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Supplemental Material

Exposure to Neighborhood Greenness and Hypertension Incidence in Adults: A Longitudinal Cohort Study in Taiwan

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Table S1. Association between long-term exposure to neighborhood greenness and incident hypertension adjusted for potential mediators in Taiwanese adults (n=442,435)

	Model 3 + BMI		Model 3 + PM _{2.5}		Model 3 + PE		-	
	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	-	
2 nd quartile	0.96 (0.92, 1.01)	0.11	0.95 (0.91, 1.00)	0.04	0.95 (0.91, 1.00)	0.04	-	
3 rd quartile	0.95 (0.91, 1.00)	0.03	0.95 (0.91, 1.00)	0.03	0.95 (0.90, 0.99)	0.03	-	
4 th quartile	0.93 (0.89, 0.98)	0.003	0.94 (0.89, 0.98)	0.007	0.93 (0.88, 0.97)	0.001	-	
Trend test	0.98 (0.96, 0.99)	0.003	0.98 (0.97, 1.00)	0.009	0.98 (0.96, 0.99)	0.002	-	
Per-0.1 increase in NDVI ₅₀₀	0.77 (0.67, 0.89)	<0.001	0.79 (0.68, 0.91)	0.001	0.76 (0.66, 0.87)	<0.001	-	
	Model 3 + BMI + PM _{2.5}		Model 3 + BMI + PE		Model 3 + PM _{2.5} + PE		Model 3 + BMI + PE + PM _{2.5}	
	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>
2 nd quartile	0.96 (0.92, 1.01)	0.12	0.96 (0.92, 1.01)	0.11	0.95 (0.91, 1.00)	0.05	0.96 (0.92, 1.01)	0.12
3 rd quartile	0.96 (0.91, 1.00)	0.04	0.95 (0.91, 1.00)	0.03	0.95 (0.91, 1.00)	0.03	0.96 (0.91, 1.00)	0.04
4 th quartile	0.94 (0.89, 0.98)	0.01	0.93 (0.89, 0.98)	0.003	0.94 (0.89, 0.98)	0.007	0.94 (0.89, 0.98)	0.01
Trend test	0.98 (0.97, 1.00)	0.009	0.98 (0.96, 0.99)	0.003	0.98 (0.97, 1.00)	0.01	0.98 (0.97, 1.00)	0.01
Per-0.1 increase in NDVI ₅₀₀	0.79 (0.68, 0.91)	0.001	0.77 (0.67, 0.89)	<0.001	0.79 (0.68, 0.91)	0.001	0.79 (0.68, 0.91)	0.001

Abbreviations: BMI, body mass index; PE, physical exercise (leisure-time); HR, hazard ratio; CI, confidence interval.

NDVI₅₀₀ was the 2-year average value of the normalized difference vegetation index (NDVI) within a 500-m buffer and the quartile cut-offs were 0.23, 0.28, and 0.38.

Time-varying Cox regression model was used. All models were adjusted for age, sex, marital status, education status, smoking status, alcohol consumption, fruit intake, vegetable intake, occupational exposure, physical labor during work, season, year of enrolment, diabetes, dyslipidemia, self-reported cardiovascular disease, and self-reported cancer. Data are complete for all variables. *p* <0.05 was considered statistically significant.

Table S2. Sensitivity analyses (1-6) of the association between long-term exposure to neighborhood greenness and incident hypertension in Taiwanese adults

	Sensitivity analysis 1		Sensitivity analysis 2		Sensitivity analysis 3		Sensitivity analysis 4		Sensitivity analysis 5		Sensitivity analysis 6	
	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>
2 nd quartile	0.94 (0.90, 0.99)	0.01	0.93 (0.89, 0.98)	0.006	0.95 (0.90, 1.00)	0.03	0.97 (0.93, 1.02)	0.31	0.96 (0.92, 1.01)	0.10	0.93 (0.88, 0.99)	0.01
3 rd quartile	0.96 (0.92, 1.01)	0.09	0.89 (0.84, 0.93)	<0.001	0.95 (0.91, 1.00)	0.04	0.97 (0.92, 1.02)	0.26	0.95 (0.91, 1.00)	0.05	0.94 (0.89, 0.99)	0.02
4 th quartile	0.94 (0.90, 0.98)	0.006	0.89 (0.85, 0.94)	<0.001	0.92 (0.88, 0.97)	<0.001	0.96 (0.91, 1.00)	0.07	0.93 (0.89, 0.97)	0.002	0.93 (0.88, 0.98)	0.009
Trend test	0.98 (0.97, 1.00)	0.02	0.96 (0.95, 0.98)	<0.001	0.98 (0.96, 0.99)	0.002	0.99 (0.97, 1.00)	0.08	0.98 (0.96, 0.99)	0.002	0.98 (0.96, 1.00)	0.02
Per-0.1 increase in NDVI ₅₀₀	0.80 (0.70, 0.92)	0.001	0.69 (0.59, 0.79)	<0.001	0.76 (0.66, 0.89)	<0.001	0.85 (0.74, 0.99)	0.03	0.77 (0.67, 0.89)	<0.001	0.79 (0.67, 0.92)	0.003

Abbreviations: HR, hazard ratio; CI, confidence interval.

NDVI₅₀₀ was the 2-year average value of the normalized difference vegetation index (NDVI) within a 500-m buffer except specify.

Sensitivity analysis 1: using the average NDVI value within a 250-m buffer (132,070 participants with 466,660 observations).

Sensitivity analysis 2: using the average NDVI value within a 1000-m buffer (107,912 participants with 378,905 observations).

Sensitivity analysis 3: using the seasonal rather than annual NDVI (125,537 participants with 442,435 observations). The seasonal average of NDVI was calculated by aggregating the 16-day interval NDVI estimates within the season when participants visit the clinical center for medical examinations.

Sensitivity analysis 4: excluding participants who changed address during follow-up (107,412 participants with 343,010 observations).

Sensitivity analysis 5: using the annual NDVI value of the year prior to the year of medical examination to examine the stability of the associations (125,537 participants with 442,435 observations).

Sensitivity analysis 6: excluding the participants with a follow up of less than 2 years (99,340 participants with 388,742 observations).

Time-varying Cox regression model was used. All models were adjusted for age, sex, marital status, education status, smoking status, alcohol consumption, fruit intake, vegetable intake, occupational exposure, physical labor during work, season, year of enrolment, diabetes, dyslipidemia, and self-reported physician-diagnosed cardiovascular disease and cancer. Data are complete for all variables. *p* <0.05 was considered statistically significant.

Table S3. Sensitivity analyses (7-12) of the association between long-term exposure to neighborhood greenness and incident hypertension in Taiwanese adults

	Sensitivity analysis 7		Sensitivity analysis 8		Sensitivity analysis 9		Sensitivity analysis 10		Sensitivity analysis 11		Sensitivity analysis 12	
	HR (95%CI)	<i>p</i>	HR (95 %CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>	HR (95%CI)	<i>p</i>
2 nd quartile	0.98 (0.94, 1.01)	0.22	0.95 (0.89, 1.01)	0.10	0.96 (0.92, 1.01)	0.13	0.95 (0.90, 0.99)	0.02	0.96 (0.91, 1.00)	0.07	0.96 (0.91, 1.00)	0.05
3 rd quartile	0.99 (0.95, 1.02)	0.43	0.96 (0.90, 1.02)	0.16	0.96 (0.91, 1.00)	0.07	0.93 (0.89, 0.98)	0.005	0.94 (0.89, 0.98)	0.005	0.93 (0.89, 0.98)	0.003
4 th quartile	0.97 (0.94, 1.00)	0.09	0.94 (0.88, 1.00)	0.04	0.92 (0.87, 0.96)	<0.001	0.91 (0.87, 0.95)	<0.001	0.92 (0.88, 0.96)	<0.001	0.92 (0.88, 0.96)	<0.001
Trend test	0.99 (0.98, 1.00)	0.14	0.98 (0.96, 1.00)	0.06	0.97 (0.96, 0.99)	0.001	0.97 (0.96, 0.99)	<0.001	0.97 (0.96, 0.99)	<0.001	0.97 (0.96, 0.99)	<0.001
Per-0.1 increase in NDVI ₅₀₀	0.86 (0.78, 0.96)	0.006	0.76 (0.63, 0.91)	0.003	0.71 (0.61, 0.83)	<0.001	0.72 (0.63, 0.83)	<0.001	0.73 (0.63, 0.84)	<0.001	0.74 (0.65, 0.85)	<0.001

Abbreviations: HR, hazard ratio; CI, confidence interval.

NDVI₅₀₀ was the 2-year average value of the normalized difference vegetation index (NDVI) within a 500-m buffer except specify.

Sensitivity analysis 7: using the new definition of hypertension of the American College of Cardiology and American Heart Association (i.e., SBP \geq 130 mmHg or DBP \geq 80 mmHg) (102,692 participants with 338,409 observations).

Sensitivity analysis 8: excluding participants who had diabetes, dyslipidemia, cardiovascular diseases, and/or cancer at baseline (94,762 participants with 335,747 observations).

Sensitivity analysis 9: further including a city-level random intercept in the model 3 to adjust for the cluster effect (125,537 participants with 442,435 observations).

Sensitivity analysis 10: further adjusting for area-level family income in the model 3 (125,537 participants with 442,435 observations).

Sensitivity analysis 11: using inverse probability weight to account for the selection bias. (125,537 participants with 442,435 observations).

Sensitivity analysis 12: truncating negative NDVI values to 0 rather than restricting our data to NDVI values greater than 0 (134,820 participants with 477,135 observations).

Time-varying Cox regression model was used. All models were adjusted for age, sex, marital status, education status, smoking status, alcohol consumption, fruit intake, vegetable intake, occupational exposure, physical labor during work, season, year of enrolment, diabetes, dyslipidemia, and self-reported physician-diagnosed cardiovascular disease and cancer. Data are complete for all variables. *p* <0.05 was considered statistically significant.

Table S4. Summary of temporal distribution of 2-year average Normalized Difference Vegetation Index (NDVI) values within a 500-m buffer for baseline visits from 125,537 participants in Taiwan

Year	N	NDVI within a 500-m buffer				
		Median	Min.	Max.	1 st Quartile (Q1)	3 rd Quartile (Q3)
2001	27080	0.30	0.16	0.88	0.23	0.40
2002	17373	0.29	0.16	0.83	0.23	0.38
2003	11145	0.29	0.15	0.82	0.23	0.38
2004	11325	0.27	0.16	0.85	0.22	0.36
2005	9842	0.27	0.15	0.81	0.22	0.36
2006	9357	0.28	0.16	0.82	0.22	0.36
2007	8648	0.28	0.14	0.84	0.23	0.36
2008	7398	0.28	0.14	0.80	0.23	0.37
2009	5320	0.26	0.14	0.81	0.22	0.34
2010	6118	0.28	0.14	0.83	0.22	0.37
2011	5191	0.28	0.14	0.83	0.23	0.36
2012	3690	0.29	0.16	0.82	0.23	0.39
2013	1656	0.30	0.16	0.85	0.24	0.40
2014	688	0.31	0.16	0.80	0.25	0.40
2015	701	0.29	0.16	0.76	0.24	0.37
2016	5	0.29	0.24	0.41	0.25	0.31

The data were used for Figure S1 Panel A.

Table S5. Summary of temporal distribution of 2-year average Normalized Difference Vegetation Index (NDVI) values within a 500-m buffer for 442,435 medical visits from 125,537 participants in Taiwan

Year	N	NDVI within a 500-m buffer				
		Median	Min.	Max.	1 st Quartile (Q1)	3 rd Quartile (Q3)
2001	27311	0.30	0.16	0.88	0.23	0.40
2002	29740	0.29	0.16	0.88	0.22	0.38
2003	29720	0.29	0.15	0.86	0.23	0.38
2004	35153	0.28	0.15	0.85	0.22	0.37
2005	34308	0.27	0.15	0.86	0.22	0.36
2006	36614	0.28	0.15	0.86	0.22	0.36
2007	36381	0.28	0.14	0.86	0.23	0.37
2008	37614	0.28	0.14	0.86	0.23	0.37
2009	31109	0.27	0.14	0.84	0.22	0.36
2010	31341	0.28	0.14	0.83	0.22	0.37
2011	30308	0.28	0.14	0.83	0.23	0.37
2012	31924	0.28	0.15	0.85	0.23	0.38
2013	24692	0.29	0.15	0.87	0.24	0.39
2014	8828	0.31	0.16	0.85	0.25	0.40
2015	9945	0.30	0.16	0.85	0.24	0.39
2016	7447	0.31	0.16	0.83	0.25	0.40

The data were used for Figure S1 Panel B.

Table S6. Summary of the association of 2-year average Normalized Difference Vegetation Index (NDVI) values within a 500-m buffer with incident hypertension in Taiwanese adults

NDVI within a 500-m buffer	HR (95%CI)
0.16	1.12 (1.02, 1.22)
0.18	1.08 (1.02, 1.15)
0.20	1.05 (1.01, 1.10)
0.22	1.03 (1.01, 1.05)
0.24	1.01 (1.00, 1.02)
0.26	1.00 (1.00, 1.01)
0.28	1.00 (1.00, 1.00)
0.30	1.00 (0.99, 1.01)
0.32	1.00 (0.99, 1.02)
0.34	1.01 (0.99, 1.03)
0.36	1.01 (0.98, 1.04)
0.38	1.01 (0.98, 1.04)
0.40	1.01 (0.97, 1.05)
0.42	1.00 (0.96, 1.05)
0.44	1.00 (0.96, 1.04)
0.46	0.99 (0.95, 1.04)
0.48	0.99 (0.94, 1.03)
0.50	0.98 (0.93, 1.03)
0.52	0.97 (0.92, 1.02)
0.54	0.96 (0.91, 1.01)
0.56	0.95 (0.90, 1.00)
0.58	0.94 (0.89, 0.99)
0.60	0.92 (0.87, 0.98)
0.62	0.91 (0.85, 0.97)
0.64	0.90 (0.84, 0.96)
0.66	0.88 (0.82, 0.95)
0.68	0.87 (0.80, 0.95)
0.70	0.85 (0.77, 0.94)
0.72	0.84 (0.75, 0.93)
0.74	0.82 (0.73, 0.93)
0.76	0.81 (0.71, 0.92)
0.78	0.79 (0.69, 0.91)
0.80	0.78 (0.66, 0.91)
0.82	0.76 (0.64, 0.90)
0.84	0.75 (0.62, 0.90)
0.86	0.73 (0.60, 0.89)

Abbreviations: HR, hazard ratio; CI, confidence interval.

The data were used for Figure S2.

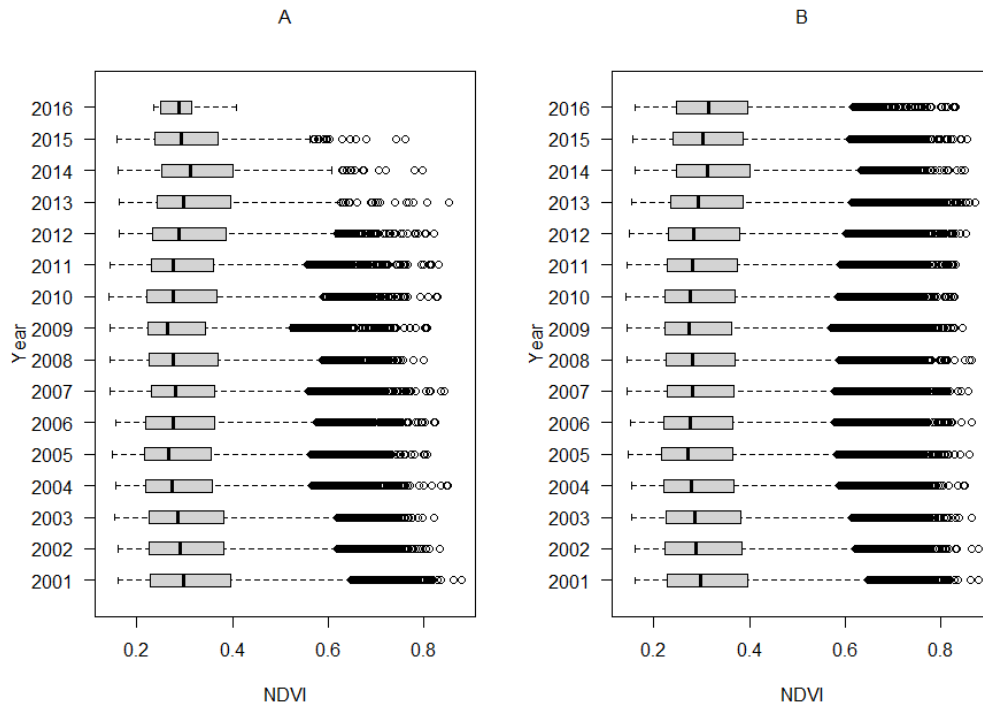


Figure S1. Temporal distribution of 2-year average Normalized Difference Vegetation Index (NDVI) values within a 500-m buffer in Taiwan.

Boxes cover the 25th–75th percentiles (interquartile ranges (IQRs)), with the center lines indicating the median concentration. Whiskers extend to the highest observations within three IQRs of the box, with more extreme observations shown as circles. Panel A illustrates the distribution of baseline NDVI values for the 125,537 participants; panel B shows the distribution of NDVI values during the 442,435 medical visits of the 125,537 participants. Summary data can be found in Table S4 & S5.

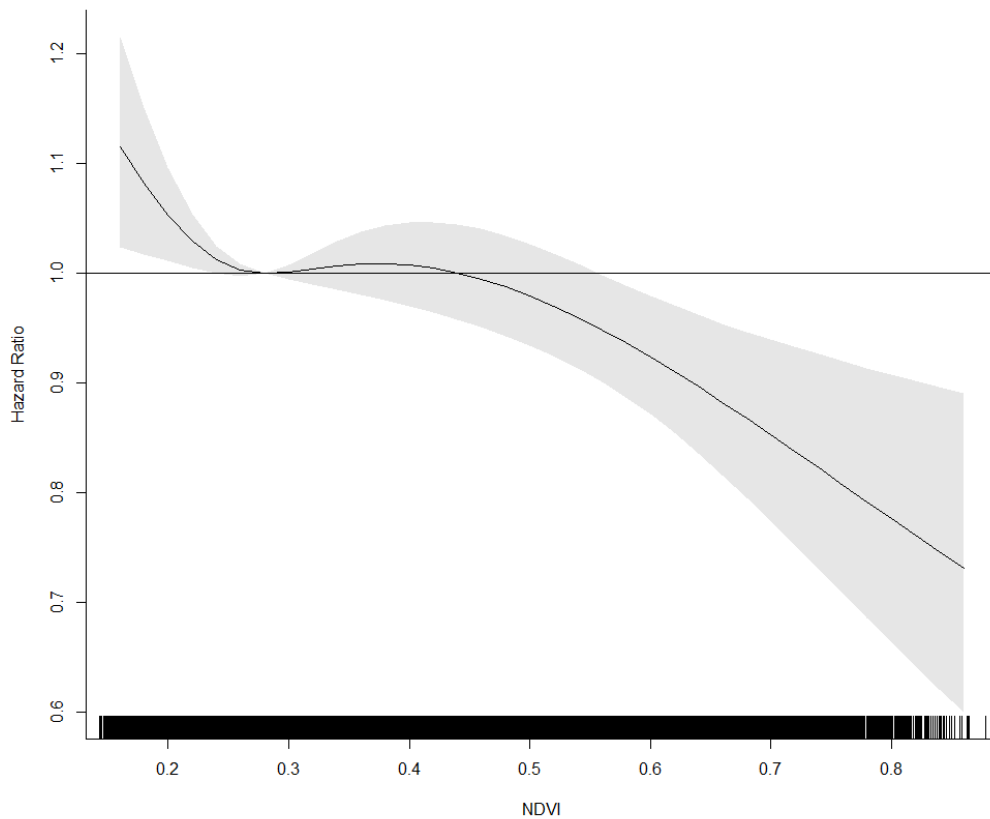


Figure S2. Concentration-response curves for the association of 2-year average Normalized Difference Vegetation Index (NDVI) values within a 500-m buffer with incident hypertension in Taiwanese adults.

Time-varying Cox regression model was used. The model was adjusted for age, sex, marital status, education status, smoking status, alcohol consumption, fruit intake, vegetable intake, occupational exposure, physical labor during work, season, year of enrolment, diabetes, dyslipidemia, and self-reported cardiovascular disease, and self-reported cancer.

The solid line indicates the estimated hazard ratio of incident hypertension, and the grey shaded area represents the 95% confidence interval. The rug plot on the *x*-axis represents individual NDVI values. Summary data can be found in Table S6.



Figure S3. Spearman correlation coefficients among greenness and covariates for 442,435 medical visits

Abbreviations: NDVI, normalized difference vegetation index; CVD, cardiovascular disease; PM_{2.5}, fine particulate matter of aerodynamic diameter <2.5µm; PE, physical exercise (leisure-time); BMI, body mass index

NDVI₅₀₀ was the 2-year average value of the normalized difference vegetation index (NDVI) within a 500-m buffer.