*Environ Health Perspect*

DOI: 10.1289/EHP12589

**Note to readers with disabilities:** *EHP* strives to ensure that all journal content is accessible to all readers. However, some figures and Supplemental Material published in *EHP* articles may not conform to 508 standards due to the complexity of the information being presented. If you need assistance accessing journal content, please contact ehp508@niehs.nih.gov. Our staff will work with you to assess and meet your accessibility needs within 3 working days.

## Supplemental Material

# Effect Modifications of Overhead-View and Eye-Level Urban Greenery on Heat–Mortality Associations: Small-Area Analyses Using Case Time Series Design and Different Greenery Measurements

Jinglu Song, Antonio Gasparrini, Thomas Fischer, Kejia Hu, and Yi Lu

## Table of Contents

**Table S1.** Descriptive statistics of size, population and socioeconomic variables in Hong Kong, 2005-2018.

**Figure S1.** A) Example of a four-image Google Street View panorama generated for a single point in Hong Kong, and B) the corresponding greenery extraction by a Python script using a deep learning technique of fully convolutional neural network.

**Figure S2.** Maps of three urban greenery measurements at the TPU level in Hong Kong: A) NDVI; B) percentage of greenspace; C) eye-level street greenery (%). The maps were created by using ArcGIS 10.5.1 (ESRI) and included data for 286 TPUs. Descriptive statistics of three urban greenery indicators are included in Table 1. Note: TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

**Figure S3.** Pearson's correlation coefficients between socio-economic variables and three urban greenery measurements.

**Figure S4.** The age-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high (95th percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults (age≥65 years, *N*=175,658) and young people (0-64 years, *N*= 46,230) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90*th* and 99*th* percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S4. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

**Figure S5.** The gender-specific overall cumulative exposure-response associations between summer temperatures and mortality predicted by an extended CTS model for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of females (*N*=99,509) and males (*N*=122,408) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S5. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

**Figure S6.** The cause-specific overall cumulative exposure-response associations between summer temperatures and mortality predicted by an extended CTS model for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by non-accidental diseases (*N*= 213,505) and cardiorespiratory diseases (*N*= 93,974) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S6. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

**Figure S7.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in older adults (age≥65 years), expressed by the ratio of RRs between TPUs with a low ($5^{th}$ percentile) and high ($95^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults from June to October within the study period 2005-2018 (*N*=175,658). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

**Figure S8.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in females, expressed by the ratio of RRs between TPUs with a low ($5^{th}$ percentile) and high ($95^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of female from June to October within the study period 2005-2018 (*N*=99,509). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

**Figure S9.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in non-accidental mortality, expressed by the ratio of RRs between TPUs with a low ($5^{th}$ percentile) and high ($95^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes non-accidental mortality data with TPU identifiers (3-digit TPU code) from June to October within the study period 2005-2018 (*N*= 213,505). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

**Figure S10.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in cardiorespiratory diseases, expressed by the ratio of RRs between TPUs with a low ($5^{th}$ percentile) and high ($95^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by cardiorespiratory diseases from June to October within the study period 2005-2018 (*N*= 93,974). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

**Figure S11.** The overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes all-cause mortality data with TPU identifiers (3-digit TPU code) from June to October within the study period 2005-2018 (*N*=221,919). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S7. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

**Figure S12.** The age-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults (age≥65 years, *N*=175,658) and young people (0-64 years, *N*= 46,230) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S8. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

**Figure S13.** The gender-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of females (*N*=99,509) and males (*N*=122,408) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S9. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; O3, ozone; PM10, particular matter with a diameter of 10 microns or less.

**Figure S14.** The cause-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and p-value for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by non-accidental diseases (*N*= 213,505) and cardiorespiratory diseases (*N*= 93,974) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S10. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

**References**

**Additional File-** Excel Document

**Table S1.** Descriptive statistics of size, population and socioeconomic variables in Hong Kong, 2005-2018.

| Variables | Mean | SD | Min | P25 | P50 | P75 | Max |
|---|---|---|---|---|---|---|---|
| Area ($km^2$) | 7.06 | 15.67 | 0.09 | 0.63 | 1.45 | 4.26 | 104.84 |
| Population (1,000 persons) | 51.44 | 47.57 | 11.76 | 18.68 | 40.65 | 60.43 | 299.78 |
| % older adults [1] | 14.57 | 3.81 | 6.15 | 11.46 | 14.57 | 17.38 | 24.05 |
| % low education [2] | 9.1 | 2.91 | 4.51 | 7.01 | 8.67 | 10.7 | 20.71 |
| % low income [3] | 3.16 | 0.89 | 0.95 | 2.64 | 3.09 | 3.45 | 8.3 |

[1] Percentage of people aged > 65 years

[2] percentage of people aged > 15 years with educational attainment only at primary school or below

[3] percentage of the working population with monthly income below the poverty line (i.e., HKD$2000 in 2006 and HKD$4000 in 2016 according to the poverty indicator in Hong Kong)[1]

***** Data for each variable were obtained from the 2006 and 2016 Hong Kong censuses.[2,3] The smallest census units with available data in the two rounds of censuses were large TPUs, in which adjacent TPUs with small population were merged into a large unit.

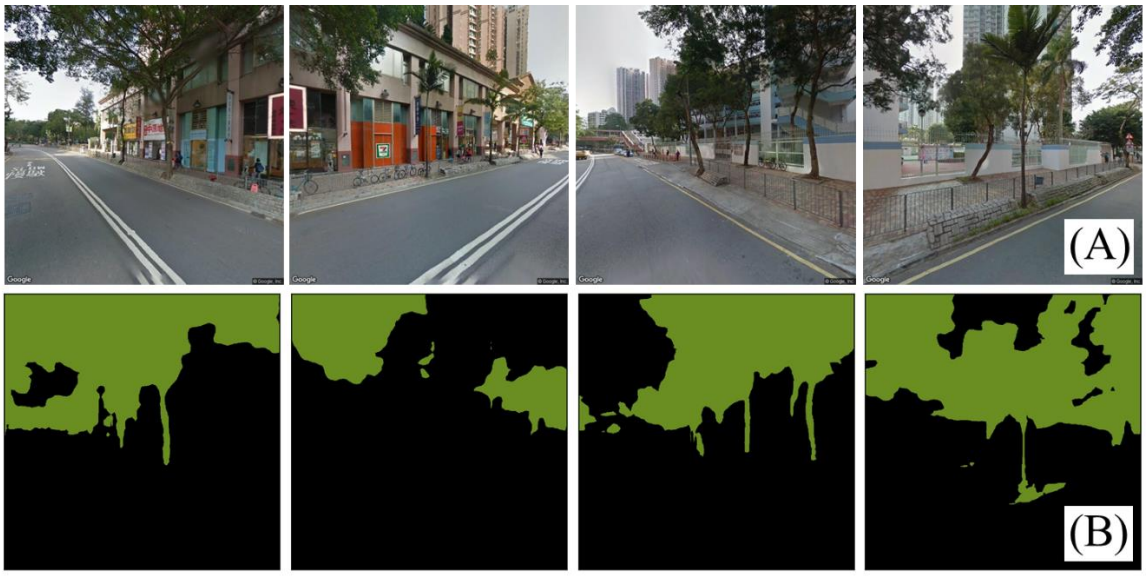


**Figure S1**. A) Example of a four-image Google Street View panorama generated for a single point in Hong Kong, and B) the corresponding greenery extraction by a Python script using a deep learning technique of fully convolutional neural network.

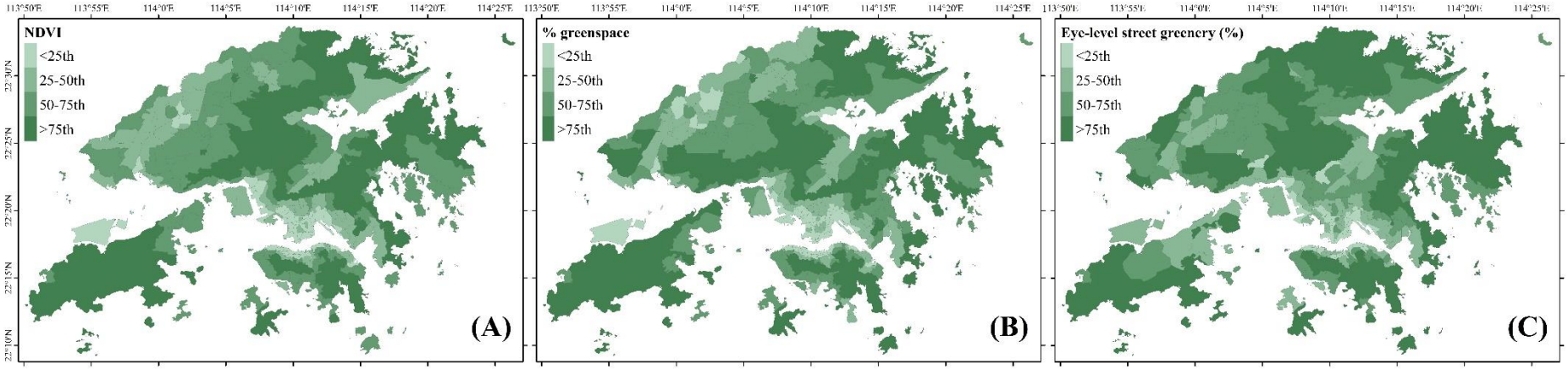


**Figure S2.** Maps of three urban greenery measurements at the TPU level in Hong Kong: A) NDVI; B) percentage of greenspace; C) eye-level street greenery (%). The maps were created by using ArcGIS 10.5.1 (ESRI) and included data for 286 TPUs. Descriptive statistics of three urban greenery indicators are included in Table 1. Note: TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

**Figure S3.** Pearson's correlation coefficients between socio-economic variables and three urban greenery measurements

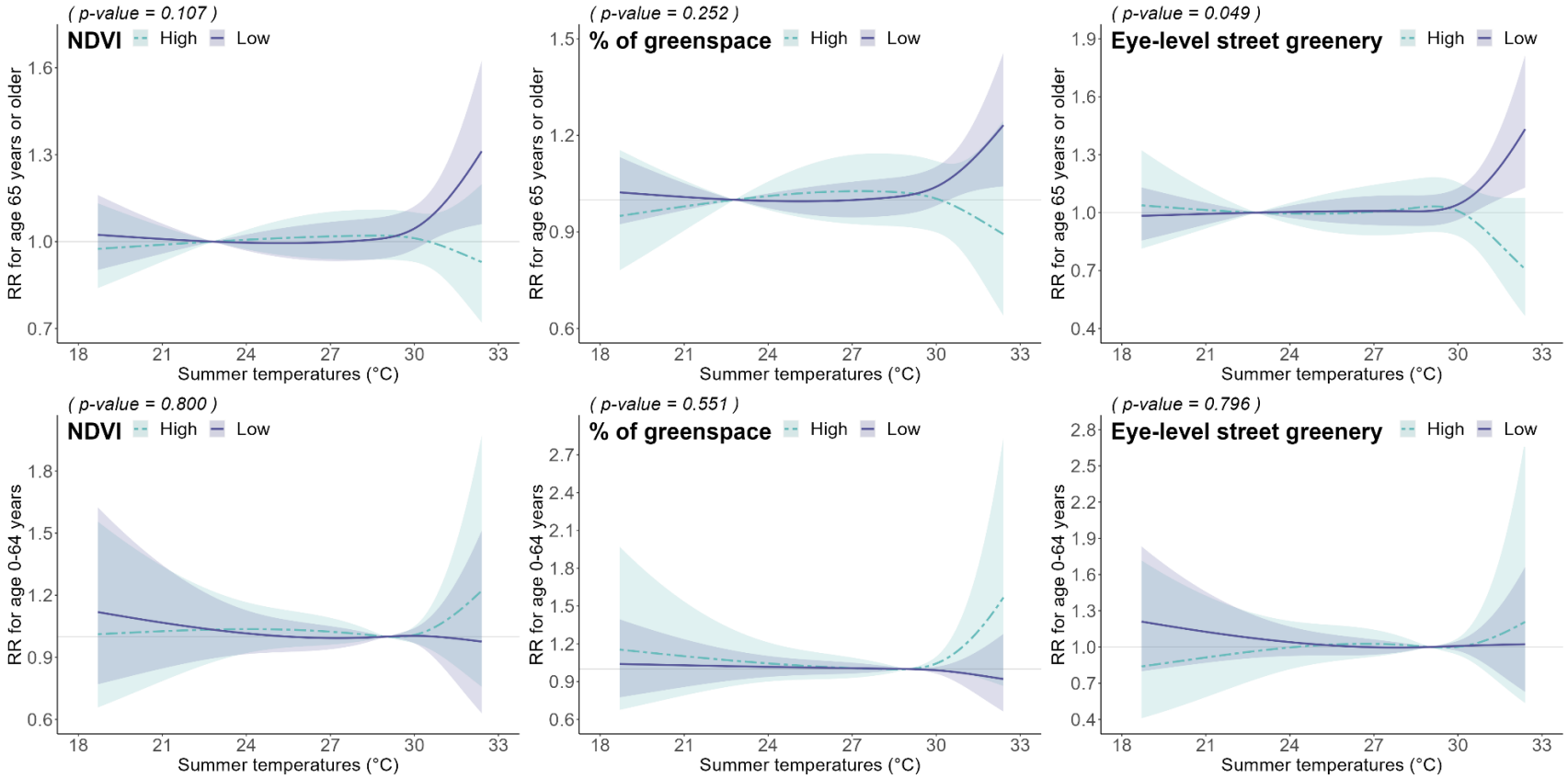


**Figure S4.** The age-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low (5th percentile, solid lines in light purple) and high (95th percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5th percentile) and high (95th percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults (age≥65 years, *N*=175,658) and young people (0-64 years, *N*= 46,230) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90th and 99th percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S4. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

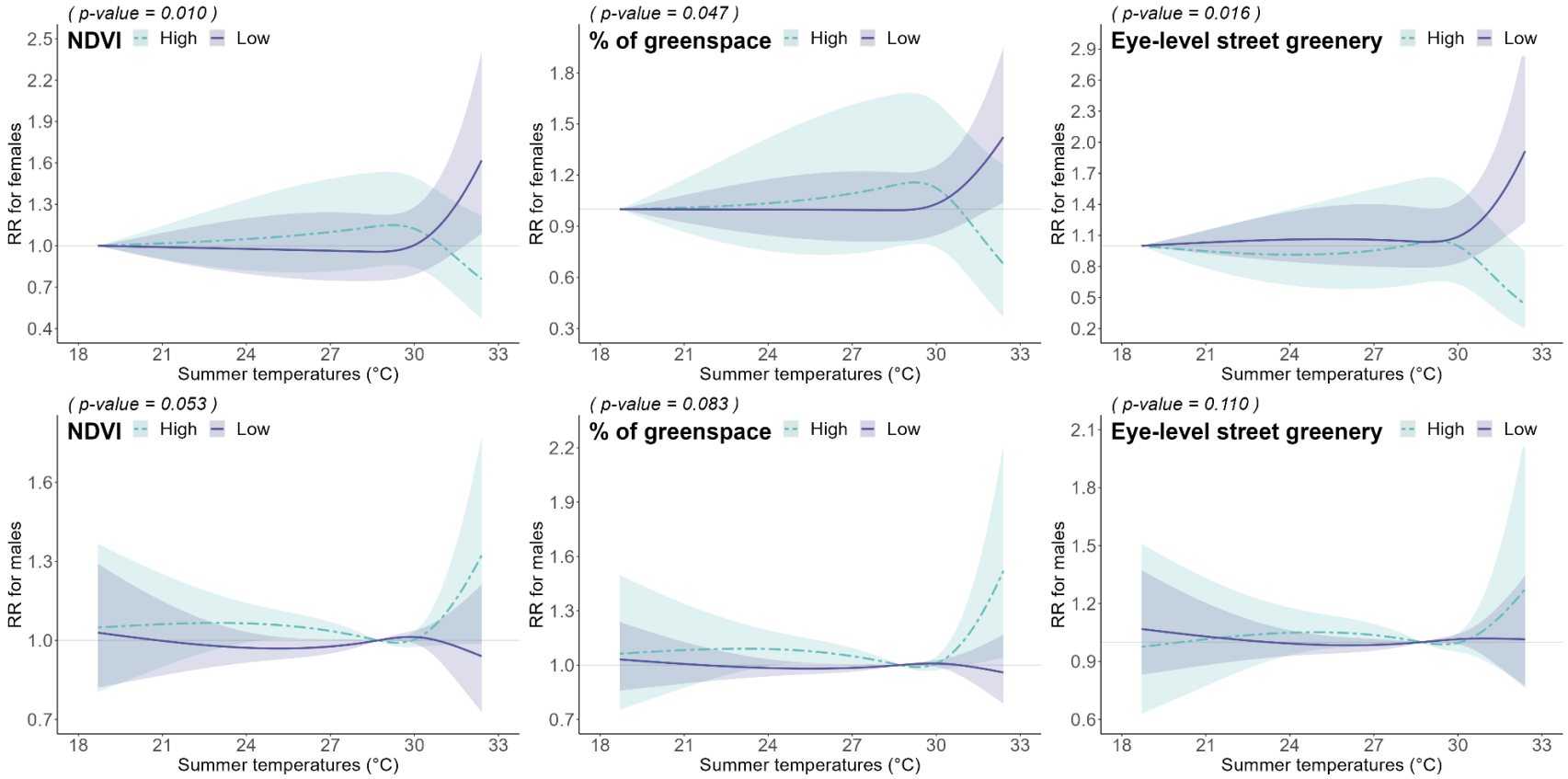


**Figure S5.** The gender-specific overall cumulative exposure-response associations between summer temperatures and mortality predicted by an extended CTS model for a TPU with a low (5$^{th}$ percentile, solid lines in light purple) and high (95$^{th}$ percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of females (*N*=99,509) and males (*N*=122,408) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90$^{th}$ and 99$^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S5. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

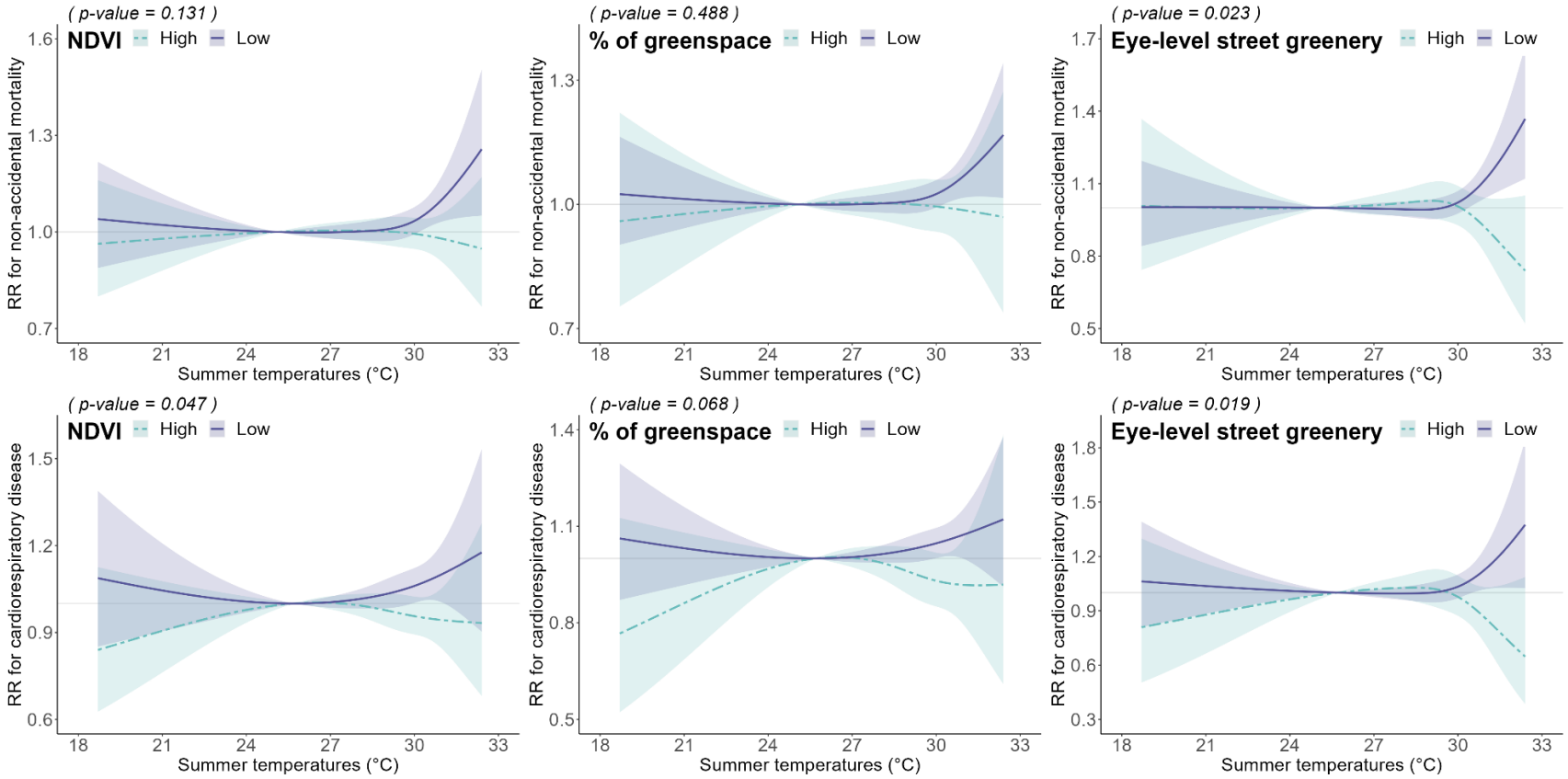


**Figure S6.** The cause-specific overall cumulative exposure-response associations between summer temperatures and mortality predicted by an extended CTS model for a TPU with a low (5th percentile, solid lines in light purple) and high (95th percentile, dashed lines in light green) value of NDVI, percent of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5th percentile) and high (95th percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by non-accidental diseases (*N*= 213,505) and cardiorespiratory diseases (*N*= 93,974) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90th and 99th percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S6. Note: RRs: relative risks; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index.

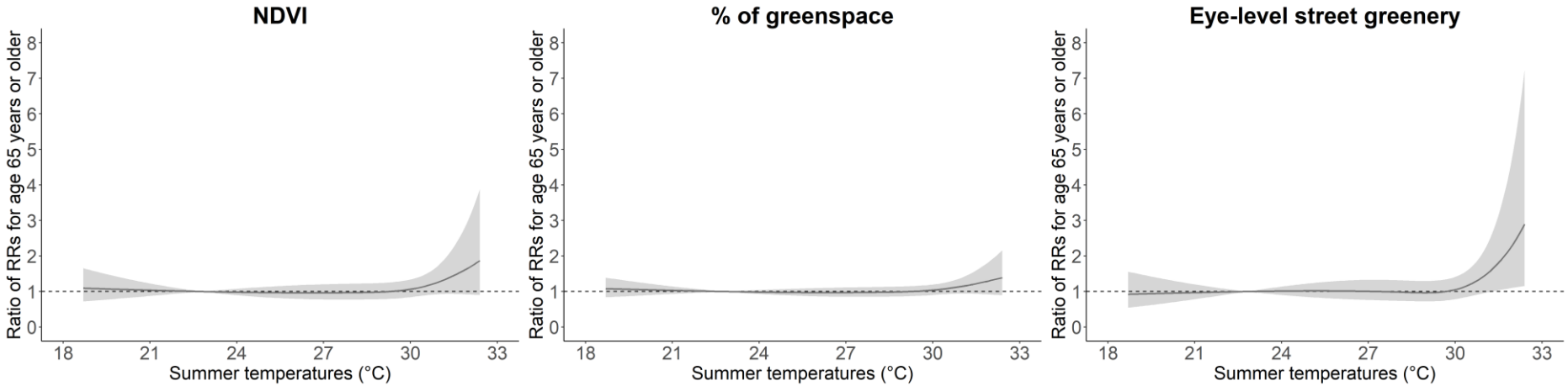


**Figure S7.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in older adults (age≥65 years), expressed by the ratio of RRs between TPUs with a low (5$^{th}$ percentile) and high (95$^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults from June to October within the study period 2005-2018 (*N*=175,658). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

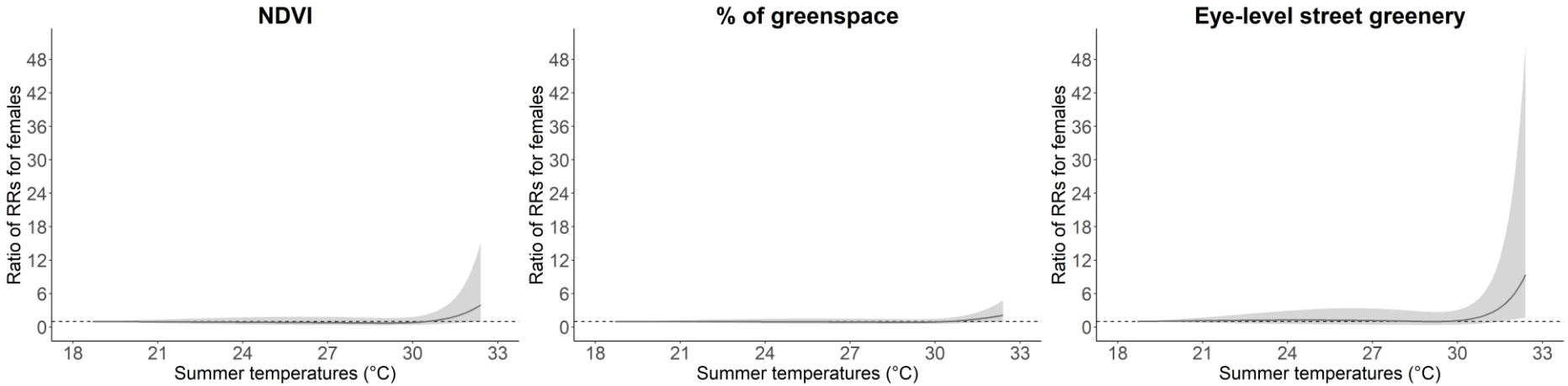


**Figure S8.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in females, expressed by the ratio of RRs between TPUs with a low (5$^{th}$ percentile) and high (95$^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of female from June to October within the study period 2005-2018 (*N*=99,509). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

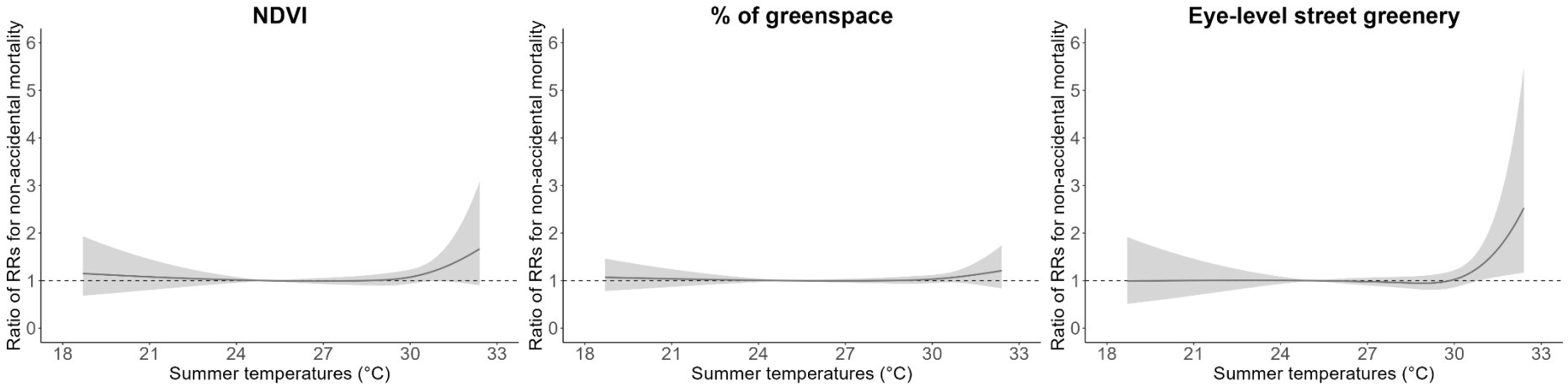


**Figure S9.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in non-accidental mortality, expressed by the ratio of RRs between TPUs with a low (5$^{th}$ percentile) and high (95$^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes non-accidental mortality data with TPU identifiers (3-digit TPU code) from June to October within the study period 2005-2018 (*N*= 213,505). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author. Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

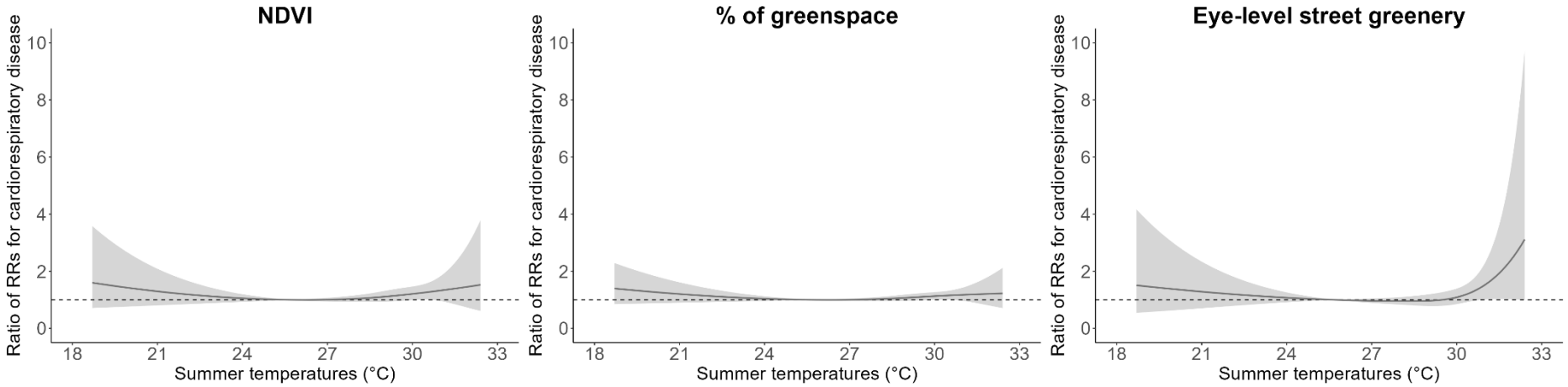


**Figure S10.** The estimated interactions between three urban greenery indicators and the overall cumulative heat-mortality associations in cardiorespiratory diseases, expressed by the ratio of RRs between TPUs with a low (5$^{th}$ percentile) and high (95$^{th}$ percentile) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, with 95% confidence intervals shown in shaded areas. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by cardiorespiratory diseases from June to October within the study period 2005-2018 (*N*= 93,974). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results are available upon request from the corresponding author.
Note: RRs, relative risks; TPU, Tertiary Planning Units; NDVI, normalized difference vegetation index.

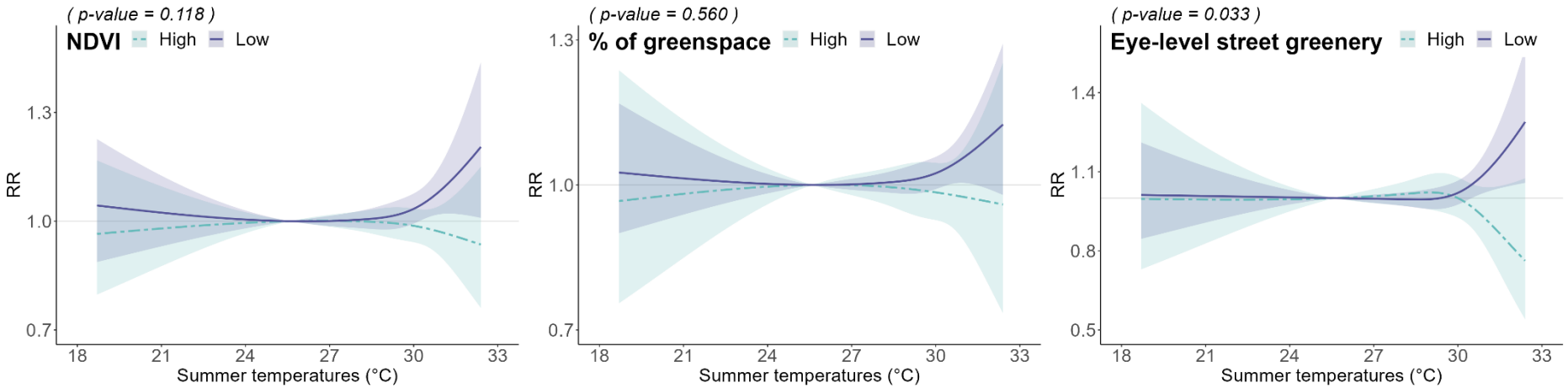


**Figure S11.** The overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low ($5^{th}$ percentile, solid lines in light purple) and high ($95^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace, and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas and *p-value* for the interaction term. The corresponding values to the low ($5^{th}$ percentile) and high ($95^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes all-cause mortality data with TPU identifiers (3-digit TPU code) from June to October within the study period 2005-2018 (*N*=221,919). The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the $90^{th}$ and $99^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S7. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

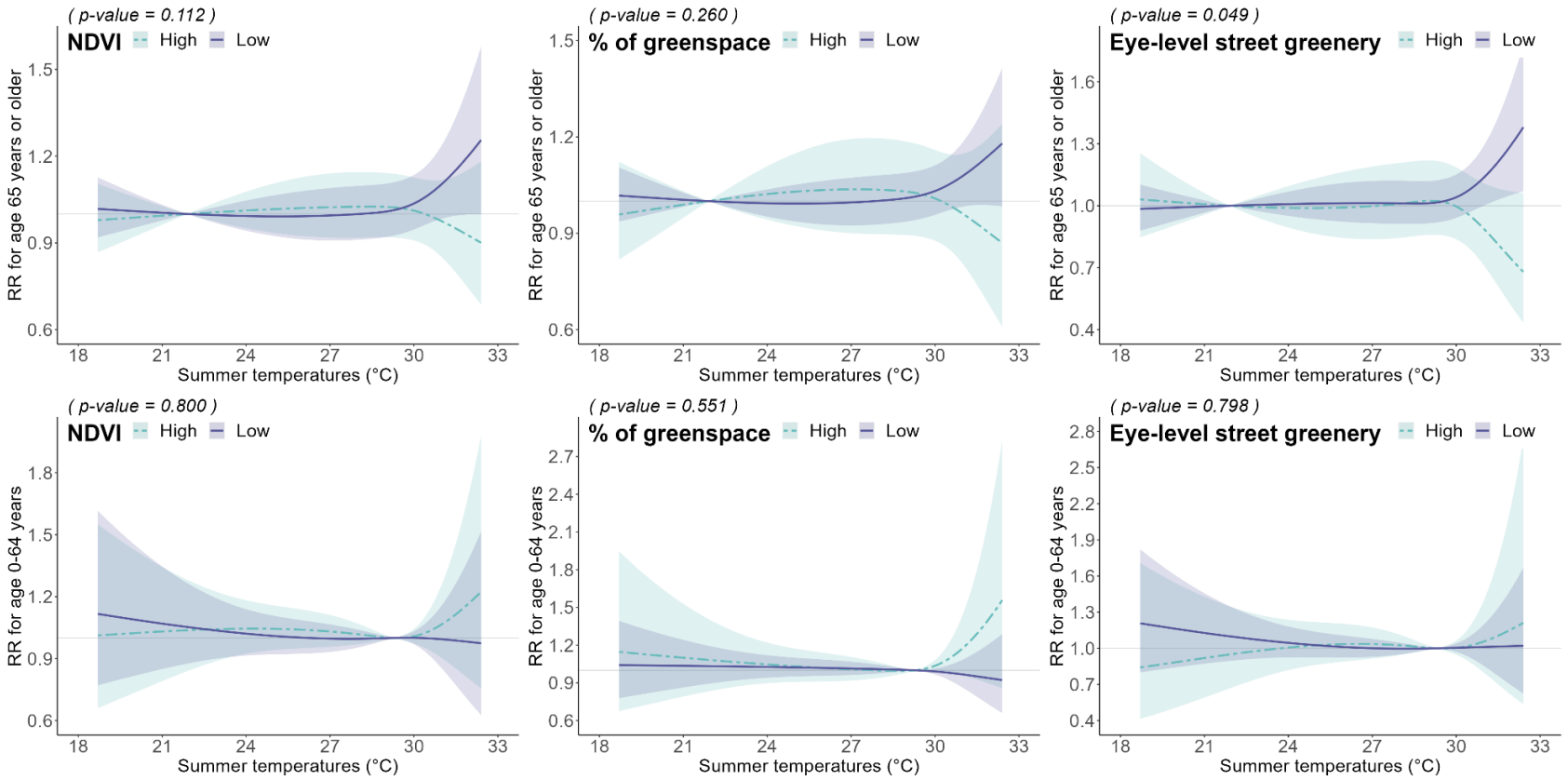


**Figure S12.** The age-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low (5$^{th}$ percentile, solid lines in light purple) and high (95$^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of older adults (age≥65 years, *N*=175,658) and young people (0-64 years, *N*= 46,230) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90$^{th}$ and 99$^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S8. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

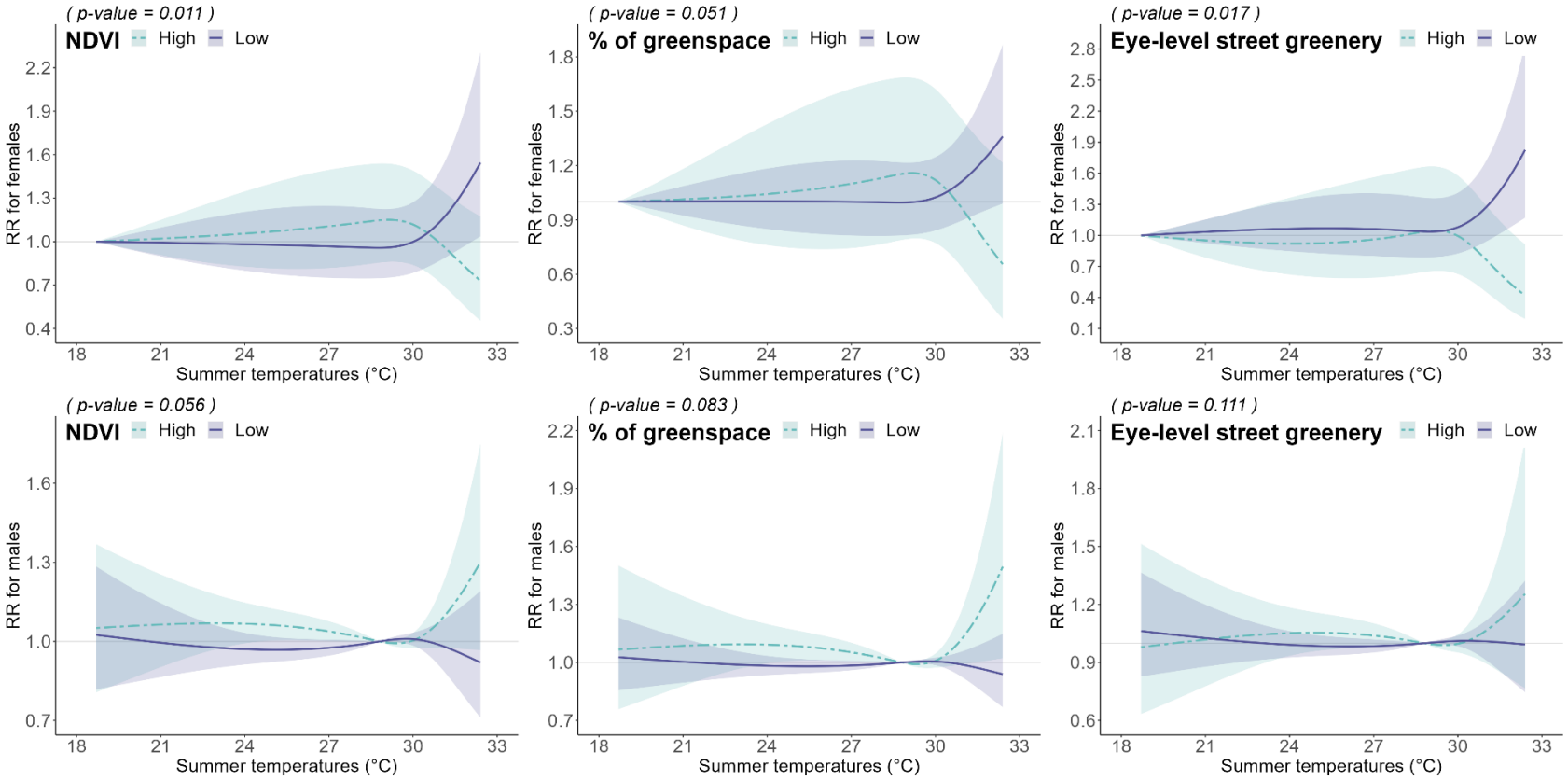


**Figure S13.** The gender-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low (5$^{th}$ percentile, solid lines in light purple) and high (95$^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes mortality data with TPU identifiers (3-digit TPU code) of females (*N*=99,509) and males (*N*=122,408) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90$^{th}$ and 99$^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S9. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

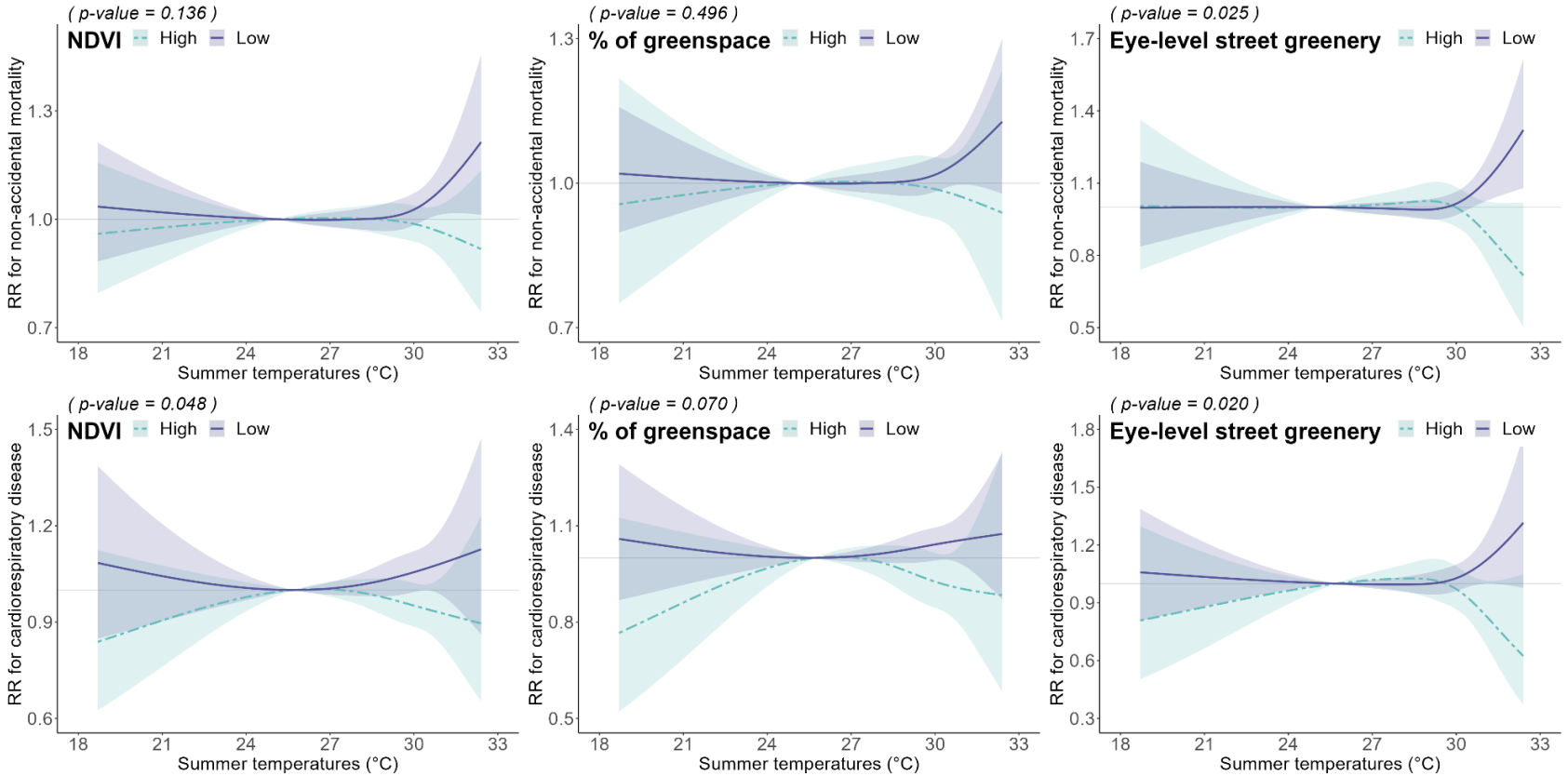


**Figure S14.** The cause-specific overall cumulative exposure-response associations between summer temperatures and mortality for a TPU with a low (5$^{th}$ percentile, solid lines in light purple) and high (95$^{th}$ percentile, dashed lines in light green) value of NDVI, percentage of greenspace and eye-level street greenery in Hong Kong, 2005-2018, after controlling the effects of daily relative humidity, $O_3$ and $PM_{10}$ concentrations at 0-1 lag days, with 95% confidence intervals shown in shaded areas, and *p-value* for the interaction term. The corresponding values to the low (5$^{th}$ percentile) and high (95$^{th}$ percentile) levels of each urban greenery indicator are 0.15 and 0.69 for NDVI, 0.01% and 97.77% for % of greenspace, and 0.02% and 66.35% for the eye-level street greenery. The analysis includes data with TPU identifiers (3-digit TPU code) of mortality caused by non-accidental diseases (*N*= 213,505) and cardiorespiratory diseases (*N*= 93,974) from June to October within the study period 2005-2018. The estimation results were predicted by an extended CTS model specifying an interaction between the cross-basis of temperature and each urban greenery metric and using data aggregated at the TPU level (286 TPUs). Numeric results at the 90$^{th}$ and 99$^{th}$ percentiles of temperatures (30.1°C and 30.9°C) by a low and high value of each urban greenery indicator are included in Excel Table S10. Note: RR, relative risk; TPU: Tertiary Planning Units; NDVI: normalized difference vegetation index; $O_3$, ozone; $PM_{10}$, particular matter with a diameter of 10 microns or less.

**Reference**


1. Hong Kong Census and Statistics Department (HKCSD). Statistics: Population and Households. Accessed March 27, 2023. https://www.censtatd.gov.hk/en/page_1226.html

2. Hong Kong Census and Statistics Department (HKCSD). The 2006 Population By-census. Accessed March 27, 2023. https://www.censtatd.gov.hk/en/scode440.html

3. Hong Kong Census and Statistics Department (HKCSD). The 2016 Population By-census. Accessed March 27, 2023. https://www.censtatd.gov.hk/en/scode459.html