 16 | 0.988 |
| AYACUCHO | a20.29 | 103.6 | 170 | NA | NA | NA | 85.56 | 154 | 171 | 0.1742 | 18.04 | 16 | 0.3214 |
| AYACUCHO | a30.39 | 92.51 | 159 | NA | NA | NA | 81.2 | 143 | 160 | 0.1222 | 11.3 | 16 | 0.7903 |
| AYACUCHO | a40.49 | 153.3 | 171 | NA | NA | NA | 121.8 | 155 | 172 | 0.2056 | 31.52 | 16 | 0.01155 |
| AYACUCHO | a50.59 | 212.8 | 190 | NA | NA | NA | 154.6 | 173 | 191 | 0.2734 | 58.18 | 17 | 2.09e-06 |
| AYACUCHO | a60.69 | 316.1 | 200 | NA | NA | NA | 175.2 | 183 | 201 | 0.4459 | 140.9 | 17 | 1.434e-21 |
| AYACUCHO | a70.79 | 443.8 | 203 | NA | NA | NA | 216 | 186 | 204 | 0.5134 | 227.9 | 17 | 6.674e-39 |
| AYACUCHO | a80 | 431.4 | 205 | NA | NA | NA | 190.6 | 188 | 206 | 0.5582 | 240.8 | 17 | 1.573e-41 |
| CAJAMARCA | a0.9 | 264.3 | 204 | NA | NA | NA | 228 | 187 | 205 | 0.1371 | 36.24 | 17 | 0.004261 |
| CAJAMARCA | a10.19 | 58.14 | 141 | NA | NA | NA | 52.72 | 125 | 142 | 0.09312 | 5.414 | 16 | 0.9933 |
| CAJAMARCA | a20.29 | 118.3 | 178 | NA | NA | NA | 99.37 | 161 | 179 | 0.1597 | 18.88 | 17 | 0.3354 |
| CAJAMARCA | a30.39 | 199.4 | 192 | NA | NA | NA | 153.6 | 175 | 193 | 0.2298 | 45.81 | 17 | 0.0001843 |
| CAJAMARCA | a40.49 | 221 | 200 | NA | NA | NA | 156.4 | 183 | 201 | 0.2924 | 64.61 | 17 | 1.791e-07 |
| CAJAMARCA | a50.59 | 532.6 | 205 | NA | NA | NA | 238.1 | 188 | 206 | 0.5529 | 294.5 | 17 | 1.532e-52 |
| CAJAMARCA | a60.69 | 865.8 | 206 | NA | NA | NA | 290.9 | 189 | 207 | 0.6641 | 575 | 17 | 2.825e-111 |
| CAJAMARCA | a70.79 | 691.9 | 206 | NA | NA | NA | 268.3 | 189 | 207 | 0.6123 | 423.7 | 17 | 2.076e-79 |
| CAJAMARCA | a80 | 531.5 | 206 | NA | NA | NA | 237.8 | 189 | 207 | 0.5527 | 293.7 | 17 | 2.205e-52 |
| CALLAO | a0.9 | 225.1 | 194 | NA | NA | NA | 211.3 | 177 | 195 | 0.06115 | 13.76 | 17 | 0.6838 |
| CALLAO | a10.19 | 56.25 | 133 | NA | NA | NA | 50.19 | 117 | 134 | 0.1076 | 6.054 | 16 | 0.9875 |
| CALLAO | a20.29 | 191.4 | 194 | NA | NA | NA | 174.2 | 177 | 195 | 0.08968 | 17.16 | 17 | 0.4433 |
| CALLAO | a30.39 | 252.6 | 201 | NA | NA | NA | 173.4 | 184 | 202 | 0.3134 | 79.17 | 17 | 5.381e-10 |
| CALLAO | a40.49 | 713.4 | 205 | NA | NA | NA | 226.5 | 188 | 206 | 0.6825 | 486.9 | 17 | 1.109e-92 |
| CALLAO | a50.59 | 1458 | 206 | NA | NA | NA | 303.8 | 189 | 207 | 0.7915 | 1154 | 17 | 1.119e-234 |
| CALLAO | a60.69 | 2350 | 206 | NA | NA | NA | 354.5 | 189 | 207 | 0.8492 | 1996 | 17 | 0 |
| CALLAO | a70.79 | 1970 | 206 | NA | NA | NA | 321.9 | 189 | 207 | 0.8366 | 1648 | 17 | 0 |
| CALLAO | a80 | 1412 | 206 | NA | NA | NA | 347.7 | 189 | 207 | 0.7538 | 1065 | 17 | 1.253e-215 |
| CUSCO | a0.9 | 284.1 | 206 | NA | NA | NA | 203.8 | 189 | 207 | 0.2828 | 80.35 | 17 | 3.321e-10 |
| CUSCO | a10.19 | 162.2 | 198 | NA | NA | NA | 136.9 | 181 | 199 | 0.1561 | 25.32 | 17 | 0.0878 |
| CUSCO | a20.29 | 247.8 | 203 | NA | NA | NA | 207.2 | 186 | 204 | 0.1637 | 40.55 | 17 | 0.001083 |
| CUSCO | a30.39 | 194.3 | 203 | NA | NA | NA | 150 | 186 | 204 | 0.2281 | 44.32 | 17 | 0.0003071 |
| CUSCO | a40.49 | 369 | 206 | NA | NA | NA | 265.8 | 189 | 207 | 0.2797 | 103.2 | 17 | 2.267e-14 |
| CUSCO | a50.59 | 456.4 | 206 | NA | NA | NA | 265.8 | 189 | 207 | 0.4175 | 190.6 | 17 | 2.246e-31 |
| CUSCO | a60.69 | 813.6 | 206 | NA | NA | NA | 326.6 | 189 | 207 | 0.5985 | 486.9 | 17 | 1.061e-92 |
| CUSCO | a70.79 | 663 | 206 | NA | NA | NA | 275.3 | 189 | 207 | 0.5848 | 387.7 | 17 | 6.791e-72 |
| CUSCO | a80 | 829.8 | 206 | NA | NA | NA | 280.9 | 189 | 207 | 0.6615 | 548.9 | 17 | 9.052e-106 |
| HUANCAVELICA | a0.9 | 174.5 | 197 | NA | NA | NA | 158.9 | 180 | 198 | 0.08932 | 15.58 | 17 | 0.5536 |
| HUANCAVELICA | a10.19 | 69.99 | 128 | NA | NA | NA | 54.2 | 112 | 129 | 0.2256 | 15.79 | 16 | 0.4679 |
| HUANCAVELICA | a20.29 | 73.45 | 146 | NA | NA | NA | 62.38 | 130 | 147 | 0.1508 | 11.07 | 16 | 0.8049 |
| HUANCAVELICA | a30.39 | 85.91 | 164 | NA | NA | NA | 77.44 | 148 | 165 | 0.09855 | 8.466 | 16 | 0.9338 |
| HUANCAVELICA | a40.49 | 162.6 | 177 | NA | NA | NA | 123.6 | 161 | 178 | 0.2396 | 38.96 | 16 | 0.001104 |
| HUANCAVELICA | a50.59 | 199.9 | 195 | NA | NA | NA | 158.2 | 178 | 196 | 0.2083 | 41.62 | 17 | 0.0007602 |
| HUANCAVELICA | a60.69 | 294.9 | 204 | NA | NA | NA | 232.9 | 187 | 205 | 0.2101 | 61.96 | 17 | 4.973e-07 |
| HUANCAVELICA | a70.79 | 352.3 | 205 | NA | NA | NA | 245.4 | 188 | 206 | 0.3035 | 106.9 | 17 | 4.561e-15 |
| HUANCAVELICA | a80 | 260.7 | 206 | NA | NA | NA | 198.9 | 189 | 207 | 0.2372 | 61.85 | 17 | 5.194e-07 |
| HUANUCO | a0.9 | 195.8 | 204 | NA | NA | NA | 176.3 | 187 | 205 | 0.09944 | 19.47 | 17 | 0.3023 |
| HUANUCO | a10.19 | 93.14 | 155 | NA | NA | NA | 82.54 | 139 | 156 | 0.1138 | 10.6 | 16 | 0.8335 |
| HUANUCO | a20.29 | 132 | 193 | NA | NA | NA | 113.8 | 176 | 194 | 0.138 | 18.22 | 17 | 0.3751 |
| HUANUCO | a30.39 | 156.4 | 191 | NA | NA | NA | 138.1 | 174 | 192 | 0.1174 | 18.37 | 17 | 0.3657 |
| HUANUCO | a40.49 | 227.2 | 200 | NA | NA | NA | 185.3 | 183 | 201 | 0.1844 | 41.9 | 17 | 0.0006929 |
| HUANUCO | a50.59 | 329.1 | 206 | NA | NA | NA | 251.4 | 189 | 207 | 0.2359 | 77.62 | 17 | 1.01e-09 |
| HUANUCO | a60.69 | 421.4 | 206 | NA | NA | NA | 216.3 | 189 | 207 | 0.4866 | 205.1 | 17 | 2.718e-34 |
| HUANUCO | a70.79 | 363.2 | 206 | NA | NA | NA | 218 | 189 | 207 | 0.3999 | 145.2 | 17 | 2.102e-22 |
| HUANUCO | a80 | 359.2 | 206 | NA | NA | NA | 225.1 | 189 | 207 | 0.3733 | 134.1 | 17 | 3.055e-20 |
| ICA | a0.9 | 157.3 | 200 | NA | NA | NA | 145 | 183 | 201 | 0.07817 | 12.29 | 17 | 0.7821 |
| ICA | a10.19 | 44.47 | 134 | NA | NA | NA | 42.52 | 118 | 135 | 0.0437 | 1.943 | 16 | 1 |
| ICA | a20.29 | 158.7 | 186 | NA | NA | NA | 137.8 | 169 | 187 | 0.1312 | 20.82 | 17 | 0.2344 |
| ICA | a30.39 | 236.1 | 195 | NA | NA | NA | 186.2 | 178 | 196 | 0.2114 | 49.91 | 17 | 0.00004362 |
| ICA | a40.49 | 556.1 | 205 | NA | NA | NA | 244.6 | 188 | 206 | 0.5601 | 311.5 | 17 | 4.692e-56 |
| ICA | a50.59 | 1030 | 206 | NA | NA | NA | 260.6 | 189 | 207 | 0.747 | 769.4 | 17 | 1.539e-152 |
| ICA | a60.69 | 1669 | 206 | NA | NA | NA | 307 | 189 | 207 | 0.816 | 1362 | 17 | 2.485e-279 |
| ICA | a70.79 | 1128 | 206 | NA | NA | NA | 288.1 | 189 | 207 | 0.7445 | 839.5 | 17 | 1.751e-167 |
| ICA | a80 | 932.6 | 206 | NA | NA | NA | 319.6 | 189 | 207 | 0.6573 | 613 | 17 | 2.527e-119 |
| JUNIN | a0.9 | 229.1 | 205 | NA | NA | NA | 212 | 188 | 206 | 0.07443 | 17.05 | 17 | 0.451 |
| JUNIN | a10.19 | 145.9 | 187 | NA | NA | NA | 130.6 | 170 | 188 | 0.1048 | 15.29 | 17 | 0.5748 |
| JUNIN | a20.29 | 198.7 | 205 | NA | NA | NA | 171.6 | 188 | 206 | 0.1361 | 27.05 | 17 | 0.05741 |
| JUNIN | a30.39 | 268.4 | 205 | NA | NA | NA | 211.4 | 188 | 206 | 0.2122 | 56.93 | 17 | 3.338e-06 |
| JUNIN | a40.49 | 426.1 | 205 | NA | NA | NA | 248.8 | 188 | 206 | 0.416 | 177.3 | 17 | 1.016e-28 |
| JUNIN | a50.59 | 814 | 206 | NA | NA | NA | 292.3 | 189 | 207 | 0.6409 | 521.7 | 17 | 5.092e-100 |
| JUNIN | a60.69 | 1019 | 206 | NA | NA | NA | 319.9 | 189 | 207 | 0.6859 | 698.7 | 17 | 1.655e-137 |
| JUNIN | a70.79 | 827.1 | 206 | NA | NA | NA | 259.1 | 189 | 207 | 0.6868 | 568.1 | 17 | 8.158e-110 |
| JUNIN | a80 | 730.8 | 206 | NA | NA | NA | 237.2 | 189 | 207 | 0.6755 | 493.7 | 17 | 4.042e-94 |
| LA LIBERTAD | a0.9 | 249.4 | 206 | NA | NA | NA | 229.9 | 189 | 207 | 0.078 | 19.45 | 17 | 0.3033 |
| LA LIBERTAD | a10.19 | 182.7 | 190 | NA | NA | NA | 154.9 | 173 | 191 | 0.1518 | 27.73 | 17 | 0.04814 |
| LA LIBERTAD | a20.29 | 251.2 | 204 | NA | NA | NA | 229.7 | 187 | 205 | 0.08543 | 21.46 | 17 | 0.2064 |
| LA LIBERTAD | a30.39 | 281.8 | 206 | NA | NA | NA | 219.3 | 189 | 207 | 0.2217 | 62.47 | 17 | 4.092e-07 |
| LA LIBERTAD | a40.49 | 524.4 | 206 | NA | NA | NA | 200.1 | 189 | 207 | 0.6184 | 324.3 | 17 | 1.088e-58 |
| LA LIBERTAD | a50.59 | 1406 | 206 | NA | NA | NA | 357.2 | 189 | 207 | 0.746 | 1049 | 17 | 3.037e-212 |
| LA LIBERTAD | a60.69 | 2229 | 206 | NA | NA | NA | 391.4 | 189 | 207 | 0.8244 | 1837 | 17 | 0 |
| LA LIBERTAD | a70.79 | 1934 | 206 | NA | NA | NA | 388.7 | 189 | 207 | 0.799 | 1546 | 17 | 7.565e-319 |
| LA LIBERTAD | a80 | 1272 | 206 | NA | NA | NA | 326.4 | 189 | 207 | 0.7433 | 945.3 | 17 | 4.386e-190 |
| LAMBAYEQUE | a0.9 | 340.7 | 181 | NA | NA | NA | 153.7 | 164 | 182 | 0.5489 | 187 | 17 | 1.137e-30 |
| LAMBAYEQUE | a10.19 | 57.98 | 118 | NA | NA | NA | 48.42 | 102 | 119 | 0.165 | 9.566 | 16 | 0.8883 |
| LAMBAYEQUE | a20.29 | 153.8 | 159 | NA | NA | NA | 105.9 | 143 | 160 | 0.3118 | 47.96 | 16 | 0.00004826 |
| LAMBAYEQUE | a30.39 | 207 | 173 | NA | NA | NA | 157.9 | 156 | 174 | 0.237 | 49.05 | 17 | 0.00005921 |
| LAMBAYEQUE | a40.49 | 581.6 | 182 | NA | NA | NA | 277.6 | 165 | 183 | 0.5227 | 304 | 17 | 1.7e-54 |
| LAMBAYEQUE | a50.59 | 1082 | 184 | NA | NA | NA | 320.7 | 167 | 185 | 0.7036 | 761.4 | 17 | 7.765e-151 |
| LAMBAYEQUE | a60.69 | 1985 | 193 | NA | NA | NA | 432.3 | 176 | 194 | 0.7823 | 1553 | 17 | 1.992e-320 |
| LAMBAYEQUE | a70.79 | 2114 | 199 | NA | NA | NA | 409.2 | 182 | 200 | 0.8065 | 1705 | 17 | 0 |
| LAMBAYEQUE | a80 | 3676 | 202 | NA | NA | NA | 654 | 185 | 203 | 0.8221 | 3022 | 17 | 0 |
| LIMA | a0.9 | 348.6 | 206 | NA | NA | NA | 268.7 | 189 | 207 | 0.2291 | 79.88 | 17 | 4.028e-10 |
| LIMA | a10.19 | 253.8 | 206 | NA | NA | NA | 213.1 | 189 | 207 | 0.1603 | 40.69 | 17 | 0.001034 |
| LIMA | a20.29 | 410.1 | 206 | NA | NA | NA | 286.5 | 189 | 207 | 0.3013 | 123.6 | 17 | 3.211e-18 |
| LIMA | a30.39 | 1254 | 206 | NA | NA | NA | 247.7 | 189 | 207 | 0.8025 | 1007 | 17 | 3.512e-203 |
| LIMA | a40.49 | 4855 | 206 | NA | NA | NA | 371.7 | 189 | 207 | 0.9234 | 4483 | 17 | 0 |
| LIMA | a50.59 | 12239 | 206 | NA | NA | NA | 726.3 | 189 | 207 | 0.9407 | 11512 | 17 | 0 |
| LIMA | a60.69 | 20219 | 206 | NA | NA | NA | 1021 | 189 | 207 | 0.9495 | 19198 | 17 | 0 |
| LIMA | a70.79 | 17310 | 206 | NA | NA | NA | 1008 | 189 | 207 | 0.9418 | 16301 | 17 | 0 |
| LIMA | a80 | 14400 | 206 | NA | NA | NA | 770 | 189 | 207 | 0.9465 | 13630 | 17 | 0 |
| LORETO | a0.9 | 225.3 | 204 | NA | NA | NA | 202 | 187 | 205 | 0.1036 | 23.35 | 17 | 0.1383 |
| LORETO | a10.19 | 84.68 | 150 | NA | NA | NA | 66.18 | 134 | 151 | 0.2185 | 18.5 | 16 | 0.2956 |
| LORETO | a20.29 | 148 | 190 | NA | NA | NA | 138.8 | 173 | 191 | 0.06196 | 9.169 | 17 | 0.9348 |
| LORETO | a30.39 | 234.6 | 199 | NA | NA | NA | 171 | 182 | 200 | 0.2709 | 63.54 | 17 | 2.705e-07 |
| LORETO | a40.49 | 412.2 | 202 | NA | NA | NA | 196.2 | 185 | 203 | 0.5239 | 216 | 17 | 1.732e-36 |
| LORETO | a50.59 | 806.8 | 204 | NA | NA | NA | 244.3 | 187 | 205 | 0.6971 | 562.4 | 17 | 1.261e-108 |
| LORETO | a60.69 | 1591 | 204 | NA | NA | NA | 404.9 | 187 | 205 | 0.7455 | 1186 | 17 | 1.105e-241 |
| LORETO | a70.79 | 1357 | 205 | NA | NA | NA | 310.5 | 188 | 206 | 0.7712 | 1047 | 17 | 9.906e-212 |
| LORETO | a80 | 806.5 | 206 | NA | NA | NA | 316.6 | 189 | 207 | 0.6074 | 489.8 | 17 | 2.626e-93 |
| MADRE DE DIOS | a0.9 | 78.23 | 130 | NA | NA | NA | 64.68 | 114 | 131 | 0.1733 | 13.55 | 16 | 0.6319 |
| MADRE DE DIOS | a10.19 | 16.24 | 78 | NA | NA | NA | 11.6 | 62 | 79 | 0.2857 | 4.64 | 16 | 0.9973 |
| MADRE DE DIOS | a20.29 | 75.72 | 151 | NA | NA | NA | 68.88 | 135 | 152 | 0.09032 | 6.839 | 16 | 0.9762 |
| MADRE DE DIOS | a30.39 | 72.37 | 139 | NA | NA | NA | 59.35 | 123 | 140 | 0.1799 | 13.02 | 16 | 0.6714 |
| MADRE DE DIOS | a40.49 | 99.54 | 149 | NA | NA | NA | 78.97 | 133 | 150 | 0.2066 | 20.57 | 16 | 0.1957 |
| MADRE DE DIOS | a50.59 | 205.3 | 162 | NA | NA | NA | 106.8 | 146 | 163 | 0.4795 | 98.44 | 16 | 6.796e-14 |
| MADRE DE DIOS | a60.69 | 251.4 | 170 | NA | NA | NA | 117.2 | 154 | 171 | 0.5337 | 134.2 | 16 | 9.861e-21 |
| MADRE DE DIOS | a70.79 | 197 | 168 | NA | NA | NA | 113.1 | 152 | 169 | 0.426 | 83.92 | 16 | 3.25e-11 |
| MADRE DE DIOS | a80 | 159.4 | 166 | NA | NA | NA | 103.2 | 150 | 167 | 0.3526 | 56.21 | 16 | 2.249e-06 |
| MOQUEGUA | a0.9 | 20.19 | 78 | NA | NA | NA | 16.97 | 62 | 79 | 0.1596 | 3.222 | 16 | 0.9997 |
| MOQUEGUA | a10.19 | 6.284 | 37 | NA | NA | NA | 2.998 | 21 | 38 | 0.523 | 3.287 | 16 | 0.9997 |
| MOQUEGUA | a20.29 | 16.63 | 82 | NA | NA | NA | 14.82 | 66 | 83 | 0.1088 | 1.809 | 16 | 1 |
| MOQUEGUA | a30.39 | 16.13 | 81 | NA | NA | NA | 13.5 | 65 | 82 | 0.1631 | 2.631 | 16 | 0.9999 |
| MOQUEGUA | a40.49 | 93.28 | 123 | NA | NA | NA | 50.43 | 107 | 124 | 0.4594 | 42.85 | 16 | 0.0002947 |
| MOQUEGUA | a50.59 | 242.7 | 151 | NA | NA | NA | 90.44 | 135 | 152 | 0.6274 | 152.3 | 16 | 2.762e-24 |
| MOQUEGUA | a60.69 | 550.9 | 184 | NA | NA | NA | 182.3 | 167 | 185 | 0.669 | 368.5 | 17 | 6.893e-68 |
| MOQUEGUA | a70.79 | 699.7 | 198 | NA | NA | NA | 230.7 | 181 | 199 | 0.6703 | 469 | 17 | 6.351e-89 |
| MOQUEGUA | a80 | 509.4 | 205 | NA | NA | NA | 224.4 | 188 | 206 | 0.5594 | 284.9 | 17 | 1.424e-50 |
| PASCO | a0.9 | 67.77 | 141 | NA | NA | NA | 50.3 | 125 | 142 | 0.2578 | 17.47 | 16 | 0.3558 |
| PASCO | a10.19 | 14.81 | 61 | NA | NA | NA | 9.727 | 45 | 62 | 0.3433 | 5.086 | 16 | 0.9953 |
| PASCO | a20.29 | 26.91 | 104 | NA | NA | NA | 25.35 | 88 | 105 | 0.05796 | 1.56 | 16 | 1 |
| PASCO | a30.39 | 51.29 | 106 | NA | NA | NA | 44.48 | 90 | 107 | 0.1327 | 6.805 | 16 | 0.9768 |
| PASCO | a40.49 | 61.74 | 130 | NA | NA | NA | 46.9 | 114 | 131 | 0.2403 | 14.84 | 16 | 0.5366 |
| PASCO | a50.59 | 138.8 | 156 | NA | NA | NA | 86.06 | 140 | 157 | 0.3799 | 52.72 | 16 | 8.365e-06 |
| PASCO | a60.69 | 192.3 | 166 | NA | NA | NA | 105 | 150 | 167 | 0.454 | 87.3 | 16 | 7.836e-12 |
| PASCO | a70.79 | 225.4 | 188 | NA | NA | NA | 150.2 | 171 | 189 | 0.3337 | 75.23 | 17 | 2.658e-09 |
| PASCO | a80 | 273.9 | 194 | NA | NA | NA | 202.1 | 177 | 195 | 0.262 | 71.74 | 17 | 1.079e-08 |
| PIURA | a0.9 | 246 | 206 | NA | NA | NA | 203.1 | 189 | 207 | 0.1742 | 42.87 | 17 | 0.0005021 |
| PIURA | a10.19 | 120.1 | 170 | NA | NA | NA | 106.5 | 154 | 171 | 0.1127 | 13.54 | 16 | 0.6333 |
| PIURA | a20.29 | 208.1 | 197 | NA | NA | NA | 165.8 | 180 | 198 | 0.203 | 42.24 | 17 | 0.0006183 |
| PIURA | a30.39 | 353 | 203 | NA | NA | NA | 210.1 | 186 | 204 | 0.4048 | 142.9 | 17 | 5.968e-22 |
| PIURA | a40.49 | 899.9 | 203 | NA | NA | NA | 319.1 | 186 | 204 | 0.6454 | 580.8 | 17 | 1.617e-112 |
| PIURA | a50.59 | 1575 | 206 | NA | NA | NA | 247.5 | 189 | 207 | 0.8428 | 1327 | 17 | 7.29e-272 |
| PIURA | a60.69 | 3123 | 206 | NA | NA | NA | 393.5 | 189 | 207 | 0.874 | 2729 | 17 | 0 |
| PIURA | a70.79 | 2392 | 206 | NA | NA | NA | 374.9 | 189 | 207 | 0.8433 | 2017 | 17 | 0 |
| PIURA | a80 | 1749 | 206 | NA | NA | NA | 385.8 | 189 | 207 | 0.7794 | 1363 | 17 | 1.32e-279 |
| PUNO | a0.9 | 225.3 | 205 | NA | NA | NA | 169.3 | 188 | 206 | 0.2486 | 56.01 | 17 | 4.713e-06 |
| PUNO | a10.19 | 126.6 | 180 | NA | NA | NA | 119.8 | 164 | 181 | 0.053 | 6.708 | 16 | 0.9785 |
| PUNO | a20.29 | 191.2 | 202 | NA | NA | NA | 179.7 | 185 | 203 | 0.0601 | 11.49 | 17 | 0.83 |
| PUNO | a30.39 | 295 | 206 | NA | NA | NA | 266.4 | 189 | 207 | 0.09692 | 28.59 | 17 | 0.03852 |
| PUNO | a40.49 | 370.5 | 206 | NA | NA | NA | 220.7 | 189 | 207 | 0.4042 | 149.7 | 17 | 2.755e-23 |
| PUNO | a50.59 | 730.5 | 206 | NA | NA | NA | 297.9 | 189 | 207 | 0.5922 | 432.6 | 17 | 2.77e-81 |
| PUNO | a60.69 | 959.1 | 206 | NA | NA | NA | 274 | 189 | 207 | 0.7143 | 685.1 | 17 | 1.264e-134 |
| PUNO | a70.79 | 863.2 | 206 | NA | NA | NA | 283.6 | 189 | 207 | 0.6715 | 579.6 | 17 | 2.976e-112 |
| PUNO | a80 | 703.8 | 206 | NA | NA | NA | 264.2 | 189 | 207 | 0.6246 | 439.6 | 17 | 9.301e-83 |
| SAN MARTIN | a0.9 | 239.4 | 203 | NA | NA | NA | 189.5 | 186 | 204 | 0.2086 | 49.95 | 17 | 0.00004294 |
| SAN MARTIN | a10.19 | 95.83 | 149 | NA | NA | NA | 77.58 | 133 | 150 | 0.1905 | 18.25 | 16 | 0.3093 |
| SAN MARTIN | a20.29 | 125.7 | 191 | NA | NA | NA | 115.5 | 174 | 192 | 0.08163 | 10.26 | 17 | 0.8922 |
| SAN MARTIN | a30.39 | 204.8 | 198 | NA | NA | NA | 153.4 | 181 | 199 | 0.2508 | 51.35 | 17 | 0.00002602 |
| SAN MARTIN | a40.49 | 313.7 | 205 | NA | NA | NA | 195.7 | 188 | 206 | 0.376 | 118 | 17 | 3.783e-17 |
| SAN MARTIN | a50.59 | 487.4 | 204 | NA | NA | NA | 244 | 187 | 205 | 0.4994 | 243.4 | 17 | 4.6e-42 |
| SAN MARTIN | a60.69 | 763.5 | 206 | NA | NA | NA | 268.7 | 189 | 207 | 0.6481 | 494.8 | 17 | 2.406e-94 |
| SAN MARTIN | a70.79 | 566.7 | 205 | NA | NA | NA | 222.8 | 188 | 206 | 0.6068 | 343.9 | 17 | 9.189e-63 |
| SAN MARTIN | a80 | 743.5 | 206 | NA | NA | NA | 292.9 | 189 | 207 | 0.6061 | 450.6 | 17 | 4.633e-85 |
| TACNA | a0.9 | 54.54 | 124 | NA | NA | NA | 42.79 | 108 | 125 | 0.2154 | 11.75 | 16 | 0.7611 |
| TACNA | a10.19 | 6.653 | 61 | NA | NA | NA | 4.638 | 45 | 62 | 0.3028 | 2.015 | 16 | 1 |
| TACNA | a20.29 | 47.05 | 115 | NA | NA | NA | 41.87 | 99 | 116 | 0.1102 | 5.184 | 16 | 0.9948 |
| TACNA | a30.39 | 83.11 | 154 | NA | NA | NA | 77.19 | 138 | 155 | 0.07122 | 5.919 | 16 | 0.9889 |
| TACNA | a40.49 | 156.1 | 172 | NA | NA | NA | 111.8 | 156 | 173 | 0.2839 | 44.32 | 16 | 0.0001761 |
| TACNA | a50.59 | 329.6 | 186 | NA | NA | NA | 204 | 169 | 187 | 0.3812 | 125.7 | 17 | 1.279e-18 |
| TACNA | a60.69 | 610.7 | 201 | NA | NA | NA | 262.3 | 184 | 202 | 0.5705 | 348.4 | 17 | 1.057e-63 |
| TACNA | a70.79 | 464.9 | 204 | NA | NA | NA | 263.4 | 187 | 205 | 0.4333 | 201.4 | 17 | 1.466e-33 |
| TACNA | a80 | 358.3 | 206 | NA | NA | NA | 245.3 | 189 | 207 | 0.3152 | 112.9 | 17 | 3.375e-16 |
| TUMBES | a0.9 | 53.94 | 133 | NA | NA | NA | 46.03 | 117 | 134 | 0.1466 | 7.907 | 16 | 0.9516 |
| TUMBES | a10.19 | 5.624 | 57 | NA | NA | NA | 3.076 | 41 | 58 | 0.453 | 2.548 | 16 | 0.9999 |
| TUMBES | a20.29 | 26.32 | 107 | NA | NA | NA | 21.66 | 91 | 108 | 0.177 | 4.658 | 16 | 0.9972 |
| TUMBES | a30.39 | 52.44 | 136 | NA | NA | NA | 39.35 | 120 | 137 | 0.2496 | 13.09 | 16 | 0.666 |
| TUMBES | a40.49 | 93.67 | 152 | NA | NA | NA | 65.36 | 136 | 153 | 0.3023 | 28.31 | 16 | 0.02899 |
| TUMBES | a50.59 | 267.8 | 174 | NA | NA | NA | 136.6 | 157 | 175 | 0.4898 | 131.2 | 17 | 1.121e-19 |
| TUMBES | a60.69 | 491.9 | 195 | NA | NA | NA | 199.6 | 178 | 196 | 0.5942 | 292.3 | 17 | 4.389e-52 |
| TUMBES | a70.79 | 368.9 | 195 | NA | NA | NA | 181.5 | 178 | 196 | 0.5081 | 187.4 | 17 | 9.411e-31 |
| TUMBES | a80 | 384.6 | 205 | NA | NA | NA | 224.7 | 188 | 206 | 0.4158 | 159.9 | 17 | 2.795e-25 |
| UCAYALI | a0.9 | 199.1 | 192 | NA | NA | NA | 153.7 | 175 | 193 | 0.228 | 45.41 | 17 | 0.0002117 |
| UCAYALI | a10.19 | 45.36 | 123 | NA | NA | NA | 36.37 | 107 | 124 | 0.1982 | 8.99 | 16 | 0.9138 |
| UCAYALI | a20.29 | 167.7 | 176 | NA | NA | NA | 146.9 | 159 | 177 | 0.1241 | 20.82 | 17 | 0.2347 |
| UCAYALI | a30.39 | 173.3 | 176 | NA | NA | NA | 138.5 | 159 | 177 | 0.2007 | 34.79 | 17 | 0.006621 |
| UCAYALI | a40.49 | 242 | 198 | NA | NA | NA | 198 | 181 | 199 | 0.1819 | 44.02 | 17 | 0.00034 |
| UCAYALI | a50.59 | 483.2 | 200 | NA | NA | NA | 247.6 | 183 | 201 | 0.4875 | 235.6 | 17 | 1.84e-40 |
| UCAYALI | a60.69 | 701.2 | 206 | NA | NA | NA | 250.9 | 189 | 207 | 0.6422 | 450.4 | 17 | 5.224e-85 |
| UCAYALI | a70.79 | 915.9 | 203 | NA | NA | NA | 284.7 | 186 | 204 | 0.6891 | 631.2 | 17 | 3.515e-123 |
| UCAYALI | a80 | 613.5 | 205 | NA | NA | NA | 310.4 | 188 | 206 | 0.4941 | 303.2 | 17 | 2.518e-54 |

### Under-registration rates

Table 6: Under-registration rates

|  |  |
| --- | --- |
| Departamento | sub.mean |
| ICA | 99.85 |
| MADRE DE DIOS | 99.17 |
| AREQUIPA | 94.81 |
| ANCASH | 85.12 |
| TUMBES | 85.04 |
| JUNIN | 82.32 |
| MOQUEGUA | 82.15 |
| CUSCO | 80.81 |
| LA LIBERTAD | 80.42 |
| HUANCAVELICA | 77.77 |
| CALLAO | 77.49 |
| TACNA | 74.44 |
| PUNO | 62.28 |
| UCAYALI | 61.8 |
| LIMA | 58.01 |
| APURIMAC | 57 |
| SAN MARTIN | 51.53 |
| AYACUCHO | 50.53 |
| PIURA | 49.41 |
| HUANUCO | 46.54 |
| PASCO | 40.6 |
| LORETO | 32.09 |
| CAJAMARCA | 28.41 |
| AMAZONAS | 27.99 |
| LAMBAYEQUE | 11.89 |

### Age-standardised deaths rates

Table 7: Age-standardised deaths rates

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Departamento | adj.rate | lci | uci | crude.rate | 2010 | 2015 | Difference |
| AMAZONAS | NA | NA | NA | 4.929 | 6.05 | 6.19 | -1.261 |
| ANCASH | NA | NA | NA | 7.949 | 6.09 | 6.15 | 1.799 |
| APURIMAC | NA | NA | NA | 7.324 | 6.76 | 6.61 | 0.7143 |
| AREQUIPA | NA | NA | NA | 7.924 | 5.53 | 5.8 | 2.124 |
| AYACUCHO | NA | NA | NA | 5.479 | 6.15 | 5.91 | -0.4305 |
| CAJAMARCA | NA | NA | NA | 5.582 | 5.39 | 5.5 | 0.08242 |
| CALLAO | NA | NA | NA | 9.808 | 4.91 | 5.27 | 4.538 |
| CUSCO | 11.48 | 11.3 | 11.66 | 6.502 | 6.88 | 6.97 | -0.4678 |
| HUANCAVELICA | NA | NA | NA | 8.551 | 5.83 | 5.54 | 3.011 |
| HUANUCO | NA | NA | NA | 7.534 | 5.94 | 5.98 | 1.554 |
| ICA | NA | NA | NA | 8.036 | 4.99 | 5.29 | 2.746 |
| JUNIN | NA | NA | NA | 7.049 | 6.17 | 6.24 | 0.8089 |
| LA LIBERTAD | NA | NA | NA | 7.011 | 5.24 | 5.39 | 1.621 |
| LAMBAYEQUE | NA | NA | NA | 12.7 | 5.25 | 5.55 | 7.147 |
| LIMA | 13.89 | 13.82 | 13.96 | 10.43 | 5.13 | 5.4 | 5.03 |
| LORETO | NA | NA | NA | 7.077 | 4.92 | 5.07 | 2.007 |
| MADRE DE DIOS | NA | NA | NA | 6.253 | 4.4 | 4.54 | 1.713 |
| MOQUEGUA | NA | NA | NA | 12.14 | 5.49 | 5.86 | 6.282 |
| PASCO | NA | NA | NA | 7.318 | 5.54 | 5.54 | 1.778 |
| PIURA | NA | NA | NA | 7.247 | 5.36 | 5.5 | 1.747 |
| PUNO | NA | NA | NA | 7.302 | 7.01 | 6.86 | 0.4425 |
| SAN MARTIN | NA | NA | NA | 6.667 | 5.47 | 5.63 | 1.037 |
| TACNA | NA | NA | NA | 6.082 | 5.09 | 5.4 | 0.6821 |
| TUMBES | NA | NA | NA | 11.48 | 4.7 | 4.94 | 6.543 |
| UCAYALI | NA | NA | NA | 7.93 | 5.68 | 5.93 | 2 |

### Counterfacutual and total deaths 2020

Table 8: Counterfacutual and total deaths 2020

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Departamento | range | sinadef | excess.T | excess.l | excess.u | excess.reg | excess.reg.l | excess.reg.u | count | count.l | count.u | total | total.l | total.u |
| AMAZONAS | a0.9 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 60 | 60 | 0 | 0 | 0 |
| AMAZONAS | a10.19 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 22 | 22 | 0 | 0 | 0 |
| AMAZONAS | a20.29 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 36 | 36 | 0 | 0 | 0 |
| AMAZONAS | a30.39 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 60 | 60 | 0 | 0 | 0 |
| AMAZONAS | a40.49 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 83 | 83 | 83 | 0 | 0 | 0 |
| AMAZONAS | a50.59 | 123 | 0 | 0 | 0 | 0 | 0 | 0 | 123 | 123 | 123 | 0 | 0 | 0 |
| AMAZONAS | a60.69 | 199 | 61 | 61 | 61 | 0 | 0 | 0 | 199 | 199 | 199 | 0 | 0 | 0 |
| AMAZONAS | a70.79 | 199 | 62 | 62 | 62 | 0 | 0 | 0 | 199 | 199 | 199 | 787.5 | 787.5 | 787.5 |
| AMAZONAS | a80 | 337 | 56 | 56 | 56 | 0 | 0 | 0 | 337 | 337 | 337 | 1323 | 1323 | 1323 |
| ANCASH | a0.9 | 243 | 3 | 3 | 3 | 0 | 0 | 0 | 243 | 243 | 243 | 601.1 | 601.1 | 601.1 |
| ANCASH | a10.19 | 101 | 2 | 2 | 2 | 0 | 0 | 0 | 101 | 101 | 101 | 0 | 0 | 0 |
| ANCASH | a20.29 | 163 | 12 | 12 | 12 | 0 | 0 | 0 | 163 | 163 | 163 | 398.2 | 398.2 | 398.2 |
| ANCASH | a30.39 | 224 | 37 | 37 | 37 | 0 | 0 | 0 | 224 | 224 | 224 | 572.3 | 572.3 | 572.3 |
| ANCASH | a40.49 | 471 | 250.6 | 221.2 | 329.6 | 250.6 | 193.8 | 289.1 | 220.4 | 181.9 | 277.2 | 737.1 | 622.7 | 941.7 |
| ANCASH | a50.59 | 890 | 572.4 | 554.3 | 700 | 572.4 | 496.3 | 626.9 | 317.6 | 263.1 | 393.7 | 1220 | 1091 | 1502 |
| ANCASH | a60.69 | 1390 | 873.8 | 866 | 1053 | 873.8 | 778.4 | 946.4 | 516.2 | 443.6 | 611.6 | 1911 | 1757 | 2282 |
| ANCASH | a70.79 | 1960 | 1041 | 1012 | 1304 | 1041 | 896.5 | 1155 | 919.5 | 804.5 | 1064 | 3004 | 2730 | 3575 |
| ANCASH | a80 | 3130 | 732.5 | 533.2 | 1105 | 732.5 | 464 | 961.9 | 2398 | 2168 | 2666 | 6214 | 5491 | 7200 |
| APURIMAC | a0.9 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 0 |
| APURIMAC | a10.19 | 51 | 0 | 0 | 0 | 0 | 0 | 0 | 51 | 51 | 51 | 0 | 0 | 0 |
| APURIMAC | a20.29 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 64 | 64 | 64 | 0 | 0 | 0 |
| APURIMAC | a30.39 | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 73 | 73 | 0 | 0 | 0 |
| APURIMAC | a40.49 | 119 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 119 | 119 | 0 | 0 | 0 |
| APURIMAC | a50.59 | 200 | 26 | 26 | 26 | 0 | 0 | 0 | 200 | 200 | 200 | 0 | 0 | 0 |
| APURIMAC | a60.69 | 275 | 0 | 25 | 0 | 62.05 | 0.3284 | 99.3 | 212.9 | 175.7 | 274.7 | 0 | 0 | 0 |
| APURIMAC | a70.79 | 447 | 39 | 39 | 39 | 0 | 0 | 0 | 447 | 447 | 447 | 0 | 0 | 0 |
| APURIMAC | a80 | 863 | 44 | 44 | 44 | 0 | 0 | 0 | 863 | 863 | 863 | 0 | 0 | 0 |
| AREQUIPA | a0.9 | 216 | 4 | 4 | 4 | 0 | 0 | 0 | 216 | 216 | 216 | 481.9 | 481.9 | 481.9 |
| AREQUIPA | a10.19 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 98 | 98 | 98 | 0 | 0 | 0 |
| AREQUIPA | a20.29 | 232 | 12 | 12 | 12 | 0 | 0 | 0 | 232 | 232 | 232 | 492.5 | 492.5 | 492.5 |
| AREQUIPA | a30.39 | 329 | 61.79 | 29 | 105.3 | 61.79 | 6.422 | 99.39 | 267.2 | 229.6 | 322.6 | 613.7 | 503.3 | 771.6 |
| AREQUIPA | a40.49 | 662 | 313.8 | 250.2 | 381 | 313.8 | 239.5 | 365.2 | 348.2 | 296.8 | 422.5 | 967.2 | 807.2 | 1174 |
| AREQUIPA | a50.59 | 1213 | 725.6 | 664.7 | 831.4 | 725.6 | 632.9 | 792 | 487.4 | 421 | 580.1 | 1719 | 1523 | 2013 |
| AREQUIPA | a60.69 | 1990 | 1160 | 1063 | 1317 | 1160 | 1022 | 1266 | 829.7 | 724.1 | 968.5 | 2697 | 2404 | 3111 |
| AREQUIPA | a70.79 | 2480 | 1279 | 1164 | 1475 | 1279 | 1113 | 1411 | 1201 | 1069 | 1367 | 3628 | 3256 | 4148 |
| AREQUIPA | a80 | 4307 | 1782 | 1625 | 2073 | 1782 | 1551 | 1979 | 2525 | 2328 | 2756 | 6858 | 6305 | 7614 |
| AYACUCHO | a0.9 | 122 | 0 | 0 | 0 | 0 | 0 | 0 | 122 | 122 | 122 | 0 | 0 | 0 |
| AYACUCHO | a10.19 | 62 | 0 | 0 | 0 | 0 | 0 | 0 | 62 | 62 | 62 | 0 | 0 | 0 |
| AYACUCHO | a20.29 | 94 | 0 | 0 | 0 | 0 | 0 | 0 | 94 | 94 | 94 | 0 | 0 | 0 |
| AYACUCHO | a30.39 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 0 | 0 |
| AYACUCHO | a40.49 | 161 | 0 | 0 | 0 | 0 | 0 | 0 | 161 | 161 | 161 | 0 | 0 | 0 |
| AYACUCHO | a50.59 | 214 | 50 | 50 | 50 | 0 | 0 | 0 | 214 | 214 | 214 | 0 | 0 | 0 |
| AYACUCHO | a60.69 | 373 | 100 | 100 | 164.8 | 82.51 | 31.85 | 117.5 | 290.5 | 255.5 | 341.1 | 882.9 | 788.5 | 1084 |
| AYACUCHO | a70.79 | 554 | 132.7 | 105 | 268.9 | 132.7 | 61.26 | 184.4 | 421.3 | 369.6 | 492.7 | 1342 | 1166 | 1683 |
| AYACUCHO | a80 | 842 | 139.8 | 78 | 310.2 | 139.8 | 39.08 | 218.2 | 702.2 | 623.8 | 802.9 | 2079 | 1800 | 2527 |
| CAJAMARCA | a0.9 | 231 | 2 | 2 | 2 | -68.2 | -179.8 | -0.1757 | 299.2 | 231.2 | 410.8 | 1058 | 817.8 | 1452 |
| CAJAMARCA | a10.19 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 75 | 75 | 0 | 0 | 0 |
| CAJAMARCA | a20.29 | 128 | 6 | 6 | 6 | 0 | 0 | 0 | 128 | 128 | 128 | 0 | 0 | 0 |
| CAJAMARCA | a30.39 | 207 | 24 | 24 | 24 | 0 | 0 | 0 | 207 | 207 | 207 | 0 | 0 | 0 |
| CAJAMARCA | a40.49 | 294 | 47 | 47 | 47 | 0 | 0 | 0 | 294 | 294 | 294 | 916.2 | 916.2 | 916.2 |
| CAJAMARCA | a50.59 | 538 | 304.5 | 304.5 | 470.3 | 265.1 | 199.5 | 308.3 | 272.9 | 229.7 | 338.5 | 1115 | 986.8 | 1476 |
| CAJAMARCA | a60.69 | 792 | 659.1 | 659.1 | 832.8 | 487.4 | 421.4 | 532.5 | 304.6 | 259.5 | 370.6 | 1593 | 1455 | 1969 |
| CAJAMARCA | a70.79 | 1072 | 554 | 554 | 854.2 | 448.4 | 342.3 | 527.8 | 623.6 | 544.2 | 729.7 | 2547 | 2293 | 3186 |
| CAJAMARCA | a80 | 1753 | 554 | 554 | 1016 | 481.2 | 329.8 | 605.3 | 1272 | 1148 | 1423 | 4806 | 4391 | 5774 |
| CALLAO | a0.9 | 156 | 3 | 3 | 3 | 0 | 0 | 0 | 156 | 156 | 156 | 0 | 0 | 0 |
| CALLAO | a10.19 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 49 | 49 | 0 | 0 | 0 |
| CALLAO | a20.29 | 185 | 15 | 15 | 15 | 0 | 0 | 0 | 185 | 185 | 185 | 0 | 0 | 0 |
| CALLAO | a30.39 | 319 | 119.6 | 82.57 | 186.6 | 119.6 | 67.59 | 153.5 | 199.4 | 165.5 | 251.4 | 591.7 | 474.4 | 781.9 |
| CALLAO | a40.49 | 639 | 525.1 | 525.1 | 606.6 | 478.5 | 437.5 | 505.5 | 160.5 | 133.5 | 201.5 | 895.1 | 832.8 | 1071 |
| CALLAO | a50.59 | 1192 | 1025 | 1025 | 1146 | 918.6 | 858.9 | 960.3 | 273.4 | 231.7 | 333.1 | 1646 | 1551 | 1903 |
| CALLAO | a60.69 | 1960 | 1716 | 1716 | 1872 | 1517 | 1442 | 1573 | 442.7 | 387.1 | 518.1 | 2715 | 2590 | 3042 |
| CALLAO | a70.79 | 2220 | 1764 | 1764 | 1970 | 1605 | 1506 | 1682 | 614.7 | 537.7 | 713.9 | 3088 | 2922 | 3508 |
| CALLAO | a80 | 2982 | 1591 | 1591 | 2031 | 1534 | 1331 | 1700 | 1448 | 1282 | 1651 | 4896 | 4518 | 5799 |
| CUSCO | a0.9 | 354 | 4 | 4 | 4 | 0 | 0 | 0 | 354 | 354 | 354 | 913.9 | 913.9 | 913.9 |
| CUSCO | a10.19 | 177 | 3 | 3 | 3 | 0 | 0 | 0 | 177 | 177 | 177 | 399 | 399 | 399 |
| CUSCO | a20.29 | 247 | 8 | 8 | 8 | 0 | 0 | 0 | 247 | 247 | 247 | 576.3 | 576.3 | 576.3 |
| CUSCO | a30.39 | 319 | 18 | 18 | 18 | 0 | 0 | 0 | 319 | 319 | 319 | 718.7 | 718.7 | 718.7 |
| CUSCO | a40.49 | 519 | 123 | 47.52 | 210.7 | 123 | 40.07 | 180.1 | 396 | 338.9 | 478.9 | 1001 | 799.2 | 1273 |
| CUSCO | a50.59 | 789 | 233.3 | 182.9 | 348.4 | 233.3 | 153.3 | 292.5 | 555.7 | 496.5 | 635.7 | 1546 | 1355 | 1850 |
| CUSCO | a60.69 | 1192 | 412.3 | 360.6 | 580 | 412.3 | 306 | 492.5 | 779.7 | 699.5 | 886 | 2194 | 1959 | 2605 |
| CUSCO | a70.79 | 1610 | 445.4 | 393.3 | 638.6 | 445.4 | 331 | 537.9 | 1165 | 1072 | 1279 | 3177 | 2908 | 3638 |
| CUSCO | a80 | 2453 | 552.7 | 468.3 | 813.7 | 552.7 | 394.4 | 685.8 | 1900 | 1767 | 2059 | 5004 | 4607 | 5635 |
| HUANCAVELICA | a0.9 | 141 | 1 | 1 | 1 | 0 | 0 | 0 | 141 | 141 | 141 | 364.6 | 364.6 | 364.6 |
| HUANCAVELICA | a10.19 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 60 | 60 | 0 | 0 | 0 |
| HUANCAVELICA | a20.29 | 76 | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 76 | 76 | 0 | 0 | 0 |
| HUANCAVELICA | a30.39 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 79 | 79 | 0 | 0 | 0 |
| HUANCAVELICA | a40.49 | 152 | 0 | 0 | 0 | 0 | 0 | 0 | 152 | 152 | 152 | 0 | 0 | 0 |
| HUANCAVELICA | a50.59 | 232 | 18 | 18 | 18 | -89.29 | -163.8 | -40.85 | 321.3 | 272.9 | 395.8 | 844.4 | 719.8 | 1036 |
| HUANCAVELICA | a60.69 | 354 | 40 | 40 | 40 | 0 | 0 | 0 | 354 | 354 | 354 | 944.7 | 944.7 | 944.7 |
| HUANCAVELICA | a70.79 | 548 | 122.7 | 52.73 | 218.8 | 122.7 | 42.67 | 179.1 | 425.3 | 368.9 | 505.3 | 1151 | 944.7 | 1441 |
| HUANCAVELICA | a80 | 782 | 20 | 20 | 20 | 0 | 0 | 0 | 782 | 782 | 782 | 1840 | 1840 | 1840 |
| HUANUCO | a0.9 | 187 | 0 | 0.4073 | 0.4073 | 0 | 0 | 0 | 187 | 187 | 187 | 605.1 | 605.5 | 605.5 |
| HUANUCO | a10.19 | 71 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 71 | 71 | 0 | 0 | 0 |
| HUANUCO | a20.29 | 125 | 10 | 10 | 10 | 0 | 0 | 0 | 125 | 125 | 125 | 0 | 0 | 0 |
| HUANUCO | a30.39 | 167 | 18 | 18 | 18 | 0 | 0 | 0 | 167 | 167 | 167 | 0 | 0 | 0 |
| HUANUCO | a40.49 | 268 | 78.09 | 34 | 161.6 | 78.09 | 32.63 | 106.5 | 189.9 | 161.5 | 235.4 | 649 | 519.5 | 869.3 |
| HUANUCO | a50.59 | 411 | 145.6 | 82 | 294.6 | 145.6 | 70.56 | 194 | 265.4 | 217 | 340.4 | 945.9 | 736.3 | 1321 |
| HUANUCO | a60.69 | 670 | 194.9 | 114 | 385.3 | 194.9 | 89.49 | 271 | 475.1 | 399 | 580.5 | 1496 | 1207 | 1975 |
| HUANUCO | a70.79 | 909 | 268.1 | 235.5 | 521.1 | 268.1 | 158.6 | 351.2 | 640.9 | 557.8 | 750.4 | 2138 | 1863 | 2711 |
| HUANUCO | a80 | 1232 | 248.4 | 103 | 546.6 | 248.4 | 99.45 | 366.3 | 983.6 | 865.7 | 1133 | 3144 | 2651 | 3880 |
| ICA | a0.9 | 170 | 3 | 3 | 3 | 0 | 0 | 0 | 170 | 170 | 170 | 348.2 | 348.2 | 348.2 |
| ICA | a10.19 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 52 | 52 | 52 | 0 | 0 | 0 |
| ICA | a20.29 | 164 | 15 | 15 | 15 | 0 | 0 | 0 | 164 | 164 | 164 | 0 | 0 | 0 |
| ICA | a30.39 | 256 | 50 | 50 | 50 | 0 | 0 | 0 | 256 | 256 | 256 | 639.5 | 639.5 | 639.5 |
| ICA | a40.49 | 527 | 277.1 | 198.8 | 330 | 277.1 | 197.6 | 328.5 | 249.9 | 198.5 | 329.4 | 750.9 | 575.1 | 954.5 |
| ICA | a50.59 | 968 | 625.4 | 553.6 | 679.2 | 625.4 | 551.9 | 677.5 | 342.6 | 290.5 | 416.1 | 1234 | 1069 | 1418 |
| ICA | a60.69 | 1468 | 1058 | 977.9 | 1121 | 1058 | 975.8 | 1118 | 409.9 | 349.6 | 492.2 | 1789 | 1601 | 1998 |
| ICA | a70.79 | 1638 | 921.4 | 808.8 | 1013 | 921.4 | 806.7 | 1011 | 716.6 | 627.4 | 831.3 | 2316 | 2029 | 2631 |
| ICA | a80 | 2520 | 1199 | 1030 | 1342 | 1199 | 1028 | 1339 | 1321 | 1181 | 1492 | 3774 | 3332 | 4251 |
| JUNIN | a0.9 | 372 | 7 | 7 | 7 | 0 | 0 | 0 | 372 | 372 | 372 | 869.7 | 869.7 | 869.7 |
| JUNIN | a10.19 | 151 | 5 | 5 | 5 | 0 | 0 | 0 | 151 | 151 | 151 | 0 | 0 | 0 |
| JUNIN | a20.29 | 219 | 14 | 14 | 14 | 0 | 0 | 0 | 219 | 219 | 219 | 549.4 | 549.4 | 549.4 |
| JUNIN | a30.39 | 322 | 92.9 | 40.43 | 154 | 92.9 | 33.88 | 131.1 | 229.1 | 190.9 | 288.1 | 619.5 | 479.2 | 816.2 |
| JUNIN | a40.49 | 554 | 188.5 | 119.4 | 290.5 | 188.5 | 101.7 | 248.6 | 365.5 | 305.4 | 452.3 | 1020 | 814.6 | 1320 |
| JUNIN | a50.59 | 947 | 458.8 | 426.7 | 610.8 | 458.8 | 366.6 | 525.2 | 488.2 | 421.8 | 580.4 | 1558 | 1376 | 1917 |
| JUNIN | a60.69 | 1393 | 659.6 | 634.5 | 869.4 | 659.6 | 544.6 | 746.4 | 733.4 | 646.6 | 848.4 | 2321 | 2099 | 2791 |
| JUNIN | a70.79 | 1805 | 523 | 422 | 754.9 | 523 | 364.1 | 651.9 | 1282 | 1153 | 1441 | 3369 | 2982 | 3954 |
| JUNIN | a80 | 2745 | 574.8 | 450.8 | 861.8 | 574.8 | 385.1 | 736.7 | 2170 | 2008 | 2360 | 5563 | 5067 | 6286 |
| LA LIBERTAD | a0.9 | 334 | 5 | 5 | 5 | 0 | 0 | 0 | 334 | 334 | 334 | 843.2 | 843.2 | 843.2 |
| LA LIBERTAD | a10.19 | 143 | 0 | 0 | 0 | 28.1 | 10.56 | 38.56 | 114.9 | 104.4 | 132.4 | 0 | 0 | 0 |
| LA LIBERTAD | a20.29 | 297 | 74.22 | 26 | 136.4 | 74.22 | 11.72 | 114 | 222.8 | 183 | 285.3 | 598.1 | 456.3 | 807.3 |
| LA LIBERTAD | a30.39 | 409 | 177.6 | 150.1 | 254 | 177.6 | 125.6 | 213 | 231.4 | 196 | 283.4 | 720.8 | 610.1 | 919.2 |
| LA LIBERTAD | a40.49 | 743 | 454.5 | 454.5 | 558.5 | 441.7 | 390.1 | 479.5 | 301.3 | 263.5 | 352.9 | 1115 | 1032 | 1332 |
| LA LIBERTAD | a50.59 | 1441 | 897.1 | 897.1 | 1101 | 865.1 | 764.8 | 938.9 | 575.9 | 502.1 | 676.2 | 2190 | 2024 | 2619 |
| LA LIBERTAD | a60.69 | 2322 | 1526 | 1526 | 1775 | 1441 | 1320 | 1535 | 880.8 | 786.9 | 1002 | 3416 | 3215 | 3924 |
| LA LIBERTAD | a70.79 | 2875 | 1790 | 1790 | 2083 | 1669 | 1531 | 1781 | 1206 | 1094 | 1344 | 4477 | 4227 | 5078 |
| LA LIBERTAD | a80 | 4055 | 1841 | 1841 | 2280 | 1755 | 1555 | 1926 | 2300 | 2129 | 2500 | 7164 | 6768 | 8065 |
| LAMBAYEQUE | a0.9 | 81 | 3 | 3 | 3 | 0 | 0 | 0 | 81 | 81 | 81 | 0 | 0 | 0 |
| LAMBAYEQUE | a10.19 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 29 | 29 | 0 | 0 | 0 |
| LAMBAYEQUE | a20.29 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 90 | 90 | 0 | 0 | 0 |
| LAMBAYEQUE | a30.39 | 176 | 58 | 58 | 58 | -14.6 | -41.94 | -1.65 | 190.6 | 177.6 | 217.9 | 0 | 0 | 0 |
| LAMBAYEQUE | a40.49 | 367 | 147 | 147 | 147 | -303.6 | -576.9 | -149.6 | 670.6 | 516.6 | 943.9 | 0 | 0 | 0 |
| LAMBAYEQUE | a50.59 | 734 | 319 | 319 | 319 | -653.2 | -1107 | -363.3 | 1387 | 1097 | 1841 | 0 | 0 | 0 |
| LAMBAYEQUE | a60.69 | 1230 | 565 | 565 | 565 | -1740 | -2771 | -1031 | 2970 | 2261 | 4001 | 10828 | 8379 | 14390 |
| LAMBAYEQUE | a70.79 | 1193 | 464 | 464 | 464 | -363.8 | -777.8 | -60.36 | 1557 | 1253 | 1971 | 5813 | 4770 | 7235 |
| LAMBAYEQUE | a80 | 1298 | 540 | 316 | 1271 | 540 | 307.7 | 696.7 | 758 | 601.3 | 990.3 | 3300 | 2505 | 4877 |
| LIMA | a0.9 | 1373 | 47 | 47 | 47 | 0 | 0 | 0 | 1373 | 1373 | 1373 | 4168 | 4168 | 4168 |
| LIMA | a10.19 | 482 | 36 | 36 | 36 | 0 | 0 | 0 | 482 | 482 | 482 | 1303 | 1303 | 1303 |
| LIMA | a20.29 | 1297 | 408.8 | 340.8 | 770.5 | 408.8 | 238.9 | 540.6 | 888.2 | 756.4 | 1058 | 2944 | 2500 | 3791 |
| LIMA | a30.39 | 2632 | 1383 | 1383 | 1852 | 1216 | 1026 | 1374 | 1416 | 1258 | 1606 | 5055 | 4646 | 6017 |
| LIMA | a40.49 | 5421 | 4781 | 4781 | 5207 | 3857 | 3679 | 4006 | 1564 | 1415 | 1742 | 8585 | 8222 | 9444 |
| LIMA | a50.59 | 10554 | 9823 | 9823 | 10613 | 7850 | 7520 | 8124 | 2704 | 2430 | 3034 | 16463 | 15790 | 18064 |
| LIMA | a60.69 | 17126 | 15512 | 15512 | 16695 | 12748 | 12241 | 13174 | 4378 | 3952 | 4885 | 25684 | 24695 | 28046 |
| LIMA | a70.79 | 19325 | 15623 | 15623 | 17260 | 12788 | 12105 | 13374 | 6537 | 5951 | 7220 | 31328 | 29920 | 34606 |
| LIMA | a80 | 27139 | 14370 | 14370 | 17191 | 12064 | 10935 | 13081 | 15075 | 14058 | 16204 | 51788 | 49262 | 57410 |
| LORETO | a0.9 | 275 | 6 | 6 | 6 | 0 | 0 | 0 | 275 | 275 | 275 | 876.4 | 876.4 | 876.4 |
| LORETO | a10.19 | 85 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 85 | 85 | 0 | 0 | 0 |
| LORETO | a20.29 | 152 | 20 | 20 | 20 | 0 | 0 | 0 | 152 | 152 | 152 | 518.8 | 518.8 | 518.8 |
| LORETO | a30.39 | 253 | 49 | 49 | 49 | -134.6 | -285.4 | -38.39 | 387.6 | 291.4 | 538.4 | 1343 | 1022 | 1846 |
| LORETO | a40.49 | 389 | 87 | 87 | 87 | -154.2 | -351.3 | -21.69 | 543.2 | 410.7 | 740.3 | 1791 | 1375 | 2409 |
| LORETO | a50.59 | 615 | 336.6 | 336.6 | 557 | 309.4 | 222.3 | 368.2 | 305.6 | 246.8 | 392.7 | 1236 | 1063 | 1713 |
| LORETO | a60.69 | 958 | 431.7 | 266 | 802.6 | 431.7 | 238.7 | 554 | 526.3 | 404 | 719.3 | 1898 | 1392 | 2807 |
| LORETO | a70.79 | 932 | 990.8 | 990.8 | 1099 | 707.3 | 664.2 | 737 | 224.7 | 195 | 267.8 | 1641 | 1555 | 1874 |
| LORETO | a80 | 783 | 686.3 | 686.3 | 874.8 | 504.3 | 433.5 | 552.6 | 278.7 | 230.4 | 349.5 | 1556 | 1405 | 1965 |
| MADRE DE DIOS | a0.9 | 92 | 0 | 0 | 0 | 0 | 0 | 0 | 92 | 92 | 92 | 0 | 0 | 0 |
| MADRE DE DIOS | a10.19 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 21 | 21 | 0 | 0 | 0 |
| MADRE DE DIOS | a20.29 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 79 | 79 | 0 | 0 | 0 |
| MADRE DE DIOS | a30.39 | 92 | 0 | 0 | 0 | 0 | 0 | 0 | 92 | 92 | 92 | 0 | 0 | 0 |
| MADRE DE DIOS | a40.49 | 117 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 117 | 117 | 0 | 0 | 0 |
| MADRE DE DIOS | a50.59 | 172 | 0 | 0 | 0 | 0 | 0 | 0 | 172 | 172 | 172 | 0 | 0 | 0 |
| MADRE DE DIOS | a60.69 | 191 | 0 | 0 | 0 | 0 | 0 | 0 | 191 | 191 | 191 | 0 | 0 | 0 |
| MADRE DE DIOS | a70.79 | 168 | 0 | 0 | 0 | 0 | 0 | 0 | 168 | 168 | 168 | 0 | 0 | 0 |
| MADRE DE DIOS | a80 | 146 | 0 | 0 | 0 | 0 | 0 | 0 | 146 | 146 | 146 | 0 | 0 | 0 |
| MOQUEGUA | a0.9 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 21 | 21 | 0 | 0 | 0 |
| MOQUEGUA | a10.19 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 10 | 0 | 0 | 0 |
| MOQUEGUA | a20.29 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 39 | 39 | 0 | 0 | 0 |
| MOQUEGUA | a30.39 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 33 | 33 | 0 | 0 | 0 |
| MOQUEGUA | a40.49 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 90 | 90 | 0 | 0 | 0 |
| MOQUEGUA | a50.59 | 173 | 0 | 0 | 0 | 0 | 0 | 0 | 173 | 173 | 173 | 0 | 0 | 0 |
| MOQUEGUA | a60.69 | 278 | 78 | 78 | 78 | 0 | 0 | 0 | 278 | 278 | 278 | 0 | 0 | 0 |
| MOQUEGUA | a70.79 | 380 | 93 | 93 | 93 | -339.8 | -566.9 | -184.9 | 719.8 | 564.9 | 946.9 | 1908 | 1517 | 2480 |
| MOQUEGUA | a80 | 506 | 192 | 149.6 | 282.1 | 192 | 125.8 | 237.8 | 314 | 268.2 | 380.2 | 940.8 | 789.2 | 1189 |
| PASCO | a0.9 | 91 | 0 | 0 | 0 | 0 | 0 | 0 | 91 | 91 | 91 | 0 | 0 | 0 |
| PASCO | a10.19 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 28 | 28 | 0 | 0 | 0 |
| PASCO | a20.29 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 45 | 45 | 0 | 0 | 0 |
| PASCO | a30.39 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 58 | 58 | 0 | 0 | 0 |
| PASCO | a40.49 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 83 | 83 | 83 | 0 | 0 | 0 |
| PASCO | a50.59 | 152 | 0 | 0 | 0 | 0 | 0 | 0 | 152 | 152 | 152 | 0 | 0 | 0 |
| PASCO | a60.69 | 220 | 0 | 0 | 0 | 0 | 0 | 0 | 220 | 220 | 220 | 0 | 0 | 0 |
| PASCO | a70.79 | 245 | 23 | 23 | 23 | 0 | 0 | 0 | 245 | 245 | 245 | 0 | 0 | 0 |
| PASCO | a80 | 293 | 30 | 30 | 30 | 0 | 0 | 0 | 293 | 293 | 293 | 0 | 0 | 0 |
| PIURA | a0.9 | 301 | 18 | 18 | 18 | 0 | 0 | 0 | 301 | 301 | 301 | 896.6 | 896.6 | 896.6 |
| PIURA | a10.19 | 91 | 0 | 0 | 0 | 0 | 0 | 0 | 91 | 91 | 91 | 0 | 0 | 0 |
| PIURA | a20.29 | 219 | 17 | 17 | 17 | 0 | 0 | 0 | 219 | 219 | 219 | 460 | 460 | 460 |
| PIURA | a30.39 | 362 | 137 | 72 | 249.4 | 137 | 62.91 | 185.1 | 225 | 176.9 | 299.1 | 706.2 | 519.6 | 1006 |
| PIURA | a40.49 | 742 | 336.5 | 295.9 | 559.2 | 336.5 | 219.4 | 415 | 405.5 | 327 | 522.6 | 1365 | 1125 | 1884 |
| PIURA | a50.59 | 1386 | 1429 | 1429 | 1535 | 1106 | 1061 | 1139 | 280.4 | 246.7 | 325.5 | 2140 | 2054 | 2360 |
| PIURA | a60.69 | 2446 | 2041 | 2041 | 2252 | 1886 | 1781 | 1965 | 560.1 | 481.4 | 665.5 | 3128 | 2975 | 3544 |
| PIURA | a70.79 | 2512 | 2271 | 2271 | 2485 | 1851 | 1758 | 1924 | 661.1 | 588.3 | 754.3 | 3841 | 3668 | 4276 |
| PIURA | a80 | 3251 | 2583 | 2583 | 2959 | 2004 | 1856 | 2126 | 1247 | 1125 | 1395 | 5914 | 5588 | 6687 |
| PUNO | a0.9 | 290 | 4 | 4 | 4 | 0 | 0 | 0 | 290 | 290 | 290 | 825.6 | 825.6 | 825.6 |
| PUNO | a10.19 | 129 | 0 | 0 | 0 | 0 | 0 | 0 | 129 | 129 | 129 | 0 | 0 | 0 |
| PUNO | a20.29 | 230 | 12 | 12 | 12 | 0 | 0 | 0 | 230 | 230 | 230 | 576.7 | 576.7 | 576.7 |
| PUNO | a30.39 | 282 | 66.6 | 23.33 | 136.9 | 66.6 | 16.22 | 97.27 | 215.4 | 184.7 | 265.8 | 678.7 | 548.3 | 892.2 |
| PUNO | a40.49 | 486 | 213.9 | 213.9 | 315.7 | 199.7 | 155.8 | 230.3 | 286.3 | 255.7 | 330.2 | 993.4 | 910.2 | 1215 |
| PUNO | a50.59 | 788 | 338.4 | 338.4 | 516.6 | 321.6 | 245.9 | 375.6 | 466.4 | 412.4 | 542.1 | 1617 | 1469 | 2003 |
| PUNO | a60.69 | 1128 | 611.6 | 611.6 | 781.6 | 543.2 | 468.9 | 599.3 | 584.8 | 528.7 | 659.1 | 2064 | 1925 | 2418 |
| PUNO | a70.79 | 1550 | 737 | 737 | 948.1 | 636.9 | 549.2 | 706.6 | 913.1 | 843.4 | 1001 | 3131 | 2948 | 3572 |
| PUNO | a80 | 2133 | 804 | 804 | 1087 | 707.6 | 593.8 | 802.8 | 1425 | 1330 | 1539 | 4604 | 4350 | 5190 |
| SAN MARTIN | a0.9 | 190 | 9 | 9 | 9 | -63.49 | -166 | -2.024 | 253.5 | 192 | 356 | 803.9 | 611.2 | 1125 |
| SAN MARTIN | a10.19 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 69 | 69 | 69 | 0 | 0 | 0 |
| SAN MARTIN | a20.29 | 153 | 14 | 14 | 14 | 0 | 0 | 0 | 153 | 153 | 153 | 0 | 0 | 0 |
| SAN MARTIN | a30.39 | 207 | 39 | 39 | 39 | -128.7 | -249 | -51.56 | 335.7 | 258.6 | 456 | 1032 | 803.9 | 1388 |
| SAN MARTIN | a40.49 | 322 | 159.6 | 159.6 | 263.8 | 151.9 | 108.8 | 180.1 | 170.1 | 141.9 | 213.2 | 652.5 | 570.9 | 881.7 |
| SAN MARTIN | a50.59 | 522 | 190.6 | 140 | 360.4 | 190.6 | 106.6 | 247.6 | 331.4 | 274.4 | 415.4 | 1143 | 928.7 | 1554 |
| SAN MARTIN | a60.69 | 744 | 453.4 | 453.4 | 635.6 | 401.5 | 324.4 | 454.9 | 342.5 | 289.1 | 419.6 | 1377 | 1233 | 1767 |
| SAN MARTIN | a70.79 | 796 | 437.6 | 437.6 | 619.3 | 379.4 | 306.1 | 433.4 | 416.6 | 362.6 | 489.9 | 1602 | 1451 | 1988 |
| SAN MARTIN | a80 | 1207 | 757.6 | 757.6 | 979.6 | 626.9 | 537 | 694.4 | 580.1 | 512.6 | 670 | 2347 | 2162 | 2816 |
| TACNA | a0.9 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 39 | 39 | 0 | 0 | 0 |
| TACNA | a10.19 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 18 | 18 | 0 | 0 | 0 |
| TACNA | a20.29 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 49 | 49 | 0 | 0 | 0 |
| TACNA | a30.39 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | 77 | 77 | 77 | 0 | 0 | 0 |
| TACNA | a40.49 | 131 | 0 | 0 | 0 | 0 | 0 | 0 | 131 | 131 | 131 | 0 | 0 | 0 |
| TACNA | a50.59 | 225 | 46 | 46 | 46 | 0 | 0 | 0 | 225 | 225 | 225 | 0 | 0 | 0 |
| TACNA | a60.69 | 375 | 72 | 72 | 72 | 0 | 0 | 0 | 375 | 375 | 375 | 1003 | 1003 | 1003 |
| TACNA | a70.79 | 396 | 131.9 | 104.4 | 213.3 | 131.9 | 80.84 | 165.7 | 264.1 | 230.3 | 315.2 | 829.9 | 713 | 1046 |
| TACNA | a80 | 444 | 118.6 | 87.06 | 205.1 | 118.6 | 65.61 | 155.3 | 325.4 | 288.7 | 378.4 | 1033 | 898.6 | 1269 |
| TUMBES | a0.9 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 58 | 58 | 0 | 0 | 0 |
| TUMBES | a10.19 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 20 | 20 | 0 | 0 | 0 |
| TUMBES | a20.29 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 47 | 47 | 0 | 0 | 0 |
| TUMBES | a30.39 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 80 | 80 | 0 | 0 | 0 |
| TUMBES | a40.49 | 116 | 0 | 0 | 0 | 0 | 0 | 0 | 116 | 116 | 116 | 0 | 0 | 0 |
| TUMBES | a50.59 | 231 | 58 | 58 | 58 | -16.23 | -42.21 | -2.051 | 247.2 | 233.1 | 273.2 | 0 | 0 | 0 |
| TUMBES | a60.69 | 366 | 109 | 109 | 109 | -202.7 | -390.3 | -80.53 | 568.7 | 446.5 | 756.3 | 1466 | 1174 | 1913 |
| TUMBES | a70.79 | 354 | 86 | 86 | 86 | -322.1 | -553 | -168.9 | 676.1 | 522.9 | 907 | 1522 | 1196 | 2012 |
| TUMBES | a80 | 505 | 197.4 | 135.7 | 284.6 | 197.4 | 119.3 | 250.9 | 307.6 | 254.1 | 385.7 | 860 | 683.1 | 1115 |
| UCAYALI | a0.9 | 137 | 9 | 9 | 9 | 0 | 0 | 0 | 137 | 137 | 137 | 398.2 | 398.2 | 398.2 |
| UCAYALI | a10.19 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 57 | 57 | 0 | 0 | 0 |
| UCAYALI | a20.29 | 135 | 9 | 9 | 9 | 0 | 0 | 0 | 135 | 135 | 135 | 0 | 0 | 0 |
| UCAYALI | a30.39 | 170 | 20 | 20 | 20 | 0 | 0 | 0 | 170 | 170 | 170 | 0 | 0 | 0 |
| UCAYALI | a40.49 | 213 | 38 | 38 | 38 | -102.6 | -250.4 | -15.72 | 315.6 | 228.7 | 463.4 | 944 | 694.6 | 1368 |
| UCAYALI | a50.59 | 422 | 85 | 85 | 85 | -204.4 | -406.8 | -69.71 | 626.4 | 491.7 | 828.8 | 1859 | 1477 | 2432 |
| UCAYALI | a60.69 | 596 | 439.6 | 439.6 | 557.6 | 383.3 | 330.3 | 419.2 | 212.7 | 176.8 | 265.7 | 986.3 | 894.2 | 1241 |
| UCAYALI | a70.79 | 653 | 88 | 88 | 88 | 0 | 0 | 0 | 653 | 653 | 653 | 1912 | 1912 | 1912 |
| UCAYALI | a80 | 649 | 395.5 | 395.5 | 550.7 | 359.8 | 291.4 | 405.9 | 289.2 | 243.1 | 357.6 | 1167 | 1044 | 1504 |
| Total | - | 211649 | 117574 | 114101 | 139810 | 94373 | 79139 | 105767 | 117276 | 105882 | 132510 | 378139 | 346655 | 437662 |

### Proportion total excess deaths per region

Table 8: Proportion total excess deaths per region

|  |  |  |
| --- | --- | --- |
| Departamento | suma | prop |
| AMAZONAS | NA | NA |
| ANCASH | 3524 | 3.451 |
| APURIMAC | NA | NA |
| AREQUIPA | NA | NA |
| AYACUCHO | NA | NA |
| CAJAMARCA | NA | NA |
| CALLAO | NA | NA |
| CUSCO | 1800 | 1.762 |
| HUANCAVELICA | NA | NA |
| HUANUCO | NA | NA |
| ICA | NA | NA |
| JUNIN | 2524 | 2.472 |
| LA LIBERTAD | NA | NA |
| LAMBAYEQUE | NA | NA |
| LIMA | 61986 | 60.71 |
| LORETO | NA | NA |
| MADRE DE DIOS | NA | NA |
| MOQUEGUA | NA | NA |
| PASCO | NA | NA |
| PIURA | NA | NA |
| PUNO | NA | NA |
| SAN MARTIN | NA | NA |
| TACNA | NA | NA |
| TUMBES | NA | NA |
| UCAYALI | NA | NA |

### Population 2020 per region

Table 8: Population 2020 per region

|  |  |
| --- | --- |
| Departamento | pop.INEI |
| MADRE DE DIOS | 153164 |
| MOQUEGUA | 189701 |
| TUMBES | 251363 |
| PASCO | 314677 |
| TACNA | 362331 |
| AMAZONAS | 427202 |
| APURIMAC | 467707 |
| HUANCAVELICA | 511794 |
| UCAYALI | 523086 |
| AYACUCHO | 725649 |
| ICA | 825042 |
| HUANUCO | 888845 |
| SAN MARTIN | 894564 |
| CALLAO | 1081491 |
| LORETO | 1085375 |
| ANCASH | 1177080 |
| LAMBAYEQUE | 1309731 |
| CUSCO | 1352476 |
| AREQUIPA | 1358108 |
| JUNIN | 1398361 |
| PUNO | 1485328 |
| CAJAMARCA | 1544325 |
| PIURA | 1914346 |
| LA LIBERTAD | 1973446 |
| LIMA | 10609166 |

## Appendix 2

### Estimations based on mortality baselines and differences - robustness check

The overall excess mortality estimates obtained from the baseline-approach model are 4.58% below the estimates obtained using the PAF model. The age distribution of mortality is highly consistent in both models. However, most differences between both estimates are concentrated in the oldest age groups. Differences between both approaches are mainly due to the inclusion of the upper confidence interval are in the final count.

Table 8: Estimations based on mortality baselines and differences

|  |  |  |  |
| --- | --- | --- | --- |
| Age.group | Epi-weeks | Positive-Excess | All-Excess |
| 0-9 | 0 | 72.85 | -519.6 |
| 10-19 | 19.01 | 174.3 | 108.5 |
| 20-29 | 49.87 | 207.7 | -135.3 |
| 30-39 | 1591 | 1719 | 1595 |
| 40-49 | 6792 | 6834 | 6803 |
| 50-59 | 14059 | 14130 | 14085 |
| 60-69 | 23561 | 23623 | 23611 |
| 70-79 | 22807 | 22912 | 22885 |
| 80+ | 21169 | 21357 | 21357 |
| Grand Total | 90048 | 91030 | 89790 |

Note: Epi-weeks (column 2) includes excess deaths during periods in which the observed mortality was above the upper uncertainty interval; Positive-Excess (column 3) includes excess in which the observed mortality was above the baseline; and All-Excess (column 4) includes both positive and negative excess deaths.

## Appendix 3

### Comparison with other studies in Peru

A simple comparison of registered deaths in Peru for months April to June of 2020 and corresponding periods in 2017-19 estimates 36,322 excess deaths.48 It does not include non-registered deaths or take improvements in data registration into account. Applying our approach to this time period gives an estimate of 35,461 (CI 95% 32,425-37,803) registered deaths which climbs to 49,648 (CI 95% 48,037-51,034). A similar comparison between 1 January to 12 July 2020 and the corresponding periods in 2017-19 shows excess 46,863 deaths, compared to 50,534 (CI 95% 44,448-55,582), applying our approach to the same period.49 This second study includes 2,000 excess deaths before March 2020, which cannot be attributed to the COVID-19 pandemic. A study of Lima metropolitan region finds an excess of 20,093 non-violent deaths for the first 24 weeks of 2020.50 This is above to our own estimate based on registered deaths in Lima over the same period: 14,659 (CI 95% 13,579 – 15,609). Adding unregistered deaths increases this to 20149 (CI 95% 18,839-21,323).

1. University of East Anglia [↑](#footnote-ref-1)
2. Pan American Health Organisation [↑](#footnote-ref-2)
3. London School of Hygiene and Tropical Medicine [↑](#footnote-ref-3)
4. London School of Hygiene and Tropical Medicine [↑](#footnote-ref-4)
5. Max Planck Institute for Demographich Research [↑](#footnote-ref-5)
6. University of East Anglia - email:[l.sempe@uea.ac.uk](mailto:l.sempe@uea.ac.uk) [↑](#footnote-ref-6)