Estimating COVID-19 hospitalisation risk in England adjusting for sociodemographic & spatial covariate effects

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Introduction

A report published by Public Health England in August 2020 highlighted disparities in risk and outcome of SARS-CoV-2 infection in the UK among different demographic groups[2]. The report findings suggest large disparities found by age, ethnicity and deprivation level. This report does not look at COVID-19 related hospital admission. At the time of this study, hospitalisation risk in England had not been looked at since the start of the pandemic.

Hospitalisation risk is an important parameter used in guiding public health policy as well as being used in predictive epidemic modelling for a variety of clinical outcomes. It also helps in understanding the social determinants of COVID-19 care.

The aim of this study was to design a model to estimate COVID-19 hospitalisation risk per demographic group and region in the English population by sex, age group, ethnicity, deprivation level and local authority.

Methods & Analysis

From the SARI study[3], COVID-19 hospital admission counts for adults between January 2020 and February 2021 in England were modelled.

The denominator used for the counts was the number of individuals to have ever been infected with SARS-CoV-2 per demographic group and local authority in England. Prevalence estimates of SARS-CoV-2 seroconversion were obtained from the REACT-2 study[5]. These were then applied to population group estimates from the 2011 UK census[1], obtained from the UK Data Service. Population estimates were inflated by comparing to 2019 population group projections from the Office of National Statistics.

A negative binomial model was built using the *MASS*[4] package in Rstudio, using sex, age group, ethnic group, local authority and deprivation as *a priori* co-variates.

Figure: Distribution of aggregated subgroup hospital admission counts
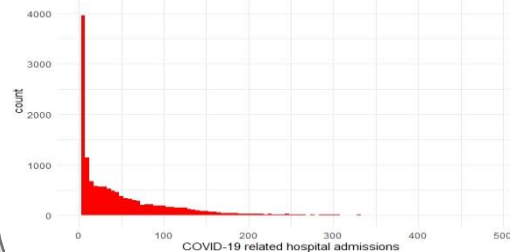
Results

80.9% of the SARI COVID-related hospitalisations were modelled in the study (47,918 of n=59,203). The subgroup hospitalisation counts showed a Poisson distribution with a mean count of zero.

Table: Risk ratios for covariates in the final fitted model

Variable		Risk Ratio (adjusted)	LRT p-value (association)
Sex			<0.01
	Male	1.00 (ref)	
	Female	0.65 (0.61, 0.69)	
Age group			<0.01
	19-24y	0.02 (0.02, 0.02)	
	25-34y	0.04 (0.03, 0.04)	
	35-44y	0.09 (0.08, 0.10)	
	45-54y	0.18 (0.16, 0.20)	
	55-64y	0.35 (0.32, 0.38)	
	65-74y	0.64 (0.58, 0.70)	
	75+y	1.00 (ref)	
Ethnic group			<0.01
	White	1.00 (ref)	
	Asian	1.94 (1.80, 2.09)	
	Black	1.19 (1.08, 1.31)	
	Mixed	0.96 (0.84, 1.10)	
	Other	4.19 (3.77, 4.67)	
Local authority			<0.01
	Unable to estimate accurately		
IMD quintile			<0.01
(most deprived)	1	1.00 (ref)	
	2	61.09 (50.37, 76.08)	
	3	532.41 (421.11, 673.12)	
	4	2300.78 (1794.33, 2950.18)	
(least deprived)	5	5441.13 (4179.26, 7084.36)	

All sociodemographic covariables were strongly associated with COVID-19 hospitalisation risk. Identified risk factors included male sex, increasing age, Black, Asian or other minor ethnic groups, and decreasing social deprivation. Local authority risk could not be accurately estimated due to high correlation with deprivation.

Discussion

The model shows evidence to suggest male sex, age, non-white ethnicity and level of deprivation as risk factors for hospitalisation due to COVID-19. The model also suggests Black, Asian and other minor ethnic groups are still at an increased risk after accounting for deprivation and location. The model does not take into account the distribution of co-morbidity in the English population. After adjusting for other co-variables, increasing hospitalisation risk in lower deprivation groups may suggest differences in healthcare seeking behaviour.

Poor model fit due to high zero counts and high correlation between local authority and deprivation variables means results should be interpreted with caution.

Conclusions

Despite shortcomings in the model fit, this study highlights disparities in hospitalisation risk across different sociodemographic groups in England. The findings can help identify risk groups for guiding intervention implementation and vaccine roll-out.

References

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4. Venables W., Ripley B. Modern applied statistics with S . 4th ed. Springer; 2002.
5. Ward H, Atchison C, Whitaker M, Ainslie K. SARS-CoV-2 antibody prevalence in England following the first peak of the pandemic. Nat Commun. 2020;12(905).