Socio-environmental correlates of physical activity in patients with chronic obstructive pulmonary disease (COPD)

SUPPLEMENTARY FILE

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Sample size power estimations

Provided sample size was fixed by the primary objective of the Urban Training^{TM} study, prior to any analysis we calculated whether the available number of patients (n=410) would allow the identification of significant differences in physical activity between groups. Calculations with the software GRANMO 7.10[1] showed that, using data from previous literature about physical activity in COPD patients from the same geographical area[2] (one third of patients (n=137) was estimated to be physically inactive, and two thirds (n=274) physically active), distribution of Normalized Difference Vegetation Index (NDVI) values in the same geographic area (mean of 0.1 and SD of 0.05)[3], and the relationship between NDVI and physical activity in other populations (difference of 0.02 between physically active and inactive)[4], and accepting an alpha risk of 0.05 in a two-sided test, the statistical power to identify an association between NDVI and physical activity as statistically significant was 96%.

[1] Marrugat J, Vila J, Pavesi M, Sanz F. [Estimation of the sample size in clinical and epidemiological investigations]. Med Clin (Barc) 1998;111:267–76.

[2] Garcia-Aymerich J, Farrero E, Félez MA, Izquierdo J, Marrades RM, Antó JM. Risk factors of readmission to hospital for a COPD exacerbation: a prospective study. Thorax 2003;58:100–5.

[3] Dadvand P, Sunyer J, Basagaña X, Ballester F, Lertxundi A, Fernández-Somoano A, et al. Surrounding greenness and pregnancy outcomes in four Spanish birth cohorts. Environ Health Perspect 2012;120:1481–7

[4] Almanza E, Jerrett M, Dunton G, Seto E, Pentz MA. A study of community design, greenness, and physical activity in children using satellite, GPS and accelerometer data. Health Place 2012;18:46–54.

Table S1. Description of the five municipalities included in the study

	Population (inhabitants)	Area (km²)	Density (inhabitants/km²)
Barcelona	1,602,386	101.4	15,810
Badalona	217,210	21.2	10,255
Mataró	124,280	22.5	5516
Viladecans	65,358	20.4	3203
Gavà	46,326	30.8	1506

Source: Idescat. Institut d'Estadística de Catalunya. Pàgina principal [Internet]. [cited 2016 Apr 9]. Available from: http://www.idescat.cat/

Table S2. Association between socio-demographic and clinical characteristics, and socio-environmental determinants in COPD patients.

	Dog walking		p-value	Grandparenting		p-value
	No	**Yes**		**No**	**Yes**	
Sex: men, n (%)	312 (86)	37 (76)	0.044	212 (84)	135 (88)	0.286
Age (years), m (SD)	69.1 (8.3)	66.5 (8.9)	0.037	68.4 (9.2)	69.5 (7)	0.211
Education: primary or less, n (%)	262 (72)	24 (49)	<0.01	174 (61)	109 (39)	0.670
Married or living with partner, n (%)	272 (76)	39 (80)	0.535	170 (67)	139 (91)	<0.01
Low socio-economic status (SES): IV-V, n (%)	255 (71)	37 (76)	0.532	182 (73)	107 (37)	0.578
Working status: active, n (%)	35 (10)	4 (9)	0.771	30 (12)	9 (6)	0.042
Smoking status: current, n (%)	82 (23)	16 (33)	0.126	64 (25)	33 (21)	0.374
Body mass index (BMI) (kg/m^2), m (SD)	28.4 (4.9)	28.7 (5.1)	0.681	28.4 (5.1)	28.5 (4.5)	0.920
Dyspnoea (mMRC grade, 0-4), m (SD)	1.1 (0.9)	1 (0.7)	0.333	1.2 (0.9)	1 (0.8)	0.083
FEV$_1$ (% predicted), m (SD)	55 (17)	62 (16)	<0.01	55 (18)	58 (174)	0.092
FEV$_1$/FVC ratio, m (SD)	55 (12)	57 (11)	0.196	54 (12)	56 (12)	0.885
6MWD (meters), m (SD)	482 (97)	507 (76)	0.087	480 (99)	496 (87)	0.091
Health-related quality of life (CAT score, 0-40), m (SD)	12.3 (7)	12 (7)	0.734	12.6 (7)	11.6 (7)	0.173
Anxiety (HAD-A score, 0-21), m (SD)	5.1 (4)	5.6 (4)	0.453	5.4 (4)	4.8 (4)	0.129
Depression (HAD-D score, 0-21), m (SD)	3.4 (3)	3.6 (4)	0.783	3.8 (4)	2.9 (3)	0.008
Diabetes mellitus, n (%)	101 (29)	13 (27)	0.817	72 (29)	40 (26)	0.509
Coronary heart disease, n (%)	35 (10)	2 (4)	0.195	28 (11)	8 (5)	0.038
Hypertension, n (%)	174 (49)	29 (60)	0.153	118 (48)	84 (55)	0.169
Musculoskeletal diseases, n (%)	129 (37)	25 (52)	0.039	100 (41)	54 (36)	0.293
Comorbidities that could affect walking, n (%)	257 (86)	41 (14)	0.066	185 (63)	111 (38)	0.818

*Some variables had missing values: 10 in diabetes, coronary heart disease, musculoskeletal diseases and hypertension, and 3 in grandparenting.

Table S3. Association between socio-demographic and clinical characteristics, and physical activity in COPD patients.

	Time in moderate-to-vigorous physical activity		p-value	VMU/min		p-value
	Low (<median)	High (≥median)		Low (<median)	High (≥median)	
Sex: men, n (%)	174 (85)	175 (85)	0.890	173 (84)	176 (86)	0.677
Age (years), m (SD)	69.6 (8.4)	68 (8.4)	0.056	70.4 (8.5)	67.4 (8.2)	<0.01
Education: primary or less, n (%)	136 (66)	150 (73)	0.132	143 (70)	143 (70)	0.998
Married or living with partner, n (%)	145 (71)	166 (81)	0.019	142 (70)	169 (82)	<0.01
Low socio-economic status (SES): IV-V, n (%)	138 (68)	154 (75)	0.127	137 (68)	155 (76)	0.081
Working status: active, n (%)	17 (9)	22 (11)	0.499	16 (8)	23 (12)	0.280
Smoking status: current, n (%)	60 (29)	38 (19)	0.011	53 (26)	45 (22)	0.354
Body mass index (BMI) (kg/m^2), m (SD)	28.9 (5.4)	28 (4.3)	0.074	29.2 (5.2)	27.6)	<0.01
Dyspnoea (mMRC grade, 0-4), m (SD)	1.4 (0.9)	0.9 (0.7)	<0.01	1.4 (1)	0.9 (0.7)	<0.01
FEV_1 (% predicted), m (SD)	53 (17)	59 (17)	<0.01	52 (17)	60 (16)	<0.01
FEV_1/FVC ratio, m (SD)	54 (13)	56 (12)	0.089	54 (14)	56 (12)	0.107
6MWD (meters), m (SD)	453 (101)	518 (76)	<0.01	440 (95)	531 (70)	<0.01
Health-related quality of life (CAT score, 0-40), m (SD)	13 (7)	11 (7)	<0.01	14 (8)	11 (6)	<0.01
Anxiety (HAD-A score, 0-21), m (SD)	5.1 (4)	5.2 (4)	0.830	4.9 (4)	5.4 (4)	0.177
Depression (HAD-D score, 0-21), m (SD)	3.9 (3.6)	3 (3)	0.008	3.8 (3.5)	3.1 (3.1)	0.023
Diabetes mellitus, n (%)	63 (31)	51 (26)	0.229	69 (34)	45 (23)	<0.01
Coronary heart disease, n (%)	18 (9)	19 (10)	0.813	23 (11)	14 (7)	0.128
Hypertension, n (%)	102 (51)	101 (51)	0.918	110 (55)	93 (47)	0.110
Musculoskeletal diseases, n (%)	73 (36)	81 (41)	0.327	74 (37)	80 (40)	0.487
Comorbidities that could affect walking, n (%)	151 (51)	147 (49)	0.658	150 (50)	148 (50)	0.825

*Some variables had missing values: 10 in diabetes, coronary heart disease, musculoskeletal diseases and hypertension, and 3 in grandparenting.

Table S4. Adjusted association between socio-environmental characteristics and secondary outcomes of physical activity amount in COPD patients.

	Steps (num/day)		Walking time (min/day)		Time in physical activity of any activity (min/day)	
	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value
Dog walking	1419 (331 to 2508)	0.01	18 (6 to 29)	<0.01	21 (4 to 39)	0.01
Grandparenting	644 (-96 to 1384)	0.09	7 (-0.5 to 15)	0.06	13 (0.7 to 25)	0.03
Age (years)	-47 (-94 to 1)	0.06	-0.5 (-1 to -0.3)	0.03	-0.6 (-1.4 to 0.1)	0.12
Sex: male	309 (-751 to 1370)	0.57	5 (-6 to 16)	0.39	-19 (-36 to -2)	0.03
Low SES: IV, V	838 (30 to 1645)	0.04	8 (-0.4 to 16)	0.06	22 (8 to 35)	<0.01
Active smoking	-1798 (-2655 to -941)	<0.01	-18 (-27 to -9)	<0.01	-30 (-44 to -16)	<0.01
Dyspnoea (mMRC, 0-4)	-782 (-1237 to -326)	<0.01	-8 (-13 to -3)	<0.01	-15 (-22 to -7)	<0.01
6MWD (meters)	12 (7 to 16)	0.30	0.6 (-0.07 to 0.16)	<0.01	0.3 (0.2 to- 0.3)	<0.01
Anxiety (HAD-A score, 0-21)	50 (-44 to 145)	<0.01	0.7 (-0.3 to 1.6)	0.18	2 (0.6 to 4)	<0.01

CI: confidence interval; VMU: vector magnitude units; SES: socio-economic status; mMRC: modified medical research council; 6MWD: six minute walking distance; HAD-A: hospital anxiety and depression scale-anxiety score.

* Each column is a single linear regression multivariable model. Coefficients are expressed as minutes of time in activity or VMU/min (one at each time), per (i) each unit of the continuous covariates, or (ii) a change with respect to reference category in categorical covariates.

Table S5. Adjusted* association between socio-environmental characteristics and secondary outcomes of physical activity amount in COPD patients, according to sex, COPD severity, municipality and neighbourhood deprivation.

Steps (num/day)

	By sex		By COPD severity		By municipality				By neighbourhood deprivation	
	Women n=61 (%15%)	Men n=350 (85%)	FEV₁≥50% n=225 (62%)	FEV₁<50% N=156 (38%)	Barcelona n=189 (46%)	Badalona n=29 (7%)	Mataró n=73 (%18)	Viladecans/Gavà n=120 (29%)	Low (<0.6 UVI) n=181	High (≥0.6 UVI) n=226
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Dog walking	1310 (-917 to 3536)	1866 (605 to 3127)	1290 (44 to 2538)	2038 (-203 to 4279)	1928 (303 to 3553)	nc	293 (-2600 to 3186)	1928 (100 to 3757)	-180 (-1732 to 1372)	2532 (924 to 4139)
Grandparenting	-1094 (-2910 to 722)	952 (137 to 1766)	871 (-40 to 1781)	128 (-1173 to 1429)	-4 (-1132 to 1124)	2914 (-89 to 5918)	1014 (-1019 to 3046)	934 (-441 to 2309)	765 (-352 to 1882)	478 (-568 to 1523)

Walking time (min/day)

	By sex		By COPD severity		By municipality				By neighbourhood deprivation	
	Women n=61 (%15%)	Men n=350 (85%)	FEV₁≥50% n=225 (62%)	FEV₁<50% N=156 (38%)	Barcelona n=189 (46%)	Badalona n=29 (7%)	Mataró n=73 (%18)	Viladecans/Gavà n=120 (29%)	Low (<0.6 UVI) n=181	High (≥0.6 UVI) n=226
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Dog walking	15 (-8 to 38)	23 (10 to 36)	15 (2 to 28)	27 (4 to 50)	23 (6 to 40)	nc	4 (-25 to 32)	24 (6 to 42)	1 (-15 to 17)	29 (13 to 46)
Grandparenting	-12 (-31 to 7)†	10 (2 to 19)†	10 (1 to 19)	2 (-11 to 16)	1 (-11 to 13)	32 (0-1 to 63)	8 (-12 to 28)	11 (-3 to 24)	8 (-4 to 19)	6 (-5 to 17)

Time in physical activity of any intensity (min/day)

	By sex		By COPD severity		By municipality				By neighbourhood deprivation	
	Women n=61 (%15%)	Men n=350 (85%)	FEV₁≥50% n=225 (62%)	FEV₁<50% N=156 (38%)	Barcelona n=189 (46%)	Badalona n=29 (7%)	Mataró n=73 (%18)	Viladecans/Gavà n=120 (29%)	Low (<0.6 UVI) n=181	High (≥0.6 UVI) n=226
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Dog walking	11 (-36 to 58)	28 (8 to 48)	19 (-3 to 41)	29 (-4 to 62)	44 (18 to 70)	nc	16 (-61 to 27)	20 (-10 to 50)	16 (-9 to 41)	22 (-4 to 49)
Grandparenting	-11 (-50 to 27)	17 (4 to 30)	21 (5 to 37)	-1 (-19 to 19)	4 (-14 to 22)	67 (12 to 123)	13 (-18 to 44)	7 (-15 to 30)	17 (-1 to 35)	10 (-7 to 28)

VMU: vector magnitude units; FEV₁: forced expiratory volume in the first second; UVI: urban vulnerability index; nc: non computable. CI: confidence interval.

* Models adjusted for age, sex, socio-economic status, dyspnea, 6MWD, and HAD-anxiety.

† P-for-interaction between grandparenting and sex in time in walking time=0.03.

Table S6. Adjusted association between socio-environmental characteristics and physical activity amount and intensity (all parameters) in COPD patients, after excluding patients with extreme values in (≥99th percentile) physical activity variables.

	Time in physical activity of moderate-to-vigorous intensity (min/day)		VMU/min		Steps (num/day)		Walking time (min/day)		Time in physical activity of any activity (min/day)	
	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value
Dog walking	17 (5 (to 29)	<0.01	49 (-5 to 102)	0.07	1264 (244 to 2283)	0.02	16 (5 to 26)	<0.01	14 (-5 to 31)	0.14
Grandparenting	7 (-1 to 16)	0.08	30 (-5 to 65)	0.09	404 (-287 to 1095)	0.25	6 (1 to 13)	0.11	11 (-0.7 to 23)	0.06
Age (y)	-0.6 (-1 to -0.06)	0.02	-1 (-3 to 1)	0.44	-33 (-77 to 12)	0.25	-0.3 (-0.8 to 0.1)	0.14	-0.5 (-1 to 0.3)	0.18
Sex: male	1 (-11 to 13)	0.87	2 (-49 to 52)	0.94	96 (-891 to 1083)	0.85	2 (-8 to 13)	0.14	-17 (-34 to 0.02)	0.05
Low SES: IV, V	9 (-0.4 to 18)	0.06	34 (-5 to 74)	0.08	614 (-142 to 1370)	0.11	6 (-2 to 14)	0.12	22 (10 to 35)	<0.01
Active smoking	-18 (-27 to -8)	<0.01	-76 (-116 to -35)	<0.01	-1553 (-2351 to -755)	<0.01	-15 (-23 to -7)	<0.01	-31 (45 to 17)	<0.01
Dyspnoea (mMRC, 0-4)	-19 (-15 to 0.2)	<0.01	-42 (-63 to -20)	<0.01	-704 (-1129 to -280)	<0.01	-7 (-12 to 3)	<0.01	-14 (-21 to -6)	<0.01
6MWD (m)	0.1 (0.1 to 0.2)	<0.01	0.8 (0.6 to 1)	<0.01	12 (8 to 16)	0.24	0.1 (0.7 to 0.2)	<0.01	0.2 (0.2 to 0.3)	<0.01
Anxiety (HAD-A score, 0-21)	1 (0.02 to 2)	0.04	7 (2 to 11)	<0.01	53 (-35 to 142)	<0.01	0.6 (-0.3 to 1.5)	0.23	2 (0.6 to 4)	<0.01

CI: confidence interval; VMU: vector magnitude units; SES: socio-economic status; mMRC: modified medical research council; 6MWD: six minute walking distance; HAD-A: hospital anxiety and depression scale-anxiety score.
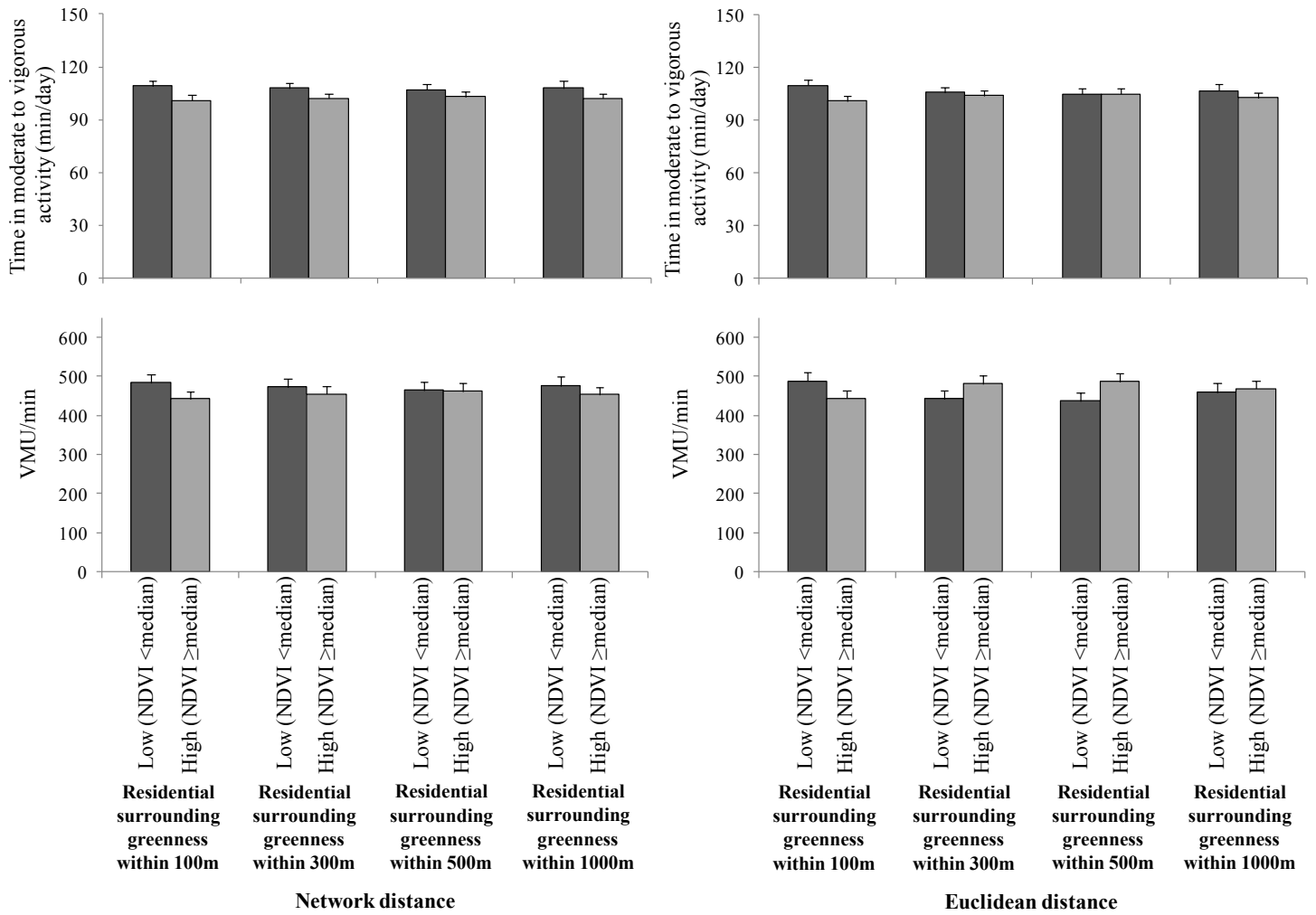
Table S7. Adjusted association between socio-environmental characteristics and physical activity amount and intensity (all parameters) in COPD patients, using a mixed effect models to account for the potential correlation between subjects within a municipality.

	Time in physical activity of moderate-to-vigorous intensity (min/day)		VMU/min		Steps (num/day)		Walking time (min/day)		Time in physical activity of any activity (min/day)	
	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value	β (95% CI)	p-value
Dog walking	19 (6 to 32)	<0.01	88 (13 to 163)	0.02	1419 (348 to 2491)	0.01	18 (6 to 29)	<0.01	21 (4 to 39)	0.01
Grandparenting	8 (-0.3 to 17)	0.06	55 (4 to 106)	0.03	644 (-85 to 1372)	0.08	7 (-0.5 to 15)	0.06	13 (1 to 25)	0.03
Age (y)	-0.7 (-1 to -0.1)	0.01	-4 (-7 to -0.3)	0.03	-47 (-94 to 0)	0.05	-0.5 (-1 to -0.3)	0.03	-0.6 (-1 to 0.1)	0.12
Sex: male	3 (-9 to 15)	0.62	24 (-49 to 97)	0.51	309 (-735 to 1353)	0.56	5 (-6 to 16)	0.39	-19 (36 to -2)	0.03
Low SES: IV-V	10 (1 to 20)	0.03	86 (29 to 142)	<0.01	838 (43 to 1632)	0.04	8 (-0.5 to 16)	0.06	22 (8 to 35)	<0.01
Active smoking	-20 (-30 to -10)	<0.01	-148 (-207 to -89)	<0.01	-1798 (-2642 to -954)	<0.01	-18 (27 to -9)	<0.01	-30 (-44 to -16)	<0.01
Dyspnoea (mMRC, 0-4)	-11 (-16 to -5)	<0.01	-59 (-91 to -27)	<0.01	-782 (-1230 to -333)	<0.01	-8 (-13 to -3)	<0.01	-15 (-22 to -7)	<0.01
6MWD (m)	0.01 (0.09 to 0.2)	<0.01	1.1 (0.8 to 1.4)	<0.01	12 (7 to 16)	0.30	0.1 (0.07 to 0.1)	<0.01	0.3 (0.2 to 0.3)	<0.01
Anxiety (HAD-A score, 0-21)	1 (0.1 to 2)	0.04	3 (-4 to 9)	0.40	50 (-43 to 143)	<0.01	0.6 (-0.3 to 2)	0.18	2 (0.6 to 4)	<0.01

CI: confidence interval; VMU: vector magnitude units; SES: socio-economic status; mMRC: modified medical research council; 6MWD: six minute walking distance; HAD-A: hospital anxiety and depression scale-anxiety score.

Figure S1. Distribution of physical activity amount and intensity according to residential surrounding greenness within different buffers using network and Euclidean distances in COPD patients.

VMU: vector magnitude units; NDVI: Normalized Difference Vegetation Index. Bars represent mean and standard error.