

THE ENVIRONMENT AND HEALTH INEQUALITIES IN HONG KONG



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FOREWORD

Two challenges faced by all countries, and the global community, are inequality and environment/climate change. There is an understandable tendency to see these as separate domains, with separate constituencies, handled by different branches of government and civil society. This report represents our view that they need to be brought together. Both, tackling health inequalities and the climate emergency, require societal change. The aim should be to create socially sustainable societies with a fair distribution of health.

The present report is the third in a series. It results from a strong collaboration between two Institutes of Health Equity – at the Chinese University of Hong Kong and at University College London. The starting questions animating this collaboration were of two types, both relevant to policy. The first is why Hong Kong should have one of the longest life expectancies in the world. Superficially, one could easily conjure up reasons why that might not be the case, environment key among them. Hong Kong has high population density and housing is a continued issue. The answers to this first set of questions are highly relevant both to future policies in Hong Kong and to other countries, particularly in Asia.

The second set of questions relate to inequalities. All societies have social and economic inequalities. As a result, all societies have inequalities in health, that are not simply the result of lack of access to health care. Our first report in this series introduced the concepts of social determinants of health with evidence from Hong Kong. The second report took a life course approach to describing and understanding the social determinants of health.

This report examines environment in two ways. The first is the local environment in which people are born, grow, live, work and age – an important part of the social determinants of health. The second way is to assess the impact of climate change on inequalities in health and the steps needed to address it.

Evidence in the report shows that impressive as is Hong Kong's health record, there is still much to be done in housing, air pollution, access to green space, as well as action on climate change. We put this report forward as an example of evidence-informed policy making. It will be important to monitor changes in policy, in the social determinants of health and in health and health equity.

The analyses and approaches we recommend in Hong Kong are applicable widely. The goal could not be more important – healthier, fairer, more sustainable societies.

Michael Marmot

Director UCL Institute of Health Equity



Prof. Sir Michael Marmot
Co-Director, CUHK Institute of Health Equity
Director, UCL Institute of Health Equity



Prof. Jean Woo
Co-Director, CUHK Institute of Health Equity



Prof. Eng-Kiong Yeoh
Co-Director, CUHK Institute of Health Equity

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REPORT WRITING TEAM:

UCL IHE: Professor Sir Michael Marmot, Director; Antia Castedo, Senior Researcher; Dr Jessica Allen, Deputy Director; Professor Peter Goldblatt, Senior Advisor.

CUHK IHE: Prof. Jean Woo, Co-Director; Prof. Eng-Kiong Yeoh, Co-Director; Prof. Hung Wong, Associate Director; Prof. Roger Chung, Associate Director; Prof. Eric Lai, Research Assistant Professor; Dr. Gary Chung, Research Assistant Professor; Ms Michelle Kwan, Research Assistant; Mr. Richard Lee, Functional Manager.

Peter Goldblatt and Antia Castedo coordinated production and analysis of tables and charts.

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ABOUT THE UCL INSTITUTE OF HEALTH EQUITY The UCL Institute of Health Equity (UCL IHE) (www.instituteofhealthequity.org) was established in 2011 to develop and support approaches to health equity and build on work that has assessed, measured and implemented approaches to tackle inequalities in health and is led by Professor Sir Michael Marmot. The Institute works to build the evidence base and advise and support implementation of approaches to health inequalities in the UK and globally.

ABOUT THE CUHK INSTITUTE OF HEALTH EQUITY The Chinese University of Hong Kong Institute of Health Equity (CUHK IHE) (www.ihe.cuhk.edu.hk) was established in 2020 as a leading institution in promoting health equity studies in the Asian region. The Institute endeavours to examine and understand issues of health equity in Hong Kong, inform government policies and intervention programmes to improve health equity in Hong Kong, and establish a network for the Asian region.

THE UCL IHE AND CUHK IHE COLLABORATION The UCL Institute of Health Equity is a collaborative partner to the CUHK Institute of Health Equity. The two institutes have a continuing collaboration to develop research and produce a series of reports to review health equity and the social determinants in Hong Kong and to build a network on related issues across Asia.

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CHAPTER 1

INTRODUCTION

The environment in which people live shapes health in myriad ways, both positive and negative, to a considerable extent through the conditions in which they are born, grow, live, work and age. (1). These conditions comprise the social determinants of health, along with the structural determinants of these conditions: the wider forces and systems governing the unequal distribution of money, power and resources. These social determinants interact to shape health throughout all stages of life – through education, housing, work, socioeconomic position and more. These are the ‘causes of the causes’ of ill health and this is why it is important to incorporate a life-course approach to examining health inequalities. (2)

Hong Kong is an advanced economy with one of the highest life expectancies in the world. Nevertheless, there are health inequalities between social groups in mortality, self-rated health, chronic conditions and other health outcomes based on income, socioeconomic position and ethnicity; we analysed these in the first report of this series: *Build back fairer: reducing social inequalities in health in Hong Kong* (published 2021). (1) Inequalities in the social determinants of health between groups originate in early years, are reinforced through education, employment and working conditions and persist, throughout their lives to old age: those from lower socioeconomic groups feel less well, experience more chronic disease and have less of their life free of impairment compared with those from higher socioeconomic groups. This was set out in the second report of this series, which took a life-course approach to health inequalities in Hong Kong (published 2022). (2)

In this report, we discuss the effects of some of the main environmental drivers of health in Hong Kong. **Chapter 2** describes how the places where people live, neighbourhoods and communities, impact on health and health inequities. This includes the quality and affordability of housing, both of which are characteristics that can have direct and indirect impacts on physical and mental health, shown by a strong global evidence base. We place a particular focus on the health impacts of crowded subdivided units in Hong Kong, given existing concerns about poor living conditions in this type of dwelling and government efforts to mitigate some of their negative impacts. The role of public housing provision in Hong Kong is also discussed, as nearly half the population lives in public housing. Access to services such as health, sports facilities and food, the quality and affordability of transport, and the role of open and green

spaces for health are also addressed in this chapter. Outdoor air pollution continues to have significant health impacts in Hong Kong, in spite of government efforts to reduce it, and we describe some evidence that indicates socioeconomic inequalities in exposure and impacts. In general, the term socioeconomic status (SES) is used in articles and reports about Hong Kong, and we follow this terminology in this report.

Climate change is one of the greatest threats to human health and will widen health inequalities. In **Chapter 3** we discuss some of its impacts in Hong Kong, including temperature increases and exacerbation of the urban heat island effect, rising sea levels, rainfall changes and growing frequency of extreme weather events. Some of these phenomena are still unfolding and their current health impacts have not yet been analysed. The evidence base is more substantial regarding temperature increases and the heat island effect, and it points to the existence of socioeconomic inequalities in impacts on health. In spite of this, it is remarkable how little health in general, and health inequalities in particular, feature in government action plans and strategies related to climate change. The differential impact and vulnerability of the health of disadvantaged groups in Hong Kong needs to be better understood so that mitigation actions also serve these population groups and do not further increase health or socioeconomic inequalities. When actions to strengthen health resilience to climate change are enhanced with an equity lens, there are health and equity benefits.

Finally, in **Chapter 4** we discuss ways to tackle health inequalities through taking action on the environmental issues outlined in the report and make recommendations based on our key findings.

CHAPTER 2

NEIGHBOURHOOD AND COMMUNITIES: IMPACTS ON HEALTH AND HEALTH BEHAVIOURS

Neighbourhoods and local communities, as the places where people are born, live, work and socialise, have been increasingly recognised as key determinants of health (3) and in Fair Society, Health Lives (The Marmot Review) we established the need to create and develop healthy and sustainable places and communities as a key policy objective. (4) Local communities can support physical and mental health by providing good quality and affordable housing, safe urban and green spaces and access to good quality local amenities. (5)

The physical and relational attributes of neighbourhoods influence one another. (6) If a neighbourhood has few public spaces, this can make it more difficult to form social relationships, influencing in turn the capacity to exercise collective action to improve this environment. A sense of community control is also important to overall community health. Social cohesion and a sense of trust and belonging are all components of a sense of control. (7)

Local communities are important across the life course and young children and older people spend a particularly large proportion of their lives within their local neighbourhoods. Among the highest priorities for health equity should be housing conditions, because of the deep impact they have on people's lives. (8) There are three main pathways through which housing can impact health: quality, including temperature control, security and affordability, (9) which

we discuss in detail below. Other significant aspects of residential communities in Hong Kong, such as green and open spaces that are safe and accessible, and outdoor air pollution, are also set out in this chapter, describing some implications for health inequalities.

Social interaction is important for health and wellbeing and social isolation and loneliness can have serious negative impacts on physical and mental health, particularly for older adults, as we explained in the second report of this series. (2) Those on lower incomes may experience comparatively greater benefits from living in a supportive and inclusive community, which can act as a buffer from stress and other negative health effects of being socioeconomically disadvantaged, so nurturing social communities might be a way of reducing health inequalities. (10) (5).



THE SOCIAL GEOGRAPHY OF HONG KONG AND AREA-LEVEL HEALTH INEQUALITIES

Studies from other countries have shown that living in deprived neighbourhoods is associated with worse physical and mental health, including greater mortality, worse self-rated health and adverse child health outcomes. (6) For England, The Marmot Review showed that those residing in the most disadvantaged neighbourhoods die on average seven years earlier than those living in the least deprived areas. (4) The follow-up Marmot report published 10 years later showed how, instead of decreasing, inequalities increased during the period 2016–18. (5) Health inequality follows a social gradient, shaping the lives not only of the poorest, but of an entire society.

Over the years, findings such as these have helped create awareness of the need to act to reduce health inequalities in England, where the critical role played by local areas is now recognised. (11) In Hong Kong, however, analysis of area-level health inequalities is limited by the scarcity of data. The Population Census does not collect routine health data and health surveys are not conducted on a regular basis. As has been explained elsewhere, this is a serious problem for conducting research into health inequalities. (12) The smallest geographical areas with aggregate socioeconomic data in the Hong Kong Census are the so-called Tertiary Planning Units (TPUs), which were divided into large and small sub-unit groups in the 2021 Census, and by Street Blocks or Village Clusters (VCs) in urban and rural areas respectively in the 2016 Census and earlier (13) – however, there was very limited health data for these smaller areas. Given the high population density in Hong Kong, collating health data on this type of smaller area is desirable to better assess geographical inequalities in health.

THE HONG KONG CONTEXT

Hong Kong is one of the most densely populated urban areas in the world, with a population of over 7 million people in a space of 1,114 square kilometres, of which about 40 percent is protected parks where no building is allowed. The Hong Kong Special Administrative Region (SAR) includes Hong Kong Island, Lantau Island, the Kowloon Peninsula and the New Territories and comprises 261 islands. The highest concentrations of people are found in Hong Kong Island, Kowloon and the new towns. The average population density in these areas is 26,000 people per square kilometre, while the rural lands of the New Territories are more sparsely populated. (14) As a comparison, the most dense small region in Europe is Paris, with 21,044 people per square kilometre. (15)

Hong Kong has one of the most expensive housing stocks globally. (16) The development of New Towns such as Tuen Mun and Sha Tin with the aim of decentralising the population from crowded urban centres did not prevent

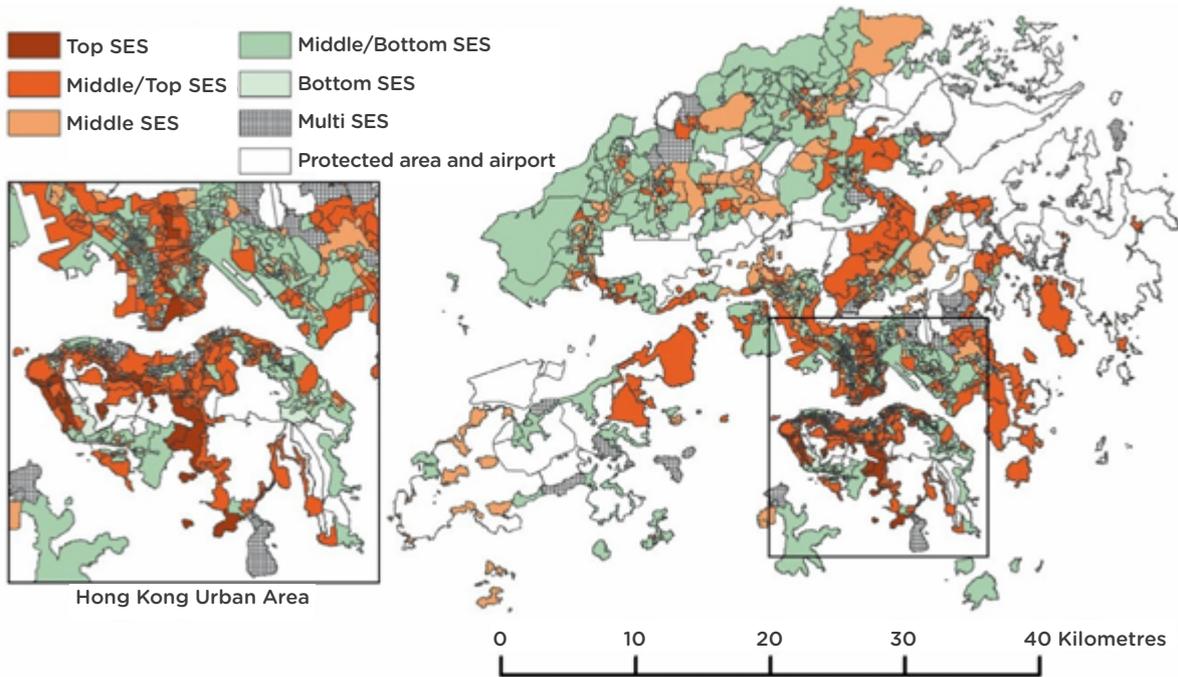
housing costs from increasing. (16) The high cost of housing has important ramifications for health inequalities, as we described in the first report of this series. (1)

Globally, many cities are segregated by social group, related to income, education or occupation, and ethnicity. Socioeconomic inequalities between areas are associated with inequalities in health, with people in more deprived areas having lower life expectancy and living fewer years free of ill-health than those in less deprived areas. (5)

There is a link between high income inequality and economic residential segregation. (17) Residential segregation promotes unequal allocation of resources and services, in turn reinforcing and perpetuating segregation based on class, race and other factors. (6) While segregation is not detrimental in itself and can enhance social cohesion and trust, it often encapsulates a multitude of problems such as inequities in education, employment, housing conditions and safe green spaces, and reinforces social exclusion. (18)

Chung et al. have shown that the prevalence of high-rise housing in Hong Kong with its mix of public and private housing, and the interconnectedness of the urban built environment, facilitate movement between different areas and access to services and resources such as shops, transport, healthcare facilities, libraries and parks, reducing social segregation across communities. (12) Mee Kam Ng et al. found that most neighbourhoods in Hong Kong are relatively socioeconomically diverse, with middle-SES areas often co-located with top- and bottom-SES areas (see Figure 1). (14) They also found that middle-/top-SES neighbourhoods cluster in high- and middle-class residential areas and middle-/bottom-SES neighbourhoods are concentrated in areas with a predominance of old tenement buildings and public housing, such as Chai Wan on Hong Kong Island, Sham Shui Po, and Kwun Tong in Kowloon, as well as New Towns more distant from the city centre. The geographical ‘self-segregation’ of people with high SES is more marked than among those with middle and low SES – and this occurs even where the areas are not wealthy, low-density residential areas (see Figure 1).

Figure 1. Spatial distribution of neighbourhoods classified by SES, Hong Kong, 2016

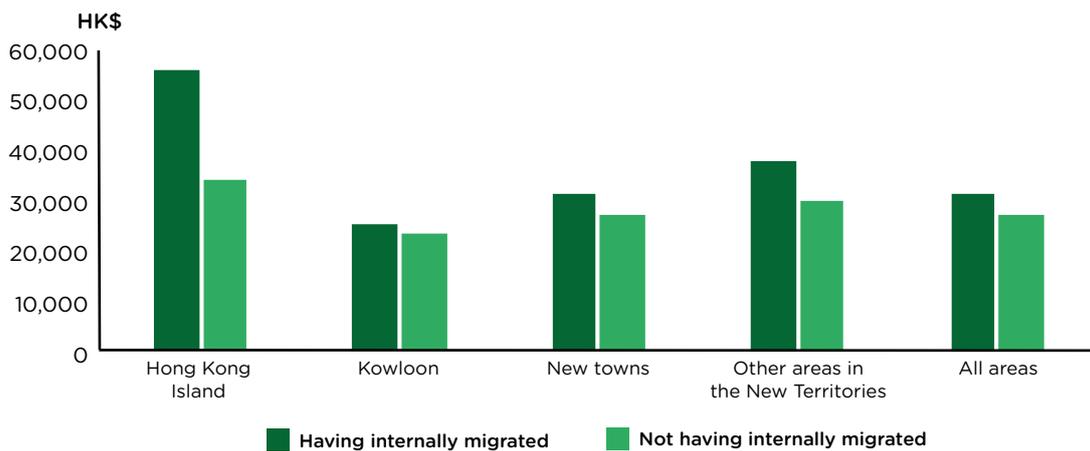


Source: Ng et al. (2021) (14)

Note: Reproduced from the classification provided by Marcińczak et al. 2015. Planning data reproduced with permission of the Director of Planning, Hong Kong.

As Figure 2 shows, in all areas, internal migrants (those who have moved from one part of Hong Kong to another) have higher incomes than those who have not migrated, and in particular internal migrants to Hong Kong Island earn considerably more than anyone else.

Figure 2. Median monthly household income of domestic households (HK\$) by area of current residence and whether having internally migrated, Hong Kong, 2021

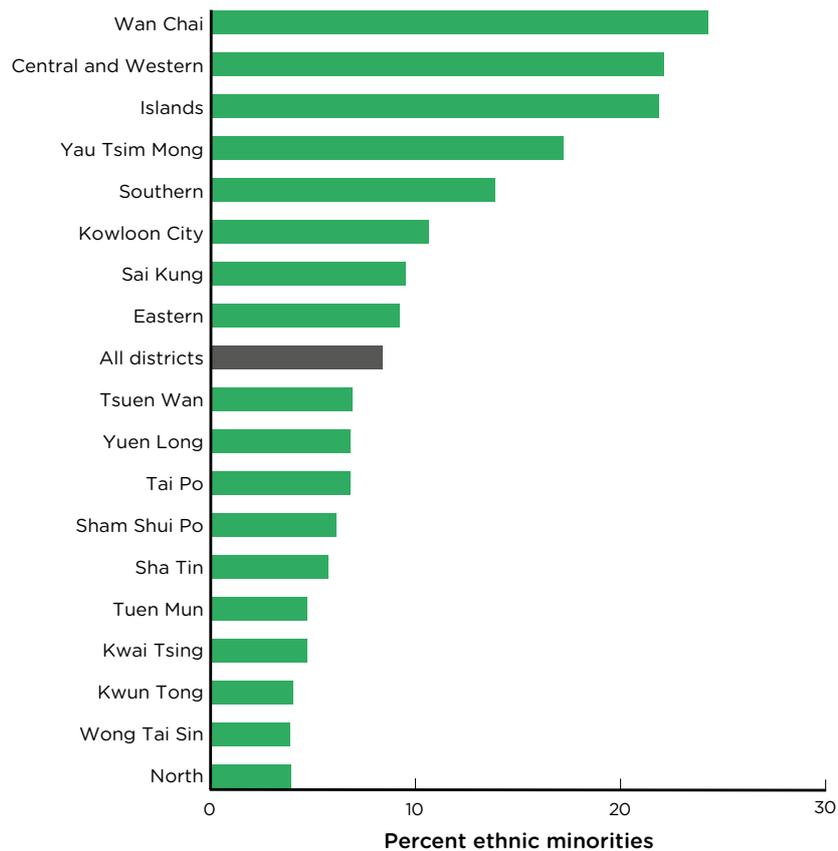


Source: Census and Statistics Department Hong Kong SAR (2022) (19).

Figure 3 shows that in 2021 the Wan Chai district in Hong Kong Island had the highest proportion of ethnic minority residents, and the North district in the New Territories had the lowest (20). By regions, Hong Kong Island had the highest presence of ethnic minorities (14.9 percent), followed by Kowloon (7.5 percent) and the New Territories (6.9 percent). Different ethnic minorities

are more likely to live in certain areas. Nearly half of Whites and over 40 percent of Koreans live in Hong Kong Island; half of all Nepalese, and nearly 40 percent of Indians and Japanese live in Kowloon; Pakistanis (57.5 percent) and Indonesians (50 percent) are more likely to live in the New Territories (20).

Figure 3. Percent of population who are from ethnic minorities by District Council, Hong Kong, 2021



Source: Census and Statistics Department Hong Kong SAR (2022) (20)

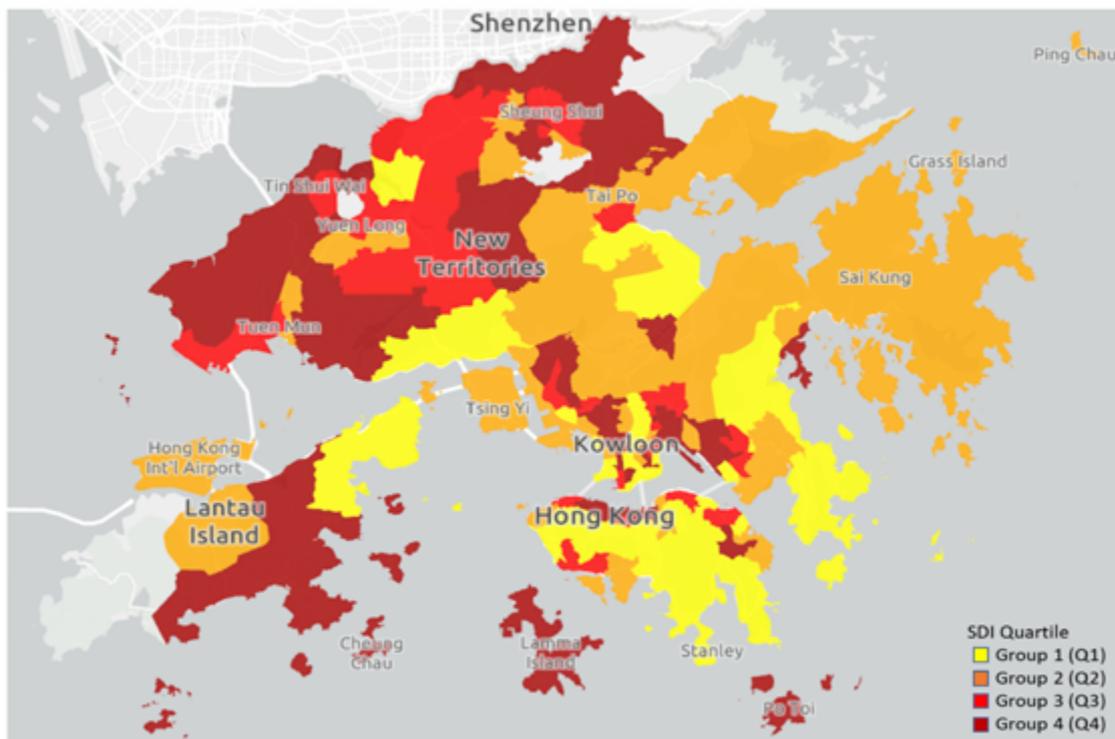


AREA DEPRIVATION AND HEALTH

A few ecological studies have used aggregate data to analyse possible correlations between area deprivation and different health outcomes in Hong Kong. Wang et al. constructed a social deprivation index (SDI) with six variables based on education, income, occupation, marital status, family composition and family size, using

socioeconomic data from the 2016 population By-Census. Using the SDI, Wang et al. ranked 154 Large Tertiary Planning Unit Groups (LTPUGs), with population sizes ranging from 10,691 to 286,232, and grouped them into four quartiles based on level of deprivation (see Figure 4).

Figure 4. Geographical distribution of social deprivation levels (in SDI quartiles), Hong Kong, 2016

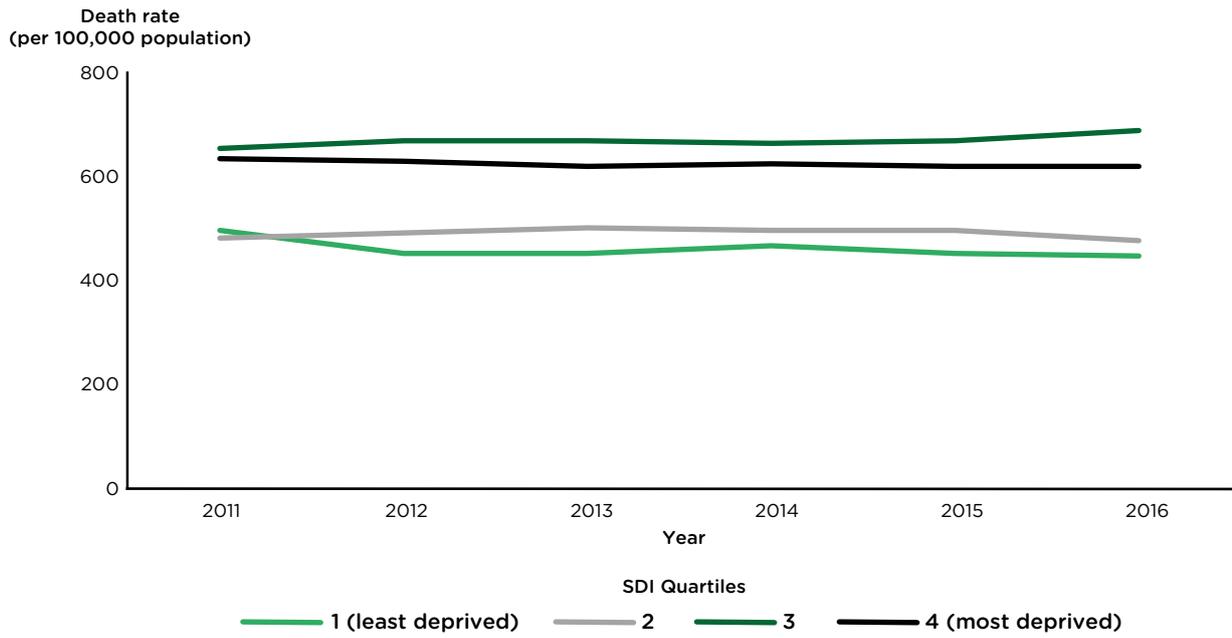


Source: Wang et al. (2021) (21).

The two most deprived quartiles had higher all-cause mortality rates than the least deprived. The largest difference was found between the third most deprived quartile and the least deprived quartile. For example, the former had a 54 percent higher standardised mortality rate than the latter in 2016 (see Figure 5). The fact that quartile 3 has worse rates than quartile 4, the most deprived, might be explained by the 'cliff-edges' created by the social protection system in Hong Kong, in particular the Comprehensive Social Security

Assistance (CSSA), a means-tested income support mechanism for the poorest that is so highly targeted that it excludes many who are also deprived but do not meet the requirements to receive the CSSA. It could also be a result of the variables chosen to construct the index. Nonetheless, the existence of inequalities in mortality between the 50 percent of population in more deprived areas (quintiles 3 and 4) and the 50 percent in less deprived areas (quartiles 1 and 2) is clear.

Figure 5. Age- and sex-standardised all-cause mortality rate by small area deprivation quintiles, Hong Kong, 2011-16



Source: Wang et al. (2021) (21).

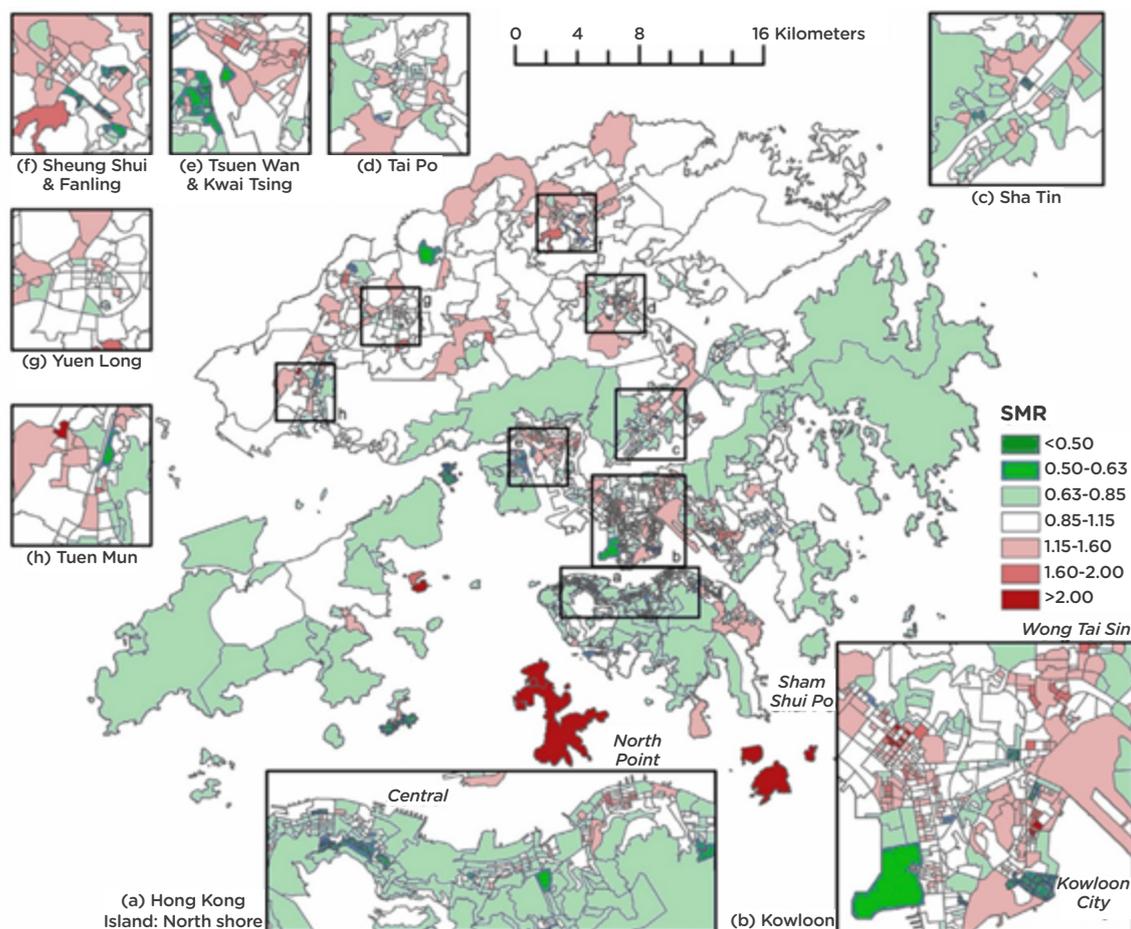


They also found a positive association between social deprivation and cancer mortality, and the difference between the second most deprived and the least deprived quartiles became bigger in 2016 (21).

Another small-area ecological study, by Hsu et al., using socioeconomic data from the 2006 Census and aggregate suicide data from the Coroner's Court for the period 2005–10, found clear geographical and socioeconomic inequalities in suicide rates in Hong Kong – see Figure 6. (22) The study used two area-level measures – Large Street Block (LSB), with a median population of 1,860; and Small Tertiary Planning Unit Group (STPUG), with a median population of 14,850, along with 14 area socioeconomic variables including: percent of adults with non-professional jobs, median household income, unemployment rate, the Gini coefficient measure of inequality, and people aged 15

years or over with only secondary education or below. The authors discovered that higher suicide rates were found in certain socioeconomically deprived and more densely populated areas, with the highest rates in parts of Kowloon (Sham Shui Po and Kowloon City) and some islands in the South, whereas the city centre generally showed lower than average rates. Suicide rates were associated with presence of population with non-professional jobs and low median household income, but not with the Gini coefficient. The authors point out that as this is an ecological study, a causal association cannot necessarily be inferred. Moreover, the study cannot tell whether there is a potential independent effect of the area separate from the aggregate effect of the individuals living in it. Additionally, none of the area socioeconomic characteristics studied were sex- or age-specific and this may limit the interpretability of findings.

Figure 6. Smoothed standardised mortality ratios (SMRs) for suicides at age 10 years and over by Large Street Blocks, Hong Kong, 2005–10



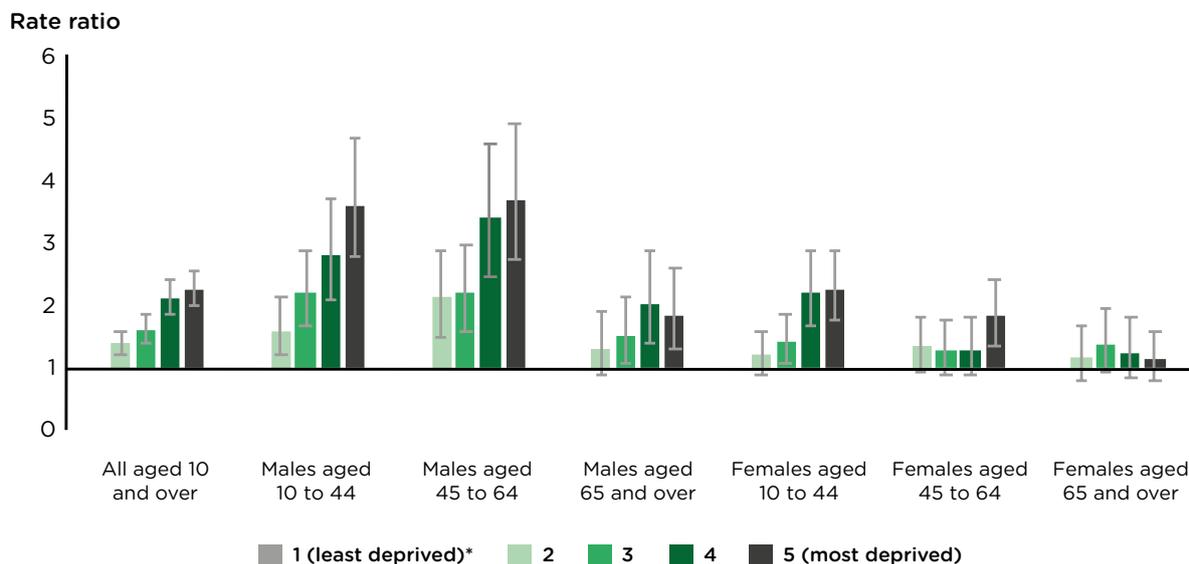
Source: Hsu et al. (22)

Note: 1,639 Large Street Blocks were included in the study.

The Hsu et al. study also showed that there is a socioeconomic gradient in suicide rates (see Figure 7). The rates were 2.3 times higher for the most deprived quintile of the LSBs than for the least deprived quintile. The gradient was more pronounced in males than

females and in younger than older groups. The authors called for community-based programmes offering educational and work opportunities targeting young and middle-aged men.

Figure 7. Rate ratios for suicide mortality by quintiles, Hong Kong, 2005-10



Source: Hsu et al. (22)

Notes: *In each age and sex group the reference group is quintile 1, comprising the least deprived Large Street Blocks. 1,639 Large Street Blocks were included in the study.

Premature mortality has also been shown to present a distinct geographical pattern with clear inequalities. A cross-sectional ecological study using mortality data from the period 2005-09 and area-based information on the 204 STPUGs covered in the 2006 By-Census – with a median population size of 16,000 – showed the presence of two corridors with increased risk of all-cause premature mortality, one in the Northern New Territories and another in central Kowloon, in a commercial area traversed by a busy road. (23) One main finding was that the risk of premature mortality was inversely associated with neighbourhood affluence. However, often, high risk areas were found very close to low-risk ones, suggesting that investigating health inequalities in Hong Kong requires a granular analysis that goes beyond patterns of macro-scale segregation due to its high population density, as discussed above. (24)

Using health data from 2008-11 for 30,000 older adults who voluntarily participated in health examinations at health centres for the elderly, along with neighbourhood information from the 2011 Census, Guo et al. set out to examine the independent effect of neighbourhood-level factors on depression. (25) Older adults (and also young

children) spend more time in their neighbourhoods than young and middle-aged adults, so their health is potentially more susceptible to influences in their immediate environment. The cross-sectional multi-level study showed an association between neighbourhood poverty and depression outcomes for women: i.e. having depression or depressive symptoms, based on the 15-item Geriatric Depression Scale (GDS) in which depression was operationalised as having eight or more symptoms. For men, the association appeared with depression but not with depressive symptoms. The researchers also concluded that some factors were protective against depression, such as a high concentration of elderly people in the area or its walkability.

The aforementioned studies show the existence of clear associations between area socioeconomic characteristics and different health outcomes in Hong Kong. However, it is important to keep in mind that ecological studies do not enable causation to be established. Ideally, new multi-level longitudinal studies would be carried out to shed some light on how area deprivation interacts with individual characteristics to affect health outcomes in Hong Kong.

HOUSING AND HEALTH INEQUALITIES IN HONG KONG

The World Health Organization has defined healthy housing as ‘shelter that supports a state of complete physical, mental and social wellbeing’. (8) The negative health effects of low-quality housing are well established. Exposure to indoor damp and mould has been associated with asthma in children, while long-term exposure to noise can cause hearing loss and psychological and physiological distress, cognitive impairment in children, and cardiovascular disease, among other negative impacts. (27, 28) The longer the accumulation of advantage and disadvantage across the life course, including that associated with housing, the greater the effect on health. (28) Living in good quality housing is of particular importance for those with chronic conditions, the elderly and small children, because of their greater vulnerability and the amount of time they spend at home.

In our first report of this series, we examined inequalities in living conditions in Hong Kong, including the problem of overcrowding, poor quality housing and unaffordability. In this chapter we expand on some of these problems and the implications for health and inequalities of the extended role of the Government in providing public housing and the issue of subdivided units (SDUs).

Cold winters are associated with peaks in mortality, in particular among the elderly, and the absence of central heating in cold climates has been linked with a higher risk of dying in winter. (29) Bad insulation, absence of ventilation and a lack of cooling systems can increase the exposure to climate extremes (26) and extended periods of high temperatures increase the number of deaths from respiratory and cardiovascular diseases, diabetes mellitus and renal disease. (30) Groups such as outdoor and manual workers, the homeless, the poor, children and the elderly ‘are more exposed and/or more physically or socioeconomically vulnerable to physiological stress, exacerbated illness and an increased risk of death from exposure to excess heat’. (30) Chapter 3 of this report deals with climate change and heat-related inequalities in health in Hong Kong.

A home can provide a sense of security, where people can feel most in control of their own lives. (29) How this sense of security relates to different aspects such as owning or renting and living in public or private accommodation depends on the context and varies between countries. In some Western countries, home ownership has been associated with better health outcomes such as better self-assessed health (31) but characteristics such as the cost of the dwelling might alter this relationship. (32) Data for England shows that households with children in owner-occupied homes are less likely to move several times compared with renting households, while parents who move the most show worse self-rated health. (33) As mentioned below, rates of home ownership have recently declined in Hong Kong. Certainly, having to constantly move home because of a lack of security,

or being faced with eviction or repossession, creates instability and stress and negatively impacts health and wellbeing. (35, 36)

Affordability can also impact health, directly and indirectly by reducing the available income for daily necessities. (35) This is all very relevant to Hong Kong where, as we have analysed in our two previous reports and will expand on below, unaffordability of housing is one of the greatest problems faced by working people.

AFFORDABILITY

There is no international consensus on the definition or measure of housing affordability. Eurostat, the statistical office of the European Union, uses the ‘housing cost overburden rate’, which shows the share of the population living in a household where total housing costs represent more than 40 percent of disposable income. Housing unaffordability has been associated with poor mental health, self-rated health and physical conditions such as walking ability, hypertension and arthritis. (36) Since having a home is an essential human need and many people spend substantial proportions of their income on housing – in renting or mortgage payments – housing affordability also conveys a balance between the cost of housing and other non-housing expenditure. If people are obliged to spend large parts of their income on housing, they will have less money left for essentials. (35)

A study conducted in 2019 showed a correlation between the affordability of housing in Hong Kong and physical and mental health. (36) The authors measured affordability by subtracting the monthly mortgage repayments or rents, if any, from monthly household income, which were then regrouped into four quartiles based on the residual income level after housing costs. The authors found that relative deprivation, which refers to the inability of respondents to afford items deemed essential by the majority of Hong Kong’s adult

population, played a mediating role in the relationship between housing affordability and health, but did not explain all the association. Deprivation accounted for 34 percent of the impact of housing affordability on physical health and 16 percent of the impact on mental health. This means that housing affordability exerted a direct effect on health through pathways other than deprivation, with the implication that it can have an impact on the whole of society, not only on the most deprived. Consequently, the study's findings suggest that addressing the issue of unaffordable housing could be a viable approach to enhancing the overall health of Hong Kong's population.

In our two previous reports, we discussed the problem of housing affordability in Hong Kong, which has one of the least affordable housing markets in the world. The median cost of a dwelling was 18.8 times the annual median pre-tax household income in the third quarter of 2022, higher than in Sydney at 13.3 times and Vancouver at 12 times median income, and the highest among another 94 housing markets in eight countries (Australia, Canada, China, Ireland, New Zealand, Singapore, the United Kingdom and the United States). (16) The termination of rent control in the private market since the early 2000s, the shortage of construction land, the land property system – whereby all land is held under a public leasehold system – and planning restrictions have all been suggested as possible causes for Hong Kong's high housing costs. The Government estimates that the revenue from the land premium (paid by commercial developers due to enhancement in land value arising from lease modifications or changes of use), which is one of its major sources of revenue, will be HK\$85 billion in 2023–24, representing about 13 percent of its total revenue. (37)

Between 2006 and 2013, the average price for a small residential unit increased by 188 percent, while the median monthly household income increased by only 30 percent. In contrast, between the 1980s and the mid-1990s the growth in median monthly household income was closely aligned with the pace of increase in flat/apartment prices. (38) The proportion of households owning the property they live in decreased to 48.6 percent in 2021 from 52.1 percent in 2011. (19) In 2021, domestic households in private residential housing (whole house/flat) median rent was 31.5 percent of income, compared with 11.7 percent in public rental housing units. (19)

As we showed in our previous report *Build back fairer: reducing socioeconomic inequalities in health in Hong Kong*, lower-income groups pay a disproportionately high proportion of their income on housing compared with those with higher incomes. (1) In 2021 the median proportion of income spent on housing fell as income decile increased, except for rental costs for deciles 9 and 10, where it was higher than for deciles 4–8, probably due to extremely high rental costs for these deciles. For the lowest income decile, the median cost of rent in 2021 was 54.6 percent of income, and the median cost of mortgage and loan repayment was 73.4 of income, compared with 15.6 and 13.4 percent, respectively, for the highest decile. (19)

As discussed further below, the unregulated private housing market coexists with strong public provision, with the state providing public housing to almost half of the population. (39)



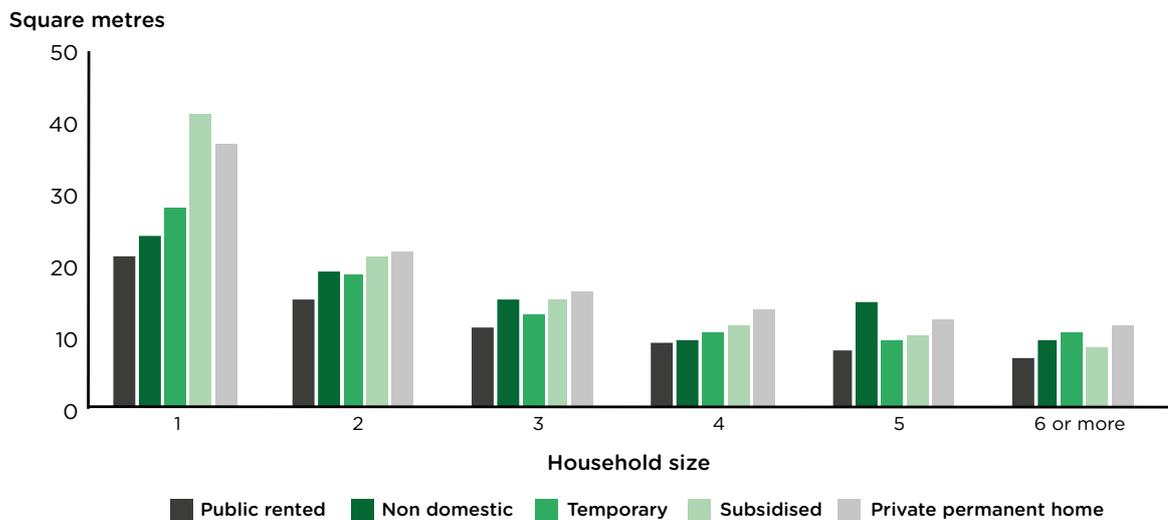
OVERCROWDING

A household is deemed to be overcrowded when there are more occupants than the capacity of the dwelling space (measured in rooms, bedrooms or floor area) and is associated with negative physical and mental health outcomes (40). Overcrowding also depends on the sex, age and the relationship of the people living in the household (40). It has been linked with worse mental health and psychological distress due to lack of privacy and increased risk of personal conflicts in the household. It has also been associated with increased risks of infectious diseases, including COVID-19 (41).

Overcrowding can also have a negative effect on educational attainment (40).

In Hong Kong, people in public rental housing have less space available to them, while owners of subsidised public housing enjoy greater per capita floor area of accommodation than renters of public housing do. As Figure 8 shows, those in private housing generally enjoy more space than all the rest, except for one- and five-person households. (19)

Figure 8. Median per capita floor area of accommodation by household size and type of housing, Hong Kong, 2021



Source: Census and Statistics Department Hong Kong SAR (2022) (19)

A longitudinal population-based cohort study (FAMILY Cohort) in Hong Kong was used to explore how residential environments are related to the development of depression. The data included a total of 16,968 participants aged 16 or above recruited between 2009 and 2011 at baseline who were then followed between 2011 and 2013. Residential density was measured at the apartment, building block and neighbourhood level and participants were assessed using the diagnostic tool for depression, the Patient Health Questionnaire-9 (PHQ -9). As residential living space reduced and block population density increased, there was an associated increase in the odds of having depressive symptoms and major depression, controlling for a range of sociodemographic factors and characteristics of the wider residential environment. (42)

TYPE OF HOUSING (PUBLIC VS PRIVATE)

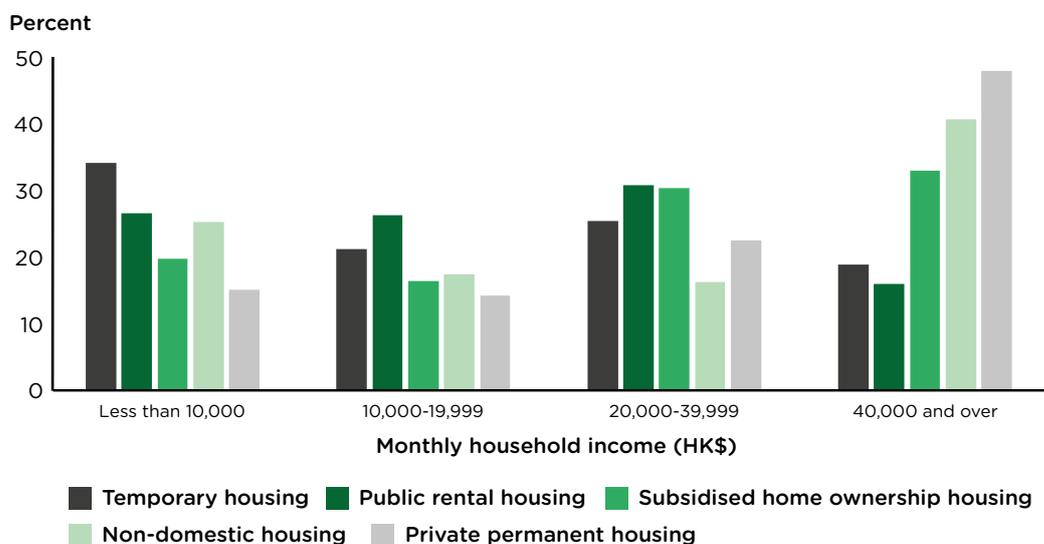
Contrary to what happens in most other areas of Hong Kong's economy, the Government plays an interventionist role in the housing market. As mentioned earlier, almost half - 45.7 percent - of the population of Hong Kong lives in public housing provided by the Housing Authority, with 30 percent of the population in public rental flats and 15.7 percent in subsidised sale flats. (39) The reason for the high prevalence of public housing dates back to the 1950s when some high-density areas experienced poverty and overcrowding, prompting the British colonial government to decentralise new building efforts by first creating new satellite towns and then in the 1970s developing New Towns. (43)

Low-income families who cannot afford to rent privately can apply for subsidised public rental housing. For example, for a household of four people it is based on a monthly income limit of HK\$30,950 and a net asset limit of HK\$573,000 (44).

Figure 9 shows how the income profile of households differed between types of housing in Hong Kong in 2021. Almost half (48 percent) of the 1.4 million households in private permanent housing had a monthly housing income of HK\$40,000 or more, compared to 16 percent of the 0.8 million households in public rented housing and 19 percent of the 24,000 households in temporary housing. Consequently, 71 percent of all households earning HK\$40,000 or more lived in private permanent housing in 2021. Conversely, around a third of households (34 percent) in temporary housing and around a quarter (27 percent) in public rental housing had a monthly household income below HK\$10,000 compared to 15 percent of

those in private permanent housing. This illustrates the extent to which housing opportunities are segregated by income (and hence affordability) in Hong Kong. While the 400,000 households in subsidised housing were fairly evenly split between the highest earning households (33 percent with income of HK\$40,000 or more) and those with middle incomes (30 percent with incomes between HK\$20,000 and HK\$40,000), it seems that the distribution of the 13,000 households in nondomestic housing (e.g. housing in places of employment) was bimodal, occupied predominantly by those on the lowest incomes or by those with the highest incomes – rather than middle income households.

Figure 9. Percent distribution of monthly domestic household income within each type of housing, Hong Kong, 2021



Source: Census and Statistics Department Hong Kong SAR (2023) (45)

Given the high income-inequality in Hong Kong and the out-of-reach prices of private property for many, for those who cannot afford to buy, public housing provides a better and more affordable alternative to poor quality/expensive rented accommodation. This has potential direct and indirect benefits for their health. (23) Since social housing exists in a wider context in which realities such as area deprivation, the quality of the built environment, access to services and stability of tenure can interact and potentially influence health, it is important to disentangle the effects of public housing from these other confounding factors at the neighbourhood level in order to demonstrate these benefits. Kandt et al. set out to do this in the study mentioned earlier that found two corridors with increased risk of all-cause premature mortality in Hong Kong, using data for all mortality causes between 2005 and 2009. (23) In addition to important geographical differences, the authors found that while public rental housing seemed at first to be positively associated with a higher risk of premature mortality, in the case of premature deaths caused by injuries (type III Premature Mortality in the study) and non-communicable diseases (type II PMR), the association was reduced and even reversed in some cases,

when adjusting for area characteristics. For example, the positive risk of type II PMR reversed to negative after controlling for neighbourhood affluence and housing instability, public rental housing thus emerging as a protective factor. (23) However, some authors have pointed out that it is important to consider that premature mortality may not reflect the overall health status of a population and other health outcomes should also be studied. (46) It is also important to note that the cross-sectional and ecological nature of the Kandt et al. study does not allow the establishment of causal relationships, even if it provides important contextual information.

While further studies are needed on the topic, Kandt et al. offer some plausible potential pathways, including the increase in households' disposable income made possible by subsidised rents; the general good quality of housing estates due to good maintenance and management by the Housing Authority; the absence of stigma given the wide presence of this type of housing in good locations; and strong social cohesion facilitated by the prioritisation of families in the allocation process.

Results along these lines were obtained in a cross-sectional study that used self-reported health information from nearly 26,000 individuals from the Government's Thematic Household Survey between October 2011 and January 2012. While living in private housing (rented or owned) was initially negatively associated with multi-morbidity, the result was reversed after adjusting for gender, age, income, employment, education and smoking status, becoming a risk factor for the presence of multi-morbidity and an increased number of chronic diseases. (47)

A study with a representative sample of 1,977 adults interviewed between May 2014 and July 2015 aimed to shed light on the relationship between public rental housing and obesogenic behaviours such as infrequent eating of fruit and vegetables, physical inactivity and prolonged sitting, but produced mixed results. (48) The authors found that public rental housing is associated with a higher density of fast-food restaurants and convenience stores relative to grocery stores and with lower street view greenness, but with a higher density of sports facilities. While renters in public housing showed a higher rate of physical activity than those in private housing, explained by the higher presence of sports facilities, they also exhibited lower rates of frequent eating of healthy food and a higher - but not significant - rate of prolonged sitting, both only partially explained by the unhealthier food environment and the lower presence of greenery.

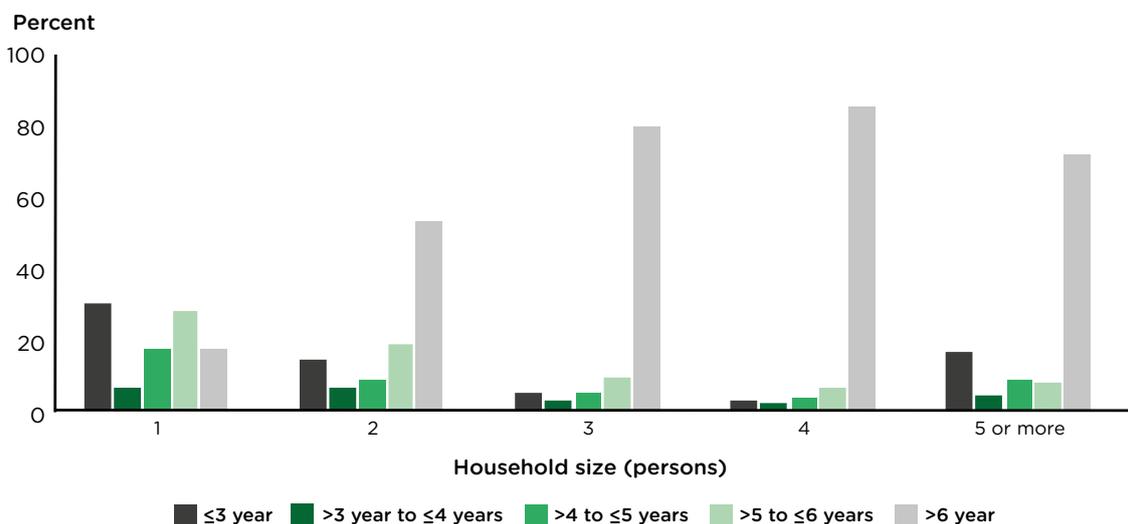
The cost of a healthy diet can be one of the barriers to good nutrition. However, a practical analysis conducted by Sin et al. showed that in Hong Kong a healthy diet is not necessarily more expensive than a typical unhealthy one. (49)

Waiting times and public expenditure on housing

While rent differentials between public and private housing have increased since the 2000s, the pace of construction of public housing has not kept up with demand and waiting times are long. (50) In spite of the Housing Authority's waiting time target of three years, the average waiting time in the year 2021-22 for public rental housing was 6.1 years. (39) Also, this target only applies to families and elderly one-person applicants. This system has been criticised for making it very difficult for young applicants to access subsidised rents. (51)

As Figure 10 shows, among those who were housed between July 2021 and June 2022, those who had been waiting for six or more years amounted to 53 percent of two-person households, 80 percent of three-person households, 85 percent of four-person households and 71 percent of households with five or more people.

Figure 10. Distribution, within each household size, of waiting times by general applicants housed in public rental housing in Hong Kong between July 2021 and June 2022

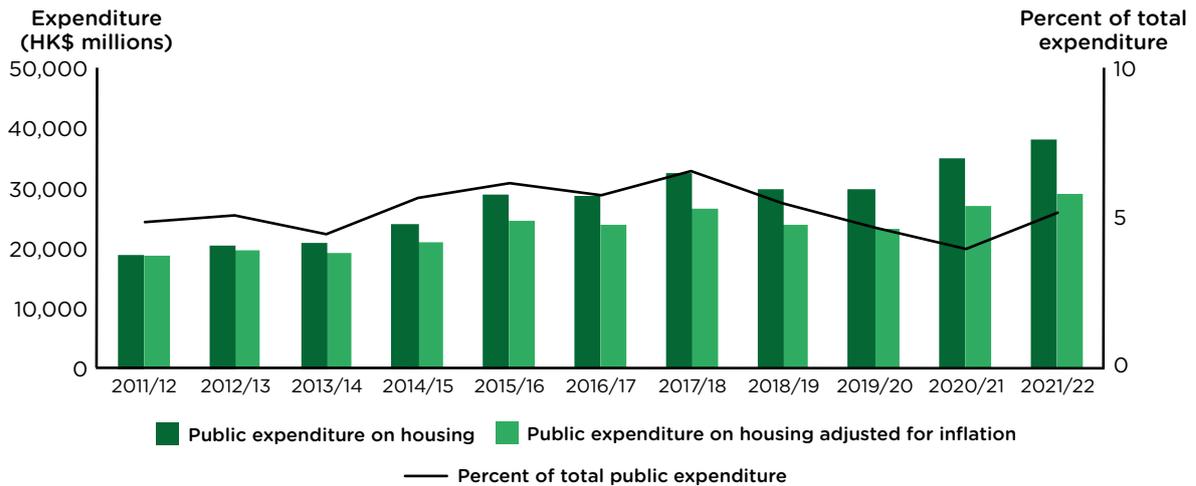


Source: Hong Kong Housing Authority and Housing Department (2023) (52).

Public expenditure on housing as a percent of total public expenditure increased between 2011/12 and 2021/22, both in absolute terms and after adjustment for consumer price inflation, although with a slight reduction in real terms between 2017/18 and 2019/20

(Figure 11). It increased from 4.9 to 6.6 percent between 2011/12 and 2017/18, then decreased to 4.0 percent in 2020/21, followed by a slight rise to 5.2 percent in 2021/22 (Figure 11).

Figure 11. Public expenditure on housing, Hong Kong, 2011/12 to 2021/22

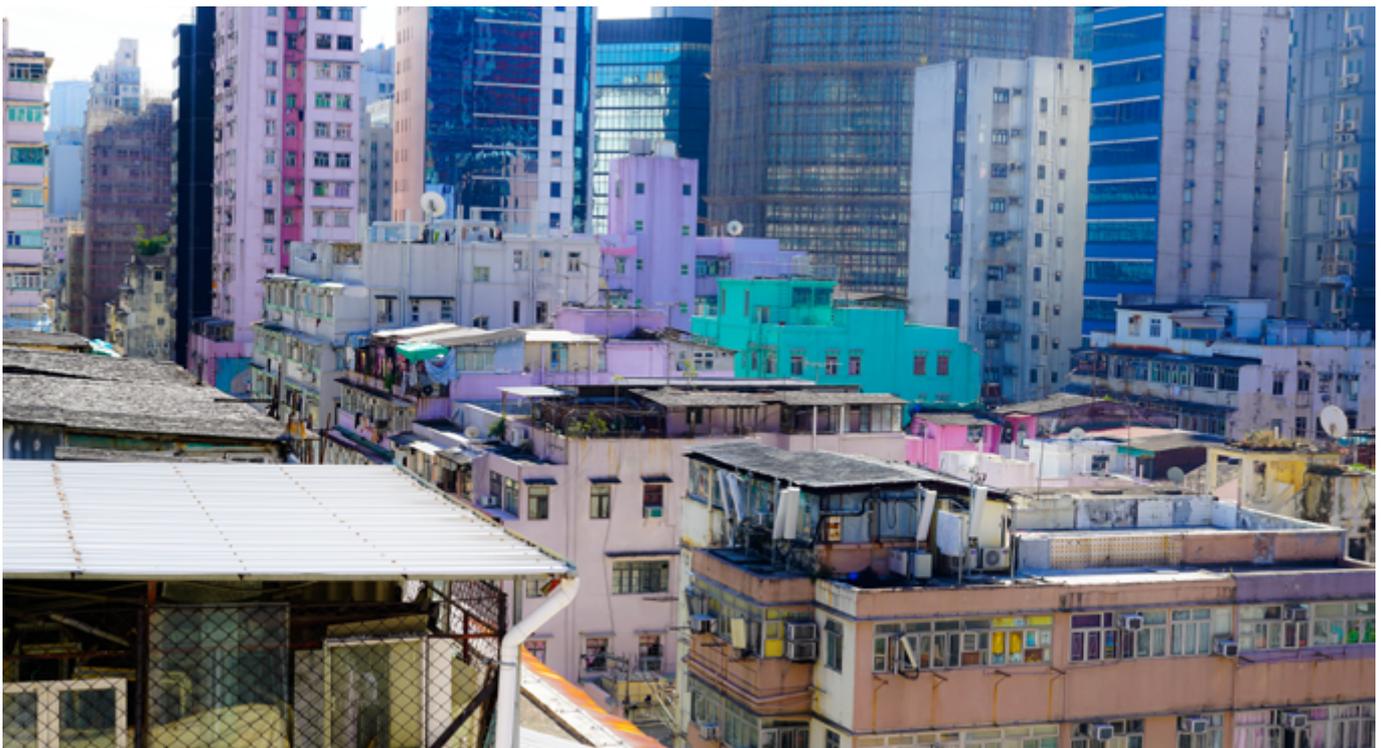


Source: Housing Bureau (2022) (39) / World Bank Consumer Price Inflation (2024) (53).

In 2018 the Government established a Task Force on Transitional Housing to increase the supply of transitional housing, including social housing in vacant residential buildings and government premises, new modular housing on government and private land, and converted housing from non-residential buildings. (54) The aim of transitional housing is to provide temporary accommodation for families on the waiting list for public rental housing and those living in inadequate housing, which includes temporary structures such as huts, squats and roof-top structures; units located in non-residential buildings, such as inside commercial and industrial buildings; units that are shared with other households, such as people living in rooms, cubicles, bed spaces and cocklofts (small upper lofts under the ridge of a roof); and subdivided units (SDUs – see below). (55)

The Funding Scheme to Support Transitional Housing Projects by Non-government Organisations set up in June 2020 has facilitated the construction of 8,047 transitional housing units and 13,082 projects have had their funding approved. (56).

The Government announced in 2022 the construction of what it calls ‘light public housing’ using modular architecture to build 30,000 new units in five years to accommodate residents who are waiting for public rental housing with subsidised rents. Applicants must have been waiting for public rental housing for at least three years to be eligible and priority is given to families. Successful applicants do not lose their place in the queue for traditional public rental housing. (57)



SUBDIVIDED UNITS (SDUs)

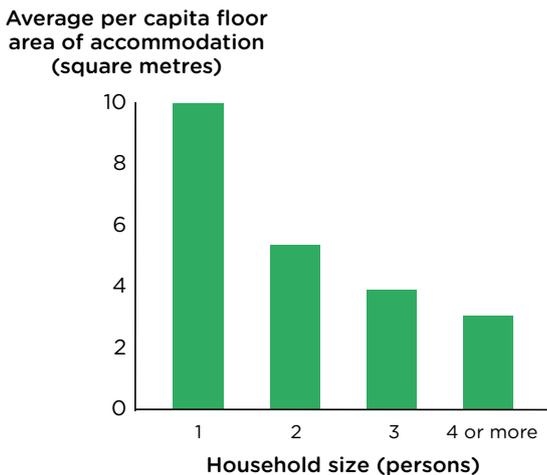
In 2022, there were 108,200 households and 216,000 persons residing in subdivided units in Hong Kong. These are living spaces created by splitting up a larger flat initially designed for a single family and are the most common type of substandard accommodation in Hong Kong. (60, 61) In 2021, although 39.6 percent of SDUs were occupied by just one person (compared with 20.2 percent in all types of housing in Hong Kong), 49.2 percent were occupied by nuclear families (compared with 61.6 percent in all types of housing). (58)

Health impacts

SDUs are a result of the unaffordability of the housing market in Hong Kong and the shortage of public rental housing. Almost half of all households living in SDUs in 2020 (48.4 percent) had applied for public rental housing, according to a Government-commissioned survey carried out in 2020/21. (60)

SDUs are not illegal but they are often a result of unauthorised works that do not comply with building codes. (61) They are typically very small: in 2021 the median per-capita floor area of SDU accommodation was 6m², while the average across all housing types was 16m². Unsurprisingly, this varies by household size, with two-person households living in slightly less than 6m² per person on average, and households of four or more persons having only 3.3m² of living space per person (see Figure 12).

Figure 12. Average per-capita floor area of accommodation in SDUs by household size, Hong Kong, 2021



Source: Census and Statistics Department Hong Kong SAR (2022) (58)

Almost 60 percent of SDU households have a total floor area of accommodation – excluding space shared between households – of between seven and 13m². (58) In the most extreme cases, SDUs are so small that they can barely accommodate one person and their belongings, thus receiving the name of ‘cage homes’.

In a representative governmental household survey of housing conditions in SDUs published in 2016, only 18.1 percent of occupants were “very satisfied” with their living environment, while 38.1 percent were “very dissatisfied” and 43.8 percent showed average levels of satisfaction. (62) According to the 2021 Population Census, only 66 percent of SDUs have their own kitchen. (58) When residents have no access to an independent and separate kitchen, the only way to cook is to do so with induction or electric cookers within their unit, which can increase exposure to air pollution and therefore may pose health risks, in particular to children. (63) This can also negatively impact on nutrition, as the kinds of foods that can be cooked at home will be limited. For example, residents without access to a proper kitchen may resort to only water-based cooking. (64)

Windows are required for ventilation and to keep indoor pollutants to a level that is safe for health. A 2016 thematic report on SDUs in Hong Kong revealed that 12 percent had no windows that could be opened and were outside the quarters when opened, allowing for proper ventilation. (62) Researchers carried out continuous monitoring of indoor air quality in eight SDUs for 48 hours in 2018 and found that the division of the space in SDUs made them more susceptible to air pollution by blocking ventilation. (64) Also, the lack of kitchen partition meant cooking fumes reached the entire space, potentially impacting all occupants. The use of air conditioning also limited the dispersion of air pollutants. Particulate matter and volatile organic compounds (VOCs) emitted while cooking, using air conditioning or by hang-drying clothes were the most prevalent pollutants, together with carbon dioxide.

Although not all people living in SDUs endure poor housing conditions, the NGO Society for Community Organisation (SoCO) has alerted against the potential impact that the poor living conditions that are common in SDUs can have on mental health, stress and ability to rest. (65) There is also a concern that SDUs might present environmental risks for health, (64, 65) structural stability problems and fire safety hazards. (66) In 2022, at the request of the Government, the Hong Kong Council of Social Service (CSS) commissioned 54 service providers to contact low-income households living in SDUs and gather information on their physical and mental health and service needs via a survey. Measuring self-rated health through the Veterans RAND 12-Item Health Survey, they obtained 1,105 valid questionnaires with a non-representative sample. Residents considered dust, noise from the street

and pests as the most serious problems, followed by a lack of natural light. Other identified problems were poor air circulation, bad odours and mould.

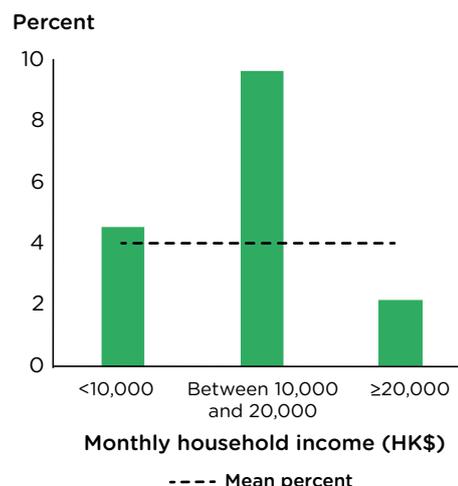
According to local media and the Financial Secretary's official blog, in 2021 the director of the State Council's Hong Kong and Macau Affairs Office, Xia Baolong, expressed the wish to eliminate all subdivided flats by no later than 2049, when the People's Republic of China will be celebrating the centenary of its founding. (68, 69)

Socioeconomic and demographic characteristics of SDU residents

Census data shows that migrants and those who are not ethnically Chinese are overrepresented in SDUs. Only 2.8 percent of ethnic-Chinese live in SDUs compared with 8.9 percent of the non-Chinese population. However, among those households where at least one member is from Mainland China and has been living in Hong Kong for less than seven years, the proportion of households living in SDUs is very high, at 23.8 percent. By ethnicity, 27.8 percent of Nepalese residing in Hong Kong live in SSDUs, while 16.2 percent of Filipinos, 11.5 of Indonesian and 9.3 of Pakistanis do so, representing much higher proportions than Whites (1.9 percent) and Indians (5.9 percent). (58)

The median household income in 2021 of those living in SDUs was lower at HK\$15,310 than the median at HK\$27,650 of all households in Hong Kong. Across all income levels, households in SDUs comprised four percent of all households, with a similar figure among households with incomes below HK\$10,000 (Figure 13). This indicates that there was not a disproportionate number of households in the lowest income band living in SDUs. However, those living in SDUs were disproportionately represented in the income band HK\$10–20,000 (9.6 percent of all households) and under-represented among households with an income of HK\$20,000 or above (2.2 percent of all households) – see Figure 13.

Figure 13. Households living in subdivided units as a percent of all households, by monthly household income, Hong Kong, 2021



Source: Census and Statistics Department Hong Kong SAR (2022) (58)

In spite of the often-poor living conditions of these units, SDUs can still be expensive for their residents. In 2021, the median rent-to-income ratio of residents of SDUs was 32 percent, slightly higher than that of all households (at 31.4 percent). This, and a concern about landlords abusively increasing rents to tenants who often have no other choice of accommodation, prompted the Government to intervene to establish rent control of SDUs. The Legislative Council approved a bill in October 2021 that establishes a 10 percent limit on annual increases, guarantees a four year security of tenure for tenants and forbids landlords from overcharging for utilities. (69) The Government has also commissioned NGOs to support tenants to defend these rights. (43)

In 2021 there were more than 2.5 times as many households paying more than HK\$6,000 in rent for SDUs than there were five years earlier, during which time consumer price inflation would only have accounted for a nine percent increase in rents – see Figure 14. (53)

Figure 14. Households living in subdivided units by monthly household rent, Hong Kong, 2016 and 2021



Source: Census and Statistics Department Hong Kong SAR (2022) (58)

ENERGY POVERTY

The issue of energy poverty has been studied mainly in the context of developed countries in Europe, focusing on the health effects of fuel poverty and cold homes. As noted by Yip et al., energy poverty in Hong Kong is of a different nature due to its climate, energy system and housing market, (70) and one of its main manifestations can be the inability to cool the home. Hong Kong has a subtropical climate with hot and humid summers. The average temperature in the summer is around 28°C and the average relative humidity around 75 percent. (73, 74) The highly dense urban environment creates an urban heat island effect. Climate change will make extreme weather more frequent and intense, increasing the impacts of heat on human health. (73)

In Hong Kong, both energy companies increased their fees in 2023 over the previous year, which had already seen an increase. (74) The average net tariff rate for CLP Power Hong Kong Ltd. and Castle Peak Power Company Ltd. increased by almost 20 percent between January 2022 and January 2023. The increase was even greater (almost 47 percent) for customers of the Hongkong Electric Company Ltd. Residents of SDUs in particular have been historically overcharged by landlords for the electricity they use, due to the common practice of using unauthorised utility meters, or the fact that even when authorised meters exist, tenants pay their fees to the landlord and not to the utility companies. (75) The installation of independent electric meters has been a basic demand from people living in these units. (76)

There are no up-to-date estimates of the reach of energy poverty in Hong Kong, even though it is likely to become a bigger problem due to more extreme temperatures related to climate change. There is already some evidence that the most disadvantaged groups are less likely to be able to shield themselves from high temperatures compared with those who are better-off.

A representative telephone survey found that around 90 percent of Hong Kong's Chinese population have access to cooling devices (air conditioners or fans), but people with the lowest education level, the unemployed, those living in public housing and those with the lowest household income are more likely to not use cooling devices. (77) A more comprehensive diagnosis of the problem could help the Government take appropriate measures.

People living in inadequate housing such as SDUs or rooftop structures can be particularly vulnerable to extreme weather events, including extreme heat. After interviewing 200 people with low incomes living in subdivided flats and measuring temperatures inside and outside their flats in 2021, a research team commissioned by Oxfam found that 45 percent of the flats presented higher temperatures than those outside. Close to 70 percent of those interviewed said that the heat affected their daily lives, and their physical health in particular. (78) The Government has not put in place specific measures to mitigate the negative effects of heat on people living in these substandard dwellings. (79)

HEALTH IMPACTS OF COLD WEATHER

In spite of the tropical climate in Hong Kong and the predominance of hot weather (discussed further below as part of climate change), some studies have pointed to the negative health effects that cold spells or lower relative temperatures in the cool season can have on a population that it is not adapted to cold in a territory with low prevalence of central heating. (80) Most air conditioning devices in Hong Kong do not have a heating option and buildings are not designed to maintain heat. (81) The cool season lasts from December to March, when mean daily temperatures vary between 10°C and 20°C. In 2008, Hong Kong experienced its longest cold spell in four decades, when mean temperatures stayed below 14°C for 24 consecutive days. (82) However, overall the amount of cold days has been decreasing in Hong Kong. (83)

Analysing over 360,000 deaths between 2007 and 2015 and controlling for the possible confounding effect of air pollution, Liu et al. found a stronger effect of low temperatures than high temperatures on non-accidental, cardiovascular, respiratory and cancer deaths. (81) Higher mortality associated with 'extreme low temperature' was found for all SES groups (using a proxy measure of TPUs' median monthly household income), a finding the authors say is consistent with literature from other subtropical cities. Another study, with data for 2002–2011 and controlling for pollution levels and other factors, found increased public hospital

admissions and deaths from heart failure with lower mean daily temperatures (11°C vs. 25°C) and a stronger association for older age groups. (80) Other studies have found an increased risk of pneumonia hospitalisation for the elderly during cold periods, (84) more asthma hospitalisations when there are low temperatures and low relative humidity in the cold season, (85) and an increase of admissions for cardiovascular diseases, intentional injuries and respiratory diseases for every decrease of 1°C within a range of 8.2°C–26.9°C during the cold season. (86)

TRANSPORT

Having access to good transport is important because most people rely on it to be able to get to work or access education, meet others, and reach all kinds of services. While good transport can improve people's opportunities, not having access to good transport increases inequalities in the social determinants of health. (5)

A healthy and sustainable transport system is one that is accessible and efficient for everyone; affordability is key for people in choosing which means of transport they use. It can also minimise the harm caused by pollution and noise, by promoting active travel (walking and cycling) for short journeys and commuting and discouraging the use of private vehicles. Active travel is good for health, because it increases overall levels of physical activity. (87) Finally, transport infrastructure can make it easier for people to access their local services, including shops and amenities, and this can reduce social isolation. (88) It is important that all these potential benefits of a healthy and sustainable transport system reach all groups in society and do not contribute to widening health inequities. Equity needs to be incorporated into the design, implementation and evaluation of interventions. (89)

PUBLIC TRANSPORT AND COMMUTING

Hong Kong's public transport system is generally considered to be very good and is used daily by 90 percent of the population. (90) Every day, 9.7 million journeys are made on the public transport system, consisting of railways, franchised and non-franchised buses, minibuses, taxis, ferries and trams. (91) The railway has been the priority in the Government's public transport policy. (92)

During the COVID-19 pandemic, some fares were frozen. After they were unfrozen, there were several rises in the first half of 2023, including an increase in fares of 2.3 percent made by the railway company, (93) a rise of between 3.9 and seven percent made by five franchised buses companies, (94) and an increase of 56 percent by one of the ferry companies. (95) Data from the latest available Household Expenditure Survey, for 2019–20, indicates that transport represented seven percent of total household expenditure in that period. (96)

Railway fares are established by MTR Corporation Limited - a company that is owned by the Government in its majority but has also been partially privatised and is listed on the Hong Kong Exchange - through the Fare Adjustment Mechanism (FAM). The FAM takes into consideration the 'overall economic performance of Hong Kong', including developments in inflation and transport workers' wages. It also considers the so-called 'Productivity Factor', (97) which is based on annual profits made by MTR's property development branch, under a

model that grants the company rights to build on top of new stations by partnering with private developers. While it has enabled the company to be self-financing and limit fare increases, (98) this policy has also been criticised for incentivising the construction of private buildings and benefiting investors instead of the general public. (99)

Most of the working population in Hong Kong needs to commute to work. Commuters favour rail travel, with 43.2 percent choosing to travel by train, while 25 percent commute by bus and 10.5 percent on foot. (19) The average commuting time for those taking public transport on weekdays is 45 minutes, while 46 percent of commuters spend more than two hours a day on public transport, according to data collected by the consultancy company Moovi. (100) There is growing evidence internationally that non-active commuting can have detrimental effects on health and wellbeing, including on mental wellbeing, via physiological factors such as high blood pressure, and due to commuting using up the time available for activities such as cooking or sleeping. (101)

Transport costs should not prevent those who are more disadvantaged in the labour market from finding and maintaining decent jobs. People who travel to work by private car/passenger van or taxi have a higher monthly income from employment (median values of HK\$42,000 and HK\$40,000, respectively) than those who take local trains (HK\$20,000), buses (HK\$18,750) and those who walk to work (HK\$13,800). (19)

Some scholars have highlighted the 'unbalanced' development between different Hong Kong regions, with most jobs concentrated in Hong Kong Island and Kowloon, while increasingly more and more people live in the New Towns in the New Territories. (100) Given the unequal geographical distribution of jobs, a higher proportion of people living in the New Towns (61 percent, or over one million people) need to work in other areas - including those working in places outside Hong Kong, and excluding those in the Marines or with no fixed places of work - compared with 57 percent of residents in Kowloon (over 613,000 workers) and 50 percent of residents in Hong Kong Island (around 313,000 people). (19) Almost half of those who need to take more than one mode of transport to work live in the New Towns. Barriers arising from these geographical imbalances can be particularly damaging for low-skilled workers, who might see their job opportunities diminished or be forced into accepting more precarious jobs. (100)

In 2019 the Government took steps to ease obstacles related to the cost of public transport, by introducing the Public Transport Fare Subsidy Scheme for those whose transport costs are high. This is a non-means-tested programme, whereby those who pay more than HK\$400 monthly on public transport receive a one-third reduction in their expenses in excess of that amount. (102) The Government extended the subsidy by reducing the threshold to HK\$200 and the cap to HK\$500 between May 2022 and October 2023. Additionally, it runs a concession scheme for older adults aged 60 and above and people with disabilities, who can travel for a maximum fee of HK\$2 per trip. It is plausible that this scheme has improved social inclusion and participation of these groups, but no assessment of this has been made.

In 2021, the Government abolished the Work Incentive Transport Subsidy Scheme (103), a means-tested subsidy that was managed by the Labour Department and aimed at easing the burden related to transport for low-income earners to help them find or stay in employment (104). An evaluation of a previous similar programme targeting job seekers and low income workers in four remote districts found that it had reduced the probability of unemployment among public rental housing residents, in particular among the young and middle-aged male residents, and increased mobility across districts for work among the middle-aged female residents (105).

Car usage

Despite the good standard of the public transport network, private car ownership has been on the rise in Hong Kong. In 2011 there were almost 434,900 licensed private cars; this number had reached 579,000 by 2021,

an increase of 33 percent. (106) Still, the rate of around 76 cars per 1,000 population at the end of 2018 was still lower than in London (303) or Singapore, (110) according to Hong Kong government data. (107) Up-to-date data on the socioeconomic characteristics of car owners and users is not available and the Government is currently conducting a new Travel Characteristics Survey, which last ran in 2011. Data from that edition of the survey indicates that richer districts and newly developed ones had higher-than-average car ownership rates. (107)

Active transport

Only 0.5 percent of the Hong Kong population use a bike in everyday life, compared with 51 percent in Utrecht (the Netherlands) – one of the highest rates in the world; 40 percent in Beijing (China) and one percent in Singapore. (108) A 2019 survey ranked Hong Kong 84th out of 90 cities surveyed globally on bike-friendliness – based on factors including usage, safety, weather, sharing options and infrastructure. (108) The Government has invested in better cycling infrastructure, such as in a growing cycle track network and on trying to improve safety for cyclists. (109)

The Transport Department is also promoting walkability to reduce congestion and improve air quality. The walkability strategy ‘places high priority’ on planning for pedestrians by creating a more conducive environment. (110) Some of the initiatives taken so far are walkway widening; enhancing accessibility of hillside areas; trialling different measures in pilot areas, such as removing pedestrian railings or introducing a low-speed limit zone; and collaborating with other departments in pedestrian planning in areas of new development. (110)



ACCESS TO SERVICES

The ‘deprivation amplification’ hypothesis suggests that neighbourhoods with people from lower economic positions experience underinvestment in public services and resources, which amplifies the negative health effects of individual and household deprivation. (113, 114) If the contrary were true, a higher level and quality of services could compensate for the scarcity of individual or household resources. (113) Not many studies have analysed geographical inequalities in access to services in Hong Kong, so conclusions in this respect can only be tentative.

A study using 2011 Census data to calculate poverty rates and 2009 data from the Lands Department by Large Street Blocks (or LSBs, numbering 1,620 with a median population of 2,110) analysed access to 28 types of services grouped into six categories: health and care services; food services; government services; family services; culture and entertainment; and physical activity and sports services. While richer neighbourhoods showed a better service-to-population ratio overall, poorer ones had better accessibility in terms of distance by road to the nearest service. An index taking into account both indicators showed no clear pattern in half of the services. (113) Beyond this, there is little evidence on inequality of usage. The authors did not study important indicators such as affordability or quality of services, which could be creating inequalities in access

between richer and poorer residents; nor did they analyse how people use these services, only whether they were available in theory.

A study analysing how access to neighbourhood services could mediate the subjective perception of poverty found no association between access to health and care, food, government, culture and entertainment, most types of physical activity and sport services, and the probability of being subjectively poor. (114) Only access to a rest garden/park was found to be associated with a lower risk of subjective poverty, but the difference was small. Data for the study was obtained from the 2015 Hong Kong Panel Survey for Poverty Alleviation, the 2011 By-Census and Lands Department Large Street Block Group 2011 data.



ACCESS TO GREEN, BLUE, AND OPEN SPACES

Green space

Access to good quality green space has been shown to be associated with better physical and mental health. (115) Among the positive health outcomes found in different studies are better perceived general and mental health, reduced all-cause mortality, reduced mortality from cardiovascular disease, reduced prevalence of type-2 diabetes and reduced adverse pregnancy outcomes. (115) As described by Markevych et al. based on available international evidence, green space can have potential benefits for health via different pathways: by reducing harm – for example, reducing exposure to air pollution, noise and heat; by restoring capacities such as attention, or by helping a person recover from stress; or by building capacities, such as encouraging physical activity and facilitating social cohesion. (116)

While the amount of green space has often been used as an indicator, other factors such as ‘accessibility, type, quality, and context of green space’ are also relevant. (115) In particular, usage depends on having safe green space within walking distance of housing. While poor communities, along with children, older people, those with mental health problems and pregnant women, seem to benefit the most from green space in cities, often those from more deprived communities are the ones with less easily accessible green space, according to findings of a narrative review of international literature. (115)

Several studies have analysed the effects of access to green space on the health and wellbeing of the Hong Kong population. An ecological study with mortality data from the 2016 Census concluded that an increase of 10 percent in the density of green space was associated with an estimated decrease of 4.8 percent in the risk of non-accidental mortality. (117)

Using data from 4,000 Chinese adults in Hong Kong aged 65 years or above at baseline (between August 2001 and December 2003) with follow-up at two years, researchers found that living in neighbourhoods with a higher percentage of green space (within a 300-metre radial buffer around participants’ homes) was linked to an improvement in frailty status, independent of a broad range of individual characteristics. (118) The association between green space and frailty remained significant for men but not for women when analysing effects by sex. Similarly, a study with 3,544 Chinese adults aged 65 or older recruited in 2001 at baseline and followed in two rounds in 2003–05 and 2005–07 showed that higher coverage of green space was linked to lower risks of all-cause mortality, circulatory system-caused mortality and stroke-caused mortality. (119)

A Hong Kong study collecting data in 2014 with 2,081 adults aged 65 or older from 12 public rental estates

found that local greenness was associated with fewer depressive symptoms within both 200m and 500m buffers. (120) However, leisure facilities offering only more passive activities (e.g. pavilions, and small open spaces) available within a 500m buffer were associated with more depressive symptoms in the study group. The authors hypothesise that a possible reason might be the inadequate size of these neighbourhood facilities in Hong Kong, which might be too small for people to enjoy their potential benefits, instead making them more aware of their unmet needs for outdoor space. However, some recent international evidence has pointed to the benefit of small recreational areas. For example, a study with data from 4.6 million adults in London found that a 1 percentage point increase in ‘pocket park’ coverage (which are areas for rest and recreation of less than 0.4 hectares) was linked to a reduction in the risk of all-cause mortality, (121) so this issue should be further investigated in the Hong Kong context.

The Hong Kong Planning Department distinguishes between different types of open space, understood as space used for recreation and enjoyment of the general public. (122) Not all public open space consists of parks and gardens, so it cannot be taken as equivalent to green space. Due to the high population density in the inhabited areas and hilly parts of the Hong Kong territory, green spaces are highly concentrated in protected areas and the urban periphery. In fact, Zhang et al. found that two-thirds of TPUs do not have any urban park. (123) In that same study, there was no association found between levels of deprivation in TPUs or a higher presence of ethnic minorities and the quantity of parks, the quality of amenities, park safety or park aesthetics. However, as the authors mention, the use of smaller geographical units would be better to avoid heterogeneity and reduce the risk of ecological fallacy. (123)

In the Hong Kong Planning Standards and Guidelines (HKPSG), which set out the minimum required provision of open space, Local Open Space (LOS) refers to small spaces of at least 500m² ‘where possible’ that serve the needs of the neighbourhood population, mainly for passive recreation. It includes seating down areas and children’s playgrounds. (124, 126) District Open Space (DOS) refers to medium-sized sites of ideally at least 1ha in area that serve the population of a district for passive and active recreation and should include sports facilities. (124, 126) Large sites that serve as Hong Kong’s ‘green lungs’ are referred to as Regional Open Space, half of which is counted towards DOS in examining the fulfilment of the HKPSG. (124, 126) Country parks, green belts and conservation areas are not considered countable open space for the purposes of minimum required standards.

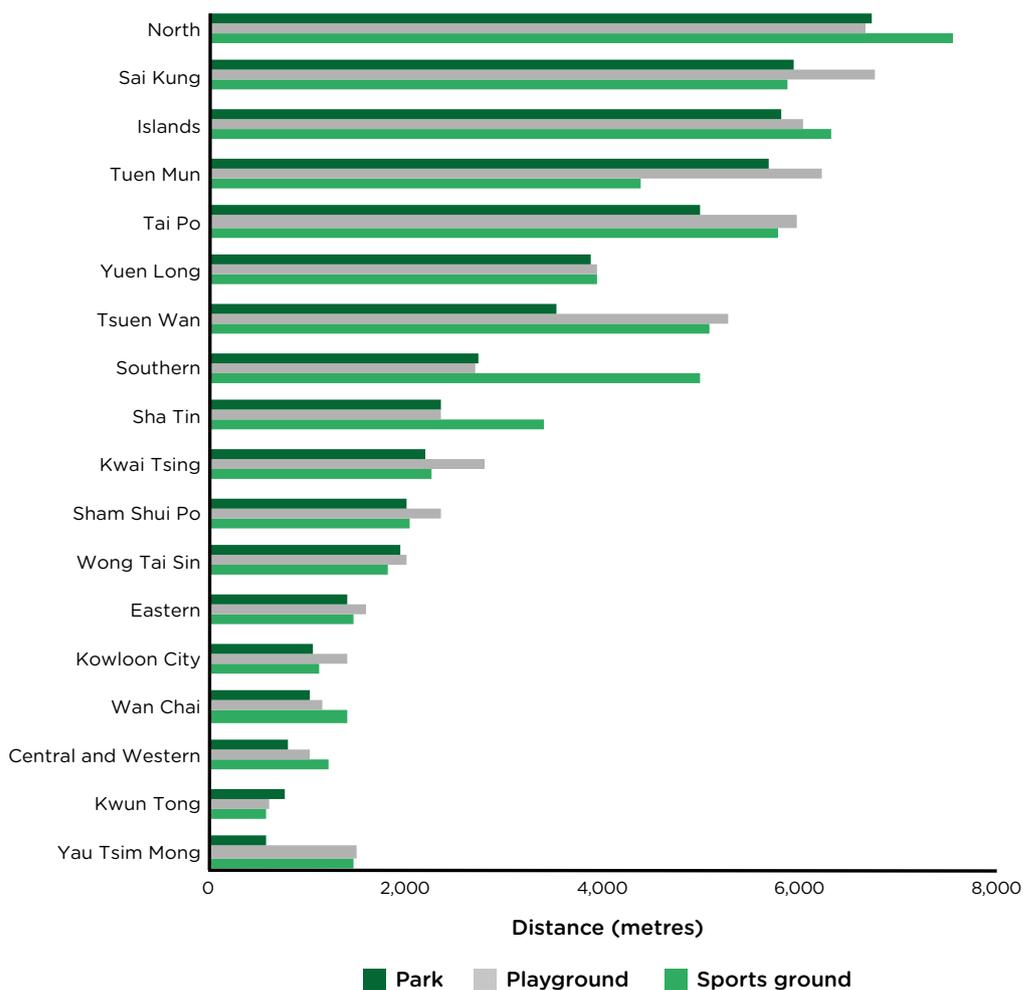
In urban areas, the minimum required provision of open space is 2m² per person, divided between 1m² per person

for District Open Space and 1m² per person for Local Open Space. (122) The Hong Kong NGO Civic Exchange estimated the amount of space per capita available after obtaining 2012 official data that had not been publicly released. It found that the Government's standard of 2m² per person was lower than that in other Asian cities, including Singapore, Seoul and Shanghai. (124) Moreover, more than half the city's urban population lived in neighbourhoods with less than 2.5m² per capita open space. However, except for a few well-off areas and some deprived neighbourhoods without any public housing, calculations made by Civic Exchange based on estimates indicate that there is not a strong relationship between area income and open space due to the fact that most public housing estates offer open space to their residents. In fact, residents of public housing seem to enjoy on average more local open space per person than those living in private developments, although with significant differences from district to district. Access to open space seems to follow a U-shaped pattern, with those better off also enjoying higher shares and residents in the middle being the most deprived. These refer mainly to residents in smaller buildings in older neighbourhoods, such as

those in the north shore of Hong Kong Island and urban Kowloon. (124) According to Civic Exchange, while some deprived areas have access to local open space via public housing, they lack access to district open space such as sports playgrounds. Additionally, simply assessing availability of some sort of open space without taking into account its characteristics (such as quality and level of greenness) offers limited insight into its potential to improve health and wellbeing.

Figure 15 shows the greatest distance people in different districts need to travel to reach the nearest recreational facility. As discussed above, the distance from a safe green space affects its health benefits – being within a short walking distance brings the greatest benefit. In those districts where the distance is greatest, more people are likely to need to travel further to access a park than those living in areas with shorter distances. Many districts have a greatest distance of 2km or more to access a park, which could be considered too high, reducing accessibility and hence the health benefits provided by safe green space. (125)

Figure 15. Greatest distance from inhabited area to nearest public open space, park, playground or sports ground for each district of Hong Kong, 2018.

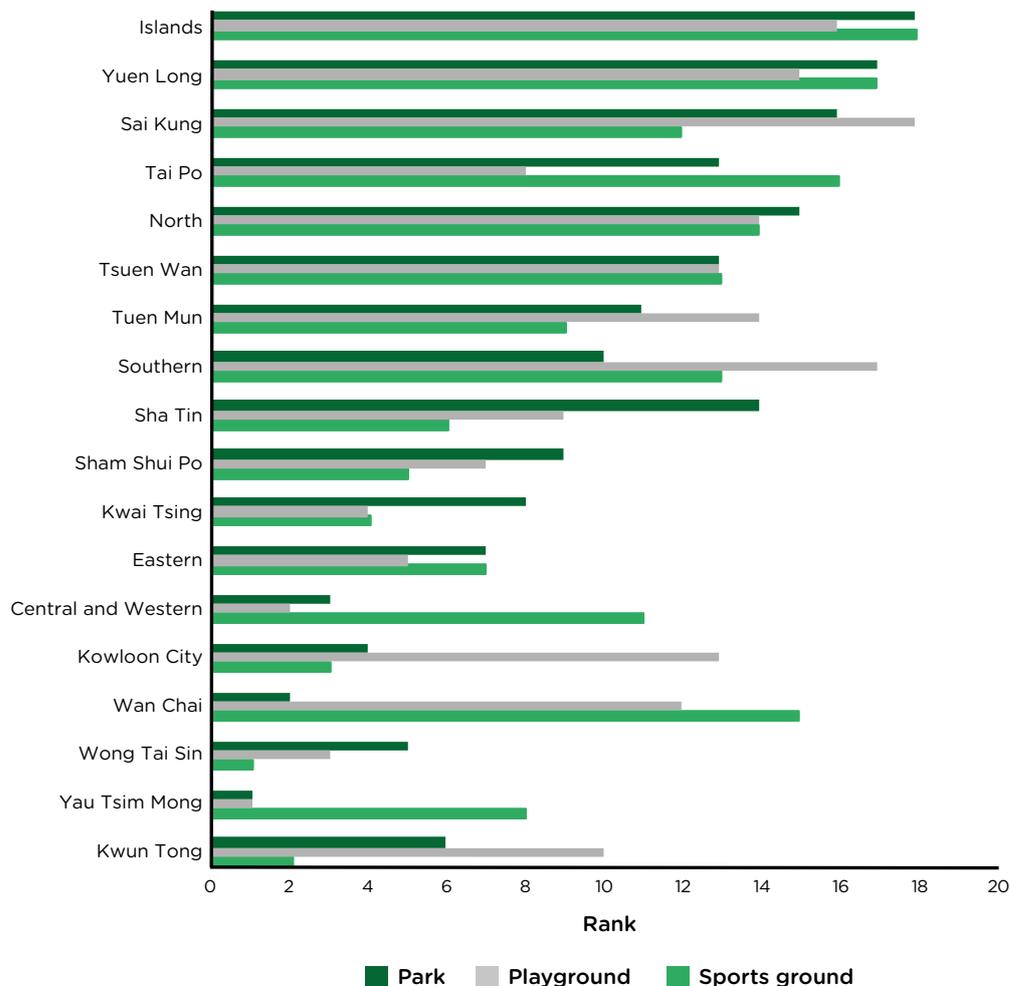


Source: Chow (2018) (125).

Figure 16 provides an indication of how districts vary in terms of accessibility to different types of public open space, based on percent of population within 400 metres of such spaces. Yau Tsim Mong and Wan Chai have the highest percent of population with ready access to parks, while Islands, Yuen Long and Sai Kung had the smallest percent. Yau Tsim Mong and Central

and Western had the largest percent of population with ready access to playgrounds, while Sai Kung and Southern had the smallest percent. In terms of access to sports grounds, the greatest percent of population with ready access was in Wong Tai Sin and Kwun Tong while the smallest was in Islands, Yuen Long and Tai Po.

Figure 16. Ranking of districts by percent of population within 400m of specified types of public open spaces, ordered by access to any type of public open space, Hong Kong, 2018



Source: Chow (2018) (125)

Blue space

Several studies in different countries have found that people who live close to blue space - i.e. a body of water including a river, lake or sea - experience increased life satisfaction, better mental health and better self-reported general health, but in general the potential health benefits of blue spaces have been less

well studied than those of green spaces (126). Due to its geographic location and the dominance of coastal landscapes, the impacts of these spaces for health and wellbeing in Hong Kong are potentially very important, but there is insufficient evidence from scientific studies on their effects.

AMBIENT AIR POLLUTION

Ambient air pollution is one of the greatest environmental threats to human health, causing 4.2 million premature deaths around the world each year and the loss of millions more years of healthy life. (127) The World Health Organization (WHO) estimates that in 2019, 37 percent of premature deaths caused by air pollution were due to ischaemic heart disease and stroke, 18 percent to chronic obstructive pulmonary disease, 23 percent to acute lower respiratory infections and 11 percent to cancer within the respiratory tract. Recent research has also found an association between ‘prenatal exposure and high levels of air pollution and developmental delay at age three, as well as psychological and behavioural problems later on, including symptoms of attention deficit hyperactivity disorder (ADHD), anxiety and depression’. (128) Increasingly, researchers are looking at possible links between air pollution and cognitive impairment, including dementia. (129)

The WHO Air Quality Guidelines (WHO AQGs) provide evidence of the damage caused to human health by air pollution at even lower concentrations than previously assumed, and sets out stringent guidelines for pollutant levels. (130) Air pollutants included are $PM_{2.5}$ and PM_{10} – particles with an aerodynamic diameter of 2.5 or 10 microns or less, respectively; ozone (O_3); nitrogen dioxide (NO_2); carbon monoxide (CO); and sulphur dioxide (SO_2).

Disadvantaged communities have been shown to face higher exposure from air pollutants in cities in multiple studies in North America, and a more limited number in New Zealand, Asia and Africa. (131) There are various reasons for this, including patterns of land use and urbanisation, and poorer housing and working conditions. (132) Evidence from Europe has been more mixed, possibly due to gentrification of inner-city areas. (133) In England, a recent study using LSOAs as geographical areas (Lower layer Super Output Areas, which represent approximately 1,600 people), found that median NO_x emissions (a combined measure of nitric oxide and nitrogen dioxide) in the most deprived decile of LSOAs were 2.3 times higher than in the least deprived decile. (134)

It is also important to note that overall exposure to high levels of ambient air pollution does not mean that all the individuals in an area will be similarly exposed or impacted. People with more socioeconomic resources might be more able to protect themselves, for example by working indoors or by accessing better medical care. (133)

There is also consistent evidence that compared with those who are better-off, people from more disadvantaged backgrounds or from ethnic minorities experience greater harm from air pollution, such as black communities in the USA (135) or people with low economic status in Europe. (136) This can be due to increased susceptibility to poor health, caused by psychosocial factors, worse health status or more constraints on being able to opt for health-promoting behaviours. (131)

AIR POLLUTION IN HONG KONG

Similar to other Asian cities, air pollution levels in Hong Kong are higher than in most European and North American cities. (137) Hong Kong’s two major air pollution sources are local street-level pollution and regional-scale smog. Industrialisation and urbanisation in the Pearl River Delta-Hong Kong-Macao region negatively impacts air quality, exposing the area to high emissions from industrial, logistic and commercial activities. Major contributors to roadside pollution include diesel vehicles, worsening congestion and high-density development creating ‘street canyon’ effects; while shipping emissions from the large number of marine vessels sailing near inhabited areas, and power plants also affect Hong Kong’s air quality. (138)

The Government launched an Air Pollution Index in 1995 to monitor the level of pollutants. In 2013 it replaced this Index with the Air Quality Health Index (AQHI), which calculates the cumulative health risk of daily hospital admissions attributable to the 3-hour average concentrations of SO_2 , NO_2 , O_3 , and $PM_{2.5}$ or PM_{10} , (whichever has a higher health risk) (139). It aims to inform the public, especially those with high health risks, reporting on a scale of 1 to 10 and 10+, with higher values indicating greater risk to health. A study found that the establishment of the AQHI was followed by reduced hospital admissions in children, particularly for respiratory tract infections and pneumonia. Although the authors could not examine the causes, they point to possible changes in behaviour by carers, who would have been more likely to keep children indoors as a response to the alerts about high health risks. (140) For the elderly, the introduction of AQHI was followed by a reduction in two sub-types of cardiovascular disease, hypertensive disease and acute myocardial infarction, but no reduction was seen regarding overall emergency hospitalisation from cardiovascular diseases or other major sub-types such as stroke and heart failure, which suggests a limited following of the guidelines by older people during the study period, illustrating the existing constraints that impede elderly

people from following official advice to protect their health. (141)

The Environmental Protection Department (HKEPD) gathers data from a monitoring network of 18 pollution stations, three of which are on roadsides. The Government monitors seven major air pollutants based on Hong Kong's Air Quality Objectives (AQOs), which were established in 1987 and updated several times

since. Where comparisons can be made, several of Hong Kong's own limits are set at a higher threshold than the latest WHO recommendations, as shown in Table 1. The table also shows the WHO Interim Targets, which 'authorities in highly polluted areas can use to develop pollution reduction policies that are achievable within realistic time frames'. (130) However, the WHO stresses that these should be steps towards achieving the air quality guideline levels, rather than end-point targets.

Table 1. Recommended WHO guidelines for air pollutant levels, progressive WHO interim targets and Hong Kong air quality objectives, by the main sources of pollution in Hong Kong

Pollutant	Main sources in Hong Kong	Averaging time (duration of exposure with a given mean concentration associated with certain health effects)	WHO Air Quality Guidelines (AQG) Level	WHO interim targets for progressively moving toward AQG levels				Hong Kong Air Quality Objectives Level ^c
				1	2	3	4	
PM _{2.5} , µg/m ₃	Marine vessels, diesel vehicles and power plants	Annual	5	35	25	15	10	25
		24-hour	15 ^a	75	50	37.5	25	50
PM ₁₀ , µg/m ₃	Marine vessels, diesel vehicles and power plants	Annual	15	70	50	30	20	50
		24-hour	45 ^a	150	100	75	50	100
O ₃ , µg/m ₃	Formed by photochemical reactions between NO _x and volatile organic compounds (VOCs) under sunlight. Linked to regional air pollution problem	Peak season	60 ^b	100	70			NA
		8-hour	100 ^a	160	120			160
NO ₂ , µg/m ₃	Oxidation of NO emitted from fuel combustion	Annual	10	40	30	20		40
		24-hour	25 ^a	120	50			NA
		1-hour	200					200
SO ₂ , µg/m ₃	Power stations and marine vessels; fuel combustion equipment and motor vehicles	24-hour	40 ^a	125	50			50
		10 minutes	500					500
CO, mg/m ₃	Vehicular emissions	24-hour	4 ^a	7				NA
		8-hour	10					10
		1-hour	35					30
		15 minutes	100					NA

Source: Authors' own tabulation, based on data and information from WHO's Air Quality Guidelines (2021) (130) and Hong Kong Air Quality Objectives (142).

Notes: µg = microgram. mg = milligram.

^a99th percentile (i.e. 3-4 exceedance days per year).

^bAverage of daily maximum 8-hour mean O₃ concentration in the six consecutive months with the highest six-month running-average O₃ concentration.

^cAll measurements of the concentration of gaseous air pollutants, i.e., sulphur dioxide, nitrogen dioxide, ozone and carbon monoxide, are to be adjusted to a reference temperature of 293 Kelvin and a reference pressure of 101.325 kilopascal.

Annual and peak season is long-term exposure, while 24-hour and 8-hour is short-term exposure.

Emissions in Hong Kong have been decreasing, as shown by both individual studies and the Government's own data from its 18 monitoring stations. This aligns with the Government's efforts to tackle emission sources via two main strategies (143):

- Control emissions from motor vehicles, marine vessels, power plants, and industrial and commercial processes locally.
- Work with Guangdong Provincial Authorities to confront the regional smog problem.

Research analysing 10-year trends in pollutants from six monitoring stations between 2011 and 2020 found that the concentration levels of NO₂, SO₂, CO, PM_{2.5} and PM₁₀ continuously decreased in the study period, while the concentration of O₃ at roadside and urban stations increased. The authors attribute the improvement in five of the main pollutants to the introduction of new, more stringent government regulations for on-road vehicles, in spite of the increase seen in the number of registered vehicles. (144) According to government data, between 2012 and 2021 PM₁₀ emissions decreased by 38 percent and NO₂ by 41 percent. (143) In 2021, SO₂, CO, PM₁₀ and PM_{2.5} emissions in all stations complied with the Government's own limits – which allow a certain number of exceedances – while roadside NO₂ levels did not comply with Hong Kong's objectives, and O₃ emissions, largely a result of the regional smog problem, were still rising. (145)

However, the Clean Air Network – an independent Hong Kong-based NGO working on raising awareness and mobilising support for cleaner air – reported that based on data from the monitoring stations, in 2022 the annual average concentration levels of NO₂, PM₁₀ and PM_{2.5} were 210 percent, 60 percent and 180 percent higher, respectively, than the WHO AQGs, and roadside emissions were even higher. (146) The Clean Air Network has asked the Government to make air quality objectives stricter to protect public health and start complying with WHO guidelines as soon as possible. The Government states that it has tightened its own objectives progressively and according to the WHO's benchmark 'where practicable'. (147)

In its latest *Clean Air Plan for Hong Kong 2035*, the Government establishes the target of improving air quality on a level with major international cities, with the ultimate goal for Hong Kong's air quality to fully meet the targets under the WHO AQGs. Specifically, it addresses roadside NO₂ and ambient ozone levels as key challenges, and outlines strategies to combat them. (147) The plan includes the following six major areas of action and corresponding measures:

- **Green transport:** take forward the Roadmap on Popularisation of Electric Vehicles, which establishes the target of achieving zero vehicular emissions by 2050; develop the green transport network; adopt green features in new development areas; promote the use of energy ferries.
- **Liveable environment:** pedestrian-friendly and bicycle-friendly policies; enhance air quality at public transport interchanges; update the Air Quality Health Index; embark on a cohort-study to examine the health impacts of air pollution.
- **Comprehensive emissions reduction:** phase out old diesel commercial vehicles; conduct trials for emission reduction devices for franchised buses; tighten the sulphur content limit of locally supplied marine fuels and impose emission standards for new petrol-powered outboard engines; extend the control of products containing VOCs.
- **Clean energy:** new low-carbon electricity generation strategy under Hong Kong's Climate Action Plan; continue to tighten emission limits of power plants under the new low-carbon electricity generation strategy; take forward the adoption of liquified natural gas (LNG) in ocean-going vessels; set up an inter-departmental working group to handle work relating to the application of hydrogen energy in Hong Kong.
- **Scientific management:** adopt innovative instruments to monitor compositions of VOCs and fine suspended particulates (PM_{2.5}) in real time; conduct district-based air quality monitoring to identify pollution distributions; apply micro-sensors to monitor ambient and indoor air quality; develop a smart air quality monitoring system to provide more detailed district-based air quality information to the public.
- **Regional collaboration:** formulate regional emissions reduction targets for 2025 and 2030 with the Guangdong Province; conduct 3D air quality monitoring with light detection and ranging (LIDAR) technology; Collaboration in the Greater Bay Area to study and monitor ozone pollution; encourage training and technical exchanges.



IMPACT OF AIR POLLUTION ON HEALTH AND HEALTH INEQUALITIES

As indicated above, air pollution from different sources causes a variety of health problems in children, the elderly and others.

Researchers found that long-term exposure to pollutants between 1996 and 2003, most likely to PM_{10} , was negatively associated with cardiorespiratory fitness in Chinese schoolchildren in a cross-sectional study conducted in 2004 with more than 2,000 participants between eight and 10 years of age in three Hong Kong districts. (148) The effect was more pronounced for girls than for boys. Children who lived in more polluted districts did not experience significant cardiorespiratory fitness gains from physical activity, in contrast to those who lived in less polluted districts.

An elderly cohort study with 66,820 Hong Kong individuals aged 65 or above found that long-term exposure to ambient $PM_{2.5}$ and black carbon were associated with increased risk of cardiovascular mortality but not respiratory mortality, controlling for individual characteristics. (137) The study was able to assign individual exposure levels and used measurements at baseline year (1998-2000) and each year during a 11-year follow-up, accounting for temporal variability, and did not find any positive associations between NO_2 and cardiovascular or respiratory mortality. However, the subjects of this study were limited to those who proactively engage in activities at elderly health centres, who might be perhaps more health-conscious and less susceptible to adverse cardiovascular and respiratory outcomes than the general population. Findings thus might not be generalisable to the whole older population of Hong Kong.

The Hedley Environmental Index developed by the University of Hong Kong, a composite measure of different types of pollution, estimates that in 2013 pollution in Hong Kong caused 7,724 deaths, 438,239 hospital bed days and 12,034,205 million doctor visits for cardiopulmonary disease. While pollution was still causing considerable health damage in 2019, the figures had decreased to 4,811 deaths, 290,930 hospital bed days and 6,873,397 doctor visits for cardiopulmonary disease. (149)

A study by Tam et al. (2015) on the daily number of deaths and hospital admissions between 2001 and 2010 based on data from the Census and Statistics Department and the Hospital Authority in Hong Kong showed that the risk of death and hospital admissions from ischemic heart disease is associated with short-term levels of PM_{2.5}, PM₁₀, NO₂, O₃ and SO₂, although the study could not attribute the health effects to a specific pollutant. (150) Additionally, pollution levels from outdoor monitoring stations were used as proxies of personal exposure and therefore did not consider important factors such as personal mobility or socioeconomic conditions which may protect individuals from exposure.

Using register mortality data from between 2007 and 2014 for 258,090 individuals, researchers set out to distinguish the effects of air pollution on specific causes of death other than cardiovascular and respiratory, which are the two most studied effects. They concluded that several pollutants have a greater impact on cause-specific mortality risk than on cardiovascular and respiratory mortality. For example, neighbourhood PM_{2.5} levels had a stronger effect on mortality risk associated with diseases of the genitourinary system than with cardiovascular and respiratory diseases. (151) The authors called for widening of the target groups of

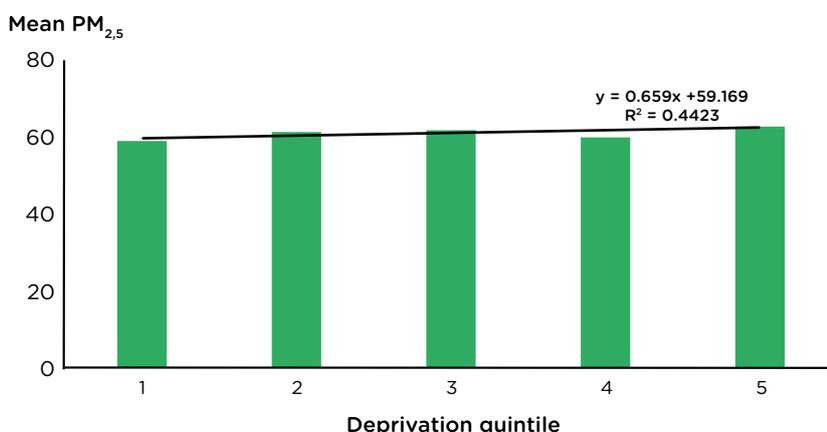
health protocols and other policy measures to include other vulnerable populations and not only those with cardiorespiratory diseases.

Several studies have investigated whether exposure to vehicular pollution and ambient PM_{2.5} differs among different socioeconomic groups in Hong Kong, and whether air pollution is associated with greater health risks among socially deprived groups. (152-155) Different indicators to measure socioeconomic status such as income, education level, occupation, and flat occupancy have been used. In general, lower SES (at the neighbourhood and individual level, and using housing type as a proxy) has been found to be associated with greater exposure to, and/or health risk from air pollution in Hong Kong, as we explain below.

Li et al.'s (2018) air pollution estimation model found a positive relationship between ambient PM_{2.5} concentration and a Social Deprivation Index (SDI) constructed with four variables: low income, low education, non-professional occupation, and non-owner-occupier. (153) The study could identify the highest levels of PM_{2.5} pollution in urban areas with high population densities such as Wong Tai Sin, along with suburban areas in the Northwest of Hong Kong that receive high levels of cross-border pollution from Shenzhen in China. The study showed 32 small areas of high social deprivation and high pollution (constituency areas, each with around 17,000 population).

Figure 17 shows that there is a small, positive association between area social deprivation measured by the SDI and mean PM_{2.5} pollution concentration. In general, more deprived areas experience a higher concentration of this pollutant than the least deprived areas.

Figure 17. Mean PM_{2.5} pollution concentration by quintiles, Hong Kong, 2013-14



Source: Li et al., 2018 (153)

Housing type can be an important factor in air pollution exposure, due to Hong Kong's patterns of housing and its historical context. A study published in 2012 estimated exposure to vehicular air pollution of Hong Kong residents with a random selection of 275 public and 295 private Building Groups (BGs) out of 2,817 based on 2001 Census data, in proportion to the population living in private and public housing and from 17 out of 18 districts (excluding the outlying island district where there were no cars). (152) The study found that residents in BGs of private housing were exposed to between 1.80 and 2.11 times as much vehicular air pollution as those in BGs of public housing, depending on the type of pollutant. Among those living in private housing BGs, residents from private estates from the lowest SDI areas were exposed to three times the amount of vehicular air pollution (PM₁₀) as those from the highest SDI areas. Inequality in exposure was smaller among residents of public housing. (152) The authors point out that this can be explained by the dynamics of public housing in Hong Kong, in which poorer people are accommodated in public housing estates in new areas where air quality is better, while some private estates are denser, have less open space, are close to busier roads and have been built with more salient street canyon conditions, characteristics that facilitate the concentration of pollutants. Additionally, in private estates wealthier groups have the means to move out from more polluted neighbourhoods while those from the most disadvantaged social classes do not.

Several studies have indicated that living in a socially deprived neighbourhood or having low SES is associated with greater harm from air pollution. A study from 2008 using the data of 24,357 people aged

30 and above who died in 1998 found socioeconomic inequalities in the health effects of PM₁₀, NO₂, SO₂ and O₃, attributing exposure from whole city averages from the eight measuring stations then existing in Hong Kong. (154) SES was assigned by a combination of educational attainment, occupational group and type of housing for each individual. The authors found that PM₁₀ and NO₂ were significantly associated with greater mortality risk among people of all ages living in public rental housing compared with those living in self-owned private housing. The effects on mortality of all four pollutants were also greater among blue-collar workers than both the never employed and white-collar groups. The authors hypothesised that this could be due either to greater vulnerability due to a higher prevalence of chronic conditions or poorer nutrition in lower SES groups, or to higher exposure to pollutants among individuals in these groups, but this could not be assessed because the study did not measure pollution at the individual level.

Another study found significant associations of NO₂, SO₂, PM₁₀ and O₃ with all non-accidental and cardiovascular mortality in Tertiary Planning Units of middle or high Social Deprivation Index (composed of six indicators), based on the number of deaths from 1996 to 2002. (155) People living in high SDI areas had higher excess risk of death from non-accidental, cardiovascular and respiratory causes associated with SO₂ and NO₂ than those from middle or low SDI areas. (155) The study could not ascertain whether this was due to higher exposure to pollutants or to higher susceptibility among more deprived individuals, because the study used averages from eight measurement stations as proxies for individual exposure.

NEIGHBOURHOOD ENVIRONMENTS

Neighbourhoods can be described as ‘places where people live, work, play and have a sense of belonging’ (156) and their physical attributes can have a direct impact on health and wellbeing. Aspects of neighbourhood design can also foster people’s opportunities for social relations and active travel, while influencing health behaviours. (156) Several studies have assessed multiple characteristics of neighbourhood environments and their effects on people’s subjective wellbeing and self-rated health in Hong Kong.

A study with 719 respondents aged 60 or above from two Hong Kong districts found a relationship between different characteristics of the neighbourhood environment and self-rated health, with older people who were more satisfied with outdoor spaces and buildings, transport, housing, social participation and respect and social inclusion having increased odds of reporting good self-rated health. (46)

A 2021 pilot study aimed to investigate the inter-relationships between neighbourhood environment and residents’ sense of place and subjective wellbeing in two very different urban areas: Shatin, a planned New Town built in the 1970s with a predominance of public housing and middle-class private housing, and Sham Shui Po, a poorer and dense old urban neighbourhood developed in the 1920s. (157) Sense of place in this study included three interrelated aspects:

- A ‘functional and cognitive sense of place related to place dependency and identity’.
- ‘People’s emotional or affective connections with a place that are related to their place attachment’.
- ‘People’s behaviour in a place indicating their intentional commitment to a place.’

The neighbourhood environment was assessed in terms of building and housing quality, pedestrian and non-motorised transport facilities, public transport, community and public spaces, traffic and pollution, and convenience. Subjective wellbeing was measured using the Keyes Mental Health Continuum-Short Form.

The results from the survey of 814 participants showed significant positive associations between neighbourhood environment, sense of place and subjective wellbeing. Those who positively assessed their neighbourhood environment, those with access to community and public space that enable social interaction, and those who had lived longer in their community showed a stronger sense of place, and those who reported a stronger sense of place showed greater subjective wellbeing, compared with others in the study. (157) Although the sampling was not representative of the population of the two neighbourhoods, the results merit some consideration. Access to community and public spaces that promote

social interactions and bonding were the strongest predictors of people’s sense of place, suggesting the importance of ensuring the availability of and access to such spaces, now and in the future. Also, redevelopment projects may have the effect of separating people from places they know and feel attached to, and this may negatively impact on their wellbeing.

Redevelopment plays a prominent role in Hong Kong due to the scarcity of land. The Urban Renewal Authority (URA) often teams up with private developers to redevelop ‘with a view to addressing the problem of urban decay and improving the living conditions of residents in old districts’. (158) However, in Hong Kong redevelopment has often been associated with gentrification (14) – a process by which residents are displaced from their neighbourhoods and the new buildings are occupied by people with higher socioeconomic status – even if this might be an unintended consequence for the URA. (159) In the past, low-income tenants have been relocated to public housing estates in the New Territories, reinforcing existing spatial inequalities (160) and displacing them from mixed-use older buildings in the city centre that provide affordable accommodation and supportive social networks. (159)

The design of urban environments has the potential to contribute to levels of physical activity, as shown in a cross-sectional study on physical activity in relation to urban environments in 14 cities, including Hong Kong. There was a positive association between physical activity and net residential density, intersection density (a measure of street connectivity), public transport density, and the number of parks. (161)

In a study covering 301 adults aged 60 and older from Sha Tin and Tai Po districts who volunteered to participate, it was found that after adjusting for socio-demographic characteristics, people who perceived their neighbourhood as being more walkable – based on a Chinese version of the abbreviated Neighbourhood Environment Walkability Scales (NEWS) – showed higher scores for life satisfaction and happiness and lower scores for loneliness, compared with residents who perceived their neighbourhoods as less walkable, although results should be interpreted with caution due to the small sample size of the study and the way that participants were selected. (162)

SOCIAL ENVIRONMENTS, SOCIAL PARTICIPATION AND SENSE OF COMMUNITY

In both Marmot Reviews for England, we stressed the importance of empowering people and communities. A sense of control over one's own life is crucial for health and wellbeing, while low control is associated with poorer health outcomes, greater levels of stress and anxiety and worse health-related behaviours. (5) Social cohesion and trust are important for a sense of community control, which in turn is important for overall community health. (5) In our recent review of health inequalities in Norway, we explained how communities can enable people to create relationships that promote health and wellbeing during their lives, providing emotional and practical support, as well as access to valuable information. (163)

In Fair Society, Health Lives (The Marmot Review), it was stated that community or social capital is shaped 'both by the ability of communities to define and organise themselves, and by the extent to which national and local organisations seek to involve and engage with communities'. (4) It is comprised of different factors in different communities, and can include 'community networks, civic engagement, a sense of belonging and equality, cooperation with others and trust in the community'. Participation in volunteering is a component of social wellbeing, which is important for improving individual physical and mental health but also collective trust, participation and social cohesion, which are in turn foundations for building fair, peaceful and resilient societies. (164)

Several studies in Hong Kong have pointed to the health benefits of social participation and a strong sense of community for life satisfaction and health, particularly in older people. Research with people aged over 60 from five Hong Kong districts found that a greater sense of community is associated with better self-rated health. However, it also found that an increased sense of community was detrimental to those with lower educational attainment in relation to their self-rated health: the greater the sense of community, the more likely that those with a lower level of education were to report poor health. This is relevant for policymakers and suggests that policies directed at improving community cohesion need to identify specific needs of different socioeconomic groups and focus on reducing inequities. (165)

A study in 2009 with 941 participants who responded to a randomised household survey aimed to explore sense of community and residents' wellbeing in all 18 districts in Hong Kong. (166) The study conceptualised sense of community as including a geographical element and a relational element referring to the quality of social ties and relationships. It found an association between a stronger sense of community and higher quality of life,

but no significant relationship between socioeconomic indicators at the individual or community level. The authors hypothesised that this could be due to the heterogeneous nature of Hong Kong neighbourhoods or to the interconnectedness between districts thanks to a good transport network that enables people to travel easily, among other possible factors. However, as is also acknowledged by the authors, units smaller than districts are needed for a more detailed analysis.

Social participation can have a mediating role on the negative effects of loneliness, as shown by a study with a convenience sample of 200 older Hong Kong adults, a majority of whom were female. Researchers found that social participation (measured with a 17-item scale on participation and engagement in social and recreational activities) was significantly associated with life satisfaction. Also, the quality of the social network (family, friends and neighbours), and social participation mediated the relationship between loneliness and life satisfaction, explaining 21 percent of the variance in the former.

There are no official surveys in Hong Kong examining socioeconomic inequalities in social support and participation. Nevertheless, data from the 2021-22 report by the Agency for Volunteer Services, one of the largest in Hong Kong promoting volunteerism, suggests important inequalities in participation. For example, 57 percent of its total of 140,000 volunteers had achieved post-secondary university education or above, while 37 percent had secondary education and only 6 percent had primary education or below. By occupation, the most prevalent was student (29 percent), followed by office worker (16 percent) and professional (15 percent). (167)

The latest wave of the World Values Survey (2017-22), which collects representative and comparable data globally every five years, has some information on participation in organised activities in Hong Kong, although it is not disaggregated by any socioeconomic

indicator. (168) The highest share of active members is found in church/religious organisations, with 11.7 percent of respondents. Active membership declines for other types of organisation. For example, 8.9 percent of respondents are active members of a sports or recreational club, slightly higher than in Singapore (8.3 percent) but much lower than in Great Britain (21 percent), for example. Among young people up to 29 years of age in Hong Kong, the rate is slightly higher at 11.2 percent. Active membership in arts, music or educational organisations is at 7.2 percent, similar to Singapore (7.3 percent) and much lower than in Great Britain (19.2 percent), for example. Only about 5 percent of respondents in Hong Kong said they were active members of a humanitarian organisation or a union.

TRUST

The same wave of the World Values Survey – which collected data in Hong Kong in 2018 – indicated comparatively low levels of trust in strangers, generalised trust and trust in others in the same neighbourhoods in Hong Kong. Only 36.4 percent of respondents said that ‘most people can be trusted’, while 63.1 percent said that ‘you need to be very careful’ in dealing with people. (168) This should be further studied, since higher levels of generalised trust have been associated with higher life satisfaction, lower levels of depressive symptoms and better self-rated health. (169) Additionally, only 6.9 percent of respondents in Hong Kong said they trust people in their neighbourhood ‘completely’, compared with 8.3 percent of respondents in Singapore and 20.9 percent in Great Britain, for example. (168)

A study with cross-sectional data from 1,635 young adults aged 17–23 collected between December 2018 and September 2019 found that actively engaging in local organisations (religious or youth), perceiving a residential neighbourhood as relatively more cohesive and being willing to accept neighbours of different ethnic origins were positively related with generalised trust among these young people. Having a good relationship with parents was also associated with generalised trust in this group. (169)



CHAPTER 3

CLIMATE CHANGE: HEALTH IMPACTS AND INEQUALITIES

On about a third of days in 2023, the average global temperature was at least 1.5°C above pre-industrial levels, the threshold set in the Paris Agreement for countries to limit temperature increases by 2100 to avoid catastrophic impacts. While this does not mean that the world has exceeded this limit, as it refers to global averages over several decades, it signals that ‘we are getting closer’ to doing so. (170) The WHO expects that climate change will cause 250,000 additional deaths globally between 2030 and 2050. (171)

Among the increased health-related risks of climate change highlighted by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2022 are changes ‘in the magnitude, frequency and intensity of extreme climate events’, such as storms, floods and heatwaves, as well as higher mean temperatures and changing precipitations patterns. These will expose populations to increased risk of illness, injury and mortality, worsen mental health and wellbeing and facilitate the spread of mosquito-borne, water- and food-borne diseases. (172)

A variety of factors, including socioeconomic and geographical, as well as individual characteristics, will determine how all these increased risks will affect different regions and individuals, (172) but the health impacts of climate change are unequal and disproportionately affect those in situations of vulnerability, including people on low incomes, minority groups, women, children, the elderly and people with chronic diseases and disabilities. (173)

It is probably too early to observe all the effects of climate change in Hong Kong, but as we explain in this chapter, data from the Hong Kong Observatory already shows an increase in annual mean temperatures and hot weather events, as well as a local rise in sea level. It is also clear that Hong Kong is susceptible to the impacts of a variety of climate change-related events due to its coastal proximity, the high density of its population, its tropical climate and location on typhoon tracks and this has the potential to impact on health and health inequalities. The Hong Kong Observatory also expects that Hong Kong’s climate will continue to experience an increase in very hot days and hot nights, fewer rainy days but increased average rainfall intensity, more extreme rainfall events and more extremely wet years, at the same time as a persisting risk of extremely dry years, a rise in sea level, and increased storm surges due to tropical cyclones. (174)

As explained by Chan et al. in *Policy Implication of Health Impacts of Climate Change in Hong Kong* (2017), potential negative impacts on health of these events are increases in heat-related illnesses, such as heat cramps, heat exhaustion, heatstroke, hyperthermia; an increase in non-communicable diseases such as cardiovascular disease, respiratory disease and skin cancer; an increase in communicable diseases, including insect-borne, water-borne, food-borne and skin-related; more physical injuries in extreme events; and impacts

on mental health, such as stress, anxiety, depression and post-traumatic stress disorder. (175)

There are as yet few academic studies or government documents directly analysing the health effects of different climate change-related events in Hong Kong on health and health inequalities. Most existing studies are indirect, restricted to the associations between temperature increases, heatwaves and the urban heat island effect on health outcomes, including mortality, with several studies focusing on their unequal impact. However, there are important gaps in knowledge, including the potential impact of other climate change-related events on the morbidity and mortality of disadvantaged groups in Hong Kong, such as those with low socioeconomic position, or the additional challenges that economic inequality in Hong Kong might create towards the goal of achieving net zero greenhouse gas emissions. It is important that those studies are developed so that the current and future impact of climate change on disadvantaged communities is better known, and measures can be taken to mitigate it and adapt.

Hong Kong’s Climate Action Plan 2050, published in 2021, is the most recent official document gathering together all the strategies, plans, targets and actions to achieve the Government’s stated goal of reaching carbon neutrality before 2050. (90) It is a cross-sectional effort that includes actions by different bureaus, including Environment, Transport and Housing, Development, Security, Financial Services and Treasury. However, there is a lack of health and health equity focus on the document, which does not consider the possible health implications of climate change in Hong Kong or the additional burden it may represent to the health system. Nor does it mention inequalities in exposure or harm or explicitly consider how climate change could disproportionately impact certain groups, despite the fact that Hong Kong is a member of the global ‘C40 Cities’ network of mayors and a signatory of its Equity Pledge, a commitment to increase action on inclusive climate action and infrastructure projects. (176)

The main sources of carbon emissions in Hong Kong are electricity generation (66 percent), transport (18 percent) and waste (7 percent). Hong Kong’s Climate Action Plan 2050 considers action on all three, some of which we will detail in this chapter, in order to make progress towards the target of being carbon-neutral before 2050. The Government claims to have allocated HK\$48.5 billion between 2011 and 2022 for the work

of the Environment bureau. (177) It has committed to reduce carbon emissions by 50 percent before 2035 from the 2005 level. To keep warming to 1.5°C as stated in the Paris Agreement, countries must collectively cut emissions by 2030 by at least 45 percent compared with 2010 levels and reach net zero by 2050. (178)

Limiting global warming to 1.5°C or even 2°C requires 'rapid and deep and in most cases immediate greenhouse gas emission reductions in all sectors' worldwide, according to the IPCC's 2022 report. (179)

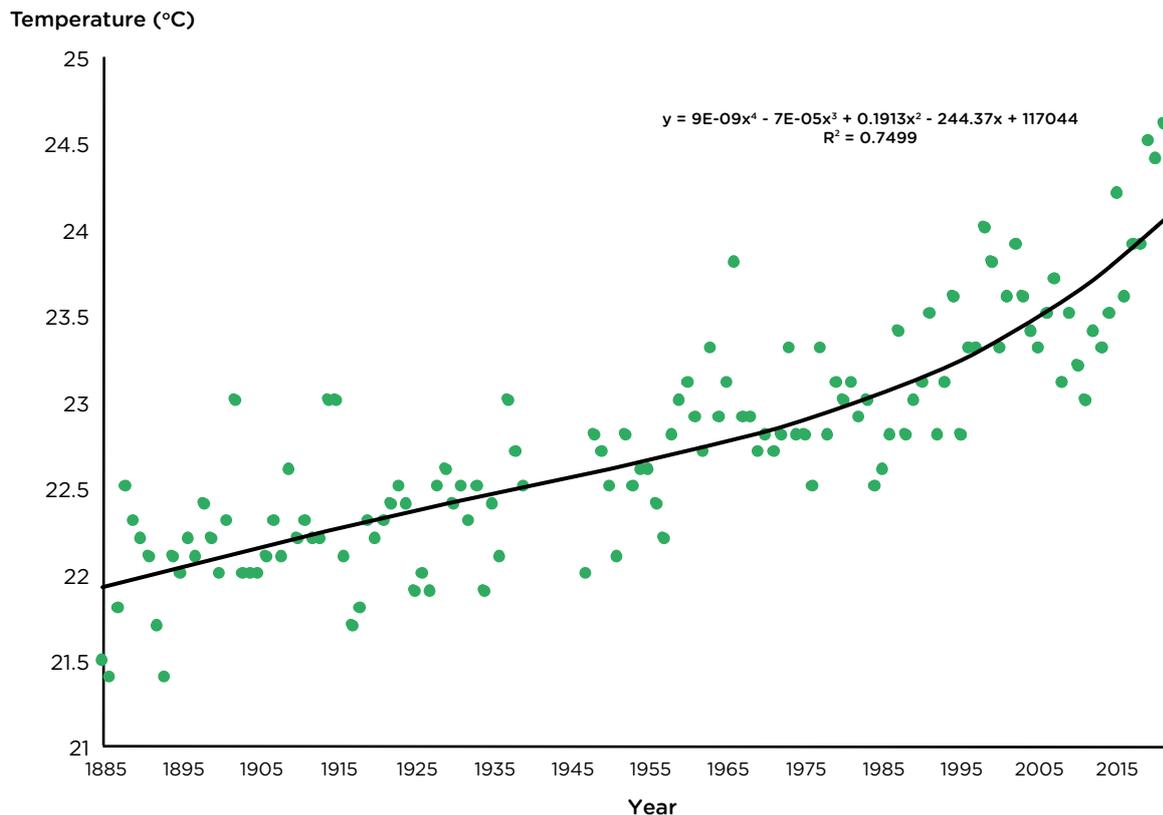
Since emissions from the extraction and burning of fossil fuels are major contributors to climate change, reducing emissions by transitioning to renewable forms of energy can help reduce the health risks associated with climate change. Other necessary mitigation actions include providing greater access to green and natural spaces, enabling active urban transport, improving energy efficiency through better design of buildings and cities, and promoting healthier and more plant-centred diets to reduce emissions from the agricultural sector. (172)



TEMPERATURE INCREASES

Annual mean temperatures have been increasing in Hong Kong. There was an average rise of 0.14°C every decade between 1885 and 2022, but the rate of increase has been faster recently, with an average rise of 0.28°C per decade between 1993 and 2022 – see Figure 18. (180)

Figure 18. Annual mean temperature recorded at the Hong Kong Observatory Headquarters (1885–2022)



Source: Hong Kong Observatory (180).

Note: 1. Data for 1940–1946 is not available. The temperature increase trends during 1885–2022 and 1993–2022 are statistically significant at the 5 percent level. 2. Although the graph is based on data from the Hong Kong Observatory website, we have fitted our own curve.

2021 was the warmest year in Hong Kong since 1884, a year which also experienced the highest recorded number of ‘very hot days’ – 54 days with a highest daytime temperature above 33°C, and ‘hot nights’ – 61 nights with a highest temperature above 28°C. (181) In 2022 the first very hot weather warning in the year was issued on 29 April, which was the earliest date in the year that such a warning had ever been issued. In the last 100 years, the number of hot nights and very hot days has increased. (83) Under the ‘intermediate’ and ‘very high’ greenhouse gas emissions scenarios considered by the IPCC in its Sixth Assessment Report, the annual mean temperature in Hong Kong is projected to rise by 2°C and 3.6°C respectively between 2081 and 2100. (182)

IMPACT ON HEALTH AND HEALTH INEQUALITIES

Several ecological retrospective studies have analysed the association between heat and health in Hong Kong. For example, adjusting for potential confounders and using data from general outpatient clinics during 1998–2006, Chan et al. reported that an average 1°C increase in daily mean temperature above 28.2°C was associated with an estimated 1.8 percent increase in mortality, with significantly higher female mortality among those aged 75 or older. (183)

Another local study showed a significant correlation between high temperatures (28°C or above, compared with 19.4°C) and hospitalisation at lags of 0–2 days for mental disorders based on data between 2002 and 2011 and accounting for pollutant levels. The association was weaker for younger age groups but stronger for those

aged 75 or above, who experienced a 20 percent higher risk of hospitalisation for mental disorders. (184) These results suggest that the double threat of global warming and an ageing population is likely to significantly increase the burden of disease in Hong Kong and preventative policies are needed.

The impact of heat waves and high temperatures is more intense in urban than in rural areas, due to several factors, including: the substitution of asphalt and concrete for vegetation; lower air flow in cities due to the density of the network of streets and buildings, which creates obstacles for cooling; and a higher production of heat in urban activities and spaces. (185) This is normally referred to as the 'urban heat island effect' and it has been associated with higher mortality risk during heatwaves among people aged 65 or above in France (185) and in the general population in Chicago, (186) for example.

Heat islands can have direct and indirect effects on health. (187) During a heatwave in 2003 in one region in the United Kingdom, over 50 percent of heat-related mortality was attributable to the heat island effect. (188) Heat islands release heat at night, and this prevents the body from using this period to recover from the heat absorbed during the day, enhancing human vulnerability to a combination of hot nights and several hot days. A study of mortality data between 2007 and 2014 set out to examine the effect of different types of prolonged heat in Hong Kong, controlling for several factors, including outdoor air pollution. The authors categorised prolonged heat based on various combinations of very hot days (33°C or above) and very hot nights (28°C or above). They found that compared with a baseline scenario, three consecutive very hot days and five consecutive hot nights had the greatest influence on mortality risk in the following three days. (189) While there was no significant relationship between the number of consecutive hot days and mortality, more consecutive hot nights contributed to higher mortality risk. Additionally, after a non-consecutive period of at least five very hot days and nights within a seven-day period there was a short, sharp peak in mortality the following day in all-cause, cardiovascular and respiratory mortality. However, this effect was short-lived. (189)

Another investigation in Hong Kong showed that extreme-heat weather events that last for more than five consecutive days and five consecutive nights are associated with a substantial increase in all-cause mortality. The effect of extreme-heat events on mortality was stronger for females and people aged 64 or above. (190) A single hot night increased mortality risk by 2.3 percent among those aged 65 or older. (190) Ho et al. found that a consecutive event with two hot days and two hot nights should be of particular concern for health authorities due both to its immediate impact on emergency admissions and to the increase in related health risks in the following days. (191)

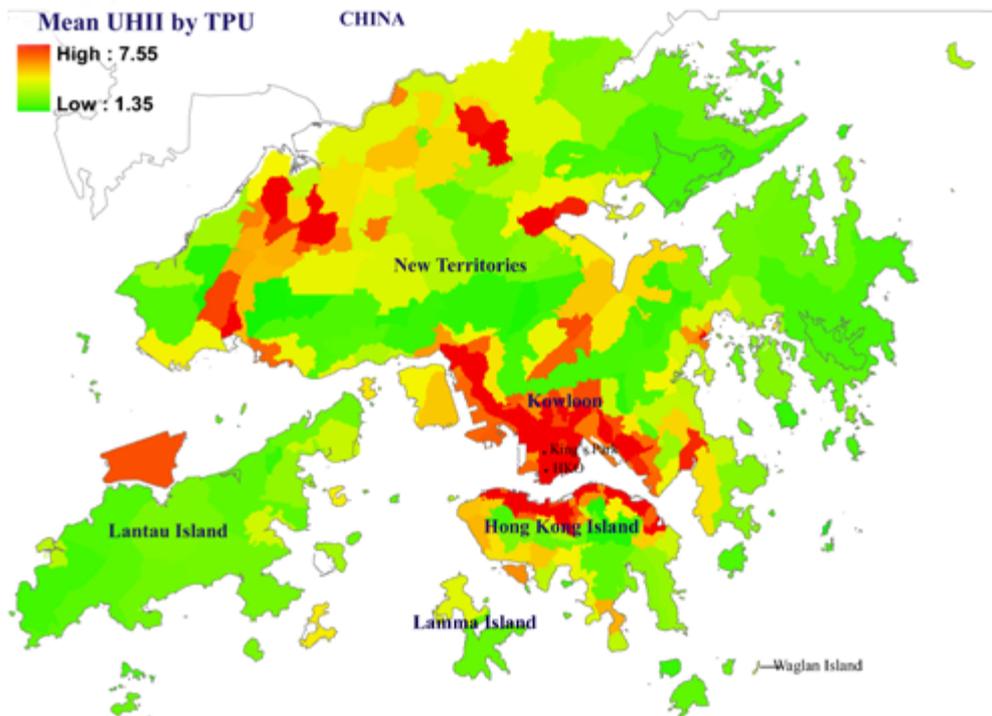
Heat island effects and climate change are 'co-evolving factors' (187) and scientists have warned that without

taking into account heat island effects, the impact of climate change on health might be underestimated. (188) The heat island effect was shown to have been 'severe' in Hong Kong, for example, during two heatwaves, in 2013 and 2018. (192) Additionally, during these events urban heat island effects were found in areas of the city with high numbers of households with six or more members, such as Kowloon City, and those with residents aged 70 or above. Both living in crowded households and being of older age can exacerbate the impact of heat on health, so this should be considered in urban planning. Several factors worsen the heat island effect in Hong Kong, including the weak wind in most of its urban areas. (72) Ventilation should therefore be considered in urban planning efforts to disperse road pollutants and moderate the heat island effect, given that worse ventilation has been shown to be associated with higher all-cause mortality in Hong Kong. (193) As pointed out by Hua et al., the urban heat island effect and the increasing frequency of extreme heat events calls for cross-sector collaboration in health action. (194)

Hua et al. developed heat risk maps of Hong Kong by overlaying the heat hazard (spatial distribution of extreme heat events), heat exposure (population density) and heat vulnerability of Large Tertiary Planning Units (LTPUs) for 2006, 2011 and 2016. (195) Vulnerability was measured along six indicators: population aged 65 or above; population aged 15 or above with low education; percent of one-person households; percent of households with low income; percent of population in public rental housing; and percent of households in low-quality quarters (temporary quarters and those in non-residential buildings). High heat risk areas were found in the northern part of the New Territories, in several New Towns and in the core urban areas including the northern side of Hong Kong Island and Kowloon. All the daytime hot spots in Kowloon stood at high-level risk at night in 2016, indicating that this area is particularly vulnerable and therefore there should be a focus on protecting its disadvantaged residents. Moreover, extreme heat events may intensify the heat island effect and subsequent health risks in other areas that would not be affected in less extreme temperature scenarios even during the hot temperature season, such as in several new towns in suburban areas, as indicated by Ho et al. (196)

Goggins et al. investigated the relationship between the urban heat island effect and mortality rate in Hong Kong using data on all deaths in Hong Kong in the hot season (June to September) between 2001 and 2009 (see Figure 19). Adjusting for pollutants and other factors, they found that every 1°C rise above 29°C was associated with a 4.1 percent increase in natural mortality in areas with a high urban heat island index. Compared with this, low urban heat island index areas experienced a 0.7 percent increase in mortality and the association was not significant. (71) They also found that in areas with a high urban heat island effect, weak wind speed is associated with a 5.7 percent increase in natural and non-cancer mortality rates compared with days with stronger winds. (71)

Figure 19. Mean Urban Heat Island Index by Tertiary Planning Units, Hong Kong, 2001–09



Source: Goggins et al. (71).

Another study, looking at the relationship between weather phenomena, pollution levels and daily hospital admissions between 1998 and 2009, found an increase in admissions for respiratory diseases, infectious diseases and unintentional injuries at temperatures above 28.5°C during the hot season. The authors did not find differences in sensitivity to heat between men and women for respiratory and infectious diseases. (86)

Exposure and vulnerability to heat varies among social groups according to individual and community characteristics. Studies from other countries have shown that lower socioeconomic level and ethnic minority groups are more likely to live in warmer neighbourhoods: for example, in Phoenix (United States). (197) Age, income and education have been shown to be important variables to explain vulnerability to heat in Chicago (United States) and South Korea. (198) Inequalities in the effects of heat have also been found in Hong Kong, as explained below, and this needs to be considered when devising climate change adaptation policies.

In a Hong Kong study on the relationship between temperature-related mortality and socioeconomic levels across the Chinese population between 1998 to 2006, the results reveal that temperature-related mortality was negatively associated with SES and that there was a social gradient by geographical area. (183) There was weak evidence that there was a gradient in mortality between those living in low-income neighbourhoods – TPUs with less than HK\$15,000 median monthly domestic household income – and those in high-income areas. Similar results were achieved in a Hong Kong study with data from 2007

to 2015, which concluded that high temperatures were associated with higher respiratory deaths among those living in poorer TPUs. (81)

Consistent with evidence from other countries, several studies in Hong Kong have found that the elderly are more vulnerable to hot weather (190, 195, 199, 200) but this can also vary according to SES. Those aged 75 or older with lower SES were found to be at a higher risk of hospitalisation due to higher temperatures during the hot season between 2010 and 2019 for the following groups of conditions: all conditions combined (other than cancers and external injuries); respiratory and circulatory causes; ischaemic heart disease; pneumonia and influenza. (199) Individuals were divided into two groups according to whether or not they received public assistance (PA) to cover hospital fees as a proxy of SES. Those who did not receive PA saw a decrease in their hospitalisation risk during hot weather. The most pronounced inequalities were found in the risk of hospitalisation for ischaemic heart disease. Hospitalisations for those aged 15–74 were less affected by heat.

Another ecological study using constituency areas found that immediate same-day high temperatures increased the risk of Accident and Emergency (A&E) attendance among people aged 65 and older living in moderate and high social vulnerability districts between 2010 and 2019. Vulnerability was measured with a multidimensional index including poverty and disability. (201) After conducting semi-structured interviews with 46 older adults in Hong Kong, Lai et al. concluded that ‘multilateral efforts are urgently needed to co-create a heat action plan to improve community awareness and resilience among this group’. (202)

RISING SEA LEVEL, RAINFALL CHANGES AND EXTREME WEATHER EVENTS

Global mean sea level is rising, and the rate of the rise is accelerating. The IPCC projects that the rise in sea level will be faster under all emissions scenarios, including those that are compatible with the temperature goal established in the Paris Agreement. By 2100, sea levels are projected to rise between 0.43m and 0.84m relative to their 1986–2005 levels. (203) However, the magnitude of rise will vary geographically due to factors such as ocean dynamics and land ice loss, but also due to human activities such as extraction of groundwater and subsidence. Sea level rise, combined with extreme sea level events such as tides, surges and waves, will impact coastal ecosystems. Some of the associated risks are enhanced erosion of the coast, more frequent flooding and salinisation of soils, ground and surface water. (203)

Figure 20 shows the change in mean sea levels since 1954. This shows a marked increase in the level during the 1990s, from 1.26 to 1.51 metres between 1991 and 2000. Prior to that period there was very little change (1.33 metres in 1954) and similarly little change after that (1.46 in 2022).

Figure 20. Annual mean sea level at Victoria Harbour, Hong Kong, 1954-2022



Source: Hong Kong Observatory (204).

Notes: 1. The increasing trend of mean sea level during 1954-2022 is statistically significant at the 5% level.

2. Data have been corrected for land settlement for the purpose of long-term trend analysis (reference is made to the following reference: Wong et al. (205))

The Hong Kong Observatory estimates that under the 'intermediate' and 'very high' emissions scenarios modelled by the IPCC, the annual mean sea level in 2100 in Hong Kong would likely rise by 0.37–0.82m and 0.57–1.08m respectively, relative to the 1995–2014 average. (206) This in turn would increase the likelihood of storm surges due to tropical cyclones. At the same time, it is projected that there will be an increase in the intensity of tropical cyclones in the Western North Pacific region, as well as in the frequency of very intense tropical cyclones, tropical cyclone-related precipitation and the risk of storm surges, which could further exacerbate the impact of storm surges and sea level rise on the threat of coastal flooding. (207) In 2018 Typhoon Mangkhut provoked a maximum rise of 3.88m in sea level during a storm surge, causing 46 reported floods, injuries to more than 450 people, the collapse of 46,000 trees, blockage of several hundred roads, damage to a sewage plant and paralysis of the railway and transport systems. (82)

Hong Kong has one of the highest rainfall totals of cities in the Pacific Rim region (82) and it is expected that climate change will increase annual rainfall. In fact, it has

already been increasing, by an average of 2.2mm per year between 1884 and 2022. (208) The annual number of heavy rain days has also been increasing, with an average rise of 0.1 day per decade between 1884 and 2022. (208) Extreme precipitation events have also become more common. (83) The increase in precipitation, together with the rise in mean temperatures, could help disease vectors proliferate and increase the prevalence of some vector-borne diseases due to climate change, but there is insufficient data to be able to evaluate this. (82)

As explained by Chan et al., the rise in sea level, increase in temperatures, changes in rainfall and increased intensity and frequency of extreme weather events may impact health via different pathways, including flooding in low-lying areas, landslides, drain backflow, storm surges and cyclones, cold spells, aggravation of the effects of air pollution, altered survival patterns of vectors and the disruption of access to health services. (175) All this may impact human health by increasing the prevalence of communicable and non-communicable diseases, causing an increase of physical injuries and damaging mental health due to stress, anxiety, depression and post-traumatic stress disorder. (175)



ADAPTATION TO CLIMATE CHANGE IMPACTS

All the above-mentioned risks require the Government to take both short- and long-term adaptation measures to reduce exposure and vulnerability to climate change and prevent the most socially disadvantaged from suffering a disproportionate impact. Given the most recent scientific projections, the IPCC advises that incremental adaptation might not be enough to adjust to the negative impacts of climate change, and that transformational adaptation, requiring system-wide changes, will increasingly be needed. (209)

An example of this can be found in adaptation to the growing risk of flooding. While installing walls to stop coastal flooding may work now, in the future other measures such as relocation of human settlements might be needed. However, the Hong Kong Government continues to allow building in low-lying areas and has approved massive land-reclamation projects which have been criticised by environmental groups such as Greenpeace for their potential environmental impact as well as economic cost. (210)

The most recent adaptation measures and priorities are laid out in Hong Kong's Climate Change Action Plan 2050 (90). These are some of the plans, measures and actions as stated in this official document.

Strengthen infrastructure

- Since 2016, the Climate Change Working Group on Infrastructure (CCWGI) coordinates departments actions on adapting to climate change.
- The CCWGI has coordinated studies on the potential effects of extreme temperatures, extreme storm surges and super typhoons on government critical infrastructure and updates the design standards for various types of infrastructure – such as ports or drainage systems – in line with the IPCC Assessment reports.
- Formulate measures and implementation plans to enhance the resilience of critical infrastructure in line with the recommendations of a study made by CCWGI.

Combat sea level rise and marine protection

- The Government has commissioned comprehensive reviews of the impacts of extreme weather events and climate change in low-lying coastal and windy locations in relation to storm surges and waves and will implement improvement works and formulate management measures for some locations.
- The Government plans to commence a strategic study on shoreline management to analyse the impacts of climate change on the development of coastal areas, to formulate long-term strategies and protection measures, and to strengthen the capabilities of the Government and relevant stakeholders in coping with climate change.

Combat extreme rainstorms and tropical cyclones

- The Government has adopted a ‘three-pronged flood prevention strategy’ which envisions intercepting stormwater upstream, storing flood midstream and improving drainage downstream. It has completed major flood prevention projects, including four drainage tunnels, four stormwater storage schemes, improvement works for rivers in the New Territories, and 27 village protection schemes in low-lying villages, among other actions.
- The Government reviews the Drainage Master Plan of various districts to assess flood risk and allocate resources for implementing drainage improvement works.
- The Government has updated the Stormwater Drainage Manual by including the impacts on the drainage system design caused by rainfall increase and sea level rise due to climate change.
- The Government designs, constructs and maintains the floor protection and drainage systems of the railway.
- The Government implements the Landslip Prevention and Mitigation Programme to upgrade government man-made slopes to mitigate natural terrain landslide risk.

Combat extreme droughts and safeguard water supply

- The Total Water Management Strategy focuses on containing freshwater demand growth and building resilience in the supply of fresh water. Water conservation, water loss management and expansion of lower grade water for non-potable purposes are three main water demand management initiatives.
- Building of first stage of the desalination plant in Tseung Kwan O.
- Reconstruction of the existing Shek Wu Hui Sewage Treatment Works in phases to increase the treatment capacity to 190,000m³ per day.
- Construction of a centralised grey water recycling system to collect, treat and supply grey water for flushing and other non-potable purposes with a treatment capacity of 3,300 m³ per day.

Combat extreme heat

- Enhance building design and promote urban forestry with a view to alleviating and coping with temperature rise.
- Revision of the design standards of public infrastructure and government buildings.
- The Government explores measures to improve the growing environment of urban trees, including applying smart technologies in tree management, reviewing the soil volume for new roadside trees, and improving soil quality of existing planting areas
- The Government ‘will continue to promote active planting, proper maintenance and preservation practices with a view to achieving a sustainable and healthy urban forest’.

Source: Hong Kong's Climate Change Action Plan 2050 (90).

Regarding urban greening, the Government has also included provisions for greenery in public works projects and official buildings. Additionally, it has approved incentives for private developers to include heat mitigating elements and make new buildings in accordance with sustainability standards. However, the voluntary nature of these measures has raised concerns about their limited impact (79).

The authorities have taken some steps towards protecting the most vulnerable from extreme weather, such as opening night heat shelters for those who need to take refuge during hot weather warnings and also during cold spells (211). However, Hong Kong's Climate Change Action Plan 2050 lacks a focus on groups in situations of vulnerability, such as persons with disabilities.

CarbonCare Innolab, a Hong Kong NGO that focuses on climate justice, innovation and participation by the youth and students, conducted since 2018 community dialogues with civil society organisations to discuss what a just transition towards a low carbon economy would look like in Hong Kong and which policy measures are needed to mitigate and adapt to the impact of climate change with a focus on vulnerable groups. The summary report published by CarbonCare Innolab

in December 2022 highlights the limitations in official strategies regarding groups such as outdoor workers, people with disabilities and those living in subdivided flats (76). For example, there were no legally binding regulations to protect outdoor workers other than basic rules regarding work-related injuries. The report recommended enacting legislation to regulate outdoor work during hot weather, including specific rest periods, hot weather allowances and provision of drinking water (76). The Labour Department has produced guidance notes on prevention of heat stroke at work based on the requirements of the Occupational Safety and Health Ordinance and aimed at helping employers to conduct risk assessments and establish preventive and control measures (212).

People with disabilities can be disproportionately impacted by climate change (213). However, their needs seem to have also been overlooked in official documents such as the Hong Kong Climate Action Plan 2050 and the Budget 2022-23 (76). The CarbonCare Innolab report recommended that people with disabilities are included by the Commissioner for Rehabilitation of the Labour and Welfare Bureau (responsible for policies in relation to this group), when formulating climate change policies and measures (76).

MITIGATION EFFORTS

Mitigating climate change means ‘preventing or reducing the flow of heat-trapping greenhouse gases into the atmosphere’ (214). It can be achieved either by reducing the sources of these gases, for example by increasing the use of renewable energies, or by increasing the storage of gases, for example by increasing the size of forests (214).

Before the publication in 2017 of Hong Kong’s Climate Action Plan 2030+ in response to the Paris Agreement, Hong Kong had already reached its peak in carbon emissions in 2014, with further reductions occurring between that year and 2019, from 6.2 tonnes per capita of emissions in 2014 to 5.3 tonnes per capita in 2019 (90). Reductions in emissions in Hong Kong can be attributed mainly to the decrease in the use of coal for electricity generation, achieved by banning the construction of new coal powered plants in 1997 and a gradual replacement of coal with natural gas and zero-carbon sources (90).

As mentioned earlier, the main sources of emissions in Hong Kong are power generation (66 percent), transport (18 percent) and waste (7 percent) (90). To achieve carbon neutrality, the Government pledges in its Hong Kong’s Climate Action Plan 2050 to achieve net-zero carbon emissions in energy supply and transport and to stop landfilling of municipal waste (90). The four main strategies to achieve carbon neutrality before 2050 are: net-zero electricity generation; energy saving and green buildings; green transport; and waste reduction.

ELECTRICITY

By 2035, the Government wants to cease the use of coal for daily electricity generation, replacing it with low to zero-carbon energy. By before 2050, the long-term target is to achieve net-zero carbon emissions in electricity generation. Hong Kong obtains much of the energy it uses from importing fuel to generate electricity or importing electricity from the Mainland. The presence of coal in the fuel mix has been reduced from 48 percent to 24 percent, increasing the share of natural gas from 27 percent to almost half (90). This has allowed to reduce carbon emissions by about 18 percent between 2015 and 2020, according to the Government’s own data. However, natural gas is a fossil fuel whose primary component is methane, which is a very powerful greenhouse gas (215). Even if emissions from burning natural gas are lower than those from burning coal or oil, they are much higher than those from renewables such as wind or solar (216).

By 2035, the Government also aims at increasing the share of renewable energy to between 7.5 and 10 percent of the total, reaching 15 percent subsequently (90). The Government expects that by 2035, offshore

wind farms could produce around 3.5 to 4 percent of the total electricity need, and that solar energy could cover around 1 to 2 percent (90). While solar panels are fitted on buildings in many countries, the Hong Kong Government has stated that the scarcity of land available makes it difficult to develop large-scale renewable energy facilities. The renewable energy targets and progress of different countries are not directly comparable because they use different timeframes and benchmarks, and their starting positions diverge. To offer some international perspective, the EU has a binding renewable target for 2030 of a minimum of 42.5 percent of its energy consumption, with the aspiration to reach 45 percent (217). Other Asian countries differ greatly. Singapore, for example, aims to produce 3 percent of its demand through solar energy by 2030 (218). The Government of the Philippines wants to reach 35 percent renewable energy in power generation by 2030, while Indonesia has a target of 23 percent of its electricity generation by renewable sources by 2025, according to Climate Action Tracker, an independent scientific project that tracks climate action and measures it against the Paris Agreement (219).

One important area where more efficiency in energy consumption can be achieved is in the use by buildings, which account for 90 percent of total energy consumption in Hong Kong (90). By 2035, the Government wants to reduce the use of energy by commercial buildings by 15-20 percent, and by 10-15 percent in residential buildings, compared with 2015. By 2050, the goal is to reduce consumption of commercial buildings by 30 to 40 percent, and by 20 to 30 percent in residential buildings, compared with 2015 (90). It aims to do this by tightening regulations to cover all buildings, conducting more frequent audits, strengthening the promotion of retro-commissioning and improving the energy efficiency of commercial and residential buildings, promoting the use of smart technologies and incorporating district cooling systems in development projects, among other measures (90). Measures implemented so far, including the Buildings Energy Efficiency Ordinance and the Mandatory Energy Efficiency Labelling Scheme, have allowed for the conservation of 2.1 billion kWh of electricity, reducing carbon emissions by 1.45 million tonnes or about 3.6 percent of total carbon emissions in 2020 compared with 2015 (90).

TRANSPORT

The Government's long-term target is to achieve zero vehicular carbon emissions before 2050. In Chapter 2 of this report, we explained that 90 percent of daily passenger trips in Hong Kong are made by public transport, with predominance of the railways. A study on the sustainability of the railway system in Hong Kong between 2008 and 2017 found that it reduced its electricity use and GHG emissions, and that emissions from trains are significantly lower than those from public franchised buses (220). Private cars are the highest source of emissions among all types of vehicles (90). The around 660,000 private cars that are circulating in Hong Kong account for 25 percent of emissions of the transport sector and around 4.5 percent of total carbon emissions. Consequently, among the main measures contemplated to reduce transport emissions in Hong Kong is promoting the use of electric vehicles. The use of private electric cars has been increasing and one in five of the newly registered private cars was electric in the first half of 2021 (90). This is supported by a subsidy scheme to install charging infrastructure in the car parks of residential buildings. Among the measures contemplated in the Hong Kong roadmap on popularisation of electric vehicles features not allowing for any new registration of fuel-propelled private cars including hybrid in 2035 or earlier (221).

The Government has also set up the New Energy Transport Fund (NET Fund), providing subsidies to the transport sector to apply green transport technologies (90). To manage traffic congestion in the city, the Government also incentivises the provision of park-and-ride facilities, incentivising car users to leave their cars near railway stations and use public transport to get to the city centre (92).

In 2017 the Government ran a pilot scheme in Central – the business district – to introduce an electronic road charging pilot scheme to assess how effective it could be in easing traffic congestion and what would be the economic and environmental benefits of such a scheme. The study was completed in September 2022 and the Government says it will 'determine when and how it should be taken forward' (222).

Other measures which have been applied to limit car growth in Hong Kong are of fiscal nature, but according to assessments by the Legislative Council Secretariat Research Office, their effect has mostly been brief and their level has not been increased for years (107).

As part of a drive to alleviate road traffic congestion, the Government has also planned different actions to redress the geographic imbalance of jobs between the central districts and the new territories. The strategic planning framework provided by the Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030 contemplates developing economic land in various areas of the New Territories to allow more people to work close to their homes (92). The development of the new so-called 'Northern Metropolis' in the New Territories could potentially contribute to reducing some of the geographic socioeconomic inequalities discussed in this report, but a specific equity-oriented goal does not appear to exist when examining the materials available on the official website (223).

WASTE REDUCTION

Over 90 percent of emissions from waste in Hong Kong in 2019 came from decomposition of waste in landfills. In 2020, the daily disposal of municipal solid waste at landfills was 1.44 kg/person, which according to the Government is a higher rate than in other major cities (224).

To reduce emissions from waste, the Government has been promoting waste reduction and recycling, as well as developing waste-to-energy facilities. In 2021, the Government passed a bill that contemplates as the main strategy for waste reduction achieving behavioural change through charging for emitted waste based on quantity. This Municipal Solid Waste Charging will come into force on the 1st of August 2024 (225). Additionally, it has opened recycling stores and spots in all districts, as well as expanded the community recycling network (90).

Since the Government expects that Hong Kong's three existing landfills will fill up in the coming years (226), an important goal in waste management is to stop relying on landfilling for waste disposal. To do this, it has been building waste management infrastructure to turn waste into energy and plans to continue building more, expecting that by 2035 around 3 to 4 percent of electricity demand could be met by these facilities (90). Additionally, other measures such as controlling the use of single-use plastics and supporting the recycling trade to adopt new technologies towards achieving higher-value added production and circular economy are contemplated in Hong Kong's Climate Action Plan 2050 (90).

CHAPTER 4

CONCLUSIONS AND THE WAY FORWARD

These are some of the key messages of this report.

HOUSING

- Hong Kong has one of the least affordable private housing markets in the world. Unaffordability adversely affects the health of those who are deprived, but also has a negative effect on health through other pathways, potentially impacting on the whole of society.
- As a result of the unaffordable housing market and insufficient public housing more than 100,000 households in Hong Kong live in subdivided units (SDUs), which are generally very small, leading to overcrowding, and offer poor living conditions, all of which can have negative impacts on physical and mental health.
- However, almost half of the population lives in good quality public housing, reducing the impact of unaffordable private housing on living conditions. However, waiting times for public rental housing are long, an average of 6.1 years, and younger people and those without children are not prioritised.
- Some ethnic minorities have a higher likelihood of living in SDUs particularly Philipinos, Nepalese and Indonesian workers.

AREA-LEVEL INEQUALITIES

- There are socioeconomic inequalities in sex and age-standardised all-cause mortality between the most deprived and the least deprived areas in Hong Kong.

GREEN AND OPEN SPACES

- Access to green and open spaces is protective of physical and mental health and wellbeing, but only if these spaces are close to home (e.g. 500 metres or less) and of good quality. In most districts, people need to travel more than two kilometres to access a park, a distance that can be considered too high in terms of accessibility.

OUTDOOR AIR POLLUTION

- Outdoor air pollution is damaging for health. Air pollution levels in Hong Kong have been declining, but there are inequalities in exposure and risk of associated health harm. People living in highly socially deprived areas have been shown to suffer a higher risk of death than those from middle or low deprivation areas from non-accidental, cardiovascular and respiratory causes associated with several pollutants.

CLIMATE CHANGE

- Some initial impacts from climate change have been observed in Hong Kong, including increasing annual mean temperatures and increased rainfall.
- Prolonged hot weather, particularly hot nights, has been shown to increase mortality in Hong Kong. Exposure and vulnerability to heat varies between groups in Hong Kong. Between 2010 and 2019, elderly people with lower socioeconomic status were most likely to be hospitalised for a range of health conditions due to higher temperatures during the hot season.
- Hong Kong's Climate Action Plan 2050 does not have a focus on health or health equity.

Based on the findings and observations in this report, we make the following nine recommendations. While these are directed at the Government, other stakeholders, such as the private and voluntary sector need to implement guidelines and recommendations produced by the Government:

- 1 → The Hong Kong Government must strengthen its focus on health inequalities, including action on reducing inequalities in built and natural environments and on the impacts of climate change.
- 2 → The Government, developers and public housing providers should work in partnership to increase the availability of affordable housing, particularly in the public rental sector, to better meet demand and reduce waiting times.
- 3 → The Government, working with partners, should set and meet a target to eliminate SDUs, through provision of suitable good quality private and public housing.
- 4 → The Government must ensure that available open spaces are safe and accessible, preferably green and within walking distance for all residents of Hong Kong.
- 5 → Despite reductions in pollution levels, the Government needs to do more to ensure compliance with WHO guidelines and reduce inequalities in exposure.
- 6 → The Government should reduce GHG emissions and make efforts along with every other country to reduce its impact on climate change. Mitigation efforts must include an equity lens.
- 7 → The Government needs to prepare for more frequent, extreme weather events and rising sea levels. In preparing, it needs to take efforts to ensure that there is not a disproportionate influence in health and its social determinants and ensure that inequalities are not exacerbated.
- 8 → Together, the Census and Statistics Department and the Centre for Health Protection should regularly collect and harmonise small-area data on health and the social determinants taking account of the high population density.
- 9 → The Census and Statistics Department should include questions related to health and care of the vulnerable in the coming round of the 2026 Population Census and monitor health inequalities.

REFERENCES

1. Marmot M, Allen J, Goldblatt P, Morrison J, Woo J, Yeoh EK, et al. Build Back Fairer: Reducing Socioeconomic Inequalities in Health in Hong Kong [Internet]. Institute of Health Equity; 2021 [cited 2023 May 10]. Available from: <https://www.instituteofhealthequity.org/resources-reports/build-back-fairer-reducing-socioeconomic-inequalities-in-health-in-hong-kong>
2. Marmot M, Castedo A, Alexander M, Allen J, Goldblatt P, Woo J, et al. Health Inequalities in Hong Kong: A Life Course Approach [Internet]. Institute of Health Equity; 2022 [cited 2023 Nov 13]. Available from: <https://www.instituteofhealthequity.org/resources-reports/health-inequalities-in-hong-kong-a-life-course-approach>
3. Buck D, Wenzel L, Beech J. The King's Fund. 2021 [cited 2023 Apr 26]. Communities and health. Available from: <https://www.kingsfund.org.uk/publications/communities-and-health>
4. Marmot M, Goldblatt P, Allen J, Boyce T, McNeish D, Grady M, et al. Fair Society Healthy Lives (The Marmot Review) [Internet]. Institute of Health Equity; 2010 [cited 2023 Apr 26]. Available from: <https://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review>
5. Marmot M, Allen J, Boyce T, Goldblatt P, Morrison J. Marmot Review 10 Years On [Internet]. 2020 [cited 2023 Apr 26]. Available from: <https://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on>
6. Diez Roux AV. Neighborhoods and Health: What Do We Know? What Should We Do? *Am J Public Health* [Internet]. 2016 Mar [cited 2023 Apr 4];106(3):430-1. Available from: <https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2016.303064>
7. Michael Marmot, Jessica Allen, Tammy Boyce, Peter Goldblatt, Joana Morrison. Marmot Review 10 Years On [Internet]. Institute of Health Equity; 2020 [cited 2023 Oct 16]. Available from: <https://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on>
8. World Health Organization. WHO Housing and health guidelines [Internet]. 2018 [cited 2023 May 9]. Available from: <https://www.who.int/publications-detail-redirect/9789241550376>
9. Munro A, Allen J, Marmot M. Evidence Review: Housing and Health Inequalities in London [Internet]. Institute of Health Equity; 2022 [cited 2023 May 9]. Available from: <https://www.instituteofhealthequity.org/resources-reports/evidence-review-housing-and-health-inequalities-in-london>
10. Public Health Scotland. Place and communities [Internet]. 2022 [cited 2023 Dec 5]. Available from: <https://www.healthscotland.scot/publications/place-and-communities>
11. Public Health England. GOV.UK. 2021 [cited 2023 Apr 28]. Place-based approaches for reducing health inequalities: main report. Available from: <https://www.gov.uk/government/publications/health-inequalities-place-based-approaches-to-reduce-inequalities/place-based-approaches-for-reducing-health-inequalities-main-report>
12. Chung GKK, Robinson M, Marmot M, Woo J. Monitoring socioeconomic inequalities in health in Hong Kong: insights and lessons from the UK and Australia. *The Lancet Regional Health - Western Pacific* [Internet]. 2023 Feb 1 [cited 2023 Apr 26];31:100636. Available from: <https://www.sciencedirect.com/science/article/pii/S2666606522002516>
13. DATA.GOV.HK. Boundaries of Tertiary Planning Units & Subunits [Internet]. 2023 [cited 2024 Jan 15]. Available from: <https://data.gov.hk/en-data/dataset/hk-pland-pland1-boundaries-of-tpu-sb-vc>
14. Ng MK, Lau YT, Chen H, He S. Dual Land Regime, Income Inequalities and Multifaceted Socio-Economic and Spatial Segregation in Hong Kong. In: van Ham M, Tammaru T, Ubarevičienė R, Janssen H, editors. *Urban Socio-Economic Segregation and Income Inequality: A Global Perspective* [Internet]. Cham: Springer International Publishing; 2021 [cited 2023 Apr 4]. p. 113-33. (The Urban Book Series). Available from: https://doi.org/10.1007/978-3-030-64569-4_6
15. Eurostat. How closely do people live together in your region? [Internet]. [cited 2023 Dec 21]. Available from: <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200430-1>
16. Cox W. Demographia International Housing Affordability – 2023 Edition Released [Internet]. Urban Reform Institute. 2023 [cited 2023 May 5]. Available from: <https://urbanreforminstitute.org/2023/03/demographia-international-housing-affordability-2023-edition-released/>
17. Kawachi I. Income inequality and economic residential segregation. *Journal of Epidemiology & Community Health* [Internet]. 2002 Mar 1 [cited 2023 Apr 25];56(3):165-6. Available from: <https://jech.bmj.com/content/56/3/165>
18. European Commission-Joint Research Centre. The Future of Cities [Internet]. 2023 [cited 2023 Apr 26]. Available from: <https://urban.jrc.ec.europa.eu/thefutureofcities/>
19. Census and Statistics Department Hong Kong SAR. 2021 Population Census - Publications - Main results [Internet]. 2022 [cited 2023 Jun 21]. Available from: <https://www.census2021.gov.hk/en/publications.html>
20. Census and Statistics Department Hong Kong SAR. 2021 Population Census - Publications - Thematic Report: Ethnic Minorities [Internet]. 2022 [cited 2023 Aug 30]. Available from: <https://www.census2021.gov.hk/en/publications.html>
21. Wang K, Law CK, Zhao J, Hui AYK, Yip BHK, Yeoh EK, et al. Measuring health-related social deprivation in small areas: development of an index and examination of its association with cancer mortality. *International Journal for Equity in Health* [Internet]. 2021 Sep 27 [cited 2023 Apr 26];20(1):216. Available from: <https://doi.org/10.1186/s12939-021-01545-9>

22. Hsu CY, Chang SS, Lee EST, Yip PSF. Geography of suicide in Hong Kong: Spatial patterning, and socioeconomic correlates and inequalities. *Social Science & Medicine* [Internet]. 2015 Apr 1 [cited 2023 May 1];130:190–203. Available from: <https://www.sciencedirect.com/science/article/pii/S0277953615001021>
23. Kandt J, Chang SS, Yip P, Burdett R. The spatial pattern of premature mortality in Hong Kong: How does it relate to public housing? *Urban Studies* [Internet]. 2017 Apr 1 [cited 2023 May 1];54(5):1211–34. Available from: <https://doi.org/10.1177/0042098015620341>
24. Jens Kandt, Shu-Sen Chang, Paul Yip, Ricky Burdett. The spatial pattern of premature mortality in Hong Kong: How does it relate to public housing? (Accepted version). LSE Research Online. 2017;
25. Guo Y, Chang SS, Chan CH, Chang Q, Hsu CY, Yip PSF. Association of neighbourhood social and physical attributes with depression in older adults in Hong Kong: a multilevel analysis. *J Epidemiol Community Health*. 2020 Feb;74(2):120–9.
26. WHO Regional Office for Europe. Environmental health inequalities in Europe: second assessment report [Internet]. World Health Organization; 2019 [cited 2023 May 9]. Available from: <https://www.who.int/europe/publications/item/9789289054157>
27. WHO Regional Office for Europe. Environmental noise guidelines for the European Region [Internet]. 2019 [cited 2023 Aug 22]. Available from: <https://www.who.int/europe/publications/item/9789289053563>
28. Institute of Health Equity. Review of social determinants and the health divide in the WHO European Region: final report [Internet]. World Health Organization; 2013 [cited 2024 Jan 17]. Available from: <https://www.instituteoftheequity.org/resources-reports/review-of-social-determinants-and-the-health-divide-in-the-who-european-region-final-report>
29. Shaw M. Housing and public health. *Annu Rev Public Health*. 2004;25:397–418.
30. World Health Organization. Heat and Health [Internet]. 2018 [cited 2023 Apr 4]. Available from: <https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health>
31. Munford LA, Fichera E, Sutton M. Is owning your home good for your health? Evidence from exogenous variations in subsidies in England. *Economics & Human Biology* [Internet]. 2020 Dec 1 [cited 2023 May 17];39:100903. Available from: <https://www.sciencedirect.com/science/article/pii/S1570677X20301738>
32. Mehdipanah R, Schulz AJ, Israel BA, Mentz G, Eisenberg A, Stokes C, et al. Neighborhood Context, Homeownership and Home Value: An Ecological Analysis of Implications for Health. *Int J Environ Res Public Health* [Internet]. 2017 Oct [cited 2023 May 17];14(10):1098. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5664599/>
33. The Health Foundation. Better housing is crucial for our health and the COVID-19 recovery [Internet]. 2020 [cited 2023 May 17]. Available from: <https://www.health.org.uk/publications/long-reads/better-housing-is-crucial-for-our-health-and-the-covid-19-recovery>
34. Stahre M, VanEenwyk J, Siegel P, Njai R. Housing Insecurity and the Association With Health Outcomes and Unhealthy Behaviors, Washington State, 2011. *Prev Chronic Dis*. 2015 Jul 9;12:E109.
35. The Health Foundation. Housing [Internet]. 2023 [cited 2023 May 10]. Available from: <https://www.health.org.uk/evidence-hub/housing>
36. Chung RYN, Chung GKK, Gordon D, Mak JKL, Zhang LF, Chan D, et al. Housing affordability effects on physical and mental health: household survey in a population with the world’s greatest housing affordability stress. *J Epidemiol Community Health*. 2020 Feb;74(2):164–72.
37. Information Services Department. Inland Revenue Department: Press Release [Internet]. 2023 [cited 2023 Nov 1]. Available from: <https://www.ird.gov.hk/eng/ppr/archives/23032901.htm>
38. Research Office. Legislative Council Secretariat. Social Mobility in Hong Kong [Internet]. Legislation Council Secretariat; 2015. Available from: <https://www.legco.gov.hk/research-publications/english/1415rb02-social-mobility-in-hong-kong-20150112-e.pdf>
39. Housing Bureau. Housing in Figures 2022 [Internet]. 2022. Available from: <https://www.hb.gov.hk/eng/publications/housing/HIF2022.pdf>
40. World Health Organization. Household crowding. In: WHO Housing and Health Guidelines [Internet]. World Health Organization; 2018 [cited 2023 Dec 14]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK535289/>
41. The Health Foundation. Trends in household overcrowding by tenure [Internet]. 2023 [cited 2023 Dec 14]. Available from: <https://www.health.org.uk/evidence-hub/housing/housing-stability-and-security/trends-in-household-overcrowding-by-tenure>
42. Sarkar C, Lai KY, Kumari S, Leung GM, Webster C, Ni MY. Characteristics of the Residential Environment and Their Association With Depression in Hong Kong. *JAMA Netw Open* [Internet]. 2021 Oct 29 [cited 2023 Apr 4];4(10):e2130777. Available from: <https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2785599>
43. Ho HK, Yip M. From micro- to nano-segregation: policy-led vertical urbanism in Hong Kong. *International Journal of Housing Policy* [Internet]. 2023 Jan 23 [cited 2023 May 10];0(0):1–15. Available from: <https://doi.org/10.1080/19491247.2022.2148339>

44. Hong Kong Housing Authority and Housing Department. Income and Asset Limits [Internet]. 2023 [cited 2023 Aug 30]. Available from: <https://www.housingauthority.gov.hk/en/flat-application/income-and-asset-limits/index.html>
45. Census and Statistics Department Hong Kong SAR. 2021 Population Census. 2023 [cited 2023 Aug 30]. Interactive Data Dissemination Service. Available from: <https://idds.census2021.gov.hk/app/idds.html>
46. Wong M, Yu R, Woo J. Effects of Perceived Neighbourhood Environments on Self-Rated Health among Community-Dwelling Older Chinese. *IJERPH* [Internet]. 2017 Jun 7 [cited 2023 Apr 4];14(6):614. Available from: <http://www.mdpi.com/1660-4601/14/6/614>
47. Chung RY, Mercer S, Lai FTT, Yip BHK, Wong MCS, Wong SYS. Socioeconomic Determinants of Multimorbidity: A Population-Based Household Survey of Hong Kong Chinese. *PLoS One*. 2015;10(10):e0140040.
48. Zhang T, Huang B, Wong H, Wong SY shan, Chung RYN. Public Rental Housing and Obesogenic Behaviors among Adults in Hong Kong: Mediator Role of Food and Physical Activity Environment. *International Journal of Environmental Research and Public Health* [Internet]. 2022 Jan [cited 2023 May 23];19(5):2960. Available from: <https://www.mdpi.com/1660-4601/19/5/2960>
49. Sin D, Yeung SSY, Woo J. A Healthy Diet Does Not Necessarily Cost More than A Typical (Unhealthy) Diet in Hong Kong. *J Nutr Health Aging* [Internet]. 2022 Feb 1 [cited 2023 Aug 30];26(2):209-10. Available from: <https://doi.org/10.1007/s12603-022-1731-x>
50. Li X, Shamsuddin S. Housing the Poor? A Comparative Study of Public Housing Provision in New York, Hong Kong, and Shenzhen. *Housing Policy Debate* [Internet]. 2022 Jul 4 [cited 2023 May 24];32(4-5):678-96. Available from: <https://doi.org/10.1080/10511482.2021.2019080>
51. Yip NM. *East Asia Forum*. 2020 [cited 2023 May 5]. Solving Hong Kong's housing affordability problem. Available from: <https://www.eastasiaforum.org/2020/05/01/solving-hong-kongs-housing-affordability-problem/>
52. Hong Kong Housing Authority and Housing Department. Number of Applications and Average Waiting Time for Public Rental Housing [Internet]. 2023 [cited 2023 Aug 30]. Available from: <https://www.housingauthority.gov.hk/en/about-us/publications-and-statistics/prh-applications-average-waiting-time/index.html>
53. The World Bank. World Bank Open Data. 2024 [cited 2024 Jan 10]. Inflation, consumer prices (annual %) - Hong Kong SAR, China. Available from: <https://data.worldbank.org>
54. Housing Bureau. Task Force on Transitional Housing [Internet]. 2022 [cited 2023 Nov 1]. Available from: <https://www.hb.gov.hk/eng/policy/housing/policy/transitional/index.html>
55. Housing Bureau. The Government of the Hong Kong Special Administrative Region of the People's Republic of China. The Long Term Housing Strategy [Internet]. 2022 [cited 2023 May 9]. Available from: <https://www.hb.gov.hk/eng/policy/housing/policy/lths/index.html>
56. Housing Bureau. Transitional Housing Projects [Internet]. 2022 [cited 2023 Nov 1]. Available from: <https://www.hb.gov.hk/eng/policy/housing/policy/transitionalhousing/transitionalhousing.html>
57. Housing Bureau. Light Public Housing [Internet]. 2022. (LC Paper No. CB(1)881/2022(01)). Available from: <https://www.legco.gov.hk/yr2022/english/panels/hg/papers/hg20221205cb1-881-1-e.pdf>
58. Census and Statistics Department Hong Kong SAR. 2021 Population Census - Publications - Thematic Report: Persons Living in Subdivided Units [Internet]. 2022 [cited 2023 May 5]. Available from: <https://www.census2021.gov.hk/en/publications.html>
59. Housing Bureau. Long Term Housing Strategy - Annual Progress Report 2022 [Internet]. 2022 [cited 2023 May 9]. Available from: <https://www.hb.gov.hk/eng/policy/housing/policy/lths/index.html>
60. Report of the Task Force for the Study on Tenancy Control of Subdivided Units [Internet]. Secretariat for the Task Force for the Study on Tenancy Control of Subdivided Units Transport and Housing Bureau; 2021 Mar [cited 2023 Nov 1]. Available from: https://www.hb.gov.hk/eng/contact/housing/studyOnTenancyControl_Report.pdf
61. Yau Y, Lau WK. Big Data Approach as an Institutional Innovation to Tackle Hong Kong's Illegal Subdivided Unit Problem. *Sustainability* [Internet]. 2018 Aug [cited 2023 May 10];10(8):2709. Available from: <https://www.mdpi.com/2071-1050/10/8/2709>
62. Census and Statistics Department Hong Kong SAR. Housing conditions of sub-divided units in Hong Kong [Internet]. 2016 [cited 2023 May 5]. (Thematic Household Survey Report No. 60). Available from: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=C0000091&scode=100>
63. Cheung PK, Jim CY, Siu CT. Air quality impacts of open-plan cooking in tiny substandard homes in Hong Kong. *Air Qual Atmos Health* [Internet]. 2019 Jul 1 [cited 2023 May 10];12(7):865-78. Available from: <https://doi.org/10.1007/s11869-019-00705-9>
64. Cheung PK, Jim CY. Indoor air quality in substandard housing in Hong Kong. *Sustainable Cities and Society* [Internet]. 2019 Jul 1 [cited 2023 May 9];48:101583. Available from: <https://www.sciencedirect.com/science/article/pii/S2210670719308479>
65. RTHK. 'Public flat wait harms singletons' mental state' [Internet]. 2022 [cited 2023 May 10]. Available from: <https://news.rthk.hk/rthk/en/component/k2/1669361-20221002.htm?>

66. Leung KK, Chow CL. A brief discussion on fire safety issues of subdivided housing units in Hong Kong. In 2016 [cited 2023 May 10]. Available from: [https://scholars.cityu.edu.hk/en/publications/a-brief-discussion-on-fire-safety-issues-of-subdivided-housing-units-in-hong-kong\(ff413c0f-5264-4b4e-894f-59b9c8fba08a\).html](https://scholars.cityu.edu.hk/en/publications/a-brief-discussion-on-fire-safety-issues-of-subdivided-housing-units-in-hong-kong(ff413c0f-5264-4b4e-894f-59b9c8fba08a).html)
67. Financial Secretary. Financial Secretary - My Blog - Working together to get rid of subdivided flats [Internet]. 2021 [cited 2023 Nov 13]. Available from: <https://www.fso.gov.hk/eng/blog/blog20210725.htm>
68. Sun F. South China Morning Post. 2022 [cited 2023 Nov 13]. Hong Kong wishes to get rid of the notorious subdivided units by 2049, will it? Available from: <https://bit.ly/3ztGCUu>
69. Housing Bureau. Tenancy Control of Subdivided Units [Internet]. 2023 [cited 2023 Oct 30]. Available from: https://www.hb.gov.hk/eng/policy/housing/policy/tenancy_control/index.html
70. Yip AO ni, Mah DN yin, Barber LB. Revealing hidden energy poverty in Hong Kong: a multi-dimensional framework for examining and understanding energy poverty. *Local Environment* [Internet]. 2020 Jul 2 [cited 2023 Apr 24];25(7):473-91. Available from: <https://doi.org/10.1080/13549839.2020.1778661>
71. Goggins WB, Chan EYY, Ng E, Ren C, Chen L. Effect Modification of the Association between Short-term Meteorological Factors and Mortality by Urban Heat Islands in Hong Kong. Cook AR, editor. *PLoS ONE* [Internet]. 2012 Jun 22 [cited 2023 Apr 4];7(6):e38551. Available from: <https://dx.plos.org/10.1371/journal.pone.0038551>
72. Ng E, Cheng V. Urban human thermal comfort in hot and humid Hong Kong. *Energy and Buildings* [Internet]. 2012 Dec [cited 2023 Apr 4];55:51-65. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0378778811004130>
73. Pörtner HO, Roberts DC, Tignor MMB, Poloczanska ES, Mintenbeck K, Alegría A, et al., editors. Summary for policymakers. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2022.
74. Legislative Council of the Hong Kong Special Administrative Region. Background brief on “Fuel Clause Charges of the two power companies” prepared by the Legislative Council Secretariat [Internet]. 2023 [cited 2023 May 9]. Available from: <https://www.legco.gov.hk/yr2023/english/panels/ea/agenda/ea20230327.htm>
75. Fong SY, Kimberley Clare O. The experience of energy poverty among young adults living in subdivided units in Hong Kong: Evidence from a phenomenological study. *Wellbeing, Space and Society* [Internet]. 2021 Jan 1 [cited 2023 Apr 21];2:100054. Available from: <https://www.sciencedirect.com/science/article/pii/S2666558121000270>
76. Yucheng KL. Hong Kong Just Transition Report - Building Partnerships to Achieve a Climate-just City [Internet]. CarbonCare InnoLab; 2022 [cited 2023 Sep 7]. Available from: <https://www.sparkblue.org/content/hong-kong-just-transition-report-building-partnerships-achieve-climate-just-city>
77. Gao Y, Chan EYY, Lam HCY, Wang A. Perception of Potential Health Risk of Climate Change and Utilization of Fans and Air Conditioners in a Representative Population of Hong Kong. *Int J Disaster Risk Sci* [Internet]. 2020 Feb 1 [cited 2023 Jun 21];11(1):105-18. Available from: <https://doi.org/10.1007/s13753-020-00256-z>
78. Oxfam. Government should form policies that help subdivided flat residents adapt to climate change [Internet]. 2021 [cited 2023 Sep 7]. Available from: <https://www.oxfam.org.hk/en/news-and-publication/oxfam-government-should-form-policies-that-help-subdivided-flat-residents-adapt-to-climate-change>
79. Legislative Council of the Hong Kong Special Administrative Region. Measures to tackle urban heat [Internet]. 2020 [cited 2023 Sep 7]. Available from: <https://www.legco.gov.hk/research-publications/english/essentials-2021ise04-measures-to-tackle-urban-heat.htm#endnote7>
80. Goggins WB, Chan EY. A study of the short-term associations between hospital admissions and mortality from heart failure and meteorological variables in Hong Kong: Weather and heart failure in Hong Kong. *Int J Cardiol*. 2017 Feb 1;228:537-42.
81. Liu S, Chan EYY, Goggins WB, Huang Z. The Mortality Risk and Socioeconomic Vulnerability Associated with High and Low Temperature in Hong Kong. *IJERPH* [Internet]. 2020 Oct 7 [cited 2023 Apr 4];17(19):7326. Available from: <https://www.mdpi.com/1660-4601/17/19/7326>
82. Chan EYY. *Climate Change and Urban Health: The Case of Hong Kong as a Subtropical City* [Internet]. Routledge; 2019 [cited 2023 Jun 27]. Available from: <https://www.routledge.com/Climate-Change-and-Urban-Health-The-Case-of-Hong-Kong-as-a-Subtropical/Chan/p/book/9780367729363>
83. Hong Kong Observatory. Climate Change in Hong Kong - Extreme weather events [Internet]. 2023 [cited 2023 Jun 19]. Available from: https://www.hko.gov.hk/en/climate_change/obs_hk_extreme_weather.htm
84. Qiu H, Sun S, Tang R, Chan KP, Tian L. Pneumonia Hospitalization Risk in the Elderly Attributable to Cold and Hot Temperatures in Hong Kong, China. *American Journal of Epidemiology* [Internet]. 2016 Oct 15 [cited 2023 Jun 27];184(8):570-8. Available from: <https://doi.org/10.1093/aje/kww041>
85. Lam HCY, Li AM, Chan EYY, Goggins WB. The short-term association between asthma hospitalisations, ambient temperature, other meteorological factors and air pollutants in Hong Kong: a time-series study. *Thorax*. 2016 Dec;71(12):1097-109.

86. Chan EY, Goggins WB, Yue JS, Lee P. Hospital admissions as a function of temperature, other weather phenomena and pollution levels in an urban setting in China. *Bull World Health Organ* [Internet]. 2013 Aug 1 [cited 2023 Jun 19];91(8):576-84. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3738307/>
87. Does active transport displace other physical activity? A systematic review of the evidence - ScienceDirect [Internet]. [cited 2023 Dec 14]. Available from: <https://www.sciencedirect.com/science/article/pii/S2214140523000671>
88. The Health Foundation. Transport and health [Internet]. 2018 [cited 2023 Dec 14]. Available from: <https://www.health.org.uk/infographic/transport-and-health>
89. Hansmann KJ, Grabow M, McAndrews C. Health equity and active transportation: A scoping review of active transportation interventions and their impacts on health equity. *Journal of Transport & Health* [Internet]. 2022 Jun 1 [cited 2023 Dec 14];25:101346. Available from: <https://www.sciencedirect.com/science/article/pii/S2214140522000184>
90. Government of the Hong Kong SAR. Hong Kong's Climate Action Plan 2050 [Internet]. 2021 [cited 2023 Jun 12]. Available from: https://cnsd.gov.hk/wp-content/uploads/pdf/CAP2050_booklet_en.pdf
91. GovHK. GovHK: Fact sheets - Transport [Internet]. 2023 [cited 2023 Jun 22]. Available from: <https://www.gov.hk/en/about/abouthk/factsheets/>
92. Legislative Council of the Hong Kong Special Administrative Region. Legislative Council Meeting of 18 November 2020 Motion on "Alleviating Road Traffic Congestion" Progress Report [Internet]. 2020. Available from: <https://www.legco.gov.hk/yr20-21/english/counmtg/motion/cm20201118m-lch-prpt-e.pdf>
93. MTR. MTR Supports the Post-pandemic Economic Recovery of Hong Kong Lowering the Fare Adjustment Rate with Special Arrangement. 2023.
94. Cheung E, Wong N, Chan K. South China Morning Post. 2023 [cited 2023 Jun 22]. 5 franchised bus firms in Hong Kong get green light to raise fares. Available from: <https://www.scmp.com/news/hong-kong/transport/article/3222290/fare-increases-hong-kongs-citybus-and-new-world-first-bus-merger-kmb-approved-exco-most-routes-see>
95. Hung E. South China Morning Post. 2023 [cited 2023 Jun 23]. Transport cost increases: how much has Hong Kong government shielded commuters? Available from: <https://www.scmp.com/news/hong-kong/transport/article/3214634/hong-kong-transport-cost-increases-how-much-has-government-shielded-commuters-fare-toll-rises>
96. Census and Statistics Department Hong Kong SAR. Household Expenditure Survey and the Rebasing of the Consumer Price Indices [Internet]. 2021 [cited 2023 Jun 22]. Available from: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1060003&scode=290>
97. MTR. MTR > Fare Adjustment Mechanism [Internet]. 2023 [cited 2023 Jun 26]. Available from: <http://www.mtr.com.hk/FareAdjustmentMechanism>
98. news.gov.hk. Hong Kong's Information Services Department. 2023 [cited 2023 Jun 26]. MTR fare mechanism refined. Available from: http://www.news.gov.hk/eng/2023/03/20230321/20230321_182300_896.html
99. Wong O. South China Morning Post. 2018 [cited 2023 Jun 22]. Time to stop favouring MTR Corp, former housing chief says. Available from: <https://www.scmp.com/news/hong-kong/politics/article/2154424/dont-give-rail-giant-mtr-corp-property-development-rights>
100. Jin S, Nie T, Pun N, Xu D. Spatial Mismatch, Different Labor Markets and Precarious Employment: The Case of Hong Kong. *Soc Indic Res* [Internet]. 2022 May 1 [cited 2023 Jun 22];161(1):51-73. Available from: <https://doi.org/10.1007/s11205-021-02819-z>
101. Royal Society for Public Health. Commuter health [Internet]. 2023 [cited 2023 Jun 22]. Available from: <https://www.rsph.org.uk/our-work/policy/wellbeing/commuter-health.html>
102. MTR. Public Transport Fare Subsidy Scheme [Internet]. 2023 [cited 2023 Jun 22]. Available from: <https://www.mtr.com.hk/en/customer/main/public-transport-fare-subsidy-scheme.html>
103. The Government of the Hong Kong Special Administrative Region. Latest arrangements of WFA Scheme and I-WITS Scheme [Internet]. 2021 [cited 2023 Jun 22]. Available from: <https://www.info.gov.hk/gia/general/202103/30/P2021033000283.htm>
104. The Government of the Hong Kong Special Administrative Region. LCQ17: Transport fare-related subsidy schemes [Internet]. 2019 [cited 2023 Aug 23]. Available from: <https://www.info.gov.hk/gia/general/202011/18/P2020111800275.htm>
105. Sha F, Li B, Guo Y, Law YW, Yip PSF, Zhang Y. Effects of the Transport Support Scheme on employment and commuting patterns among public rental housing residents in Hong Kong. *Transport Policy* [Internet]. 2020 Mar 1 [cited 2023 Jun 22];87:10-8. Available from: <https://www.sciencedirect.com/science/article/pii/S0967070X19301210>
106. Research Office. Legislative Council Secretariat. Transport [Internet]. 2022. (ISSH01/2022). Available from: <https://www.legco.gov.hk/research-publications/english/2022iss01-private-cars-in-hong-kong-20220210-e.pdf>
107. Research Office. Legislative Council Secretariat. Measures to contain private car growth in selected places [Internet]. 2019. Available from: <https://www.legco.gov.hk/research-publications/english/1819in21-measures-to-contain-private-car-growth-in-selected-places-20190911-e.pdf>

108. Research Office. Legislative Council Secretariat. Bicycle-friendly policy in Hong Kong [Internet]. 2021. Available from: <https://www.legco.gov.hk/research-publications/english/2021iss17-bicycle-friendly-policy-in-hong-kong-20210204-e.pdf>
109. Cycling Information Centre - Transport Department. Introduction [Internet]. 2023 [cited 2023 Dec 15]. Available from: https://www.td.gov.hk/mini_site/cic/en/index.html
110. Transport Department. Concern over Environment | Annual transport digest [Internet]. 2022 [cited 2023 Jun 22]. Available from: https://www.td.gov.hk/mini_site/atd/2022/en/section8.html
111. Macintyre S. Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity? *International Journal of Behavioral Nutrition and Physical Activity* [Internet]. 2007 Aug 7 [cited 2023 Jun 27];4(1):32. Available from: <https://doi.org/10.1186/1479-5868-4-32>
112. Ribeiro AI, Fraga S, Severo M, Kelly-Irving M, Delpierre C, Stringhini S, et al. Association of neighbourhood disadvantage and individual socioeconomic position with all-cause mortality: a longitudinal multicohort analysis. *The Lancet Public Health* [Internet]. 2022 May 1 [cited 2023 Jun 27];7(5):e447-57. Available from: [https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667\(22\)00036-6/fulltext](https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(22)00036-6/fulltext)
113. Guo Y, Chang SS, Chen M, Yip PSF. Do Poorer Areas Have Poorer Access to Services in Hong Kong? A Small-Area Analysis Based on Multiple Spatial Accessibility Indicators. *Soc Indic Res* [Internet]. 2018 Jul 1 [cited 2023 Apr 4];138(1):1-21. Available from: <https://doi.org/10.1007/s11205-017-1658-5>
114. Peng C, Yip P. Access to Neighbourhood Services and Subjective Poverty in Hong Kong. *Applied Research Quality Life* [Internet]. 2023 Apr 1 [cited 2023 Jun 27];18(2):1015-35. Available from: <https://doi-org.libproxy.ucl.ac.uk/10.1007/s11482-022-10125-0>
115. Kruize H, van der Vliet N, Staatsen B, Bell R, Chiabai A, Muiños G, et al. Urban Green Space: Creating a Triple Win for Environmental Sustainability, Health, and Health Equity through Behavior Change. *International Journal of Environmental Research and Public Health* [Internet]. 2019 Jan [cited 2023 May 22];16(22):4403. Available from: <https://www.mdpi.com/1660-4601/16/22/4403>
116. Markevych I, Schoierer J, Hartig T, Chudnovsky A, Hystad P, Dzhambov AM, et al. Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental Research* [Internet]. 2017 Oct 1 [cited 2023 May 24];158:301-17. Available from: <https://www.sciencedirect.com/science/article/pii/S0013935117303067>
117. Huang Z, Chan EYY, Wong CS, Liu S, Zee BCY. Health Disparity Resulting from the Effect of Built Environment on Temperature-Related Mortality in a Subtropical Urban Setting. *Int J Environ Res Public Health* [Internet]. 2022 Jul 12 [cited 2023 Jun 14];19(14):8506. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9322054/>
118. Yu R, Wang D, Leung J, Lau K, Kwok T, Woo J. Is Neighborhood Green Space Associated With Less Frailty? Evidence From the Mr. and Ms. Os (Hong Kong) Study. *Journal of the American Medical Directors Association* [Internet]. 2018 Jun [cited 2023 Apr 4];19(6):528-34. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1525861017307004>
119. Wang D, Lau KKL, Yu R, Wong SYS, Kwok TTY, Woo J. Neighbouring green space and mortality in community-dwelling elderly Hong Kong Chinese: a cohort study. *BMJ Open* [Internet]. 2017 Jul [cited 2023 Apr 4];7(7):e015794. Available from: <https://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2016-015794>
120. Lu S, Liu Y, Guo Y, Ho HC, Song Y, Cheng W, et al. Neighborhood Built Environment and Late-Life Depression: A Multilevel Path Analysis in a Chinese Society. *The Journals of Gerontology: Series B* [Internet]. 2021 Dec 1 [cited 2023 May 25];76(10):2143-54. Available from: <https://doi.org/10.1093/geronb/gbab037>
121. Hajna S, Nafilyan V, Cummins S. Associations between residential greenspace exposure and mortality in 4 645 581 adults living in London, UK: a longitudinal study. *The Lancet Planetary Health* [Internet]. 2023 Jun 1 [cited 2023 Jun 6];7(6):e459-68. Available from: <https://www.sciencedirect.com/science/article/pii/S2542519623000578>
122. Planning Department. Planning Department - Hong Kong Planning Standards and Guidelines [Internet]. 2022 [cited 2023 May 24]. Available from: https://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/index.htm
123. Zhang R, Zhang CQ, Cheng W, Lai PC, Schüz B. The neighborhood socioeconomic inequalities in urban parks in a High-density City: An environmental justice perspective. *Landscape and Urban Planning* [Internet]. 2021 Jul 1 [cited 2023 Apr 24];211:104099. Available from: <https://www.sciencedirect.com/science/article/pii/S0169204621000621>
124. Lai C. Unopened Space. Mapping Equitable Availability of Open Space in Hong Kong [Internet]. Civic Exchange; 2022 Sep [cited 2023 Apr 4]. Available from: <https://civic-exchange.org/report/unopened-space-mapping-equitable-availability-of-open-space-in-hong-kong/>
125. Chow J. Public Open Space Accessibility in Hong Kong. A Geospatial Analysis [Internet]. Civic Exchange; 2018 [cited 2023 May 24]. Available from: <https://civic-exchange.org/report/open-space-geospatial-analysis/>
126. White MP, Elliott LR, Gascon M, Roberts B, Fleming LE. Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research* [Internet]. 2020 Dec 1 [cited 2023 May 25];191:110169. Available from: <https://www.sciencedirect.com/science/article/pii/S0013935120310665>
127. World Health Organization. Air pollution [Internet]. 2023 [cited 2023 Apr 5]. Available from: <https://www.who.int/health-topics/air-pollution>

128. World Health Organization. What are the WHO Air quality guidelines? [Internet]. 2021 [cited 2023 May 30]. Available from: <https://www.who.int/news-room/feature-stories/detail/what-are-the-who-air-quality-guidelines>
129. Alzheimer's Society. Air pollution and dementia [Internet]. 2023 [cited 2023 May 30]. Available from: <https://www.alzheimers.org.uk/about-dementia/risk-factors-and-prevention/air-pollution-and-dementia>
130. World Health Organization. WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide [Internet]. 2021 [cited 2023 May 29]. Available from: <https://apps.who.int/iris/handle/10665/345329>
131. Hajat A, Hsia C, O'Neill MS. Socioeconomic Disparities and Air Pollution Exposure: A Global Review. *Curr Environ Health Rep* [Internet]. 2015 Dec [cited 2023 May 29];2(4):440-50. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4626327/>
132. European Environment Agency. Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe [Internet]. 2018 [cited 2023 May 29]. Available from: <https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts>
133. Directorate-General for Environment (European Commission), University of the West of England (UWE). Science Communication Unit. Links between noise and air pollution and socioeconomic status [Internet]. LU: Publications Office of the European Union; 2016 [cited 2023 May 29]. Available from: <https://data.europa.eu/doi/10.2779/200217>
134. Gray NR, Lewis AC, Moller SJ. Deprivation based inequality in NO_x emissions in England. *Environ Sci: Adv* [Internet]. 2023 Aug 29 [cited 2023 Dec 15];2(9):1261-72. Available from: <https://pubs.rsc.org/en/content/articlelanding/2023/va/d3va00054k>
135. American Lung Association. Disparities in the Impact of Air Pollution [Internet]. 2023 [cited 2023 Jun 7]. Available from: <https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities>
136. Deguen S, Zmirou-Navier D. Social inequalities resulting from health risks related to ambient air quality—A European review. *European Journal of Public Health* [Internet]. 2010 Feb 1 [cited 2023 Jun 7];20(1):27-35. Available from: <https://doi.org/10.1093/eurpub/ckp220>
137. Yang Y, Tang R, Qiu H, Lai PC, Wong P, Thach TQ, et al. Long term exposure to air pollution and mortality in an elderly cohort in Hong Kong. *Environment International* [Internet]. 2018 Aug [cited 2023 Apr 5];117:99-106. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0160412017318731>
138. Environment Bureau. Clean Air Plan for Hong Kong 2013-2017 Progress Report [Internet]. 2017. Available from: https://www.eeb.gov.hk/sites/default/files/CleanAirPlanUpdateEng_W3C.pdf
139. GovHK (www.gov.hk). GovHK: Air Quality Health Index [Internet]. 2023 [cited 2024 Feb 9]. Available from: <https://www.gov.hk/en/residents/environment/air/aqhi.htm>
140. Mason TG, Schooling CM, Chan KP, Tian L. An evaluation of the air quality health index program on respiratory diseases in Hong Kong: An interrupted time series analysis. *Atmospheric Environment* [Internet]. 2019 Aug [cited 2023 Apr 5];211:151-8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1352231019303127>
141. Mason TG, Mary Schooling C, Ran J, Chan KP, Tian L. Does the AQHI reduce cardiovascular hospitalization in Hong Kong's elderly population? *Environment International* [Internet]. 2020 Feb [cited 2023 Apr 5];135:105344. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0160412019324456>
142. Environmental Protection Department. Air Quality Objectives [Internet]. 2023 [cited 2024 Feb 7]. Available from: https://www.epd.gov.hk/epd/english/environmentinhk/air/air_quality_objectives/air_quality_objectives.html
143. Environmental Protection Department. Air [Internet]. 2023 [cited 2023 Jun 20]. Available from: https://www.epd.gov.hk/epd/english/environmentinhk/air/air_maincontent.html
144. Tan Y, Han S, Chen Y, Wu Z, Lee S cheng. Long-term variation and evaluation of air quality across Hong Kong. *Journal of Environmental Sciences* [Internet]. 2023 May 1 [cited 2023 May 30];127:284-94. Available from: <https://www.sciencedirect.com/science/article/pii/S1001074222002595>
145. Environmental Protection Department. Air Quality in Hong Kong 2021 [Internet]. 2022. Available from: https://www.aqhi.gov.hk/api_history/english/report/files/AQR2021e_final.pdf
146. Clean Air Network. Clean Air Network. 2023 [cited 2023 May 30]. Air Pollution in Hong Kong. Available from: <https://hongkongcan.org/knowledge-hub/air-pollution-in-hong-kong/>
147. Environment Bureau, Transport and Housing Bureau, Food and Health Bureau, Development Bureau. Clean Air Plan for Hong Kong 2035 [Internet]. 2021. Available from: https://www.eeb.gov.hk/sites/default/files/pdf/Clean_Air_Plan_2035_eng.pdf
148. Gao Y, Chan EYY, Zhu Y, Wong TW. Adverse effect of outdoor air pollution on cardiorespiratory fitness in Chinese children. *Atmospheric Environment* [Internet]. 2013 Jan 1 [cited 2023 Jun 29];64:10-7. Available from: <https://www.sciencedirect.com/science/article/pii/S1352231012009375>
149. The University of Hong Kong. Hedley Environmental Index [Internet]. 2022 [cited 2023 Aug 24]. Available from: <https://hedleyindex.hku.hk/en>

150. Tam WWS, Wong TW, Wong AHS. Association between air pollution and daily mortality and hospital admission due to ischaemic heart diseases in Hong Kong. *Atmospheric Environment* [Internet]. 2015 Nov [cited 2023 Apr 5];120:360–8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1352231015303137>
151. Ho HC, Wong MS, Chan TC. Spatially differentiating the effects of long-term air pollution on specific causes of death from cardiovascular and respiratory mortality in Hong Kong: a territory-wide register-based study. *Air Qual Atmos Health* [Internet]. 2020 Jun [cited 2023 Apr 5];13(6):721–30. Available from: <https://link.springer.com/10.1007/s11869-020-00828-4>
152. Fan X, Lam K che, Yu Q. Differential exposure of the urban population to vehicular air pollution in Hong Kong. *Science of The Total Environment* [Internet]. 2012 Jun [cited 2023 Apr 5];426:211–9. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0048969712004184>
153. Li VO, Han Y, Lam JC, Zhu Y, Bacon-Shone J. Air pollution and environmental injustice: Are the socially deprived exposed to more PM2.5 pollution in Hong Kong? *Environmental Science & Policy* [Internet]. 2018 Feb [cited 2023 Apr 5];80:53–61. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1462901117306020>
154. Ou CQ, Hedley AJ, Chung RY, Thach TQ, Chau YK, Chan KP, et al. Socioeconomic disparities in air pollution-associated mortality. *Environmental Research* [Internet]. 2008 Jun [cited 2023 Apr 5];107(2):237–44. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0013935108000595>
155. Wong CM, Ou CQ, Chan KP, Chau YK, Thach TQ, Yang L, et al. The Effects of Air Pollution on Mortality in Socially Deprived Urban Areas in Hong Kong, China. *Environmental Health Perspectives* [Internet]. 2008 Sep [cited 2023 Apr 5];116(9):1189–94. Available from: <https://ehp.niehs.nih.gov/doi/10.1289/ehp.10850>
156. Public Health England. GOV.UK. 2017 [cited 2023 May 31]. Spatial planning for health: evidence review. Available from: <https://www.gov.uk/government/publications/spatial-planning-for-health-evidence-review>
157. Ng MK, Yeung TC, Kwan MP, Tieben H, Lau TYT, Zhu J, et al. Place qualities, sense of place and subjective well-being: a study of two typical urban neighbourhoods in Hong Kong. *Cities & Health* [Internet]. 2022 Nov 2 [cited 2023 Apr 4];6(6):1122–33. Available from: <https://www.tandfonline.com/doi/full/10.1080/23748834.2021.1993038>
158. Urban Renewal Authority - URA. Redevelopment [Internet]. 2023 [cited 2023 Jun 6]. Available from: <https://www.ura.org.hk/en/redevelopment>
159. La Grange A, Pretorius F. State-led gentrification in Hong Kong. *Urban Studies* [Internet]. 2016 Feb 1 [cited 2023 May 17];53(3):506–23. Available from: <https://doi.org/10.1177/0042098013513645>
160. Civic Exchange. Treating the Symptoms: A Critical Review of Urban Renewal in Hong Kong [Internet]. 2010 [cited 2023 Jun 6]. Available from: <https://civic-exchange.org/report/treating-the-symptoms-a-critical-review-of-urban-renewal-in-hong-kong/>
161. Sallis JF, Cerin E, Conway TL, Adams MA, Frank LD, Pratt M, et al. Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study. *The Lancet* [Internet]. 2016 May [cited 2023 Apr 4];387(10034):2207–17. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0140673615012842>
162. Yu R, Cheung O, Lau K, Woo J. Associations between Perceived Neighborhood Walkability and Walking Time, Wellbeing, and Loneliness in Community-Dwelling Older Chinese People in Hong Kong. *IJERPH* [Internet]. 2017 Oct 9 [cited 2023 Apr 4];14(10):1199. Available from: <http://www.mdpi.com/1660-4601/14/10/1199>
163. Goldblatt P, Castedo A, Allen J, Lionello L, Bell R, Marmot M, et al. Rapid review of inequalities in health and wellbeing in Norway since 2014 [Internet]. Institute of Health Equity; 2023 [cited 2023 Jun 6]. Available from: <https://www.instituteoftheequity.org/resources-reports/rapid-review-of-inequalities-in-health-and-wellbeing-in-norway-since-2014>
164. WHO Office for Investment for Health & Development. Harnessing the benefits of well-being policies and investments for health [Internet]. 2023 [cited 2023 Nov 1]. Available from: <https://www.who.int/europe/publications/m/item/harnessing-the-benefits-of-well-being-policies-and-investments-for-health>
165. Lai ETC, Yu R, Woo J. Social gradient of self-rated health in older people—the moderating/mediating role of sense of community. *Age and Ageing* [Internet]. 2021 Jul 1 [cited 2023 Dec 20];50(4):1283–9. Available from: <https://doi.org/10.1093/ageing/afaa277>
166. Mak WWS, Cheung RYM, Law LSC. Sense of Community in Hong Kong: Relations with Community-Level Characteristics and Residents' Well-Being. *American Journal of Community Psychology* [Internet]. 2009 [cited 2023 Jun 6];44(1-2):80–92. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1007/s10464-009-9242-z>
167. Agency for Volunteer Service. 2021-2022 Annual Service Report [Internet]. 2023 [cited 2023 Jun 6]. Available from: https://www.av.s.org.hk/eng/annual_reports
168. Haerpfer C, Inglehart R, Moreno A, Welzel C, Kizilova K, Diez-Medrano J, et al. World Values Survey Wave 7 (2017-2022) Cross-National Data-Set [Internet]. World Values Survey Association; 2022 [cited 2023 Jun 6]. Available from: <http://www.worldvaluessurvey.org/WVSDocumentationWV7.jsp>
169. Lai AHY, Leung CKM, Chan CKY, Lam WTL, So CTY, Lau WSY. Neighborhood as a place to foster generalized trust among young adults in Hong Kong. *Journal of Community Psychology* [Internet]. 2022 [cited 2023 Apr 20];50(5):2163–76. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1002/jcop.22761>

170. U. N. Environment Programme. Emissions Gap Report 2023 [Internet]. U. N. Environment Programme; 2023 Nov [cited 2023 Dec 20]. Available from: <http://www.unep.org/resources/emissions-gap-report-2023>
171. World Health Organization. Climate change [Internet]. 2023 [cited 2023 Jun 12]. Available from: <https://www.who.int/health-topics/climate-change>
172. Cissé G, McLeman R, Adams H, Aldunce P, Bowen K, Campbell-Lendrum D, et al. Health, wellbeing and the changing structure of communities. In: Pörtner HO, Roberts DC, Tignor MMB, Poloczanska ES, Mintenbeck K, Alegría A, et al., editors. *Climate Change 2022: Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2022.
173. Romanello M, McGushin A, Napoli CD, Drummond P, Hughes N, Jamart L, et al. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. *The Lancet* [Internet]. 2021 Oct 30 [cited 2023 Jun 12];398(10311):1619–62. Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(21\)01787-6/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01787-6/fulltext)
174. Environment Bureau. Hong Kong Climate Change Report 2015 [Internet]. 2015 [cited 2023 Jun 16]. Available from: <https://policy.asiapacificenergy.org/node/2938>
175. Chan EY, Hung H, Lau GN, Ng EY. Policy Implication of Health Impacts of Climate Change in Hong Kong [Internet]. Collaborating Centre for Oxford University and CUHK for Disaster and Medical Humanitarian Response | Institute of Environment, Energy and Sustainability (IEES), The Chinese University of Hong Kong; 2017 [cited 2023 Jun 12]. Available from: <https://www.hkjcdpri.org.hk/policy-brief-policy-implication-health-impacts-climate-change-hong-kong-0>
176. C40 Cities. C40 Cities. 2023 [cited 2023 Sep 4]. Hong Kong. Available from: <https://www.c40.org/cities/hong-kong/>
177. Environmental Protection Department. Policy Documents [Internet]. 2022 [cited 2023 Sep 8]. Available from: https://www.epd.gov.hk/epd/english/resources_pub/policy_documents/index.html
178. United Nations. United Nations. United Nations; 2023 [cited 2023 Nov 13]. For a livable climate: Net-zero commitments must be backed by credible action. Available from: <https://www.un.org/en/climatechange/net-zero-coalition>
179. IPCC. Climate Change 2022: Mitigation of Climate Change [Internet]. 2023 [cited 2023 Jun 12]. Available from: <https://www.ipcc.ch/report/ar6/wg3/>
180. Hong Kong Observatory. Climate Change in Hong Kong - Temperature [Internet]. 2023 [cited 2023 Jun 19]. Available from: https://www.hko.gov.hk/en/climate_change/obs_hk_temp.htm
181. Hong Kong Observatory. The Year's Weather - 2021 [Internet]. 2022 [cited 2023 May 9]. Available from: <https://www.hko.gov.hk/en/wxinfo/pastwx/2021/ywx2021.htm>
182. Hong Kong Observatory. Annual mean temperature projection for Hong Kong [Internet]. 2023 [cited 2023 Jun 15]. Available from: https://www.hko.gov.hk/en/climate_change/proj_hk_temp_mean.htm
183. Chan EYY, Goggins WB, Kim JJ, Griffiths SM. A study of intracity variation of temperature-related mortality and socioeconomic status among the Chinese population in Hong Kong. *J Epidemiol Community Health* [Internet]. 2012 Apr [cited 2023 Apr 4];66(4):322–7. Available from: <https://jech.bmj.com/lookup/doi/10.1136/jech.2008.085167>
184. Chan E, Lam H, So S, Goggins W, Ho J, Liu S, et al. Association between Ambient Temperatures and Mental Disorder Hospitalizations in a Subtropical City: A Time-Series Study of Hong Kong Special Administrative Region. *IJERPH* [Internet]. 2018 Apr 14 [cited 2023 Apr 4];15(4):754. Available from: <http://www.mdpi.com/1660-4601/15/4/754>
185. Laaidi K, Zeghnoun A, Dousset B, Bretin P, Vandentorren S, Giraudet E, et al. The Impact of Heat Islands on Mortality in Paris during the August 2003 Heat Wave. *Environmental Health Perspectives* [Internet]. 2012 Feb [cited 2023 Apr 4];120(2):254–9. Available from: <https://ehp.niehs.nih.gov/doi/10.1289/ehp.1103532>
186. Whitman S, Good G, Donoghue ER, Benbow N, Shou W, Mou S. Mortality in Chicago attributed to the July 1995 heat wave. *Am J Public Health* [Internet]. 1997 Sep [cited 2023 Jun 12];87(9):1515–8. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1380980/>
187. Tong S, Prior J, McGregor G, Shi X, Kinney P. Urban heat: an increasing threat to global health. *BMJ* [Internet]. 2021 Oct 25 [cited 2023 Jun 12];375:n2467. Available from: <https://www.bmj.com/content/375/bmj.n2467>
188. Heaviside C, Vardoulakis S, Cai XM. Attribution of mortality to the urban heat island during heatwaves in the West Midlands, UK. *Environ Health*. 2016 Mar 8;15 Suppl 1(Suppl 1):27.
189. Ho HC, Lau KKL, Ren C, Ng E. Characterizing prolonged heat effects on mortality in a sub-tropical high-density city, Hong Kong. *Int J Biometeorol* [Internet]. 2017 Nov [cited 2023 Apr 4];61(11):1935–44. Available from: <http://link.springer.com/10.1007/s00484-017-1383-4>
190. Wang D, Lau KKL, Ren C, Goggins WBI, Shi Y, Ho HC, et al. The impact of extremely hot weather events on all-cause mortality in a highly urbanized and densely populated subtropical city: A 10-year time-series study (2006–2015). *Science of The Total Environment* [Internet]. 2019 Nov [cited 2023 Apr 4];690:923–31. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0048969719331523>

191. Ho HC, Lau K, Ren C, Wang D. Systematic identification of heat events associated with emergency admissions to enhance the heat-health action plan in a subtropical city: a data-driven approach. *Environ Sci Pollut Res Int*. 2022 Dec;29(59):89273–82.
192. Galdies C, Lau HS. Urban Heat Island Effect, Extreme Temperatures and Climate Change: A Case Study of Hong Kong SAR. In: Leal Filho W, Nagy GJ, Borga M, Chávez Muñoz PD, Magnuszewski A, editors. *Climate Change, Hazards and Adaptation Options: Handling the Impacts of a Changing Climate* [Internet]. Cham: Springer International Publishing; 2020 [cited 2023 Apr 4]. p. 369–88. (Climate Change Management). Available from: https://doi.org/10.1007/978-3-030-37425-9_20
193. Wang P, Goggins WB, Shi Y, Zhang X, Ren C, Ka-Lun Lau K. Long-term association between urban air ventilation and mortality in Hong Kong. *Environmental Research* [Internet]. 2021 Jun 1 [cited 2023 Nov 14];197:111000. Available from: <https://www.sciencedirect.com/science/article/pii/S0013935121002942>
194. Hua J, Shi Y, Ren C, Lau KKL, Ng EYY. Impact of Urban Overheating and Heat-Related Mortality in Hong Kong. In: Aghamohammadi N, Santamouris M, editors. *Urban Overheating: Heat Mitigation and the Impact on Health* [Internet]. Singapore: Springer Nature; 2022 [cited 2023 Nov 14]. p. 275–92. (Advances in Sustainability Science and Technology). Available from: https://doi.org/10.1007/978-981-19-4707-0_14
195. Hua J, Zhang X, Ren C, Shi Y, Lee TC. Spatiotemporal assessment of extreme heat risk for high-density cities: A case study of Hong Kong from 2006 to 2016. *Sustainable Cities and Society* [Internet]. 2021 Jan 1 [cited 2023 Apr 4];64:102507. Available from: <https://www.sciencedirect.com/science/article/pii/S2210670720307253>
196. Ho JY, Shi Y, Lau KKL, Ng EYY, Ren C, Goggins WB. Urban heat island effect-related mortality under extreme heat and non-extreme heat scenarios: A 2010–2019 case study in Hong Kong. *Science of The Total Environment* [Internet]. 2023 Feb 1 [cited 2023 Nov 14];858:159791. Available from: <https://www.sciencedirect.com/science/article/pii/S0048969722068917>
197. Harlan SL, Brazel AJ, Prashad L, Stefanov WL, Larsen L. Neighborhood microclimates and vulnerability to heat stress. *Soc Sci Med*. 2006 Dec;63(11):2847–63.
198. Reid CE, O’Neill MS, Gronlund CJ, Brines SJ, Brown DG, Diez-Roux AV, et al. Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspect* [Internet]. 2009 Nov [cited 2023 Jun 14];117(11):1730–6. Available from: <https://ehp.niehs.nih.gov/doi/10.1289/ehp.0900683>
199. Guo YT, Bernard Goggins W, Chan EYY, Ho KF. Individual socioeconomic status as a modifier of the association between high ambient temperature and hospital admissions: a time series study in Hong Kong, 2010–2019. *Environ Sci Pollut Res* [Internet]. 2022 Sep [cited 2023 Apr 4];29(44):67353–61. Available from: <https://link.springer.com/10.1007/s11356-022-20512-7>
200. Song J, Huang B, Kim JS, Wen J, Li R. Fine-scale mapping of an evidence-based heat health risk index for high-density cities: Hong Kong as a case study. *Science of The Total Environment* [Internet]. 2020 May [cited 2023 Apr 4];718:137226. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0048969720307361>
201. Ho JY en, Lai ET, Chau PH, Chong KC, Woo J. The role of older adult-focused social vulnerability on the relationship between temperature and emergency department attendance in a subtropical Asian city. *Archives of Gerontology and Geriatrics* [Internet]. 2024 Feb 1 [cited 2023 Nov 1];117:105195. Available from: <https://www.sciencedirect.com/science/article/pii/S016749432300273X>
202. Lai ETC, Chau PH, Cheung K, Kwan M, Lau K, Woo J. Perception of extreme hot weather and the corresponding adaptations among older adults and service providers—A qualitative study in Hong Kong. *Front Public Health* [Internet]. 2023 Feb 10 [cited 2023 Nov 14];11:1056800. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9980346/>
203. Oppenheimer, M, Glavovic BC, Hinkel J, van de Wal R, Maignan AK, Abd-Elgawad A, et al. Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [Internet]. Cambridge University Press; 2019 [cited 2023 Jun 15]. Available from: <https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/>
204. Hong Kong Observatory. Climate Change in Hong Kong - Mean sea level [Internet]. 2023 [cited 2023 Jun 15]. Available from: https://www.hko.gov.hk/en/climate_change/obs_hk_sea_level.htm
205. Wong WT, Li KW, Yeung KH. Long Term Sea Level Change in Hong Kong. *Hong Kong Meteorological Society bulletin* [Internet]. 2003 [cited 2024 Feb 5];13(Nos. 1/2). Available from: <https://digitalrepository.lib.hku.hk/catalog/ks65pc92x#?c=&m=&s=&cv=&xywh=-1553%2C-53%2C4904%2C2324>
206. Hong Kong Observatory. Mean sea level projection for Hong Kong [Internet]. 2023 [cited 2023 Jun 15]. Available from: https://www.hko.gov.hk/en/climate_change/proj_hk_msl.htm
207. Hong Kong Observatory. Global Climate Projections - Tropical cyclones [Internet]. 2023 [cited 2023 Jun 16]. Available from: https://www.hko.gov.hk/en/climate_change/proj_global_tc.htm
208. Hong Kong Observatory. Climate Change in Hong Kong - Rainfall [Internet]. 2023 [cited 2023 Jun 19]. Available from: https://www.hko.gov.hk/en/climate_change/obs_hk_rainfall.htm

209. Pörtner HO, Roberts DC, Tignor MMB, Poloczanska ES, Mintenbeck K, Alegría A, et al., editors. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. 2022.
210. South China Morning Post. South China Morning Post. 2023 [cited 2023 Jun 16]. Activists call for Hong Kong government to be open over land reclamation project. Available from: <https://www.scmp.com/news/hong-kong/health-environment/article/3214785/green-campaigners-call-hong-kong-government-be-upfront-real-financial-and-environmental-cost-lantau>
211. Home Affairs Department. Service Provided [Internet]. 2023 [cited 2023 Sep 7]. Available from: https://www.had.gov.hk/en/public_services/emergency_services/emergency.htm#3
212. Labour Department. Guidance Notes on Prevention of Heat Stroke at Work [Internet]. 2023 [cited 2023 Nov 14]. Available from: <http://ldoldwebsite1.netsoft.net.../eng/news/content.htm>
213. Stein PJS, Stein MA. Climate change and the right to health of people with disabilities. The Lancet Global Health [Internet]. 2022 Jan 1 [cited 2023 Sep 7];10(1):e24-5. Available from: [https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(21\)00542-8/fulltext](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(21)00542-8/fulltext)
214. European Environment Agency. What is the difference between adaptation and mitigation? [Internet]. 2023 [cited 2023 Jun 27]. Available from: <https://www.eea.europa.eu/help/faq/what-is-the-difference-between>
215. C40 Knowledge. Coal: How your city can leave it behind [Internet]. 2021 [cited 2023 Sep 4]. Available from: https://www.c40knowledgehub.org/s/article/Coal-How-your-city-can-leave-it-behind?language=en_US
216. Union of Concerned Scientists. Environmental Impacts of Natural Gas [Internet]. 2023 [cited 2023 Sep 4]. Available from: <https://www.ucsusa.org/resources/environmental-impacts-natural-gas>
217. European Commission. Renewable energy targets [Internet]. 2023 [cited 2023 Nov 14]. Available from: https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en
218. Singapore Green Plan. Our Targets [Internet]. 2023 [cited 2023 Nov 14]. Available from: <https://www.greenplan.gov.sg/targets/>
219. Climate Action Tracker. Policies & action [Internet]. 2023 [cited 2023 Nov 14]. Available from: <https://climateactiontracker.org/countries/philippines/policies-action/>
220. To WM, Lee PKC, Yu BTW. Sustainability assessment of an urban rail system – The case of Hong Kong. Journal of Cleaner Production [Internet]. 2020 Apr 20 [cited 2023 Dec 20];253:119961. Available from: <https://www.sciencedirect.com/science/article/pii/S0959652620300081>
221. Environment Bureau. Hong Kong Roadmap on popularisation of electric vehicles [Internet]. 2021. Available from: https://www.evhomecharging.gov.hk/downloads/ev_booklet_en.pdf
222. Transport Department. Electronic Road Pricing (ERP) Pilot Scheme in Central [Internet]. 2023 [cited 2023 Jun 23]. Available from: https://www.td.gov.hk/en/transport_in_hong_kong/its/intelligent_transport_systems_strategy_review_and_erppc/index.html
223. Developing Bureau, Planning Department. Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030 [Internet]. 2023 [cited 2023 Jun 23]. Available from: https://www.pland.gov.hk/pland_en/p_study/comp_s/hk2030plus/index.htm
224. GovHK. GovHK: Municipal Solid Waste Charging [Internet]. 2022 [cited 2023 Jun 28]. Available from: <https://www.gov.hk/en/residents/environment/waste/management/mswcharging.htm>
225. Environmental Protection Department. Municipal Solid Waste Charging (MSW Charging) [Internet]. Environmental Protection Department; 2023. (LC Paper No. CB(1)784/2023(01)). Available from: <https://www.legco.gov.hk/yr2023/chinese/panels/ea/papers/ea20230714cb1-784-1-ec.pdf>
226. Environmental Protection Department. MSW Charging [Internet]. MSW Charging. 2023 [cited 2023 Jun 28]. Available from: <https://www.mswcharging.gov.hk/en/>

