Stroke-related length of hospitalization trends and in-hospital mortality in Peru

L. Max Labán-Seminario, MD[1], Rodrigo M. Carrillo-Larco, PhD[1,2], Antonio Bernabe-Ortiz, PhD[1,3]

[1] CRONICAS Center of Excellence in Chronic Diseases, Universidad Peruana Cayetano Heredia, Lima, Peru.
[2] Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, London, UK.
[3] Universidad Científica del Sur, Lima, Perú.

Corresponding Author:
Antonio Bernabe-Ortiz
CRONICAS Center of Excellence in Chronic Diseases, Universidad Peruana Cayetano Heredia.
Address: Av. Armendáriz 445, Miraflores, Lima 18, Peru.
Email address: antonio.bernabe@upch.pe

Abstract

36 **Background.** Peru faces challenges to provide adequate care to stroke patients. Length of
37 hospitalization and in-hospital mortality are two well-known indicators of stroke care. We aimed
38 to describe the length of stay (LOS) of stroke in Peru, and to assess in-hospital mortality risk due
39 to stroke, and subtypes.
40 **Methods.** This retrospective cohort study used hospitalization registries coding with ICD-10
41 from 2002 to 2017 (n=98,605) provided by the Ministry of Health; in-hospital mortality was
42 available for 2016-2017 (n=6,566). Stroke cases aged ≥35 years were divided into subarachnoid
43 hemorrhage (I60), intracerebral hemorrhage (I61), cerebral infarction (I63), and stroke not
44 specified as hemorrhage or infarction (I64). Data included stroke LOS and in-hospital mortality;
45 socio-demographic and clinical variables. We fitted a region- and hospital level-stratified
46 Weibull proportional hazard model to assess the in-hospital mortality.
47 **Results.** The median LOS was 7 days (IQR: 4-13). Hemorrhagic strokes had median LOS longer
48 than ischemic strokes and stroke not specified as hemorrhage or infarction (p=<0.001). The case
49 fatality rate (CFR) of patients with stroke was 11.5% (95% CI: 10%-12%). Subarachnoid
50 hemorrhage (HR= 2.45; 95% CI: 1.91-3.14), intracerebral hemorrhage (HR: 1.95; 95% CI: 1.55-
51 2.46), and stroke not specified as hemorrhage or infarction (HR=1.45; 95% CI: 1.16-1.81) were
52 associated with higher in-hospital mortality risk in comparison to ischemic strokes.
53 **Discussion.** Between 2002 and 2017, LOS due to stroke has not changed in Peru in stroke
54 patients discharged alive. Hemorrhagic cases had the longest LOS and highest in-hospital
55 mortality risk during 2016 and 2017. The findings of our study seem to be consistent with a
56 previous study carried out in Peru and similar to that of HIC and LMIC, also there is an
57 increased median LOS in stroke cases managed in specialized centers. Likewise, LOS seems to
58 depend on the type of stroke, where ischemic stroke cases have the lowest LOS. Peru needs to
59 improve access to stroke care.

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Introduction

75 Over the last decades, stroke has mounted to be among the top causes of death globally with 6.2
76 million fatal cases in 2017 [1]; noteworthy, 71% of them occurred in low- and middle-income

77 countries (LMIC) [2]. Likewise, in Latin America, the hemorrhagic cases seem to happen more
78 often than in High Income Countries (HIC) [3], which can lead to a large hospital burden of 7632
79 stroke hospitalizations reaching 47,200 United States Dollar (USD) as 1-year hospital cumulative
80 cost [4–7] between 2008 and 2009. Likewise, the care cost, LOS, and mortality of hemorrhagic
81 stroke are greater than ischemic stroke, which contribute to significant socioeconomic disparities
82 in stroke care of universal healthcare systems, especially in scarce settings and in low
83 socioeconomic status population [7,8,9].
84 Although an emerging economy, Peru faces difficulties to provide adequate care to stroke
85 patients because of the dearth of logistics and human resources as well as inequalities [10] in the
86 clinical settings of the Ministry of Health (MoH), which is organized into three levels of
87 healthcare according to whether general or specialized care is required, such as the third-level
88 facilities offer better support for stroke specialized care [11,12]. However, the most care facilities
89 do not have sufficient capacity for emergency treatment, and stroke care centers with neuro-
90 imaging are centralized and reduced [13,14]. Stroke profiles have been studied in limited
91 populations and scenarios in Peru [15-18]. Likewise, the stroke mortality in Peruvian public
92 hospitals decreased between 2005 and 2015 [19]. However, an approximation of the use of
93 hospital resources at the national level is not yet available. LOS provides general information
94 about the efficiency of the use of hospital resources, and it is frequently reported in stroke quality
95 registries [20]. This study aims to describe LOS in Peru between 2002 and 2017, overall and by
96 type of stroke; also, to study in-hospital mortality between 2016 and 2017.
97
98 **Materials & Methods**

99 **Study design**

100 We conducted a retrospective cohort using national open access registries of the Peruvian
101 Ministry of Health (MoH) aimed to determine if hemorrhagic stroke is associated with a longer
102 hospital stay and the risk of in-hospital mortality compared to ischemic stroke and stroke not
103 specified. MoH provided registries of cerebrovascular diseases with ICD-10 codes. Methods of
104 collected data were detailed in Luis Labán (2021) [21]. Further descriptions were included in
105 supplemental methods.

106 **Study population**

107 Participants were included using the methods described above in Luis Labán (2021) [21]. Stroke
108 patients cared by physicians with an only primary diagnostic code ICD-10 were identified from
109 first-, second- and third-level health facilities, which cover approximately 55% of Peru's
110 population [22]. The ICD-10 codes were standardized in all health facilities of MoH from 2002
111 onwards [23]. We cleaned the data following these steps. First, we selected the stroke diagnosis
112 of interest: subarachnoid hemorrhage (ICD-10 code I60), intracerebral hemorrhage (ICD-10 code
113 I61), cerebral infarction (ICD-10 code I63), and stroke not specified as hemorrhage or infarction
114 (ICD-10 code I64). Second, we only kept patients who were discharged alive by a physician
115 from 2002 to 2017 to analyze stroke LOS (i.e., patients whose discharge record was due to other
116 reasons for discharge, such as voluntary discharge, transferred patients, discharge with death
117 registry, and missing data were not included due to possible biases related to the course of in-
118 hospital medical management); likewise, stroke deaths were only available in 2016 and 2017
119 which were included for in-hospital mortality analysis. Third, we only included adults aged ≥35
120 years because only a relatively small proportion of subjects (5.6%) were younger than 35 years
121 in the complete dataset; likewise, more than 60% of them did not have discharge date data to
122 calculate the length of stay and the most frequent cause of the cerebrovascular disease belongs to
123 the group of other cerebrovascular diseases (ICD-10 code I67) with 24% (n=1,730). Lastly, we
124 excluded cases with LOS below and above the 1st and 99th percentile of each year to avoid
125 implausible values or potential data entry errors [6].

126 **Variables**

127 The outcomes of interest were: i) stroke LOS, defined as the days between discharge and
128 hospitalization date, for which we employed data from 2002 to 2017. ii) in-hospital mortality
129 (time-to-event variable), which was defined as the days elapsed between hospital admission date
130 until the stroke case was discharged by medical indication (censored) or died during
131 hospitalization, where we included all data related to time to death or discharge from 2015 to
132 2017.

133 We used socio-demographic and clinical variables to describe LOS trends and in-hospital
134 mortality: sex; age (35-54, 55-74 and ≥75 years); Peruvian region (Lima/Callao, rest of the
135 Coast, Highlands and Amazon) and health facility level (level I: primary care facilities; level II:
136 intermediate care facilities; and level III: specialized hospitals and institutes), which ones
137 employed to fit the mortality analysis; and type of stroke, which one was the exposure of interest
138 (ICD-10: subarachnoid hemorrhage (I60), intracerebral hemorrhage (I61), cerebral infarction
139 (I63) used as a reference, and stroke not specified as hemorrhage or infarction (I64)).

140 **Statistical analysis**

141 Statistical methods used in this study have been detailed above in Luis Labán (2021) [21]. We
142 described variables through mean/median or absolute/relative frequencies, according to the
143 distribution and whether they were numerical or categorical. We computed medians along with

144   interquartile ranges (IQR) because LOS had a non-normal distribution using the Kolmogorov-
145   Smirnov test. We carried out comparisons between variables using the following tests: the Chi-
146   square test compared categorical variables, whereas the Kruskal-Wallis test and corrected for
147   multiple comparisons (Dunn's test with Bonferroni correction) compared continuous numerical
148   variables. Also, we employed the Mann-Whitney-Wilcoxon Rank Sum test to compare the
149   means of LOS according to sex and level. We analyzed the trend of LOS from 2002 to 2017 by
150   sex through the Spearman correlation (rho). We used the Poisson distribution with 95%
151   confidence intervals (95% CI) to estimate the case-fatality rate (CFR), and we employed the two-
152   proportion z-test to get p-values. For the mortality analysis, we used the Kaplan-Meier method
153   (unadjusted) and log-rank test to examine the in-hospital survival by type of stroke. We
154   evaluated the proportional hazard assumptions for the primary exposure as well as for the
155   additional covariates (age and sex), then we fitted a region- and hospital level-stratified Weibull
156   proportional hazard model. Likewise, we employed the Schoenfeld Test to corroborate the
157   proportional hazard assumption, and we evaluated the Weibull distribution of the baseline hazard
158   through the log(-log(Survival)) and log(time) plot. We analyzed interactions in the model
159   described above through the likelihood-ratio test: stroke type and level of the facility, as well as
160   stroke type and regions. We developed the analyses with R (v4.0.0) [24].

161   **Ethics**

162   This study is an analysis of health records with de-identified information. The analyzed data did
163   not present any personal information, and no human subjects were enrolled. We did not seek
164   ethical approval by an institutional review board or ethics committee.
165
166   # Results

167   **Overall description**

168   Between 2002 and 2017, a total of 98,605 MoH records from first-, second- and third-level
169   healthcare facilities were identified. Of these, 58% (n=57,153) were cerebrovascular diseases of
170   interest (hemorrhagic stroke, ischemic stroke, and stroke not specified). The most frequently
171   excluded diagnoses were: other specified cerebrovascular diseases (ICD-10 code I678) with 20%
172   (n=19,962) and cerebrovascular disease unspecified (ICD-10 code I679) with 12% (n=11,912).
173   Only 39,810 records were included in the final analysis (*Fig.1*). About 45% (n=17,815) of stroke
174   cases were from first- and second-level facilities; 50% (n=19,840) of cases were reported from
175   Lima/Callao, followed by the rest of the Coast (i.e., outside Lima, the capital city) with 27%
176   (n=10,851).
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178   **Figure 1. Flowchart of patients from the Peruvian MOH admitted between 2002 and 2017**
179   **and assessed for eligibility.**
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181 Cases of stroke aged, on average, 68.1 (SD=13.9) years. Between 2002 and 2014, there were
182 apparently more women than men (14,312 vs. 13,741); after 2014, the number of cases of men
183 increased slightly that of women (6,055 vs. 5,702). Between 2002 and 2017, most of the stroke
184 cases were not specified as hemorrhage or infarction (51%, n=20,449), followed by cerebral
185 infarction (24%, n=9,635), intracerebral hemorrhage (16%, n=6,352), and subarachnoid
186 hemorrhage (8%, n=3,374). Both first- and second-level facilities reported 64% (n=13,117) of
187 stroke cases not specified as hemorrhage or infarction, whereas the third-level facilities reported
188 76% (n=7,382) of hemorrhagic cases.

189 **Length of hospitalization**

190 Stroke cases had a median LOS of 7 days (IQR: 4-13) ranging from 2 to 55 days, and it did not
191 vary across years (*Fig.2A*). Between 2002 and 2017, there was no clear LOS difference by sex
192 (p=0.05): men (7 [IQR: 4-13]) and women (7 [IQR: 4-13]) (*Fig.2B*), and there were differences
193 of LOS in each group of age (p=<0.001): <55 (8 [IQR: 5-15]), 55-74 (7 [IQR: 4-13], and 75+ (7
194 [IQR: 4-12])); that is, older people would stay fewer days than younger patients (*Fig.2C*).
195 Subarachnoid hemorrhage showed the largest LOS (*Fig.2D*). Hemorrhagic conditions had longer
196 LOS than the ischemic cases and stroke not specified as hemorrhage or infarction (p=<0.001):
197 subarachnoid hemorrhage (12 [IQR: 6.25-20]), intracerebral hemorrhage (10 [IQR: 6-17]),
198 cerebral infarction (8 [IQR: 5-14]) and stroke not specified as hemorrhage or infarction (6 [IQR:
199 4-10]). Across years, third-level facilities had higher LOS than first- and second-level facilities
200 (p=<0.001): I-II (5 [IQR: 3-9]) and III (10 [IQR: 6-16]) (*Fig.2E*); and Lima/Callao and the rest
201 of the Coast were the regions with the largest LOS (p=<0.001): Lima/Callao (9 [IQR: 5-16]),
202 Rest Coast (7 [IQR: 4-11]), Amazon (5 [IQR: 3-7]) and Highlands (6 [IQR: 3-9]) (*Fig.2F*).
203
204 **Figure 2. Length of hospitalization due to cerebrovascular disease in Peru 2002-2017, by**
205 **(A) year, (B) sex, (C) age group, (D) stroke type, (E) care level, and (F) region.** LOS data
206 were represented through median and IQR. P-values for LOS comparisons by sex and care level
207 were performed using Wilcoxon-rank sum. P-values for multiple LOS comparisons by year, age,
208 ICD-10 and region were obtained using the Wilcoxon rank-sum and Dunn's test following
209 Kruskal-Wallis test. P-value obtained from the comparison between hemorrhagic condition
210 group (I60 and I61), ischemic cases (I63), and stroke not specified (I64) used Kruskal-Wallis
211 test. Y-axis in Figure2: a) Years of hospitalization of stroke patients discharged alive. b) Sex of
212 the stroke cases discharged alive. c) Age in years of the stroke cases discharged alive. d)
213 International Classification of Diseases (ICD-10) of the stroke cases discharged alive. e)
214 Category of the health facility corresponding to the stroke cases discharged alive. f) Region of
215 the health facilities where the stroke cases discharged alive were managed.

216   **Mortality and type of stroke**

217   Between 2016 and 2017, 6,566 cases of stroke were recorded, and 757 deaths occurred during
218   that period (CFR=11.5%; 95% CI: 10.7%-12.4%). Females had larger CFR than males: 13%
219   (95% CI: 12%-14%) vs. 10% (95% CI: 9%-11%, p=<0.001). Subarachnoid hemorrhage (CFR=
220   21.5%; 95% CI: 18%-25%) and intracerebral hemorrhage (CFR= 14.9%; 95% CI: 12.8%-17%)
221   had larger CFR than stroke not specified as hemorrhage or infarction (CFR= 10.5%; 95% CI:
222   9.3%-11.7%) and cerebral infarction (CFR= 6.9%; 95% CI: 5.7%-8.1%). Clinical and socio-
223   demographic variables according to mortality status are described in *Table 1*.
224
225   **Table 1. Socio-demographic and clinical variables according to the outcome of**
226   **hospitalization between 2002 and 2017.**
227   ᵃ Only, data time to discharge was included.
228   ᵇ Death data were only available for 2016 and 2017
229   ᶜ P-values of intra-hospital mortality obtained through the comparison between categorical
230   variables to the Chi2 test for independence, while this value for numerical variables to the
231   Kruskal-Wallis test.
232
233   Kaplan-Meier estimates showed an in-hospital survival difference among the stroke subtypes
234   (*Fig.3*; log-rank test p=<0.001). Patients with ischemic stroke had the highest survival compared
235   with other types of stroke. Violations of the proportional hazard (PH) assumption in the crude
236   (p=0.004) and adjusted (p=0.006) models were found, and baseline hazards seemed to have a
237   linear relationship between log(-log(survival) and log(time). Likewise, the global Schoenfeld
238   Test was statistically significant (p=0.004). As a result, we used a region- and hospital level-
239   stratified Weibull proportional hazard model. We did not include interactions in the region- and
240   hospital level-stratified Weibull proportional hazard model, as the likelihood-ratio test did not
241   display significant differences between models with interactions and without them (p=0.21 and
242   p=0.20; p=0.21 and p=0.12, respectively for each model).
243
244   **Figure 3. Kaplan-Meier survival curve by type of stroke in 2016 and 2017.**
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246   Subarachnoid hemorrhage (HR = 2.34; 95% CI: 1.83 - 2.99), intracerebral hemorrhage (HR =
247   1.89; 95% CI: 1.50 - 2.38), and stroke not specified as hemorrhage or infarction (HR = 1.48;
248   95% CI: 1.19 - 1.85) had higher in-hospital mortality risk compared to ischemic stroke cases.
249   These risk estimates remained similar after adjusting for sex and age: HR = 2.45 (95% CI: 1.91 -
250   3.14), HR = 1.95 (95% CI: 1.55 - 2.46), and HR = 1.45 (95% CI: 1.16 - 1.81) for subarachnoid
251   hemorrhage, intracerebral hemorrhage and stroke not specified as hemorrhage or infarction,
252   respectively.
253
254   **Discussion**

Main results

The median LOS of stroke cases was similar in both sexes and has not changed across the years. Hemorrhagic cases had longer LOS than ischemic cases. Between 2016 and 2017, more than 1 in 10 stroke cases died, and after controlling for age and sex, the risk of death was higher among individuals with subarachnoid hemorrhage, intracerebral hemorrhage, and not specified as hemorrhage or infarction, compared to those with ischemic stroke.

Comparison with previous studies

In our study, we described LOS of stroke patients discharged alive. Different studies have reported median LOS of all stroke patients (alive and dead), showing a higher median LOS among cases with in-hospital stroke for the first time and a similar median LOS among managed stroke cases in the stroke units compared to our findings: a study in Canada, including 28,837 patients with stroke for the first time of community-onset and intra-hospital onset, reported a median LOS of 8 days and 15 days, respectively [25]; whereas those cases managed in stroke units had a shorter median LOS of 6 days compared to the median LOS of 9 in the stroke cases attended in General Neurology Wards [26].

Moreover, LOS seems to depend on the type of stroke, where the ischemic stroke cases have the lowest LOS: a study carried out in the US evaluated hemorrhagic events with the first hospitalization, which reported a longer median LOS [7] in the subarachnoid hemorrhage cases (8 days), and the same median LOS (5 days) between the intracerebral hemorrhage and ischemic stroke cases. Likewise, a study in Argentina enrolling 1,991 cases of ischemic stroke found a median LOS of 5 days, similar to the one herein reported [27], while a Peruvian study conducted in 2,314 stroke patients from one third-level hospital from 2000 to 2009 reported a general median LOS of 7 days consistent with our findings; however, the results of median LOS for each stroke subtype was contrary to those mentioned above: median LOS of ischemic cases were the highest of all with 10 days, followed by hemorrhagic cases (hemorrhagic stroke: 9 days, and subarachnoid hemorrhage: 8 days) and stroke not specified and stroke not specified (8 days) [18].

A systematic review about early CFR (21-day to 1 month) for stroke reported a considerable variation, ranging between 23% and 35% in LMIC from 2000 to 2008, and varied between 20% and 30% in HIC in the same period [3]. Although data from LMIC was scarce, the incidence of stroke was higher than in HIC, highlighting the need for launching appropriate stroke prevention programs in LMIC paired with robust surveillance or data collection programs. Likewise, a Peruvian study carried out in a third-level facility reported a general CFR of 19.5% in the period 2000-2009, where hemorrhagic stroke had the highest CFR of all with 31.8%, which was slightly higher than our findings [18].

293 Hemorrhagic strokes (i.e., subarachnoid and intracerebral hemorrhages) had the highest in-
294 hospital mortality risk, as shown in previous studies [28-30]. A study using data from the Global
295 Burden of Disease 2013, including stroke patients aged 20-64 years, reported two times more
296 deaths in hemorrhagic stroke than ischemic stroke, especially in LMIC [31].

Results interpretation

298 This study describes median LOS in stroke patients discharged alive. Despite this, the findings of
299 our study seem to be similar to that of HIC, but there is an increased median LOS in stroke cases
300 managed in specialized centers. Besides, the CFR reported in our study seems to be below
301 international and national estimates. Different factors may play a role in explaining these
302 findings. Inadequate reporting and under-reporting may be potential issues as some stroke
303 patients may not access healthcare or die before accessing the health system, which probably
304 explains the differences between CFR findings [32,33]. The highest frequency of deaths in the
305 first days after hospitalization, mainly due to hemorrhagic events or due to the conditions of
306 multi-morbidity in the older patients [19], could lead to a lower LOS, mainly in the elderly
307 patients, as shown in other reports [19,31]. Likewise, although some Peruvian clinical practice
308 guidelines for the management of ischemic stroke claim a quick neuroimaging exam (25 minutes
309 from arrival at the health facility) [12], it could hardly be carried out in daily clinical practice due
310 to healthcare resource limitations and geographic distances between health facilities to the
311 reference facility, as well as a reduced and centralized number of CT-scan [14], among which 26
312 (46%) are from the capital of Peru, therefore, it could explain the large proportion of stroke cases
313 not specified as hemorrhage or ischemic.

315 Transferred patients from a first- or second-level to a third-level facility may be severe stroke
316 cases with a higher risk of complications that need ICU care; this could lead to longer LOS and
317 higher CFR [7,34-36], and it may negatively affect the stroke patient outcomes in scarce settings
318 [34,36-38].

320 Hemorrhagic cases have been noted to have up to 4 times the risk of death than ischemic cases,
321 which is consistent with our findings [39]. Death outcome seems to be related to stroke severity,
322 type of hemorrhagic lesion, and delay in referral and healthcare access [7,39-42]. Moreover,
323 complicated hemorrhagic events with re-bleeding require adequate management as soon as
324 possible [40]. As such, individuals with hemorrhagic stroke are at high risk of death, given the
325 shortcomings mentioned above in the Peruvian health system.

Public health relevance

327 LOS is an important indicator that reflects the use of hospital resources. In Peru, LOS in stroke
328 patients has been similar over the years and relatively similar to LOS of LMIC and HIC.
329 However, these results must be interpreted with caution due to the heterogeneous characteristics

330 between the populations. Likewise, a mortality report from the Ministry of Health indicated a
331 growing stroke mortality trend in the period 2003-2015 [43], while a Peruvian study with data
332 from the Ministry of Health reported global stroke mortality decreased in the period 2005-2015
333 [19], which it can be explained by the different methodologies used in both studies. In this study,
334 the mortality trend could not be determined because we did not have mortality data for that
335 period. In local clinical experience, Peru faces challenges related to timely access to stroke care;
336 these challenges are much more profound in settings with limited health resources, where the
337 stroke units are limited, and instead, there are second- and third-level facilities that attend
338 patients with acute stroke, of which third-level facilities can provide access to CT-scan [12,14].
339 These problems require urgent attention through strategies to improve access to healthcare (i.e.,
340 telediagnosis and telemonitoring) and decentralization strategies (i.e., the creation of stroke units
341 with neuroimaging) to reduce hospital resource gaps [16,44,45]. This way, it could make the
342 diagnosis and management more effective and less expensive for the families of stroke patients.
343 Also, there is a need to monitor appropriate stroke care indicators and assess the impact of
344 potential interventions [4].

345

346 Public health policies should be strengthened and aimed to reduce the prevalence and mortality
347 related to stroke. These objectives can be reached by the decentralization of both human and
348 logistic resources, along with a reorganization of the healthcare system, so that patients can
349 receive adequate primary or secondary prevention without exhausting the limited resources
350 [46,47], and by increasing health literacy in the general population; thus, they can acknowledge
351 the relevance of identifying early signs of stroke to seek healthcare are promptly [3,40,48].

352 **Strengths and limitations**

353 Benefiting from a large national database, we studied trends of in-patient LOS and in-hospital
354 mortality among stroke patients in Peru. However, this study presents some limitations that
355 should be highlighted. First, we only utilized records from the MoH, which provides health care
356 to about 55% of the population, especially those with economic limitations. Therefore, we
357 consider that the distribution of the population included in our study is representative of those
358 insured to MOH. Likewise, the studied sample is sufficiently large, which optimizes the
359 generalizability of our results to the Peruvian population affiliated to MOH. However, the
360 socioeconomic status of those insured to MOH would not support generalizing our results to the
361 private sector and other countries. Second, we could not control whether patients were referred
362 from the first- and second-level facilities to third-level facilities; besides, we could not identify
363 which patients were readmitted for stroke as these data were not available nor data on stroke
364 severity were available, so our data could not be representative for populations of mild-to-
365 moderate stroke admissions who survive and spend a short LOS. Third, mortality data were
366 provided only from 2016 to 2017, and unmeasured confounders (lack of data regarding stroke
367 severity measurements (i.e the NIHSS scale), disability at discharge (i.e the modified Ranking
368 Scale), prestroke medications, acute stroke treatments, ICU or operating room utilization and

369 complications associated with hospitalizations and interventions (i.e hospital-acquired
370 infections), and delay in arrival at the reference health center) could have biased our estimates.
371 Fourth, there was no availability of data related to stroke hospital costs, so it was not possible to
372 get complementary estimates of the use of health resources in relation to LOS. Finally, both
373 coding bias and lack of information coverage in regions outside large cities could underestimate
374 reported cases.
375

Conclusions

377 LOS in patients with stroke has not changed in Peru from 2002 to 2017, consistent with previous
378 studies in Peru and other LMIC and HIC. Hemorrhagic stroke had longer LOS than ischemic
379 stroke. Hemorrhagic strokes (i.e., subarachnoid and intracerebral hemorrhage) had a higher risk
380 of in-hospital mortality. Our findings suggest needing strategies to improve access to stroke care.
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Figure 1

Flowchart of patients from the Peruvian MOH admitted between 2002 and 2017 and assessed for eligibility.

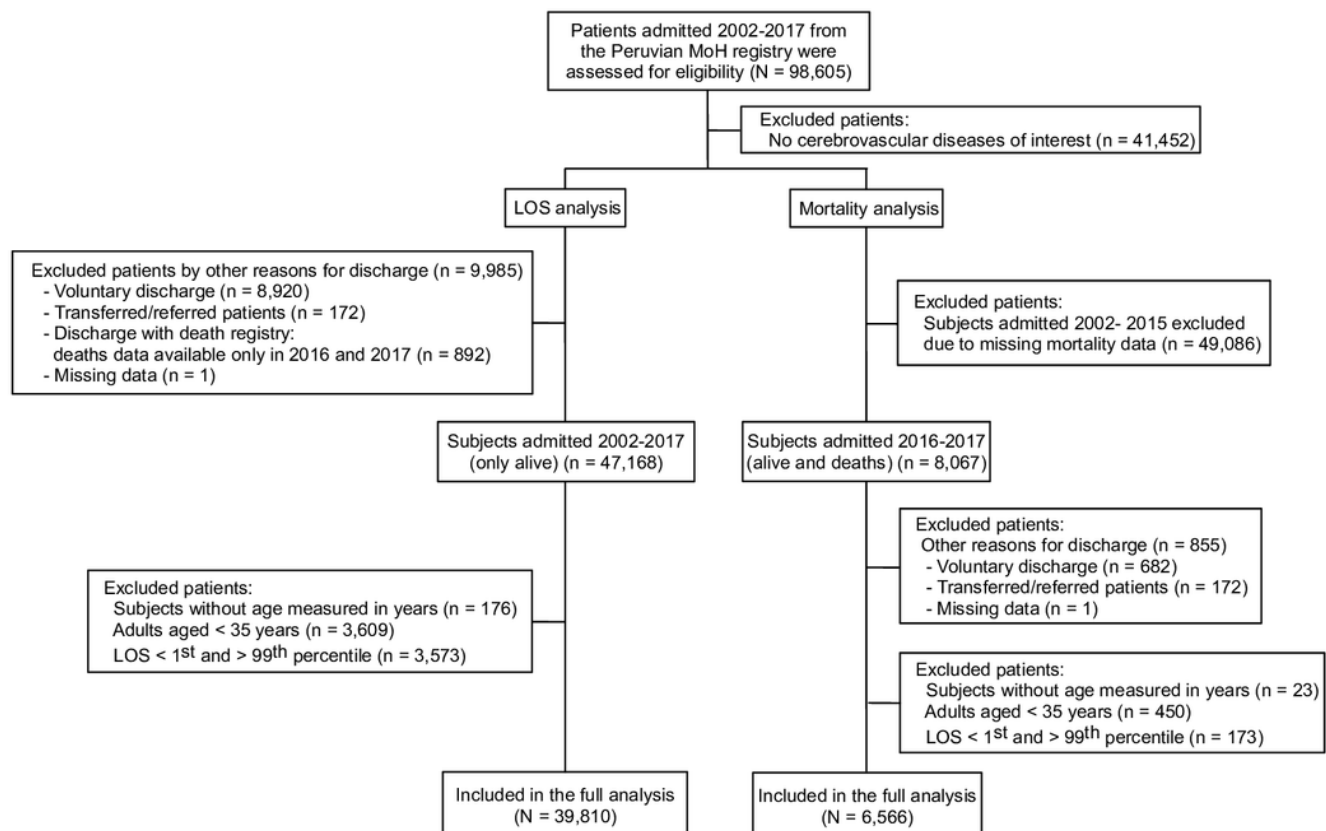



Figure 2

Figure 2. Length of hospitalization due to cerebrovascular disease in Peru 2002-2017, by (A) year, (B) sex, (C) age group, (D) stroke type, (E) care level, and (F) region.

LOS data were represented through median and IQR. P-values for LOS comparisons by sex and care level were performed using Wilcoxon-rank sum. P-values for multiple LOS comparisons by year, age, ICD-10 and region were obtained using the Wilcoxon rank-sum and Dunn's test following Kruskal-Wallis test. P-value obtained from the comparison between hemorrhagic condition group (I60 and I61), ischemic cases (I63), and stroke not specified (I64) used Kruskal-Wallis test. Y-axis in Figure2: a) Years of hospitalization of stroke patients discharged alive. b) Sex of the stroke cases discharged alive. c) Age in years of the stroke cases discharged alive. d) International Classification of Diseases (ICD-10) of the stroke cases discharged alive. e) Category of the health facility corresponding to the stroke cases discharged alive. f) Region of the health facilities where the stroke cases discharged alive were managed.

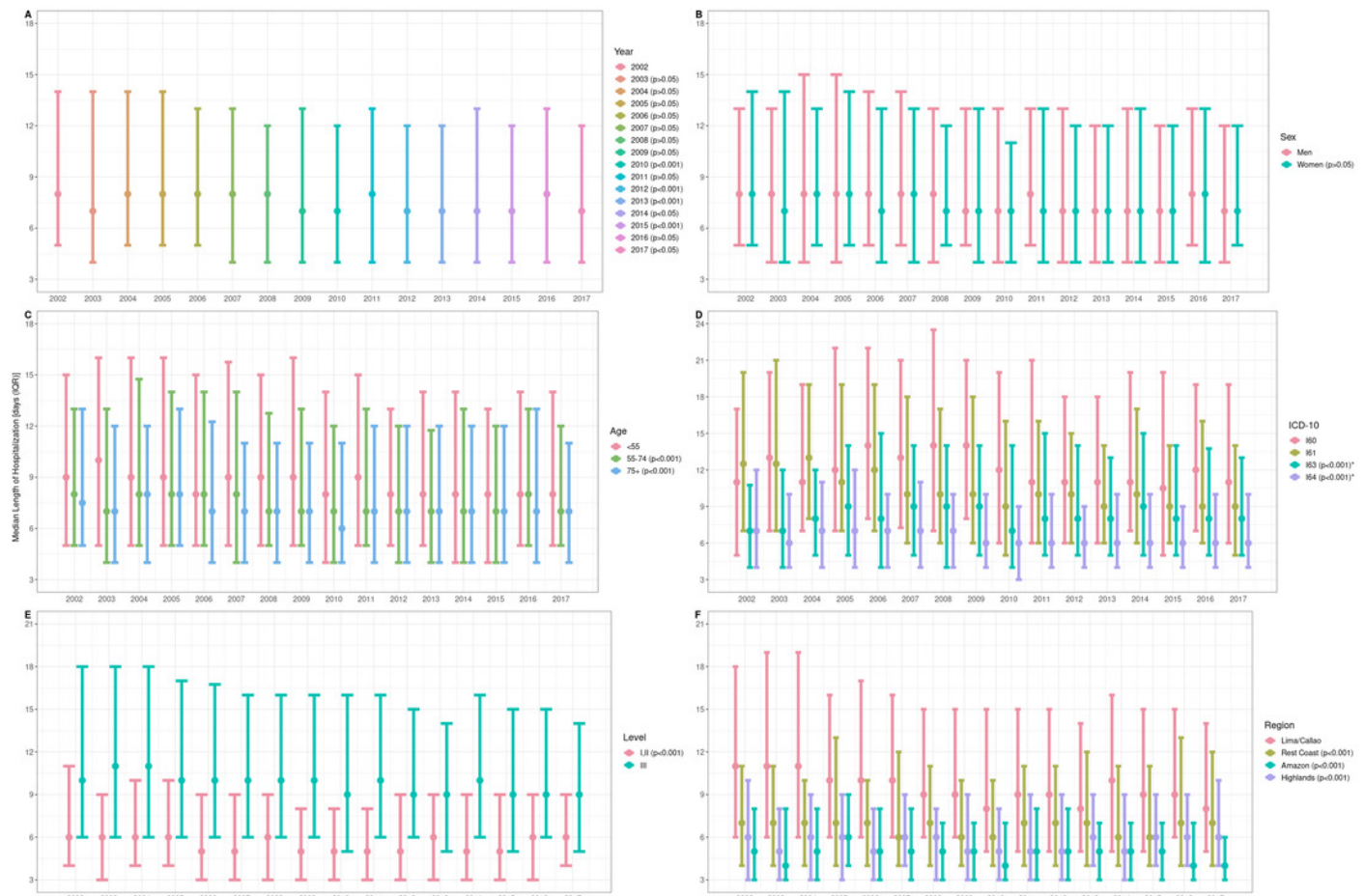
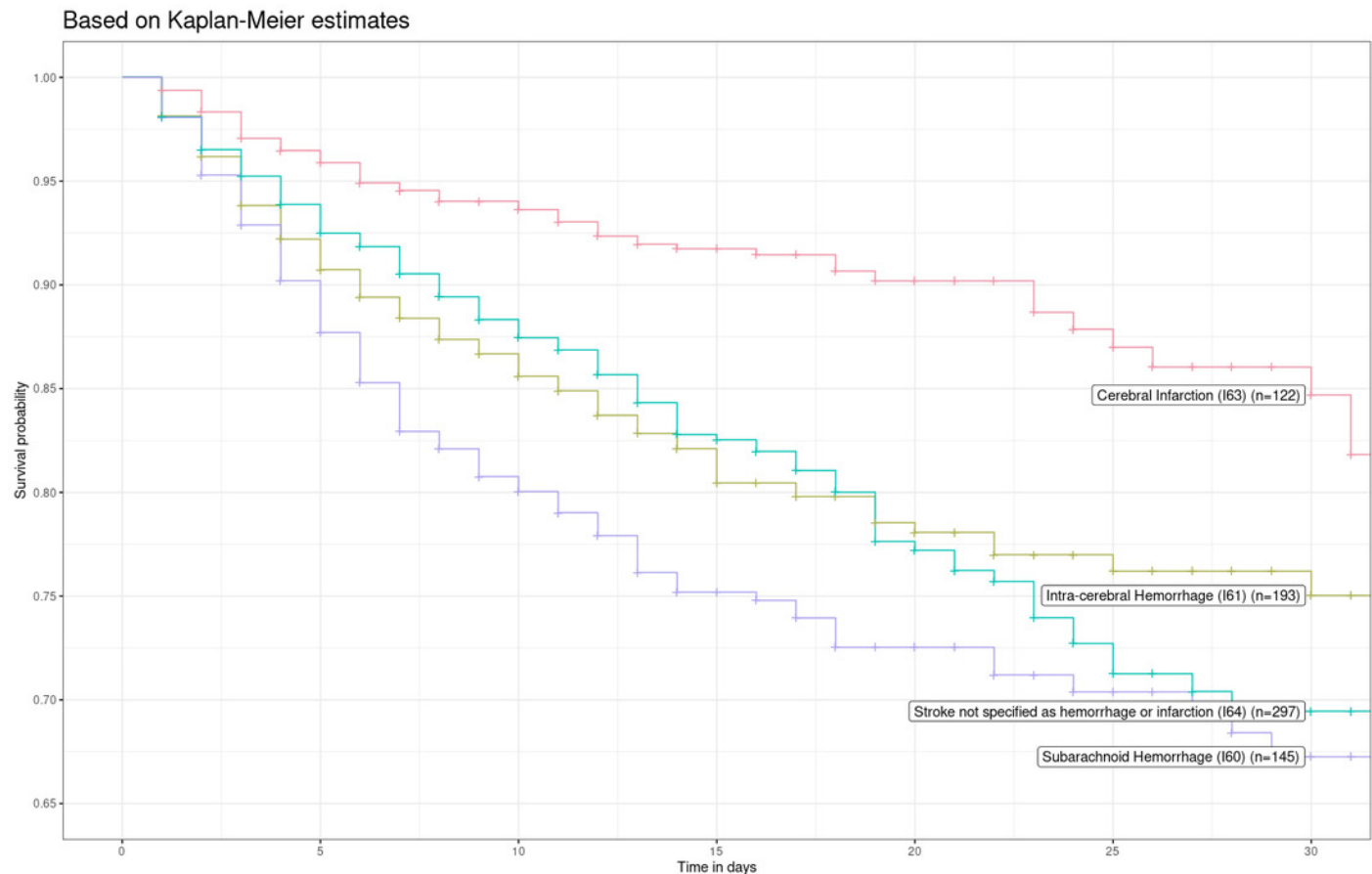



Figure 3

Kaplan-Meier survival curve by type of stroke in 2016 and 2017.

![Kaplan-Meier survival curves by type of stroke. Based on Kaplan-Meier estimates. The x-axis shows Time in days (0 to 30) and the y-axis shows Survival probability (0.65 to 1.00). Five curves are labeled: Cerebral Infarction (I63) (n=122), Intra-cerebral Hemorrhage (I61) (n=193), Stroke not specified as hemorrhage or infarction (I64) (n=297), Subarachnoid Hemorrhage (I60) (n=145).]

Socio-demographic and clinical variables according to the outcome of hospitalization between 2002 and 2017.

[a] Only, data time to discharge was included. [b] Death data were only available for 2016 and 2017. [c] P-values of intra-hospital mortality obtained through the comparison between categorical variables to the Chi2 test for independence, while this value for numerical variables to the Kruskal-Wallis test.

Socio-demographic and clinical characteristics	Admissions to hospitalization between 2002 and 2017*			P value [c]
	Patients admitted 2002-2017 for LOS analysis [a]	Patients admitted 2016-2017 for intra-hospital mortality analysis [b]		
	Discharged alive (N = 39,810)	Discharged alive (N =5,809)	Deaths (N = 757)	
Sex				
Men	19,796 (49.7%)	2,974 (51.2%)	331 (43.7%)	<0.001
Women	20,014 (50.3%)	2,835 (48.8%)	426 (56.3%)	
Age (years) (mean ± SD)	68.1 ± 13.9	68.3 ± 13.8	70 ± 14.2	
Age (years)				
<55	7,394 (18.6%)	1,054 (18.1%)	122 (16.1%)	0.09
55-74	17,874 (44.9%)	2,588 (44.6 %)	323 (42.7%)	
75+	14,542 (36.5%)	2,167 (37.3%)	312 (41.2%)	

Region

Lima/Callao	19,840 (49.8%)	2,772 (47.7%)	308 (40.7%)	<0.001
Rest Coast	10,851 (27.3%)	1,592 (27.4%)	203 (26.8%)	
Amazon	2,633 (6.6%)	515 (8.9%)	66 (8.7%)	
Highlands	6,486 (16.3%)	930 (16%)	180 (23.8%)	

Facility Level

I or II	17,815 (44.8%)	2,498 (43%)	388 (51.3%)	<0.001
III	21,995 (55.2%)	3,311 (56.9%)	369 (48.7%)	

ICD-10

I60	3,374 (8.5 %)	529 (9.1%)	145 (19.2%)	<0.001
I61	6,352 (15.9%)	1,098 (18.9%)	193 (25.5%)	
I63	9,635 (24.2%)	1,643 (28.3%)	122 (16.1%)	
I64	20,449 (51.4%)	2,539 (43.7%)	297 (39.2%)	

LOS (days)	7 (4-13)	7 (4-12)	5 (2-9)	<0.001
[Median (IQR)] - [Rangos]	[2-55]	[1-59]	[1-53]	