



ORIGINAL ARTICLE

Distance to the nearest park and its relationship with metabolic health: A cross-sectional study in a Spanish adult cohort



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KEYWORDS

Green space;
Park accessibility;
Dyslipidemia;
Obesity;
Cardiometabolic risk;
Public health

Abstract

Objective: To analyse the relationships between park proximity and biomarkers, anthropometric measurements, and physical activity levels in a Spanish adult cohort.

Design: Cross-sectional study.

Site: Spain.

Participants: A subsample of Cuenca adults from the DESVELA project cohort.

Interventions: Not applicable.

Main measurements: A range of sociodemographic, lifestyle, environmental, anthropometric and biomarker measurements were analysed. Analysis of covariance was conducted while controlling for sex, age and education level; distance to the nearest park was categorized into percentiles.

Results: The study population comprised 174 individuals, 98 female (56.3%). The mean age of the participants was 51.7 ± 9.8 years, with a range of 33–76 years. Analysis of covariance was conducted while controlling for sex, age and education level; distance to the nearest park

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PALABRAS CLAVE

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Dislipidemia;
Obesidad;
Riesgo
cardiometabólico;
Salud pública

was categorized into percentiles. The results revealed statistically significant p-values for HDL cholesterol ($p=0.02$), weight ($p=0.03$), and body mass index (BMI) ($p=0.03$), with additional trends toward significance for triglycerides ($p=0.06$) and vigorous physical activity ($p=0.08$). **Conclusions:** Residing at a distance of up to 550 metres from a park is associated with higher levels of HDL cholesterol, as well as lower weight and body mass index, indicating more favorable metabolic profiles among those living closer to a park compared to those living farther away.

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Distancia al parque más cercano y su relación con la salud metabólica: un estudio transversal en una cohorte de adultos Españoles

Resumen

Objetivo: Analizar las relaciones entre la proximidad a parques y biomarcadores, medidas antropométricas y niveles de actividad física en una cohorte adulta española.

Diseño: Estudio transversal.

Lugar: España.

Participantes: Una submuestra de adultos de Cuenca de la cohorte del proyecto DESVELA.

Intervenciones: No aplicable.

Medidas principales: Se analizaron una serie de mediciones sociodemográficas, de estilo de vida, ambientales, antropométricas y de biomarcadores. Se realizó un análisis de covarianza controlando el sexo, la edad y el nivel educativo; la distancia al parque más cercano se clasificó en percentiles.

Resultados: La población del estudio estaba formada por 174 individuos, 98 mujeres (56,3%). La edad media de los participantes era de $51,7 \pm 9,8$ años, con un intervalo de 33-76 años. Se realizó un análisis de covarianza controlando el sexo, la edad y el nivel educativo; la distancia al parque más cercano se clasificó en percentiles. Los resultados revelaron valores p estadísticamente significativos exclusivamente para el colesterol HDL ($p=0,02$), el peso ($p=0,03$) y el índice de masa corporal ($p=0,03$), con tendencias adicionales hacia la significación para los triglicéridos ($p=0,06$) y la actividad física vigorosa ($p=0,08$).

Conclusiones: Residir a una distancia de hasta 550 metros de un parque se asocia con mayores niveles de colesterol HDL, así como con un menor peso e índice de masa corporal, lo que indica perfiles metabólicos más favorables en quienes viven más cerca de un parque en comparación con quienes viven más lejos.

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Introduction

The urban environment has been identified as a key health determinant^{1,2} with a significant impact on human health outcomes, including mental and physical health^{3–6} improvements. In this context, modifications to urban design have been proposed with an emphasis on the concept of “healthy cities” to enhance population health.^{7–9} The incorporation of green spaces represents a significant aspect of this novel and forward-thinking approach, which is informed by the concept of salutogenesis.¹⁰

Parks constitute a fundamental component of urban green spaces,^{11,12} as they provide accessible areas for recreation, physical activity and social interaction, thereby making a significant contribution to the physical and mental well-being of both children and adults.^{13–16} The accessibility of parks, understood as their proximity and ease of use, is essential to optimize the benefits they offer.¹⁷ Parks located within the walking distance of homes offer multiple

health benefits by encouraging a more active and healthier lifestyle.^{18,19} Studies have demonstrated that shorter distances to parks are associated with better overall metabolic health, emphasizing the importance of green space in urban planning to promote health equity.^{20–23}

Cardiometabolic health is a fundamental aspect of disease prevention, particularly in the context of conditions such as type 2 diabetes, obesity and cardiovascular diseases, which represent significant global health burdens in terms of morbidity and mortality.^{24,25} These conditions affect a significant proportion of the population, with concerning prevalence rates.²⁶ For example, in Spain, the prevalence of metabolic syndrome is approximately 31% in adults, with a higher prevalence of abdominal obesity and lipid disorders.^{27,28} This syndrome is a significant risk factor for coronary heart disease.^{29,30} Furthermore, cardiovascular diseases are a significant public health concern, accounting for considerable burdens of morbidity and mortality.^{25,26} In addition, cardiovascular diseases represent the primary

cause of mortality worldwide.^{31,32} Early management of risk factors is essential to prevent disease progression and its associated complications.^{33,34} These findings highlight the urgent need to prioritize prevention strategies and promote healthy lifestyles to improve cardiometabolic health at the population level.

To the best of our knowledge, no previous studies have specifically examined the association of metabolic health with variables that concern blood lipids, glucose parameters and anthropometric metrics and its relationship with accessibility to parks in adults in the Spanish context. This gap in the scientific literature highlights the relevance of the present cross-sectional study, especially given the growing interest in the design of healthy and equitable cities.

Therefore, the objective of this study was to analyse the relationships between park proximity and biomarkers, anthropometric measurements, and physical activity levels in a Spanish adult cohort.

Materials and methods

Study design

This cross-sectional study was conducted between 2021 and 2023 as part of a multicenter study aimed at recreating a prospective cohort of individuals assigned to primary health-care centers within nine autonomous communities in Spain (Cataluña, País Vasco, Castilla y León, Aragón, Galicia, Islas Baleares, Castilla-La Mancha, Andalucía and Madrid).³⁵

Participants

This cross-sectional study population consisted of individuals aged between 35 and 74 years who were randomly selected and assigned to the Castilla-La Mancha Primary Healthcare Centre. Individuals with a terminal condition or who were institutionalized at the time of recruitment; those with intellectual disabilities, dementia, or language difficulties; and those intending to relocate from Spain within five years of the study's commencement were excluded from participation.

Sampling and sample size

The sample size was computed via the GRANMO sample size calculation. We considered the estimation of the relative risk for a cohort study using the Poisson approximation, with 10 years of follow-up and a rate of loss to follow-up of 30%, accepting an alpha risk of 0.05 and a beta risk of 0.2 in a bilateral contrast.^{35,36}

In the total cohort of the DESVELA project, a total of 352 individuals from the Castilla-La Mancha community were invited to participate in the study via post. Of these, 223 agreed to take part, representing a participation rate of 63%. However, those who did not provide data on their postal address were subsequently excluded from this study, resulting in a final sample size of 174 individuals.

Ethical considerations

The present study was approved by The Commission of Inquiry of the Integrated Area Management of Cuenca with

the project registration number 2019/PI2119. The research was performed under the regulations of this committee. The study participants were all informed about the objectives of the study, and written informed consent was obtained before individual participation.

Data collection

In this study, anthropometric measurements, blood analyses and a heteroadministered structured questionnaire were employed as data collection instruments.³⁵ On the one hand, the anthropometric parameters and blood tests were measured by trained staff under the internal procedures of the DESVELA cohort project. On the other hand, the questions were divided into two sections, including sociodemographic and lifestyle information.

Demographics

Demographic variables included age, sex, marital status, education level, and socioeconomic level.

Lifestyle

The two questionnaires used in this study to evaluate several lifestyles have been validated in Spanish. Adherence to the Mediterranean diet was assessed via the PREDIMED³⁷ and PREDIMED plus³⁸ questionnaires. The level of physical activity was assessed with the International Physical Activity Questionnaire.³⁹

Environment

The distance to the nearest park was selected as the exposure variable. The variable was calculated for each participant on the basis of their registered postal address. First, the participants' residential addresses were geolocated using geocoding tools based on the Google Maps Application Programming Interface (API), implemented via Google Sheets,^{40,41} which returned geographic coordinates in the World Geodetic System (WGS84) format. The coordinates were then entered into Google Maps,^{42,43} where the nearest park was identified from each participant's location.

Anthropometrics

Body weight (kg) and height (cm) were measured in light clothing and without shoes, respectively, via a calibrated scale and a wall-mounted stadiometer. Body mass index (BMI),⁴⁴ which serves as an indirect proxy for overall adiposity, was calculated as weight (kg) divided by the square of height (m). Abdominal adiposity was determined by measuring the circumference of the waist⁴⁵ (cm) at the level of the iliac crest, in line with standard practice. Waist circumference was measured with the use of an anthropometric tape.

Blood tests

We collected blood samples from the participants after at least 8 h of fasting. The levels of total cholesterol (mg/dL), triglycerides (mg/dL), LDL cholesterol (mg/dL), HDL

cholesterol (mg/dL), fasting glucose (mg/dL), and glycosylated haemoglobin (HbA1c, %) were measured.^{46–48}

Statistical analysis

Descriptive statistics for categorical variables are reported as frequency counts and percentages. For continuous variables, we reported the means and standard deviations (SDs). For categorical variables, differences were assessed via the chi-square (χ^2) test to determine statistical significance. For continuous variables, comparisons between two groups were performed using the Student's t-test, while comparisons involving more than two groups were analyzed via one-way analysis of variance (ANOVA). The corresponding *p* values, defined as $p < 0.05$, were calculated to evaluate the statistical significance.

We categorized the independent variables into quartiles as follows: below the 25th percentile ($P < 25$), between the 25th and 75th percentiles (P25–P75), and above the 75th percentile ($P > 75$). This stratification was performed to explore potential nonlinear relationships between the independent variable and the outcomes of interest.

Analysis of covariance (ANCOVA) was conducted to evaluate the associations between the exposure variables (in quartiles) and the outcome variables, adjusting for age, sex, and educational level. Statistical significance was defined as $p < 0.05$. To further investigate potential differences, separate analyses were conducted for males and females.

All the statistical operations were conducted with IBM SPSS Statistics software, version 29.⁴⁹

Results

Table 1 presents the baseline characteristics of the study participants, differentiated by sex. The study population comprised 174 individuals, 98 of whom were female (56.3%). The mean age of the participants was 51.7 ± 9.8 years, with a range of 33–76 years. Over half (54.6%) of the participants engaged in high levels of physical activity and demonstrated moderate adherence to the Mediterranean diet (57.5%). The mean distance to the nearest park was 430.1 ± 253.6 m. Additionally, Table S1 (supplementary material) shows the sociodemographic information of the study participants, organized by percentiles of distance to the nearest park.

With respect to the blood test, a notable reduction in mean triglyceride levels was observed in the group residing ≤ 250 m from a park. Furthermore, an increase in HDL cholesterol levels was observed in individuals residing ≤ 250 m from a park. In terms of anthropometry, the group residing between 260 and 550 m from a park presented lower BMI and waist circumference values. For weekly physical activity levels, the group residing ≤ 250 m from a park demonstrated greater total, moderate, and vigorous physical activity minutes. In contrast, the group residing between 260 and 550 m exhibited greater minutes spent on walking physical activity. The aforementioned data are illustrated in Fig. 1, which depicts the percentiles of distance to the nearest park. Moreover, the mean differences in percentiles are illustrated in Fig. 2.

ANOVA revealed no significant associations between park quartile and age ($p = 0.21$), sex ($p = 0.28$), or level of

education ($p = 0.94$). ANCOVA was conducted while controlling for sex, age and education level; distance to the nearest park was categorized into percentiles. The ANCOVA results revealed statistically significant *p* values for HDL cholesterol ($p = 0.02$) in favor of the shorter distance to the park (≤ 250 meters) compared to the greatest distance category (≥ 600 meters) (Table 2). Additionally, there was a trend toward significance for improvements in triglycerides ($p = 0.06$) and vigorous physical activity ($p = 0.08$). Furthermore, statistically significant *p* values for weight ($p = 0.03$) and BMI ($p = 0.03$) in favor of the intermediate distance to the park (260–550 meters) compared to the greatest distance category (≥ 600 meters). Notably, when stratified by sex, a significant *p* value was observed only for BMI in men ($p = 0.01$) (supplementary material, Tables S2 and S3).

Discussion

The main aim of this study was to analyse the relationships between park proximity and biomarkers, anthropometric measurements, and physical activity levels in a Spanish adult cohort. The results of this study indicate that proximity to a park is significantly associated with cardiometabolic health indicators. Specifically, living ≤ 250 m in a park was associated with higher levels of HDL cholesterol. Additionally, living at an intermediate distance, between 260 and 550 m, from a park was linked to lower weight and a reduced BMI. Moreover, there was a trend suggesting that residing closer to a park may also be associated with lower triglyceride levels and higher levels of vigorous physical activity.

In relation to blood lipids, the findings of this study are in accordance with those of previous studies, which similarly reported lower triglyceride levels and higher HDL cholesterol levels.^{50–52} Although the present study focused on proximity to the nearest park, many of these other studies examined these associations via the Normalized Difference Vegetation Index (NDVI). Both metrics are comparable in their capacity to reflect greenery objectively.^{53,54} With respect to anthropometry, a relationship has also been identified between proximity to greenness and better BMI and waist circumference in other studies.^{55–57} These results reinforce the evidence for this relationship, indicating a robust trend that has been documented across different populations and contexts.

A noteworthy finding of our study is the significant association between park proximity and higher levels of HDL. Previous research has demonstrated a positive association between residential greenness and physical activity levels.^{15,58–60} Additionally, a substantial body of evidence has shown a positive correlation between exercise and the activity of lipoprotein lipase, a key enzyme involved in cholesterol metabolism, in which triglycerides play a key role.^{61–63} Our study did not find a significant correlation between park proximity and triglycerides; however, a trend toward lower levels of this biomarker was observed. In addition, our study revealed a better lipid profile in females than in males. This more favourable trend in women has also been corroborated in other studies where greenness has been examined as an independent variable.^{51,64} This could be attributed to women's tendency to walk more than men do, as shown in the present study, as a form of physical

Table 1 Study sample sociodemographic characteristics.

Sociodemographic characteristics	Total n (%)	Men	Women	p
Sample size	174 (100.0)	74 (43.7)	98 (56.3)	–
Mean age (SD)	51.7 (9.8)	51.7 (10.4)	51.8 (9.4)	0.48
Foreign nationality	4 (2.3)	2 (2.7)	2 (2.0)	0.78
Marital status				0.78
Single	29 (16.7)	13 (17.6)	15 (15.3)	
Married	122 (70.1)	53 (71.7)	68 (69.4)	
Divorced	9 (5.2)	3 (4.1)	6 (6.1)	
Widowed	7 (4.0)	3 (4.1)	4 (4.1)	
Level of education				0.07
Uneducated	2 (1.1)	1 (1.4)	1 (1.0)	
Primary education	11 (6.3)	3 (4.1)	8 (8.2)	
Secondary education	56 (36.2)	31 (41.9)	23 (23.5)	
University education	99 (56.9)	37 (50.0)	62 (63.3)	
Monthly income				0.69
Low	22 (12.6)	9 (12.2)	13 (13.3)	
Medium	71 (40.8)	29 (39.2)	40 (40.8)	
High	68 (39.1)	33 (44.6)	35 (35.7)	
Risk of poverty or social exclusion	16 (9.2%)	6 (8.1)	9 (9.2)	0.67
Physical activity				0.00*
Low	23 (13.2)	10 (13.5)	10 (10.2)	
Moderate	53 (30.5)	45 (60.8)	40 (40.8)	
High	95 (54.6)	15 (20.3)	47 (48.0)	
Adherence to the Mediterranean diet				0.01*
Low	14 (8.0)	10 (13.5)	4 (4.1)	
Moderate	100 (57.5)	45 (60.8)	53 (54.1)	
High	49 (28.2)	15 (20.3)	34 (34.7)	
Distance to the nearest park, meters, mean (SD)	430.1 (253.6)	430.2 (264.1)	432.4 (247.4)	0.28
P < 25	44 (25.3)	22 (29.7)	21 (21.4)	
P25–P75	87 (50.0)	32 (43.3)	54 (55.1)	
P > 75	43 (24.7)	20 (27.0)	23 (23.5)	

Abbreviations: P, percentile; SD, standard deviation.

The column labelled “p” refers to the chi-square test for qualitative variables and the Student’s t-test for quantitative variables. An asterisk (*) indicates $p < 0.05$. Discrepancies in totals are due to missing responses on certain variables or incomplete questionnaires from some participants.

exercise that is positive for maintaining good cholesterol levels.^{65–67}

With respect to the anthropometric findings, the study revealed no statistically significant correlation between waist circumference and proximity to the park. However, a notable trend emerged, with individuals residing closer to the park exhibiting lower waist circumferences. Additionally, the analysis revealed a statistically significant association between distance to the park and better BMI, especially in men. BMI is linked to physical activity, which could be attributed to increased engagement in strength-building exercises among males, which may have a positive impact on this parameter.^{65,68,69}

In relation to physical activity levels, it is imperative to emphasize the findings of this study in the context of the recommendations established by the World Health Organization (WHO). According to the WHO, adults should engage in 150–300 min of moderate physical activity and 75–150 min of vigorous activity per week.⁷⁰ The participants in this study met the minimum recommended levels of activity. However, it is worth noting that people living within 550 m of a park had consistently higher levels of physical activity than those living more than 550 m away did, and this was true for both sexes. This highlights the potential role of accessible recreational spaces in promoting healthier lifestyles.

The present study revealed a statistically significant correlation between the 25th percentile and the 25th–75th percentiles. This is equivalent to values of ≤ 250 m and between 260 m and 550 m, respectively. A distance of less than 250 m would be equivalent to a three-to-five-minute walk, thereby facilitating frequent and expeditious access to the park. Conversely, individuals residing between 260 and 550 m, which is equivalent to approximately a five- to ten-minute walk, still have relatively convenient access.^{71,72} Notably, those who live in proximity to parks may inhabit areas with superior socioeconomic and urbanistic conditions, which has been associated with enhanced health outcomes.^{73,74}

Among the strengths of this study is the use of the distance to the nearest park as a measure of residential greenness, which implicitly includes accessibility to green space, a relevant aspect for analysis. Moreover, no prior studies have employed this measure to assess cardiometabolic health, as the NDVI is generally used, although it is not able to distinguish accessibility to greenery. However, several notable limitations were discerned, including the small sample size of only 174 subjects, which might have limited the statistical power needed to detect statistical significance. Additionally, the cross-sectional design of the study constrains the capacity to infer causal relationships between the analysed variables.

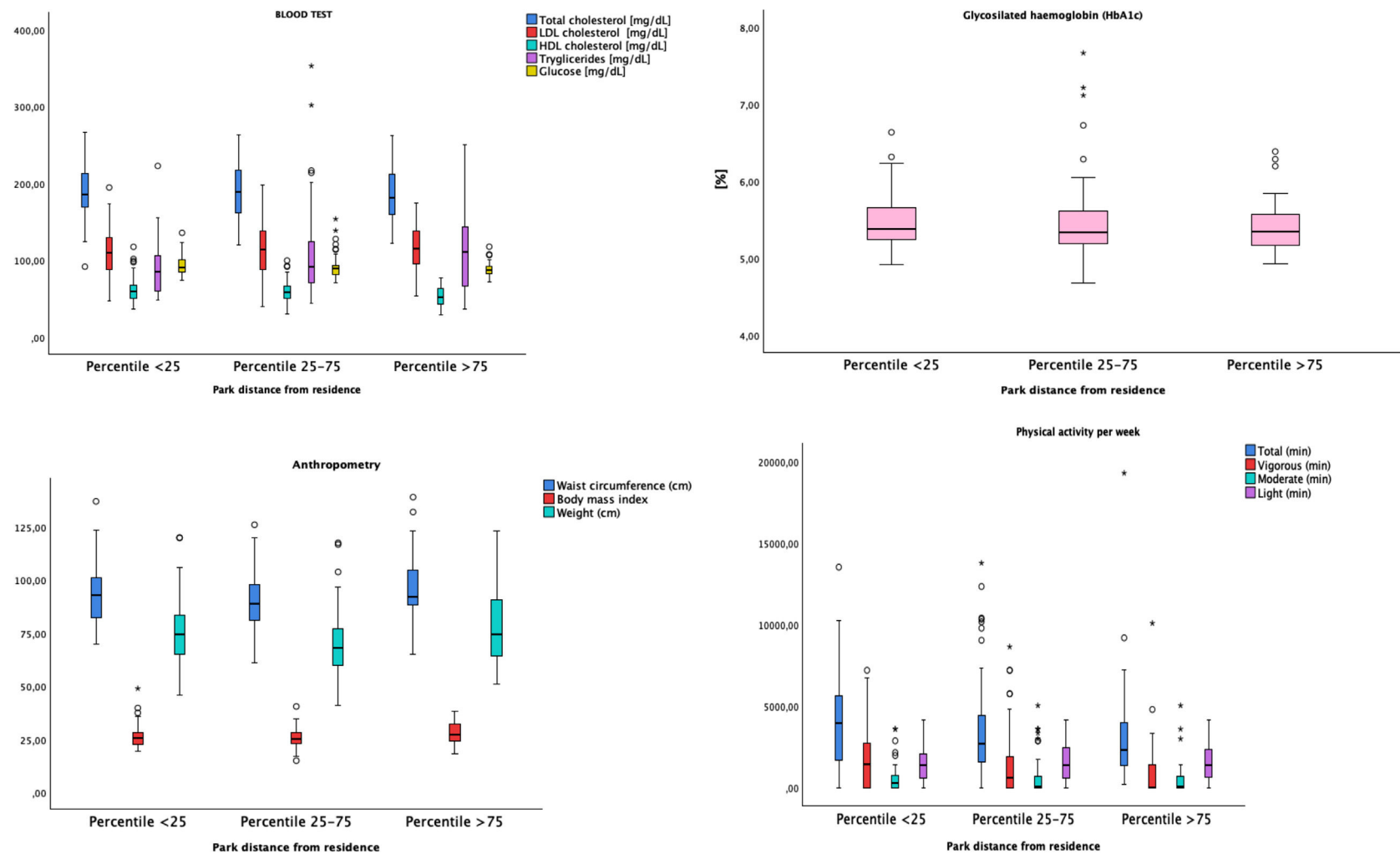


Figure 1 Blood test, anthropometry and physical activity group means based on percentiles of distance to the nearest park.

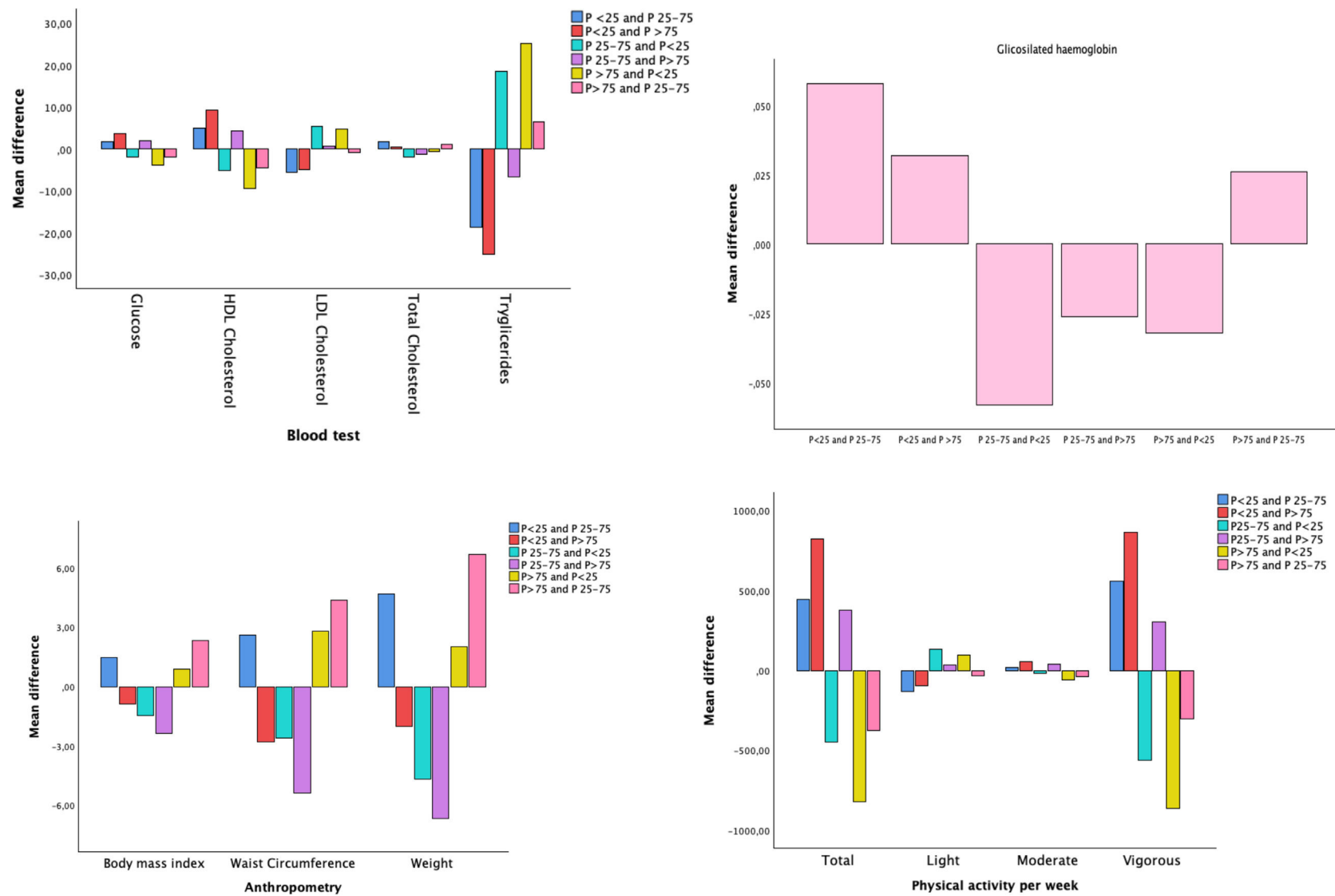


Figure 2 Blood test, anthropometry and physical activity mean difference in groups based on percentiles of distance to the nearest park.

Table 2 Differences in anthropometry, blood test and physical activity by distance to the nearest park percentiles, adjusted for age, sex and education level.

	Low (percentile <25) Range: 30–250 m	Moderate (percentile 25–75) Range: 260–550 m	High (percentile >75) Range: 600–1600 m	<i>p</i>
<i>Blood test, mean (SD)</i>				
Total cholesterol	187.9 (39.7) <i>n</i> = 40	189.6 (34.2) <i>n</i> = 77	187.8 (38.4) <i>n</i> = 33	0.97
Triglycerides	89.2 (35.4) <i>n</i> = 39	102.6 (53.5) <i>n</i> = 76	113.8 (56.6) <i>n</i> = 31	0.06
HDL cholesterol	63.0 (18.5) <i>n</i> = 39	60.2 (14.1) <i>n</i> = 74	53.8 (11.8) <i>n</i> = 32	0.02*
LDL cholesterol	108.2 (33.0) <i>n</i> = 38	115.3 (33.1) <i>n</i> = 74	113.8 (33.2) <i>n</i> = 32	0.70
Glucose	93.5 (13.7) <i>n</i> = 40	92.0 (14.1) <i>n</i> = 73	83.5 (9.5) <i>n</i> = 33	0.48
Glycosylated hemoglobin	5.5 (0.4) <i>n</i> = 39	5.5 (0.5) <i>n</i> = 78	5.4 (0.4) <i>n</i> = 33	0.79
<i>Anthropometry, mean (SD)</i>				
BMI	26.9 (5.7) <i>n</i> = 42	25.4 (4.3) <i>n</i> = 82	27.7 (5.0) <i>n</i> = 42	0.03*
Waist circumference	93.3 (15.0) <i>n</i> = 42	90.2 (12.0) <i>n</i> = 82	95.5 (16.0) <i>n</i> = 42	0.08
Weight	76.6 (17.1) <i>n</i> = 42	69.9 (14.6) <i>n</i> = 82	78.2 (17.9) <i>n</i> = 42	0.03*
<i>Physical activity, weekly minutes</i>				
Light	1444 (1219) <i>n</i> = 42	1612 (1231) <i>n</i> = 82	1527 (1003) <i>n</i> = 41	0.84
Moderate	637 (924) <i>n</i> = 42	579 (1028) <i>n</i> = 82	585 (1062) <i>n</i> = 41	0.97
Vigorous	1897 (2169) <i>n</i> = 42	1165 (1684) <i>n</i> = 82	1038 (1850) <i>n</i> = 41	0.08
Total	3978 (3151) <i>n</i> = 42	3357 (2677) <i>n</i> = 82	3150 (3200) <i>n</i> = 41	0.42

Abbreviations: BMI, body mass index.

ANCOVA results with a significance level at $p < 0.05$ represented by and asterisk (*). Discrepancies in totals are due to missing data from participants who did not undergo blood testing, anthropometric measurements, or did not complete the physical activity questionnaire.

Finally, it was not possible to use the NDVI index in the main analyses because the city of interest in this study is small and has homogeneous greenery, which makes this index inappropriate.^{75,76}

The findings of this study have significant implications for practice, indicating the potential role of urban green spaces in promoting cardiometabolic health. Residing at up to 550 m from a park has been linked with favourable alterations in the lipid profile and a reduction in the prevalence of obesity. This evidence reinforces the importance of public policies aimed at increasing and preserving accessible green spaces, thus contributing to the general well-being of the population.

Conclusions

In conclusion, the results of this study indicate that residing at a distance of up to 550 metres from a park is significantly associated with higher levels of HDL cholesterol, as well as lower body weight and BMI. Furthermore, the findings showed a trend toward improvements in triglycerides and vigorous physical activity among those living closer to a park. These findings emphasize the significance of proximity to urban green spaces for metabolic health, which could have implications for urban design and public policies aimed

at enhancing population well-being. Nevertheless, further studies are needed to investigate the potential causes and mechanisms underlying these associations.

Ethical approval

The present study was approved by The Commission of Inquiry of the Integrated Area Management of Cuenca with the project registration number 2019/PI2119. The research was performed under the regulations of this committee. The study participants were all informed about the objectives of the study, and written informed consent was obtained before individual participation.

Declaration of competing interests

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this article.

Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version available at <https://doi.org/10.1016/j.aprim.2025.103347>.

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