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Association between neighborhood physical characteristics and mental health among older adults in Spain ☆



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ABSTRACT

The aim was to assess the impact of neighborhood physical environment on mental health among non-institutionalized older adults. A cross-sectional analysis was conducted over a representative sample of 5,071 people ≥ 65 years from the Spanish National Health Survey. The survey included nine items addressing the self-perceived degree of discomfort due to neighborhood physical problems. Participants were categorized into groups with “no problems”, “some problems” (somewhat discomfort on 1–4 items) and “many problems” (somewhat discomfort on ≥ 5 items or very much discomfort on ≥ 1 item). Mental health status was assessed using the General Health Questionnaire, consisting of 12 items assessing the severity of a psychological distress over the past few weeks. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated using logistic regressions. A dose-response association (p -trend < 0.001) was found between living in neighborhoods with some (OR: 1.41; 95% CI: 1.14–1.75) or many problems (OR: 1.93; 95% CI: 1.55–2.42) affecting the physical environment with poor mental health of community dwelling older adults. Integrating and articulating health considerations into public policymaking regarding housing and the residential environment can have broad implications for healthy aging.

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Introduction

Healthy aging is a worldwide challenge.^{1,2} Compressing the burden of lifetime morbidity and disability into a shorter period before death could help contain rising health care expenditure and social costs. Mental disorders are among the leading causes of the global health-related burden and could become increasingly relevant in the coming years, due to population growth and aging and the long lasting impact of the COVID-19 pandemic.³ The burden of mental disorders is recognized as a major obstacle for healthy aging. Indeed, up to 15–25% of older people suffer from some mental disorder^{4,5}; concretely, neurological and mental disorders account for 6.6% of total disability and represent the fifth most important contributor to disease burden in the older adult population.^{2,6} Of these, depression is

one of the most prevalent and disabling clinical conditions affecting older people.^{5,7}

Although certain conceptual models support the importance of environmental factors in achieving healthy aging,^{8,9} there is limited research on the influence of neighborhood characteristics on older adults' health.¹⁰ In general, it is known that living in socially disadvantaged neighborhoods is associated with unhealthy behaviors, adverse health events, and increased all-cause mortality.¹¹ However, the multiple associations between the wide range of neighborhood characteristics and health outcomes are still unclear and need to be studied in greater depth. Of all the neighborhood characteristics, the physical environment is perhaps the most easily modifiable. Therefore, understanding its impact on the health of older people should be a priority for decision-makers and translational research.

To date, only a few studies have assessed the association between physical neighborhood problems and mental health status, providing relatively consistent results. Domènech-Abella et al¹² in a study of 869 older adults in Belgium, found that neighborhood physical environment (mobility and safety) was associated with better mental health, and that this association was mediated by loneliness. Thus,

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improving the physical environment might lead to less loneliness, which in turn would lead to better mental health. Other studies in China and the USA came to the same conclusion, yet they also gave an important role to physical activity as a possible mediator.^{13,14} Nevertheless, the effect of the neighborhood environment on mental health may vary across countries, considering that residential architecture, the culture of neighborhood relationships, and even climate may influence this association.^{15,16} Moreover, according to our pre-defined hypothesis, the mediators could be different in Spain, given the high family cohesion of southern European countries and the increased mobility favored by a friendlier climate, which could mitigate the potential mediating effect of loneliness and physical activity.

Thereby, and given that no previous study has explored this association in Spain, this study aimed to assess the impact of neighborhood physical environment on the mental health over a representative sample of Spanish community dwelling older people, and to understand the role of certain potential mediators, such as social isolation and physical activity.

Subjects and methods

Study design and participants

The data were taken from the 2017 Spanish National Health Survey (SP-NHS), comprising a representative sample of the Spanish non-institutionalized population, whose methods have been reported elsewhere.¹⁷ Briefly, the SP-NHS used a stratified tri-stage sampling design. The first stage selected census sections with probability proportional to their size, the second stage selected family households, and the third stage selected one adult in each household. The data collection was conducted by trained staff through a computer-assisted face-to-face interview. Of the 29,195 subjects that formed the study sample, the present study included 5,071 people ≥ 65 years.

Study variables

Neighborhood environment

Participants in the SP-NHS completed a "housing characteristics" questionnaire, which addresses self-perceived physical problems with the neighborhood environment. The questionnaire summarizes the degree of discomfort ("very much" / "somewhat" / "not at all") with the following nine neighborhood problems: 1) noise coming from outside their home, 2) foul smells coming from outside, 3) poor quality drinking water, 4) poor street cleanliness, 5) high air pollution caused by a nearby industry, 6) high air pollution caused by other causes, 7) lack of green areas, 8) presence of troublesome animals (e.g. dogs, cats, pigeons, etc.), and 9) crime, violence or vandalism in the neighborhood. Subsequently, participants were categorized into three neighborhood groups according to the following criteria: subjects were considered to live in a neighborhood with "no problems" when they answered "not at all" to all 9 items; if they answered "somewhat" to 1–4 items, they were considered to live in a neighborhood with "some problems"; and if they reported that their neighborhood was "somewhat" affected on ≥ 5 items or "very much" on any items, it was considered that they lived in a neighborhood with "many problems".

Additionally, each "not at all" response was scored 0 points, each "somewhat" response was given 1 point, and each "very much" response was assigned 2 points. Thus, a quantitative variable was obtained, with a total score that ranged from 0 to 18 (neighborhood with maximal problems); tertiles of this score were also used in the analyses.

Mental health status

Mental health status was the health outcome and was assessed using the Goldberg General Health Questionnaire (GHQ-12),

validated in Spain.¹⁸ This questionnaire comprises 12 items with four response options: "not at all" / "the same as usual" / "somewhat more than usual" / "much more than usual". The score was calculated assigning 0 points to the responses "not at all" and "same as usual", and 1 point to the responses "somewhat more than usual" and "much more than usual". Subsequently, the scores of all items were summed resulting in an overall score ranging from 0 to 12 points. A score ≥ 3 points indicated poor mental health status.

Other variables

Socio-demographic information included sex, age, educational level, social class,¹⁹ inhabitants of the locality and marital status. Also, a synthetic measure of social isolation was used, which was operationalized by combining the variables 'perceived social support' and 'cohabitation'. Social support was measured with the Duke-UNC questionnaire, which is a self-administered scale of 11 items with Likert-type responses (5 options) with a score range between 11 and 55 points.²⁰ Using the 15th percentile of our sample as a cut-off point (41 points), the Spanish older population was classified according to "scarce social support" and "adequate social support". Subsequently, the information on cohabitation (living alone/accompanied) was added and the social isolation indicator was constructed. People who lived accompanied and had adequate social support were considered as not being socially isolated; whereas people who lived alone and had scarce social support were considered to suffer severe social isolation. The remaining combinations were labeled as moderate isolation.

Lifestyle variables were also collected, including self-reported tobacco smoking (never, former, current smoker), alcohol intake, and physical activity. Alcohol intake (g/d) was estimated using a beverage frequency questionnaire, which included the most common alcoholic drinks in Spain. Heavy drinker was defined as a consumer of >280 or 170 g/week for men and women, respectively. Physical activity was based on the frequency of leisure time activity, with the possible answers being: 1) "I do not exercise, I spend my free time doing sedentary activities; 2) "I do some occasional physical or sports activity (walking, cycling, gardening, gymnastics, etc.); and 3) "I do physical activity or sports training several times a week (gymnastics, running, swimming, cycling, team games, etc.);" this was used to classify individuals as sedentary, with moderate-, or with intense-physical activity, respectively.

Finally, three health status variables were included. First, functional dependence, according to the ability to carry out five activities of daily living (eating, sitting, getting up from a chair or bed, dressing, going to the toilet and showering); a person with some difficulty to perform any of these tasks was classified as "dependent". Second, self-perceived health. And third, morbidity, defined as a medical diagnosis of cardiovascular disease (high blood pressure, coronary heart disease, varicose veins in the legs and other heart diseases), diabetes, stroke, chronic respiratory disease (rhinitis, asthma and chronic obstructive pulmonary disease), musculoskeletal diseases (osteoarthritis, cervical/low back pain and osteoporosis), cancer and depression.

Statistical analyses

The analyses accounted for the complex sampling design using the survey procedure in STATA v.15 (Stata Corp, College Station, TX). Only p-values <0.05 were considered statistically significant.

Of the 5071 participants aged ≥ 65 years, we excluded 61 subjects lacking data on neighborhood characteristics, 104 on GHQ-12 and 177 on other variables. Thus, the analytical sample consisted of 4729 people (Fig. 1). The cross-sectional association between having some or many neighborhood physical problems (versus having none) and poor mental health was summarized with odds ratios (OR) and their 95% confidence interval (CI), obtained from logistic regression. Three

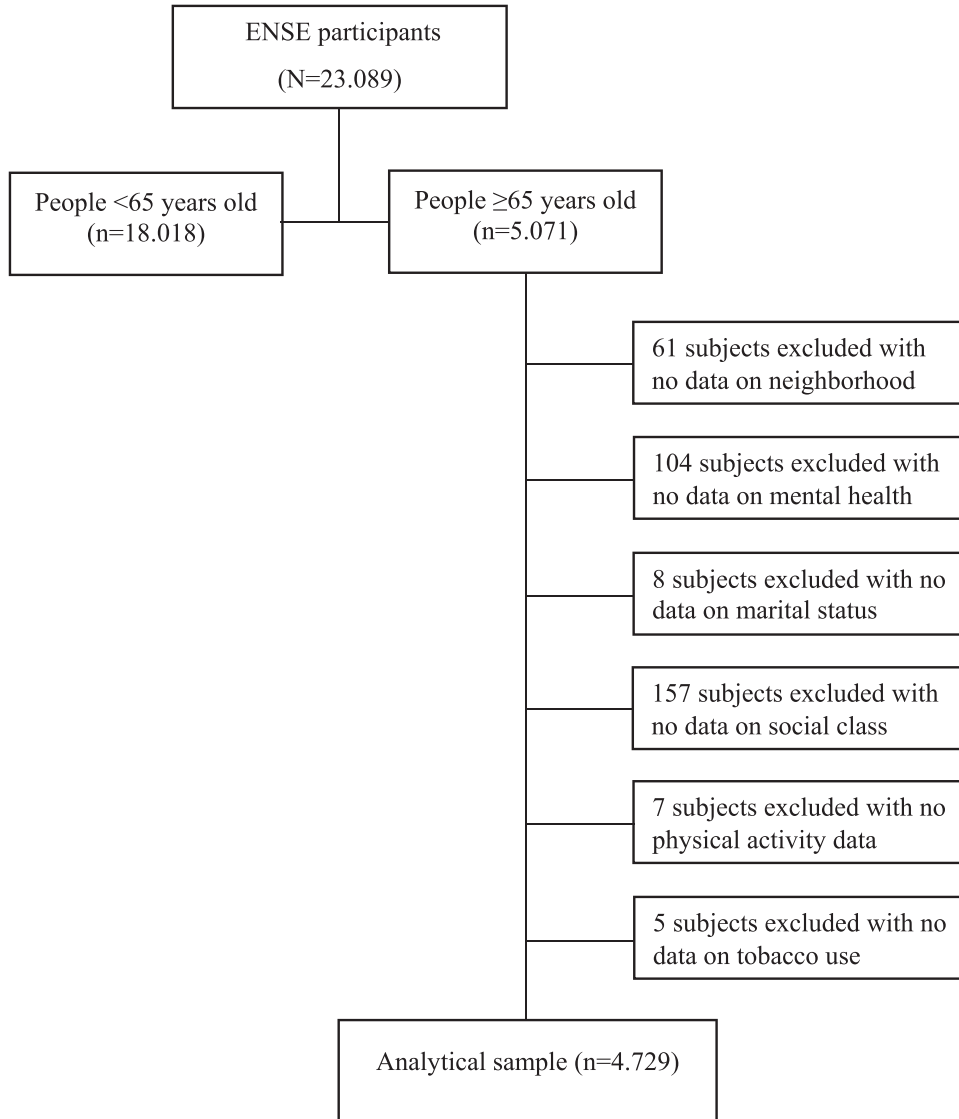


Fig. 1. Study flowchart.

models were built: the first one was adjusted for sociodemographic variables, the second one was further adjusted for lifestyle variables, and the third model was additionally adjusted for morbidity. Analyses were performed on the entire sample and repeated after excluding persons with a self-reported medical diagnosis of depression. To assess the dose-response association, the analyses were replicated using the score of the neighborhood physical problems as a quantitative variable (p-for-trend).

In addition, the isolated contribution of the nine neighborhood environment characteristics to mental health status was studied. Finally, stratified analyses were performed according to the size of the locality, social isolation, physical activity, and perceived health status. To assess whether the results varied significantly between these strata, models with and without interaction terms were compared using likelihood ratio tests (p-value of interaction).

Results

In total, 22.6% of people aged ≥65 years in Spain reported poor mental health. These were more often women, older, of lower social class, widowed, living in intermediate or severe social isolation, sedentary, dependent in ADLs, with poor or very poor self-perceived

health status, physician-diagnosed morbidity, and a high rate of depression (Table 1). About 30% of the study population lived in neighborhoods without problems. Those living in neighborhoods with more problems were more frequently smokers and heavy drinkers (>240 g/week for men and >170 g/week for women), under the age of 85 years, and residing in localities with > 10,000 inhabitants (Table 1).

Overall, poor mental health was associated with living in a neighborhood with some physical problems (OR: 1.41; 95% CI: 1.14–1.75) or many problems (OR: 1.93; 95% CI: 1.55–2.42) (Table 2). Stronger results were found when the analyses were restricted to people without a diagnosis of depression. Moreover, the greater the number of neighborhood problems detected by the participant, the greater the probability of having poor health status (p-trend<0.001). The results were consistent when tertiles of the score were used to summarize the neighborhood physical problems (Supplementary Table 1).

With the exception of violence or delinquency, all individual components of neighborhood physical characteristics were associated with a higher likelihood of poor mental health (Table 3). Among these, the most relevant were industrial pollution (OR: 2.67; 95%CI: 1.55–4.59), presence of troublesome animals (OR: 1.80; 95%CI: 1.37–2.36) and scarcity of green areas (OR: 1.49; 95%CI: 1.10–2.03).

Table 1Sociodemographic, lifestyle and morbidity characteristics of participants according to mental health status and physical characteristics of the neighborhood ($n = 4729$).

	Mental health		Physical characteristics of the neighborhood		
	Normal	Deficient	No problems	Some problems	Many problems
All participants, n (%)	3,659 (77.4)	1,070 (22.6)	1,423 (30.1)	1,540 (32.6)	1,766 (37.3)
Women, n (%)	1,876 (72.0)	730 (28.0)	767 (29.4)	882 (33.8)	957 (36.7)
Age ≥ 85 years, n (%)	415 (67.1)	204 (32.9)	225 (36.4)	211 (34.1)	183 (29.5)
Primary education or less, n (%)	2,314 (73.6)	831 (26.4)	1,035 (32.9)	1,038 (33.0)	1,072 (34.1)
Unskilled workers, n (%)	458 (69.0)	206 (31.0)	211 (31.8)	225 (33.9)	228 (34.3)
Locality <10,000 inhabitants, n (%)	899 (77.9)	255 (22.1)	519 (45.0)	377 (32.7)	257 (22.3)
Widowed, n (%)	813 (68.4)	375 (31.6)	393 (33.1)	384 (32.3)	412 (34.6)
Social isolation, n (%)	915 (68.7)	417 (31.3)	403 (30.3)	452 (34.0)	477 (35.8)
Smoker, n (%)	360 (84.3)	67 (15.7)	111 (30.0)	129 (30.3)	187 (43.8)
Heavy drinker, n (%)	168 (80.5)	41 (19.5)	43 (20.7)	55 (26.4)	111 (53.0)
Sedentary, n (%)	1,341 (65.5)	708 (34.5)	607 (29.6)	652 (31.8)	790 (38.6)
Dependency for ADL, n (%)	356 (42.1)	490 (57.9)	254 (30.1)	1,273 (32.8)	1,442 (37.1)
Poor/very poor health, n (%)	344 (41.8)	479 (58.2)	241 (29.3)	262 (31.8)	320 (38.9)
Morbidity, n (%)					
Cardiovascular disease	2,453 (74.7)	833 (25.3)	969 (29.5)	1,066 (32.4)	1,251 (38.1)
Diabetes	767 (69.2)	341 (30.8)	308 (27.8)	354 (31.9)	447 (40.3)
Stroke	141 (62.7)	84 (37.3)	64 (28.5)	81 (36.1)	80 (35.4)
Chronic respiratory disease	765 (68.6)	350 (31.4)	294 (26.3)	368 (33.0)	453 (40.7)
Musculoskeletal disease	2,019 (70.8)	833 (29.2)	815 (28.6)	961 (33.7)	1,076 (37.7)
Cancer	315 (67.1)	155 (32.9)	123 (26.2)	163 (34.7)	184 (39.1)
Depression	371 (46.1)	434 (53.9)	228 (28.3)	284 (35.3)	293 (36.4)

ADL: activities of daily living.

In the stratified analyses, a significant interaction was found with the size of the locality (p for interaction=0.001) and with physical activity (p for interaction=0.027). The association between neighborhood physical characteristics and poor mental health was of a greater magnitude in larger localities and in people who engaged in moderate/high physical activity (Table 4). Neither social isolation nor health status significantly mediated this association.

Discussion

This study analyzed data from a representative sample of the Spanish population aged ≥ 65 years, finding that living in a physical environment with some or many reported problems was associated with worse mental health. This association was stronger in larger localities and in people who regularly engaged in moderate or intense physical activity.

The present study was the first to explore this association in Spain; however, similar results have been observed in other countries

using slightly different procedures. In a longitudinal study with 13,919 individuals from the Health and Retirement Study in the US, older people who lived in neighborhoods with worse perceived characteristics, such as the presence of graffiti, garbage, abandoned houses and crime, experienced greater feelings of anxiety and/or more depressive symptoms.²¹ Also, a study in three municipalities of Flanders (Belgium) found that several deficits in the residential environment, such as lack of essential services, heavy traffic, and mobility and safety problems, were associated with a worse score on the psychological frailty subscale of the Comprehensive Frailty Assessment Instrument Plus.¹² In addition, this association has been tested in samples of younger people. Gupta et al.²² conducted a cohort study involving 66,275 people >19 years with diabetes living in New Brunswick (Canada), and reported that people in the most deprived neighborhoods (i.e., low socioeconomic status, high unemployment rate, residences awaiting repair, etc.) made greater use of health services for mood and anxiety disorders during the six-year follow-up period.

Table 2

Association between physical characteristics of the neighborhood and poor mental health of older adults in Spain.

	No problems	Some problems	Many problems	p-trend
Total sample ($n = 4729$)				
Participants, n	1,423	1,540	1,766	
Cases of poor mental health, n (%)	254 (17.8)	350 (22.7)	466 (26.4)	
Model 1, OR (95% CI)	1.00	1.38 (1.14–1.68)	1.95 (1.61–2.37)	<0.001
Model 2, OR (95% CI)	1.00	1.39 (1.15–1.69)	1.90 (1.56–2.31)	<0.001
Model 3, OR (95% CI)	1.00	1.41 (1.14–1.75)	1.93 (1.55–2.42)	<0.001
Subjects without depression ($n = 3924$)				
Participants, n	1,196	1,256	1,472	
Cases of poor mental health, n (%)	142 (11.9)	200 (15.9)	294 (20.0)	
Model 1, OR (95% CI)	1.00	1.47 (1.14–1.88)	2.22 (1.74–2.84)	<0.001
Model 2, OR (95% CI)	1.00	1.48 (1.15–1.91)	2.17 (1.69–2.78)	<0.001
Model 3, OR (95% CI)	1.00	1.46 (1.12–1.90)	2.19 (1.67–2.87)	<0.001

OR: odds ratio; CI: confidence interval.

^aAdjusted for sex, age (65–69, 70–74, 75–79, 80–84, ≥ 85 years), educational level (primary or less, secondary, high school or vocational training, university), social class (directors or managers, skilled workers, semi-skilled, unskilled), size of locality (<10,000, 10,000–99,999, 100,000–499,000, $\geq 500,000$ inhabitants), marital status (single, married, widowed, separated) and social isolation (no isolation, intermediate, severe).

^bFurther adjusted for tobacco (non-smoker, ex-smoker or current smoker), alcohol (abstainer, moderate drinker, heavy drinker) and leisure-time physical activity (sedentary, moderate physical activity, high physical activity).

^cFurther adjusted for functional dependence (independent, dependent), perceived health status (very good or good, fair, poor or very poor) and morbidity, including cardiovascular disease, diabetes, stroke, chronic respiratory disease, musculoskeletal disease, cancer and depression.

Table 3

Association between specific components of neighborhood physical characteristics and poor mental health of older adults in Spain (n = 4729).

	No problems	Some problems	Many problems	p-trend
External noise				
Cases of poor mental health, n (%)	776 (72.5)	189 (17.7)	106 (9.86)	
Model 1, OR (95% CI)	1.00	1.37 (1.12–1.68)	1.60 (1.23–2.08)	<0.001
Model 2, OR (95% CI)	1.00	1.33 (1.08–1.64)	1.59 (1.21–2.10)	<0.001
Model 3, OR (95% CI)	1.00	1.28 (1.03–1.59)	1.44 (1.04–1.99)	0.005
Foul smells				
Cases of poor mental health, n (%)	852 (79.6)	164 (15.3)	54 (5.07)	
Model 1, OR (95% CI)	1.00	1.56 (1.26–1.93)	1.60 (1.10–2.33)	<0.001
Model 2, OR (95% CI)	1.00	1.56 (1.26–1.94)	1.59 (1.08–2.33)	<0.001
Model 3, OR (95% CI)	1.00	1.48 (1.15–1.90)	1.45 (0.97–2.17)	0.001
Poor water quality				
Cases of poor mental health, n (%)	718 (67.1)	199 (15.2)	153 (14.3)	
Model 1, OR (95% CI)	1.00	1.34 (1.11–1.62)	1.65 (1.30–2.08)	<0.001
Model 2, OR (95% CI)	1.00	1.27 (1.05–1.55)	1.52 (1.19–1.94)	<0.001
Model 3, OR (95% CI)	1.00	1.25 (1.01–1.56)	1.35 (1.03–1.76)	0.006
Poor cleanliness				
Cases of poor mental health, n (%)	668 (62.4)	262 (24.4)	141 (13.2)	
Model 1, OR (95% CI)	1.00	1.34 (1.12–1.61)	1.36 (1.07–1.74)	<0.001
Model 2, OR (95% CI)	1.00	1.31 (1.01–1.58)	1.31 (1.01–1.68)	0.004
Model 3, OR (95% CI)	1.00	1.33 (1.08–1.63)	1.20 (0.90–1.59)	0.033
Industrial pollution				
Cases of poor mental health, n (%)	986 (92.1)	58 (5.44)	26 (2.46)	
Model 1, OR (95% CI)	1.00	1.44 (1.02–2.03)	2.34 (1.40–3.90)	<0.001
Model 2, OR (95% CI)	1.00	1.43 (1.01–2.04)	2.59 (1.54–4.33)	<0.001
Model 3, OR (95% CI)	1.00	1.30 (0.89–1.90)	2.67 (1.55–4.59)	0.001
Contamination from other causes				
Cases of poor mental health, n (%)	924 (86.3)	106 (9.89)	41 (3.81)	
Model 1, OR (95% CI)	1.00	1.56 (1.17–2.09)	1.39 (0.90–2.15)	0.004
Model 2, OR (95% CI)	1.00	1.71 (1.27–2.30)	1.46 (0.93–2.29)	0.003
Model 3, OR (95% CI)	1.00	1.43 (1.05–1.96)	1.42 (0.85–2.38)	0.024
Lack of green areas				
Cases of poor mental health, n (%)	803 (75.0)	163 (15.2)	105 (9.80)	
Model 1, OR (95% CI)	1.00	1.19 (0.96–1.47)	1.64 (1.25–2.16)	<0.001
Model 2, OR (95% CI)	1.00	1.18 (0.95–1.47)	1.50 (1.13–1.99)	0.013
Model 3, OR (95% CI)	1.00	1.22 (0.96–1.56)	1.49 (1.10–2.03)	0.004
Troublesome animals				
Cases of poor mental health, n (%)	725 (67.7)	186 (17.4)	159 (14.9)	
Model 1, OR (95% CI)	1.00	1.19 (0.96–1.47)	1.64 (1.25–2.16)	<0.001
Model 2, OR (95% CI)	1.00	1.18 (0.95–1.47)	1.50 (1.13–1.99)	<0.001
Model 3, OR (95% CI)	1.00	1.08 (0.86–1.34)	1.80 (1.37–2.36)	0.001
Crime or violence				
Cases of poor mental health, n (%)	817 (76.3)	207 (19.4)	47 (4.34)	
Model 1, OR (95% CI)	1.00	1.29 (1.06–1.57)	1.36 (0.91–2.03)	0.006
Model 2, OR (95% CI)	1.00	1.31 (1.07–1.60)	1.34 (0.88–2.02)	0.008
Model 3, OR (95% CI)	1.00	1.19 (0.95–1.48)	1.24 (0.80–1.93)	0.095

OR: odds ratio; CI: confidence interval.

^aAdjusted for sex, age (65–69, 70–74, 75–79, 80–84, ≥85 years), educational level (primary or less, secondary, high school or vocational training, university), social class (directors or managers, skilled workers, semi-skilled, unskilled), size of locality (<10,000, 10,000–99,999, 100,000–499,000, ≥500,000 inhabitants), marital status (single, married, widowed, separated) and social isolation (no isolation, intermediate, severe).

^bAdditionally adjusted for tobacco (non-smoker, ex-smoker or current smoker), alcohol (abstainer, moderate drinker, heavy drinker) and leisure time physical activity (sedentary, moderate physical activity, high physical activity).

^cFurther adjusted for functional dependence (independent, dependent), perceived health status (very good or good, fair, poor or very poor) and morbidity, including cardiovascular disease, diabetes, stroke, chronic respiratory disease, musculoskeletal disease, cancer and depression.

Although most of the neighborhood characteristics studied were associated with poor mental health, the most notable were air pollution, troublesome animals, and scarcity of green areas. The presence of green areas is possibly the most frequently addressed factor in the literature. Both intervention and observational studies have shown significant associations between increased exposure to green spaces and better morbidity and mortality indicators.²³ In an interesting experiment in Virginia (USA), Roe J et al²⁴ observed the beneficial effects of walking in green environments on mental and cognitive health compared to walking in a less pleasant environment. Regarding air pollution, there is a growing evidence that it may affect the central nervous system. In a meta-analysis by Liu et al.²⁵ increased ambient particulate matter concentration was strongly associated with higher depression risk, especially for long-term exposure to the smallest particles (<2.5 μm). In addition, exposure to air pollutants has been linked to poor sleep quality,²⁶ although it is difficult to

know whether poor sleep quality is a cause or a consequence of poor mental health. Finally, in high-income countries, the presence of animals is almost always linked to physical activity, either as an inducer of physical exercise among pet owners,²⁷ or as a limiter when dogs are unattended or abandoned.²⁸ Finally, although in other studies insecurity related to crime was particularly harmful for mental health in older adults,^{12,21} this association was less evident in Spain, probably because insecurity is restricted to very specific urban neighborhoods that may have been underrepresented in a nationwide population survey.

In studies associating neighborhood characteristics with residents' health, it is especially important to consider the role of possible mediators.²⁹ Domènech-Abella et al¹² found that loneliness was a significant mediator of this association, meaning that in neighborhoods with environmental deficiencies, people were more likely to feel lonely, and this largely determined a worse mental health. In

Table 4

Association between physical characteristics of the neighborhood and poor mental health of older adults in Spain, stratified by number of inhabitants, social isolation, physical activity, and perceived health status.

	No problems	Some problems	Many problems	p-trend	p-interaction
Size of the locality					0.001
<10,000 inhabitants					
Cases of poor mental health, n (%)	98 (38.3)	102 (39.8)	56 (22.0)		
Fully adjusted model, OR (95% CI)	1.00	1.85 (1.25–2.74)	1.48 (0.91–2.39)	0.035	
10,000–99,999 inhabitants					
Cases of poor mental health, n (%)	69 (25.8)	86 (32.0)	113 (42.2)		
Fully adjusted model, OR (95% CI)	1.00	0.90 (0.60–1.35)	1.57 (1.02–2.40)	0.033	
≥100,000 inhabitants					
Cases of poor mental health, n (%)	87 (15.9)	163 (29.8)	297 (54.3)		
Fully adjusted model, OR (95% CI)	1.00	1.60 (1.13–2.27)	2.39 (1.72–3.33)	<0.001	
Social isolation					0.596
No social isolation					
Cases of poor mental health, n (%)	160 (24.5)	212 (32.5)	281 (43.0)		
Fully adjusted model, OR (95% CI)	1.00	1.49 (1.11–2.01)	1.99 (1.47–2.69)	<0.001	
With social isolation					
Cases of poor mental health, n (%)	94 (22.5)	138 (33.0)	185 (44.5)		
Fully adjusted model, OR (95% CI)	1.00	1.36 (1.02–1.83)	1.98 (1.46–2.69)	<0.001	
Physical activity					0.027
Moderate/high					
Cases of poor mental health, n (%)	78 (21.6)	111 (30.7)	173 (47.8)		
Fully adjusted model, OR (95% CI)	1.00	1.36 (0.98–1.90)	2.36 (1.90–3.27)	<0.001	
Sedentary					
Cases of poor mental health, n (%)	176 (24.9)	239 (33.8)	293 (41.4)		
Fully adjusted model, OR (95% CI)	1.00	1.59 (1.20–2.10)	1.59 (1.19–2.11)	0.002	
Health status					0.253
Very good/good/average					
Cases of poor mental health, n (%)	131 (22.2)	206 (34.9)	254 (43.0)		
Fully adjusted model, OR (95% CI)	1.00	1.62 (1.26–2.08)	2.07 (1.59–2.70)	<0.001	
Poor/very poor					
Cases of poor mental health, n (%)	123 (25.7)	144 (30.1)	212 (44.2)		
Fully adjusted model, OR (95% CI)	1.00	1.06 (0.69–1.61)	1.89 (1.22–2.91)	0.003	

OR: odds ratio; CI: confidence interval.

^aAdjusted by sex, age (65–69, 70–74, 75–79, 80–84, ≥85 years), educational level (primary or less, secondary, high school or vocational training, university), social class (directors or managers, skilled workers, semi-skilled, unskilled), size of locality (<10,000, 10,000–99,999, 100,000–499,000, ≥500,000 inhabitants) and marital status (single, married, widowed, separated), social isolation (no isolation, intermediate, severe), tobacco (non-smoker, ex-smoker or current smoker), alcohol (abstainer, moderate drinker, heavy drinker), leisure-time physical activity (sedentary, moderate physical activity, high physical activity), functional dependence (functional dependence, functional dependence, functional dependence, functional dependence, high physical activity), functional dependence (independent, dependent), perceived health status (very good or good, fair, poor or very poor) and morbidity, including cardiovascular disease, diabetes, stroke, chronic respiratory disease, musculoskeletal disease, cancer and depression.

contrast, our results did not confirm this hypothesis in Spain, because the impact of neighborhood problems on mental health is almost identical in socially isolated older people compared to those who are not socially isolated. Although physical environment characteristics have been recognized as determinants for the participation of older people in out-of-home activities, affecting opportunities for social connectedness, and protecting from psychological distress,¹² this does not seem to be the causal path in Spain. Indeed, according to our results, neighborhood physical characteristics might jointly affect Spanish older adults, by creating a globally hostile scenario. Thus, a neighborhood with many environmental problems, even if they can be considered minor underlying threats (e.g., noise, unpleasant odors, dirt, pollution, etc.), may act as a chronic stressor that triggers feelings of mistrust and vulnerability among older adults,²¹ which, in the long term, can undermine their mental health.

Other interesting interactions are found in the stratified analyses. First, the studied association was especially strong in the most populated localities. In general, it is accepted that the effect of the physical environment on general health is greater in large and densely populated cities,³⁰ because there is a greater concentration of the neighborhood problems considered, such as environmental and noise pollution, scarcity of green areas, crime problems, etc. Along these lines, Sarkar et al.¹⁶ in a population-based cohort study in Hong Kong ($n = 16,968$), observed a strong direct association between building block concentration and depressive symptoms. Second, physical activity also constituted an important effect modifier of the studied association, although in the opposite direction to

other studies. According to our results, older people living in areas with more physical problems had worse mental health if they were more physically active. In contrast, previous studies showed that neighborhoods with more favorable characteristics, especially availability of places to walk and relax, showed a better compliance to physical activity recommendations,³¹ which led to better health outcomes.³² Nonetheless, these studies mainly examined social characteristics of the neighborhood, such as cohesion or reciprocity, whereas our study only included physical characteristics, and thus the results are not strictly comparable. In any case, our results may have a simple explanation that is consistent with the principle of epidemiological dose-response causality, since individuals who are more physically active are also more exposed to neighborhood characteristics, which would support a greater association in this population group.

Given that older adults may be especially vulnerable to physical neighborhood problems,²¹ research on the design of the built environment for older people should be prioritized, together with interventions to preserve mental health and quality of life during aging. Specifically, interventions targeting modifiable neighborhood physical characteristics may be highly relevant for neighborhoods with many self-reported problems by older adults, as this would contribute to the reduction of health inequalities. According to King et al.,^{33,34} a key element is to consider neighborhood residents as active participants in the political and scientific process, within a "research-to-action" approach. Thus, people should engage in identifying community needs, interpretation, consensus building,

proposals for solution, and collaboration with decision-makers and researchers to design feasible and satisfactory environmental changes.

Our study has several limitations. First, as in any cross-sectional analysis, reverse causality may also exist. For instance, people with mental disorders are more likely to perceive their neighborhood negatively, compared to healthy people, which would lead us to overestimate our association. However, if this were true, the association would have only occurred in those who were socially isolated and with a diagnosis of depression, yet, in our study, the association occurred equally in the strata defined by these variables and was maintained after adjusting for these and other confounders. Second, although we controlled our analyses for important sociodemographic indicators, such as social class or level of education, we were unable to consider income data, both for the neighborhood as a whole and for the individual participant. Participants in the SP-NHS did not indicate their neighborhood of residence; thereby, it was not possible to link individual data with neighborhood average income. Moreover, although the SP-NHS included a question on the household income level, 22% of respondents omitted this information. Third, although the GHQ-12 questionnaire is validated for use in Spain and is one of the most widely used worldwide, it has a standardized reliability coefficient of 0.78, which means that it is not exempt from measurement error.

Conclusions

In Spain, older people living in neighborhoods with problems affecting their physical environment presented worse mental health. The most relevant environmental problems for mental health were air pollution, the presence of bothersome animals, and the scarcity of green areas. This association was independent of social isolation and health status, however, it was stronger among more physically active people living in larger localities, probably due to greater exposure to the physical characteristics of the neighborhood. Future studies with longitudinal designs should be carried out to reinforce these findings.

Public policies aiming to improve residential environments, along with holistically addressing the mental health of people living in problematic neighborhoods, can have broad implications for achieving healthy aging. This is particularly important since one of the strategies for healthy aging is "aging in place," which involves facilitating older adults to remain in their own homes and communities in a safe, comfortable, and happy manner.

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Declaration of Competing Interest

Authors declare no conflict of interest.

Supplementary materials

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