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ABSTRACT

Background: the pandemic may undermine the equity of access to and utilisation of health services for conditions other than COVID-19. The objective of the study is to evaluate the indirect impact of COVID-19 and lockdown measures on sociodemographic inequalities in healthcare utilisation in seven Italian areas.

Methods: in this multi-centre retrospective study we evaluated whether the association between educational level or deprivation and indicators of hospital utilisation and quality of care was modified by the COVID-19. We also assessed variations in gradients by sex and age class. We estimated age-standardised rates and prevalence and their relative percent changes comparing pandemic (2020) and pre-pandemic (2018-19) periods, and the Relative Index of Inequalities fitting multivariable Poisson models with an interaction between socioeconomic position and period.

Results: compared to 2018-19, hospital utilisation and, to a lesser extent, timeliness of procedures indicators fell during the first months of 2020. Larger declines were registered among women, the elderly, and the low educated resulting in a shrinkage (or widening if RII <1) of the educational gradients for most of the indicators. Timeliness of procedures indicators did not show any educational gradient neither before nor during the pandemic. Inequalities by deprivation were nuanced and did not substantially change in 2020.

Conclusions: the socially patterned reduction of hospital utilisation may lead to a potential exacerbation of health inequalities among groups that were already vulnerable before the pandemic. The healthcare service can contribute to contrast health disparities worsened by COVID-19 through a more efficient communication and locally appropriate interventions.

Keywords: epidemiology, health inequalities, COVID-19

What is already known on this subject

- During the first pandemic months there was a general reduction in hospital utilisation.
- The way the pandemic is undermining the equity of access to and utilisation of health services for conditions other than COVID-19 has been only partially explored.

What this study adds

- This Italian multi-centre study showed that during the first seven pandemic months, women, the elderly, and the low educated experienced the greatest drop in hospitalisation for acute conditions, scheduled surgery, and oncological surgery compared to 2018-19, with resulting changes in the educational gradient.
- Patients' hospital management was not affected by socioeconomic position.
- Mid and long-term consequences of socially patterned reductions in hospital utilisation can deepen existing health inequalities and the healthcare service should contribute to contrast them.

How this study might affect research, practice or policy

- The healthcare service can contribute to contrast health disparities worsened by COVID-19 through communication strategies tailored to different health literacy levels on how and when safely access care and through the strengthening of primary care and preventive services to implement appropriate interventions and foster community empowerment.
- The implementation of systematic, comprehensive, and timely monitoring systems of health inequalities requires the availability of up-to-date socioeconomic information on health databases.

INTRODUCTION

The COVID-19 pandemic and the control measures adopted since its inception have had a short- and medium-term impact on the supply of and access to preventive and curative health services globally, for a multiplicity of acute and chronic health conditions, including urgent ones, regardless of the burden of the epidemic in each area.[1 2]

The Italian network MIMICO-19 was set up in early 2020 to estimate the indirect effects of the pandemic on hospital utilisation and quality of care in seven regions representing the country. Early findings showed that during the first wave accesses to the emergency room, hospitalisations for cardiovascular diseases and for planned or oncological surgery dropped. Conversely, the timeliness of time-dependent interventions remained unchanged.[3]

Inequalities in access to healthcare are well documented, even in universal health systems.[4] The contraction in healthcare supply and utilisation caused by the SARS-CoV-2 epidemic can potentially exacerbate social inequalities in health in the context of a syndemic pandemic resulting from the interaction between the unequal distribution of the COVID-19 burden, the non-communicable diseases, and the social determinants of health.[5 6] However, whereas there is a mounting literature unveiling the socially patterned nature of the pandemic and showing that COVID-19 risks and unfavourable outcomes are higher among black and minority ethnic groups,[7] and individuals from socioeconomically deprived backgrounds,[8-10] little is known about the indirect effects of COVID-19 on health and healthcare inequalities. Despite early concerns about the disproportionately large negative impact of the disruption of care on vulnerable populations,[11] to the best of our knowledge, only few studies have investigated how the pandemic is undermining the equity of access to and utilisation of health services for conditions other than COVID-19.[12-14]

The main objective of the study is therefore to evaluate the indirect impact of COVID-19 and related containment measures on socioeconomic inequalities in hospital utilisation and quality of care through a selection of validated indicators in Italy. The secondary objective is to assess potential variations in gradients by sex and age class.

METHODS

Study design, population, and data sources

This is a multi-centre retrospective study carried out within the MIMICO-19 network[3] and based on the individual record linkage of regional health administrative and statistical data sources via a unique anonymous key.[15] Socioeconomic information relevant for the study were available for five regions (Piedmont, Emilia-Romagna, Tuscany, Puglia, Sicily) and two metropolitan areas: the local health unit of Milan (ATS Milan) and the municipality of Rome.

The study population, derived from the health population registers, consisted of the residents as of 1st January 2018 in each of the abovementioned geographical areas aged ≥30 years in 2011 and still alive during the observation time.

We considered two observation periods: (1) pandemic period, which was further split into two subperiods: lockdown (9th March to 18th May 2020) and post-lockdown (19th May to 30th September 2020); (2) comparison period covering the average of the corresponding subperiods in 2018-19.

Hospital Discharges and Emergency Room (ER) archives were used to retrieve the outcomes of interest. The last census, held in 2011, was the source of the information on the socioeconomic position (SEP) measured through the individual educational level in adulthood (i.e., in those aged ≥30 years) and the deprivation index at the census block level.[16]

Outcomes

We chose 12 indicators of hospital utilisation and quality of care encompassing several clinical areas and validated within the National Healthcare Outcomes Programme, an evaluation programme run by the National Agency for Regional Healthcare Services.[17] Hospital utilisation was assessed through indicators of **volume**, defined as absolute number of cases or procedures: five for acute conditions, two for scheduled surgery, and three for oncological surgery. To represent the healthcare quality, we chose two indicators of **timeliness of procedures**. For each indicator, we included all episodes registered in the study population within the two observation periods. Table 1 reports the indicators, the ICD-9 codes used in their definition, and their availability.

Table 1: list of indicators with their selection criteria (ICD-9-CM codes, and age and sex were applicable) and geographical availability

Category	Indicator	International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM Diseases) codes and other classifications	Geographical availability
Volumes: acute conditions	Total accesses to Emergency Room	NA	All
	Accesses to Emergency Room for life-threatening conditions (ER emergency)	Triage code: red (life-threatening condition requiring immediate care)	All except Tuscany and Rome
	Hospitalisation for ST-elevation myocardial infarction (STEMI)	Diseases: 410.xx, excluding 410.7x, 410.9x	All
	Hospitalisation for ischaemic stroke	Diseases: 433.x1, 434.x1, 436 excluding 430, 431, 432.x	All
	Hospitalisation for femoral neck fracture in subject aged ≥65 years	Diseases: 820.xx and age >=65 (excluding rehabilitation and long-term care)	All
Volumes: scheduled surgery	Knee replacement surgery	Procedures: 81.54, 81.55, 00.80, 00.81, 00.82, 00.83, 00.84	All
	Benign prostatic hyperplasia surgery	Diseases: 600.xx, 601.xx, 602.0, 602.1, 602.2, 788.2x, 788.4x, procedures: 60.2x, 60.96, 60.97, men	All
Volumes: oncological surgery	Surgery for malignant neoplasm of breast	Diseases: 174.x, 198.81, 233.0 and procedures: 85.2x, 85.33, 85.34, 85.35, 85.36, 85.4x, women	All
	Surgery for malignant neoplasm of lung	Diseases: 162.2, 162.3, 162.4, 162.5, 162.8, 162.9, 197.0 and procedures: 32.3, 32.4, 32.5, 32.6, 32.9, 32.29	All
	Surgery for malignant neoplasm of colon and rectum	Colon: diseases: 153.x, 197.5 and procedures: 45.7x, 45.8, 45.9x, 46.03, 46.04, 46.1x excluded diseases: 48.49, 48.5, 48.6. Rectum: diseases: 154.x, 197.5 and procedures: 48.49, 48.5, 48.6x excluded procedures: 45.7x, 45.8, 45.9x, 46.03, 46.04, 46.1x	All
Timeliness of procedures	Percutaneous transluminal coronary angioplasty (PTCA) interventions within 90' in patients with STEMI	Numerator: procedures 00.66, 36.01, 36.02, 36.05, 36.06, 36.07 within 90' from admission. Denominator: diseases: 410.xx, excluding 410.7x, 410.9x	All except ATS Milan, Emilia-Romagna, Tuscany
	Surgery within 2 days in femoral neck fracture in subject aged ≥65 years	Numerator: procedures 81.51, 81.52, 79.00, 79.05, 79.10, 79.15, 79.20, 79.25, 79.30, 79.35, 79.40, 79.45, 79.50, 79.55 within 2 days from the admission. Denominator: diseases: 820.xx in subjects aged ≥65 years	All

Exposures and other variables

Educational level was our primary SEP indicator, because it is a reliable measure that bridges socioeconomic conditions from early life to adulthood.[18] It was classified into three levels according to the highest attained qualification: low (primary education or less, corresponding to the 0-1 levels of the International Standard Classification of Education 1997, modified in 2011 (ISCED-11)[19]), middle (lower secondary and short-cycle upper secondary education, ISCED-11: 2-3C), high (from completed upper secondary onwards, ISCED-11: from 3A/B upwards). However, information on education was only available for three regions (Piedmont, Emilia-Romagna, Puglia) and the municipality of Rome.[15] Therefore, we also used the deprivation index at the census block, as a proxy of individual SEP,[20] which was available for all geographical areas included in the study. It was grouped into five quintiles (1 less deprived, 5 more deprived) and used in the secondary analyses whose results are commented in the text but only reported in the supplemental material.

Age was classified into 5-year age bands (30-34, 35-39, …, 85+) for adjustment and into two groups (30-64, 65+) for stratification.

Statistical analyses

All analyses were carried out for each sex and age group to explore whether differences exist within these population groups.

To assess whether the association between SEP and outcomes was modified by the pandemic and the lockdown measures, we employed both a descriptive and an analytic approach.

First, we estimated age-standardised rates (number of episodes/population) for the volume indicators and age-standardised prevalence (number of procedures/total accesses eligible for that procedure) for the indicators of timeliness of procedures through direct standardisation using the 2013 European standard population.[21] Standardised rates were stratified by observation period and SEP indicator. To assess changes over time for each SEP stratum, we computed relative percent changes as the ratio between the difference of rates or prevalence in the pandemic and the pre-pandemic periods and the rates or prevalence in the pre-pandemic period.

Secondly, we fitted Poisson models (with robust errors for process indicators[22]) adjusted for age and geographical area, and with an interaction term between SEP indicators and period. Through these models, we estimated the Relative Index of Inequality (RII), a summary measure that quantifies the social gradient in relative terms,[23] for both the pandemic and the pre-pandemic periods. Values above 1 indicate worse outcomes in the most disadvantaged group whereas those below 1 in the most advantaged one. To test the interaction, we used the likelihood ratio test for volume indicators and the Wald test for timeliness of procedures indicators.

RESULTS

Inequalities by educational level

The four areas included in the main analysis covers approximately 9.5 million people, about 20% of the Italian inhabitants aged ≥30 years. Piedmont and Emilia-Romagna contribute for about 30% each, Rome for the 17%, and Puglia for the 25%; 42% and 47% of male and female population, respectively, were aged >65 years (table 2). During the first seven months of the pandemic, volumes of total accesses to ER and scheduled surgery dropped by approximately one third compared to 2018-19; the lowest reduction was registered for the malignant lung cancer surgery with a 4% decline among males and a 9% increase among women (absolute numbers for 2018-19 are reported in supplemental table 1).

Table 2: Age and geographical distribution of the population, absolute number (N) and column percentage (%) of hospital volumes and timeliness of procedures in 2020 and percent change from 2020 to 2018-19 by educational level and sex

		Men								Women							
		Total		Educational level						Total		Educational level					
				Low		Middle		High				Low		Middle		High	
		N	%	N	(%)	N	(%)	N	(%)	N	%	N	(%)	N	(%)	N	(%)
Population																	
Total		4494291	100	853490	19.0	1783627	39.7	1857174	41.3	5134520	100	1428677	27.8	1709058	33.3	1996785	38.9
Age group	**30-64**	2606502	58.0	144221	5.5	1170080	44.9	1292201	49.6	2728894	53.1	173263	6.3	1058505	38.8	1497126	54.9
	≥65	1887789	42.0	709269	37.6	613547	32.5	564973	29.9	2405626	46.9	1255414	52.2	650553	27.0	499659	20.8
Geographical area	**Piedmont**	1290467	28.7	242662	18.8	566651	43.9	481154	37.3	1463918	28.5	398520	27.2	565522	38.6	499876	34.1
	Emilia-Romagna	1342618	29.9	255449	19.0	544722	40.6	542447	40.4	1492872	29.1	400592	26.8	498879	33.4	593401	39.7
	Rome	722773	16.1	75723	10.5	212865	29.5	434185	60.1	891125	17.4	154230	17.3	245348	27.5	491547	55.2
	Puglia	1138433	25.3	279656	24.6	459389	40.4	399388	35.1	1286605	25.1	475335	36.9	399309	31.0	411961	32.0
Indicators of hospital volumes and timeliness of procedures																	
		Total	Percent change 2020 vs 2018-19	Educational level						Total	Percent change 2020 vs 2018-19	Educational level					
		N		Low		Middle		High		N		Low		Middle		High	
				N	(%)	N	(%)	N	(%)			N	(%)	N	(%)	N	(%)
Total accesses to Emergency Room	***All ages***	595599	-33.7	161428	27.1	249144	41.8	185027	31.1	575670	-39.2	210043	36.5	194423	33.8	171204	29.7
	30-64	290161	-33.1	23925	8.2	151785	52.3	114451	39.4	255816	-39.2	20388	8.0	112623	44.0	122805	48.0
	≥65	305438	-34.4	137503	45.0	97359	31.9	70576	23.1	319854	-39.2	189655	59.3	81800	25.6	48399	15.1
Accesses to Emergency Room for life-threatening conditions	***All ages***	18544	-7.8	7847	42.3	6515	35.1	4182	22.6	15678	-12.5	9600	61.2	3757	24.0	2321	14.8
	30-64	4797	-5.5	522	10.9	2647	55.2	1628	33.9	2401	-13.8	290	12.1	1179	49.1	932	38.8
	≥65	13747	-8.6	7325	53.3	3868	28.1	2554	18.6	13277	-12.3	9310	70.1	2578	19.4	1389	10.5
Access for ST-elevation myocardial infarction	***All ages***	4117	-6.6	1063	25.8	1706	41.4	1348	32.7	1681	-15.7	877	52.2	488	29.0	316	18.8
	30-64	1646	3.5	151	9.2	854	51.9	641	38.9	294	1.7	44	15.0	154	52.4	96	32.7
	≥65	2471	-12.4	912	36.9	852	34.5	707	28.6	1387	-18.7	833	60.1	334	24.1	220	15.9
Access for ischaemic stroke	***All ages***	4919	-10.2	2102	42.7	1664	33.8	1153	23.4	4749	-9.9	2984	62.8	1088	22.9	677	14.3
	30-64	924	3.5	85	9.2	515	55.7	324	35.1	457	9.3	60	13.1	222	48.6	175	38.3
	≥65	3995	-12.8	2017	50.5	1149	28.8	829	20.8	4292	-11.6	2924	68.1	866	20.2	502	11.7
Access for femoral neck fracture	**≥65**	3029	-5.8	1584	52.3	750	24.8	695	22.9	8875	-5.6	5840	65.8	1803	20.3	1232	13.9
Access for knee replacement surgery	***All ages***	2179	-22.5	694	31.8	949	43.6	536	24.6	4403	-28.5	2078	47.2	1500	34.1	825	18.7
	30-64	490	14.5	61	12.4	262	53.5	167	34.1	684	-7.8	96	14.0	385	56.3	203	29.7
	≥65	1689	-29.1	633	37.5	687	40.7	369	21.8	3719	-31.4	1982	53.3	1115	30.0	622	16.7
Access for prostatic hyperplasia surgery (M) or malignant breast cancer surgery (W)	***All ages***	3461	-34.2	723	20.9	1276	36.9	1462	42.2	6984	-14.2	1641	23.5	2379	34.1	2964	42.4
	30-64	857	-11.1	36	4.2	360	42.0	461	53.8	3568	-3.3	171	4.8	1327	37.2	2070	58.0
	≥65	2604	-39.3	687	26.4	916	35.2	1001	38.4	3416	-23.2	1470	43.0	1052	30.8	894	26.2
Access for malignant lung cancer surgery	***All ages***	933	-4.3	269	28.8	369	39.5	295	31.6	682	9.3	187	27.4	236	34.6	259	38.0
	30-64	203	35.3	12	5.9	119	58.6	72	35.5	204	20.0	16	7.8	81	39.7	107	52.5
	≥65	730	-11.5	257	35.2	250	34.2	223	30.5	478	5.3	171	35.8	155	32.4	152	31.8
Access for malignant colorectal cancer surgery	***All ages***	2186	-11.0	743	34.0	784	35.9	659	30.1	1876	-11.0	867	46.2	523	27.9	486	25.9
	30-64	462	2.7	31	6.7	217	47.0	214	46.3	416	6.7	50	12.0	171	41.1	195	46.9
	≥65	1724	-14.1	712	41.3	567	32.9	445	25.8	1460	-15.0	817	56.0	352	24.1	291	19.9
PTCA within 90' in ST-elevation myocardial infarction	***All ages***	1724	-8.2	378	21.9	739	42.9	607	35.2	501	-17.9	240	47.9	163	32.5	98	19.6
	30-64	807	2.3	71	8.8	416	51.5	320	39.7	109	-3.5	23	21.1	56	51.4	30	27.5
	≥65	917	-15.8	307	33.5	323	35.2	287	31.3	392	-21.1	217	55.4	107	27.3	68	17.3
Replacement surgery within 48 hours in femoral neck fracture	**≥65**	1906	-3.8	978	51.3	478	25.1	450	23.6	6175	-5.0	4049	65.6	1255	20.3	871	14.1

Figure 1 shows the relative percent changes in the age-standardised rates and prevalence by sex and age groups (underlying rates and details of percent changes are reported in supplemental table 2). Both rates and prevalence were generally lower during the pandemic year compared to 2018-19. Besides, relative percent reductions of volumes rates were generally greater among the low educated of both sexes and age groups; on the contrary, reductions on the prevalence of timely procedures were less pronounced and not explicitly socially patterned. Women experienced larger declines than men. Subjects aged ≥65 years experienced the greater contraction in hospital volumes compared to the younger counterpart, except for accesses to the ER in both sexes and timeliness of PTCA among women.

These differential reductions were mirrored in the changes in the social gradient of volumes and timeliness indicators measured through the RII. For most of the indicators, educational differences were evident both in 2018-19 and in 2020; however, during the seven months of 2020 greater rates' drops occurred among the low educated and therefore the gradient for all volume indicators either shrank (for those whose risk was greater than 1, e.g., total ER access) or widened (for those whose risk was close to or lower than 1, e.g., prostatic hyperplasia surgery) (figure 2). Furthermore, there was an interaction between educational level and period suggesting significant changes in the educational gradient in 2020 for all volume indicators in both sexes. In the analyses by age group (figure 3), educational differentials were wider among men and people aged 30-64 years than their counterparts, although the uncertainty of the estimates was greater among the youngest mainly due to a small number of events in this age group. Moreover, some interactions lost their statistical significance. In the age group 30-64 years, reductions of the gradient remained significant only for ER accesses in both sexes and for indicators of prostatic hyperplasia surgery in men and breast cancer surgery in women. In the age group ≥65 years, the educational gradient significantly narrowed for indicators of ER access and scheduled surgery in both sexes, and for indicators of acute cardiovascular conditions (STEMI and ischaemic stroke) and lung cancer surgery among females.

Conversely, indicators of timeliness of procedures did not show neither a gradient nor relevant changes across time in both sexes and age groups.

Inequalities by deprivation index

The seven geographical areas for which the deprivation index was available totalled about 16 million individuals, one third of the Italian population aged ≥30 years (supplemental table 3).

Relative percent changes in the age-standardised rates for volume indicators and prevalence for timeliness of procedures indicators did not show a clear social gradient meaning that they were not consistently higher among the more or less deprived nor any difference between the two age groups emerged (supplemental figure 1 and table 4). As seen for education, declines were consistently greater among women. The RIIs revealed that, although inequalities in access to ER, cardiovascular acute conditions, and scheduled surgery were present before the pandemic, their magnitude did not substantially change in 2020 (supplemental figures 2 and 3), except for total ER access and malignant lung cancer surgery among all-ages males, total ER access among 30 to 64-year-old women and malignant colorectal cancer among women aged ≥65 years. It is worth noting that for total ER access the gradient by deprivation index showed a tendency to widen, contrary to what happened for educational inequalities.

DISCUSSION

This multi-centre study covering seven Italian geographical areas showed that, compared to 2018-19, hospital volumes and, to a lesser extent, indicators of timeliness of procedures fell during the first seven months of the COVID-19 pandemic, with larger declines among women and the elderly. At the same time, the low educated of both sexes, who are at higher risk of baseline hospital admission because of their greatest burden of diseases, experienced larger drops in ER access and most of the hospitalisation rates, with a resulting shrinkage (or widening when the RRI was <1) of the educational gradient for volume indicators. Indicators of timeliness of procedures did not show any educational gradient neither before nor during the pandemic. The assessment of inequalities through the deprivation index returned a more nuanced picture with smaller differentials whose magnitude did not substantially change in 2020. Our results are in line with the scant evidence on the indirect effects of COVID-19 on healthcare inequalities showing that socially vulnerable individuals, women, and the elderly have suffered more from disruptions in healthcare provision.[12 13 14]

The reasons behind the global decrease in hospital utilisation during the pandemic are manifold and, arguably, deeply intertwined with the root causes of health inequalities. They span from the massive reorganisation of hospital care to the change in patients' behaviours, a possible decrease in disease incidence, and the presence of competing risks from COVID-19 and excess mortality.[1 2 24]

In Italy as elsewhere, the sudden widespread of the pandemic has triggered a profound reorganisation of the national health service, including the hospital system, with changes in the supply of services other than COVID-19 diagnosis and treatment and suspension and cancellation of deferrable interventions such as elective surgery.[25] Concurrently, the warnings about the SARS-CoV-2 and the "stay-at-home" messages issued by public authorities have likely induced a self-limitation of the demand in the population who worried about hospital contamination. The ability to access to and travel through healthcare services as well as to adhere to public health recommendations and realise whether a health problem is urgent enough to seek medical care or to wait and see is influenced by individual and system-level factors. These factors include socioeconomic position, culture and language, self-efficacy and perceived barriers, which together contribute to define the level of health literacy,[26] and system's complexity and acute care orientation.[27] In line with the results of a Danish study, we found that, during the pandemic, low educated people generally experienced a lower access to hospital compared to their higher educated counterpart. This may result from increased barriers of access, mostly experienced by socioeconomically vulnerable populations, due to the unexpected system's rearrangement and a restrictive interpretation of recommendations which led to avoidance of medical care for fear of COVID-19, for both potentially life-threatening conditions, such as myocardial infarction, and scheduled interventions, such as knee replacement.

Inequalities not only ran along the lines of SEP but also at the intersection with age and gender. Contractions in hospital utilisation were larger among the oldest subjects, a result that emerged also from a European multi-national study,[14] possibly linked to a greater fear of the infection consequences. We also found that women, especially those more disadvantaged, experienced larger drops in hospital access than men, another finding reported by previous researches.[13 14] This may reflect gender inequalities stemming from women often playing a central caring role in the family setting and prioritising relatives' needs over their own[13] and a greater compliance with activity-restraining policy measures.[28]

Decreased service utilisation may also result from an increase use of digital health solutions (e.g. telemedicine, online and apps information exchanges, remote patient engagement),[29] whose utilisation has ramped up during the pandemic, though not uniformly at national level.[30] Our information systems cannot currently capture trends in digital health and therefore we could not ascertain whether digital solutions have had a differential reach across social groups (e.g., larger use among deprived communities living in rural areas). However, it is worth recalling that overlooking equity issues in the development of digital care may further amplify existing health inequalities.[31]

The decrease in diseases' incidence, such as myocardial infarction and stroke, has also been claimed as a reason for reduced hospital access during the pandemic.[2] However, the lower utilisation is likely to be the effect of people avoiding hospitals, especially vulnerable groups as argued before, and eventually dying at home from untreated conditions rather than of a lower incidence. This hypothesis has been confirmed by Italian studies reporting a significant reduction of hospitalisations for myocardial infarction but also a concomitant increase in the out-of-hospital cardiac mortality.[32 33]

Italy has paid a very high toll in terms of mortality during the first pandemic phases;[34] the risk of all-cause and COVID-19-related death was higher among the elderly[35] and among deprived groups.[8] This competing risk from COVID-19 and excess mortality may have depleted the population in need of hospital assistance, especially the most disadvantaged and oldest pockets, and may partially explain the unequal decrease in hospital utilisation.

The good news is the absence of educational inequalities in PTCA interventions in STEMI patients and surgery for femoral neck fracture in the elderly, whose timelines was guaranteed during the pandemic. This result is in line with earlier findings of a study carried out in Lazio region that reported improvements over time in terms of equity due to an increasingly comparable management across educational levels for both PTCA in STEMI patients and femoral neck fracture surgery.[36] Authors argued that the greater is the urgency, the more the inequality decreases and that healthcare organisation and quality seems to be more important than patients' choice in time-sensitive procedures. Our findings too suggest that patients' hospital management is not affected by individual SEP and that health inequalities mostly originate outside secondary care and are driven by wider determinants (e.g., education, housing, working conditions, access to primary and preventive healthcare), which interact sindemically to shape people's exposure to noxious factors.

Estimates by deprivation did not show a clear social gradient nor significant changes between the pre-pandemic and pandemic period, even when we only considered the areas included in the main analyses by education (supplemental table 5). A certain degree of exposure misclassification and, to a lesser extent, the ecological bias inherent to the metric may explain these results. Indeed the deprivation index is based on 2011 sociodemographic data[16] whose distribution has sensibly changed in the last decade, especially in metropolitan areas, and therefore it may not accurately describe the current distribution of the social and material deprivation and dilute the association between SEP and outcomes.

Strengths and limitations

The is the first study to assess socioeconomic inequalities in hospital utilisation for conditions other than COVID-19 during the pandemic in Italy, and one of the few in Europe. It draws upon health information and administrative registries that virtually cover the entire resident population minimising the risk of selection bias and allow to follow people over time[37] and explore multiple outcomes simultaneously. Moreover, thanks to its wide geographical coverage, it provides a robust approximation of the national situation during the first pandemic phases. The study is not exempt from drawbacks. As recalled above, the information on SEP came from the 2011 census and may not accurately describe the current situation. However, the educational level is deemed to be stable after the age of 30[18] and therefore the 2011 data can still be considered a reliable source. Unfortunately, however, this information was available only for four regions. In order to implement a comprehensive and timely monitoring systems for health inequalities a more complete availability of socioeconomic data on health information systems would be desirable, as also recommended by the Joint Action on Health Equity Europe.[38] Results cannot be generalised beyond national borders because both the intensity with which the pandemic hit the country and the features of our national health system, which guarantees universal access to the population. Finally, the nature of our study did not allow to directly investigate the reasons behind the decrease in hospital utilisation and the underlying social patterns.

CONCLUSIONS AND IMPLICATIONS FOR POLICIES

During the first months of the COVID-19 pandemic in Italy, the low educated, the elderly, and the women experienced a significant ER access and hospitalisation contraction with the consequent shrinkage of the social gradient.

Mid and long-term consequences of this socially patterned reduction range from a surge in late-presenting conditions to a potential exacerbation of health inequalities among those groups that were already the most vulnerable before the pandemic. Besides public policies expanding social protection and public services,[6] the healthcare service as a whole should contribute to contrast health disparities worsened by COVID-19. As recommended by the Independent Panel for Pandemic Preparedness and Response, to protect the most vulnerable populations' health in the pandemics that may occur in the future, countries need to prepare effective, coordinated, and equity-oriented containment strategies.[39] To this extent, it is crucial to deliver a more efficient communication on how and when safely access care to enable people, particularly the most disadvantaged, to navigate the system. It is also vital to strengthen primary healthcare and preventive services to implement locally appropriate interventions and foster community participation and empowerment. These efforts, along with those needed to act on the wider social determinants, require a sustained financial support in terms of human resources and infrastructures as envisaged in the Italian National Recovery and Resilience Plan[40] that represents an unprecedented opportunity to tackle health inequalities.

Contributors

CDG, TS, RG, and GCo designed the study. CDG conducted the analysis and drafted the first version of the manuscript, RG and TS contributed to subsequent versions. CDG, TL, SF, MF, EC, GCe, AGR, OL, CF, and AA were involved in the data collection and preparation at local level. All authors were involved in critically revising the manuscript and approving the final version.

Competing interests

None of the authors declare competing interests.

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Patients consent for publication

Unidentifiable aggregated data were used to carry out secondary analyses on information that are already routinely collected for administrative reasons by participating institutions (regional health authorities and local health units), and that subsequently feed the national information system of the Ministry of Health. Investigators had full access to all anonymised databases. The set of indicators analysed are validated within the PNE National Healthcare Outcomes Programme, a national evaluation programme run by the National Agency for Regional Healthcare Services; their use is authorised for routine activities of quality improvement and health service research by regional health authorities and for which individuals' written consent is not required under the current national regulation (latest ministerial decree number 261 issued on the 07/12/2016).

Data availability statement

Individual anonymous data from health administrative databases have been processed at each regional health department, under appropriate privacy regulations, and only unidentifiable aggregated data have been shared with the researcher who carried out the analysis. Authors followed the RECORD guidelines for reporting observational studies. The health administrative databases which are the data sources of this study are not publicly available; the unidentifiable aggregated data will be available from the corresponding author upon reasonable request.

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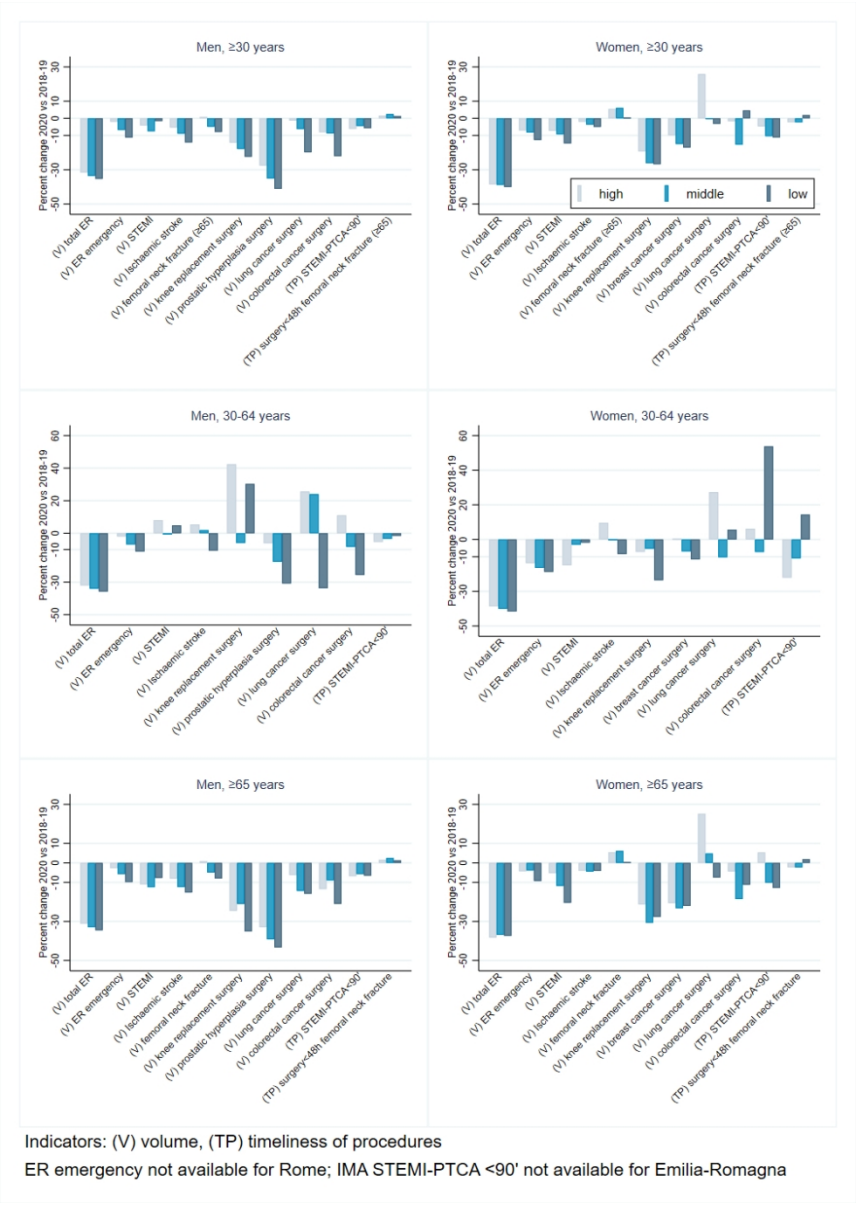
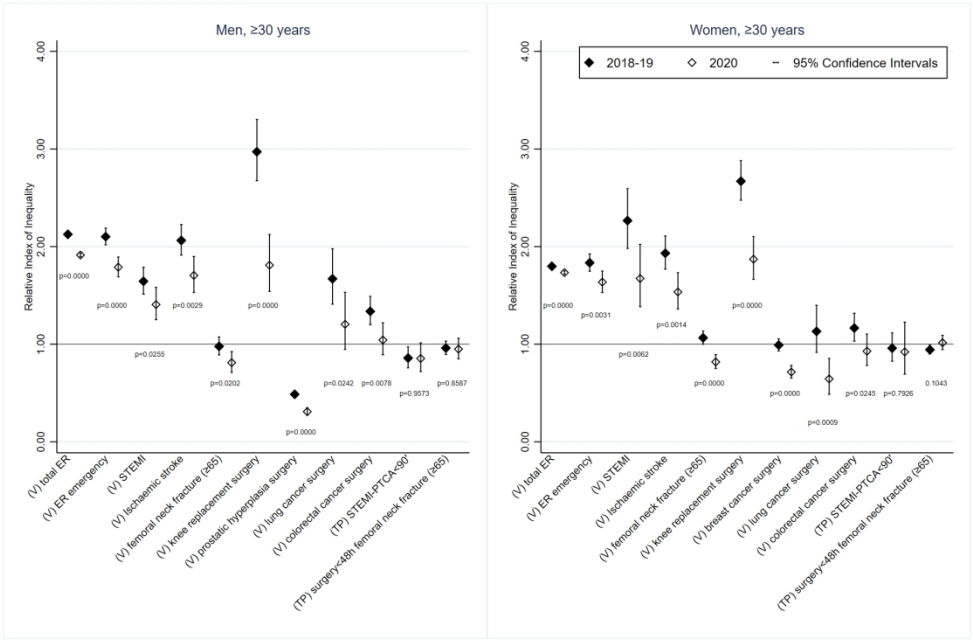


Figure 1. Relative percent changes of age-standardised rates for the volume indicators and age-standardised prevalence for the timeliness of procedure indicators by educational level, sex, and age group

354x496mm (72 x 72 DPI)

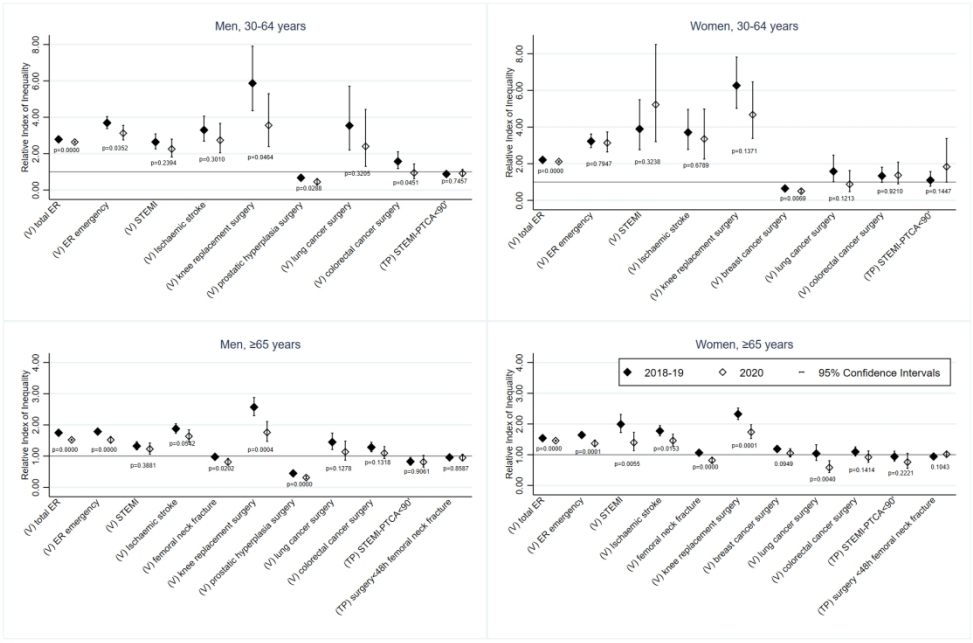


Indicators: (V) volumes, (TP) timeliness of procedures; p: p-value for interaction

ER emergency not available for Rome; IMA STEMI-PTCA <90' not available for Emilia-Romagna

Figure 2. Relative Index of Inequality and 95% confidence intervals by educational level, hospital volumes and timeliness of procedure indicators and period, and sex, all ages

694x496mm (72 x 72 DPI)



Indicators: (V) volumes, (TP) timeliness of procedures; p: p-value for interaction

ER emergency not available for Rome; IMA STEMI-PTCA <90' not available for Emilia-Romagna

Figure 3. Relative Index of Inequality and 95% confidence intervals by educational level, hospital volumes and timeliness of procedure indicators, period, sex, and age group

694x496mm (72 x 72 DPI)

Indirect impact of the COVID-19 pandemic and its containment measures on social inequalities in hospital utilisation in Italy

Supplemental material

Supplemental table 1: average absolute number (N) and column percentage (%) of hospital volumes and timeliness of procedures indicators in 2018-19 by educational level and sex

			Men							Women						
			Educational level						Total	Educational level						Total
			Low		Middle		High			Low		Middle		High		
			N	(%)	N	(%)	N	(%)	N	N	(%)	N	(%)	N	(%)	N
2018-2019 average	**Total accesses to Emergency room**	***Total***	254671	28.3	373486	41.6	270579	30.1	898736	351487	37.1	316546	33.4	279223	29.5	947256
		30-64	36494	8.4	228500	52.7	168479	38.9	433473	34512	8.2	186186	44.2	200371	47.6	421069
		≥65	218177	46.9	144986	31.2	102100	21.9	465263	316975	60.2	130360	24.8	78852	15.0	526187
	Accesses to Emergency Room for life-threatening conditions	***Total***	8900	44.2	6982	34.7	4240	21.1	20122	11294	63.0	4084	22.8	2549	14.2	17927
		30-64	566	11.1	2888	56.9	1624	32.0	5078	339	12.2	1375	49.4	1070	38.4	2784
		≥65	8334	55.4	4094	27.2	2616	17.4	15044	10955	72.3	2709	17.9	1479	9.8	15143
	Access for ST-elevation myocardial infarction (STEMI)	***Total***	1214	27.5	1834	41.6	1362	30.9	4410	1146	57.4	527	26.4	322	16.1	1995
		30-64	142	8.9	866	54.5	582	36.6	1590	39	13.5	147	50.9	103	35.6	289
		≥65	1072	38.0	968	34.3	780	27.7	2820	1107	64.9	380	22.3	219	12.8	1706
	Access for ischaemic stroke	***Total***	2485	45.4	1805	33.0	1185	21.6	5475	3480	66.0	1130	21.4	663	12.6	5273
		30-64	93	10.4	501	56.1	299	33.5	893	52	12.4	217	51.9	149	35.6	418
		≥65	2392	52.2	1304	28.5	886	19.3	4582	3428	70.6	913	18.8	514	10.6	4855
	Access for femoral neck fracture	***≥65***	1766	54.9	780	24.2	671	20.9	3217	6500	69.2	1736	18.5	1162	12.4	9398
	Access for knee replacement surgery	***Total***	1098	39.1	1134	40.4	578	20.6	2810	3183	51.7	2010	32.6	968	15.7	6161
		30-64	44	10.3	277	64.7	107	25.0	428	131	17.7	407	54.9	204	27.5	742
		≥65	1054	44.2	857	36.0	471	19.8	2382	3052	56.3	1603	29.6	764	14.1	5419
	Access for prostatic hyperplasia surgery (M) or malignant breast cancer surgery (W)	***Total***	1375	26.2	1931	36.7	1951	37.1	5257	2190	26.9	2789	34.3	3158	38.8	8137
		30-64	52	5.4	432	44.8	480	49.8	964	208	5.6	1426	38.6	2056	55.7	3690
		≥65	1323	30.8	1499	34.9	1471	34.3	4293	1982	44.6	1363	30.6	1102	24.8	4447
	Access for malignant lung cancer surgery	***Total***	328	33.6	374	38.4	273	28.0	975	209	33.5	230	36.9	185	29.6	624
		30-64	13	8.7	87	58.0	50	33.3	150	12	7.1	85	50.0	73	42.9	170
		≥65	315	38.2	287	34.8	223	27.0	825	197	43.4	145	31.9	112	24.7	454
	Access for malignant colorectal cancer surgery	***Total***	931	37.9	847	34.5	678	27.6	2456	1026	48.7	609	28.9	472	22.4	2107
		30-64	37	8.2	233	51.8	180	40.0	450	34	8.7	183	46.9	173	44.4	390
		≥65	894	44.6	614	30.6	498	24.8	2006	992	57.8	426	24.8	299	17.4	1717
	Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	***Total***	458	24.4	808	43.0	612	32.6	1878	325	53.3	192	31.5	93	15.2	610
		30-64	69	8.7	432	54.8	288	36.5	789	16	14.2	62	54.9	35	31.0	113
		≥65	389	35.7	376	34.5	324	29.8	1089	309	62.2	130	26.2	58	11.7	497
	Replacement surgery within 48 hours in femoral neck fracture	***≥65***	1076	54.3	481	24.3	424	21.4	1981	4426	68.1	1241	19.1	836	12.9	6503

Supplemental table 2: age-standardised rates for volume indicators and age-standardised prevalence for the timeliness of procedures indicators (per 100,000 persons) with their corresponding 95% confidence intervals (95% CI) and relative percent changes by sex, age group, and educational level

Hospital access indicators	Age group	Educational level: High							Middle							Low						
		Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		*Relative percent change*	Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		*Relative percent change*	Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		*Relative percent change*
Men																						
Total accesses to Emergency Room	Total	15034.3	14997.2	15071.5	10274.9	10230.1	10319.7	*-31.7*	21208.3	21165.1	21251.5	14078.4	14026.4	14130.4	*-33.6*	26328.0	26211.1	26445.0	17024.4	16884.7	17164.2	*-35.3*
	30-64	13046.1	13004.9	13087.2	8863.2	8814.1	8912.3	*-32.1*	19728.7	19676.2	19781.1	13009.2	12946.6	13071.7	*-34.1*	25664.5	25486.8	25842.1	16467.5	16255.7	16679.4	*-35.8*
	≥65	18450.1	18378.0	18522.2	12700.2	12612.4	12788.1	*-31.2*	23750.2	23675.1	23825.3	15915.3	15823.6	16007.0	*-33.0*	27467.9	27379.1	27556.8	17981.1	17872.8	18089.5	*-34.5*
Accesses to Emergency Room for life-threatening conditions	Total	258.3	252.8	263.9	253.1	245.4	260.9	*-2.0*	399.5	392.8	406.2	372.1	363.0	381.2	*-6.9*	567.9	551.4	584.4	504.0	482.9	525.2	*-11.2*
	30-64	126.7	122.3	131.0	126.0	119.9	132.1	*-0.5*	238.3	232.0	244.5	217.4	209.0	225.9	*-8.7*	371.4	347.4	395.4	322.3	291.7	352.9	*-13.2*
	≥65	484.6	471.4	497.7	471.6	453.2	489.9	*-2.7*	676.5	661.8	691.1	637.7	617.6	657.8	*-5.7*	905.5	888.0	923.0	816.2	792.7	839.8	*-9.9*
Access for ST-elevation myocardial infarction (STEMI)	Total	81.2	78.2	84.3	77.8	73.6	82.1	*-4.2*	101.2	97.9	104.5	93.6	89.1	98.1	*-7.6*	106.5	99.6	113.5	104.8	94.7	115.0	*-1.6*
	30-64	46.0	43.4	48.6	49.7	45.8	53.5	*8.1*	67.7	64.5	70.9	67.1	62.6	71.7	*-0.8*	81.9	71.9	92.0	85.9	71.3	100.6	*4.9*
	≥65	141.8	134.7	148.8	126.2	116.8	135.6	*-11.0*	158.9	151.8	165.9	139.0	129.7	148.4	*-12.5*	148.8	140.9	156.7	137.3	126.2	148.4	*-7.7*
Access for ischaemic stroke	Total	76.3	73.2	79.4	72.2	68.0	76.4	*-5.4*	104.4	101.0	107.8	95.0	90.4	99.7	*-9.0*	130.4	124.5	136.3	112.1	104.2	119.9	*-14.1*
	30-64	23.9	22.0	25.8	25.2	22.5	28.0	*5.4*	39.4	37.0	41.9	40.2	36.7	43.7	*1.9*	50.7	43.1	58.2	45.2	35.1	55.4	*-10.7*
	≥65	166.3	158.6	174.0	152.8	142.4	163.3	*-8.1*	216.0	207.7	224.3	189.3	178.3	200.2	*-12.4*	267.4	257.9	276.9	226.8	214.4	239.2	*-15.2*
Access for femoral neck fracture	≥65	132.6	125.6	139.7	133.7	123.7	143.7	*0.8*	132.3	125.7	138.8	125.7	116.7	134.7	*-5.0*	138.3	132.9	143.7	127.3	119.8	134.8	*-8.0*
Access for knee replacement surgery	Total	37.8	35.7	40.0	32.4	29.6	35.2	*-14.3*	65.5	62.8	68.2	53.8	50.3	57.2	*-17.9*	74.8	70.5	79.0	58.0	51.9	64.1	*-22.4*
	30-64	9.2	8.0	10.4	13.1	11.1	15.1	*42.4*	21.4	19.7	23.2	20.2	17.7	22.6	*-5.9*	22.9	18.1	27.7	29.9	21.9	37.9	*30.3*
	≥65	87.0	81.5	92.5	65.6	58.9	72.4	*-24.6*	141.3	134.6	147.9	111.6	103.2	120.0	*-21.0*	163.9	155.7	172.0	106.3	96.8	115.9	*-35.1*
Access for prostatic hyperplasia surgery	Total	121.4	117.5	125.2	87.9	83.3	92.4	*-27.6*	111.3	107.8	114.9	72.3	68.3	76.2	*-35.1*	92.0	87.4	96.5	54.2	48.9	59.4	*-41.1*
	30-64	38.7	36.3	41.1	36.3	33.0	39.6	*-6.2*	33.1	30.9	35.3	27.3	24.5	30.2	*-17.5*	25.5	20.7	30.3	17.6	11.7	23.5	*-30.9*
	≥65	263.4	253.9	272.9	176.5	165.5	187.5	*-33.0*	245.7	236.9	254.5	149.4	139.7	159.1	*-39.2*	206.2	197.0	215.4	116.9	106.8	127.1	*-43.3*
Access for malignant lung cancer surgery	Total	18.5	17.0	20.0	18.2	16.1	20.3	*-1.4*	22.4	20.8	23.9	21.0	18.8	23.1	*-6.3*	25.3	22.6	28.0	20.3	17.1	23.5	*-19.9*
	30-64	4.5	3.7	5.3	5.6	4.3	6.9	*25.7*	7.4	6.3	8.5	9.2	7.5	10.9	*24.1*	9.0	5.8	12.2	6.0	2.4	9.5	*-33.7*
	≥65	42.5	38.7	46.4	39.9	34.6	45.1	*-6.3*	48.0	44.1	51.9	41.1	36.0	46.3	*-14.4*	53.3	48.6	58.1	44.9	38.6	51.2	*-15.8*
Access for malignant colorectal cancer surgery	Total	43.6	41.3	45.9	40.0	36.9	43.1	*-8.1*	49.0	46.7	51.4	44.7	41.5	47.8	*-8.9*	54.9	51.1	58.7	42.8	38.2	47.3	*-22.1*
	30-64	15.0	13.5	16.5	16.6	14.4	18.8	*11.1*	18.4	16.8	20.1	16.9	14.6	19.2	*-8.4*	20.0	15.4	24.6	14.9	9.5	20.3	*-25.6*
	≥65	92.7	87.0	98.4	80.3	72.8	87.8	*-13.4*	101.6	95.9	107.2	92.4	84.8	100.1	*-9.0*	114.8	108.3	121.4	90.7	82.5	98.9	*-21.0*
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	59.6	57.6	61.6	56.0	53.0	58.9	*-6.1*	58.9	57.1	60.7	56.2	53.6	58.9	*-4.5*	50.4	48.2	52.7	47.5	44.1	51.0	*-5.7*
	30-64	67.4	64.3	70.5	63.8	59.6	68.0	*-5.3*	67.6	65.1	70.1	65.2	61.5	68.9	*-3.5*	61.3	55.0	67.6	60.4	51.9	68.8	*-1.6*
	≥65	53.6	50.9	56.3	50.0	45.9	54.1	*-6.8*	51.1	48.7	53.6	48.2	44.5	52.0	*-5.7*	48.8	46.4	51.2	45.6	41.8	49.4	*-6.5*
Replacement surgery within 48 hours in femoral neck fracture	≥65	63.8	61.3	66.4	64.9	61.3	68.4	*1.6*	62.1	59.7	64.5	63.7	60.2	67.1	*2.5*	61.0	59.4	62.6	61.8	59.4	64.2	*1.3*
Women																						
Total accesses to Emergency Room	Total	14387.7	14351.2	14424.1	8845.2	8803.3	8887.1	*-38.5*	18866.3	18823.1	18909.4	11533.1	11483.2	11582.9	*-38.9*	21707.8	21596.3	21819.4	13006.4	12878.5	13134.3	*-40.1*
	30-64	13421.0	13382.3	13459.8	8230.2	8186.0	8274.5	*-38.7*	18234.3	18178.9	18289.7	10917.4	10854.2	10980.6	*-40.1*	21752.6	21580.0	21925.1	12697.7	12500.1	12895.4	*-41.6*
	≥65	16048.3	15975.0	16121.6	9901.7	9816.9	9986.5	*-38.3*	19951.9	19883.2	20020.6	12590.8	12509.8	12671.8	*-36.9*	21630.9	21567.5	21694.3	13536.8	13462.1	13611.5	*-37.4*
Accesses to Emergency Room for life-threatening conditions	Total	156.9	152.4	161.4	145.8	139.6	152.0	*-7.1*	227.9	222.8	232.9	209.0	202.2	215.8	*-8.3*	308.2	297.6	318.7	269.1	255.8	282.4	*-12.7*
	30-64	73.1	70.0	76.2	63.1	59.0	67.1	*-13.7*	127.0	122.1	132.0	106.1	99.8	112.4	*-16.5*	174.3	158.6	190.0	141.7	122.0	161.3	*-18.7*
	≥65	300.8	289.8	311.8	287.8	272.5	303.2	*-4.3*	401.1	390.4	411.9	385.6	370.6	400.6	*-3.9*	538.1	528.4	547.9	488.0	474.8	501.3	*-9.3*
Access for ST-elevation myocardial infarction (STEMI)	Total	22.8	21.0	24.5	21.1	18.7	23.5	*-7.3*	29.4	27.7	31.2	26.7	24.3	29.1	*-9.4*	35.3	32.3	38.3	30.1	26.2	34.0	*-14.6*
	30-64	7.8	6.8	8.8	6.6	5.3	7.9	*-15.0*	12.9	11.4	14.4	12.5	10.5	14.5	*-3.1*	17.4	13.2	21.6	17.1	11.6	22.6	*-1.8*
	≥65	48.5	44.0	53.0	46.0	39.8	52.1	*-5.2*	57.9	53.8	62.0	51.0	45.5	56.5	*-11.8*	66.0	62.3	69.7	52.5	47.9	57.1	*-20.5*
Access for ischaemic stroke	Total	47.6	45.0	50.2	46.6	43.0	50.3	*-2.0*	62.2	59.6	64.7	59.9	56.3	63.5	*-3.7*	76.9	73.1	80.7	73.0	68.1	78.0	*-5.0*
	30-64	11.0	9.8	12.2	12.0	10.2	13.8	*9.6*	18.6	16.8	20.4	18.6	16.0	21.1	*-0.4*	24.3	19.2	29.5	22.3	15.9	28.7	*-8.5*
	≥65	110.4	103.7	117.2	106.0	96.6	115.4	*-4.0*	137.0	130.7	143.3	130.9	122.1	139.6	*-4.5*	167.2	161.9	172.5	160.2	152.6	167.8	*-4.1*
Access for femoral neck fracture	≥65	245.0	235.0	255.1	258.5	243.8	273.1	*5.5*	251.5	243.0	259.9	266.9	254.5	279.3	*6.2*	268.2	262.3	274.0	269.2	260.4	278.1	*0.4*
Access for knee replacement surgery	Total	71.2	68.0	74.4	57.4	53.4	61.5	*-19.3*	114.1	110.5	117.6	84.2	79.9	88.5	*-26.2*	137.8	133.0	142.6	100.8	94.7	107.0	*-26.8*
	30-64	15.5	14.0	17.0	14.4	12.4	16.4	*-7.2*	31.9	29.7	34.0	30.2	27.1	33.2	*-5.3*	44.0	38.3	49.6	33.6	26.3	40.9	*-23.6*
	≥65	166.8	158.4	175.2	131.3	120.8	141.8	*-21.3*	255.4	246.5	264.2	177.0	166.6	187.4	*-30.7*	299.0	290.3	307.8	216.3	205.3	227.4	*-27.7*
Access for malignant breast cancer surgery	Total	170.4	166.0	174.8	153.5	147.7	159.3	*-9.9*	158.5	154.3	162.8	134.7	129.2	140.2	*-15.0*	130.7	123.4	138.1	108.4	98.3	118.6	*-17.0*
	30-64	138.3	134.1	142.5	138.6	132.6	144.6	*0.3*	125.8	121.1	130.6	117.2	110.6	123.7	*-6.9*	98.5	87.7	109.4	87.1	72.0	102.3	*-11.6*
	≥65	225.7	216.1	235.2	179.1	167.2	191.0	*-20.6*	214.7	206.6	222.8	164.9	154.9	174.9	*-23.2*	186.1	178.9	193.2	145.0	136.1	154.0	*-22.0*
Access for malignant lung cancer surgery	Total	13.0	11.7	14.3	16.3	14.2	18.4	*25.8*	13.3	12.1	14.5	13.2	11.5	14.9	*-0.4*	12.0	10.1	13.9	11.6	9.1	14.2	*-3.2*
	30-64	5.9	5.0	6.8	7.5	6.1	9.0	*27.4*	7.3	6.2	8.4	6.5	5.1	8.0	*-10.3*	6.2	3.5	8.8	6.5	3.1	9.9	*5.6*
	≥65	25.1	21.9	28.2	31.4	26.3	36.4	*25.2*	23.6	20.9	26.3	24.8	20.8	28.7	*4.8*	22.1	19.6	24.6	20.4	16.8	24.0	*-7.5*
Access for malignant colorectal cancer surgery	Total	32.0	29.9	34.1	31.5	28.5	34.4	*-1.7*	34.4	32.4	36.3	29.1	26.6	31.6	*-15.4*	35.5	32.8	38.2	37.1	32.3	41.9	*4.7*
	30-64	12.7	11.4	14.1	13.5	11.6	15.4	*6.2*	15.3	13.7	16.8	14.2	12.0	16.3	*-7.2*	13.7	10.1	17.3	21.1	14.2	28.0	*53.8*
	≥65	65.1	60.0	70.3	62.3	55.0	69.5	*-4.4*	67.2	62.7	71.7	54.7	49.0	60.5	*-18.6*	72.8	68.8	76.9	64.6	59.2	70.1	*-11.2*
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	41.5	37.5	45.6	39.6	33.5	45.6	*-4.7*	49.1	45.8	52.4	43.9	39.0	48.9	*-10.5*	39.7	37.4	42.0	35.3	31.7	38.8	*-11.2*
	30-64	49.4	41.8	57.1	38.5	27.8	49.3	*-22.1*	58.2	51.9	64.5	51.8	42.6	61.0	*-11.0*	51.2	39.9	62.5	58.6	43.1	74.0	*14.4*
	≥65	38.0	33.2	42.8	40.1	32.7	47.4	*5.4*	45.4	41.5	49.2	40.8	34.9	46.6	*-10.2*	39.1	36.8	41.5	34.1	30.5	37.7	*-12.9*
Replacement surgery within 48 hours in femoral neck fracture	≥65	72.2	70.4	74.0	70.6	68.0	73.1	*-2.3*	71.7	70.2	73.2	70.0	67.9	72.1	*-2.4*	68.1	67.3	68.9	69.4	68.2	70.6	*1.9*

Supplemental table 3: age and geographical distribution of the population, absolute number (N) and column percentage (%) of hospital volumes and timeliness of procedures indicators in 2020 and 2018-19 and percent change from 2020 to 2018-19, by deprivation index and sex (A: men, B: women)

A. Men

			Deprivation quintile										Total	Percent change 2020 vs 2018-19
			1 (less deprived)		2		3		4		5 (more deprived)		N	
			N	(%)	N	(%)	N	(%)	N	(%)	N	(%)		
Population														
Total			1555281	20.5	1521400	20.1	1500317	19.8	1501864	19.8	1492710	19.7	7571572	na
Age group	**30-64**		863651	19.4	881424	19.8	886266	19.9	907915	20.4	922144	20.7	4461400	na
	≥65		691630	22.2	639976	20.6	614051	19.7	593949	19.1	570566	18.3	3110172	na
Geographical area	**Piedmont**		271181	21.1	261976	20.4	258600	20.1	252664	19.6	242614	18.9	1287035	na
	ATS Milan		214583	20.3	208574	19.7	210293	19.8	209179	19.7	217024	20.5	1059653	na
	Emilia-Romagna		278300	22.0	258567	20.4	248324	19.6	242902	19.2	238182	18.8	1266275	na
	Tuscany		196044	19.8	198879	20.1	196350	19.9	199073	20.1	197970	20.0	988316	na
	Rome		144518	20.1	145261	20.2	145853	20.3	144935	20.1	139612	19.4	720179	na
	Puglia		232007	20.7	225888	20.1	222383	19.8	221511	19.7	219907	19.6	1121696	na
	Sicily		218648	19.4	222255	19.7	218514	19.4	231600	20.5	237401	21.0	1128418	na
Indicators of hospital volumes and timeliness of procedures														
2020	**Total accesses to Emergency Room**	***Total***	136662	19.1	134192	18.7	137331	19.2	142904	20.0	164957	23.0	716046	-33.5
		30-64	60591	17.3	63815	18.2	66756	19.0	71929	20.5	87639	25.0	350730	-33.0
		≥65	76071	20.8	70377	19.3	70575	19.3	70975	19.4	77318	21.2	365316	-34.0
	Accesses to Emergency Room for life-threatening conditions	***Total***	5648	20.1	5277	18.8	5331	19.0	5514	19.6	6312	22.5	28082	-7.1
		30-64	1279	16.9	1341	17.7	1437	19.0	1540	20.4	1968	26.0	7565	-2.9
		≥65	4369	21.3	3936	19.2	3894	19.0	3974	19.4	4344	21.2	20517	-8.6
	Access for ST-elevation myocardial infarction (STEMI)	***Total***	1300	18.8	1312	19.0	1359	19.7	1400	20.3	1542	22.3	6913	-6.4
		30-64	493	16.6	514	17.3	596	20.1	617	20.8	743	25.1	2963	5.3
		≥65	807	20.4	798	20.2	763	19.3	783	19.8	799	20.2	3950	-13.6
	Access for ischaemic stroke	***Total***	1719	20.6	1605	19.2	1676	20.1	1648	19.7	1704	20.4	8352	-10.4
		30-64	289	17.5	298	18.1	315	19.1	334	20.3	411	25.0	1647	6.1
		≥65	1430	21.3	1307	19.5	1361	20.3	1314	19.6	1293	19.3	6705	-13.7
	Access for femoral neck fracture	***≥65***	1248	23.4	1061	19.9	1009	18.9	1025	19.2	990	18.6	5333	-6.8
	Access for knee replacement surgery	***Total***	833	21.3	836	21.4	789	20.2	752	19.3	692	17.7	3902	-24.7
		30-64	166	19.4	182	21.3	178	20.8	166	19.4	162	19.0	854	6.4
		≥65	667	21.9	654	21.5	611	20.0	586	19.2	530	17.4	3048	-30.4
	Access for prostatic hyperplasia surgery	***Total***	1291	22.8	1180	20.8	1121	19.8	1115	19.7	958	16.9	5665	-34.4
		30-64	303	21.1	300	20.8	297	20.6	303	21.1	236	16.4	1439	-11.0
		≥65	988	23.4	880	20.8	824	19.5	812	19.2	722	17.1	4226	-39.8
	Access for malignant lung cancer surgery	***Total***	376	22.6	308	18.5	329	19.8	316	19.0	335	20.1	1664	-8.5
		30-64	70	19.1	69	18.8	74	20.2	68	18.5	86	23.4	367	20.3
		≥65	306	23.6	239	18.4	255	19.7	248	19.1	249	19.2	1297	-14.3
	Access for malignant colorectal cancer surgery	***Total***	763	21.2	745	20.7	727	20.2	686	19.1	678	18.8	3599	-11.4
		30-64	152	19.4	149	19.1	152	19.4	171	21.9	158	20.2	782	6.0
		≥65	611	21.7	596	21.2	575	20.4	515	18.3	520	18.5	2817	-15.2
	Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	***Total***	336	19.6	333	19.5	344	20.1	316	18.5	381	22.3	1710	-7.9
		30-64	142	17.8	136	17.0	172	21.5	159	19.9	190	23.8	799	2.4
		≥65	194	21.3	197	21.6	172	18.9	157	17.2	191	21.0	911	-15.4
	Replacement surgery within 48 hours in femoral neck fracture	***≥65***	766	23.6	646	19.9	598	18.5	644	19.9	586	18.1	3240	6.0
2018-2019 average	**Total accesses to Emergency Room**	***Total***	206747	19.2	202416	18.8	207566	19.3	215099	20.0	245591	22.8	1077419	na
		30-64	90777	17.3	95431	18.2	100714	19.2	107606	20.6	129057	24.6	523585	na
		≥65	115970	20.9	106985	19.3	106852	19.3	107493	19.4	116534	21.0	553834	na
	Accesses to Emergency Room for life-threatening conditions	***Total***	6058	20.0	5634	18.6	5834	19.3	5928	19.6	6772	22.4	30226	na
		30-64	1286	16.5	1407	18.1	1497	19.2	1576	20.2	2021	26.0	7787	na
		≥65	4772	21.3	4227	18.8	4337	19.3	4352	19.4	4751	21.2	22439	na
	Access for ST-elevation myocardial infarction (STEMI)	***Total***	1393	18.9	1436	19.4	1452	19.7	1489	20.2	1617	21.9	7387	na
		30-64	475	16.9	539	19.2	538	19.1	584	20.8	677	24.1	2813	na
		≥65	918	20.1	897	19.6	914	20.0	905	19.8	940	20.6	4574	na
	Access for ischaemic stroke	***Total***	1957	21.0	1836	19.7	1792	19.2	1851	19.9	1884	20.2	9320	na
		30-64	272	17.5	272	17.5	299	19.3	332	21.4	378	24.3	1553	na
		≥65	1685	21.7	1564	20.1	1493	19.2	1519	19.6	1506	19.4	7767	na
	Access for femoral neck fracture	***≥65***	1329	23.2	1177	20.6	1099	19.2	1058	18.5	1061	18.5	5724	na
	Access for knee replacement surgery	***Total***	1084	20.9	1100	21.2	1042	20.1	1013	19.6	941	18.2	5180	na
		30-64	140	17.4	177	22.0	156	19.4	163	20.3	167	20.8	803	na
		≥65	944	21.6	923	21.1	886	20.2	850	19.4	774	17.7	4377	na
	Access for prostatic hyperplasia surgery	***Total***	2002	23.2	1758	20.4	1734	20.1	1617	18.7	1524	17.6	8635	na
		30-64	342	21.2	332	20.5	342	21.2	312	19.3	289	17.9	1617	na
		≥65	1660	23.7	1426	20.3	1392	19.8	1305	18.6	1235	17.6	7018	na
	Access for malignant lung cancer surgery	***Total***	358	19.7	346	19.0	368	20.2	353	19.4	393	21.6	1818	na
		30-64	45	14.8	61	20.0	58	19.0	64	21.0	77	25.2	305	na
		≥65	313	20.7	285	18.8	310	20.5	289	19.1	316	20.9	1513	na
	Access for malignant colorectal cancer surgery	***Total***	865	21.3	846	20.8	794	19.6	789	19.4	767	18.9	4061	na
		30-64	155	21.0	151	20.5	145	19.6	139	18.8	148	20.1	738	na
		≥65	710	21.4	695	20.9	649	19.5	650	19.6	619	18.6	3323	na
	Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	***Total***	361	19.4	360	19.4	355	19.1	385	20.7	396	21.3	1857	na
		30-64	129	16.5	144	18.5	146	18.7	175	22.4	186	23.8	780	na
		≥65	232	21.5	216	20.1	209	19.4	210	19.5	210	19.5	1077	na
	Replacement surgery within 48 hours in femoral neck fracture	***≥65***	812	23.6	717	20.8	678	19.7	617	17.9	623	18.1	3447	na

na = not applicable

B. Women

			Deprivation quintile										Total	Percent change 2020 vs 2018-19
			1 (less deprived)		2		3		4		5 (more deprived)			
			N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	
Population														
Total			1785509	20.6	1743921	20.1	1717738	19.8	1713345	19.8	1695694	19.6	8656207	na
Age group	**30-64**		913063	19.6	931541	20.0	934931	20.0	949448	20.3	940256	20.1	4669239	na
	≥65		872446	21.9	812380	20.4	782807	19.6	763897	19.2	755438	18.9	3986968	na
Geographical area	**Piedmont**		294749	20.2	294862	20.2	295050	20.2	293596	20.1	282937	19.4	1461194	na
	ATS Milan		249162	20.8	237432	19.8	237605	19.8	234780	19.6	239092	20.0	1198071	na
	Emilia-Romagna		303937	21.5	288550	20.4	278306	19.7	271954	19.3	268283	19.0	1411030	na
	Tuscany		226781	20.0	227569	20.1	224693	19.9	227410	20.1	224992	19.9	1131445	na
	Rome		185032	20.8	182232	20.5	179862	20.2	174493	19.6	168379	18.9	889998	na
	Puglia		269186	21.2	256448	20.2	252340	19.9	248210	19.5	244607	19.2	1270791	na
	Sicily		256662	19.8	256828	19.9	249882	19.3	262902	20.3	267404	20.7	1293678	na
Indicators of hospital volumes and timeliness of procedures														
2020	**Total accesses to Emergency Room**	***Total***	131909	18.8	131415	18.8	134547	19.2	140705	20.1	161444	23.1	700020	-39.4
		30-64	53826	17.3	56723	18.2	60225	19.3	64440	20.7	76391	24.5	311605	-39.7
		≥65	78083	20.1	74692	19.2	74322	19.1	76265	19.6	85053	21.9	388415	-39.1
	Accesses to Emergency Room for life-threatening conditions	***Total***	3916	20.1	3603	18.5	3689	18.9	3904	20.0	4392	22.5	19504	-12.1
		30-64	563	19.1	511	17.4	542	18.4	615	20.9	714	24.2	2945	-13.1
		≥65	3353	20.2	3092	18.7	3147	19.0	3289	19.9	3678	22.2	16559	-12.0
	Access for ST-elevation myocardial infarction (STEMI)	***Total***	504	18.0	546	19.5	559	20.0	557	19.9	628	22.5	2794	-13.5
		30-64	61	12.1	109	21.6	106	21.0	97	19.2	132	26.1	505	-0.4
		≥65	443	19.4	437	19.1	453	19.8	460	20.1	496	21.7	2289	-15.9
	Access for ischaemic stroke	***Total***	1605	20.1	1582	19.8	1588	19.9	1513	18.9	1708	21.4	7996	-11.7
		30-64	143	17.8	144	18.0	142	17.7	161	20.1	212	26.4	802	9.7
		≥65	1462	20.3	1438	20.0	1446	20.1	1352	18.8	1496	20.8	7194	-13.6
	Access for femoral neck fracture	***≥65***	3577	22.5	3124	19.6	3059	19.2	3068	19.3	3080	19.4	15908	-7.4
	Access for knee replacement surgery	***Total***	1593	20.8	1534	20.0	1521	19.9	1469	19.2	1542	20.1	7659	-31.0
		30-64	203	17.1	215	18.1	227	19.1	238	20.1	303	25.5	1186	-7.6
		≥65	1390	21.5	1319	20.4	1294	20.0	1231	19.0	1239	19.1	6473	-34.0
	Access for malignant breast cancer surgery	***Total***	2496	21.3	2402	20.5	2342	20.0	2292	19.5	2196	18.7	11728	-15.4
		30-64	1207	20.3	1235	20.8	1143	19.3	1234	20.8	1113	18.8	5932	-7.0
		≥65	1289	22.2	1167	20.1	1199	20.7	1058	18.3	1083	18.7	5796	-22.5
	Access for malignant lung cancer surgery	***Total***	250	21.1	216	18.3	223	18.9	243	20.5	251	21.2	1183	-0.4
		30-64	76	19.9	64	16.8	69	18.1	88	23.0	85	22.3	382	11.4
		≥65	174	21.7	152	19.0	154	19.2	155	19.4	166	20.7	801	-5.2
	Access for malignant colorectal cancer surgery	***Total***	681	22.3	591	19.4	619	20.3	598	19.6	564	18.5	3053	-13.0
		30-64	139	20.2	109	15.8	149	21.7	150	21.8	141	20.5	688	7.5
		≥65	542	22.9	482	20.4	470	19.9	448	18.9	423	17.9	2365	-17.6
	Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	***Total***	85	17.0	92	18.4	106	21.2	97	19.4	120	24.0	500	-16.8
		30-64	10	9.2	21	19.3	21	19.3	18	16.5	39	35.8	109	0.0
		≥65	75	19.2	71	18.2	85	21.7	79	20.2	81	20.7	391	-20.5
	Replacement surgery within 48 hours in femoral neck fracture	***≥65***	2400	22.5	2098	19.7	2100	19.7	2068	19.4	2007	18.8	10673	6.6
2018-2019 average	**Total accesses to Emergency Room**	***Total***	217951	18.9	216505	18.7	223822	19.4	232132	20.1	264848	22.9	1155258	na
		30-64	89265	17.3	94940	18.4	100500	19.4	106860	20.7	125486	24.3	517051	na
		≥65	128686	20.2	121565	19.0	123322	19.3	125272	19.6	139362	21.8	638207	na
	Accesses to Emergency room for life-threatening conditions	***Total***	4458	20.1	4124	18.6	4158	18.7	4393	19.8	5066	22.8	22199	na
		30-64	579	17.1	652	19.2	618	18.2	685	20.2	855	25.2	3389	na
		≥65	3879	20.6	3472	18.5	3540	18.8	3708	19.7	4211	22.4	18810	na
	Access for ST-elevation myocardial infarction (STEMI)	***Total***	629	19.5	637	19.7	587	18.2	655	20.3	721	22.3	3229	na
		30-64	86	17.0	102	20.1	91	17.9	108	21.3	120	23.7	507	na
		≥65	543	19.9	535	19.7	496	18.2	547	20.1	601	22.1	2722	na
	Access for ischaemic stroke	***Total***	1827	20.2	1823	20.1	1724	19.0	1801	19.9	1882	20.8	9057	na
		30-64	120	16.4	144	19.7	138	18.9	156	21.3	173	23.7	731	na
		≥65	1707	20.5	1679	20.2	1586	19.0	1645	19.8	1709	20.5	8326	na
	Access for femoral neck fracture	***≥65***	3829	22.3	3396	19.8	3356	19.5	3246	18.9	3354	19.5	17181	na
	Access for knee replacement surgery	***Total***	2258	20.3	2187	19.7	2211	19.9	2187	19.7	2253	20.3	11096	na
		30-64	219	17.1	213	16.6	267	20.8	271	21.1	313	24.4	1283	na
		≥65	2039	20.8	1974	20.1	1944	19.8	1916	19.5	1940	19.8	9813	na
	Access for malignant breast cancer surgery	***Total***	2975	21.5	2803	20.2	2775	20.0	2744	19.8	2559	18.5	13856	na
		30-64	1293	20.3	1301	20.4	1280	20.1	1314	20.6	1188	18.6	6376	na
		≥65	1682	22.5	1502	20.1	1495	20.0	1430	19.1	1371	18.3	7480	na
	Access for malignant lung cancer surgery	***Total***	267	22.5	224	18.9	225	18.9	239	20.1	233	19.6	1188	na
		30-64	71	20.7	64	18.7	67	19.5	65	19.0	76	22.2	343	na
		≥65	196	23.2	160	18.9	158	18.7	174	20.6	157	18.6	845	na
	Access for malignant colorectal cancer surgery	***Total***	722	20.6	718	20.5	684	19.5	672	19.2	713	20.3	3509	na
		30-64	114	17.8	137	21.4	127	19.8	137	21.4	125	19.5	640	na
		≥65	608	21.2	581	20.3	557	19.4	535	18.6	588	20.5	2869	na
	Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	***Total***	104	17.3	123	20.5	117	19.5	121	20.1	136	22.6	601	na
		30-64	13	11.9	21	19.3	21	19.3	28	25.7	26	23.9	109	na
		≥65	91	18.5	102	20.7	96	19.5	93	18.9	110	22.4	492	na
	Replacement surgery within 48 hours in femoral neck fracture	***≥65***	2549	22.3	2296	20.1	2250	19.7	2161	18.9	2177	19.0	11433	na

na = not applicable

Supplemental table 4: age-standardised rates for volume indicators and age-standardised prevalence for the timeliness of procedures indicators (per 100,000 persons) with their corresponding 95% confidence intervals (95% CI) and relative percent changes by sex, age group, and deprivation index

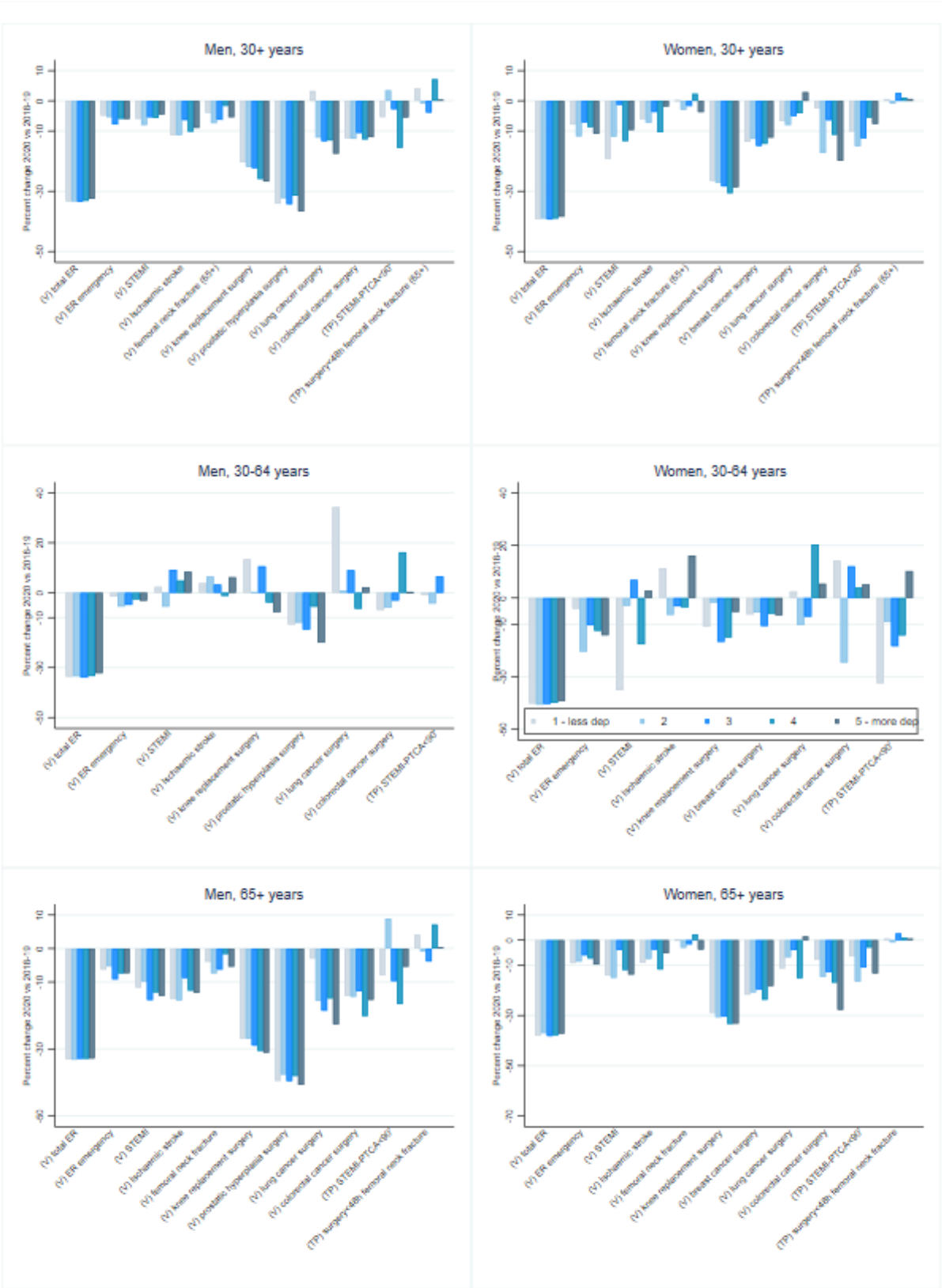
Hospital access indicators	Age group	Deprivation level																			
		1 (less deprived)							2							3					
		Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		relative percent change	Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		relative percent change	Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		relative percent change
Men																					
Total accesses to Emergency Room	Total	12394	12357	12431	8259	8216	8303	-33.4	12657	12620	12694	8437	8393	8481	-33.3	13249	13211	13288	8809	8764	8854	-33.5
	30-64	10495	10449	10541	6967	6913	7021	-33.6	10822	10775	10868	7201	7147	7256	-33.5	11361	11314	11408	7498	7443	7553	-34.0
	≥65	15656	15596	15717	10480	10407	10553	-33.1	15810	15747	15873	10559	10484	10635	-33.2	16493	16428	16558	11062	10983	11140	-32.9
Accesses to Emergency Room for life-threatening conditions	Total	311	305	317	296	288	304	-4.9	314	308	320	297	289	306	-5.4	338	331	344	311	303	320	-7.8
	30-64	145	140	151	143	135	151	-1.5	156	150	162	147	139	155	-5.5	166	160	172	158	150	166	-4.8
	≥65	596	584	609	559	542	576	-6.3	586	574	599	555	537	573	-5.3	633	619	646	575	556	593	-9.2
Access for ST-elevation myocardial infarction (STEMI)	Total	81	78	84	76	72	81	-6.0	88	85	91	81	77	86	-8.0	92	89	95	87	82	92	-5.4
	30-64	52	49	55	53	48	58	2.4	59	55	62	56	51	60	-5.5	59	55	62	64	59	69	9.2
	≥65	131	125	137	116	108	124	-11.6	139	132	145	125	116	134	-9.8	149	142	156	126	117	135	-15.4
Access for ischaemic stroke	Total	99	96	102	88	83	92	-11.4	101	97	104	89	85	94	-11.3	103	100	107	97	92	102	-6.4
	30-64	30	28	33	31	28	35	3.8	30	28	33	32	29	36	6.5	33	31	36	34	30	38	3.3
	≥65	218	210	225	185	175	195	-15.1	222	214	230	187	177	198	-15.5	224	216	232	204	193	215	-8.8
Access for femoral fracture	≥65	145	140	151	140	132	148	-3.9	145	140	151	135	126	143	-7.4	144	138	150	135	126	143	-6.3
Access for knee replacement surgery	Total	61	58	63	48	45	52	-20.4	67	64	70	52	49	56	-21.9	65	63	68	51	47	54	-22.3
	30-64	16	14	17	18	15	20	13.4	19	17	21	19	17	22	0.2	17	16	19	19	16	22	10.6
	≥65	138	132	144	101	93	109	-26.9	148	141	155	108	100	117	-26.9	148	141	155	105	97	113	-29.0
Access for prostatic hyperplasia surgery	Total	116	112	119	76	72	81	-34.1	109	105	113	74	70	78	-32.3	111	107	114	73	68	77	-34.3
	30-64	37	34	40	32	28	36	-12.7	36	33	39	32	28	35	-12.0	37	35	40	32	28	35	-14.8
	≥65	252	243	260	152	143	162	-39.5	234	226	243	146	136	156	-37.6	237	228	245	143	133	153	-39.6
Access for malignant lung cancer surgery	Total	21	20	23	22	20	24	3.3	22	20	24	19	17	21	-12.2	25	23	26	21	19	24	-13.4
	30-64	6	5	7	8	6	9	34.3	7	6	9	7	6	9	0.8	7	6	9	8	6	10	9.1
	≥65	48	45	52	47	42	52	-3.0	47	43	51	40	35	45	-15.7	54	50	59	44	39	50	-18.6
Access for malignant colorectal cancer surgery	Total	48	45	50	42	39	45	-12.4	49	47	52	43	40	46	-12.6	48	46	51	43	40	46	-10.6
	30-64	18	16	20	17	14	19	-6.9	17	15	19	16	13	19	-6.0	17	15	19	16	14	19	-3.1
	≥65	99	93	104	85	78	92	-14.2	105	99	110	90	82	97	-14.4	102	96	108	89	82	96	-12.8
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	57	55	60	54	50	58	-5.4	56	54	59	58	54	62	3.5	56	54	59	55	51	59	-2.8
	30-64	67	62	71	66	60	72	-1.0	68	63	72	65	58	71	-4.3	65	61	70	70	64	75	6.6
	≥65	53	50	56	49	44	54	-8.0	50	47	54	55	50	60	9.0	51	48	54	46	41	51	-9.7
Replacement surgery within 48h in femoral neck fracture	≥65	62	60	63	64	61	68	4.1	61	59	63	61	58	64	-0.9	62	60	64	60	57	63	-3.9
Women																					
Total accesses to Emergency Room	Total	11182	11148	11216	6795	6757	6833	-39.2	11514	11479	11548	7019	6980	7057	-39.0	12131	12095	12166	7353	7313	7392	-39.4
	30-64	9943	9899	9987	5946	5897	5995	-40.2	10325	10281	10370	6133	6083	6182	-40.6	10863	10818	10908	6485	6435	6536	-40.3
	≥65	13310	13258	13362	8254	8195	8314	-38.0	13555	13501	13609	8540	8478	8603	-37.0	14309	14252	14365	8843	8778	8908	-38.2
Accesses to Emergency Room for life-threatening conditions	Total	194	189	198	178	173	184	-7.9	196	192	200	173	167	179	-11.8	200	196	205	186	180	192	-7.2
	30-64	76	72	80	73	68	79	-4.1	85	81	89	67	62	73	-20.4	82	78	87	74	68	79	-10.4
	≥65	395	386	403	359	347	371	-9.1	387	378	396	354	342	366	-8.5	403	394	412	379	366	392	-6.0
Access for ST-elevation myocardial infarction (STEMI)	Total	25	24	26	20	18	22	-19.2	27	26	29	24	22	26	-11.9	26	25	28	26	24	28	-1.3
	30-64	10	8	11	6	5	8	-35.1	11	10	13	11	9	13	-2.9	10	9	11	11	9	13	6.9
	≥65	52	48	55	44	40	49	-14.1	55	52	59	47	42	52	-15.0	54	50	57	52	47	57	-3.9
Access for ischaemic stroke	Total	61	59	64	58	55	61	-6.1	66	64	68	61	58	65	-7.3	66	64	68	64	60	67	-3.7
	30-64	14	12	15	15	13	18	11.4	16	14	18	15	12	17	-6.4	15	13	17	15	12	17	-3.2
	≥65	144	138	149	131	123	138	-9.0	152	147	158	141	133	149	-7.5	153	147	159	147	139	156	-3.8
Access for femoral fracture	≥65	292	285	299	292	281	302	0.1	281	273	288	272	262	283	-3.0	286	279	294	282	271	292	-1.7
Access for knee replacement surgery	Total	107	104	110	79	75	83	-26.5	112	109	115	82	77	86	-27.1	118	114	121	84	80	89	-28.4
	30-64	23	21	25	20	17	23	-10.9	22	20	24	21	18	24	-1.8	27	25	30	23	20	26	-16.6
	≥65	252	244	260	179	169	189	-28.9	267	258	275	185	175	195	-30.7	274	265	282	190	180	201	-30.4
Access for malignant breast cancer surgery	Total	164	159	168	141	136	147	-13.6	160	155	164	139	134	145	-12.6	162	158	166	138	132	143	-14.9
	30-64	136	131	142	128	120	135	-6.3	136	131	141	129	121	136	-5.6	134	129	139	120	113	127	-10.7
	≥65	211	203	218	165	156	174	-21.7	200	192	207	158	149	167	-20.8	210	202	217	169	159	178	-19.6
Access for malignant lung cancer surgery	Total	15	13	16	14	12	15	-6.8	13	12	15	12	11	14	-8.0	14	13	15	13	11	15	-5.1
	30-64	8	6	9	8	6	10	2.4	7	6	8	7	5	8	-10.3	7	6	9	7	5	9	-7.1
	≥65	27	24	29	24	20	27	-11.2	24	21	27	22	19	26	-6.8	25	22	27	24	20	27	-4.0
Access for malignant colorectal cancer surgery	Total	32	30	34	31	29	34	-2.5	35	33	37	29	26	31	-17.3	34	32	35	31	29	34	-6.4
	30-64	12	11	14	14	12	16	14.2	15	13	16	11	9	13	-24.6	14	12	15	15	13	18	12.1
	≥65	66	62	70	61	56	66	-7.8	70	66	74	60	54	65	-14.7	68	64	72	59	54	65	-12.7
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	40	36	44	36	30	42	-10.2	43	39	47	37	31	43	-15.1	44	40	48	39	33	44	-12.4
	30-64	53	41	65	36	19	53	-32.4	45	36	54	41	27	54	-9.1	61	50	72	50	39	61	-18.4
	≥65	39	35	43	36	30	43	-6.3	43	39	47	36	29	42	-16.5	41	37	46	37	31	43	-10.9
Replacement surgery within 48h in femoral neck fracture	≥65	67	66	68	67	66	69	0.6	68	67	69	67	65	69	-0.9	67	66	68	69	67	71	2.7

Hospital access indicators	Age group	4							5 (more deprived)						
		Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		relative percent change	Standardised rate/prevalence 2018-19	95% CI		Standardised rate/prevalence 2020	95% CI		relative percent change
Men															
Total accesses to Emergency Room	Total	13807	13768	13846	9227	9181	9273	-33.2	16057	16016	16099	10840	10790	10890	-32.5
	30-64	11848	11800	11895	7892	7837	7948	-33.4	13988	13938	14038	9482	9422	9542	-32.2
	≥65	17174	17106	17241	11521	11439	11602	-32.9	19612	19540	19685	13174	13086	13262	-32.8
Accesses to Emergency Room for life-threatening conditions	Total	351	345	358	330	321	339	-5.9	419	412	426	394	384	404	-6.0
	30-64	171	165	177	167	159	175	-2.6	217	211	224	210	201	220	-3.2
	≥65	660	646	674	611	592	631	-7.4	766	750	781	709	688	731	-7.4
Access for ST-elevation myocardial infarction (STEMI)	Total	95	92	99	90	85	95	-5.7	107	103	111	102	97	107	-4.5
	30-64	63	59	66	66	60	71	4.9	73	69	76	79	73	84	8.4
	≥65	152	145	159	132	123	141	-13.1	166	159	174	143	133	153	-14.2
Access for ischaemic stroke	Total	110	106	113	99	94	103	-10.2	117	113	121	107	101	112	-8.9
	30-64	36	33	39	36	32	39	-1.2	41	38	44	44	39	48	6.2
	≥65	236	228	245	207	195	218	-12.5	247	238	256	215	203	227	-13.3
Access for femoral fracture	≥65	144	138	150	142	133	150	-1.6	156	149	162	147	138	157	-5.4
Access for knee replacement surgery	Total	67	64	70	49	46	53	-25.9	64	61	67	47	43	50	-26.8
	30-64	18	16	20	18	15	20	-3.9	19	17	21	17	15	20	-7.8
	≥65	150	142	157	104	95	112	-30.5	141	134	148	97	89	106	-31.1
Access for prostatic hyperplasia surgery	Total	107	103	110	73	69	77	-31.5	103	99	106	65	61	69	-36.7
	30-64	34	31	37	32	29	36	-5.6	31	29	34	25	22	28	-19.9
	≥65	231	223	240	143	133	153	-38.0	225	216	234	133	123	143	-40.7
Access for malignant lung cancer surgery	Total	24	22	26	21	18	23	-13.2	28	26	30	23	20	25	-17.5
	30-64	8	6	9	7	5	9	-6.4	9	8	10	9	7	11	2.2
	≥65	52	47	56	44	38	49	-14.9	60	55	64	46	40	52	-22.7
Access for malignant colorectal cancer surgery	Total	49	46	51	43	39	46	-12.8	50	47	52	44	40	47	-12.0
	30-64	16	14	18	18	16	21	16.2	17	15	19	17	14	19	0.0
	≥65	106	100	112	85	77	92	-20.2	106	100	112	90	82	98	-15.3
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	59	57	62	50	46	54	-15.6	55	53	58	52	49	56	-5.5
	30-64	72	68	76	61	55	67	-14.4	64	60	67	60	55	66	-5.6
	≥65	51	48	55	43	38	48	-16.6	49	46	53	47	42	52	-5.4
Replacement surgery within 48 hours in femoral neck fracture	≥65	59	57	61	63	60	66	7.2	59	57	61	59	56	62	0.4
Women															
Total accesses to Emergency Room	Total	12648	12612	12684	7710	7669	7751	-39.0	14696	14657	14734	9048	9004	9092	-38.4
	30-64	11353	11308	11399	6819	6768	6870	-39.9	13423	13374	13472	8148	8093	8204	-39.3
	≥65	14872	14814	14930	9241	9174	9308	-37.9	16883	16822	16945	10594	10522	10666	-37.3
Accesses to Emergency Room for life-threatening conditions	Total	215	210	219	196	190	202	-8.7	262	257	267	233	226	240	-11.0
	30-64	92	87	96	80	74	86	-12.5	117	112	122	100	94	107	-14.1
	≥65	427	417	437	396	382	409	-7.3	511	500	522	461	447	476	-9.7
Access for ST-elevation myocardial infarction (STEMI)	Total	30	28	32	26	24	28	-13.3	34	32	36	31	28	33	-9.7
	30-64	12	10	13	10	8	12	-17.6	13	12	15	14	11	16	2.8
	≥65	61	57	65	54	48	59	-11.9	70	65	74	60	54	66	-13.7
Access for ischaemic stroke	Total	70	68	73	63	59	66	-10.4	76	73	78	74	70	78	-1.9
	30-64	17	15	19	16	14	19	-3.6	19	17	21	22	19	25	16.2
	≥65	161	155	167	143	134	151	-11.7	173	167	180	164	155	173	-5.2
Access for femoral neck fracture	≥65	285	278	293	292	281	303	2.3	305	297	313	294	282	305	-3.7
Access for knee replacement surgery	Total	120	116	123	83	79	87	-30.6	126	122	129	90	85	94	-28.7
	30-64	28	26	30	24	21	27	-15.0	32	30	35	31	27	34	-5.3
	≥65	277	268	286	185	174	195	-33.4	286	277	295	191	180	202	-33.2
Access for malignant breast cancer surgery	Total	160	156	165	137	132	143	-14.2	151	147	155	132	127	138	-12.2
	30-64	136	131	141	128	120	135	-6.0	124	119	129	116	109	123	-6.6
	≥65	202	195	210	154	145	164	-23.7	197	189	204	161	151	171	-18.3
Access for malignant lung cancer surgery	Total	15	14	16	14	13	16	-4.2	15	13	16	15	13	17	2.9
	30-64	7	6	9	9	7	11	20.4	8	7	9	9	7	10	5.4
	≥65	28	25	31	24	20	28	-15.1	26	23	28	26	22	30	1.5
Access for malignant colorectal cancer surgery	Total	34	32	36	30	28	33	-11.2	36	34	38	29	26	31	-19.9
	30-64	15	13	16	15	13	18	4.0	14	12	15	14	12	17	5.2
	≥65	68	64	72	56	51	62	-16.9	75	70	79	54	49	60	-27.7
Percutaneous transluminal coronary angioplasty (PTCA) within 90' in STEMI	Total	42	38	46	40	34	45	-5.5	43	39	46	39	34	45	-7.7
	30-64	58	49	67	50	35	65	-14.2	55	46	64	61	49	73	10.2
	≥65	39	34	43	37	31	44	-2.9	40	36	44	35	29	41	-13.3
Replacement surgery within 48 hours in femoral neck fracture	≥65	67	66	68	67	66	69	1.1	65	64	66	65	64	67	0.6

Supplemental table 5: Relative Index of Inequality (RII), 95% confidence intervals (95%CI) and p-value for interaction (between deprivation and period) by deprivation index, type of hospital indicators (volumes or timeliness of procedures), period, sex, and areas included in the analysis (all – 7 areas – and only those included in the analysis by educational level – 4 areas), all ages

Hospital access indicators	Period	**Men (7 areas)**				**Men (4 areas)**				**Women (7 areas)**				**Women (4 areas)**			
		RII	95% CI		p-value	RII	95% CI		p-value	RII	95% CI		p-value	RII	95% CI		p-value
Total accesses to Emergency Room	2018-19	1.36	1.36	1.37	*0.000*	1.40	1.39	1.41	*0.005*	1.38	1.38	1.39	0.131	1.40	1.39	1.40	0.780
	2020	1.39	1.38	1.40		1.42	1.41	1.43		1.39	1.38	1.40		1.39	1.38	1.41	
Accesses to Emergency Room for life-threatening conditions	2018-19	1.35	1.31	1.40	0.525	1.35	1.31	1.40	0.333	1.36	1.32	1.40	0.837	1.35	1.30	1.40	0.766
	2020	1.33	1.27	1.39		1.31	1.25	1.38		1.35	1.29	1.42		1.36	1.28	1.44	
Access for ST-elevation myocardial infarction	2018-19	1.35	1.27	1.43	0.442	1.36	1.26	1.46	0.481	1.35	1.24	1.47	0.304	1.34	1.20	1.49	0.249
	2020	1.40	1.29	1.52		1.42	1.28	1.59		1.46	1.29	1.67		1.51	1.27	1.79	
Access for ischaemic stroke	2018-19	1.20	1.14	1.26	0.390	1.14	1.07	1.22	0.672	1.21	1.15	1.27	0.702	1.17	1.09	1.25	*0.040*
	2020	1.25	1.16	1.35		1.17	1.06	1.30		1.23	1.14	1.33		1.33	1.20	1.47	
Access for femoral neck fracture	2018-19	1.05	0.98	1.12	0.692	1.04	0.95	1.14	0.901	1.03	0.99	1.07	0.863	1.03	0.98	1.09	0.554
	2020	1.07	0.98	1.18		1.05	0.93	1.19		1.02	0.97	1.08		1.01	0.94	1.08	
Access for knee replacement surgery	2018-19	1.02	0.95	1.09	0.332	0.98	0.89	1.08	0.312	1.17	1.12	1.23	0.270	1.19	1.12	1.27	0.088
	2020	0.96	0.86	1.07		0.89	0.77	1.04		1.11	1.03	1.21		1.07	0.97	1.19	
Access for prostatic hyperplasia surgery (men) / breast cancer surgery (women)	2018-19	0.86	0.81	0.90	0.885	0.90	0.84	0.96	0.782	0.93	0.89	0.97	0.859	0.94	0.89	0.99	0.549
	2020	0.85	0.77	0.93		0.88	0.78	0.99		0.94	0.88	1.00		0.91	0.84	0.99	
Access for malignant lung cancer surgery	2018-19	1.32	1.18	1.48	*0.041*	1.39	1.19	1.63	0.217	1.02	0.88	1.16	0.170	1.01	0.83	1.23	0.478
	2020	1.07	0.90	1.27		1.17	0.93	1.47		1.20	0.98	1.47		1.14	0.87	1.49	
Access for malignant colorectal cancer surgery	2018-19	1.04	0.97	1.12	0.980	1.05	0.95	1.16	0.881	1.11	1.03	1.21	0.054	1.07	0.96	1.19	0.177
	2020	1.04	0.93	1.17		1.04	0.89	1.20		0.96	0.85	1.09		0.94	0.80	1.10	
PTCA within 90' in ST-elevation myocardial infarction	2018-19	0.93	0.79	1.10	0.418	1.01	0.93	1.10	0.133	0.99	0.77	1.27	0.913	1.01	0.88	1.16	0.340
	2020	0.84	0.69	1.03		0.90	0.81	1.00		1.11	0.77	1.59		1.17	0.90	1.52	
Replacement surgery within 48 hours in femoral neck fracture	2018-19	0.98	0.88	1.08	0.651	0.98	0.91	1.06	0.309	1.00	0.90	1.12	0.935	1.02	0.97	1.08	0.312
	2020	0.99	0.90	1.09		1.06	0.94	1.19		0.98	0.91	1.07		0.98	0.92	1.04	

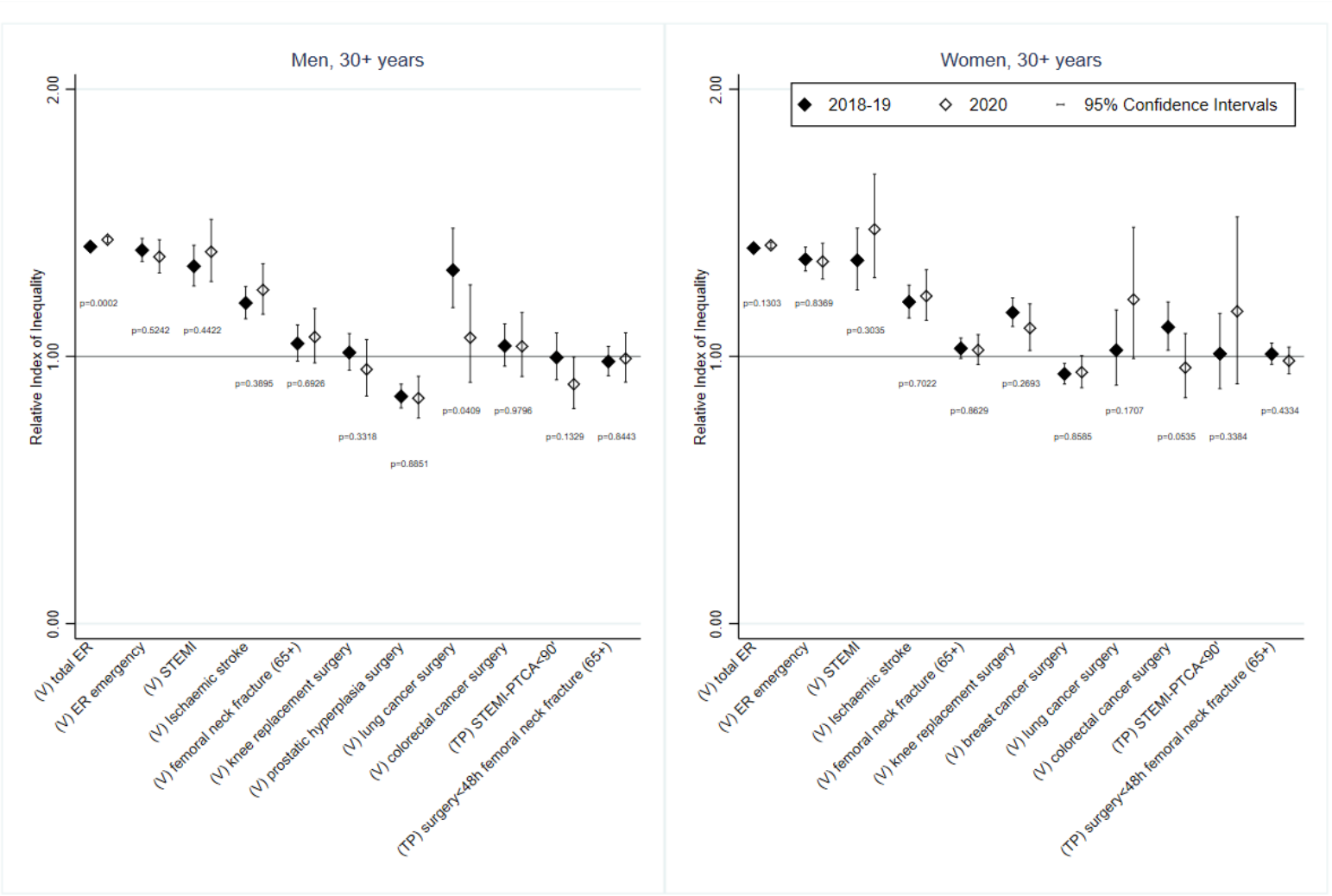
Supplemental figure 1: relative percent changes of age-standardised rates for the volume indicators and age-standardised prevalence for the timeliness of procedures indicators by deprivation index, sex, and age groups



Indicators: (V) volumes, (TP) timeliness of procedures

ER emerg not available for Tuscany,Rome, IMA STEMI-PTCA<90' for Milan,Emilia-Romagna,Tuscany

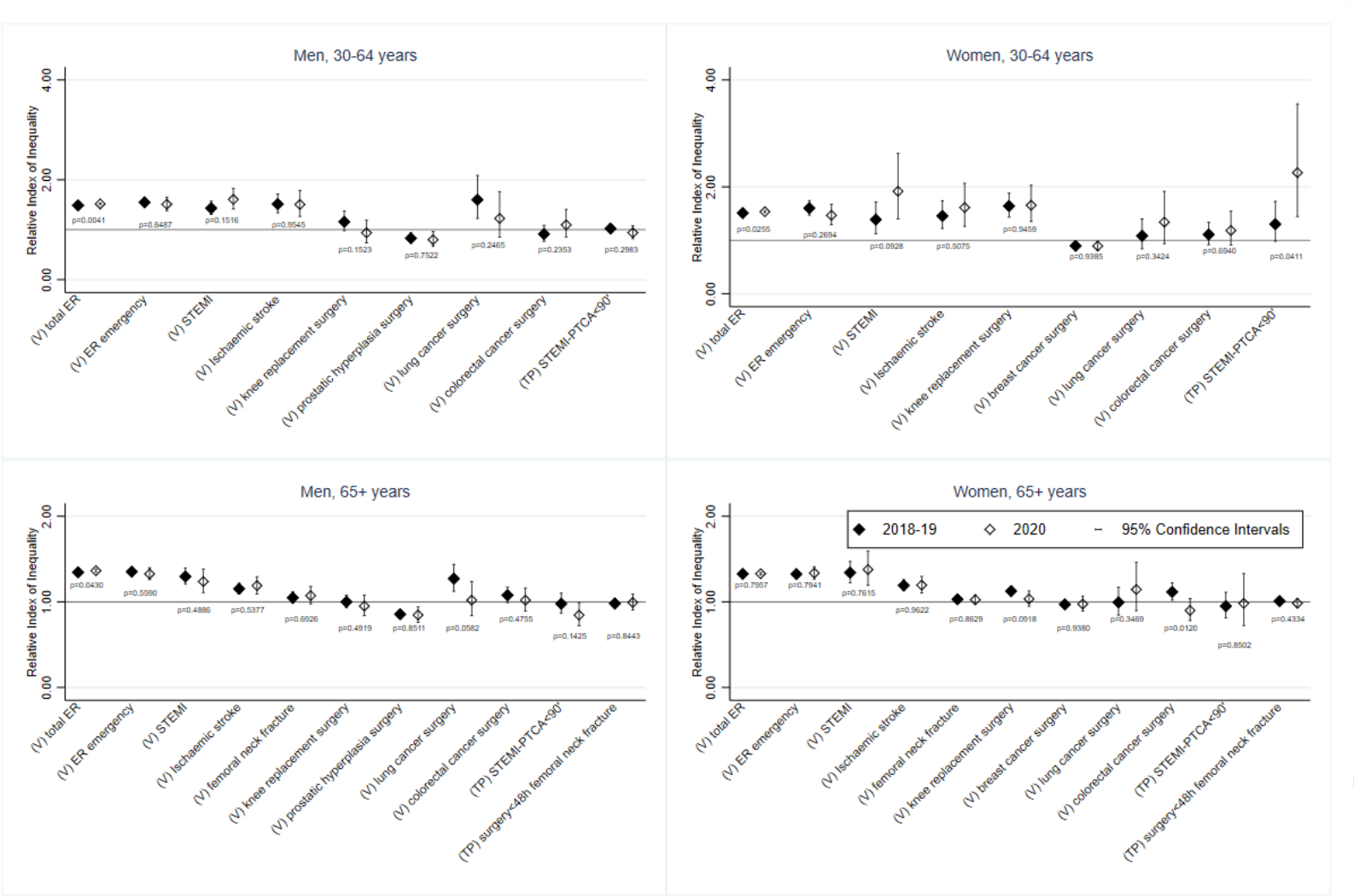
Supplemental figure 2: Relative Index of Inequality and 95% confidence intervals by deprivation index, hospital volumes and timeliness of procedures indicators and period, and sex, all ages



Indicators: (V) volumes, (TP) timeliness of procedures; p: p-value for interaction

ER emergency not available for Tuscany, Rome; IMA STEMI-PTCA<90' for Milan, Emilia-Romagna, Tuscany

Supplemental figure 3: Relative Index of Inequality and 95% confidence intervals by deprivation index, hospital volumes and timeliness of procedures indicators, period, sex, and age group



Indicators: (V) volumes, (TP) timeliness of procedures; p: p-value for interaction

ER emergency not available for Tuscany, Rome; IMA STEMI-PTCA<90' for Milan, Emilia-Romagna, Tuscany