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## Supplementary appendix

### Association between urban green space and postpartum depression, and the role of physical activity: a retrospective cohort study in Southern California

#### Authors:

Yi Sun<sup>a, b</sup> PhD, John Molitor<sup>c</sup> PhD, Tarik Benmarhnia<sup>d</sup> PhD, Chantal Avila<sup>e</sup> MA, Vicki Chiu<sup>e</sup> MS, Jeff Slezak<sup>e</sup> MS, David A. Sacks<sup>e, f</sup> MD, Jiu-Chiuan Chen<sup>g</sup> MD, Darios Getahun<sup>e, h\*</sup> MD, Prof Jun Wu<sup>b\*</sup> PhD

a. Institute of Medical Information, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China.

b. Department of Environmental and Occupational Health, Program in Public Health, University of California, Irvine, CA, USA.

c. College of Public Health and Human Sciences, Oregon State University, Corvallis, OR 97331, USA.

d. Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive #0725, CA La Jolla 92093, USA.

e. Department of Research & Evaluation, Kaiser Permanente Southern California, Pasadena, CA, USA.

f. Department of Obstetrics and Gynecology, University of Southern California, Keck School of Medicine, Los Angeles, CA, USA.

g. Departments of Population & Public Health Sciences and Neurology, University of Southern California, Los Angeles, CA 90033, USA.

h. Department of Health Systems Science, Kaiser Permanente Bernard J. Tyson School of Medicine, Pasadena, CA, USA.

\* Equal contribution senior authors

#### Corresponding authors

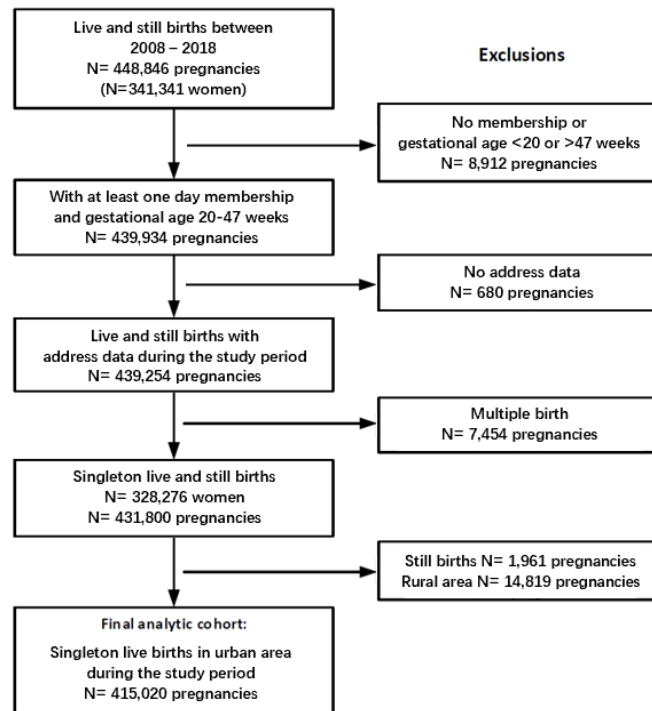
Jun Wu, PhD  
junwu@hs.uci.edu

Darios Getahun, MD, PhD, MPH  
Darios.T.Getahun@kp.org

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**Supplementary Figure S1. Study cohort composition.**

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**Supplementary Table S1. ICD9/10 diagnostic codes and medications used to ascertain postpartum depression diagnosis.**

<b>ICD-9-CM Code</b>	<b>ICD-10-CM Code</b>	<b>Medications</b>
300.4	F32.9	Bupropion
309.0	F33.0	Celexa
311	F33.2	Citalopram
	F33.3	Cymbalta
	F33.41	Desvenlafaxine
	F33.9	Duloxetine
	F34.1	Effexor
	F43.21	Escitalopram
	F53.0	Fluoxetine
		Lexapro
		Paroxetine
		Paxil
		Pristiq
		Prozac
		Sertraline
		Venlafaxine
		Wellbutrin
		Zoloft

**Supplementary Table S2. Summary statistics of green space indicators and physical activity levels.**

<b>Exposures</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>25th</b>	<b>50th</b>	<b>75th</b>	<b>Max</b>	<b>N</b>
<b>Individual green space exposure</b>								
<b>Street view green space 200m, %</b>								
Total green space	25.28	5.04	12.79	21.71	24.19	27.70	64.41	415020
Tree	15.62	5.13	2.44	12.03	14.77	18.37	47.33	415020
Low-lying vegetation	4.36	1.63	0.35	3.22	4.08	5.18	22.11	415020
Grass	5.30	1.79	0.10	4.03	5.08	6.32	23.09	415020
<b>Street view green space 500m, %</b>								
Total green space	25.15	3.97	16.46	22.41	24.34	27.04	64.63	415020
Tree	15.32	4.12	3.88	12.60	14.73	17.54	42.05	415020
Low-lying vegetation	4.53	1.41	1.10	3.55	4.29	5.22	17.80	415020
Grass	5.30	1.43	0.92	4.34	5.13	6.05	19.47	415020
<b>Street view green space 1000m, %</b>								
Total green space	25.21	3.50	0.00	22.81	24.51	26.89	56.10	415020
Tree	15.23	3.67	0.00	12.93	14.69	17.22	39.85	415020
Low-lying vegetation	4.65	1.29	0.00	3.76	4.41	5.31	16.23	415020
Grass	5.33	1.28	0.00	4.51	5.19	5.92	18.78	415020
<b>Green space indicators</b>								
Mean annual NDVI 200m, (0-1)	0.27	0.06	0.03	0.23	0.27	0.31	0.64	415020
Mean annual NDVI 500m (0-1)	0.27	0.06	0.03	0.24	0.27	0.31	0.64	415020
Mean annual NDVI 1000m (0-1)	0.27	0.06	0.03	0.24	0.27	0.31	0.64	415020
Land-cover green space 200m, %	8.41	16.00	0.00	0.00	1.12	9.22	99.93	415020
Land-cover green space 500m, %	12.24	17.47	0.00	1.07	4.75	15.99	99.97	415020
Land-cover green space 1000m, %	15.29	18.84	0.00	2.29	6.99	21.78	99.99	415020
Tree canopy cover 200m, %	2.03	2.61	0.00	0.33	1.15	2.68	39.17	415020
Tree canopy cover 500m, %	2.00	2.27	0.00	0.50	1.28	2.64	35.66	415020
Tree canopy cover 1000m, %	2.02	2.11	0.00	0.62	1.37	2.69	35.46	415020
Distance to the nearest park, km	0.52	0.45	0.00	0.22	0.42	0.69	0.86	415020
<b>Zip code level green space exposure used in within-between random effects models</b>								
<b>Street view green space 200m, %</b>								
Total green space	26.31	3.97	18.56	23.42	25.78	28.51	45.36	584
Tree	16.57	4.02	7.43	13.71	16.05	19.12	31.41	584
Low-lying vegetation	4.67	1.19	1.96	3.83	4.45	5.30	10.90	584
Grass	5.06	1.23	1.52	4.18	4.97	5.74	10.33	584
<b>Street view green space 500m, %</b>								
Total green space	26.23	3.90	19.25	23.34	25.65	28.43	44.65	584
Tree	16.31	3.95	7.51	13.59	15.79	18.52	34.29	584
Low-lying vegetation	4.83	1.16	2.63	3.94	4.63	5.50	9.86	584
Grass	5.09	1.20	2.17	4.27	4.96	5.69	10.27	584
<b>Street view green space 1000m, %</b>								
Total green space	26.23	3.89	14.12	23.45	25.59	28.47	49.57	584
Tree	16.17	3.88	7.82	13.53	15.56	18.31	34.79	584
Low-lying vegetation	4.95	1.18	2.32	4.05	4.73	5.60	10.39	584
Grass	5.11	1.20	2.34	4.33	4.96	5.71	9.96	584
<b>Green space indicators</b>								
Mean annual NDVI 200m, (0-1)	0.27	0.06	0.04	0.25	0.27	0.30	0.73	584
Mean annual NDVI 500m (0-1)	0.27	0.06	0.04	0.25	0.27	0.29	0.74	584

Mean annual NDVI 1000m (0-1)	0.27	0.06	0.04	0.25	0.27	0.29	0.78	584
Land-cover green space 200m, %	10.33	14.04	0.00	1.71	5.21	12.63	99.93	584
Land-cover green space 500m, %	14.12	16.07	0.00	3.17	8.35	18.60	99.97	584
Land-cover green space 1000m, %	17.31	17.95	0.02	4.09	11.22	24.78	99.99	584
Tree canopy cover 200m, %	2.56	2.45	0.00	0.93	1.83	3.66	19.31	584
Tree canopy cover 500m, %	2.57	2.43	0.00	0.95	1.85	3.52	18.08	584
Tree canopy cover 1000m, %	2.62	2.46	0.00	0.98	1.96	3.58	18.05	584
Distance to the nearest park, km	0.50	0.40	0.00	0.33	0.43	0.57	7.55	584
<b>Annual NDVI levels in the study region over years</b>								
2008	0.29	0.12	0.00	0.24	0.31	0.33	0.76	-
2009	0.29	0.12	0.00	0.24	0.30	0.32	0.78	-
2010	0.30	0.12	0.00	0.25	0.32	0.34	0.79	-
2011	0.30	0.12	0.00	0.26	0.32	0.34	0.79	-
2012	0.28	0.12	0.00	0.23	0.30	0.32	0.77	-
2013	0.28	0.12	0.00	0.23	0.29	0.31	0.79	-
2014	0.27	0.12	0.00	0.22	0.28	0.30	0.78	-
2015	0.28	0.12	0.00	0.24	0.30	0.31	0.75	-
2016	0.27	0.12	0.00	0.23	0.29	0.31	0.75	-
2017	0.29	0.12	0.00	0.24	0.31	0.33	0.78	-
2018	0.27	0.12	0.00	0.23	0.29	0.30	0.78	-
Physical activity during pregnancy	79.02	80.36	0.00	22.50	60.00	110.80	1050.0	337205

SD, standard deviation; NDVI, normalized difference vegetation index.

**Supplementary Table S3. Associations between residential green space and maternal postpartum depression among urban population.**

Postpartum Depression Exposures	Model A		Model B		Model C		Model D		Model E	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	Between effect	Within effect
<b>Street view green space 200m, %</b>										
Total green space	<b>0.99 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.99 (0.97, 0.99)</b>	<b>0.99 (0.97, 0.99)</b>	<b>0.96 (0.93, 0.99)</b>	0.99 (0.98, 1.01)		
Tree	0.99 (0.97, 1.00)	<b>0.98 (0.97, 0.99)</b>	0.98 (0.97, 1.00)	0.99 (0.98, 1.00)	0.99 (0.98, 1.00)	0.99 (0.98, 1.00)	<b>0.95 (0.92, 0.97)</b>	1.00 (0.99, 1.01)		
Low-lying vegetation	<b>0.98 (0.97, 0.99)</b>	0.99 (0.97, 1.00)	<b>0.98 (0.97, 0.99)</b>	<b>0.99 (0.97, 0.99)</b>	<b>0.99 (0.97, 0.99)</b>	<b>0.99 (0.97, 0.99)</b>	1.01 (0.99, 1.04)	<b>0.96 (0.97, 0.99)</b>		
Grass	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	<b>1.05 (1.02, 1.07)</b>	0.99 (0.98, 1.00)		
<b>Street view green space 500m, %</b>										
Total green space	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.96 (0.93, 0.99)</b>	0.99 (0.98, 1.00)		
Tree	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.95 (0.92, 0.97)</b>	1.00 (0.98, 1.01)		
Low-lying vegetation	0.99 (0.97, 1.00)	0.99 (0.98, 1.00)	0.99 (0.97, 1.00)	0.99 (0.97, 1.00)	0.99 (0.97, 1.00)	0.99 (0.97, 1.00)	1.01 (0.99, 1.04)	<b>0.99 (0.98, 0.99)</b>		
Grass	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	<b>1.05 (1.02, 1.07)</b>	0.99 (0.98, 1.00)		
<b>Street view green space 1000m, %</b>										
Total green space	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.96 (0.93, 0.99)</b>	0.99 (0.99, 1.01)		
Tree	<b>0.98 (0.96, 0.99)</b>	<b>0.97 (0.96, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.95 (0.92, 0.97)</b>	1.00 (0.99, 1.01)		
Low-lying vegetation	0.99 (0.97, 1.01)	0.99 (0.98, 1.01)	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)	1.01 (0.99, 1.04)	<b>0.99 (0.98, 0.99)</b>		
Grass	<b>1.02 (1.01, 1.03)</b>	<b>1.02 (1.01, 1.03)</b>	1.02 (1.00, 1.03)	1.02 (1.00, 1.03)	1.02 (1.00, 1.03)	1.02 (1.00, 1.03)	<b>1.05 (1.03, 1.07)</b>	1.00 (0.99, 1.01)		
<b>Green space indicators</b>										
NDVI 200m, (0-1)	1.01 (0.99, 1.02)	1.01 (0.99, 1.03)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	<b>1.09 (1.07, 1.12)</b>	<b>0.99 (0.98, 0.99)</b>		
NDVI 500m, (0-1)	1.02 (1.00, 1.04)	<b>1.02 (1.01, 1.04)</b>	<b>1.02 (1.01, 1.04)</b>	<b>1.02 (1.01, 1.04)</b>	<b>1.02 (1.01, 1.04)</b>	<b>1.02 (1.01, 1.04)</b>	<b>1.09 (1.06, 1.12)</b>	0.99 (0.98, 1.00)		
NDVI 1000m, (0-1)	1.01 (0.99, 1.02)	1.01 (0.99, 1.03)	1.01 (0.99, 1.026)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	<b>1.09 (1.07, 1.12)</b>	0.99 (0.98, 1.00)		
Land-cover green space 200m, %	1.00 (0.99, 1.01)	0.99 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	<b>1.04 (1.02, 1.06)</b>	1.00 (0.99, 1.00)		
Land-cover green space 500m, %	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	<b>1.06 (1.04, 1.08)</b>	0.99 (0.99, 1.00)		
Land-cover green space 1000m, %	1.01 (1.00, 1.02)	1.01 (0.99, 1.03)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	<b>1.07 (1.04, 1.09)</b>	0.99 (0.99, 1.00)		
Tree canopy cover 200m, %	<b>0.99 (0.98, 0.99)</b>	<b>0.99 (0.98, 0.99)</b>	<b>0.99 (0.98, 0.99)</b>	<b>0.99 (0.98, 0.99)</b>	<b>0.99 (0.98, 0.99)</b>	<b>0.99 (0.98, 0.99)</b>	<b>0.97 (0.95, 0.99)</b>	1.00 (0.99, 1.00)		
Tree canopy cover 500m, %	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.96 (0.94, 0.99)</b>	0.99 (0.99, 1.00)		
Tree canopy cover 1000m, %	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.96, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.98 (0.97, 0.99)</b>	<b>0.96 (0.94, 0.98)</b>	0.99 (0.99, 1.00)		
Park<500m, yes vs. no	1.00 (0.99, 1.01)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.99, 1.00)	1.00 (0.99, 1.02)		
Physical activity during pregnancy	<b>0.93 (0.91, 0.94)</b>	<b>0.92 (0.90, 0.93)</b>	<b>0.92 (0.90, 0.93)</b>	<b>0.92 (0.90, 0.93)</b>	<b>0.92 (0.90, 0.93)</b>	<b>0.92 (0.91, 0.94)</b>	-	<b>0.93 (0.92, 0.94)</b>		

NDVI, normalized difference vegetation index. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for per interquartile range (IQR) increment for green space indicators.

Model A: Models adjusted for maternal age, race/ethnicity, educational level, and block group household income. Zip code was fitted as a random effect.

Model B: Model A + further adjusted for smoking during pregnancy, season of conception, year of infant birth, insurance type, preterm birth, and pregnancy-related comorbidities (preeclampsia, gestational hypertension and gestational diabetes).

Model C: (n=398,616) Models A + excluding infants conceived > 19 weeks before 1 January 2008 or < 43 weeks before 31 December 2018.

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Model D: Models A + multiple delivery as a random effect.

Model E (within-between random effects models):  $y_{ir} = \beta_0 + \beta_{1W}(x_{ir} - \bar{x}_r) + \beta_{2B}\bar{x}_r + \beta_3 z_i + (v_r + \epsilon_{ir})$ .

Here, for individual  $i$  and region  $r$ ,  $\beta_{1W}$  represents the within region effect, while  $\beta_{2B}$  represents the between effect. The within effects reflect remaining individual-level effects after accounting for the between effects (i.e., individual observations clustered by zip code), while between effects reflect neighborhood-level effects (i.e., zip code in this study) with keeping the deviation constant. Confounder adjustments are denoted using simplified notation  $\beta_3 z_i$ ,  $v_r$  are the zip code random effects, the  $\epsilon_{ir}$  are the model's residuals for individuals.

Significant results were bolded.



**Supplementary Table S4. Adjusted odds ratios (ORs) and 95% confidence intervals (CI) of postpartum depression associated with street view based total green space (500 m) among population subgroups.**

Description	ORs per IQR green space indicators	95% CI		p value for Cochrane's Q test
<b>Maternal age</b>				
< 25	1.03	1.00	1.07	<0.0001
25-34	0.98	0.97	1.00	
≥ 35	0.95	0.92	0.97	
<b>Maternal race/ethnicity</b>				
African American	1.03	0.97	1.08	0.001
Asian	0.95	0.91	0.99	
Hispanic	1.00	0.98	1.03	
Non-Hispanic white	0.95	0.93	0.97	
Multiple/other	0.99	0.92	1.05	
<b>Household income</b>				
Low (Q1-Q2)	1.00	0.98	1.02	0.021
High (Q3-Q4)	0.96	0.95	0.98	
<b>Maternal education</b>				
< College	1.01	0.99	1.04	0.003
≥ College	0.97	0.95	0.98	

ORs and 95% CIs were calculated for per interquartile range (IQR) increment for green space indicators. Models adjusted for maternal age, race/ethnicity, educational level, and block group household income. Zip code was fitted as a random effect.

**Supplementary Table S5. Percent change and 95% confidence intervals of associations between green space and physical activity during the entire pregnancy.**

<b>Green space exposures</b>	<b>Percent change, 95%CI</b>	
<b>Street view green space 200m, 10%</b>		
Total green space	0.49	(-0.35, 1.32)
Tree	0.75	(-0.12, 1.61)
Low-lying vegetation	1.79	(-0.80, 4.38)
Grass	<b>-3.22</b>	<b>(-5.58, -0.87)</b>
<b>Street view green space 500m, 10%</b>		
Total green space	<b>1.92</b>	<b>(0.72, 3.13)</b>
Tree	<b>2.70</b>	<b>(1.46, 3.95)</b>
Low-lying vegetation	1.86	(-1.49, 5.21)
Grass	<b>-7.04</b>	<b>(-10.50, -3.57)</b>
<b>Street view green space 1000m, 10%</b>		
Total green space	<b>1.97</b>	<b>(0.42, 3.51)</b>
Tree	<b>3.65</b>	<b>(2.02, 5.28)</b>
Low-lying vegetation	2.14	(-1.97, 6.25)
Grass	<b>-13.73</b>	<b>(-18.18, -9.29)</b>
<b>Green space indicators</b>		
NDVI 200m, 0.1	<b>1.29</b>	<b>(0.12, 2.46)</b>
NDVI 500m, 0.1	1.32	(-0.01, 2.65)
NDVI 1000m, 0.1	<b>1.34</b>	<b>(0.14, 2.54)</b>
Land-cover greenness 200m, 10%	0.12	(-0.14, -0.38)
Land-cover greenness 500m, 10%	-0.01	(-0.03, 0.02)
Land-cover greenness 1000m, 10%	-0.01	(-0.03, 0.02)
Tree canopy cover 200m, 10%	<b>3.80</b>	<b>(2.09, 5.52)</b>
Tree canopy cover 500m, 10%	<b>5.55</b>	<b>(3.31, 7.79)</b>
Tree canopy cover 1000m, 10%	<b>6.55</b>	<b>(3.82, 9.28)</b>
Proximity to the nearest park, 0.1km	<b>0.13</b>	<b>(0.04, 0.22)</b>

NDVI, normalized difference vegetation index. All models adjusted for maternal age, race/ethnicity, educational level, and block group household income. Zip code was fitted as a random effect. Significant results were bolded.