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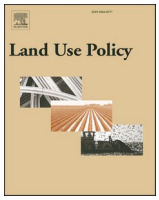

Perception of green spaces' role in enhancing mental health and mental well-being in small and medium-sized cities

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ABSTRACT

Understanding the impact of green spaces on public health is crucial for urban planning and mental well-being enhancement in small and medium-sized cities (SMSCs). This study compares the influence of green spaces on mental well-being and psychological distress in Córdoba and Nitra. Using a cross-sectional survey, responses from 632 participants were collected and evenly distributed between the two cities. Mental well-being and psychological distress were assessed using the WHO-5 and K6 scales, while also considering sociodemographic factors and green space usage frequency. The findings indicate that green space perception positively correlates with mental well-being in both cities. However, the extent and nature of engagement with these spaces, and their associated health benefits, significantly differ between Córdoba and Nitra. In Nitra, more time spent in green spaces was strongly linked to higher mental well-being scores. In contrast, in Córdoba, this association was significant only for those spending over three hours in green spaces. The impacts on psychological distress varied, with notable negative associations tied to the frequency of green exercise in Nitra. These results suggest that while green spaces generally support mental well-being and reduce psychological distress, the benefits are not uniformly experienced across different urban settings. Variations could be due to distinct urban characteristics like size and weather. This study highlights the need for a nuanced understanding of how green spaces influence public health, tailored to each city's specific characteristics. It emphasizes the importance for urban planners to consider these factors to maximize the health benefits of green spaces.

1. Introduction

Green spaces play a pivotal role in enhancing the health and mental well-being of urban populations worldwide (Van Den Bosch and Nieuwenhuijsen 2017) and across Europe (Bowler et al., 2010; Rutt and Gulsrud, 2016; Buckland and Pojani 2023; Rall et al., 2015). These urban oases offer a myriad of benefits, ranging from environmental sustainability to psychological health improvements. In large cities, the positive impacts of green spaces have been well-documented, highlighting their role in reducing stress levels, enhancing social cohesion, and contributing to overall mental well-being (Hartig et al., 2014; White et al., 2013). They are particularly valuable in mitigating the challenges of urban living, such as air pollution and the urban heat island effect. These spaces, often encompassing parks, gardens, and urban forests, not only improve environmental quality but also offer residents opportunities for recreation and social interaction, which are crucial for mental health and community well-being (Wolch, Byrne, and Newell 2014; Janhäll 2015; McConnachie and Shackleton 2010).

Mental health and mental well-being are critical components of overall health, encompassing more than just the absence of mental disorders or disabilities. The World Health Organization (WHO) defines mental health as a state of well-being in which an individual realizes their own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can contribute to their community (WHO, 2021). This comprehensive view positions mental health not merely as the absence of mental illness but as a state of overall well-being, essential for personal development and effective community engagement. Mental well-being, on the other hand, extends to include individuals' perceptions of life satisfaction, purpose, and their ability to manage feelings and behaviors effectively. It encompasses emotional, psychological, and social well-being, profoundly influencing how we think, feel, and act (Diener et al., 2009). This broader conception of

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mental well-being reflects an inclusive approach to mental health, recognizing the importance of positive life experiences and personal fulfillment (Keyes, 2002; Seligman, 2012).

As urbanization continues to rise, integrating green spaces into urban planning and policy-making has become increasingly important (World Health Organization 2016). These green spaces serve multiple purposes: they provide environmental benefits like air purification and temperature regulation, and they offer spaces for physical activity and social interaction, contributing to the overall quality of life in urban environments (Sugiyama et al., 2018; Lee and Maheswaran 2010; van den Berg et al., 2015). The role of these spaces became even more evident during global challenges such as the Covid-19 pandemic, highlighting their importance as critical infrastructure within urban settings (Ugolini et al., 2020; Derks, Giessen, and Winkel 2020; Lopez 2020). However, the majority of research has focused on larger metropolitan areas, with less known about the impact of green spaces in smaller urban contexts.

In Europe, the majority of the urban population resides in small to medium-sized cities (SMSCs), which are home to diverse and dynamic communities (United Nations 2014). These cities face unique challenges, particularly when located on the periphery, and often lack the resources of larger urban areas (McPhearson et al., 2016; Hamdouch, Demaziere, and Banovac 2017). Although they may benefit from less congestion and closer community ties, SMSCs often struggle with limited economic resources and technical capabilities, impacting their ability to provide comprehensive services, including health and well-being initiatives (Servillo, Atkinson, and Hamdouch 2017). Additionally, disparities in the quality and availability of urban infrastructures, including green spaces, can exacerbate social inequities in health and well-being within these cities (Cohen-Shacham et al., 2016; Vemuri et al., 2011). Addressing these disparities and understanding the specific needs of SMSCs is crucial for effective urban planning and policy-making.

While it is widely recognized that green spaces contribute positively to the mental well-being of urban residents, the specific nature of this relationship, particularly in the context of SMSCs, remains underexplored. This study aims to fill this gap by focusing on the residents' perceptions and usage patterns of green spaces in two representative SMSCs. Our research seeks to understand how these perceptions, along with the frequency and duration of visits to green spaces, impact the mental well-being of city residents. This focus is important as it moves beyond the traditional emphasis on physical health benefits and environmental aspects, delving into the psychological and social dimensions of urban green spaces (Maas et al., 2009; Dadvand et al., 2015).

This paper aims to examine specific socio-human aspects related to green spaces – such as the frequency and duration of visits, time spent exercising in these spaces, and the overall perception of green spaces – and their impact on the mental health and well-being of inhabitants in two small and medium-sized cities in Spain and Slovakia. This study aims to elucidate the relationship between green spaces and mental well-being in SMSCs, through addressing four key research questions: 1) Is individual mental health and mental well-being associated with the frequency and duration of visits to green spaces? 2) Is people's mental health and mental well-being connected to their perception of the quality of the green spaces they frequent? 3) Is the appearance and perception of quality of neighbourhoods' green areas associated with people's mental health and mental well-being? and 4) Is exercise one of the mediators between green areas and people's mental health and mental well-being? Our research questions are designed to explore the complex interplay between physical engagement with green spaces and the psychological benefits derived from these interactions, thus contributing to the development of more informed urban planning decisions that can enhance the quality of life in these unique urban settings. To our knowledge, this is the first study to evaluate these relationships, taking into account the specific context and characteristics of smaller cities.

2. Methods

2.1. Research focus and assumptions

Our study primarily focuses on examining the relationship between urban green spaces and mental well-being in small and medium-sized cities. To achieve this, we designed four research questions to be assessed using a sample from the population of each city. Based on the literature and research on green spaces and mental well-being, we proposed four hypotheses or assumptions to guide our data analysis: 1) Urban green spaces positively impact the mental well-being of residents in small and medium-sized cities; 2) The frequency and duration of visits to green spaces are directly correlated with improved mental well-being. 3) Residents' perceptions of the quality of green spaces significantly influence their mental well-being. 4) Physical activity in green spaces acts as a mediator in enhancing residents' mental well-being.

To verify the validity of these assumptions, our methodology involves a cross-sectional survey distributed among the residents of two small and medium-sized cities: Córdoba and Nitra. The survey was designed to gather data on participants' mental well-being and psychological distress, their use and perception of urban green spaces, and sociodemographic information.

2.2. Study place

This research is part of a European Union-funded initiative aimed at developing and applying innovative nature-based solutions to promote inclusive health and mental well-being across small and medium-sized urban centres (SMSCs). The project spans four cities—Córdoba, Spain; Nitra, Slovakia; Riga, Latvia; and Lucca, Italy—focusing on activating and leveraging underused urban resources.

Our study specifically investigates two distinct urban settings within this project framework: Córdoba, Spain, and Nitra, Slovakia. Córdoba, a southern Spanish city with a population of approximately 325,000, is endowed with diverse urban greenery that accounts for nearly 10% of the city's total area. The green spaces here are varied, comprising historical gardens, expansive public parks, riverfront greenways, and small neighborhood green spots, contributing to a rich tapestry of both public and private green areas accessible to residents. Nitra, with its approximately 77,500 inhabitants, contrasts with Córdoba in size but similarly features a multifaceted network of green spaces including river parks, communal gardens, and city parks that punctuate the urban landscape (Fig. 1).

The distribution of green spaces in both cities reflects a complex interplay of historical development, urban planning, and modern demands. In Córdoba, green spaces such as the renowned "Jardines de la Agricultura" are centrally located and serve as cultural heritage sites, while newer developments have sought to expand accessible greenery into outlying neighborhoods. Nitra's green spaces, on the other hand, are characterized by their multifunctional use, blending recreational areas with spots of natural beauty, such as the Zobor Nature Reserve and Hidepark on the city's outskirts (Fig. 2).

In understanding the context of this study, it is essential to note the variations in the seasonal use and cultural significance of these green spaces, which influence residents' perceptions and interactions with their local environment. While Córdoba experiences a Mediterranean climate with dry and hot summers, prompting evening gatherings in cooler park settings, Nitra's humid continental climate with cold winters brings about a different pattern of green space utilization, often concentrated in the warmer months.

2.3. Questionnaire and recruitment process

This study (2021–085-RM) was granted approval by the ethics committee of the University of Reading and all procedures related to data collection and treatment were supervised by a Data Protection

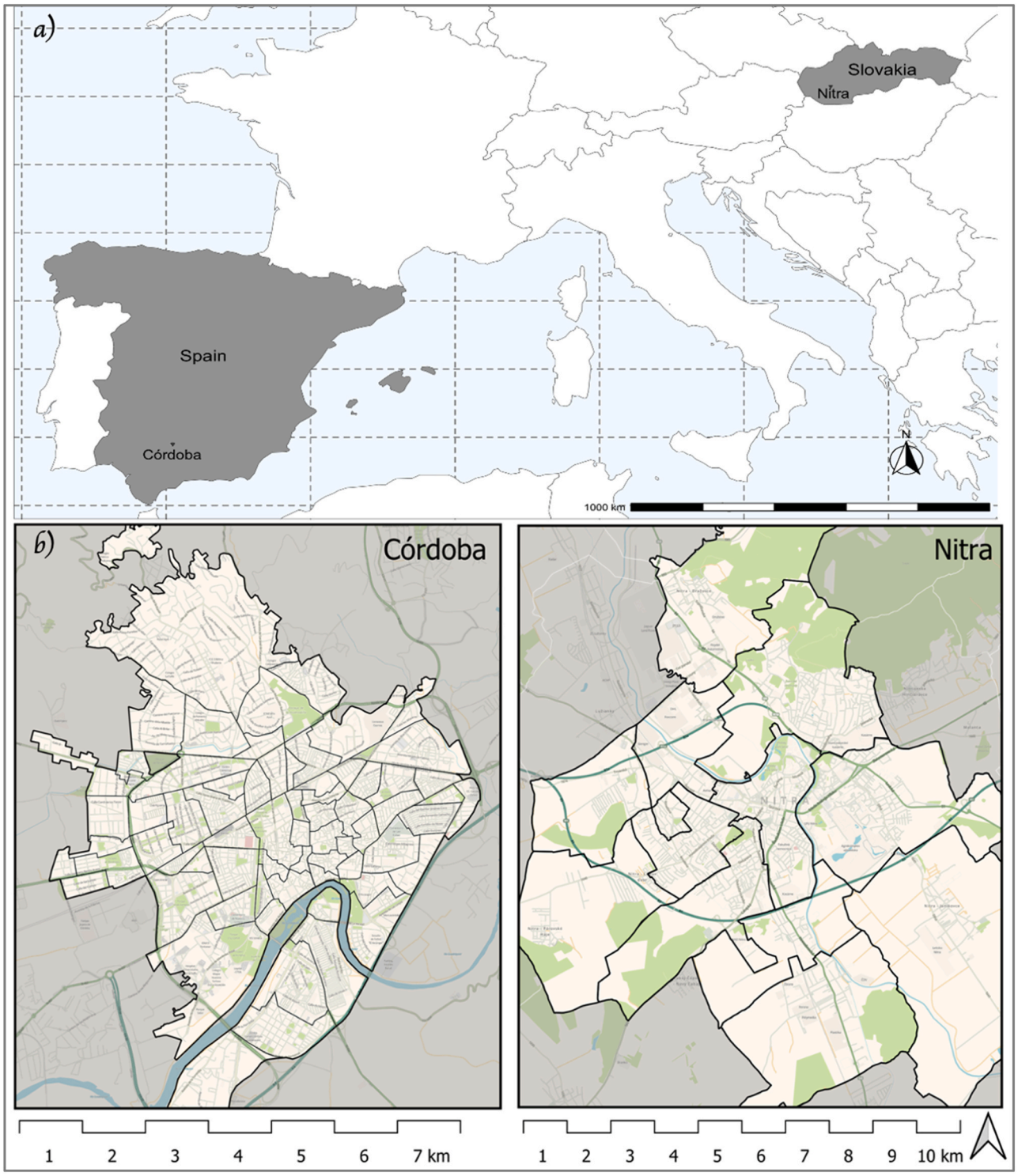

Fig. 1. a) Location of Spain and Slovakian in Europe, and the cities Córdoba (Spain) and Nitra (Slovakia) in each country. b) Map of Córdoba (left) and Nitra (right) with green areas highlighted.

Officer, ensuring adherence to European data protection norms (Das, 2018). Each survey included a page of instructions and a separate informed consent form, which participants were required to accept before beginning the survey and prior to participation. Our study employed a non-probability dissemination technique in two cities, aiming to reach not only a random selection of the general population but also minority and vulnerable groups (Baltar and Brunet, 2012). The survey was disseminated via social networks and other local websites (associations, local government). To maintain a balanced sample and extend reach to residents not typically accessing these dissemination channels, we partnered with a local association that helps migrants and people in need in Nitra. In Córdoba, we partner with two associations that work in Las Palmeras neighbourhood on the social inclusion of vulnerable populations. These organisations distributed questionnaires to the collectives they work with. Due to the nature of our survey's dissemination, we were unable to calculate the population who had access but chose not to participate, thereby inhibiting our ability to calculate a response rate (Bethlehem, 2010). A total of 632 adults (aged

Fig. 2. Examples of green spaces in both cities. A) Traditional “patio” or courtyard in Córdoba (Spain): People use these spaces as social hubs. B) Using floral plants in pots is typical of patios in Córdoba (Spain). C) View of the green landscape in Nitra (Slovakia). D) Allotments in Hidepark, Nitra (Slovakia).

18 or older) consented to participate in the study. Data collection occurred in November 2021. Questionnaires were offered in the native language of each location (Spanish for Córdoba, and Slovak for Nitra). Since the questionnaires were utilized in a broader study, they encompassed various topics such as demographics, interactions with animals, perceptions of green spaces and public areas within the city, behavioural shifts during the COVID-19 pandemic, and social cohesion. The questionnaires comprised 63 questions, organized into five sections. However, for the purposes of this study, we selectively extracted variables pertinent to our research questions, which included sociodemographic information (age, gender, highest educational attainment, and employment status), as well as measures of mental well-being, mental health, and perceptions of green spaces.

We employed the World Health Organisation’s WHO-5 scale to gauge the current mental well-being of participants (World Health Organization, 1998). This scale is a self-reported measure, which relies on participants’ personal assessments of their mental well-being. While this method offers valuable insights into the respondents’ subjective experiences and is a widely accepted tool for screening depressive symptoms, we acknowledge the inherent limitations of self-reporting measures, including potential bias and the influence of current mood states on the respondents’ answers. The scale prompts participants to rate five statements (e.g., "Cheerful and in good spirits," "Calm and relaxed," etc.) based on their experiences over the previous two weeks, with ratings ranging from 0 to 5 (0 indicating ’At no time’, 5 indicating ’All of the time’). The cumulative raw score ranged from 0 to 25. To convert this to a percentage, scores were multiplied by four. We computed Cronbach’s alpha to confirm the scale’s internal consistency (0.89, 95% CI: 0.87-0.90).

Psychological distress was assessed using the Kessler Psychological Distress Scale (K6) (Kessler et al., 1997). This scale is a brief screening scale designed to identify individuals at risk of serious mental illness. The K6 has been validated in numerous studies, such as Prochaska et al. (2012), which confirmed its accuracy in quantifying moderate mental distress that is clinically significant. This validation supports our use of the K6 as a reliable indicator of psychological distress levels in the studied population, but as the WHO-5 it is a self-reported measured and it can be prone to bias. This scale asks participants to consider six statements (e.g., "Feeling nervous," "Feeling hopeless," etc.) and rate them from 0 to 4 according to their feelings over the past 30 days (0 indicating ’None of the time’, 4 indicating ’All of the time’). The total raw score varies from 0 to 24. To verify the scale’s internal consistency, we again calculated Cronbach’s alpha (0.88, 95% CI: 0.86- 0.89), then we created a binary variable classifying all values lower than 13 as healthy and all values of 13 or higher as psychological distress (Bessaha, 2017).

To evaluate the perception of green areas in participants’ neighbourhoods, we asked participants to rate their agreement with the statements, "Safe, accessible, and pleasant green areas are easy to find in your neighbourhood/living area" and “Easy to find a green area to exercise”. Each statement was rated on a scale from 0 to 5, with 0 indicating complete disagreement and 5 indicating complete agreement. The combined score for the two statements ranged from 0 to 10. To assess the perceptions of frequently used green spaces, participants were asked to rate their agreement with the following statement: "Public spaces in your city, where you spend most of your time, are well-maintained, pleasant, accessible, frequented by people all ages, and frequented by people of all ethnicities" (where 0 meant ’totally disagree’ and 5 meant ’totally agree’). Cronbach’s alpha (0.87, 95% CI: 0.84-0.89). The assessment scale of all the statements combined ranged from 0 to 25, Cronbach’s alpha (0.85, 95% CI: 0.83- 0.87). To understand how often participants engaged with these green areas, we asked: "During a typical workday, how much time do you spend in public green spaces for recreation or sport?" The answers ranged from “Not time at all (0)” to “More than 3 h (5)”. Finally, to assess if green exercise was somehow associated with the perception of mental well-being, we asked: "In the

past two months how often did you go to a green area to exercise?", the answers varied from “Not at all (0)” to “More than two times a week (4)”.

2.4. Data analysis

We evaluated each city separately. The variable ’ethnicity minority’ was discarded because not enough participants reported belonging to a minority in neither of the cities. We also discarded the category “non-binary” for gender, due to the lack of respondents in each city. Given the differences in the educational systems between the two countries, we grouped the categories "no education", "primary education", "secondary education", and in the case of Nitra “higher level of vocational training” into a category called "no education to secondary education". Participants who reported "having a bachelor’s degree" or, in the case of Córdoba "attending a technical school" were combined into "university or technical", and finally, those with a "master’s degree" or a "doctorate" were classified as "postgraduate". We also used age and employment status as confounders for the models, and here once again to avoid loss of statistical power, we created a collapsed working status category. We decided to use employment status instead of household income due to the collinearity between the latter, and the level of education, and because employment status has a significant association with wellbeing and psychological distress (Bonanomi and Rosina, 2022; Booker and Sacker, 2011). In both cases we fitted a model with the variables with the original categories, and then the collapsed categories and compare the models using AICc and the power of the models.

We assessed covariance between the variables using Kendall’s Tau for numerical variables and chi-squared for categorical variables, evaluating each city separately. For each city, we created one univariate model for the response variable WHO-5 (scale for mental well-being), one logistic model for K6 (Scale for psychological distress) and the predictor variables (perception of the quality of the green space people visited the most, perception of the green spaces in their neighbourhoods, duration of visits to the green spaces, and times a week exercising in a green space). We then fitted the models for the univariate models that were significant but corrected by confounders to explore if the associations remained significant. All statistical analyses were performed using R version 4.1.1 (2021–08-10) (R Core Team 2023).

3. Results

3.1. Sociodemographic and descriptive statistics

The analysis included a total of 632 completed surveys, evenly distributed with 316 responses from each city. This sample size is consistent with similar studies that explore the relationship between mental well-being and green spaces, which have sample sizes ranging from 201 to 289 (Gozalo, Morillas, and González, 2019; Vujcic et al., 2019; Kothencz and Blaschke, 2017). The sociodemographic characteristics of the participants are presented in Appendix A. The sample from both cities was primarily composed of women, representing 61% of participants in Córdoba and 63% in Nitra. Participants’ average age in Córdoba was slightly higher (40 years) than in Nitra (37 years). The level of education varied significantly between the two cities. Nearly half (47%) of the participants in Córdoba reported having either not studied at all or only completed mandatory education. Conversely, in Nitra, over half (54%) of the participants reported holding postgraduate degrees as their highest level of education. Employment status also differed between the two cities. A considerable percentage of the respondents in Córdoba were seeking employment at the time of the survey (23%), while only 29% of the people surveyed reported having a full-time job, in Nitra, on the other hand, over half (51%) of the participants were full time employed.

In terms of ethnic diversity, both cities showed a relatively low proportion of ethnic minority participants, with 5.1% in Córdoba and 6.3% in Nitra. Mental well-being and psychological distress were assessed using the WHO-5 and K6 scales, respectively, while the perception of green space, frequency of exercise in green areas, and time spent in green spaces were also evaluated. Results for these variables were comparable in both cities. However, the engagement with green spaces differed slightly; 30% of Nitra’s participants and 34% from Córdoba reported they do not visit green spaces and only a small percentage of participants, 4.7% in Nitra and 6.6% in Córdoba, reported spending more than three hours in green spaces a day.

3.2. Impacts of green space on mental well-being

Univariate models from both cities indicated that the participant’s perception of their most frequented green spaces was positively associated with their mental well-being, as assessed by the WHO-5 scale (Nitra: $p < 0.001$, Córdoba: $p = 0.027$) (Table 1). However, the strength of this association was small in both contexts (Nitra: $\beta = 1.00$; 95% CI 0.61, 1.36. Córdoba: $\beta = 0.46$; 95% CI 0.05, 0.87). Notably, even when adjusted for sociodemographic variables, these associations remained significant (Nitra: $p < 0.001$; $\beta = 0.92$; 95% CI 0.48, 1.36. Córdoba: $p = 0.004$; $\beta = 0.64$; 95% CI 0.19, 1.08) (Table 2). Likewise, the perception of neighbourhood green spaces correlated with mental well-being in both cities (Nitra: $p < 0.001$, Córdoba: $p = 0.013$) (Table 2). Although the strength of these associations was also small (Nitra: $\beta = 1.01$; 95% CI 1.13, 2.64. Córdoba: $\beta = 1.00$; 95% CI 0.22, 1.75), they remained significant when adjusted for sociodemographic factors (Nitra: $p < 0.001$; $\beta = 1.83$; 95% CI 0.98, 2.69. Córdoba: $p = 0.002$; $\beta = 1.34$; 95% CI 0.47, 2.22) (Table 2).

For Nitra, univariate models indicated significant differences in mental well-being between participants who did not visit green spaces and those who spent one to two hours ($p = 0.002$; $\beta = 10.3$; 95% CI 3.83, 16.8), two to three hours ($p = 0.002$; $\beta = 12.4$; 95% CI 3.35, 21.5), and more than three hours a day ($p = 0.004$; $\beta = 16.7$; 95% CI 5.16, 28.3) in such spaces (Table 1). The strength of the associations increased with time spent in green spaces. In contrast, in Córdoba, a significant association was only found between non-visit and staying more than three hours in a green area ($p = 0.010$; $\beta = 13$; 95% CI 3.16, 23.0). The association’s strength in Córdoba was higher than in the perception of green space categories. However, after adjustment for sociodemographic factors, these associations were attenuated and became non-significant in both cities (Table 2).

Finally, the associations between green exercise and mental well-being in Nitra indicated that participants who engaged in green exercise less than once a week ($p = 0.007$; $\beta = 7.91$; 95% CI 2.15, 13.69), one to two times a week ($p = 0.01$; $\beta = 8.28$; 95% CI 1.59, 14.9), and more than twice a week ($p < 0.001$; $\beta = 15.5$; 95% CI 7.05, 23.9) had significantly higher mental well-being than those who did not engage at all. These associations were robust to adjustment for sociodemographic factors. In Córdoba, as with the time spent in green spaces, a significant association was only found between the reference category "Not at all" and "More than 2 times a week" ($p = 0.01$; $\beta = 10.8$; 95% CI 2.37, 19.2). These findings suggest a potential differential impact of green space engagement on mental well-being in the two cities. Which can be explained by other sociodemographic, physical, weather, and cultural factors not assessed here.

3.3. Impacts of green space on psychological distress

Contrary to the findings for mental well-being, significant negative associations, for Nitra, were exclusively between psychological distress and neighbourhood green space perception (OR = 0.85, $p = 0.003$) (Table 1). For Córdoba, on the other hand, the models show negative association between psychological distress and perception of the most frequently visited greenspace (OR = 0.95, $p = 0.04$), perception of neighbourhood’s green space (OR = 0.87, $p = 0.003$), and time spent in the green space, but only for the category “between 1 or 2 h” (OR =

Table 1
Univariate regression models of perception of the four green variables measured (green spaces visited frequently, perception of green spaces in the neighbourhood, time of visit to green space, and weekly times exercising in green areas) with the World Health Organisation's (WHO-5) Scale (left) and psychological distress the Kessler Psychological Distress Scale (K6) (right). For the WHO-5 scale the table shows the beta, 95% confidence interval, and the p-value. For the K6 Scale the table shows the odds ratio (OR), 95% confidence interval, and the p-value. The p-value of significant results are highlighted in bold.

Nitra, Slovakia						
WHO-5, N = 316				K6, N = 316		
Greenspace measure	Beta	95% CI	p-value	OR	95% CI	p-value
"Perception of green areas frequently visit in quartiles"						
Intercept	42.8	37.3, 48.3	—	0.38	0.20, 0.71	—
Perception of green space	0.99	0.61, 1.36	**< 0.001**	0.97	0.93, 1.01	0.18
"Perception of green areas in the neighbourhood in quartiles"						
Intercept	45.4	40.5, 50.3	—	0.51	0.30, 0.86	—
Perception of green space	1.88	1.13, 2.64	**< 0.001**	0.88	0.80, 0.96	**0.004**
"Time of visit to green space", reference = No time at all						
Intercept	49.9	45.6, 54.2	—	0.35	0.22, 0.55	—
Not time at all	—	—	—	—	—	—
Less than an hour	5.31	-0.68, 11.3	0.08	0.65	0.33, 1.27	0.194
Between 1 and 2 h	10.3	3.83, 16.8	**0.002**	0.69	0.33, 1.44	0.159
Between 2 and 3 h	12.4	3.35, 21.5	**0.007**	0.64	0.22, 1.88	0.111
More than three hours	16.7	5.16, 28.3	**0.004**	0.43	0.09, 2.07	0.148
"Weekly times exercising in green areas", reference = None at all						
Intercept	50.9	47.49, 54.4	—	0.32	0.22, 0.47	—
None at all	—	—	—	—	—	—
Less than once a week	7.91	2.15, 13.6	**0.007**	0.69	0.36, 1.35	0.28
1 to 2 times a week	8.28	1.59, 14.9	**0.015**	0.78	0.36, 1.67	0.52
more than 2 times a week	15.5	7.05, 23.9	**< 0.001**	0.34	0.09, 1.18	0.09
Córdoba, Spain						
WHO-5, N = 316				**K6**, N = 316		
Greenspace measure	**Beta**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
"Perception of green areas frequently visit in quartiles"						
Intercept	55.9	49.08, 62.7	—	0.62	0.29, 1.34	—
Perception of green space	0.46	0.05, 0.87	**0.027**	0.94	0.90, 0.99	**0.02**
"Perception of green areas in the neighbourhood in quartiles"						
Intercept	56.91	51.7, 62.1	—	0.77	0.460, 1.29	—
Perception of green space	0.99	10.2, 1.75	**0.013**	0.82	0.754, 0.89	**< 0.001**
"Time of visit to green space", reference = No time at all						
Intercept	61.5	57.5, 65.5	—	0.35	0.232, 0.54	—
Not time at all	—	—	—	—	—	—
Less than an hour	-2.65	-8.62, 3.31	0.38	0.84	0.44, 1.61	0.211
Between 1 and 2 h	5.18	-1.07, 11.4	0.10	0.30	0.12, 0.72	**0.007**
Between 2 and 3 h	-0.40	-10.7, 9.96	0.93	0.75	0.23, 2.45	0.232
More than three hours	13.0	3.16, 23.0	**0.010**	0.83	0.28, 2.45	0.756
"Weekly times exercising in green areas", reference = None at all						
Intercept	62.1	58.87, 65.3	—	0.27	0.18, 0.39	—

Table 1 (*continued*)

Nitra, Slovakia						
WHO-5, N = 316				K6, N = 316		
Greenspace measure	Beta	95% CI	p-value	OR	95% CI	p-value
Greenspace measure	**Beta**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
None at all	—	—	—	—	—	—
Less than once a week	4.78	-1.63, 11.2	0.14	1.01	0.49, 2.07	0.96
1 to 2 times a week	0.68	-6.13, 7.49	0.84	1.19	0.57, 2.46	0.63
more than 2 times a week	9.87	1.81, 17.9	**0.01**	0.47	0.15, 1.42	0.18

0.30, p = 0.007) (Table 1). The associations in all cases remained significant after correcting for confounder factor (Table 2).

4. Discussion

Our findings contribute to existing literature by exploring the role of green space use and perception in perceived mental health and mental well-being in the under-explored context of SMSCs. These results reinforce the crucial impact of both green space perception and visit duration on mental well-being within the context of Córdoba and Nitra, mirroring findings from larger urban areas (Hartig et al., 2014; White et al., 2013). However, results were slightly different across cities of differing sizes—Córdoba medium, Nitra small—and weather conditions—Córdoba dry, Nitra wet—indicating that the perception and impact of green spaces on mental well-being can be associated by the size of the city, the weather conditions, and other sociodemographic factors. Nevertheless, the results show the need for high-quality, accessible green spaces in all urban environments. For example, our results show that in Nitra the perception of the green space most visited, the perception of the quality of the green areas in the neighbourhood, the time visiting green areas, and the frequency of exercise in green areas are associated with mental well-being as measured with the WHO-5 scale, while in Córdoba, time visiting green areas and exercising in green areas were only positively associated with mental well-being in one category. On the other hand, the perception of the green space most visited, the perception of the quality of the green areas in the neighbourhood, and the time visiting green areas were negatively associated with psychological distress as measured by the K-6 Scale; in Nitra, only the time visiting green areas showed a negative association with psychological distress. Regardless of the differences between cities in the associations of green spaces and the perceived mental health and mental well-being of its inhabitants, the results show that in general, good quality and accessible green spaces bring benefits to people using them. Strategies like the Accessible Natural Greenspace Standards (ANGST) (Pauleit et al., 2003) for urban green spaces, focusing on quality and proximity, could help ensure this, benefiting public mental health across diverse urban settings.

1. **Is individual mental well-being associated with the frequency and duration of visits to green spaces?**

   Our findings expand upon the work of Beyer et al. (2014), focusing on how green spaces impact the perception of mental health and well-being through residents' use, perception, and time spent in these spaces. An intriguing dynamic was observed between the duration of green space visits and mental well-being, which seemed to have different associations in the two cities. In the case of Córdoba, time visiting green spaces is negatively associated with psychological distress, while in the case of Nitra, the results show a positive association between time spent in a green space and mental well-being. The associations remained after controlling for

Table 2
Corrected univariate regression models of perception of the four green variables measured (green spaces visited frequently, perception of green spaces in the neighbourhood, time of visit to green space, and weekly times exercising in green areas) with the World Health Organisation's (WHO-5) Scale (left) and psychological distress the Kessler Psychological Distress Scale (K6) (right). All models were corrected by sociodemographic factors (Age, gender, employment status, and highest level of education achieved). For the WHO-5 scale the table shows the beta, 95% confidence interval, and the p-value. For the K6 Scale the table shows the odds ratio (OR), 95% confidence interval, and the p-value. The p-value of significant results are highlighted in bold.

Nitra, Slovakia						
	WHO-5, N = 316			K6, N = 316		
Greenspace measure	Beta	95% CI	p-value	OR	95% CI	p-value
"Perception of green areas frequently visit in quartiles"						
Intercept	42.6	27.7, 57.4	—	—	—	—
Perception of green space	0.92	0.48, 1.36	**< 0.001**	—	—	—
"Perception of green areas in the neighbourhood in quartiles"						
Intercept	45.0	30.7, 59.3	—	2.12	0.36, 12.5	—
Perception of green space	1.83	0.98, 2.69	**< 0.001**	0.70	0.66, 0.85	**< 0.001**
"Time of visit to green space", reference = No time at all						
Intercept	48.5	34.1, 62.9	—	0.10	0.01, 0.72	—
Less than an hour	5.37	-1.23, 11.9	0.11	—	—	—
Between 1 and 2 h	12.0	4.79, 19.2	**0.001**	—	—	—
Between 2 and 3 h	12.2	2.42, 22.1	**0.015**	—	—	—
More than three hours	16.2	4.17, 28.3	**0.008**	—	—	—
"Weekly times exercising in green areas", reference = None at all						
Intercept	52.6	38.7, 66.4	—	—	—	—
Less than once a week	8.6	2.63, 14.69	**0.005**	—	—	—
1 to 2 times a week	7.94	0.86, 15.0	**0.02**	—	—	—
more than 2 times a week	15.8	7.33, 24.3	**< 0.001**	—	—	—
Córdoba, Spain						
WHO-5, N = 316				**K6**, N = 316		
Greenspace measure	**Beta**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
"Perception of green areas frequently visit in quartiles"						
Intercept	58.4	43.3, 73.5	—	0.26	0.024, 1.73	—
Perception of green space	0.64	0.19, 1.08	**0.004**	0.95	0.91, 0.99	**0.04**
"Perception of green areas in the neighbourhood in quartiles"						
Intercept	60.3	45.6, 75.0	—	0.47	0.06, 3.66	—
Perception of green space	1.34	0.47, 2.22	**0.002**	0.87	0.776, 0.95	**0.003**
"Time of visit to green space", reference = No time at all						
Intercept	66.9	53.1, 80.6	—	0.10	0.01, 0.72	—
Less than an hour	-3.06	-9.20, 3.07	0.38	—	—	—
Between 1 and 2 h	4.12	-2.24, 10.5	0.10	0.32	0.12, 0.85	**0.02**
Between 2 and 3 h	-0.56	-11.1, 9.98	0.93	—	—	—
More than three hours	12.8	2.84, 22.9	**0.01**	—	—	—
"Weekly times exercising in green areas", reference = None at all						
Intercept	65.5	50.8, 80.1	—	—	—	—

Table 2 (*continued*)

Nitra, Slovakia						
	WHO-5, N = 316			K6, N = 316		
Greenspace measure	Beta	95% CI	p-value	OR	95% CI	p-value
Less than once a week	5.06	-1.57, 11.7	0.13	—	—	—
1 to 2 times a week	0.98	-5.90, 7.87	0.78	—	—	—
more than 2 times a week	10.8	2.37, 19.2	**0.01**	—	—	—

sociodemographic factors, highest level of education achieved, employment status, gender, and age. This suggests that the benefits of green spaces for perceived mental health and mental well-being seem to vary depending on the interplay between green space engagement and the city's characteristics, possibly including weather, size, and cultural bond with nature. For example, Leech et al. (2002) found differences in the time spent outdoors between Canadians and Americans due to weather conditions. Moreover, Burger et al. (2012) found that cultural heritage affected the differences in perceptions of green areas between Native American kids and Caucasian kids. It is possible that the extreme hot weather in Córdoba affects the psychological distress of its inhabitants, and they rely on green areas to counteract the effects of weather, while in Nitra, where the weather is not extreme, people use green spaces more for comfort and not as a mandatory necessity, hence they influence mental well-being and not necessarily psychological distress.

2. **Is people's mental well-being connected to their perception of the quality of the green spaces they frequent? And is the appearance and perception of the quality of neighbourhood's green areas associated with people's mental well-being?**

   Our results show that the perception of the most frequently visited green space and the neighbourhood green space were associated with mental well-being, even after adjusting for sociodemographic factors. However, for psychological distress, we only found a negative association with neighbourhood green space. These results are interesting because they highlight the importance of four arguments in public health literature: the traits of green spaces, surrounding greenness, distance to green space, and both access to and quality and perception of green areas. It seems that the perception of green spaces—including perceptions of safety, accessibility, and attractiveness to residents—is associated with the overall mental well-being of people. However, for psychological stress, only green spaces close to the home are associated with lower chances of suffering from anxiety or depression. For example, Nutsford, Pearson, and Kingham (2013) showed a positive association between shorter distances to accessible green spaces, the percentage of greenness, and reduced odds of suffering from anxiety or mood disorders. Moreover, Feng and Astell-Burt (2018) demonstrated that for women in the postpartum period, the perception of the quality of nearby green areas was associated with lower odds of suffering from psychological distress. Similarly, other studies have found that the quality and accessibility of neighbourhood green areas are related to better mental health and mental well-being (Pope et al., 2018; Francis et al., 2012). Our findings show that perceived green space quality and accessibility significantly influence their use and related perceived mental health benefits (Linnell et al., 2015).

3. **Is exercise one of the mediators between green areas and people's mental well-being?**

Our results show that exercise was positively associated with mental well-being in Nitra, while in Córdoba, the positive association was found only for those reporting exercising more than two times a week in a

green area. These results also align with previous work showing that exercise in green spaces emerged as a potential critical mediator in the relationship between green space exposure and mental well-being (Barton and Pretty, 2010; Gladwell et al., 2013). The association remained significant after correcting for sociodemographic factors for both cities. Nevertheless, our results show differences between the two cities, which might be an indication that the characteristics of the city, including urban design, size, and weather conditions, and other socio-demographic factors not assessed here, like habits and cultural heritage, might influence the role of green exercise and mental well-being. For example, Klimek et al. (2022) showed that for a country with continental weather (Germany), solar radiation, higher temperatures, and sunshine hours were related to the time people spent walking outside; humidity, wind, and rainfall were negatively associated with time walking outside. It is possible that for Nitra, the association between the weather and levels of physical activity outdoors behaves similarly due to the similar continental weather. However, the case of Córdoba is the complete opposite; this city is the hottest city in Spain, and high temperatures are detrimental for people; it is possible that in this city people would rather exercise inside than outdoors.

5. Overall discussion

The results show that overall, green spaces are associated with better perceived mental health and mental well-being; however, they also show differences between the two cities. As highlighted before, factors related to urban design, weather, size of the city, cultural heritage of the population, and so on might influence the strength of the associations knowing how these factors work is essential to create appropriate public health strategies, and not necessarily do the associations between green spaces and mental well-being present in large cities work equally in SMSCs.

Moreover, while our study provides valuable insights into the relationship between green spaces and mental well-being in urban settings, it is important to acknowledge that we did not specifically account for the varied experiences of different stakeholders, such as women and ethnic minorities. Research has demonstrated that these groups can interact with and perceive urban green spaces differently due to distinct cultural, social, and environmental factors. For instance, women's engagement with green spaces is often influenced by considerations of safety, accessibility, and caregiving responsibilities, which may shape their experiences differently from men, who might prioritize green spaces for recreational activities (Kabisch and Haase, 2014; Bell et al., 2014). Similarly, ethnic minorities may experience green spaces in ways that are distinct from non-minority groups, influenced by factors like cultural practices and socioeconomic status (Li and Wen, 2013; Evans et al., 2012). Recognizing these differences is crucial for a comprehensive understanding of urban green spaces' impact on mental well-being. Our study's findings must therefore be considered with the caveat that they may not fully capture the nuanced experiences of these diverse groups. This realization highlights a significant area for future research and underscores the importance of inclusive urban planning that addresses the needs of all community members to promote equitable access to the mental well-being benefits of green spaces.

As we observe global urbanization trends and population concentration in smaller European cities, understanding the mental health benefits, or at least the perceived ones, of green spaces is vital for effective urban planning. Taking into consideration the size and the population of European cities is vital to develop proper policies promoting public health. Effective urban planning should be based on strong evidence-based information. The unique requirements of peripheral SMSCs have, unfortunately, been largely overlooked (Wagner and Growe, 2021). This lack of research on the role of green spaces in smaller cities in Europe for self-reported mental health and mental well-being and the fact that urban research and solutions are inherently context-specific is indeed a call to action for deeper investigations into the intersection of green spaces and mental health within the distinctive context of these smaller urban settings.

Our findings in Córdoba and Nitra suggest that cultural differences significantly influence how green spaces are perceived and utilized, impacting residents' mental well-being. This observation aligns with studies like those by Rutt and Gulsrud (2016) and Kabisch and Haase (2014), who note that cultural practices, ethnicity disparities, and urban densities, among other socio-economic factors limited the availability of green areas and social interactions play a crucial role in urban settings. In Córdoba, cultural norms may prioritize communal urban spaces (e.g., city squares) over green spaces for social mental well-being, a trend observed in southern European cities (Rigolon et al., 2018, 2021). In contrast, Nitra's cultural orientation and abundance of green spaces might reflect a stronger inclination towards nature engagement for recreational needs, mirroring patterns seen in central and northern Europe (Low, 2016). These findings underscore the need to consider socio-cultural dimensions, including traditions and community dynamics, when evaluating the impact of green spaces on perceived mental health, as suggested by Bell et al. (2014).

The unique cultural and socio-economic contexts of Córdoba and Nitra may have influenced our findings, necessitating caution against over-generalization. This perspective is supported by Wood et al. (2017), who emphasize the importance of contextual factors in urban green space studies. The distinct climatic conditions, urban designs, and cultural heritages in each city suggest that experiences with green spaces are highly context-specific. This approach is advocated by Evans et al. (2012), who argue for the inclusion of diverse cultural and socio-economic factors in green space research. Therefore, our study, while providing valuable initial insights, is a starting point for more in-depth investigations that encompass a broader range of variables, as recommended by Markevych et al. (2017). Future research should aim to integrate cultural, socio-economic, and psychological factors to fully grasp the complex dynamics of urban green spaces and their impact on mental health, aligning with the comprehensive approach suggested by Gascon et al. (2016).

6. Limitations

Our study significantly contributes to understanding the role of green spaces in mental health within SMSCs, though there are several limitations. First, the cross-sectional design prevents definitive causal inferences. Our study provides a snapshot of the association between green space exposure and mental health outcomes but doesn't conclusively ascertain whether increased green space exposure directly leads to improved mental well-being or reduced psychological distress over time (James et al., 2015). The role of green exercise as a mediator also requires further exploration. Longitudinal designs should be employed in future studies for more nuanced comprehension of causal direction and potential temporal fluctuations.

Secondly, our study relied on self-reported measures for green space exposure, which are susceptible to biases such as recall and social desirability, or inaccuracies in self-perception. Incorporating additional measures, like Geographic Information Systems (GIS) data (Richardson et al., 2013), could provide a different dimension of analysis and complement our findings. Future studies could benefit from using such methods to offer a more comprehensive view that combines both quantitative and qualitative insights.

Furthermore, our study's generalisability might be limited given that it draws on data from only two cities. Variations in socio-cultural, economic, and environmental contexts between cities could significantly impact the relationship between green space exposure and mental health. Despite these limitations, our research identified differences in the 2 cities, underscoring the relevance of context-specific evidences and offers a valuable foundation for further research on the role of green spaces for mental health, particularly in SMSCs. This area, though nascent, holds the potential for shaping urban planning and public

health policies.

Lastly, another significant limitation of our study is the absence of a gender perspective, which could have provided invaluable insights into the nuanced ways in which different genders interact with and perceive green spaces. The lack of sex-disaggregated data means that our findings do not account for the gender-specific challenges and needs in urban green spaces, such as safety concerns that might disproportionately affect women and potentially influence their mental well-being. This limitation precludes a comprehensive understanding of how gender roles and identities shape the experiences of urban greenery. We recognize that including such a perspective could greatly enrich the data and inform more inclusive urban planning policies. Acknowledging this gap, future research should incorporate gender analysis to unveil these critical dynamics, allowing for the development of green spaces that cater to the diverse needs of all city residents, thereby supporting the mental well-being of the entire community.

7. Conclusion

Our research provides a crucial contribution to the expanding literature on the importance of green spaces in mental health and mental well-being. Importantly, our study gives particular attention to the less-explored context of SMSCs in Europe—specifically, Córdoba and Nitra and to the relevance of inhabitants' perceptions on the use of green spaces and the derived benefits. While the overarching benefits of green spaces appear to be universal, our results suggest nuanced differences between the citizen perceptions in both cities.

In Córdoba, a medium-sized city with dry weather conditions, the time spent in green areas was notably connected to reduced psychological distress. Contrastingly, in Nitra, a smaller city with wet weather, the duration of green space visits was positively associated with overall mental well-being. These varying outcomes across cities point to the intricate ways in which city size, climate, and other sociodemographic factors may influence the perceptions and the mental health benefits accrued from green spaces.

As the world grapples with rapid urbanization and a rising tide of mental health issues, our study serves as a timely reminder of the invaluable role that green spaces can play in promoting public health. These insights underscore that it is not merely the existence but also the perception and usability of green spaces that require careful consideration in both future research and policy development. Green spaces must not only be present but should also be recognised as accessible, safe, and appealing to maximize their full health benefits. This is especially relevant for SMSCs in Europe, which are home to a significant portion of the population and often face constraints in terms of land, finances, and technical resources to develop green spaces. Thus, understanding how green spaces interact with sociodemographic variables and mental health is essential for equitable and effective urban planning. Our findings strongly advocate for using sound scientific evidence as the cornerstone for planning green infrastructures that balance maximum health benefits with existing urban constraints. Consequently, these results should guide policymakers and urban planners in crafting strategies that are tailored to the unique characteristics of SMSCs.

Ethics approval and consent to participate

This study (2021–085-RM) has been granted approval by the ethics committee of the University of Reading. Participants were informed about the purpose of the research, data collection and management, and the anonymity of the survey, and then they signed an informed consent. Data are treated respecting the anonymity of the participants.

CRediT authorship contribution statement

Delgado-Serrano María Mar: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Cruz-Piedrahita Catalina:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Katarína Melichová:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Mac Fadden Isotta:** Resources, Methodology, Investigation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. No funding was received from any public, commercial, or not-for-profit sectors to carry out the research presented in this manuscript. All procedures were followed in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. All authors contributed equally to the design, implementation, and analysis of the research reported. The manuscript has not been published previously, and it is not under consideration for publication elsewhere. Corresponding author affirms that he/she had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors have read and approved the final version of the manuscript for publication.

Data Availability

Data will be made available on request.

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Appendices

Appendix A. Summary of sociodemographic factors, green space variables (green spaces visited frequently, perception of green spaces in the neighbourhood, time of visit to green space, and weekly times exercising in green areas), the World Health Organisation's (WHO-5) Scale and the psychological distress the Kessler Psychological Distress Scale (K6) from 632 survey respondents, 316 in each city (Córdoba in Spain, and Nitra in Slovakia). Categorical variables (top of the table) show the categories of the left side and the total N and the equivalent percentage of each category on the right. Numeric variables (bottom of the table) show the mean and the standard deviation of each variable

Appendix A

Summary of sociodemographic factors, green space variables (green spaces visited frequently, perception of green spaces in the neighbourhood, time of visit to green space, and weekly times exercising in green areas), the World Health Organisation's (WHO-5) Scale and the psychological distress the Kessler Psychological Distress Scale (K6) from 632 survey respondents, 316 in each city (Córdoba in Spain, and Nitra in Slovakia). Categorical variables (top of the table) show the categories of the left side and the total N and the equivalent percentage of each category on the right. Numeric variables (bottom of the table) show the mean and the standard deviation of each variable.

Characteristic	Cordoba, N = 316[1]	Nitra, N = 316[1]
Gender		
Female	195 (62%)	198 (63%)
Male	121 (38%)	118 (37%)
Highest level of education achieved		
No education to secondary education	147 (47%)	49 (16%)
University or tech	108 (34%)	91 (30%)
Postgrad	61 (19%)	166 (54%)
Employment status		
Freelance or unpaid work	18 (5.7%)	47 (15%)
Full-Time Paid Employed	92 (29%)	159 (51%)
In education	39 (12%)	18 (5.8%)
Looking for work	76 (24%)	11 (3.5%)
Part time working	41 (13%)	16 (5.1%)
Retired	22 (7.0%)	39 (12%)
Temporary not working	28 (8.9%)	22 (7.1%)
Ethnic minority		
No	283 (90%)	287 (91%)
Prefer not to say	12 (3.8%)	9 (2.8%)
Yes	21 (6.6%)	20 (6.3%)
Kessler Psychological Distress Scale (K6)		
Healthy	250 (80%)	237 (75%)
Psychological distress	66 (20%)	79 (25%)
Duration of Vitis to green spaces		
No time at all	111 (35%)	96 (30%)
Less than one hour	91 (29%)	102 (32%)
1 to 2 h	73 (23%)	76 (24%)
2 to 3 h	19 (6.0%)	27 (8.5%)
More than 3 h	22 (7.0%)	15 (4.7%)
Times a week exercising in green areas		
No time at all	168 (53%)	96 (30%)
Less than once a week	60 (19%)	54 (17%)
1 to 2 times a week	53(17%)	86 (27%)
more than 2 times a week	35 (11%)	30 (9.5%)
Numeric Variables		
Age	40 (16)	37 (12)
World Health Organisation's WHO-5	16 (5.3)	14 (5.4)
Perception of green space most visited	16 (6)	13 (6)
Perception of green space in the neighbourhood	6.1 (3.2)	5.7 (3.1)

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