Impacts of physical environment on elderly health and well-being in high-density cities: Implications on urban planning and design for active ageing

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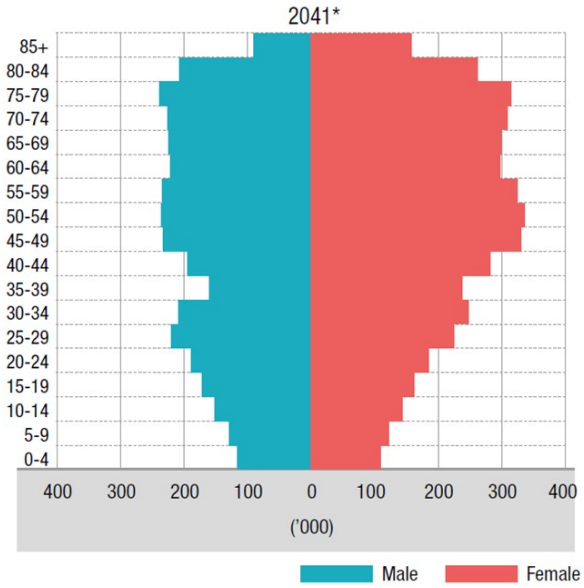
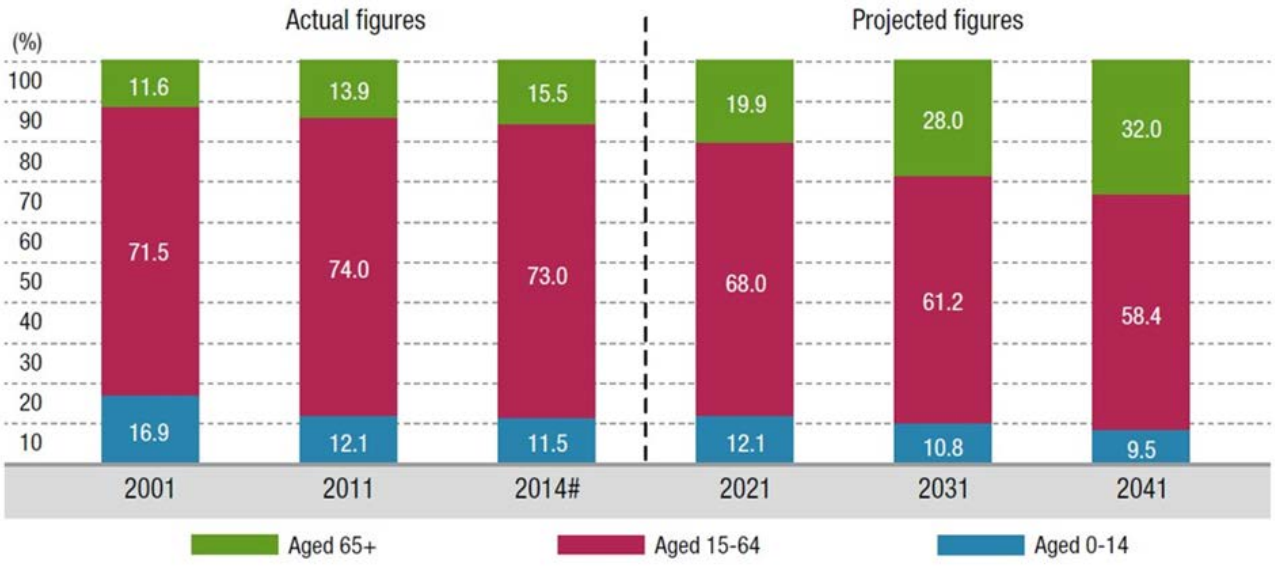
Conference on "Promoting Intrinsic Capacity in Ageing"

AGEING TREND IN HONG KONG

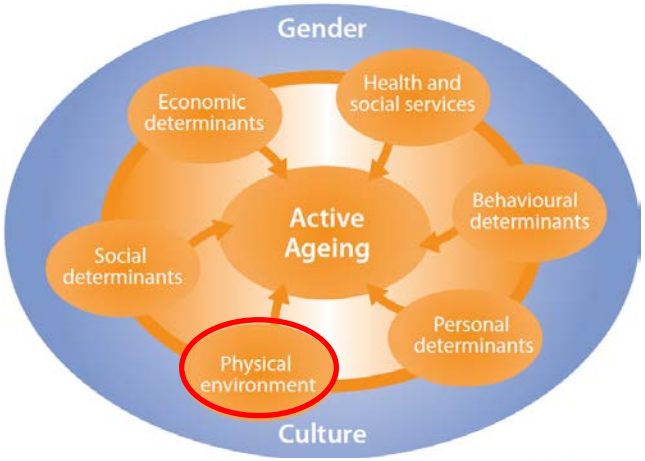
- 1/3 of the population will be elderly in 2041
- Longer life expectancy and declining birth rate

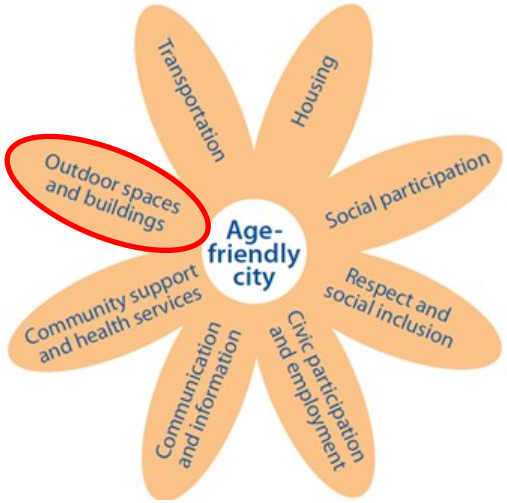


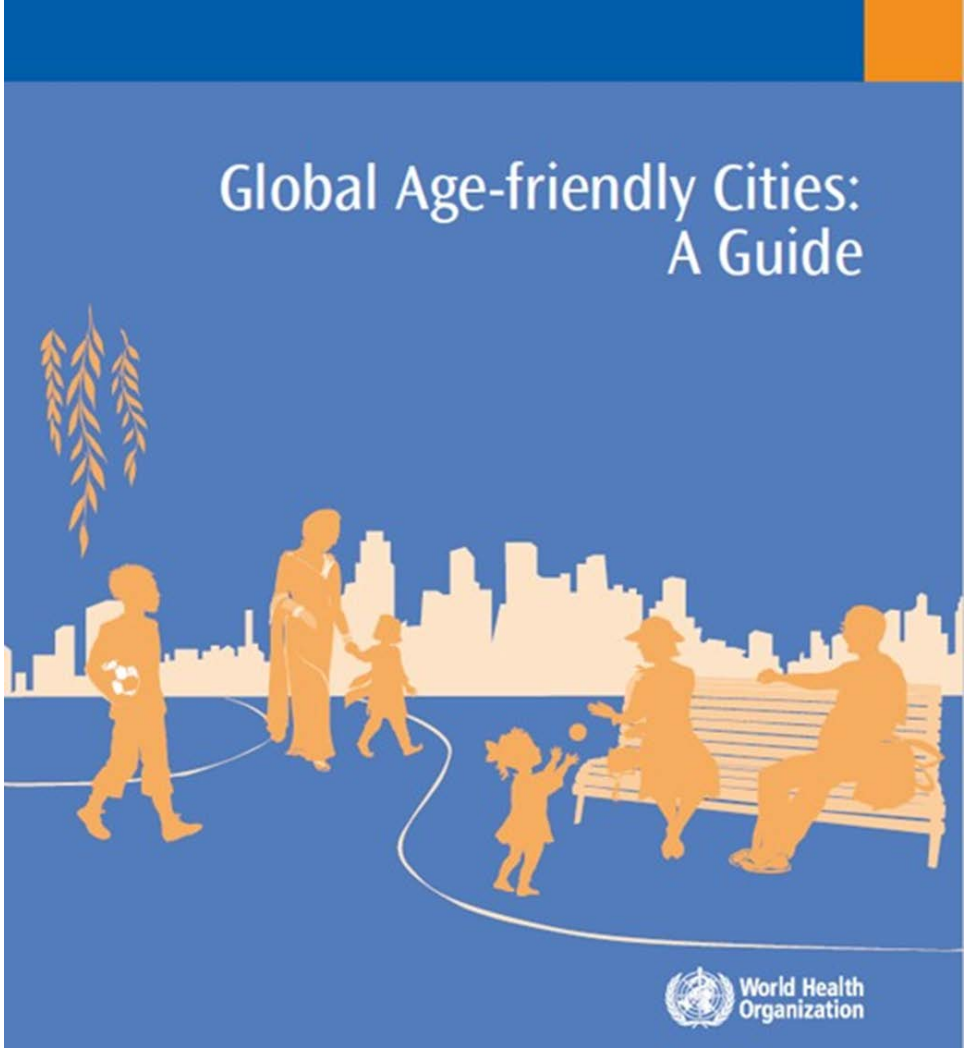


Chief Secretary for Administration's Office, 2015. Population Policy: Strategies and Initiatives. Hong Kong Government, Hong Kong.

EMBRACING OPPORTUNITIES

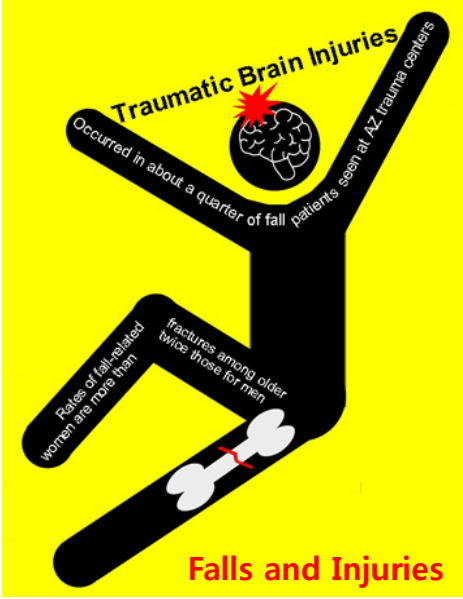






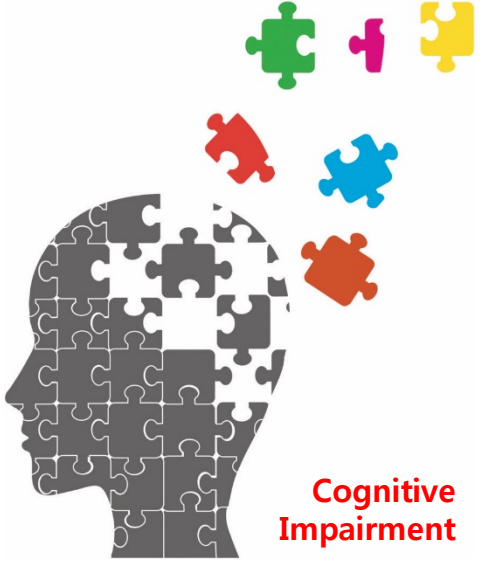
ENVIRONMENT AND PHYSICAL HEALTH

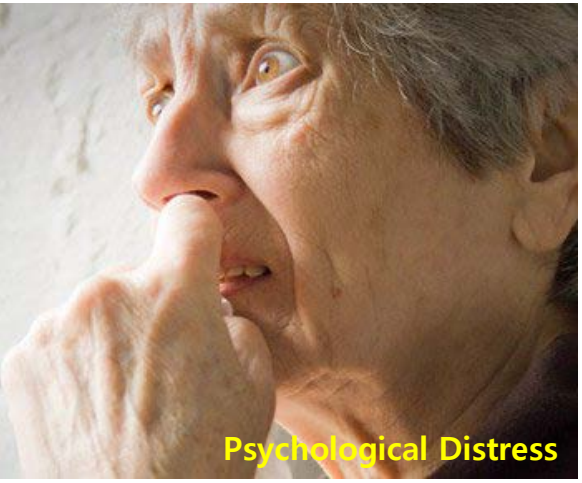
- Disablement process
- Physical functioning
- Mortality
- Diseases related to environmental quality



ENVIRONMENT AND MENTAL HEALTH

- Quality of housing
- Social interactions
- Sensory stimulations
- Restorative capacity





ENVIRONMENT AND LIFE SATISFACTION

- Quality of life and life satisfaction
- Healthy or successful ageing
- Indirectly related to physical and mental health
- Subjective well-being
- Most of the studies found that life satisfaction is closely related to the quality of living environment
- WHO consider the enhancement of quality of life as a major issue in ageing



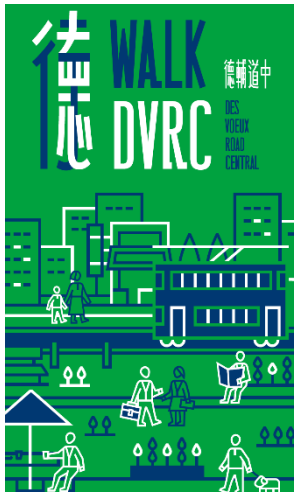
OUR BUILT ENVIRONMENT


DENSITY

- Visual and physical access to the outdoors
- High density and mixed land use
  - Increase in pedestrian activity
- Exposure to natural light and ventilation
  - Mood (emotional stress)
  - Comfort (physical stress)
- Balance between development need and the quality of the built environment

STREET DESIGN

- Street pattern
  - Willingness to visit neighbours outside
- Neighbourhood walkability
  - Connectivity and accessibility
  - Environmental quality and safety
- Walkability was proved to be associated with physical health



URBAN GREEN SPACE

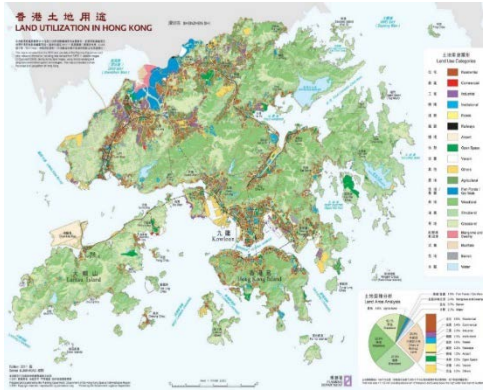
- Alleviating urban heat island effect
- Enhancing thermal comfort
- Improving air quality
- Encouraging physical activity
- Aesthetic values and many more…

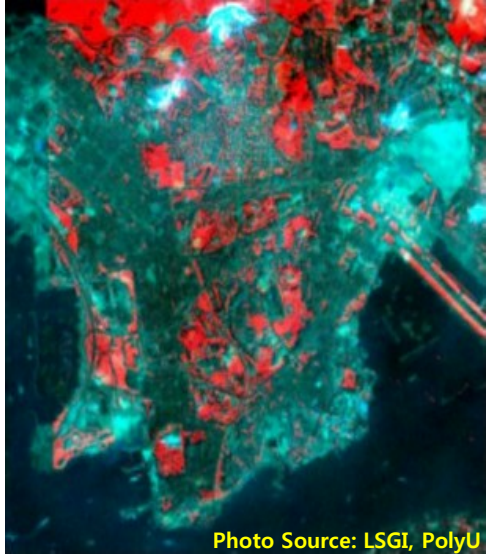
MR AND MS OS COHORT STUDY

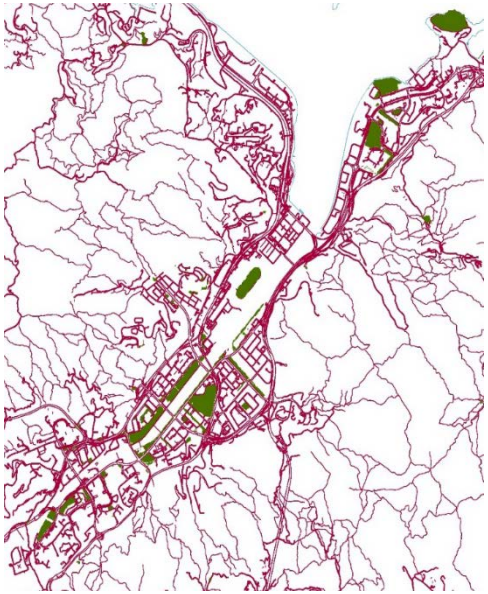
- 4000 subjects recruited from 2001-2003
  - 2000 each for men and women
- Health outcome variables
  - Interview and questionnaire
  - Physical examination and measurements
- Georeferenced based on their residential addresses
  - To obtain an understanding of surrounding living environment

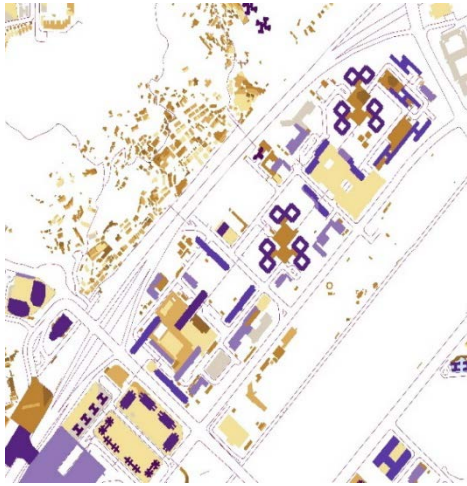
Baseline 2001-2003	1st Follow-up (2YFU) 2003-2005	2nd Follow-up (4YFU) 2005-2007	3rd Follow-up (7YFU) 2008-2010	Current (14YFU) 2015-2017
2000 Male 2000 Female	1745 Male 1682 Female	1566 Male 1587 Female	989 Male 889 Female	

BUILT ENVIRONMENT DATA









ROAD NETWORK

LAND USE

GREENERY

BUILDING FORM

NEIGHBOURHOOD GREEN SPACE AND MORTALITY

- The contributions of neighbouring green space to mortality
- Validated address: 3,544
- 300m buffer was used to represent the neighbourhood characteristics

Neighbouring green space and all-cause mortality in elderly people in Hong Kong: a retrospective cohort study

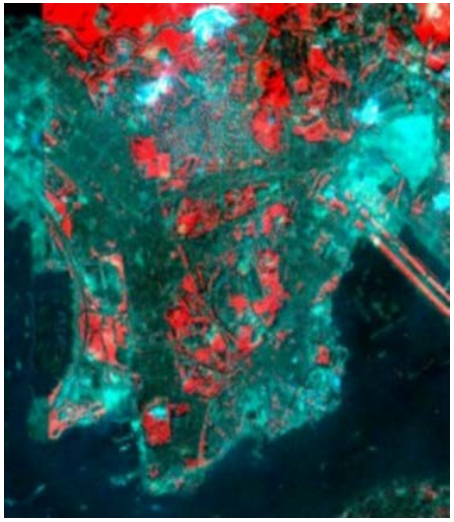
Dan Wang, Kevin Ka-Lun Lau, Ruby H Y Yu, Samuel Y S Wong, Timothy C Y Kwok, Jean Woo

Wang D, Lau KKL, Yu RHY, Wong SYS, Kwok TCY, Woo J, 2016. The Lancet 388: S82.

BMJ Open **Neighbouring green space and mortality in community-dwelling elderly Hong Kong Chinese: a cohort study**

Dan Wang,[1,2] Kevin Ka-Lun Lau,[2,3,4] Ruby Yu,[2,5] Samuel Y S Wong,[1,6] Timothy T Y Kwok,[2,5] Jean Woo[2,5]

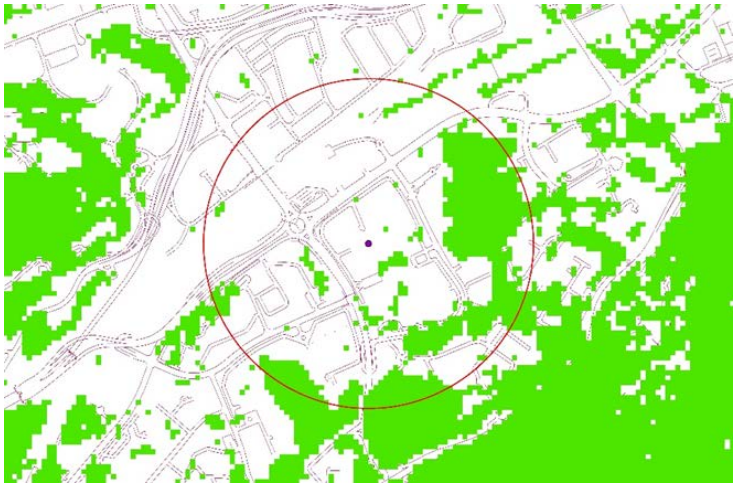
Wang D, Lau KKL, Yu RHY, Wong SYS, Kwok TTY, Woo J, 2017. BMJ Open 7: e015794.



Normalized Difference Vegetation Index (NDVI)

- Ratio between near-infrared and red (visible) region of spectral reflectance
- To represent the possibility of having live green vegetation

$$\mathrm{NDVI} = \frac{\rho_{\mathrm{nir}} - \rho_{\mathrm{red}}}{\rho_{\mathrm{nir}} + \rho_{\mathrm{red}}}$$

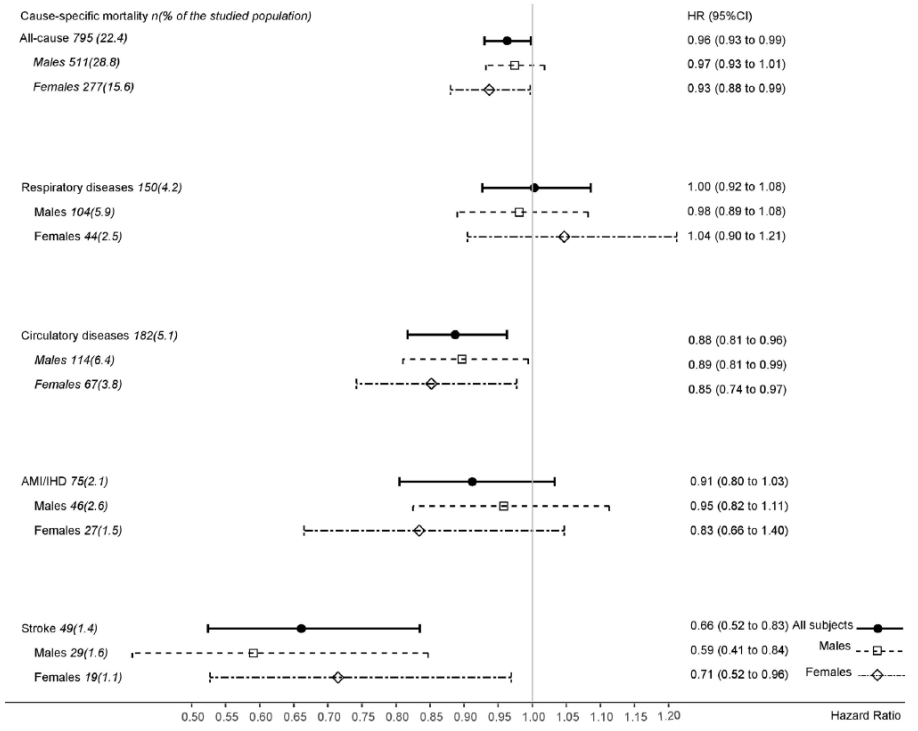


NEIGHBOURHOOD GREEN SPACE AND MORTALITY

- Green space generally has a protective effect to mortality
- Particularly for mortality caused by circulatory diseases (e.g. stroke)
- Effect tends to be stronger in female
  - Greater exposure to green space due to daily activities
- In highly urbanized cities, neighbourhood green space has a great potential in preventive healthcare

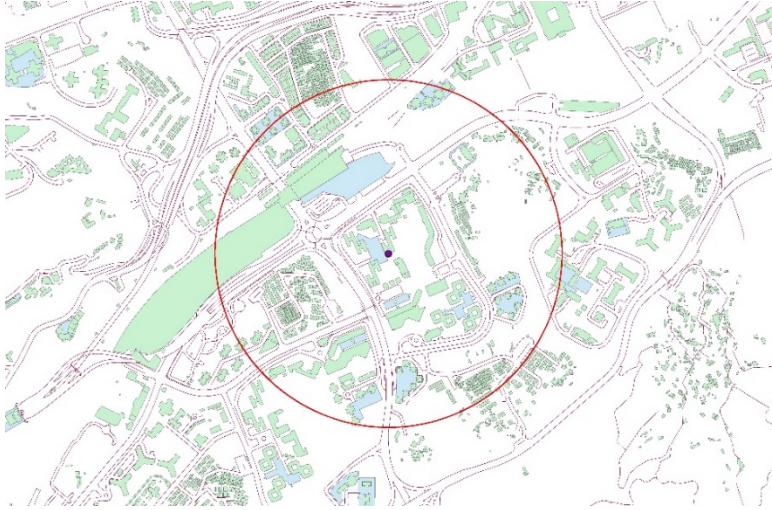
Table 3 Multivariate-adjusted HRs and 95% CIs of all-cause and cause-specific mortality with every 10% increase in coverage of green space within a 300m radius buffer

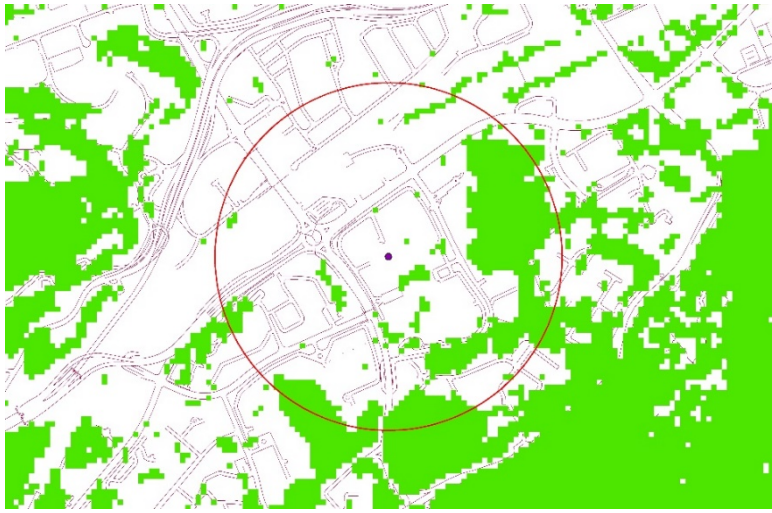
	HR (95% CI), adjusted for demographic, socioeconomic, lifestyle factors, baseline health status, housing type and years lived in HK	
Outcomes	Model 1*	Model 2†
	Green space (10%)	Green space (10%)
All-cause mortality	0.963 (0.930 to 0.998)‡	0.964 (0.931 to 0.999)‡
Respiratory disease-caused mortality	1.003 (0.927 to 1.086)	1.004 (0.928 to 1.087)
Circulatory disease-caused mortality	0.887 (0.817 to 0.963)§	0.888 (0.817 to 0.964)§
IHD/AMI	0.912 (0.805 to 1.033)	0.912 (0.805 to 1.033)
Stroke	0.661 (0.524 to 0.835)§	0.658 (0.519 to 0.833)§



MAPPING GERIATRIC DEPRESSION RISK

- Mr/Ms Os baseline data
- Age; Gender; Marital Status; Educational Level; Years of Living in Hong Kong; Living Status
- Geriatric Depression Scale (GDS-15)
  - Cutoff values for depression: GDS ≥ 8
- Variables of built environment
  - % open space; % vegetation; % building coverage; avg building height; and std building height





Article

Spatial Variability of Geriatric Depression Risk in a High-Density City: A Data-Driven Socio-Environmental Vulnerability Mapping Approach

Hung Chak Ho [1,2,*], Kevin Ka-Lun Lau [1,3,4,*], Ruby Yu [4,5], Dan Wang [4], Jean Woo [4,5], Timothy Chi Yui Kwok [4,5,6] and Edward Ng [1,3,7]

SOCIO-ENVIRONMENTAL VULNERABILITY INDEX

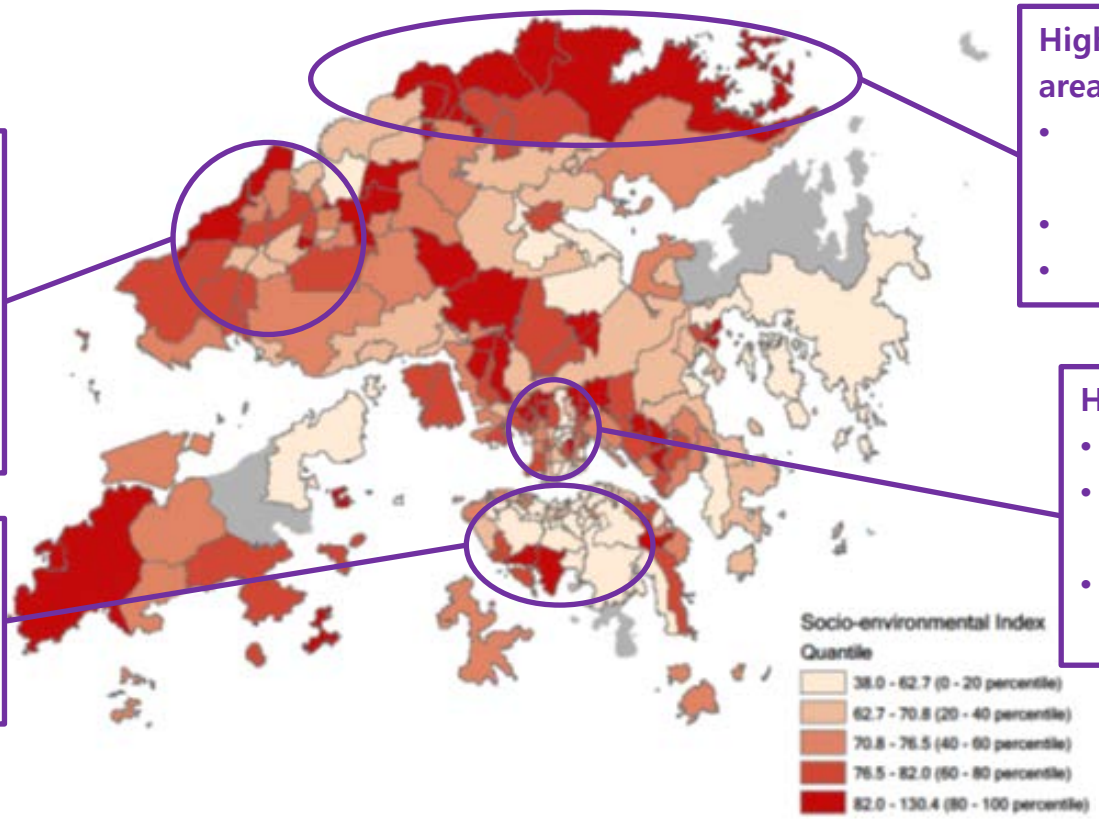
$$\log\left(\frac{\text{Depression}}{\text{Not Depression}}\right) \sim \text{older ages} + \text{male} + \text{not married} + \text{low education} + \text{living alone} + \text{new immigrant} + \%\ \text{open space} + \%\ \text{vegetation} + \%\ \text{building coverage} + \text{avg build height} + \text{std build height}$$

Higher in the remote areas
- Low socio-economic status
- Low population
- Lack of social cohesion

Moderately high in new towns
- Socially deprived
- High-rise buildings
- Better social connections in the community

High in old urban core
- Socially vulnerable
- High S.D. of building height
- Distinctive built environment

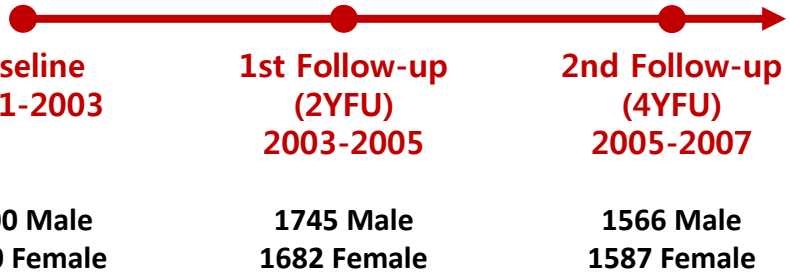
Generally lower on the Hong Kong Island
- Higher socio-economic conditions

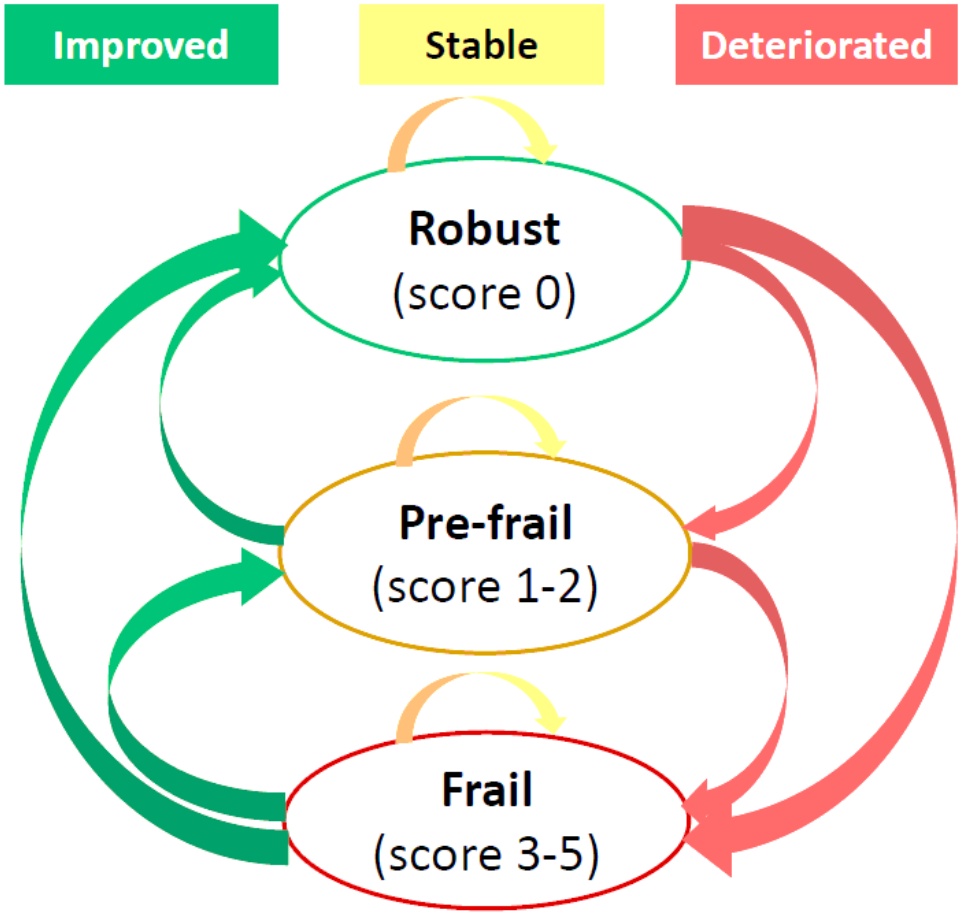


Ho HC, Lau KKL, Yu R, Wang D, Woo J, Kwok TCY, Ng E, 2017. Spatial variability of geriatric depression risk in a high-density city: A data-driven socio-environmental vulnerability mapping approach. International Journal of Environmental Research and Public Health 14(9): 994.

FRAILTY TRANSITION AND GREENSPACE

- Prevalence of frailty among older people in Hong Kong: 5.8%
- Five-item frailty phenotypes
  - Exhaustion
  - Muscle weakness
  - Slow walking speed
  - Weight loss
  - Low physical activity





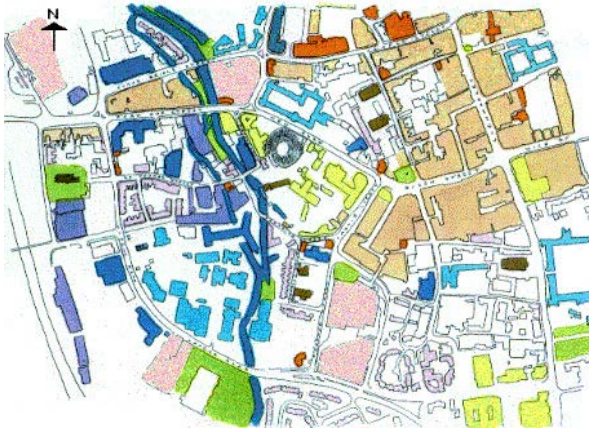
D. WANG, K. Lau, R. Yu, S. Wong, T. Kwok, J. Woo; Neighboring green space and transitions between frailty states among Chinese elderly In Hong Kong, IAGG World Congress 2017, 23-27 July 2017, San Francisco, USA.

FRAILTY TRANSITION AND GREENSPACE

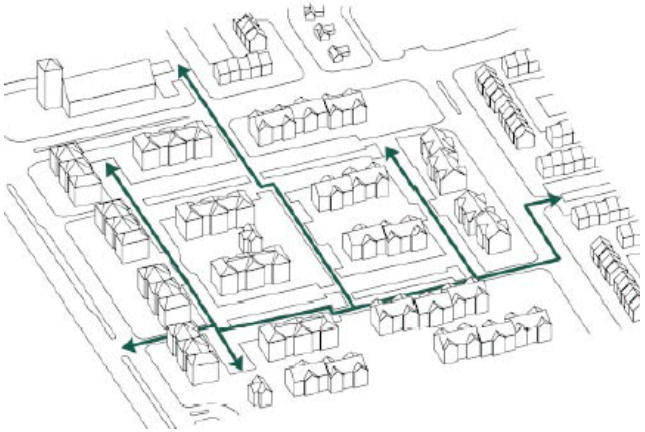
	Deteriorated in frailty status	Stable in frailty status	Improved in frailty status	OR (95% CI)		
				Crude	Adjusted * (model 1)	Adjusted † (model 2)
All participants	n=833	n=2130	n=264			
Green space quartile, n (%)						
Q1 (0.00 - 4.53)	227 (28.5%)	519 (65.0%)	52 (6.5%)	1	1	1
Q2 (4.54 - 13.20)	204 (25.3%)	540 (67.0%)	62 (7.7%)	1.17 (0.96, 1.44)	1.16 (0.94, 1.44)	1.13 (0.91, 1.40)
Q3 (13.21 - 34.12)	212 (26.3%)	519 (64.5%)	74 (9.2%)	1.18 (0.97, 1.45)	1.18 (0.95, 1.46)	1.18 (0.95, 1.47)
Q4 (≥34.13)	190 (23.2%)	552 (67.5%)	76 (9.3%)	1.34 (1.10, 1.65)	1.33 (1.07, 1.64)	1.29 (1.04, 1.60)
P-trend	-	-	-	0.006	0.0135	0.022
Men	n=346	n=1148	n=149			
Green space quartile, n (%)						
Q1 (0.00 - 4.53)	108 (24.7%)	294 (67.3%)	35 (8.0%)	1	1	1
Q2 (4.54 - 13.20)	87 (20.9%)	294 (70.7%)	35 (8.4%)	1.19 (0.89, 1.59)	1.16 (0.86, 1.56)	1.11 (0.83, 1.50)
Q3 (13.21 - 34.12)	90 (22.6%)	267 (67.1%)	41 (10.3%)	1.19 (0.89, 1.59)	1.08 (0.80, 1.46)	1.06 (0.78, 1.43)
Q4 (≥34.13)	61 (15.6%)	293 (74.7%)	38 (9.7%)	1.56 (1.16, 2.10)	1.47 (1.08, 1.99)	1.40 (1.03, 1.90)
P-trend	-	-	-	0.005	0.0287	0.056
Women	n=487	n=982	n=115			
Green space quartile, n (%)						
Q1 (0.00 - 4.53)	119 (33.0%)	225 (62.3%)	17 (4.7%)	1	1	1
Q2 (4.54 - 13.20)	117 (30.0%)	246 (63.1%)	27 (6.9%)	1.19 (0.89, 1.58)	1.18 (0.86, 1.61)	1.18 (0.86, 1.62)
Q3 (13.21 - 34.12)	122 (30.0%)	252 (61.9%)	33 (8.1%)	1.23 (0.92, 1.64)	1.28 (0.94, 1.75)	1.31 (0.95, 1.79)
Q4 (≥34.13)	129 (30.3%)	259 (60.8%)	38 (8.9%)	1.24 (0.94, 1.65)	1.23 (0.90, 1.67)	1.23 (0.90, 1.68)
P-trend	-	-	-	0.138	0.1715	0.156

* Model 1: adjusted for age, sex, marital status, socioeconomic status, current smoking status, alcohol intake, diet quality and baseline frailty status.
† Model 2: adjusted for covariates in model 1 and also for no. of diseases, cognitive function, physical activity and depression.

NEIGHBOURHOOD WALKABILITY



Land Use Mix-access



Street Connectivity

Infrastructure for Walking

Aesthetics

Traffic Safety

Safety from Crime

Yu R, Cheung O, Lau K, Woo J, 2017. Associations between perceived neighborhood walkability and walking time, wellbeing, and loneliness in community-dwelling older Chinese people in Hong Kong. International Journal of Environmental Research and Public Health 14(10): 1199.

NEIGHBOURHOOD WALKABILITY

- The associations of walkability with walking time, physical activity, subjective wellbeing, and loneliness
- Reduced version of Neighborhood Environment Walkability Scale (NEWS)
- Walkability is positively associated with walking time
    - But the relationship with physical activity is not significant
- Also associated with better life satisfaction, happiness, and less loneliness
    - Environmental mastery and autonomy
- Individual components are also associated with measures of well-being
    - e.g. safety issues are significant in depression and loneliness

FURTHER WORK - WHAT IS "GREEN SPACE" IN HIGH-DENSITY CITIES?

- Perceived qualities and the availability of green space
- Features present in green space and their conditions
- Preference and usage pattern of elderly people
- Associated with physical activity and mental health
- Perception, preference and usage pattern in high-density environment
    - Due to the constraints in land availability
- Relationship with physical and mental health conditions
- How should we design our green space in Hong Kong?

DESIGN ELEMENTS

- Relative importance of different design elements
- How they are preferred?
- Differences between types of green spaces
- Effect of individual factors on perception towards green spaces

PILOT STUDY IN HONG KONG AND TAINAN

VISIT FREQUENCY

- Positively related to the amount of green areas and number of trees
- Amount of sports, recreational facilities, resting areas

HEALTH CONDITIONS

- Self-rated health increases with the number of trees in the neighbourhood
- Less often to feel depressed with higher aesthetics
- Role limitation due to emotional health decreases with increasing area and aesthetic quality of green spaces

PERCEIVED SAFETY

- Role limitation due to physical health is reduced with increasing perceived safety.
- Restriction of physical activity
- Sense of insecurity in the neighbourhood


Zhangrong xincheng, Tainan


Sau Mau Ping South Estate, Hong Kong

POLICY IMPLICATIONS

- Promote an age-friendly built environment for "active ageing", "ageing in place", "inter-generational support" and community participation for elderly
- Urban planning and design can contribute to a more age-friendly living environment
  - To embrace the characteristics of high-density cities

An age-friendly built environment emphasizes enablement rather than disablement.

- *Louise Plouffe and Alexandre Kalache (2010)*

Thank you very much