The association of COVID-19 incidence with temperature, humidity, and UV radiation – A Global multi-city analysis

7. Appendix

Supplementary Table S1: Included countries, cities, their cumulative inhabitants per country and data sources.

Country	Cities/Regions included	Number of Cities	Inhabitants of included areas	Source
Brazil	Belem, BeloáHorizonte, Curitiba, Fortaleza, Joaoá Pessoa, Maceio, Natal, Recife, Salvador, Saoá Luis, Saoá Paulo, Teresina, Vitoria	13	48,555,954	Minsiterio da Saúde Brasil, https://covid.saude.gov.br/
Canada	Calgary, Hamilton, Ottawa, Toronto, Edmonton, Kingston, London Ontario, Niagara, Regina, Montreal, Saskatoon, Vancouver, Kitchener-Waterloo, Windsor, Winnipeg	15	20,623,986	https://github.com/ishaberry/Covid19Canada Berry I, Soucy J-PR, Tuite A, Fisman D. Open access epidemiologic data and an interactive dashboard to monitor the COVID-19 outbreak in Canada. CMAJ. 2020 Apr
Chile	Temuco, Chillan, Santiago, Valparaiso	4	3,945,179	https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Chile
Czech Republic	Prague	1	583,087	The Ministry of Health of the Czech Republic - https://onemocneni-aktualne.mzcr.cz/api/v2/covid-19 Komenda M., Bulhart V., Karolyi M., et al. Complex reporting of coronavirus disease (COVID-19) epidemic in the Czech Republic: use of interactive web-based application in practice. Journal of Medical Internet Research. 2020, 22(5), e19367.
Estonia	Tallin	1	537,039	Estonian Health Board - https://www.terviseamet.ee/et/koroonaviirus/avaandmed
Finland	Helsinki	1	1,115,957	Finnish Institute of Health and Welfare (THL)
France	Nice, Strasbourg, Marseille, Dijon, Bordeaux, Toulouse, Montpellier, Rennes, Grenoble, Nantes, Nancy, Lille, Paris, Lens-Douai, Clermont-Ferrand, Lyon, Le Havre	17	13,812,425	Santé Publique France
Germany	Berlin, Bremen, Dortmund, Dresden, Düsseldorf, Frankfurt, Hamburg, Hannover, Köln, Leipzig, München, Stuttgart	12	20,426,293	“Fallzahlen in Deutschland” of the Robert Koch-Institut (RKI) - Link to the dataset: https://www.arcgis.com/home/item.html?id=f10774f1c63e40168479a1feb6c7ca74
Italy	Ancona, Bari, Bologna, Brescia, Brindisi, Cagliari, Catania, Florence, Frosinone, Genoa, Latina, Milan, Naples, Padua, Palermo, Pisa, Rieti, Rome, Taranto, Trieste, Turin, Venice, Viterbo	23	15,651,954	Protezione civile

Japan	Nagoya, Chiba, Fukuoka, Sapporo, Kobe, Yokohama, Kyoto, Osaka, Saitama, Tokyo	10	51,012,754	Health authority
Kuwait	Kuwait	1	4,270,571	COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University
Mexico	Tijuana, Valley of Mexico, Leon, Guadalajara, Toluca de Lerdo, Monterrey, Puebla-Tlaxcala, San Luis Potosi	8	36,020,435	https://datos.gob.mx/busca/dataset/informacion-referente-a-casos-covid-19-en-mexico
Peru	Apurimac, Arequipa, Ayacucho, Cajamarca, Cusco, Huancavelica, Huanuco, Ica, Junin, La Libertad, Lambayeque, Lima, Loreto, Piura, Puno, San Martin,Tacna, Ucayali	18	21,935,550	Ministry of Health Peru https://www.datosabiertos.gob.pe/group/datos-abiertos-de-covid-19
Romania	Brasov, Bucharest, Cluj-Napoca, Constanta, Craiova Galati, Iasi, Timisoara	8	3,077,532	PRESS RELEASE, Strategic Communication Group, MINISTRY OF INTERNAL AFFAIRS
Singapore	Singapore	1	3,900,000	Ministry of Health Singapore. (https://www.moh.gov.sg/covid-19/past-updates , https://www.moh.gov.sg/covid-19/situation-report)
Spain	A Coruna, Albacete, Alicante, Almeria, Vitoria, Oviedo, Avila, Badajoz, Palma Mallorca, Barcelona, Bilbao, Burgos, Caceres, Cadiz, Santander, Castellon, Ceuta, Ciudad Real, Cordoba, Cuenca, San Sebastian, Girona, Granada, Guadalajara, Huelva, Huesca, Jaen, Logrono, Palmas G. Canaria, Leon, Lleida, Lugo, Madrid, Malaga, Melilla, Murcia, Pamplona, Ourense, Palencia, Pontevedra, Salamanca, Segovia, Sevilla, Soria, Tarragona, Tenerife, Teruel, Toledo, Valencia, Valladolid, Zamora, Zaragoza	52	20,726,264	https://cnecovid.isciii.es/covid19/#documentación-y-datos
South Africa	City of Cape Town	1	4,040,358	JHU
South Korea	Busan, Daegu, Daejeon, Gwangju, Incheon, Seoul	6	31,748,268	http://ncov.mohw.go.kr/
United Kingdom	Barnsley, Basildon, Basingstoke, Bedford, West Midlands, Blackburn, Blackpool, Brighton and Hove, Bristol, Burnley, Cambridge, Chelmsford, Cheltenham, Chesterfield, Colchester, Coventry, Crawley, Derby, Doncaster, Eastbourne, Exeter, Gloucester, Hastings, Ipswich, Kingston upon Hull, Leicester, Lincoln, Liverpool, London, Luton, Maidstone, Manchester, Mansfield, Medway Towns, Milton Keynes, Northampton, Norwich, Nottingham, Oxford, Peterborough, Plymouth, Preston, Reading, Sheffield, Slough, Southend-on-Sea, Stoke-on-Trent, Sunderland, Swindon, Thanet, Warrington, Wigan, Worcester, York	54	28,341,792	Public Health England
United States	Akron, Albany, Albuquerque, Allentown, Anaheim, Anchorage, Ann Arbor, Annandale, Atlanta, Atlantic City, Augusta, Austin, Aztec, Bakersfield, Baltimore,	209	65,605,596	COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

	Bangor, Barnstable, Bath, Baton Rouge, Beaver Dam, Birmingham, Boise City, Boston, Boulder, Brownsville, Buffalo, Burlington, Canton, Carlisle, Cedar Rapids, Charleston (SC), Charleston (WV), Charlotte, Chattanooga, Chicago, Cincinnati, Cleveland, Colorado Springs, Columbia, Columbus, Corpus Christi, Dallas, Davenport, Dayton, Daytona Beach, Denver, Des Moines, Detroit, Dover, Durham, East St. Louis, El Centro, El Paso, Elizabeth, Elkhart, Erie, Essex, Eugene, Evansville, Everett, Fargo, Fayetteville, Flint, Fort Lauderdale, Fort Myers, Fort Pierce, Fort Wayne, Fort Worth, Fresno, Gainesville, Gary, Gettysburg, Grand Haven, Grand Junction, Grand Rapids, Green Bay, Greensboro, Greensburg, Greenville, Harrisburg, Hartford, Hickory, Holland, Honolulu, Houston, Indianapolis, Iowa City, Jacksonville, Jersey City, Kalamazoo, Kansas City, Kenosha, Klamath Falls, Knoxville, La Porte, Lafayette (LA), Lafayette (IN), Lake Charles, Lakeland, Lancaster, Lansing, Las Vegas, Layton, Little Rock, Los Angeles, Louisville, Macon, Madison (IL), Madison (WI), Mcallen, Medford, Melbourne, Melville, Memphis, Mercer, Miami, Middlesex, Middletown, Milwaukee, Minneapolis, Mobile, Modesto, Monroe, Montgomery, Muncie, Muskegon, Myrtle Beach, Nampa, Nashua, Nashville, New Haven, New London, New Orleans, New York, Newark, Newburgh, Niles, Norfolk, Oakland, Ocala, Oklahoma City, Omaha, Orlando, Ottawa, Palm Beach, Paterson, Pensacola, Philadelphia, Phoenix, Pittsburgh, Plymouth, Port Arthur, Portage, Portland (OR), Portland (ME), Providence, Provo, Raleigh, Reading, Reno, Richmond, Riverside, Rochester, Rockville, Sacramento, Salt Lake City, San Antonio, San Diego, San Francisco, San Jose, Santa Barbara, Sarasota, Scranton, Seattle, Sioux City, South Bend, Spartanburg, Spokane, Springfield (MO), Springfield (MA), St. Charles, St. Louis, St. Petersburg, Stamford, State College, Steubenville, Stockton, Tacoma, Tallahassee, Tampa, Terre Haute, Toledo, Toms River, Topeka, Trenton, Tucson, Tulsa, Upper Marlboro, Vancouver, Ventura, Visalia, Washington (PA); Washington (DC), Wichita, Wilmington, Winston-Salem, Worcester, York, Youngstown			

Supplementary Table S2. Heterogeneity indicator (I^2 (%)), and Wald test p-value of fixed effects predictors of meta-regression models.

	Random effects	Fixed effects	n	I^2 (%)	P value
Air Temperature					
Model A	Country & Climatic zones		455	67.3	
Model B	Country & Climatic zones		426	67.2	
Model C	Country & Climatic zones		426	66.2	
		% Old population			0.001
		GDP			0.017
		Average temperature			0.029
Model D	Cities	Country	455	64.0	
Relative Humidity					
Model A	Country & Climatic zones		455	68.3	
Model B	Country & Climatic zones		426	68.3	
Model C	Country & Climatic zones		426	67.5	
		% Old population			0.041
		GDP			0.072
		Average temperature			0.086
Model D	Cities	Country	455	64.7	
Absolute Humidity					
Model A	Country & Climatic zones		455	67.8	
Model B	Country & Climatic zones		426	67.7	
Model C	Country & Climatic zones		426	64.0	

		% Old population			0.063
		GDP			0.001
		Average temperature			0.0001
Model D	Cities	Country	455	63.1	
UV radiation					
Model A	Country & Climatic zones		455	68.7	
Model B	Country & Climatic zones		426	69.0	
Model C	Country & Climatic zones		426	67.8	
		% Old population			0.528
		GDP			0.012
		Average temperature			0.001
Model D	Cities	Country	455	65.3	

Model A, cities and groups defined by country and climatic zones as random effects, no fixed effects; Model B, cities and groups defined by country and climatic zones as random effects, no fixed effects in the subset of cities with meta-predictors. Model C, cities and groups defined by country and climatic zones as random effects, % old population, GDP and Average temperature as fixed effects. Model D, cities and country as random effects, no fixed effects.

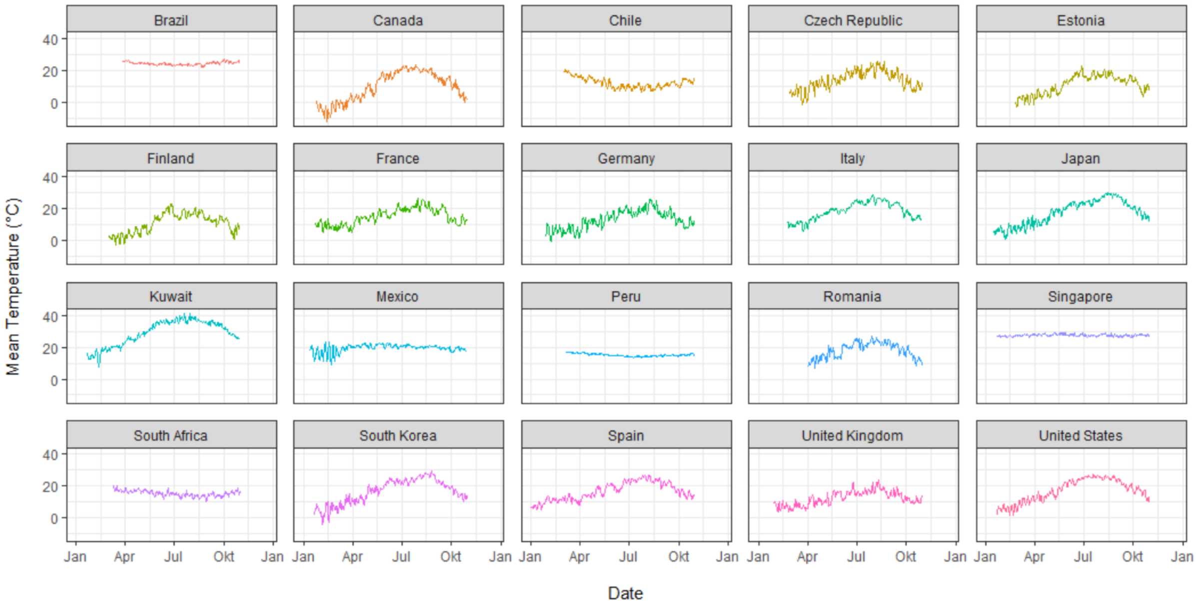
Supplementary Table S3. QAIC values according to different model specifications

	Temperature	**RH**	**AH**	**UV radiation**
Main Model A	2500686	2783301	2498724	2524589
Trend 4 df	2632104	2741196	2662476	2821396
Lag 10 days	2527528	2517654	2532304	2525128

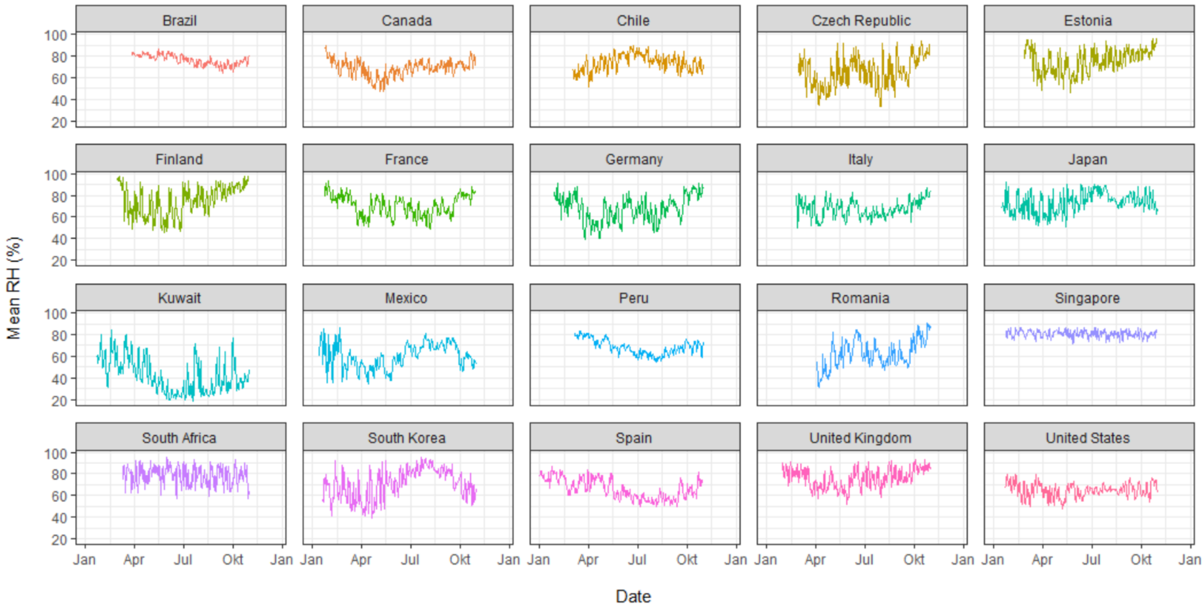
Supplementary Table S4: Pearson correlation of the four primary exposure variables averaged over all included cities.

	Temperature	**RH**	**AH**	**UV**
Temperature	1			
RH	-0.12	1		
AH	0.88	0.33	1	
UV	0.44	-0.79	0.06	1

Supplementary Figure S1. Daily mean average temperature time-series aggregated for all cities per country in 2020.

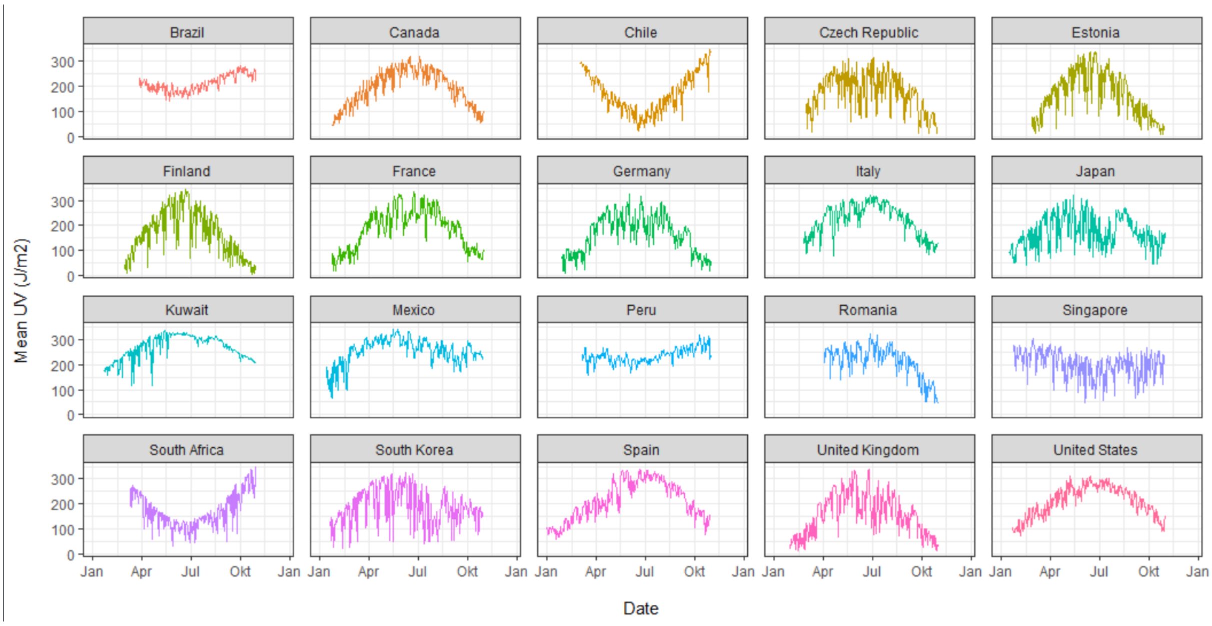


Supplementary Figure S2. Daily mean exposure RH time-series aggregated for all cities per country in 2020.

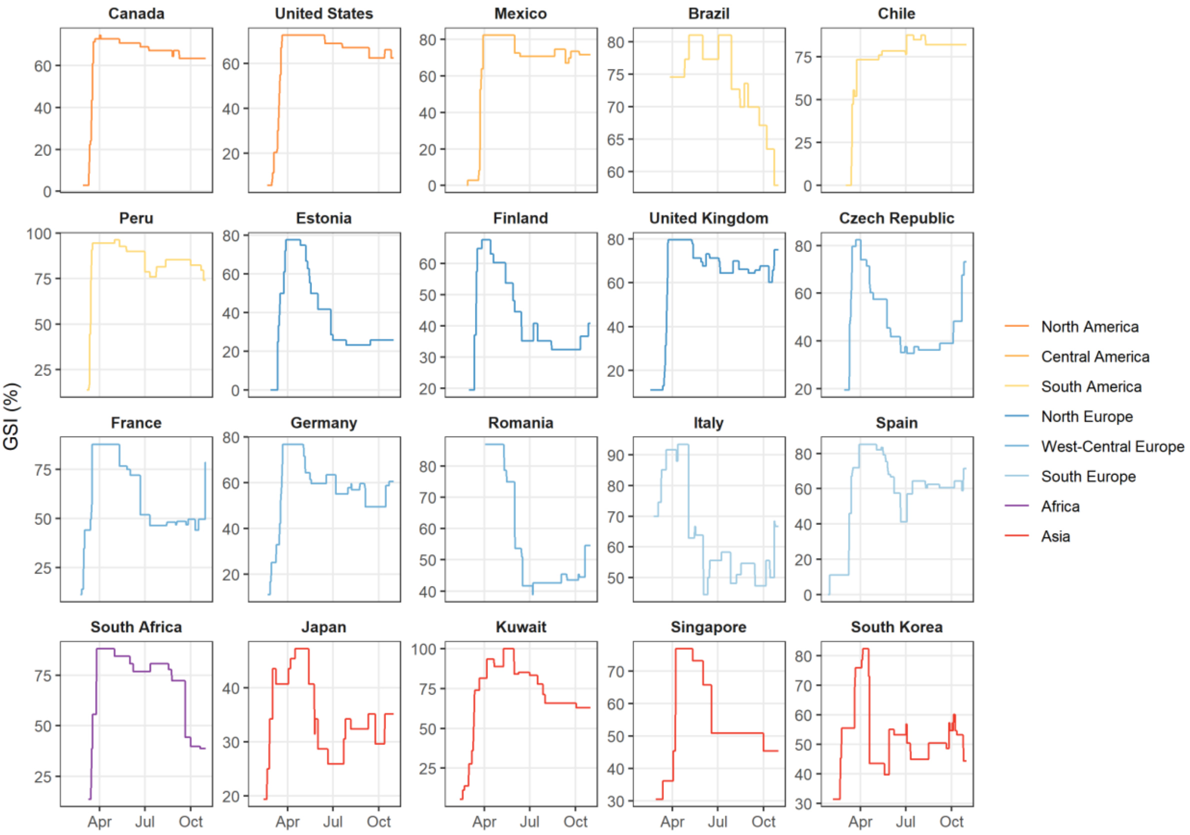


Supplementary Figure S3. Daily mean exposure AH time-series aggregated for all cities per country in 2020.

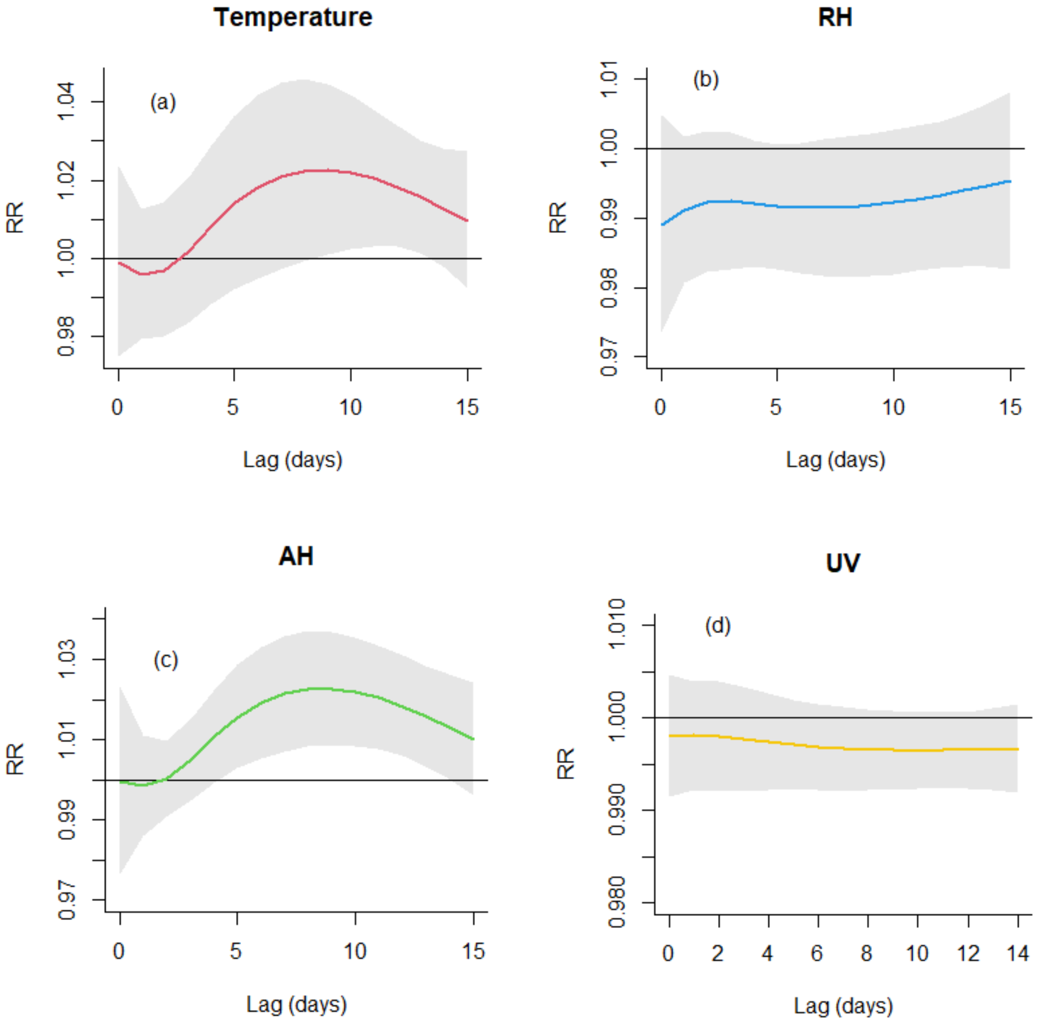
Supplementary Figure S4. Daily mean exposure UV time-series aggregated for all cities per country in 2020.



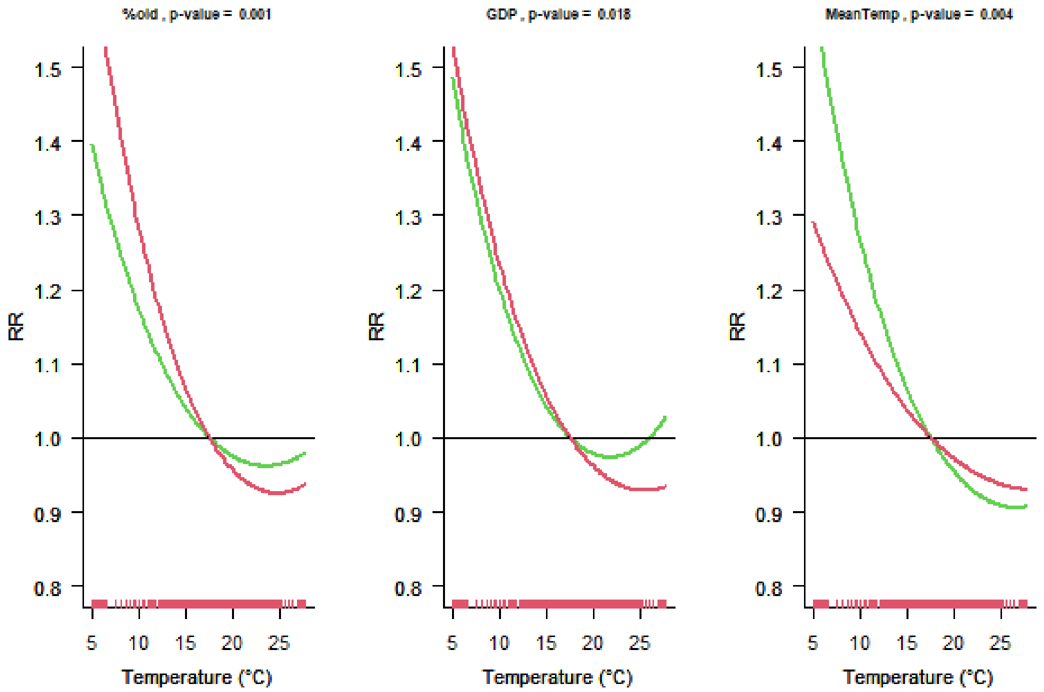
Supplementary Figure S5. Daily mean GSI time-series aggregated for all cities per country



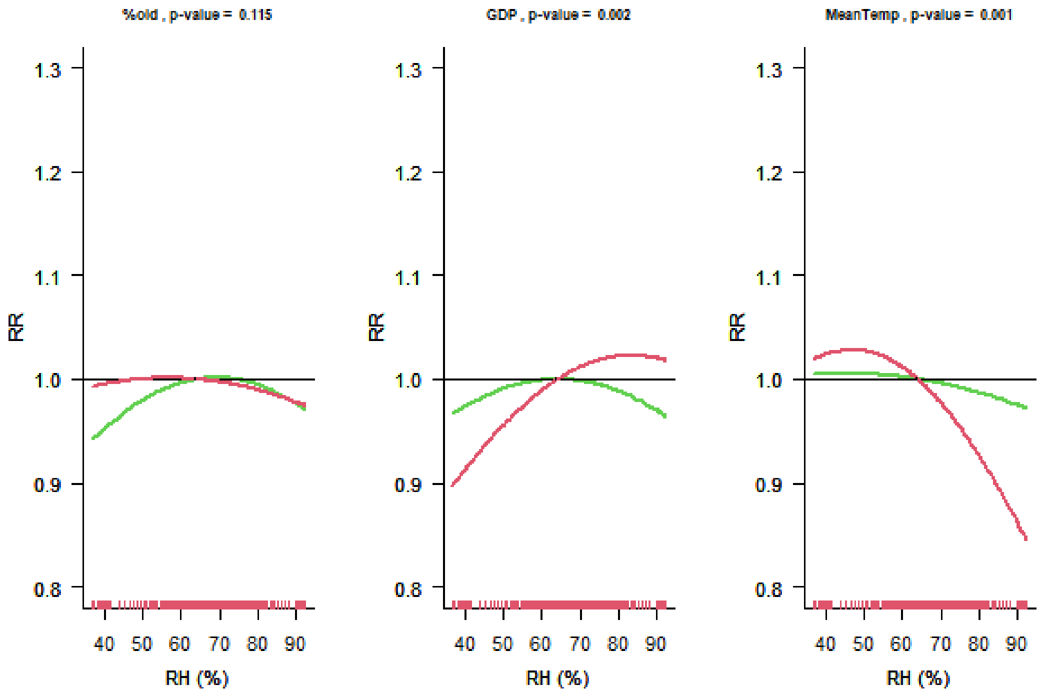
Supplementary Figure S6. Lagged effects of the association between meteorological variables and COVID-19 incidence for all exposures (Model A).



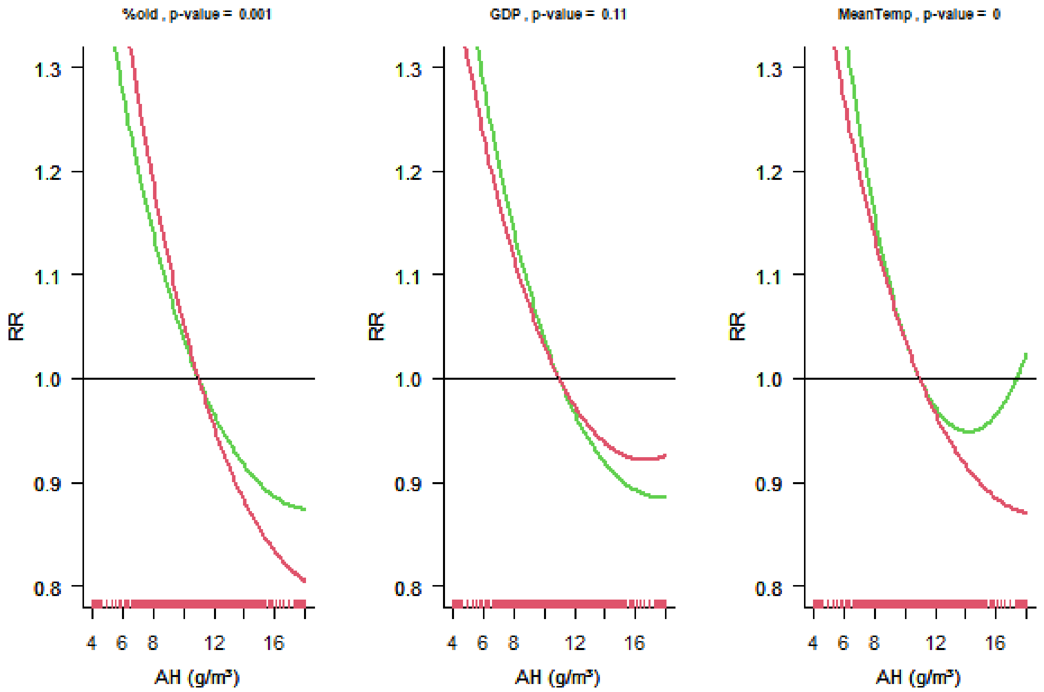
Supplementary Figure S7a. Modifiers of the association between temperature and COVID-19 incidence. Predicted association curves for +0.5SD (red) and –0.5SD (green) valued of the modifier (Model C).



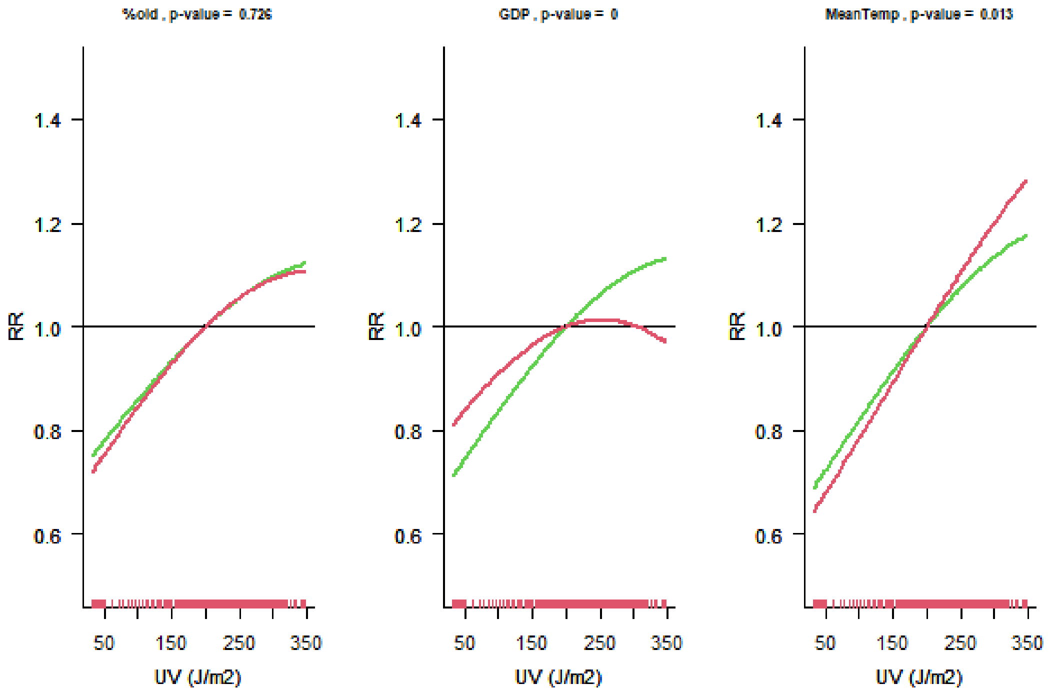
Supplementary Figure S7b. Modifiers of the association between relative humidity and COVID-19 incidence. Predicted association curves for +0.5SD (red) and –0.5SD (green) valued of the modifier (Model C).



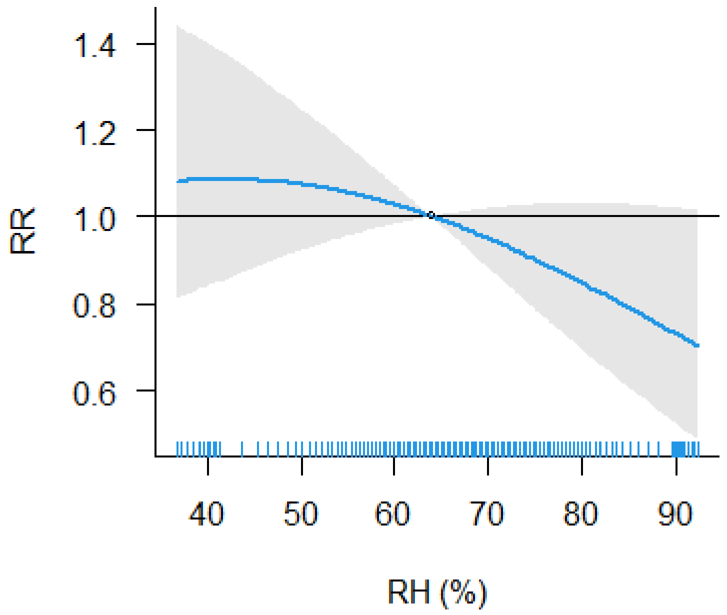
Supplementary Figure S7c. Modifiers of the association between absolute humidity and COVID-19 incidence. Predicted association curves for +0.5SD (red) and –0.5SD (green) valued of the modifier (Model C).



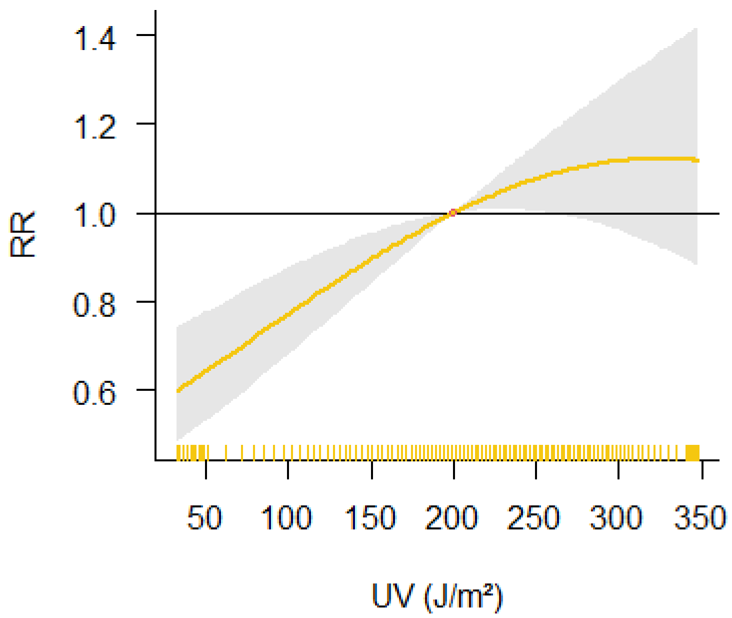
Supplementary Figure S7d. Modifiers of the association between UV radiation and COVID-19 incidence. Predicted association curves for +0.5SD (red) and –0.5SD (green) valued of the modifier (Model C).



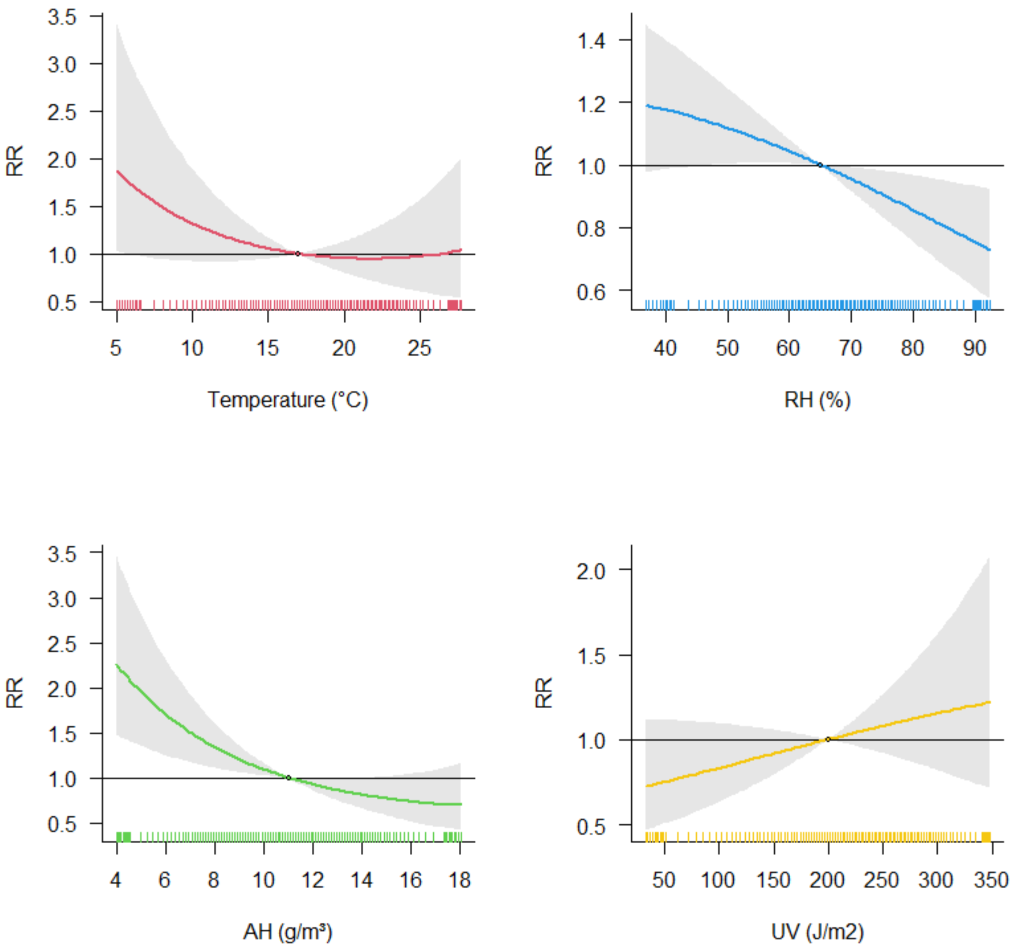
Supplementary Figure S8. Association between relative humidity and COVID-19 incidence adjusted by daily mean temperature.



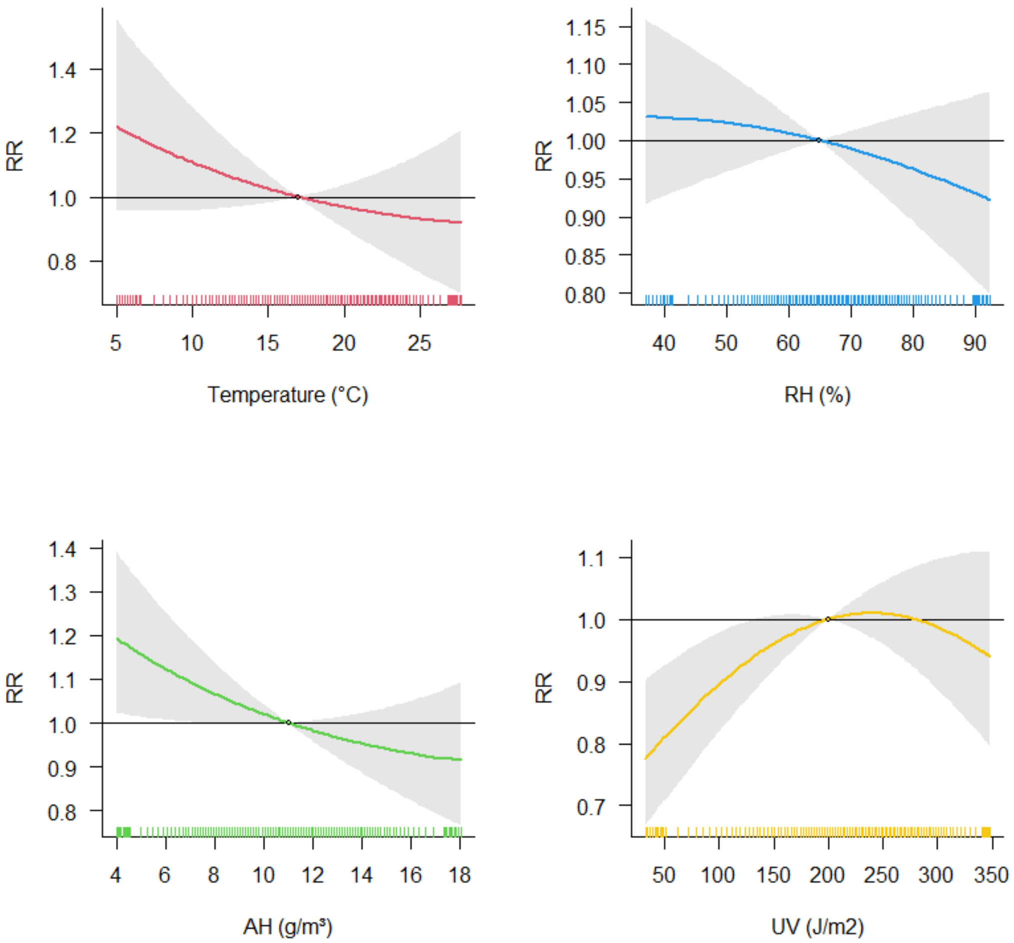
Supplementary Figure S9. Association between UV radiation and COVID-19 incidence adjusted by daily mean temperature.



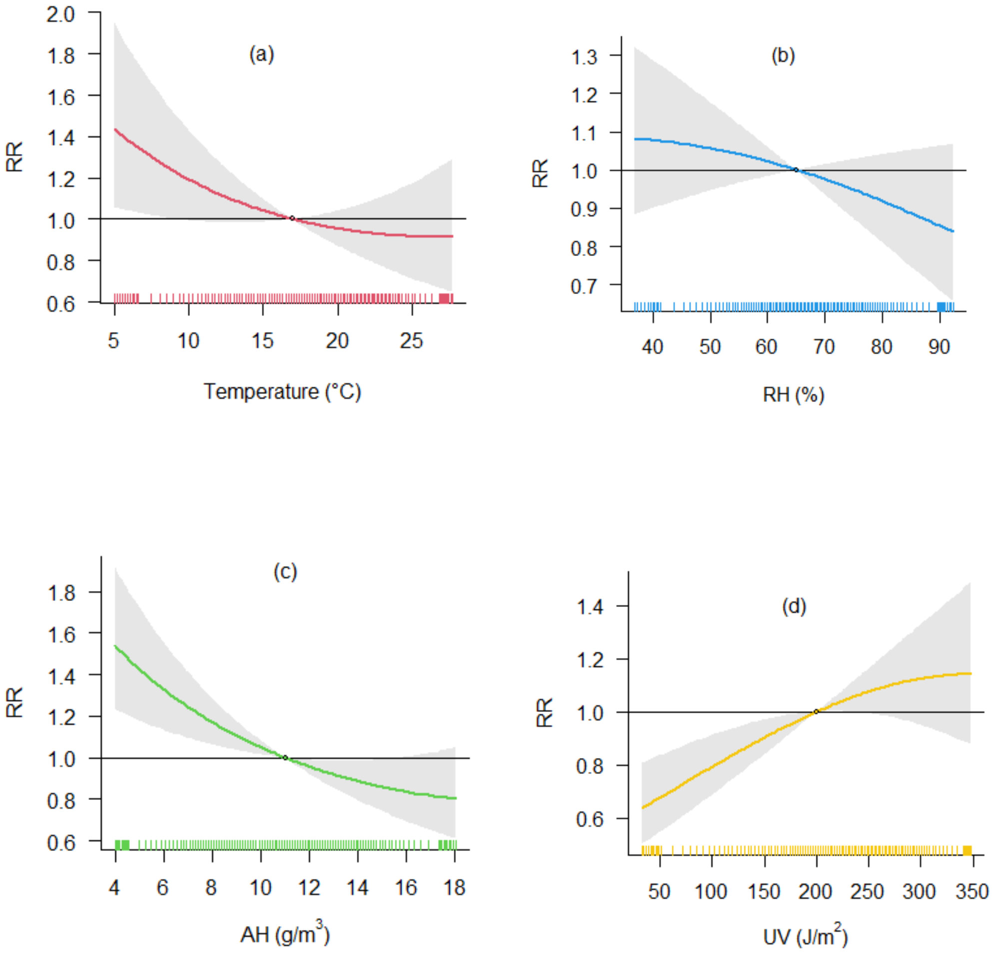
Supplementary Figure S10. Association between meteorological variables and COVID-19 incidence. Model A with 4 df.



Supplementary Figure S11. Association between meteorological variables and COVID-19 incidence. Model A with 10 days lag.



Supplementary Figure S12. Association between meteorological variables and COVID-19 incidence with the first-stage models adjusted by air pollution (PM10) and Model A meta-regression.



Supplementary Figure S13. Association between meteorological variables and COVID-19 incidence stratified by climatic zone. The number (n) of cities included in the analysis for each category is indicated in the figure legends.