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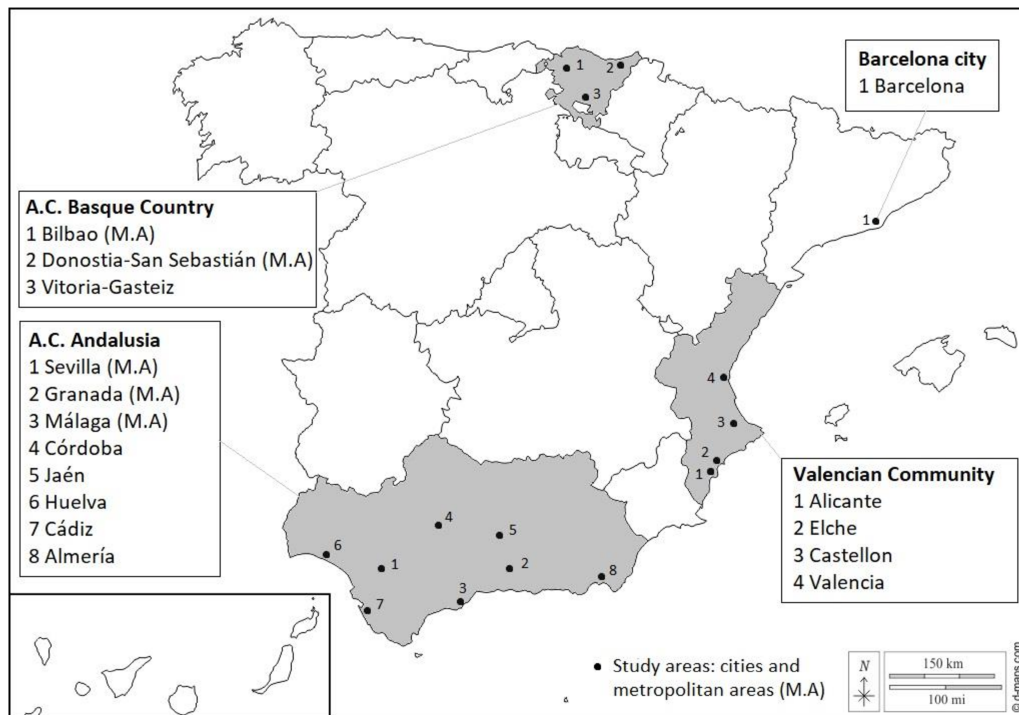
Section 1. GENERAL CHARACTERISTICS OF THE STUDY AREAS

Figure S1. Study areas of the project, being the cities and metropolitan areas (M.A) with more than 100,000 inhabitants from the autonomous communities of the Basque Country and Andalusia, Valencian Community, and the city of Barcelona. Figure edited from Daniel Dalet / d-maps.com.

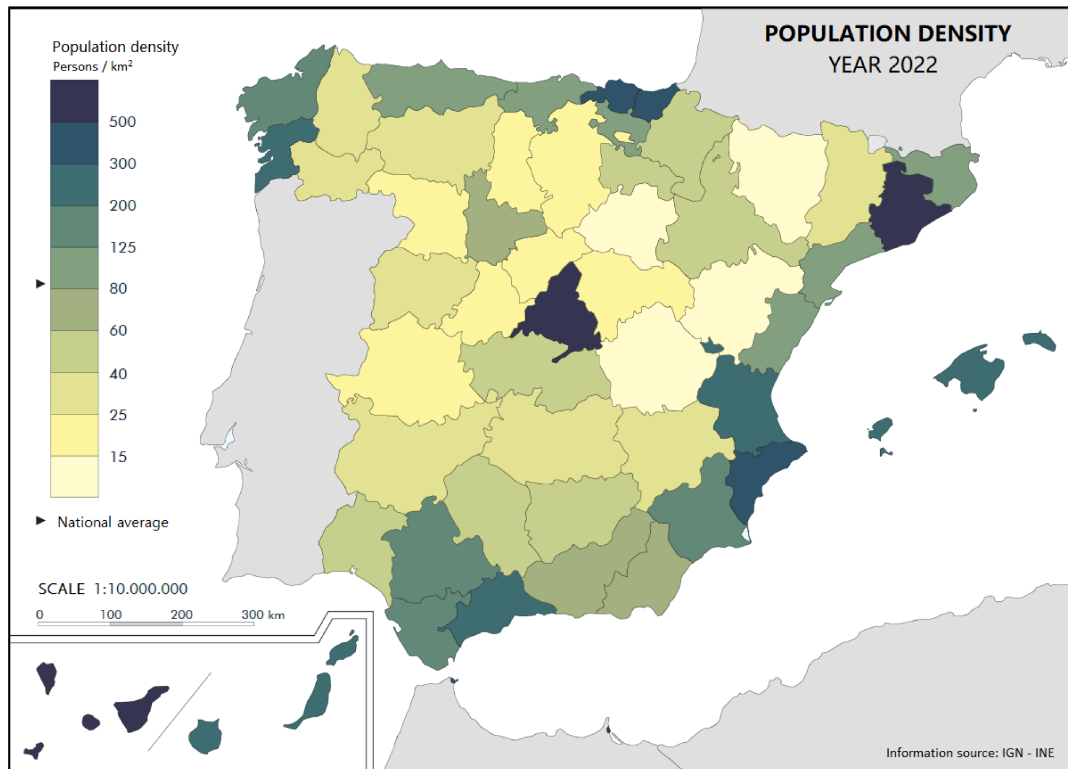


Figure S2. Population density of Spanish provinces in 2022. Figure edited from Instituto Geográfico Nacional, *La población en España 2022*. Accessed through: <https://www.ign.es/pobesp/pe1.htm>

Section 2. GENERAL CHARACTERISTICS OF THE POPULATION HEALTH SURVEYS

Table S1. Characteristics of the study areas and the population health surveys comprised in the project.

Study area	Cities and areas of influence	Population health survey	Responsible body	Sample size	Data collection period
A.C. Basque Country	Vitoria-Gasteiz Donostia-San Sebastián (M.A) Bilbao (M.A)	Encuesta de Salud de la Comunidad Autónoma País Vasco (ESCAV)	✓ Basque Department of Health	7,846	2022 October – 2023 June
A.C. Andalusia	Almería Cádiz Córdoba Huelva Jaén Granada (M.A) Malaga (M.A) Sevilla (M.A)	Encuesta Andaluza de Salud (EAS)	✓ Andalusian School of Public Health (EASP)	3,085	2022 April – 2023 April
Barcelona city	Barcelona	Encuesta de Salud de Barcelona (ESB)	✓ Barcelona Public Health Agency (ASPB)	4,000	2021 February – 2022 March
Valencian Community	Castellon Valencia Elche Alicante	Encuesta Salud Comunidad Valenciana (ESCV)	✓ Foundation for the Promotion of Health and Biomedical Research in the Valencian Region (DGSP)	3,134	2022 April – 2022 December

Abbreviations: A.C., Autonomous community; M.A, Metropolitan Area.

Section 3. OVERVIEW OF THE VARIABLES OF THE STUDY PER STUDY AREA

Table S2. Objective urban environmental exposures obtained through GIS estimations.

GIS Variables	Study areas: A.C. s of the Basque Country and Andalusia, Valencian Community & the city of Barcelona	
OBJECTIVE URBAN ENVIRONMENTAL EXPOSURES	Scale	Variable
a) Surrounding natural spaces		
Green Spaces		
Green space percentage	100, 300, 500m buffers	Percentage of green space.
NDVI	100, 300, 500m buffers	Annual mean Normalised Difference Vegetation Index (NDVI) of the year when the surveys were conducted and the mean NDVI of the last 5 years previous to the surveys.
Tree percentage	100, 300, 500m buffers	Percentage of tree cover based on Growing stock volume (GSV) data.
Distance to green space		Euclidean distance to the nearest major green space (green surface over 5,000m ²).
Green spaces Yes (vs. No)	100, 300, 500m buffers	Dichotomous variable of presence of major green spaces (green surface over 5,000m ²) from local topographical or Europe-wide maps (Urban atlas).
Blue spaces		
Blue spaces Yes (vs. No)	100, 300, 500m buffers	Dichotomous variable of presence of water surfaces. Based on Urban Atlas.
Blue space percentage	100, 300, 500m buffers	Percentage of water surface. Based on Urban Atlas.
Distance to blue space		Euclidean distance to the nearest water surface over 5,000m ² . Based on Urban Atlas.
b) Built environment		
Building density	100, 300, 500m buffers	The building density around each household will be calculated accounting for the perimeter and height of the buildings from local cadastre data or Europe-wide maps (Urban Atlas).
Population density	100, 300, 500m buffers	The number of inhabitants (per km ²) surrounding the home addresses.
Street connectivity	100, 300, 500m buffers	Using data from OpenStreetMap®.
Accessibility (bus lines)	100, 300, 500m buffers	Access to public transport bus lines from local topographical maps or OpenStreetMap®.
Accessibility (bus stops)	100, 300, 500m buffers	Access to public transport bus stops from local topographical maps or OpenStreetMap®.
Facility richness	100, 300, 500m buffers	Using local topographical maps or OpenStreetMap®.
Facility density	100, 300, 500m buffers	Using local topographical maps or OpenStreetMap®.
Land use	100, 300, 500m buffers	Mixed land use will be estimated by Shannon's Evenness Index based on Urban Atlas data.
Walkability index	100, 300, 500m buffers	Index constructed from seven indicators: population density, street connectivity, street density, facility richness, facility density, land use, transport density, and average slope.
c) Traffic infrastructure		
Major road Yes (vs. No)	100, 300, 500m buffers	Dichotomous variable of presence of a major road (OpenStreetMap®).
Inverse distance		Inverse distance to the nearest major road (OpenStreetMap®).

GIS Variables	Study areas: A.C. s of the Basque Country and Andalusia, Valencian Community & the city of Barcelona	
OBJECTIVE URBAN ENVIRONMENTAL EXPOSURES	Scale	Variable
d) Environmental stressors		
Air pollution		
PM _{2.5}	Street level (at residential address)	PM _{2.5} exposure indicators include: a) the annual average for the last five years, and b) the five-year average for the last five years based on spatiotemporal land-use random-forest models.
PM ₁₀	Street level (at residential address)	PM ₁₀ exposure indicators include: a) the annual average for the last five years, and b) the five-year average for the last five years based on spatiotemporal land-use random-forest models.
NO ₂	Street level (at residential address)	NO ₂ exposure indicators include: a) the annual average for the last five years, and b) the five-year average for the last five years based on spatiotemporal land-use random-forest models.
Noise		
Day (L _d)	Street level (at residential address)	Exposition to environmental noise at street level during the day indicated as: a) the annual average for the last five years, and b) the five-year average for the last five years based on Strategic Noise Maps derived under the EU Directive 2002/49/EC from the Ministry for the Ecological Transition and the Demographic Challenge.
Evening (L _e)	Street level (at residential address)	Exposition to environmental noise at street level during the evening indicated as: a) the annual average for the last five years, and b) the five-year average for the last five years based on Strategic Noise Maps derived under the EU Directive 2002/49/EC from the Ministry for the Ecological Transition and the Demographic Challenge.
Night (L _n)	Street level (at residential address)	Exposition to environmental noise at street level during the night indicated as: a) the annual average for the last five years, and b) the five-year average for the last five years based on Strategic Noise Maps derived under the EU Directive 2002/49/EC from the Ministry for the Ecological Transition and the Demographic Challenge.
Total (L _{den})	Street level (at residential address)	Total exposition to environmental noise at street level indicated as: a) the annual average for the last five years, and b) the five-year average for the last five years based on Strategic Noise Maps derived under the EU Directive 2002/49/EC from the Ministry for the Ecological Transition and the Demographic Challenge.

Abbreviations: A.C., Autonomous community; NDVI, Normalised Difference Vegetation Index; GSV, Growing stock volume; PM_{2.5}, Fine particulate matter with a diameter of 2.5µm or less; PM₁₀, Fine particulate matter with a diameter of 10µm or less; NO₂, Nitrogen dioxide

Table S3. Area-level socioeconomic (SES) variables obtained through GIS estimations.

GIS Variables		Study areas: A.C. s of the Basque Country and Andalusia, Valencian Community & the city of Barcelona	
AREA-LEVEL SES VARIABLES	Scale	Variable	
a) Mean income			
Average household net income	Census tract	Average household net income. Income data collection is based on standardised annual requests to the different collaborating tax organisations. Data from 2021. Data source INE ¹ .	
Average household gross income	Census tract	Average household gross income. As components of gross income, five exhaustive categories are considered: wages, pensions, unemployment benefits, other benefits, other income. Data from 2021. Data source INE ¹ .	
Average net income per person	Census tract	Net income per person is obtained, for each household, by dividing the net household income by the number of members of said household. Data from 2021. Data source INE ¹ .	
Average gross income person	Census tract	Gross income per person is obtained, for each household, by dividing the gross household income by the number of members of said household. Data from 2021. Data source INE ¹ .	
Average income per consumption unit	Census tract	Equivalent income is a measure of household income that takes account of the differences in a household's size and composition, and thus is equalised or made equivalent for all household sizes and compositions. The equalised income is calculated by dividing the household's total net income by its equivalent size, which is calculated using the modified OECD equivalence scale. This scale attributes a weight to all members of the household: 1.0 to the first adult; 0.5 to the second and each subsequent person aged 14 and over; 0.3 to each child aged under 14. Data from 2021. Data source INE ¹ .	
b) Income distribution P80/P20	Census tract	Ratio between the 80th percentile and the 20th percentile of the income distribution per unit of consumption. Data from 2021. Data source INE ¹ .	
c) Gini index	Census tract	The Gini index measures the degree of inequality in the distribution of income/wealth, used to estimate how far a country's wealth or income distribution deviates from an equal distribution ² . A Gini coefficient of 0 reflects perfect equality, where all income or wealth values are the same, while a Gini coefficient of 1 (or 100%) reflects maximal inequality among values, a situation where a single individual has all the income while all others have none. Data from 2021. Data source INE ¹ .	
d) MEDEA deprivation index	Census tract	A deprivation index developed to study the social inequalities in health in Spain. The index is composed by percentage of the population with manual labour, percentage of the population with casual labour, percentage of the population unemployed, percentage of the population with insufficient education, percentage of the population of young people with insufficient education ³ . Data from 2021.	

Abbreviations: A.C., Autonomous community; SES., Socioeconomic status

¹ INEbase. Atlas de Distribución de Renta de los Hogares (ADRH). INE. Retrieved 19 December 2023, from https://www.ine.es/metodologia/metodologia_adrh.pdf

² Gini, Corrado (1936). "On the Measure of Concentration with Special Reference to Income and Statistics", Colorado College Publication, General Series No. 208, 73–79.

³ Domínguez-Berjón, M. F., Borrell, C., Cano-Serral, G., Esnaola, S., Nolasco, A., Pasarín, M. I., Ramis, R., Saurina, C., & Escolar-Pujolar, A. (2008). Construcción de un índice de privación a partir de datos censales en grandes ciudades españolas: (Proyecto MEDEA). *Gaceta Sanitaria*, 22(3), 179–187.

Table S4. Variables collected through Population Health Surveys.

Population Health Survey Variables	Study areas			
	A.C. Basque Country	A.C. Andalusia	Barcelona city	Valencian Community
OUTCOMES				
a) Perceived health				
General Health	Ordinal 1-5	Ordinal 1-5	Ordinal 1-5	Ordinal 1-5
Mental Health	Ordinal 1-5 [MHI/5 items]	Ordinal 1-6 [SF-12/3 items]	Ordinal 1-4 [GHQ-12/12 items]	Ordinal 1-4 [GHQ-12 /12 items]
b) Quality of life				
Health-related quality of life	Ordinal 1-5 [EuroQoL / 5 items]	Ordinal 1-6/1-5 [SF-12 / 5 items]	Ordinal 1-5 [EuroQoL / 5 items]	Ordinal 1-5 [EuroQoL / 5 items]
c) Sleep				
Sleep duration	Continuous - Total hours/day	Continuous - Total hours/day	Continuous - Total hours/day	Continuous - Total hours/day
Quality of sleep	Ordinal 1-5 [SATSD / 5 items]	Ordinal 1-4 [4 items]	Ordinal 1-10	Ordinal 1-5 [SATSD / 5 items]
d) Consumption of medication for common mental disorders¹				
Antidepressants	yes/no – reference 2 days	yes/no – reference 2 weeks	yes/no - reference 2 days	yes/no - reference 2 weeks
Hypnotics	yes/no - reference 2 days	yes/no - reference 2 weeks	yes/no - reference 2 days	yes/no – reference 2 weeks
Anxiolytics	yes/no - reference 2 days	yes/no - reference 2 weeks	yes/no - reference 2 days	yes/no - reference 2 weeks
e) Chronic mental health problems²				
Anxiety	yes/no - reference ever	yes/no – reference present	yes/no - reference ever	yes/no – reference ever
Depression	yes/no - reference ever	yes/no - reference present	yes/no - reference ever	yes/no - reference ever
Insomnia	yes/no - reference ever	-	-	yes/no - reference ever
Other	yes/no - reference ever	-	yes/no - reference ever	yes/no - reference ever
COVARIATES				
a) Anthropometric variables				
Age	Discrete	Discrete	Discrete	Discrete
Weight	Continuous	Continuous	Continuous	Continuous
Height	Continuous	Continuous	Continuous	Continuous
BMI	Continuous	Continuous	Continuous	Continuous
Biologic sex	Categorical - 3 conditions	Categorical - 2 conditions	Categorical - 2 conditions	Categorical - 2 conditions
Gender identity	Categorical - 3 conditions	-	Categorical - 3 conditions	-
b) Individual socioeconomic variables				
Education level	Categorical - 9 conditions	Categorical - 13 conditions	Categorical - 11 conditions	Categorical - 9 conditions
Occupational status	Categorical [CNO11]	Categorical [CNO11]	Categorical [CNO11]	Categorical [CNO11]
Household size	Discrete	Discrete	Discrete	Discrete

Population Health Survey Variables	Study areas			
	A.C. Basque Country	A.C. Andalusia	Barcelona city	Valencian Community
Household income	Categorical - 11 conditions	-	-	Categorical - 8 conditions
Economic difficulty	Categorical - 6 conditions	Categorical - 6 conditions	Categorical - 6 conditions	Categorical - 6 conditions
Employment status	yes/no	yes/no	yes/no	yes/no
Country of birth	Categorical & Open	Categorical & Open	Categorical & Open	Categorical & Open
Marital status	Categorical - 6 conditions	Categorical - 5 conditions	Categorical - 5 conditions	Categorical - 5 conditions
c) Lifestyle factors				
Alcohol consumption	Categorical - 8 conditions	Categorical - 10 conditions	Categorical - 4 conditions	Categorical - 8 conditions
Passive smoking at home	Likert 1-5	yes/no	Discrete (Nº smokers)	yes/no
Daily tobacco consumption	yes/no	Categorical - 4 conditions	Categorical - 3 conditions	Categorical - 4 conditions
e) Physical Health				
Chronic health problems	Categorical - 38 conditions	Categorical - 25 conditions	Categorical - 25 conditions	Categorical - 21 conditions
d) Mobility				
Years at household	Discrete	-	Discrete	Discrete
MEDIATORS				
a) Physical activity				
Physical activity	Discrete - IPAQ	Discrete - IPAQ	Discrete - IPAQ	Discrete - IPAQ
- Vigorous	MET-min/week	MET-min/week	MET-min/week	MET-min/week
- Moderate	MET-min/week	MET-min/week	MET-min/week	MET-min/week
- Walking	MET-min/week	MET-min/week	MET-min/week	MET-min/week
- Sitting	Time spent (hours + minutes)	Time spent (hours + minutes)	Time spent (hours + minutes)	Time spent (hours + minutes)
b) Social cohesion				
Social support	Ordinal 1-5 [Duke / 11 items]	Ordinal 1-5 [Duke / 11 items]	Ordinal 1-5/1-4 [OSLO/ 3 items]	Ordinal 1-5 [Duke / 11 items]
Loneliness	Ordinal 1-4	Ordinal 1-4	Ordinal 1-4	Ordinal 1-4
SUBJECTIVE URBAN ENVIRONMENTAL EXPOSURES				
a) Perception of the neighbourhood				
Noise outside dwelling	Likert 1-3	Likert 1-3	Likert 1-5	Likert 1-3
Neighbourhood air pollution	Likert 1-3	Likert 1-3	-	Likert 1-3
Shortage of green spaces	Likert 1-3	Likert 1-3	-	Likert 1-3
Insecurity	Likert 1-3	Likert 1-3	Likert 1-5	Likert 1-3

¹ The subjects are provided with a list of medications and are asked if they have consumed any of them in the last 2 days or 2 weeks depending on the study area.

² Subjects are provided with a list of chronic health problems and are asked if they currently suffer or have ever suffered (depending on the study area) from any of them.

A) Prevalence of common mental disorders in Spain.

A recent report published by the Spanish National Health System (2020), based on a representative sample of users of said system, found that the overall prevalence of mental health problems in Spain is 27.4%. The most common general mental health issues were anxiety, depression, and sleep disorders, with a prevalence of 6.7%, 4.1%, and 5.4%, respectively. Higher prevalence of these disorders was observed in the female population, those born in Spain and with increasing age. The same report notes that in the case of anxiety and depression, a clear social gradient is observed, with both disorders being 3.4 and 2.5 times more prevalent in the population with lower income levels. In the case medication prescriptions, anxiolytics, antidepressants, and hypnotics were prescribed at rates of 34% for women and 17% for males over 40. The 2020 European Health Survey revealed no discernible territorial differences in the prevalence of chronic mental health conditions among individuals aged 15 and older in Spain. However perceived health status showed slight regional disparities, with Valencia reporting the highest percentage of "bad or very bad" health at 9.4%, followed by Andalucía (7.4%), the Basque Country (7%), and Catalonia (4.9%). However, given that the results presented in this report pertain to a timeframe predating the onset of the COVID-19 pandemic, it is anticipated that the prevalence of these conditions has risen universally among all age groups and regions (Henares Montiel et al., 2020). This increase can be attributed to escalated stress and health-related concerns stemming from the pandemic, exacerbated by associated constraints like lockdown measures and the resultant impact on mental health care services during the pandemic (Balluerka et al., 2020).

Balluerka, N., Gómez, J., Hidalgo, M., Gorostiaga, A., Espada, P., Padilla, J., & Santed, M. (2020). LAS CONSECUENCIAS PSICOLÓGICAS DE LA COVID-19 Y EL CONFINAMIENTO INFORME DE INVESTIGACIÓN

Henares Montiel J, Ruiz-Pérez I, Sordo L. Salud mental en España y diferencias por sexo y por comunidades autónomas. *Gaceta Sanitaria*. 2020;34:114–9.

INEbase / Society /Health /European Survey of Health in Spain. INE. Retrieved December 2023. https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176784&idp=1254735573175

Sistema Nacional de Salud. (2020). Base de Datos Clínicos de Atención Primaria-BDCAP. <https://cpage.mpr.gob.es/>

Section 4. DATA MANAGEMENT PLAN

A) RESEARCH ACTIVITIES

Step 1. Population Health Surveys' (PHS) data curation and calibration

The selected individuals were contacted by a phone call, SMS, or letter to arrange an appointment for a face-to face interview for the purpose of the survey. The database produced with the interviews will be pseudonymised from that with the personal data for the contact by assigning a unique code for each participant and remains under the custody of the responsible body in each study area; the Basque Department of Health in the Basque Country, Escuela Andaluza de Salud Pública (EASP) in Andalusia, Agència de Salut Pública de Barcelona (ASPB) in Barcelona, and Conselleria de Salut Universal i Salut Pública (DGSP) in Valencian Community.

Step 2. Harmonisation

Initially, the databases of each study area will be cleaned, and the variables that require it will be harmonised. The vast majority of the variables to be used in the project have been collected identically in the Population Health Surveys of the study areas included. The variables to be harmonized are listed below and the measures used in each study area can be found in Table S2.

The variables that need harmonisation can be distinguished between simple or complex variables, depending on the level of difficulty and the manipulation of data that require the harmonisation of the respective variable:

- Simple variables: Chronic mental health problems, Educational level, Occupation status, Household income, Loneliness, Noise outside dwelling, and Insecurity.

- Complex variables: mental health, health-related quality of life, sleep quality, consumption of medication for common mental disorders, alcohol consumption, passive smoking at home, tobacco consumption, physical health, and social support.

The Maelstrom Research Guidelines for the rigorous harmonisation of retrospective data (77) will be applied. Among the variables that need harmonisation, the majority can be easily re-categorised (simple variables). For instance, in the case of scales with different score ranges (e.g., Likert scale levels), standardised scores will be calculated, or other procedures will be followed to ensure comparability. The procedure to follow with variables measured with different scales will be more complex (complex variables). For these, the content of each variable will be studied to detect the common content (e.g., items) in each of the study areas. Once detected, aggregate scores will be calculated for the common items, and these scores will be used for statistical analyses. The remaining non-harmonizable variables will be assessed for their potential for performing separate statistical analysis for each study area.

Step 3. Georeferentiation

The responsible bodies, in collaboration with regional Statistical Institutes or Population Registers, will link the health survey data to the geographical coordinates of each respondent's home address. The geographical coordinates will also be pseudonymised and sent this way to the research group specialised in Geographic Information System (GIS) estimations that will calculate UrbEE. In order to further ensure the protection of the personal data of the survey participants and enhance their anonymity, fictional coordinates will be created in a number five times the number of participants selected for the study in each study area and sent to the research group specialised in GIS estimations together with the real coordinates.

Step 4. GIS estimation of Urban Environmental Exposures (UrbEE)

A company specialised in GIS estimations will calculate the objective urban environmental exposures (UrbEE) of all the geocodes, including the participants' coordinates and the fictional coordinates by GIS.

Step 5. Selection and linkage of data

After the estimations are finalised, the responsible bodies of the surveys in each study area will re-select the geocodes of the participants and add the new urban environmental variables to the database with the PHS data. The researchers will be provided with the resultant database of each study area composed by the PHS data and the UrbEE (without geocodes and personal data of the participants). This guarantees that the data supplied are protected by statistical secrecy, not misused and treated anonymously and globally at all times.

Step 6. Pooling

Finally, the final databases of all the study areas will be pooled, creating the final pooled database to be used in the planned analyses.

B) DATA STORAGE AND PROCESSING

Data will be kept at all times on servers located in the responsible centre of this project. This way, data will be stored on the University of the Basque Country UPV/EHU's own servers, complying with the greater security and privacy requirements of the LOPD as the data is not sent to external servers. The entire process of recording, dumping and storage of the data will be anonymised, with the data collected being exclusively linked to a sample unit code. Access to the anonymised microdata will be limited to technicians from the responsible centres of each study area through profiles with regulated permissions that allow for supervising and controlling access to the information. Supervision of the data management will be assigned to the principal

investigators with expert advice, and to the data protection officer of the centre responsible for the project.

C) ETHICAL CONSIDERATIONS AND ACCOUNTABILITY

The study was approved by the regional Research Ethics Committee of the **Basque Country**, ETHICS COMMITTEE FOR RESEARCH INVOLVING MEDICINAL PRODUCTS IN THE BASQUE COUNTRY (CEIm-E) (protocol code PI2022138, dated 9th November 2022); **Andalusia**, BIOMEDICAL RESEARCH ETHICS COMMITTEE OF THE PROVINCE OF GRANADA (CEI/CEIM GRANADA) (protocol code 2078-N-22, dated 27th December 2022); **Barcelona**, PARC DE SALUT MAR CLINICAL RESEARCH ETHICS COMMITTEE (CEIm) (protocol code 2022/10667, dated 2nd December 2022); **Valencian Community**, ETHICS COMMITTEE FOR CLINICAL RESEARCH OF THE DIRECTORATE GENERAL OF PUBLIC HEALTH AND CENTER FOR ADVANCED RESEARCH IN PUBLIC HEALTH (CEIC DGSP / CSISP) (protocol code 20221125/04, dated 25th November 2022).

This study is based on secondary data obtained from four independent Population Health Surveys (PHS) from Spain. Since the present study does not involve the activity of data collection, to obtain the informed consent from the subjects is not applicable for this study. However, the PHS included this project are official statistical operations included in the respective Statistical Plans of each study area. This ensures that the data provided is protected by statistical confidentiality, it is not misused, its treatment is anonymous and global at all times, and that indirect identification is impossible. Data are collected and processed in accordance with the provisions of the General Data Protection Regulation (GDPR) and in accordance with the provisions of Article 5 of the Organic Law 3/2018 of 5 December on the Protection of Personal Data and the guarantee of digital rights (Regulation (EU) 2016/679), they will be treated confidentially, with access to them being granted to personnel who strictly need to process them in the framework of the study.

Furthermore, the transfer of data occurs between organisations within the Public Health System of each region and the regional or local government itself. This is done in the context of a research project conducted exclusively in the public sphere and with the legitimacy of the use of administrative records as research infrastructures in accordance with the General Health Act, the Biomedical Research Act and the General Law on Public Health. The results of the study will provide information at a sufficiently aggregated territorial level to prevent indirect identification. Furthermore, the project's results will be beneficial to the general population in a holistic way, thanks to its socioeconomic and environmental context, and its evolution over several years from the onset of the COVID-19 pandemic. Therefore, the risk to the privacy of the study population is minimal compared to the potential benefits the results will bring.