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 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 new online registration system (SINADEF) at this time.

Findings

We estimate that registered mortality nationally underestimates mortality by 28.3% (95% CI 28.5% - 28.1%). We estimate total all-cause excess mortality during the period of analysis at 136,245 (95% CI 122,566 - 145,130) of which 97,695 (95% CI 87,624 - 104,337) were captured by the vital registration system. Deaths at age 60 and over accounted for 76% (95% CI 75.6% - 78.3%) 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 67,425 (95% CI 65,413 - 69,216) excess deaths, while the regions of Amazonas and Pasco account for less than 300 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.

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Research in context

Evidence before this study

We searched PubMed, Google Scholar, medRxiv, and SocArXiv for studies published up to December 08, 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 few studies computing overall COVID-19 mortality in 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, 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.

1 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 agencies[9,10], academia[11–14] 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. Also, the progressive implementation of electronic registration of deaths in recent years enables comparisons of spatial and temporal trends in death registration.[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 sub-national data 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.

2 Data and methods

2.1 Data

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); (ii) crude mortality rate estimates disaggregated by region and year from 2015 to 2020 from INEI; (iii) individual-level registered deaths by region and age since 2017 from the Sistema Informático Nacional de Defunciones (SINADEF); and (iv) individual-level registered COVID-19 deaths by region and age in 2020 from the Ministry of Health (MoH).

2.2 Excess mortality methods

Our approach to estimate excess mortality decomposes into three terms, namely 1) excess registered deaths, 2) excess unregistered deaths, 3) unregistered COVID-19 deaths. Figure 1 summarises data sources used (squares), analysis performed (diamonds) and different outputs (circles).

To estimate the first term, excess registered deaths, we fit quasi-Poisson regressions to weekly deaths since 2017 by age-groups and region, as follows:

$$log(\text{Deaths}_i) = \beta_0 + \beta_1 \text{COVID-19} + \beta_2 \text{Week} + \beta_3 \text{Year} + \beta_4 \epsilon_{t-1} + \log(\text{Pop}) + \epsilon_t \quad (1)$$

where we fit weekly counts of deaths Week and a variable Year to address long-term trends. Additionally, we use lagged residuals ϵ_{t-1} and the log of population in 2020 as an offset. Finally, we compute a dichotomous variable starting in the week corresponding to March 16 2020 as the first registered case of COVID-19 in the country.

Secondly, we compute the population attributable fraction[30] based on the relative risk RR from parameter β_1 in equation (1), as follows:

$$\widehat{\text{Excess}_{\text{Reg}}} = (\text{RR} - 1)/\text{RR} * \text{n} \quad (2)$$

where n is the weekly number of deaths,[31] computed cumulatively over time.

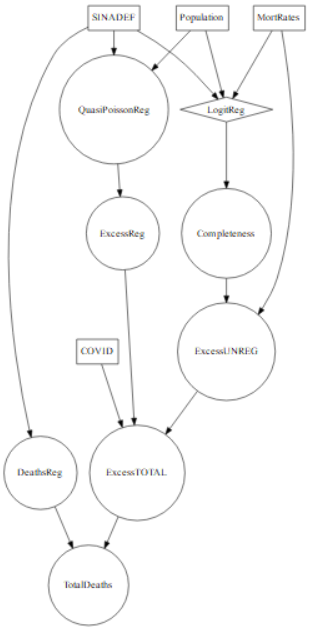

Figure 1: Flowchart: Data, analysis and outputs

To estimate our second term, we predict the logit of death registration completeness for years 2017 and 2019 (years for which data are available).[29] We exploit variability in mortality rates, population aged 60 years and over and rurality to address potential differences in terms of registration completeness. We model random-effects regressions by region using the equation:

$$\begin{aligned} \text{logit}(\text{Reg complete}_{jk}) = \beta_0 + \beta_1 * \text{RegCDR} + \beta_2 * \text{RegCDR}^2 + \\ \beta_3 * \text{complete} < 5 + \beta_4 * \text{P}_{60+} + \beta_5 * \log(\text{5q0}) + \beta_6 * \text{LPG} + \beta_7 * \text{k} + \epsilon_{jk} + \gamma_j \end{aligned} \tag{3}$$

where RegCDR and RegCDR^2 are the Crude Death Rates based on the Registration System, complete < 5 is the completeness registration rate for infants, $log(\text{5q0})$ is the logarithm under-five mortality rate and P_{60+} represents the fraction of the population at 60 years and over. LPG 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.[32] Rurality is an important factor to explain delays and underregistration of deaths as the system requires access to internet and computers. Additionally, ϵ_{jk} in the error term and γ_j is the region-level random effect.

Then, we compute the completeness of deaths registration, $\widehat{\text{Completeness}}$ using the inverse logit of the predicted values from equation (3) and $\widehat{\text{Excess}}_{\text{Reg}}$ from equation (2), as follows:

$$\widehat{\mu}_{\text{Deaths}_{\text{Not reg}}} = \left(1 - \widehat{\text{Completeness}}\right) * \sum \widehat{\text{Excess}}_{\text{Reg}} \tag{4}$$

The third term, unregistered COVID-19 deaths, is computed to correct for situations where the proportion of cumulative cases of COVID-19 exceeds registered deaths for that period. It 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:

$$\widehat{\mu}_{\text{Deaths}_{\text{COVID not reg}}} = \begin{cases} \widehat{\mu}_{\text{Deaths}_{\text{COVID Reg}}} - \widehat{\mu}_{\text{Excess}_{\text{Reg}}} & \text{if } \widehat{\mu}_{\text{Deaths}_{\text{COVID Reg}}} > \widehat{\mu}_{\text{Excess}_{\text{Reg}}}, \\ 0 & \text{if } \widehat{\mu}_{\text{Deaths}_{\text{COVID Reg}}} < \widehat{\mu}_{\text{Excess}_{\text{Reg}}}. \end{cases} \tag{5}$$

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 with very small populations. In those cases $\widehat{\mu}_{\text{Deaths}_{\text{Not reg}}}$ is set to 0 as, if not, they would add negative values to the sum. A second 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 $\widehat{\text{Excess}}_{\text{Reg}} \leq 0$ is taken account of in our final estimates. A third 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 β_1 in equation (1) is not statistically significant and therefore we set $\widehat{\text{Excess}}_{\text{Reg}} = 0$.

Equation (6) summarises the estimation of $\widehat{\text{Excess}}_{\text{T}_{\text{min/mean/max}}}$ as follows:

$$\widehat{\text{Excess}}_{\text{T}_{\text{min/mean/max}}} = \widehat{\text{Excess}}_{\text{Reg}_{\text{min/mean/max}}} + \widehat{\mu}_{\text{Deaths}_{\text{Not reg}}} + \text{Deaths}_{\text{COVID Not Reg}} \tag{6}$$

Finally, we estimate total mortality during 2020 by adding $\widehat{\text{Excess}}_{\text{T}_{\text{min/mean/max}}}$ from equation (6) and the counterfactual difference of SINADEF deaths during 2020 and $\widehat{\text{Excess}}_{\text{Reg}_{\text{min/mean/max}}}$, adjusted by $\widehat{\text{Completeness}}$ as follows:

$$\widehat{\text{Total}_{Mortality\ 2020}} = \widehat{\text{Excess}}_{\text{T}_{\text{min/mean/max}}} + \Big(\big(\sum_{week=1}^{52} \text{SINADEF}_{2020} - \widehat{\text{Excess}}_{\text{Reg}_{\text{min/mean/max}}} \big) * \big(1 + \widehat{\text{Completeness}} \big) \Big) \tag{7}$$

To adress 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 methods[33] based on population INEI population estimates by region and age-group for 2020 as the standard population.[34]

3 Results

Estimates of completeness of registration derived from our logistic regression model fit the data according to marginal and conditional R^2 and Root Mean Square of Errors parameters. Model fit and goodness-of-fit are presented in Appendix 1. Figure 2 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).

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 97,695 (95% CI 87,624 - 104,337), of which 37,724 are reported as COVID-19 deaths. This represents an increase of 159 % (95% CI 132 % - 177 %) compared to MoH data.

Table 1: Summary of estimations, Peru, 2020.

Terms	Estimates (95% CI)
Excess registered deaths	97695 (87624 - 104337)
Completeness of CRVS deaths registration	71.7 % (64.3 % - 76.6 %)
Excess TOTAL mortality	136245 (122566 - 145130)
Counterfactual estimated deaths in 2020	113974 (107332 - 124045)

Terms	Estimates (95% CI)
Total estimated deaths in 2020	289172 (266608 - 311735)

Table 2 shows estimates by region. Lima, which includes the capital, accounts for 67425 (95% CI 65413 - 69216) total excess deaths, and Amazonas 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 76% of total excess mortality. There was negative excess registered mortality for the two youngest age groups: under 9 and 10 to 19.

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	279.2	151.9	352.2	144.1	70.05	186.5	31
ANCASH	3818	3344	4200	3234	2821	3566	103
APURIMAC	748.8	407.6	978.8	511.3	272.7	672.1	18
AREQUIPA	5323	4469	5822	4919	4108	5394	147
AYACUCHO	654.4	393.4	837.3	370.1	195.4	492.4	101
CAJAMARCA	2448	811.3	3141	1300	345.7	1704	218
CALLAO	6748	6479	6978	5476	5257	5664	40
CUSCO	1794	1060	2339	1386	770	1843	142
HUANCAVELICA	481.9	384.3	551.7	387.5	307.6	444.6	8
HUANUCO	1339	799	1727	845.9	493.9	1099	41
ICA	3678	3330	3955	3616	3268	3892	57
JUNIN	3172	2597	3627	2592	2104	2978	121
LA LIBERTAD	6788	6217	7256	5619	5141	6010	68
LAMBAYEQUE	7954	7831	8044	4228	4162	4275	0
LIMA	67425	65413	69216	47459	46041	48721	69
LORETO	3864	3588	4075	2246	2081	2371	94
MADRE DE DIOS	317.8	220.1	377.6	269.9	172.9	329.2	46
MOQUEGUA	872.5	715.2	978.9	727.4	593.9	817.6	15
PASCO	260.5	-291.7	440.8	54.87	-291.6	167.9	173
PIURA	10678	10343	10963	7046	6823	7235	72
PUNO	3007	2039	3637	2096	1394	2554	120
SAN MARTIN	1993	1116	2475	1252	660.8	1576	135
TACNA	554.8	384.5	660.4	430	294.4	514	15
TUMBES	758.8	605.5	865.4	650.1	516.8	742.8	11
UCAYALI	1288	159.7	1632	837.5	21.09	1086	131
Total	136245	122566	145130	97695	87624	104337	1976

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	332	-2269	999.1	-513.3	-2296	-51.68	1083
10-19	136.2	-69.95	187.9	-34.78	-226.1	12.03	163
20-29	641.5	52.1	911.6	192.6	-176.7	368.9	367
30-39	2447	2138	2684	1581	1349	1757	201

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
40-49	8983	8065	9545	6449	5773	6875	86
50-59	20121	18715	21138	14615	13563	15379	0
60-69	34218	32642	35432	24831	23655	25741	37
70-79	34187	31843	36017	24847	23073	26233	3
> 80	35178	31451	38215	25727	22910	28023	35
Total	136245	122566	145130	97695	87624	104337	1975

Our second term, excess unregistered deaths, is estimated to be 36,574 deaths (95% CI 32,966 - 38,817). This represents 28.3 % (95% CI 23 % - 35.7 %) of our estimate of the total registered and unregistered deaths. Coastal regions show the highest values where Lima accounts for 19,966 additional deaths, followed by Piura (3,726) and Lambayeque (3,632). Our third term adds 1,976 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 (147), Cajamarca and Puno (both with 173).

Combining all these terms, our estimate of total excess deaths during 2020 is 136,245 (95% CI 122,566 - 145,130) and our estimate of total deaths for 2020 is 289,172 (95% CI 266,608 - 311,735). This is 19.5 % (95% CI 9.8 % - 26.9 %) more than the number of deaths projected by INEI for 2020.

Figure 3 shows all cause age-standardised death rates. We find that Moquegua, Callao, and Lima (CI 95% ranging from 9.14 to 11.5) present the highest rates, ranging from 9.58 to 11.4, while regions of Amazonas, Ayacucho, and Cusco show the lowest rates ranging from 4.58 to 6.86 (CI 95% ranging from 4.38 to 7) (left). We find that Amazonas shows -1.61 deaths per 1000 in comparison to INEI's projections for 2020, which suggests that INEI overestimates mortality rates in Amazonas (right).

4 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.[35] 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.[36] 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.[37]

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.[38–41] 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.[42–44]

We estimate that overall excess mortality in Peru was 261 % (95% CI 225 % - 285 %) higher than the level officially attributed to COVID-19. Registered excess mortality was 159 % (95% CI 132 % - 177 %) 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.[45,46] Our estimates of regional variations in excess mortality are in line with,[45] 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 76% of excess mortality. No other published study in Peru provides data disaggregated by age

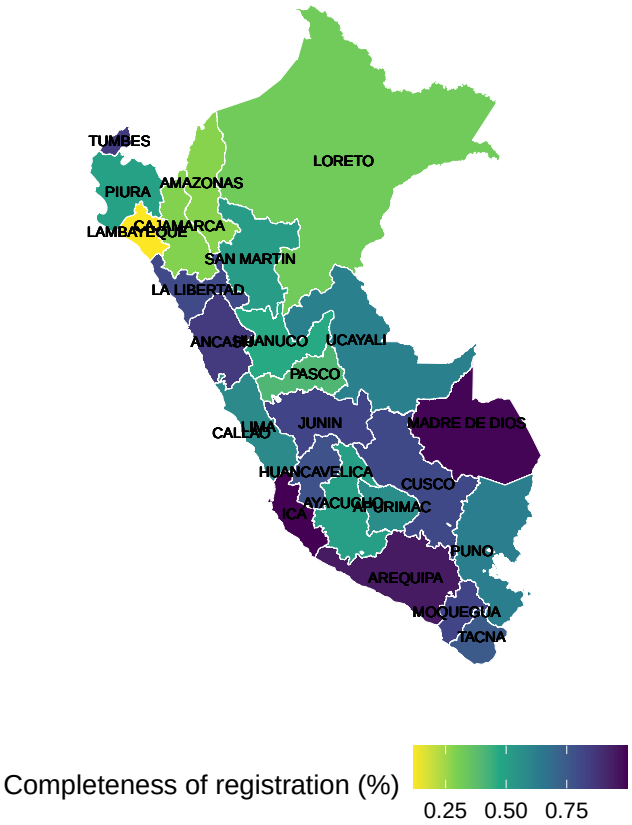

Figure 2: Completeness of registration

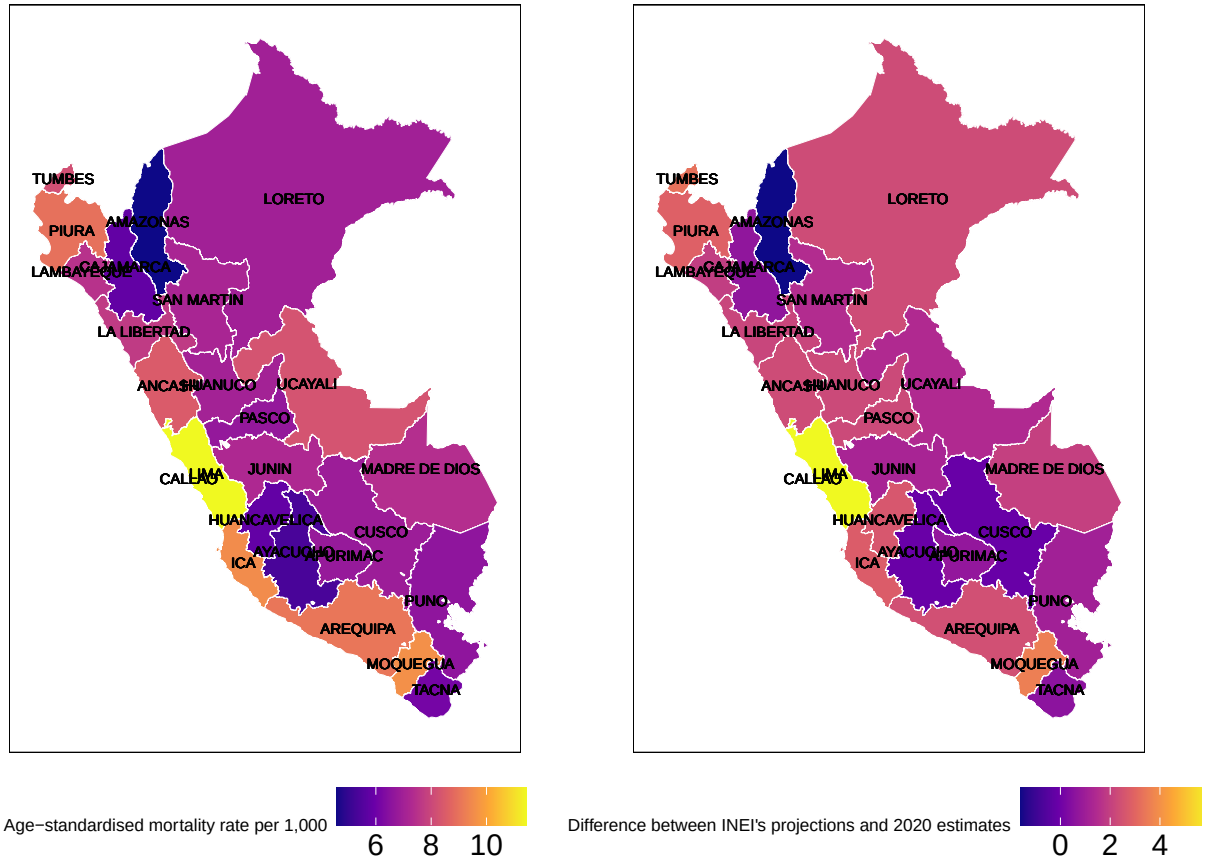

Figure 3: Age-standardised mortality rates

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.[43] An analysis of European countries reports that 91% of excess COVID-19 deaths occurred among people aged 65 or more.[40] This reflects a higher proportion of population aged 60 or more in Europe (25.5% in 2020) than in Peru.

5 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.

6 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.

7 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.

8 Declaration of interests

All other authors declare no competing interests.

9 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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12 Appendices

12.1 Appendix 1: Model fit registration completeness

Table 4: Model fit Mixed-effect logistic regression

R2m	R2c	RMSE.normalised	RMSE
0.7435	0.8699	0.05267	0.2389

12.1.1 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	70.49	136	NA	NA	NA	63.94	130	137	0.09292	6.55	6	0.3645
AMAZONAS	a10.19	24.47	74	NA	NA	NA	22.09	68	75	0.09712	2.376	6	0.882
AMAZONAS	a20.29	22.62	106	NA	NA	NA	21.78	100	107	0.03714	0.8399	6	0.991
AMAZONAS	a30.39	41.52	119	NA	NA	NA	34.85	113	120	0.1606	6.669	6	0.3525
AMAZONAS	a40.49	77.28	159	NA	NA	NA	74.79	153	160	0.03215	2.484	6	0.8702
AMAZONAS	a50.59	125.9	172	NA	NA	NA	114.5	166	173	0.09033	11.37	6	0.0775
AMAZONAS	a60.69	263.5	179	NA	NA	NA	175.9	173	180	0.3325	87.6	6	9.556e-17
AMAZONAS	a70.79	243.1	200	NA	NA	NA	230.8	194	201	0.05043	12.26	6	0.05647
AMAZONAS	a80	279.1	209	NA	NA	NA	249.5	203	210	0.1059	29.56	6	0.00004
ANCASH	a0.9	234.9	209	NA	NA	NA	217	203	210	0.07629	17.92	6	0.00642

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
ANCASH	a10.19	109	183	NA	NA	NA	108	177	184	0.009083	0.9897	6	0.986
ANCASH	a20.29	171.9	200	NA	NA	NA	163.1	194	201	0.05121	8.802	6	0.185
ANCASH	a30.39	196.3	201	NA	NA	NA	188.1	195	202	0.04138	8.122	6	0.2293
ANCASH	a40.49	353.7	207	NA	NA	NA	254	201	208	0.2818	99.66	6	2.952e-19
ANCASH	a50.59	791.8	209	NA	NA	NA	337.7	203	210	0.5736	454.1	6	6.294e-95
ANCASH	a60.69	1186	211	NA	NA	NA	343.4	205	212	0.7105	842.8	6	8.662e-179
ANCASH	a70.79	1201	211	NA	NA	NA	407.8	205	212	0.6605	793.2	6	4.461e-168
ANCASH	a80	934.5	211	NA	NA	NA	471.1	205	212	0.4958	463.3	6	6.626e-97
APURIMAC	a0.9	105.1	169	NA	NA	NA	101.5	163	170	0.03422	3.598	6	0.7309
APURIMAC	a10.19	21.71	104	NA	NA	NA	20.5	98	105	0.05571	1.21	6	0.9764
APURIMAC	a20.29	41.26	135	NA	NA	NA	37.75	129	136	0.08516	3.514	6	0.7421
APURIMAC	a30.39	68.23	148	NA	NA	NA	65.67	142	149	0.03743	2.554	6	0.8624
APURIMAC	a40.49	120.5	162	NA	NA	NA	104.3	156	163	0.1343	16.17	6	0.01285
APURIMAC	a50.59	182	194	NA	NA	NA	150.1	188	195	0.1753	31.89	6	0.00001
APURIMAC	a60.69	284.2	202	NA	NA	NA	237.6	196	203	0.164	46.6	6	2.246e-08
APURIMAC	a70.79	275.9	210	NA	NA	NA	210	204	211	0.239	65.94	6	2.773e-12
APURIMAC	a80	398	210	NA	NA	NA	246.3	204	211	0.381	151.6	6	3.474e-30
AREQUIPA	a0.9	239.6	207	NA	NA	NA	223.1	201	208	0.06897	16.52	6	0.0112
AREQUIPA	a10.19	104.9	172	NA	NA	NA	94.86	166	173	0.09533	9.995	6	0.1249
AREQUIPA	a20.29	188.4	201	NA	NA	NA	182.2	195	202	0.03283	6.186	6	0.4027
AREQUIPA	a30.39	239.2	209	NA	NA	NA	205.9	203	210	0.1391	33.27	6	9.285e-06
AREQUIPA	a40.49	614.1	207	NA	NA	NA	304.5	201	208	0.5041	309.5	6	7.375e-64
AREQUIPA	a50.59	1524	210	NA	NA	NA	342.2	204	211	0.7754	1181	6	5.265e-252
AREQUIPA	a60.69	2509	211	NA	NA	NA	404	205	212	0.839	2105	6	0
AREQUIPA	a70.79	2570	211	NA	NA	NA	441.8	205	212	0.8281	2128	6	0
AREQUIPA	a80	2815	211	NA	NA	NA	538.2	205	212	0.8088	2276	6	0
AYACUCHO	a0.9	157.4	173	NA	NA	NA	131	167	174	0.1672	26.32	6	0.00019
AYACUCHO	a10.19	52.87	122	NA	NA	NA	50.42	116	123	0.04636	2.451	6	0.8739
AYACUCHO	a20.29	104.5	167	NA	NA	NA	94.35	161	168	0.09699	10.13	6	0.1191
AYACUCHO	a30.39	96.41	161	NA	NA	NA	89.75	155	162	0.06905	6.657	6	0.3537
AYACUCHO	a40.49	171.5	172	NA	NA	NA	151.9	166	173	0.1141	19.57	6	0.00330
AYACUCHO	a50.59	215.1	191	NA	NA	NA	183.8	185	192	0.1453	31.26	6	0.00002
AYACUCHO	a60.69	346	205	NA	NA	NA	219.9	199	206	0.3645	126.1	6	8.52e-25
AYACUCHO	a70.79	499.8	208	NA	NA	NA	295.5	202	209	0.4087	204.2	6	2.382e-41
AYACUCHO	a80	485.4	209	NA	NA	NA	283.2	203	210	0.4167	202.3	6	6.228e-41
CAJAMARCA	a0.9	261.1	206	NA	NA	NA	223	200	207	0.1459	38.1	6	1.075e-06
CAJAMARCA	a10.19	53.35	143	NA	NA	NA	51.82	137	144	0.02858	1.525	6	0.9578

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
CAJAMARCA	a0.29	129.5	182	NA	NA	NA	121.9	176	183	0.05887	7.624	6	0.2669
CAJAMARCA	a0.39	183.2	193	NA	NA	NA	158.6	187	194	0.1345	24.64	6	0.00039
CAJAMARCA	a0.49	253.6	201	NA	NA	NA	198.7	195	202	0.2162	54.83	6	5.01e-10
CAJAMARCA	a0.59	553.2	209	NA	NA	NA	272.7	203	210	0.507	280.4	6	1.273e-57
CAJAMARCA	a0.69	873.1	210	NA	NA	NA	335.1	204	211	0.6162	538	6	5.471e-113
CAJAMARCA	a0.79	754.7	211	NA	NA	NA	323.6	205	212	0.5712	431.1	6	5.751e-90
CAJAMARCA	a80	640.8	211	NA	NA	NA	364.7	205	212	0.4308	276.1	6	1.078e-56
CALLAO	a0.9	226.1	198	NA	NA	NA	214.8	192	199	0.05004	11.32	6	0.0791
CALLAO	a10.19	54.22	134	NA	NA	NA	52.25	128	135	0.03627	1.966	6	0.9228
CALLAO	a20.29	188.2	201	NA	NA	NA	179.2	195	202	0.04817	9.069	6	0.1698
CALLAO	a30.39	287.1	205	NA	NA	NA	228.5	199	206	0.204	58.56	6	8.815e-11
CALLAO	a40.49	740.9	208	NA	NA	NA	309.7	202	209	0.582	431.2	6	5.394e-90
CALLAO	a50.59	1510	211	NA	NA	NA	365.2	205	212	0.7582	1145	6	3.529e-244
CALLAO	a60.69	2428	210	NA	NA	NA	418.6	204	211	0.8276	2010	6	0
CALLAO	a70.79	2093	211	NA	NA	NA	411.6	205	212	0.8033	1681	6	0
CALLAO	a80	1616	211	NA	NA	NA	500.4	205	212	0.6903	1115	6	9.919e-238
CUSCO	a0.9	311	211	NA	NA	NA	261.9	205	212	0.1579	49.11	6	7.072e-09
CUSCO	a10.19	162.5	196	NA	NA	NA	154.1	190	197	0.05191	8.437	6	0.2078
CUSCO	a20.29	237.3	205	NA	NA	NA	219.9	199	206	0.07327	17.38	6	0.00797
CUSCO	a30.39	204.6	206	NA	NA	NA	178.2	200	207	0.1293	26.46	6	0.00018
CUSCO	a40.49	374.3	210	NA	NA	NA	308.7	204	211	0.1752	65.56	6	3.319e-12
CUSCO	a50.59	496.7	210	NA	NA	NA	341.4	204	211	0.3127	155.3	6	5.88e-31
CUSCO	a60.69	863.2	211	NA	NA	NA	409.1	205	212	0.5261	454.1	6	6.342e-95
CUSCO	a70.79	745.5	211	NA	NA	NA	366.5	205	212	0.5084	379	6	9.061e-79
CUSCO	a80	968.5	211	NA	NA	NA	455.5	205	212	0.5297	513	6	1.302e-107
HUANCAVELICA	a0.9	180.1	200	NA	NA	NA	170.5	194	201	0.05377	9.686	6	0.1385
HUANCAVELICA	a10.19	79.24	135	NA	NA	NA	74.69	129	136	0.05741	4.549	6	0.6028
HUANCAVELICA	a20.29	68.08	146	NA	NA	NA	61.39	140	147	0.09825	6.689	6	0.3506
HUANCAVELICA	a30.39	79.13	159	NA	NA	NA	77.18	153	160	0.02467	1.952	6	0.924
HUANCAVELICA	a40.49	158	176	NA	NA	NA	138.2	170	177	0.1251	19.76	6	0.00305
HUANCAVELICA	a50.59	210.3	199	NA	NA	NA	182.4	193	200	0.1325	27.86	6	0.00009
HUANCAVELICA	a60.69	289.6	206	NA	NA	NA	225	200	207	0.2232	64.64	6	5.109e-12
HUANCAVELICA	a70.79	383.5	210	NA	NA	NA	283.4	204	211	0.261	100.1	6	2.39e-19
HUANCAVELICA	a80	283	209	NA	NA	NA	241.9	203	210	0.1452	41.1	6	2.767e-07

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
HUANUCO	a0.9	197.9	207	NA	NA	NA	178.9	201	208	0.09617	19.03	6	0.00410
HUANUCO	a10.19	98.72	161	NA	NA	NA	92.18	155	162	0.06624	6.539	6	0.3655
HUANUCO	a20.29	118.3	190	NA	NA	NA	113.7	184	191	0.03885	4.594	6	0.5969
HUANUCO	a30.39	177.5	194	NA	NA	NA	169.8	188	195	0.04327	7.68	6	0.2625
HUANUCO	a40.49	248.7	204	NA	NA	NA	223	198	205	0.1033	25.7	6	0.00025
HUANUCO	a50.59	335.8	210	NA	NA	NA	280.7	204	211	0.1642	55.13	6	4.354e-10
HUANUCO	a60.69	450.2	210	NA	NA	NA	258.3	204	211	0.4262	191.9	6	1.019e-38
HUANUCO	a70.79	423	211	NA	NA	NA	293	205	212	0.3072	130	6	1.315e-25
HUANUCO	a80	399.5	210	NA	NA	NA	296.2	204	211	0.2585	103.3	6	5.162e-20
ICA	a0.9	176.6	204	NA	NA	NA	172.4	198	205	0.02426	4.285	6	0.6382
ICA	a10.19	55.59	133	NA	NA	NA	49.71	127	134	0.1058	5.884	6	0.4363
ICA	a20.29	157.8	191	NA	NA	NA	146.6	185	192	0.0705	11.12	6	0.08467
ICA	a30.39	225.2	199	NA	NA	NA	179.6	193	200	0.2026	45.62	6	3.521e-08
ICA	a40.49	547.1	206	NA	NA	NA	236	200	207	0.5686	311.1	6	3.424e-64
ICA	a50.59	1065	211	NA	NA	NA	298.8	205	212	0.7195	766.4	6	2.843e-162
ICA	a60.69	1750	211	NA	NA	NA	354.4	205	212	0.7975	1395	6	2.573e-298
ICA	a70.79	1184	209	NA	NA	NA	392.6	203	210	0.6684	791.3	6	1.185e-167
ICA	a80	1048	210	NA	NA	NA	444.7	204	211	0.5758	603.7	6	3.723e-127
JUNIN	a0.9	250.7	211	NA	NA	NA	242.6	205	212	0.03244	8.132	6	0.2286
JUNIN	a10.19	136.6	192	NA	NA	NA	131.6	186	193	0.03684	5.032	6	0.5398
JUNIN	a20.29	203.9	208	NA	NA	NA	192.2	202	209	0.05719	11.66	6	0.06997
JUNIN	a30.39	255.6	209	NA	NA	NA	241.5	203	210	0.05546	14.18	6	0.02771
JUNIN	a40.49	446.4	210	NA	NA	NA	299.5	204	211	0.329	146.9	6	3.543e-29
JUNIN	a50.59	824.6	211	NA	NA	NA	300.3	205	212	0.6358	524.2	6	5.079e-110
JUNIN	a60.69	1085	211	NA	NA	NA	366.7	205	212	0.662	718.2	6	7.065e-152
JUNIN	a70.79	907.6	211	NA	NA	NA	370.2	205	212	0.5921	537.4	6	7.476e-113
JUNIN	a80	929	211	NA	NA	NA	451.9	205	212	0.5135	477.1	6	7.343e-100
LA LIBERTAD	a0.9	250.4	209	NA	NA	NA	231.7	203	210	0.07484	18.74	6	0.00462
LA LIBERTAD	a10.19	181	190	NA	NA	NA	172.1	184	191	0.0492	8.905	6	0.179
LA LIBERTAD	a20.29	244.2	208	NA	NA	NA	233.6	202	209	0.04356	10.64	6	0.1003
LA LIBERTAD	a30.39	270.6	210	NA	NA	NA	235.5	204	211	0.1296	35.06	6	4.203e-06
LA LIBERTAD	a40.49	567.4	210	NA	NA	NA	335.8	204	211	0.4082	231.6	6	3.541e-47

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
LA LIBERTAD	a50.59	1518	211	NA	NA	NA	432.6	205	212	0.715	1085	6	3.217e-231
LA LIBERTAD	a60.69	2366	211	NA	NA	NA	463.6	205	212	0.8041	1903	6	0
LA LIBERTAD	a70.79	2050	211	NA	NA	NA	454.6	205	212	0.7783	1596	6	0
LA LIBERTAD	a80	1492	211	NA	NA	NA	520.2	205	212	0.6515	972.2	6	9.102e-207
LAMBAYEQUE	a0.9	350.2	182	NA	NA	NA	168.1	176	183	0.5199	182.1	6	1.239e-36
LAMBAYEQUE	a10.19	60.08	114	NA	NA	NA	50.58	108	115	0.1583	9.509	6	0.1469
LAMBAYEQUE	a20.29	150.1	163	NA	NA	NA	106.9	157	164	0.288	43.24	6	1.045e-07
LAMBAYEQUE	a30.39	203	176	NA	NA	NA	138.7	170	177	0.3168	64.3	6	5.989e-12
LAMBAYEQUE	a40.49	571.5	182	NA	NA	NA	280.5	176	183	0.5093	291.1	6	6.656e-60
LAMBAYEQUE	a50.59	1090	186	NA	NA	NA	287	180	187	0.7367	802.8	6	3.85e-170
LAMBAYEQUE	a60.69	2064	198	NA	NA	NA	376.2	192	199	0.8177	1687	6	0
LAMBAYEQUE	a70.79	2191	203	NA	NA	NA	407.5	197	204	0.814	1783	6	0
LAMBAYEQUE	a80	3716	205	NA	NA	NA	523.4	199	206	0.8592	3193	6	0
LIMA	a0.9	463.5	211	NA	NA	NA	381.5	205	212	0.1769	82.01	6	1.37e-15
LIMA	a10.19	282.5	211	NA	NA	NA	249.6	205	212	0.1165	32.9	6	0.00001
LIMA	a20.29	497.2	211	NA	NA	NA	397.1	205	212	0.2014	100.2	6	2.316e-19
LIMA	a30.39	1413	211	NA	NA	NA	417.9	205	212	0.7043	995.4	6	8.86e-212
LIMA	a40.49	5115	211	NA	NA	NA	484.2	205	212	0.9053	4631	6	0
LIMA	a50.59	12694	211	NA	NA	NA	813.8	205	212	0.9359	11880	6	0
LIMA	a60.69	20998	211	NA	NA	NA	1062	205	212	0.9494	19936	6	0
LIMA	a70.79	18227	211	NA	NA	NA	1162	205	212	0.9362	17065	6	0
LIMA	a80	15668	211	NA	NA	NA	1500	205	212	0.9042	14167	6	0
LORETO	a0.9	249	209	NA	NA	NA	239.4	203	210	0.03849	9.583	6	0.1434
LORETO	a10.19	79.99	150	NA	NA	NA	75.03	144	151	0.06197	4.957	6	0.5494
LORETO	a20.29	143.8	191	NA	NA	NA	137.1	185	192	0.04696	6.755	6	0.3441
LORETO	a30.39	218.4	199	NA	NA	NA	178.1	193	200	0.1846	40.31	6	3.964e-07
LORETO	a40.49	447.8	206	NA	NA	NA	251.1	200	207	0.4391	196.6	6	1.001e-39
LORETO	a50.59	857.3	208	NA	NA	NA	348.5	202	209	0.5935	508.9	6	1.038e-106
LORETO	a60.69	1598	210	NA	NA	NA	402.3	204	211	0.7482	1196	6	3.809e-255
LORETO	a70.79	1387	210	NA	NA	NA	399	204	211	0.7123	987.9	6	3.709e-210
LORETO	a80	866.2	210	NA	NA	NA	384.4	204	211	0.5562	481.8	6	7.119e-101
MADRE DE DIOS	a0.9	74.38	132	NA	NA	NA	64.89	126	133	0.1277	9.495	6	0.1476

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
MADRE DE DIOS	a10.19	20.02	80	NA	NA	NA	18.57	74	81	0.07268	1.455	6	0.9624
MADRE DE DIOS	a20.29	72.1	153	NA	NA	NA	68.6	147	154	0.04849	3.496	6	0.7445
MADRE DE DIOS	a30.39	69.1	140	NA	NA	NA	65	134	141	0.05943	4.107	6	0.6622
MADRE DE DIOS	a40.49	93.59	149	NA	NA	NA	80.19	143	150	0.1432	13.4	6	0.03707
MADRE DE DIOS	a50.59	217.3	165	NA	NA	NA	128.2	159	166	0.4099	89.09	6	4.674e-17
MADRE DE DIOS	a60.69	262.2	176	NA	NA	NA	140.2	170	177	0.4655	122.1	6	6.002e-24
MADRE DE DIOS	a70.79	202.9	172	NA	NA	NA	124.5	166	173	0.3863	78.37	6	7.77e-15
MADRE DE DIOS	a80	174	176	NA	NA	NA	119.8	170	177	0.3115	54.19	6	6.762e-10
MOQUEGUA	a0.9	19.28	77	NA	NA	NA	17.95	71	78	0.06896	1.329	6	0.97
MOQUEGUA	a10.19	4.309	39	NA	NA	NA	3.837	33	40	0.1096	0.4721	6	0.9982
MOQUEGUA	a20.29	17.29	82	NA	NA	NA	15.32	76	83	0.1138	1.967	6	0.9227
MOQUEGUA	a30.39	16.74	79	NA	NA	NA	16.19	73	80	0.03268	0.5468	6	0.9972
MOQUEGUA	a40.49	92.24	123	NA	NA	NA	60.59	117	124	0.3431	31.64	6	0.00001
MOQUEGUA	a50.59	253.6	157	NA	NA	NA	108.5	151	158	0.5722	145.1	6	8.333e-29
MOQUEGUA	a60.69	556	186	NA	NA	NA	214.4	180	187	0.6144	341.6	6	9.672e-71
MOQUEGUA	a70.79	718.1	203	NA	NA	NA	259.1	197	204	0.6392	459	6	5.739e-96
MOQUEGUA	a80	530.2	209	NA	NA	NA	255	203	210	0.5191	275.2	6	1.67e-56
PASCO	a0.9	69.04	140	NA	NA	NA	59.47	134	141	0.1386	9.57	6	0.144
PASCO	a10.19	14.4	60	NA	NA	NA	12.54	54	61	0.1295	1.865	6	0.9317
PASCO	a20.29	31.61	101	NA	NA	NA	28.9	95	102	0.08596	2.718	6	0.8434
PASCO	a30.39	49.05	105	NA	NA	NA	46.53	99	106	0.05121	2.512	6	0.8671
PASCO	a40.49	58.92	131	NA	NA	NA	49.41	125	132	0.1614	9.508	6	0.147
PASCO	a50.59	138.3	163	NA	NA	NA	92.35	157	164	0.3324	45.97	6	3.002e-08
PASCO	a60.69	211.9	169	NA	NA	NA	134.9	163	170	0.3634	77.02	6	1.469e-14
PASCO	a70.79	243.2	192	NA	NA	NA	180.2	186	193	0.2589	62.96	6	1.123e-11
PASCO	a80	291.5	196	NA	NA	NA	234.5	190	197	0.1954	56.97	6	1.856e-10
PIURA	a0.9	270.7	209	NA	NA	NA	243.1	203	210	0.1017	27.54	6	0.00011
PIURA	a10.19	111	169	NA	NA	NA	105.1	163	170	0.05287	5.868	6	0.4381
PIURA	a20.29	226.6	200	NA	NA	NA	191.7	194	201	0.1539	34.88	6	4.543e-06
PIURA	a30.39	359.6	206	NA	NA	NA	224.5	200	207	0.3756	135.1	6	1.098e-26
PIURA	a40.49	935.7	207	NA	NA	NA	348.3	201	208	0.6278	587.4	6	1.188e-123
PIURA	a50.59	1661	211	NA	NA	NA	360.1	205	212	0.7832	1301	6	7.442e-278

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
PIURA	a60.69	3278	211	NA	NA	NA	458.5	205	212	0.8601	2820	6	0
PIURA	a70.79	2489	211	NA	NA	NA	430.9	205	212	0.8269	2058	6	0
PIURA	a80	1948	211	NA	NA	NA	586.2	205	212	0.699	1361	6	5.291e-291
PUNO	a0.9	265.3	209	NA	NA	NA	215.7	203	210	0.1869	49.59	6	5.691e-09
PUNO	a10.19	135.9	185	NA	NA	NA	130.9	179	186	0.03661	4.977	6	0.5468
PUNO	a20.29	217.2	206	NA	NA	NA	212.4	200	207	0.02212	4.804	6	0.5692
PUNO	a30.39	278.8	207	NA	NA	NA	272.7	201	208	0.02196	6.121	6	0.4098
PUNO	a40.49	403	210	NA	NA	NA	296.6	204	211	0.264	106.4	6	1.166e-20
PUNO	a50.59	752.1	210	NA	NA	NA	342.7	204	211	0.5443	409.4	6	2.654e-85
PUNO	a60.69	1015	211	NA	NA	NA	342.8	205	212	0.6622	671.9	6	7.014e-142
PUNO	a70.79	926.8	211	NA	NA	NA	356.3	205	212	0.6156	570.6	6	5.204e-120
PUNO	a80	857.7	211	NA	NA	NA	455.9	205	212	0.4685	401.8	6	1.158e-83
SAN MARTIN	a0.9	213.3	206	NA	NA	NA	193.4	200	207	0.09295	19.82	6	0.00297
SAN MARTIN	a10.19	95.47	152	NA	NA	NA	89.04	146	153	0.06737	6.431	6	0.3766
SAN MARTIN	a20.29	120	188	NA	NA	NA	112.7	182	189	0.06044	7.25	6	0.2983
SAN MARTIN	a30.39	204.7	205	NA	NA	NA	174.1	199	206	0.1499	30.69	6	0.00002
SAN MARTIN	a40.49	327.1	208	NA	NA	NA	239.7	202	209	0.2671	87.36	6	1.068e-16
SAN MARTIN	a50.59	502	207	NA	NA	NA	287.3	201	208	0.4278	214.7	6	1.374e-43
SAN MARTIN	a60.69	815.9	211	NA	NA	NA	334.5	205	212	0.59	481.4	6	8.727e-101
SAN MARTIN	a70.79	605.2	210	NA	NA	NA	305.6	204	211	0.4949	299.5	6	1.04e-61
SAN MARTIN	a80	815.5	211	NA	NA	NA	382.6	205	212	0.5308	432.9	6	2.351e-90
TACNA	a0.9	54.88	128	NA	NA	NA	49.48	122	129	0.09839	5.4	6	0.4936
TACNA	a10.19	4.114	66	NA	NA	NA	3.482	60	67	0.1535	0.6314	6	0.9959
TACNA	a20.29	47.15	125	NA	NA	NA	43.83	119	126	0.07035	3.317	6	0.7681
TACNA	a30.39	91.16	155	NA	NA	NA	88.77	149	156	0.02618	2.387	6	0.8809
TACNA	a40.49	161	174	NA	NA	NA	128.6	168	175	0.201	32.36	6	0.00001
TACNA	a50.59	347.6	191	NA	NA	NA	212.8	185	192	0.3879	134.8	6	1.239e-26
TACNA	a60.69	602.6	201	NA	NA	NA	293.5	195	202	0.5129	309.1	6	9.249e-64
TACNA	a70.79	453.1	209	NA	NA	NA	273.2	203	210	0.3971	179.9	6	3.53e-36
TACNA	a80	360.2	209	NA	NA	NA	312.5	203	210	0.1324	47.7	6	1.354e-08
TUMBES	a0.9	57.83	131	NA	NA	NA	56.4	125	132	0.02475	1.431	6	0.9639
TUMBES	a10.19	5.142	58	NA	NA	NA	4.129	52	59	0.1969	1.013	6	0.9851

Departamento	range	null.deviance	df.null	logLik	AIC	BIC	deviance	df.residual	nobs	fit	dif.dev	df	p
TUMBES	a20.29	29.23	109	NA	NA	NA	27.67	103	110	0.05337	1.56	6	0.9554
TUMBES	a30.39	53.22	130	NA	NA	NA	48.04	124	131	0.09742	5.185	6	0.5203
TUMBES	a40.49	98.7	152	NA	NA	NA	77.51	146	153	0.2148	21.2	6	0.00169
TUMBES	a50.59	274.3	179	NA	NA	NA	151.5	173	180	0.4475	122.7	6	4.357e-24
TUMBES	a60.69	472.5	191	NA	NA	NA	214.4	185	192	0.5462	258.1	6	7.579e-53
TUMBES	a70.79	375.1	197	NA	NA	NA	224.3	191	198	0.402	150.8	6	5.234e-30
TUMBES	a80	398.4	210	NA	NA	NA	256	204	211	0.3575	142.4	6	3.067e-28
UCAYALI	a0.9	189.3	193	NA	NA	NA	158.6	187	194	0.162	30.65	6	0.00002
UCAYALI	a10.19	43.62	126	NA	NA	NA	41.36	120	127	0.05167	2.254	6	0.8949
UCAYALI	a20.29	141	174	NA	NA	NA	131.5	168	175	0.06747	9.512	6	0.1468
UCAYALI	a30.39	170.5	177	NA	NA	NA	150.9	171	178	0.1147	19.54	6	0.00333
UCAYALI	a40.49	255.5	202	NA	NA	NA	221	196	203	0.1348	34.43	6	5.548e-06
UCAYALI	a50.59	518	205	NA	NA	NA	287.8	199	206	0.4443	230.1	6	7.143e-47
UCAYALI	a60.69	747.7	210	NA	NA	NA	345.2	204	211	0.5383	402.5	6	8.098e-84
UCAYALI	a70.79	899.3	206	NA	NA	NA	304.6	200	207	0.6613	594.7	6	3.206e-125
UCAYALI	a80	630	209	NA	NA	NA	343.5	203	210	0.4548	286.6	6	6.198e-59

12.1.2 Under-registration rates

Table 6: Under-registration rates

Departamento	sub.mean
ICA	99.85
MADRE DE DIOS	99.18
AREQUIPA	94.78
ANCASH	85.11
TUMBES	85.03
JUNIN	82.28
MOQUEGUA	82.13
CUSCO	80.77
LA LIBERTAD	80.41
HUANCAVELICA	77.72
CALLAO	77.51
TACNA	74.43
PUNO	62.26
UCAYALI	61.77
LIMA	58.08
APURIMAC	57
SAN MARTIN	51.55
AYACUCHO	50.54
PIURA	49.47
HUANUCO	46.6

Departamento	sub.mean
PASCO	40.59
LORETO	32.12
CAJAMARCA	28.46
AMAZONAS	28.02
LAMBAYEQUE	11.86

12.1.3 Age-standardised deaths rates

Table 7: Age-standardised deaths rates

Departamento	adj.rate	lci	uci	crude.rate	2010	2015	Difference
AMAZONAS	4.578	4.378	4.786	4.583	6.05	6.19	-1.607
ANCASH	8.46	8.295	8.628	8.435	6.09	6.15	2.285
APURIMAC	6.746	6.512	6.985	7.325	6.76	6.61	0.7147
AREQUIPA	9.038	8.879	9.2	8.197	5.53	5.8	2.397
AYACUCHO	5.338	5.171	5.509	5.797	6.15	5.91	-0.113
CAJAMARCA	5.796	5.677	5.918	6.158	5.39	5.5	0.6578
CALLAO	11.03	10.83	11.23	10.56	4.91	5.27	5.285
CUSCO	6.857	6.718	6.998	6.833	6.88	6.97	-0.1367
HUANCAVELICA	5.81	5.603	6.023	8.139	5.83	5.54	2.599
HUANUCO	7.016	6.842	7.192	8.202	5.94	5.98	2.222
ICA	9.491	9.282	9.703	8.029	4.99	5.29	2.739
JUNIN	7.251	7.11	7.393	7.447	6.17	6.24	1.207
LA LIBERTAD	7.681	7.559	7.804	7.516	5.24	5.39	2.126
LAMBAYEQUE	7.47	7.322	7.619	7.464	5.25	5.55	1.914
LIMA	11.42	11.36	11.49	11.4	5.13	5.4	6.002
LORETO	6.965	6.809	7.124	7.357	4.92	5.07	2.287
MADRE DE DIOS	7.395	6.97	7.838	6.516	4.4	4.54	1.976
MOQUEGUA	9.58	9.145	10.03	9.429	5.49	5.86	3.569
PASCO	6.705	6.422	6.997	7.76	5.54	5.54	2.22
PIURA	8.935	8.802	9.07	8.352	5.36	5.5	2.852
PUNO	6.589	6.459	6.721	7.906	7.01	6.86	1.046
SAN MARTIN	7.141	6.967	7.318	7.1	5.47	5.63	1.47
TACNA	6.12	5.868	6.38	5.977	5.09	5.4	0.5771
TUMBES	8.178	7.828	8.539	8.173	4.7	4.94	3.233
UCAYALI	8.267	8.022	8.517	7.34	5.68	5.93	1.41

12.1.4 Counterfacutual and total deaths 2020

Table 8: Counterfacutual and total deaths 2020

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.reg	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
AMAZONAS	18.9	60	0	0	0	0	0	0	60	60	60	103.2	103.2	10
AMAZONAS	19.19	22	3.953	3.953	3.953	0	0	0	22	22	22	41.79	41.79	41
AMAZONAS	19.29	36	3.544	3.544	3.544	0	0	0	36	36	36	65.46	65.46	65
AMAZONAS	19.39	60	14.01	14.01	14.01	0	0	0	60	60	60	117.2	117.2	11
AMAZONAS	19.49	83	9.918	9.918	9.918	0	0	0	83	83	83	152.7	152.7	15
AMAZONAS	19.59	123	0	0	0	0	0	0	123	123	123	211.5	211.5	21
AMAZONAS	19.69	199	128.3	67.9	163.4	74.62	39.48	95.03	124.4	104	159.5	342.2	246.7	43

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.rege	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
AMAZONAS	a0.79	199	119.5	52.58	157.3	69.46	30.57	91.48	129.5	107.5	168.4	342.2	237.5	4
AMAZONAS	a80	337	0	0	0	0	0	0	337	337	337	579.6	579.6	57
ANCASH	a0.9	243	56.96	56.96	56.96	0	0	0	243	243	243	336.1	336.1	33
ANCASH	a10.19	101	1.879	1.879	1.879	0	0	0	101	101	101	117.9	117.9	11
ANCASH	a20.29	163	0	0	0	0	0	0	163	163	163	187.3	187.3	18
ANCASH	a30.39	224	44.37	44.37	44.37	0	0	0	224	224	224	301.7	301.7	30
ANCASH	a40.49	471	209.4	152.4	249.2	182.3	132.7	216.9	288.7	254.1	338.3	541.1	444.3	63
ANCASH	a50.59	892	545.7	491	588.2	475	427.4	512	417	380	464.6	1025	927.5	1
ANCASH	a60.69	1391	982.2	939.9	1018	855	818.1	886.2	536	504.8	572.9	1598	1520	1
ANCASH	a70.79	1960	1118	1035	1188	973.6	901.2	1034	986.4	925.7	1059	2252	2099	2
ANCASH	a80	3133	859	622	1053	747.7	541.4	916.2	2385	2217	2592	3599	3169	4
APURIMAC	a0.9	100	17.71	17.71	17.71	0	0	0	100	100	100	160.7	160.7	16
APURIMAC	a10.19	51	0	0	0	0	0	0	51	51	51	72.93	72.93	72
APURIMAC	a20.29	64	0	0	0	0	0	0	64	64	64	91.52	91.52	91
APURIMAC	a30.39	73	0	0	0	0	0	0	73	73	73	104.4	104.4	10
APURIMAC	a40.49	119	0	0	0	0	0	0	119	119	119	170.2	170.2	17
APURIMAC	a50.59	200	95.48	50	123.8	66.77	34.97	86.59	133.2	113.4	165	286	212.2	35
APURIMAC	a60.69	275	120.3	45.41	164.5	84.11	31.76	115	190.9	160	243.2	393.2	274.2	51
APURIMAC	a70.79	449	212.1	130.8	267.7	148.4	91.46	187.2	300.6	261.8	357.5	642	505.1	7
APURIMAC	a80	863	303.2	163.7	405	212	114.5	283.2	651	579.8	748.5	1234	992.8	14
AREQUIPA	a0.9	216	0.6139	-199.5	73.5	-64.88	-255.1	4.389	280.9	211.6	471.1	296.2	23.12	56
AREQUIPA	a10.19	98	5.555	-189.6	51.69	-46.86	-232.3	-3.006	144.9	101	330.3	158	-83.31	39
AREQUIPA	a20.29	232	22.9	22.9	22.9	0	0	0	232	232	232	267	267	2
AREQUIPA	a30.39	329	0	0	0	0	0	0	329	329	329	346.2	346.2	34
AREQUIPA	a40.49	662	303.9	248.1	344.8	288.8	235.8	327.7	373.2	334.3	426.2	696.5	599.8	79
AREQUIPA	a50.59	1213	657.1	599.8	703.5	624.5	570.1	668.6	588.5	544.4	642.9	1276	1173	13
AREQUIPA	a60.69	1990	1236	1174	1288	1175	1116	1224	815.4	765.7	874.2	2094	1980	2
AREQUIPA	a70.79	2480	1269	1163	1357	1206	1106	1290	1274	1190	1374	2609	2415	28
AREQUIPA	a80	4307	1828	1650	1980	1737	1568	1882	2570	2425	2739	4532	4202	48
AYACUCHO	a0.9	122	48.86	48.86	48.86	0	0	0	122	122	122	231.2	231.2	23
AYACUCHO	a10.19	62	0	0	0	0	0	0	62	62	62	92.66	92.66	92
AYACUCHO	a20.29	95	2.545	2.545	2.545	0	0	0	95	95	95	144.5	144.5	14
AYACUCHO	a30.39	100	0	0	0	0	0	0	100	100	100	149.5	149.5	14
AYACUCHO	a40.49	161	12.44	12.44	12.44	0	0	0	161	161	161	253.1	253.1	25
AYACUCHO	a50.59	214	0	0	0	0	0	0	214	214	214	319.8	319.8	31
AYACUCHO	a60.69	373	37.47	37.47	37.47	0	0	0	373	373	373	594.9	594.9	59
AYACUCHO	a70.79	554	296	201.9	361.2	198.1	135.1	241.7	355.9	312.3	418.9	828	668.7	98
AYACUCHO	a80	843	257	90.2	374.8	172	60.35	250.7	671	592.3	782.6	1260	975.4	15
CAJAMARCA	a0.9	232	-98.92	-857.1	91.3	-141.1	-583	-30.17	373.1	262.2	815	541	-407.4	14
CAJAMARCA	a10.19	75	18.63	18.63	18.63	0	0	0	75	75	75	147.3	147.3	14
CAJAMARCA	a20.29	128	-30.21	-360.6	58.14	-50.62	-243.2	0.8895	178.6	127.1	371.2	276.2	-142.6	69
CAJAMARCA	a30.39	207	0	0	0	0	0	0	207	207	207	355.1	355.1	35
CAJAMARCA	a40.49	294	0	0	0	0	0	0	294	294	294	504.3	504.3	50
CAJAMARCA	a50.59	539	309	188.9	389.8	180.1	110.1	227.2	358.9	311.8	428.9	924.6	723.7	1
CAJAMARCA	a60.69	793	661.6	567.9	731.8	385.7	331.1	426.6	407.3	366.4	461.9	1360	1196	1
CAJAMARCA	a70.79	1071	694.9	568	793.5	405.1	331.1	462.5	665.9	608.5	739.9	1837	1612	2
CAJAMARCA	a80	1752	892.6	685.5	1058	520.4	399.6	616.6	1232	1135	1352	3005	2633	3
CALLAO	a0.9	156	1.395	1.395	1.395	0	0	0	156	156	156	192.5	192.5	19
CALLAO	a10.19	49	3.393	3.393	3.393	0	0	0	49	49	49	63.41	63.41	63

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.rege	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
CALLAO	a20.29	185	34.73	34.73	34.73	0	0	0	185	185	185	261.3	261.3	26
CALLAO	a30.39	319	0	0	0	0	0	0	319	319	319	390.7	390.7	39
CALLAO	a40.49	641	489	456.6	514.4	399.2	372.8	420	241.8	221	268.2	785.2	727.3	8
CALLAO	a50.59	1192	1028	1002	1050	839	818.3	856.9	353	335.1	373.7	1460	1413	1
CALLAO	a60.69	1958	1563	1511	1608	1276	1233	1313	682	645.4	724.5	2398	2301	2
CALLAO	a70.79	2222	1774	1724	1817	1448	1408	1484	774	738.3	814.5	2722	2628	2
CALLAO	a80	2982	1855	1745	1949	1514	1425	1591	1468	1391	1557	3653	3449	3
CUSCO	a0.9	354	71.1	71.1	71.1	0	0	0	354	354	354	493.2	493.2	49
CUSCO	a10.19	178	14.64	14.64	14.64	0	0	0	178	178	178	226.9	226.9	22
CUSCO	a20.29	246	56.02	56.02	56.02	0	0	0	246	246	246	349.3	349.3	34
CUSCO	a30.39	319	0	0	0	0	0	0	319	319	319	380.3	380.3	38
CUSCO	a40.49	519	0	0	0	0	0	0	519	519	519	618.8	618.8	61
CUSCO	a50.59	789	212.3	80.46	302.6	178.1	67.49	253.8	610.9	535.2	721.5	940.7	718.6	1
CUSCO	a60.69	1193	421	266.4	532.5	353.1	223.5	446.6	839.9	746.4	969.5	1422	1156	1
CUSCO	a70.79	1610	304.5	87.73	466.1	255.4	73.58	390.9	1355	1219	1536	1920	1541	2
CUSCO	a80	2451	714.2	483.5	896.5	599	405.5	751.9	1852	1699	2045	2922	2509	3
HUANCAVELICA	a0.9	141	0	0	0	0	0	0	141	141	141	172.4	172.4	17
HUANCAVELICA	a10.19	60	0.1187	0.1187	0.1187	0	0	0	60	60	60	73.49	73.49	73
HUANCAVELICA	a20.29	76	0	0	0	0	0	0	76	76	76	92.94	92.94	92
HUANCAVELICA	a30.39	79	7.968	7.968	7.968	0	0	0	79	79	79	104.6	104.6	10
HUANCAVELICA	a40.49	152	0	0	0	0	0	0	152	152	152	185.9	185.9	18
HUANCAVELICA	a50.59	232	0	0	0	0	0	0	232	232	232	283.7	283.7	28
HUANCAVELICA	a60.69	355	202.4	165.7	228.5	165.5	135.5	186.9	189.5	168.1	219.5	434.1	371.3	49
HUANCAVELICA	a70.79	548	271.4	210.5	315.2	221.9	172.1	257.7	326.1	290.3	375.9	670.1	565.4	77
HUANCAVELICA	a80	782	0	0	0	0	0	0	782	782	782	956.3	956.3	95
HUANUCO	a0.9	187	39.3	39.3	39.3	0	0	0	187	187	187	326.2	326.2	32
HUANUCO	a10.19	71	0	0	0	0	0	0	71	71	71	108.9	108.9	10
HUANUCO	a20.29	125	0	0	0	0	0	0	125	125	125	191.8	191.8	19
HUANUCO	a30.39	166	1.915	1.915	1.915	0	0	0	166	166	166	256.6	256.6	25
HUANUCO	a40.49	267	0	0	0	0	0	0	267	267	267	409.6	409.6	40
HUANUCO	a50.59	411	168.5	60.39	236.4	109.8	39.37	154.1	301.2	256.9	371.6	630.5	454.5	80
HUANUCO	a60.69	670	384.8	294	451.7	250.9	191.6	294.4	419.1	375.6	478.4	1028	870.1	1
HUANUCO	a70.79	908	318.4	160.2	433.4	207.6	104.4	282.5	700.4	625.5	803.6	1393	1120	1
HUANUCO	a80	1233	426	243.2	564.5	277.7	158.5	368	955.3	865	1074	1891	1570	2
ICA	a0.9	170	26.85	26.85	26.85	0	0	0	170	170	170	197.1	197.1	19
ICA	a10.19	52	4.948	4.948	4.948	0	0	0	52	52	52	57.02	57.02	57
ICA	a20.29	163	25.05	25.05	25.05	0	0	0	163	163	163	188.3	188.3	18
ICA	a30.39	256	77.51	41.01	101.1	77.4	40.95	100.9	178.6	155.1	215.1	256.4	196.3	31
ICA	a40.49	527	250.1	214.2	277.1	249.8	213.9	276.7	277.2	250.3	313.1	527.8	464.9	59
ICA	a50.59	967	559.6	527	586.6	558.8	526.2	585.7	408.2	381.3	440.8	968.4	908.8	1
ICA	a60.69	1468	1032	1008	1053	1031	1006	1052	437.4	416	461.9	1470	1424	1
ICA	a70.79	1638	705.6	614.8	778.5	704.6	613.9	777.3	933.4	860.7	1024	1640	1477	1
ICA	a80	2521	996	868.7	1101	994.5	867.4	1099	1526	1422	1654	2525	2292	2
JUNIN	a0.9	372	36.27	36.27	36.27	0	0	0	372	372	372	474.2	474.2	47
JUNIN	a10.19	151	24	24	24	0	0	0	151	151	151	201.8	201.8	20
JUNIN	a20.29	219	39.56	39.56	39.56	0	0	0	219	219	219	297.4	297.4	29
JUNIN	a30.39	322	20.98	20.98	20.98	0	0	0	322	322	322	400.1	400.1	40
JUNIN	a40.49	553	292.2	237.3	331.8	248.2	201.5	281.8	304.8	271.2	351.5	651	556.5	74
JUNIN	a50.59	947	463.9	384	525.1	394.1	326.1	446	552.9	501	620.9	1115	973.7	1
JUNIN	a60.69	1394	708.5	615.2	782.8	601.9	522.6	665	792.1	729	871.4	1641	1473	1
JUNIN	a70.79	1806	789.4	665.1	889.7	670.6	565	755.8	1135	1050	1241	2126	1902	2
JUNIN	a80	2746	797.2	574.7	977	677.2	488.2	829.9	2069	1916	2258	3233	2830	3

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.reg	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
LA LIBERTAD	a0.9	334	36.34	36.34	36.34	0	0	0	334	334	334	435.8	435.8	43
LA LIBERTAD	a10.19	142	0	0	0	0	0	0	142	142	142	169.8	169.8	16
LA LIBERTAD	a20.29	297	31.73	31.73	31.73	0	0	0	297	297	297	386.9	386.9	38
LA LIBERTAD	a30.39	409	141.4	77.26	184.8	118.2	64.6	154.6	290.8	254.4	344.4	489.1	381.6	59
LA LIBERTAD	a40.49	743	398.9	332	448.5	333.6	277.6	375.1	409.4	367.9	465.4	888.6	772.1	10
LA LIBERTAD	a50.59	1443	1017	961	1063	850.3	803.5	889.1	592.7	553.9	639.5	1726	1623	18
LA LIBERTAD	a60.69	2323	1581	1503	1647	1322	1257	1377	1001	945.7	1066	2778	2634	29
LA LIBERTAD	a70.79	2871	1848	1752	1931	1545	1465	1615	1326	1256	1406	3434	3254	30
LA LIBERTAD	a80	4055	1734	1524	1913	1450	1274	1599	2605	2456	2781	4850	4461	51
LAMBAYEQUE	a0.9	81	0.01314	0.01314	0.01314	0	0	0	81	81	81	152.4	152.4	15
LAMBAYEQUE	a10.19	29	22.72	11.68	28.28	12.08	6.21	15.03	16.92	13.97	22.79	54.56	37.96	71
LAMBAYEQUE	a20.29	90	67.26	33.33	85.76	35.75	17.72	45.58	54.25	44.42	72.28	169.3	116.9	22
LAMBAYEQUE	a30.39	175	184	164.6	198	97.78	87.51	105.3	77.22	69.74	87.49	329.2	295.9	36
LAMBAYEQUE	a40.49	368	560.9	550.4	569.5	298.1	292.6	302.7	69.88	65.29	75.44	692.4	673.2	71
LAMBAYEQUE	a50.59	734	1223	1216	1228	649.8	646.5	652.8	84.18	81.2	87.46	1381	1369	13
LAMBAYEQUE	a60.69	1231	2013	2004	2021	1070	1065	1074	161.2	156.8	166.1	2316	2299	23
LAMBAYEQUE	a70.79	1194	1963	1954	1972	1043	1038	1048	150.6	146	155.6	2246	2228	23
LAMBAYEQUE	a80	1298	1921	1897	1941	1021	1009	1032	277.2	266.2	289.5	2442	2398	24
LIMA	a0.9	1374	69.06	69.06	69.06	0	0	0	1374	1374	1374	2019	2019	20
LIMA	a10.19	483	0	0	0	0	0	0	483	483	483	685.5	685.5	68
LIMA	a20.29	1297	294.4	69.31	457.7	207.4	48.84	322.5	1090	974.5	1248	1841	1452	22
LIMA	a30.39	2631	1561	1409	1689	1100	992.7	1190	1531	1441	1638	3734	3454	40
LIMA	a40.49	5419	4928	4829	5019	3472	3402	3536	1947	1883	2017	7691	7501	78
LIMA	a50.59	10548	10270	10128	10401	7236	7136	7329	3312	3219	3412	14970	14697	15
LIMA	a60.69	17129	16617	16397	16822	11708	11554	11852	5421	5277	5575	24310	23886	24
LIMA	a70.79	19325	16736	16399	17047	11792	11555	12011	7533	7314	7770	27427	26779	28
LIMA	a80	27134	16950	16112	17712	11943	11353	12480	15191	14654	15781	38510	36910	40
LORETO	a0.9	275	27.83	27.83	27.83	0	0	0	275	275	275	489.5	489.5	48
LORETO	a10.19	85	30.32	30.32	30.32	0	0	0	85	85	85	173	173	1
LORETO	a20.29	152	13.07	13.07	13.07	0	0	0	152	152	152	268.2	268.2	26
LORETO	a30.39	255	23.01	23.01	23.01	0	0	0	255	255	255	451.1	451.1	45
LORETO	a40.49	389	305.3	244.8	347.2	181.8	145.8	206.8	207.2	182.2	243.2	653	550.6	75
LORETO	a50.59	615	645.1	600.3	679.5	384.2	357.6	404.7	230.8	210.3	257.4	1032	953.3	11
LORETO	a60.69	958	1119	1081	1151	666.8	644	685.7	291.2	272.3	314	1608	1538	10
LORETO	a70.79	933	1035	987.7	1073	616.3	588.3	639	316.7	294	344.7	1566	1481	10
LORETO	a80	785	665.8	579.8	730.1	396.6	345.4	434.9	388.4	350.1	439.6	1318	1168	14
MADRE DE DIOS	a0.9	92	21.98	21.98	21.98	0	0	0	92	92	92	114.7	114.7	11
MADRE DE DIOS	a10.19	21	0	0	0	0	0	0	21	21	21	21.17	21.17	21

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.reg	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
MADRE DE DIOS	a20.29	79	11.14	11.14	11.14	0	0	0	79	79	79	90.79	90.79	90
MADRE DE DIOS	a30.39	92	7.051	7.051	7.051	0	0	0	92	92	92	99.81	99.81	99
MADRE DE DIOS	a40.49	117	5.523	5.523	5.523	0	0	0	117	117	117	123.5	123.5	12
MADRE DE DIOS	a50.59	172	72.59	50.95	86.35	71.99	50.53	85.64	100	86.36	121.5	173.4	138	20
MADRE DE DIOS	a60.69	191	75.09	48.45	91.77	74.48	48.05	91.02	116.5	99.98	142.9	192.6	149.2	23
MADRE DE DIOS	a70.79	168	53.04	16.52	73.61	52.61	16.39	73.01	115.4	94.99	151.6	169.4	112.3	22
MADRE DE DIOS	a80	146	71.41	58.43	80.21	70.83	57.96	79.55	75.17	66.45	88.04	147.2	125.4	1
MOQUEGUA	a0.9	21	7.205	7.205	7.205	0	0	0	21	21	21	31.96	31.96	31
MOQUEGUA	a10.19	10	0	0	0	0	0	0	10	10	10	11.79	11.79	11
MOQUEGUA	a20.29	39	7.951	7.951	7.951	0	0	0	39	39	39	53.92	53.92	53
MOQUEGUA	a30.39	33	0	0	0	0	0	0	33	33	33	38.9	38.9	3
MOQUEGUA	a40.49	90	50.91	37.3	59.18	43.19	31.65	50.21	46.81	39.79	58.35	106.1	84.2	1
MOQUEGUA	a50.59	173	122	102.7	134.4	103.5	87.16	114	69.51	58.96	85.84	203.9	172.2	23
MOQUEGUA	a60.69	277	210.3	190.2	224.4	178.4	161.4	190.4	98.56	86.61	115.6	326.5	292.3	36
MOQUEGUA	a70.79	380	272.7	246.6	291.7	231.4	209.3	247.5	148.6	132.5	170.7	447.9	402.9	49
MOQUEGUA	a80	506	201.4	123.2	254	170.9	104.5	215.5	335.1	290.5	401.5	596.4	465.6	72
PASCO	a0.9	91	-22.04	-231.9	36.06	-38.78	-170.5	-2.333	129.8	93.33	261.5	184.8	-83.16	45
PASCO	a10.19	28	0	0	0	0	0	0	28	28	28	44.63	44.63	44
PASCO	a20.29	45	18.02	18.02	18.02	0	0	0	45	45	45	89.76	89.76	89
PASCO	a30.39	58	27.07	27.07	27.07	0	0	0	58	58	58	119.5	119.5	11
PASCO	a40.49	83	-11.94	-250.2	48.06	-38.61	-188.1	-0.9746	121.6	83.97	271.1	181.9	-116.3	48
PASCO	a50.59	152	105	71.95	125.9	65.87	45.13	78.97	86.13	73.03	106.9	242.3	188.4	29
PASCO	a60.69	219	105.8	34.82	147.1	66.39	21.84	92.28	152.6	126.7	197.2	349.1	236.8	46
PASCO	a70.79	245	3.43	3.43	3.43	0	0	0	245	245	245	394	394	3
PASCO	a80	294	35.14	35.14	35.14	0	0	0	294	294	294	503.8	503.8	50
PIURA	a0.9	302	72.02	72.02	72.02	0	0	0	302	302	302	526.6	526.6	52
PIURA	a10.19	91	0	0	0	0	0	0	91	91	91	137	137	1
PIURA	a20.29	219	0	0	0	0	0	0	219	219	219	329.7	329.7	32
PIURA	a30.39	362	282.6	245	310.1	187.8	162.7	206	174.2	156	199.3	544.9	479.8	6
PIURA	a40.49	743	786	757.9	809	522.1	503.5	537.5	220.9	205.5	239.5	1118	1067	1
PIURA	a50.59	1387	1561	1535	1585	1037	1020	1053	349.8	334.4	367.3	2088	2038	2
PIURA	a60.69	2446	2840	2805	2873	1887	1863	1908	559	537.6	582.8	3682	3614	3
PIURA	a70.79	2514	2539	2476	2594	1687	1645	1723	827.5	790.8	868.9	3784	3667	3
PIURA	a80	3251	2597	2452	2721	1725	1629	1808	1526	1443	1622	4894	4625	5
PUNO	a0.9	291	-28.48	-299.6	89.24	-86.06	-282.9	-0.5979	377.1	291.6	573.9	490.9	102	87
PUNO	a10.19	129	0	0	0	0	0	0	129	129	129	177.7	177.7	17

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.reg	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
PUNO	a20.29	230	0	0	0	0	0	0	230	230	230	316.8	316.8	31
PUNO	a30.39	282	29.62	29.62	29.62	0	0	0	282	282	282	418	418	4
PUNO	a40.49	486	175.5	63.66	246.5	127.4	46.22	178.9	358.6	307.1	439.8	669.4	486.6	85
PUNO	a50.59	788	285.3	119	395.4	207.1	86.4	287.1	580.9	500.9	701.6	1085	808.9	13
PUNO	a60.69	1128	721	627.6	793.8	523.5	455.6	576.3	604.5	551.7	672.4	1554	1387	17
PUNO	a70.79	1551	737.5	585.7	856.5	535.4	425.2	621.9	1016	929.1	1126	2136	1865	24
PUNO	a80	2134	1086	913.3	1226	788.8	663.1	890.4	1345	1244	1471	2939	2626	33
SAN MARTIN	a0.9	191	-30.18	-392.2	80.91	-82.92	-326.8	-8.088	273.9	199.1	517.8	376.5	- 96.67	84
SAN MARTIN	a10.19	69	0	0	0	0	0	0	69	69	69	102.4	102.4	10
SAN MARTIN	a20.29	153	16.97	16.97	16.97	0	0	0	153	153	153	244.1	244.1	24
SAN MARTIN	a30.39	208	25.09	25.09	25.09	0	0	0	208	208	208	333.9	333.9	33
SAN MARTIN	a40.49	322	209.3	155.4	245.1	141	104.7	165.1	181	156.9	217.3	478	388.4	56
SAN MARTIN	a50.59	522	308.2	225.3	365.6	207.6	151.8	246.3	314.4	275.7	370.2	774.9	634.6	91
SAN MARTIN	a60.69	744	526.8	447.5	585.7	354.9	301.4	394.6	389.1	349.4	442.6	1104	966.3	1
SAN MARTIN	a70.79	796	384.2	255.9	475.7	258.8	172.4	320.4	537.2	475.6	623.6	1182	961.9	14
SAN MARTIN	a80	1207	553.1	382	679.9	372.5	257.3	458	834.5	749	949.7	1792	1494	20
TACNA	a0.9	39	2.767	2.767	2.767	0	0	0	39	39	39	51.74	51.74	51
TACNA	a10.19	18	4.71	4.71	4.71	0	0	0	18	18	18	27.31	27.31	27
TACNA	a20.29	49	7.401	7.401	7.401	0	0	0	49	49	49	68.93	68.93	68
TACNA	a30.39	77	0	0	0	0	0	0	77	77	77	96.69	96.69	96
TACNA	a40.49	131	0	0	0	0	0	0	131	131	131	164.5	164.5	16
TACNA	a50.59	225	118.4	59.71	150.4	94.31	47.55	119.8	130.7	105.2	177.5	282.5	191.8	37
TACNA	a60.69	375	233.4	181.6	267.1	185.9	144.7	212.7	189.1	162.3	230.3	470.9	385.4	55
TACNA	a70.79	396	188.1	128.3	228	149.8	102.2	181.6	246.2	214.4	293.8	497.2	397.6	59
TACNA	a80	444	0	0	0	0	0	0	444	444	444	557.5	557.5	55
TUMBES	a0.9	58	4.373	4.373	4.373	0	0	0	58	58	58	71.06	71.06	71
TUMBES	a10.19	20	1.349	1.349	1.349	0	0	0	20	20	20	24.34	24.34	24
TUMBES	a20.29	47	5.631	5.631	5.631	0	0	0	47	47	47	59.67	59.67	59
TUMBES	a30.39	80	0	0	0	0	0	0	80	80	80	91.98	91.98	91
TUMBES	a40.49	116	0	0	0	0	0	0	116	116	116	133.4	133.4	13
TUMBES	a50.59	232	165.2	150.4	176	143.7	130.8	153.1	88.32	78.92	101.2	266.7	241.1	29
TUMBES	a60.69	366	259.3	241.5	273.2	225.6	210	237.6	140.4	128.4	156	420.8	389.1	45
TUMBES	a70.79	354	173.9	128	204.6	151.2	111.3	177.9	202.8	176.1	242.7	407	330.4	48
TUMBES	a80	505	149	74.37	200.3	129.6	64.69	174.2	375.4	330.8	440.3	580.6	454.7	70
UCAYALI	a0.9	137	-29.09	-828.4	88.08	-99.65	-677.9	-14.88	236.6	151.9	814.9	298	- 618.5	1
UCAYALI	a10.19	57	0	0	0	0	0	0	57	57	57	78.79	78.79	78
UCAYALI	a20.29	135	13.78	13.78	13.78	0	0	0	135	135	135	200.4	200.4	20
UCAYALI	a30.39	170	0	0	0	0	0	0	170	170	170	235	235	2
UCAYALI	a40.49	213	8.077	8.077	8.077	0	0	0	213	213	213	302.5	302.5	30
UCAYALI	a50.59	422	189.6	110.2	241.6	137.2	79.72	174.8	284.8	247.2	342.3	583.3	452	71
UCAYALI	a60.69	596	437.9	387.9	475.1	316.8	280.7	343.7	279.2	252.3	315.3	823.8	736.7	9
UCAYALI	a70.79	655	381	295.6	441.3	275.6	213.8	319.3	379.4	335.7	441.2	905.4	759.6	10

Departamento	rango	sinadef	excess.T	excess.l	excess.u	excess.reg	excess.reg.l	excess.reg.u	count	count.l	count.u	total	total.l	to
UCAYALI	a80	649	286.9	172.5	364.4	207.5	124.8	263.6	441.5	385.4	524.2	897.1	705.2	1
Total	-	211669	136245	122566	145130	97695	87624	104337	113974	107332	124045	289172	266608	31

12.1.5 Proportion total excess deaths per region

Table 9: Proportion total excess deaths per region

Departamento	suma	prop
AMAZONAS	279.2	0.2734
ANCASH	3818	3.739
APURIMAC	748.8	0.7334
AREQUIPA	5323	5.213
AYACUCHO	654.4	0.6409
CAJAMARCA	2448	2.397
CALLAO	6748	6.608
CUSCO	1794	1.757
HUANCAVELICA	481.9	0.4719
HUANUCO	1339	1.311
ICA	3678	3.602
JUNIN	3172	3.107
LA LIBERTAD	6788	6.648
LAMBAYEQUE	7954	7.789
LIMA	67425	66.03
LORETO	3864	3.785
MADRE DE DIOS	317.8	0.3113
MOQUEGUA	872.5	0.8545
PASCO	260.5	0.2551
PIURA	10678	10.46
PUNO	3007	2.945
SAN MARTIN	1993	1.952
TACNA	554.8	0.5433
TUMBES	758.8	0.7431
UCAYALI	1288	1.261

12.1.6 Population 2020 per region

Table 10: 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

Departamento	pop.INEI
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

12.2 Appendix 2

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.[45] 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.[46] 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.[47] This is above to our own estimate based on registered deaths in Lima over the same period: 14659 (CI 95% 13579 – 15609). Adding unregistered deaths increases this to 20149 (CI 95% 18839-21323).