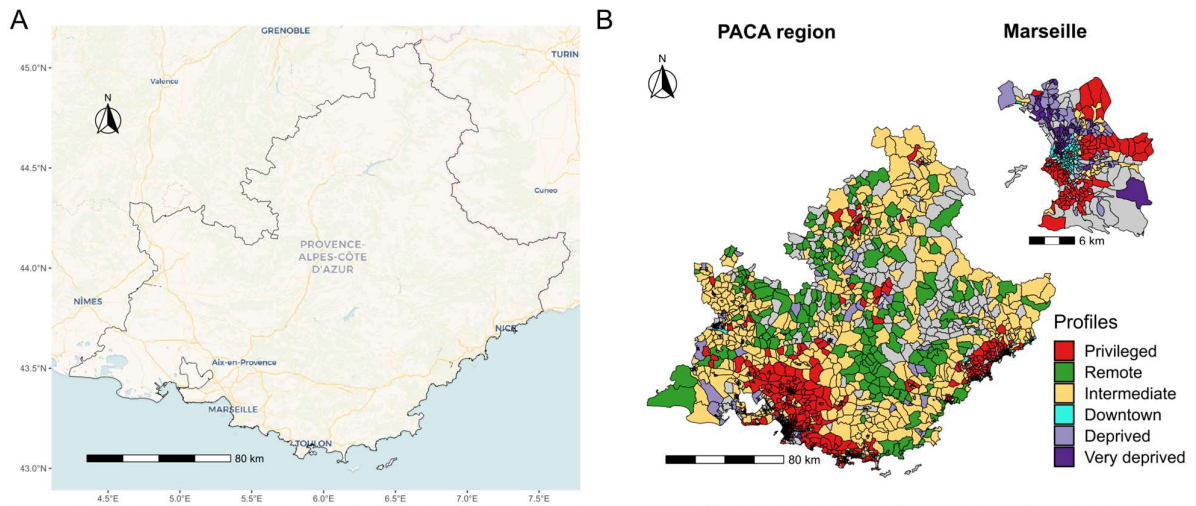


Supplementary data

Table S1: Database sources

Database name	Date of publication	Last access to the database	Author	URL
Equipment	12/07/2021	13/07/2021	INSEE	https://www.insee.fr/fr/statistiques/3568629?sommaire=3568656&q=bpe+2020
Census	09/12/2020	12/04/2021	INSEE	https://www.insee.fr/fr/statistiques/4515565?sommaire=4516122&q=recensement+2017#consulter
Housing	09/12/2020	21/05/2021	INSEE	https://www.insee.fr/fr/statistiques/4515532?sommaire=4516107&q=base+logement#dictionnaire
European deprivation index (EDI)	2015		MapInMed	https://anticipe.eu/plateformes/MAPinMED
Vaccination	10 /09/2021	20/09/2021		https://datavaccin-covid.ameli.fr/explore/?exclude.theme=Datavisualisation&sort=modified
IRIS borders (shapefile)		21/05/2021	French Government	https://www.data.gouv.fr/en/datasets/decoupage-iris-combine-aux-limites-communales-openstreetmap/
Localised Potential Access (LPA)	02/03/2020	30/07/2021	DREES	https://drees2-sgsocialgouv.opendatasoft.com/explore/dataset/530-l-accessibilite-potentielle-localisee-apl/information/



Source : © OpenStreetMap contributors, © CARTO (CC BY 4.0) license, data.gouv, INSEE, MapInMed / Author : P Garneret / Edition : October 2025

Figure. S1: Geographic overview of the Provence-Alpes-Côte d'Azur (PACA) region. (A) Map of the PACA region and its main cities. (B) Spatial distribution of socio-demographic profiles across the PACA region, with a detailed focus on Marseille. Grey areas correspond to IRIS unit with no hospitalisation data reported.

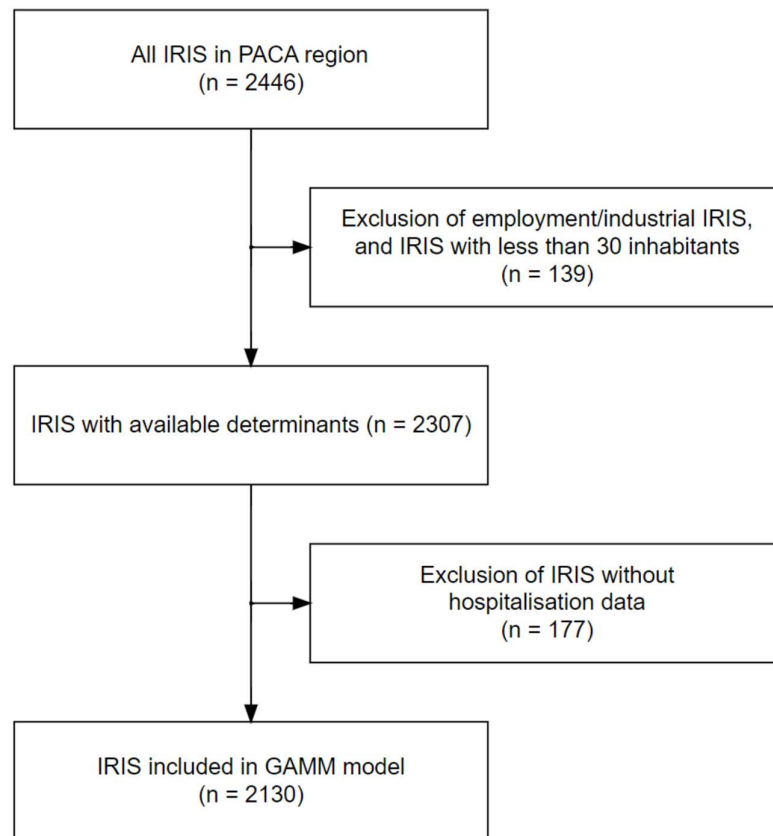
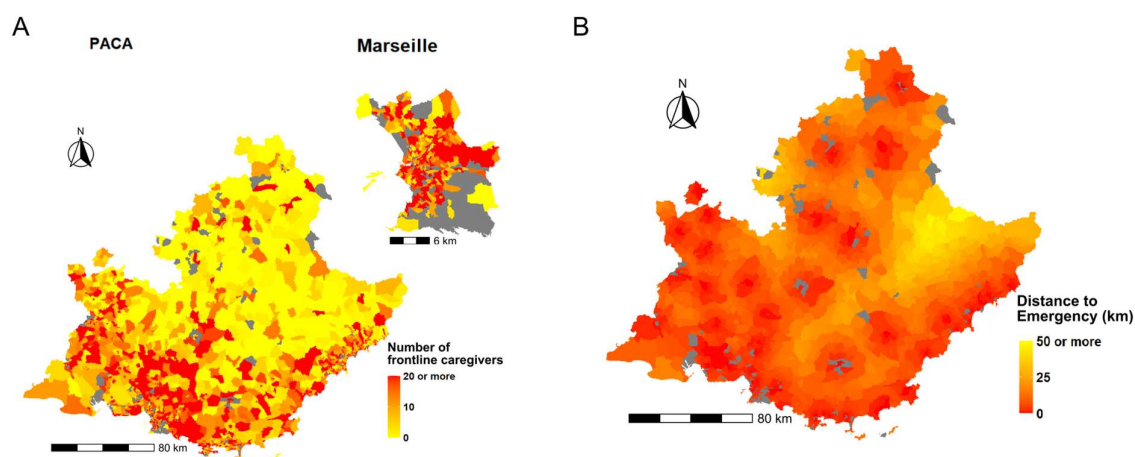


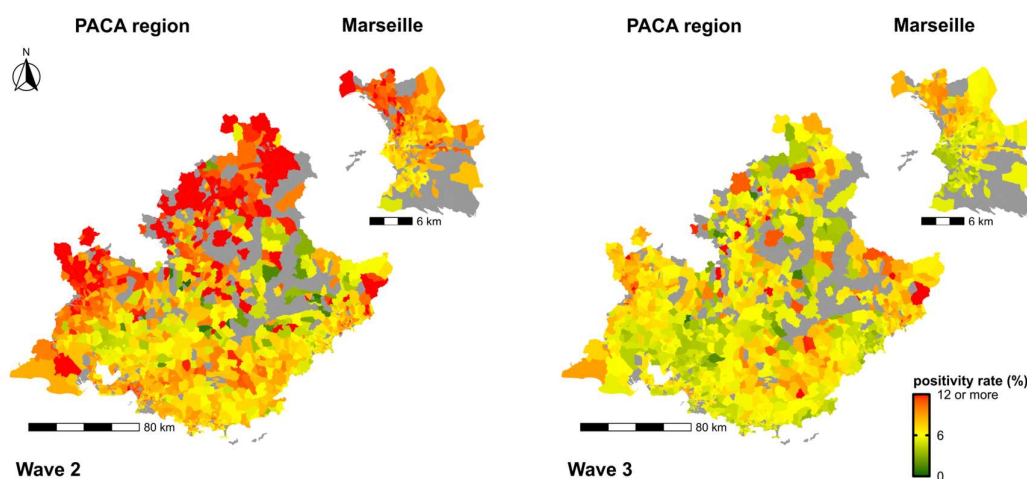
Figure S2: Flow chart of IRIS selection.

2130 IRIS (4.92 million inhabitants) were included among the 2446 IRIS in PACA region (5.04 million inhabitants).



Source : data.gouv, INSEE / Author : G Gaubert / Edition : October 2025

Figure S3 : (A) Map of the number of frontline caregivers per IRIS, in PACA region and its main city Marseille. The NA (grey) class correspond to unpopulated areas (B) Map of the distance to Emergency reception service for each service, at the IRIS level in PACA region. The NA (grey) class correspond to unpopulated areas. Distances were calculated between IRIS centroids.



Source : data.gouv, SI-DEP / Author : P Garneret / Edition : October 2025

Figure S4 : Spatial distribution of COVID-19 positivity rate, in the PACA region, with a focus on Marseille, during epidemic waves 2 and 3. Grey areas correspond to IRIS unit with no hospitalisation data reported.

Table S2: Adjusted incidence rate ratios (IRR) for COVID-19 infection

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.01	0.97 - 1.06	0.489	1.04	1 - 1.08	0.048
	Intermediate	1.04	1.02 - 1.06	0.001	1.08	1.06 - 1.1	< 0.001
	Downtown	1.02	0.99 - 1.06	0.208	1.04	1.01 - 1.08	0.004
	Deprived	1.07	1.05 - 1.1	< 0.001	1.16	1.14 - 1.19	< 0.001
	Very deprived	1.18	1.14 - 1.22	< 0.001	1.31	1.27 - 1.36	< 0.001
Age structure profile (ref : Young adults)	Families	1.09	1.06 - 1.11	< 0.001	1.08	1.06 - 1.11	< 0.001
	Balanced	1.06	1.03 - 1.09	< 0.001	1.06	1.03 - 1.08	< 0.001
	Elderly	1.03	1 - 1.06	0.056	1.00	0.98 - 1.03	0.82
Accessibility to general practitioner		1.01	1 - 1.02	0.087	1.00	0.99 - 1.01	0.968
Retirement home presence		0.98	0.97 - 1	0.018	0.98	0.96 - 0.99	0.001
Distance to Emergency reception (km)		0.99	0.99 - 1	0.004	1.00	0.99 - 1	0.08
Laboratory presence		1.02	1 - 1.04	0.028	1.00	0.99 - 1.02	0.911
Number of frontline caregivers		1.00	1 - 1	0.032	1.00	1 - 1	0.008

Table S3: Adjusted hospitalisation-to population rate ratio (HRR) for COVID-19 in conventional settings.

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.18	1.01 - 1.37	0.035	1.20	1.07 - 1.35	0.001
	Intermediate	1.15	1.05 - 1.25	0.003	1.15	1.07 - 1.23	< 0.001
	Downtown	1.03	0.9 - 1.17	0.656	1.10	1 - 1.22	0.054
	Deprived	1.30	1.18 - 1.44	< 0.001	1.26	1.17 - 1.36	< 0.001
	Very deprived	1.38	1.2 - 1.59	< 0.001	1.28	1.15 - 1.43	< 0.001
Age structure profile (ref : Young adults)	Families	1.10	0.99 - 1.22	0.087	1.13	1.04 - 1.23	0.003
	Balanced	1.09	0.98 - 1.21	0.119	1.15	1.06 - 1.25	0.001
	Elderly	1.39	1.23 - 1.56	< 0.001	1.29	1.17 - 1.41	< 0.001
Accessibility to general practitioner		1.00	0.96 - 1.03	0.83	1.01	0.99 - 1.04	0.356
Retirement home presence		1.16	1.09 - 1.23	< 0.001	1.08	1.03 - 1.13	0.001
Distance to Emergency reception (km)		0.98	0.98 - 0.99	< 0.001	0.99	0.99 - 1	0.029
Laboratory presence		1.02	0.95 - 1.09	0.556	1.03	0.98 - 1.08	0.305
Number of frontline caregivers		1.00	1 - 1	0.137	1.00	1 - 1	0.056

Table S4: Adjusted hospitalisation-to population rate ratio (HRR) for COVID-19 in ICU settings

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.15	0.86 - 1.53	0.347	1.14	0.94 - 1.38	0.18
	Intermediate	1.27	1.09 - 1.49	0.003	1.11	1 - 1.24	0.045
	Downtown	1.09	0.86 - 1.39	0.474	1.02	0.87 - 1.18	0.845
	Deprived	1.37	1.14 - 1.65	0.001	1.11	0.98 - 1.25	0.104
	Very deprived	1.76	1.38 - 2.24	< 0.001	1.42	1.2 - 1.67	< 0.001
Age structure profile (ref : Young adults)	Families	1.15	0.94 - 1.4	0.18	1.32	1.16 - 1.51	< 0.001
	Balanced	1.15	0.94 - 1.41	0.17	1.25	1.09 - 1.43	0.001
	Elderly	1.36	1.08 - 1.69	0.007	1.34	1.16 - 1.55	< 0.001
Accessibility to general practitioner		1.00	0.95 - 1.06	0.883	1.03	0.99 - 1.07	0.123
Retirement home presence		0.95	0.85 - 1.07	0.391	1.00	0.93 - 1.08	0.98
Distance to Emergency reception (km)		1.00	0.99 - 1.01	0.929	0.99	0.97 - 1	0.008
Laboratory presence		1.00	0.88 - 1.13	0.957	1.02	0.94 - 1.11	0.606
Number of frontline caregivers		1.00	1 - 1.01	0.151	1.00	1 - 1	0.976

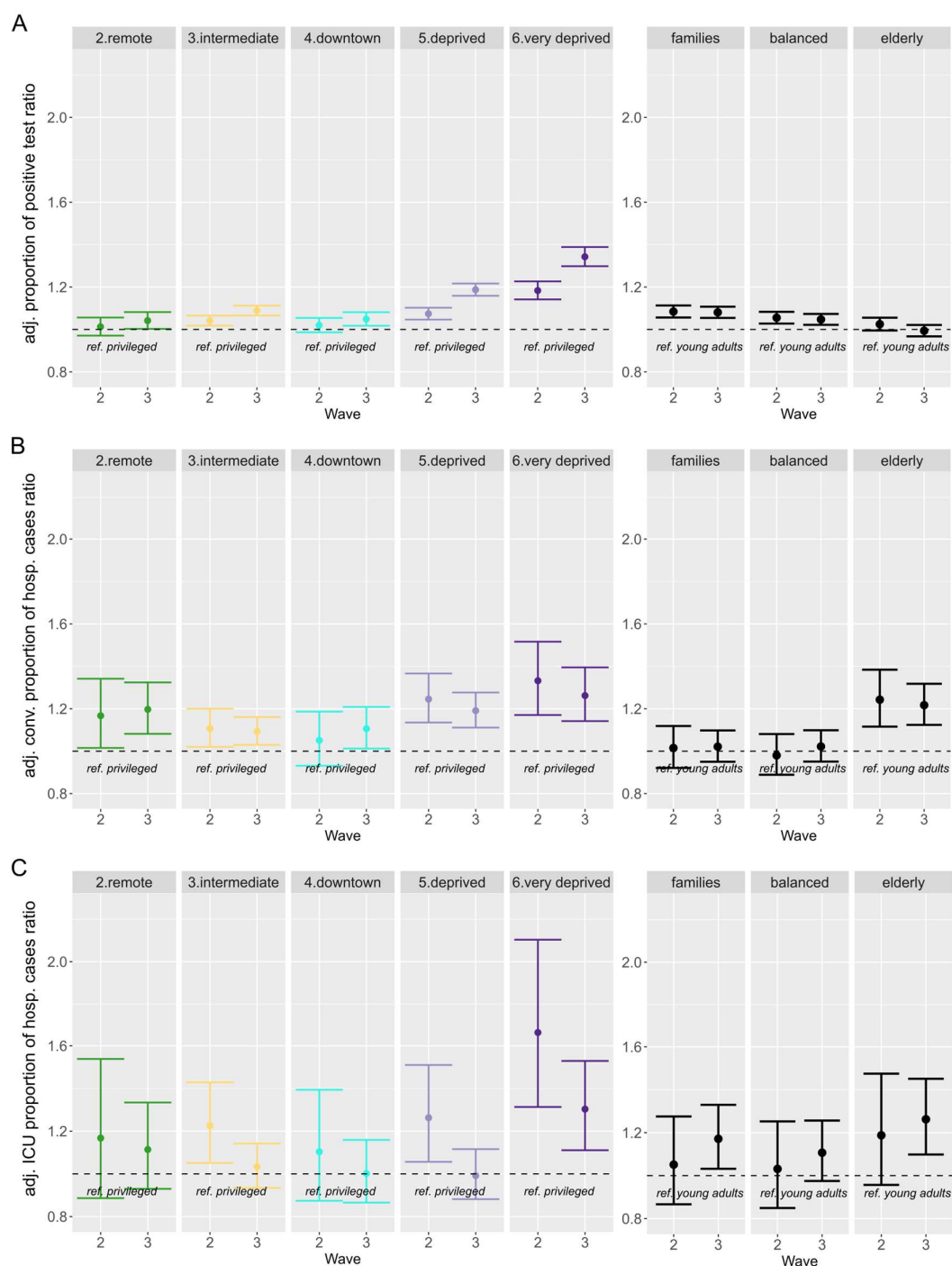


Figure S5: Forest plots of (A) adjusted proportion of positive test ratio, (B) adjusted proportion of hospitalised cases ratio in conventional settings, and (C) adjusted proportion of hospitalised cases ratio in ICU settings, across waves 2 and 3. Left panels show variations according to sociodemographic profiles (reference category, “privileged” profile), while right panels show variations according to age profiles (reference category, “young adults” profile).

Table S5: Adjusted proportion of positive tests ratio for COVID-19

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.01	0.97 - 1.06	0.557	1.04	1 - 1.08	0.035
	Intermediate	1.04	1.02 - 1.07	0.001	1.09	1.07 - 1.11	< 0.001
	Downtown	1.02	0.99 - 1.05	0.245	1.05	1.02 - 1.08	0.002
	Deprived	1.07	1.05 - 1.1	< 0.001	1.19	1.16 - 1.22	< 0.001
	Very deprived	1.18	1.14 - 1.23	< 0.001	1.34	1.3 - 1.39	< 0.001
Age structure profile (ref : Young adults)	Families	1.08	1.06 - 1.11	< 0.001	1.08	1.05 - 1.11	< 0.001
	Balanced	1.06	1.03 - 1.08	< 0.001	1.05	1.02 - 1.07	< 0.001
	Elderly	1.02	1 - 1.06	0.1	0.99	0.97 - 1.02	0.662
Accessibility to general practitioner		1.01	1 - 1.02	0.07	1.00	0.99 - 1.01	0.852
Retirement home presence		0.98	0.96 - 0.99	0.005	0.97	0.96 - 0.99	< 0.001
Distance to Emergency reception (km)		0.99	0.99 - 1	0.002	1.00	0.99 - 1	0.094
Laboratory presence		1.02	1 - 1.03	0.034	1.00	0.98 - 1.02	0.962
Number of frontline caregivers		1.00	1 - 1	0.033	1.00	1 - 1	0.003

Table S6: Adjusted proportion of hospitalised cases ratio (pHCR) for COVID-19 in conventional settings

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.17	1.02 - 1.34	0.03	1.20	1.08 - 1.32	0.001
	Intermediate	1.11	1.02 - 1.2	0.015	1.09	1.03 - 1.16	0.004
	Downtown	1.05	0.93 - 1.19	0.42	1.11	1.01 - 1.21	0.026
	Deprived	1.25	1.14 - 1.37	< 0.001	1.19	1.11 - 1.28	< 0.001
	Very deprived	1.33	1.17 - 1.52	< 0.001	1.26	1.14 - 1.39	< 0.001
Age structure profile (ref : Young adults)	Families	1.01	0.92 - 1.12	0.764	1.02	0.95 - 1.1	0.569
	Balanced	0.98	0.89 - 1.08	0.687	1.02	0.95 - 1.1	0.553
	Elderly	1.24	1.12 - 1.38	< 0.001	1.22	1.12 - 1.32	< 0.001
Accessibility to general practitioner		0.98	0.95 - 1.02	0.319	1.01	0.98 - 1.03	0.677
Retirement home presence		1.10	1.04 - 1.16	0.001	1.08	1.04 - 1.13	< 0.001
Distance to Emergency reception (km)		0.99	0.98 - 1	0.093	1.00	0.99 - 1	0.318
Laboratory presence		1.00	0.94 - 1.06	0.874	1.00	0.96 - 1.05	1
Number of frontline caregivers		1.00	1 - 1	0.302	1.00	1 - 1	0.037

Table S7: Adjusted proportion of hospitalised cases ratio (pHCR) for COVID-19 in ICU settings

Variable	Modality	wave 2			wave 3		
		SIR	CI95	p	SIR	CI95	p
Socioeconomic profile (ref : Privileged)	Remote	1.17	0.89 - 1.54	0.271	1.11	0.93 - 1.33	0.242
	Intermediate	1.23	1.05 - 1.43	0.009	1.03	0.93 - 1.14	0.523
	Downtown	1.10	0.87 - 1.39	0.408	1.00	0.87 - 1.16	0.983
	Deprived	1.26	1.06 - 1.51	0.011	0.99	0.88 - 1.12	0.89
	Very deprived	1.66	1.31 - 2.1	< 0.001	1.30	1.11 - 1.53	0.001
Age structure profile (ref : Young adults)	Families	1.05	0.87 - 1.28	0.611	1.17	1.03 - 1.33	0.014
	Balanced	1.03	0.85 - 1.25	0.755	1.11	0.98 - 1.26	0.116
	Elderly	1.19	0.96 - 1.47	0.119	1.26	1.1 - 1.45	0.001
Accessibility to general practitioner		1.00	0.95 - 1.05	0.904	1.03	0.99 - 1.07	0.144
Retirement home presence		0.90	0.8 - 1	0.059	1.00	0.93 - 1.08	0.967
Distance to Emergency reception (km)		1.01	1 - 1.02	0.149	0.99	0.98 - 1	0.097
Laboratory presence		0.98	0.87 - 1.11	0.743	1.00	0.93 - 1.09	0.908
Number of frontline caregivers		1.00	1 - 1	0.316	1.00	1 - 1	0.913

Table S8: Moran's I estimates of spatial autocorrelation for COVID-19 indicators across IRIS in the PACA region, stratified by epidemic wave

Indicator	Wave	Moran's Index	p-value
Incidence rates	2	0,29	< 0.001
	3	0,41	< 0.001
Conventional hospitalisation-to-population rate	2	0,16	< 0.001
	3	0,08	< 0.001
ICU hospitalisation-to-population rate	2	0	0.477
	3	0,1	< 0.001

Table S9: Moran's I estimates of spatial autocorrelation in GAMM residuals for COVID-19 indicators across IRIS in the PACA region, stratified by epidemic wave

Indicator	Wave	Moran's Index	p-value
Incidence rates	2	-0,01	0.724
	3	0,04	0.004
Conventional hospitalisation-to-population rate	2	-0,02	0.939
	3	-0,04	0.996
ICU hospitalisation-to-population rate	2	-0,02	0.908
	3	-0,02	0.944