Singapore – a case study

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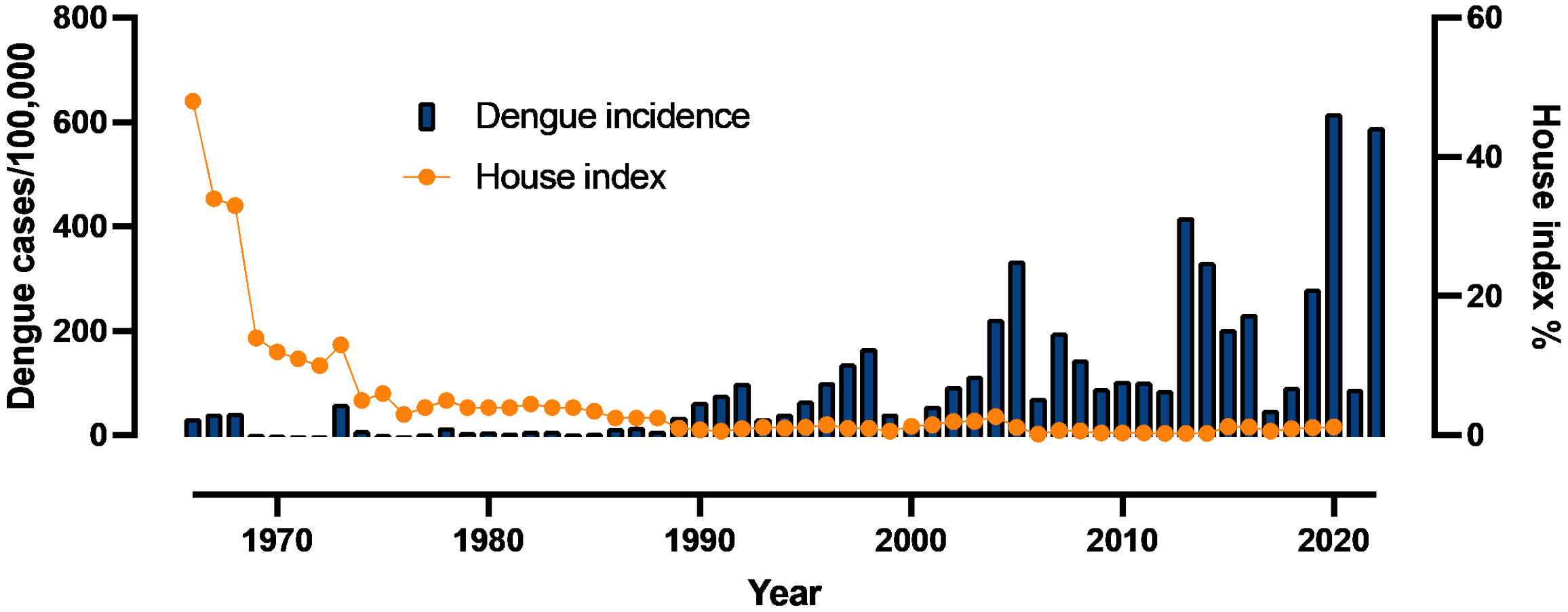
Non-vector control-based interventions

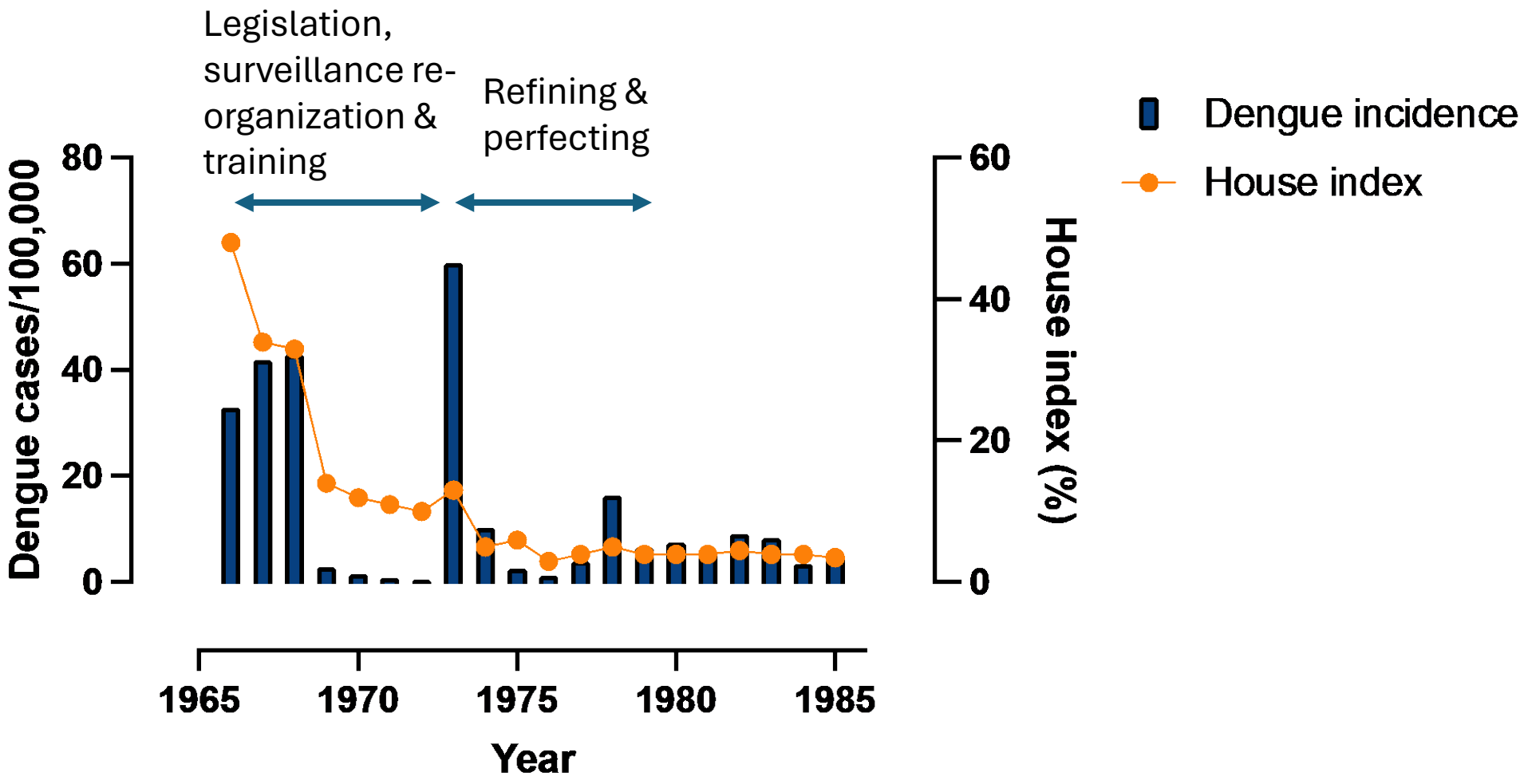
Dengue incidence and Aedes population density (house index) in Singapore, 1966-2022

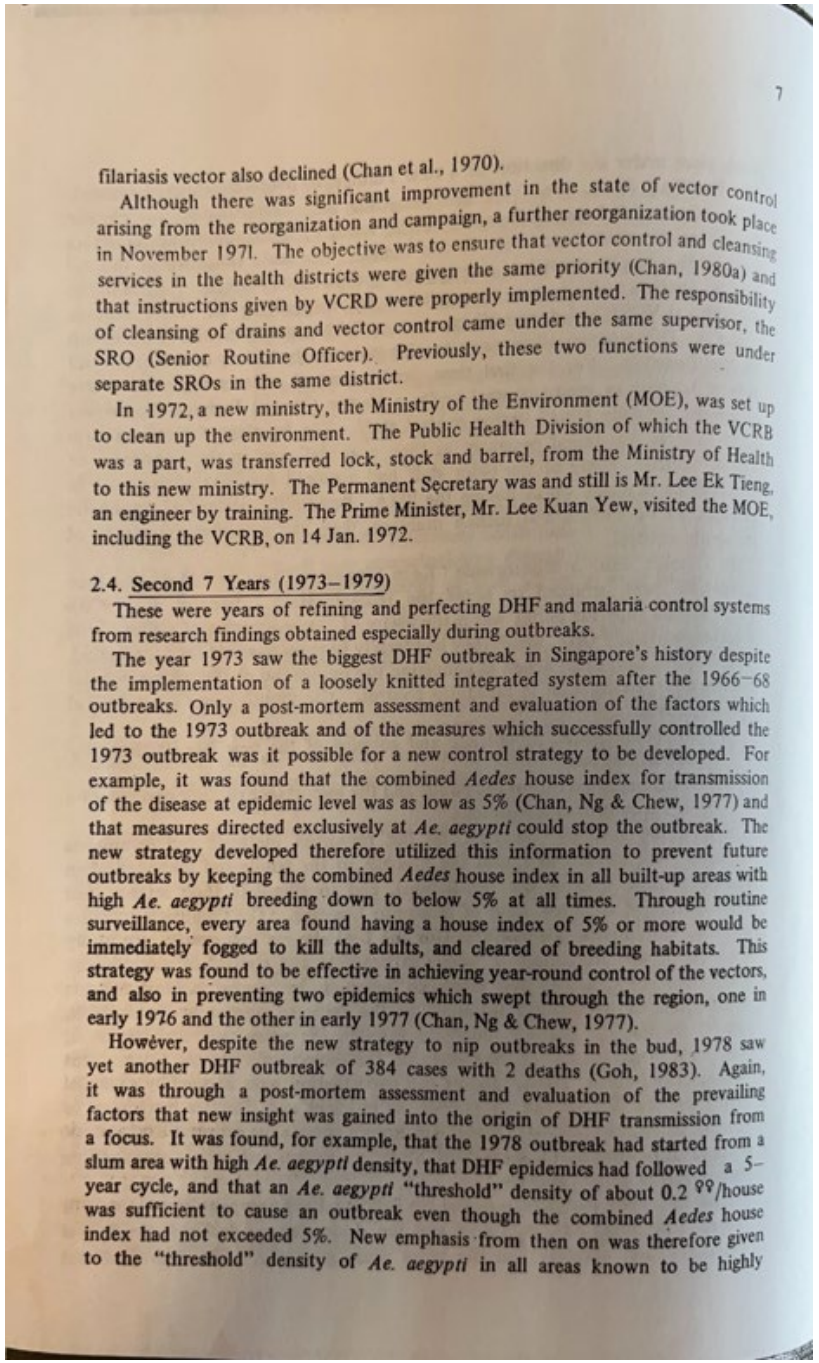


Data from Ministry of Health, Singapore

Dengue control in Singapore – the early years

Chan KL (1985), Singapore's Dengue Haemorhagic Fever Control Programme. SEAMIC Publication





filariasis vector also declined (Chan et al., 1970).

Although there was significant improvement in the state of vector control arising from the reorganization and campaign, a further reorganization took place in November 1971. The objective was to ensure that vector control and cleansing services in the health districts were given the same priority (Chan, 1980a) and that instructions given by VCRD were properly implemented. The responsibility of cleansing of drains and vector control came under the same supervisor, the SRO (Senior Routine Officer). Previously, these two functions were under separate SROs in the same district.

In 1972, a new ministry, the Ministry of the Environment (MOE), was set up to clean up the environment. The Public Health Division of which the VCRB was a part, was transferred lock, stock and barrel, from the Ministry of Health to this new ministry. The Permanent Secretary was and still is Mr. Lee Ek Tieng, an engineer by training. The Prime Minister, Mr. Lee Kuan Yew, visited the MOE, including the VCRB, on 14 Jan. 1972.

2.4. Second 7 Years (1973–1979)

These were years of refining and perfecting DHF and malaria control systems from research findings obtained especially during outbreaks.

The year 1973 saw the biggest DHF outbreak in Singapore's history despite the implementation of a loosely knitted integrated system after the 1966–68 outbreaks. Only a post-mortem assessment and evaluation of the factors which led to the 1973 outbreak and of the measures which successfully controlled the 1973 outbreak was it possible for a new control strategy to be developed. For example, it was found that the combined *Aedes* house index for transmission of the disease at epidemic level was as low as 5% (Chan, Ng & Chew, 1977) and that measures directed exclusively at *Ae. aegypti* could stop the outbreak. The new strategy developed therefore utilized this information to prevent future outbreaks by keeping the combined *Aedes* house index in all built-up areas with high *Ae. aegypti* breeding down to below 5% at all times. Through routine surveillance, every area found having a house index of 5% or more would be immediately fogged to kill the adults, and cleared of breeding habitats. This strategy was found to be effective in achieving year-round control of the vectors, and also in preventing two epidemics which swept through the region, one in early 1976 and the other in early 1977 (Chan, Ng & Chew, 1977).

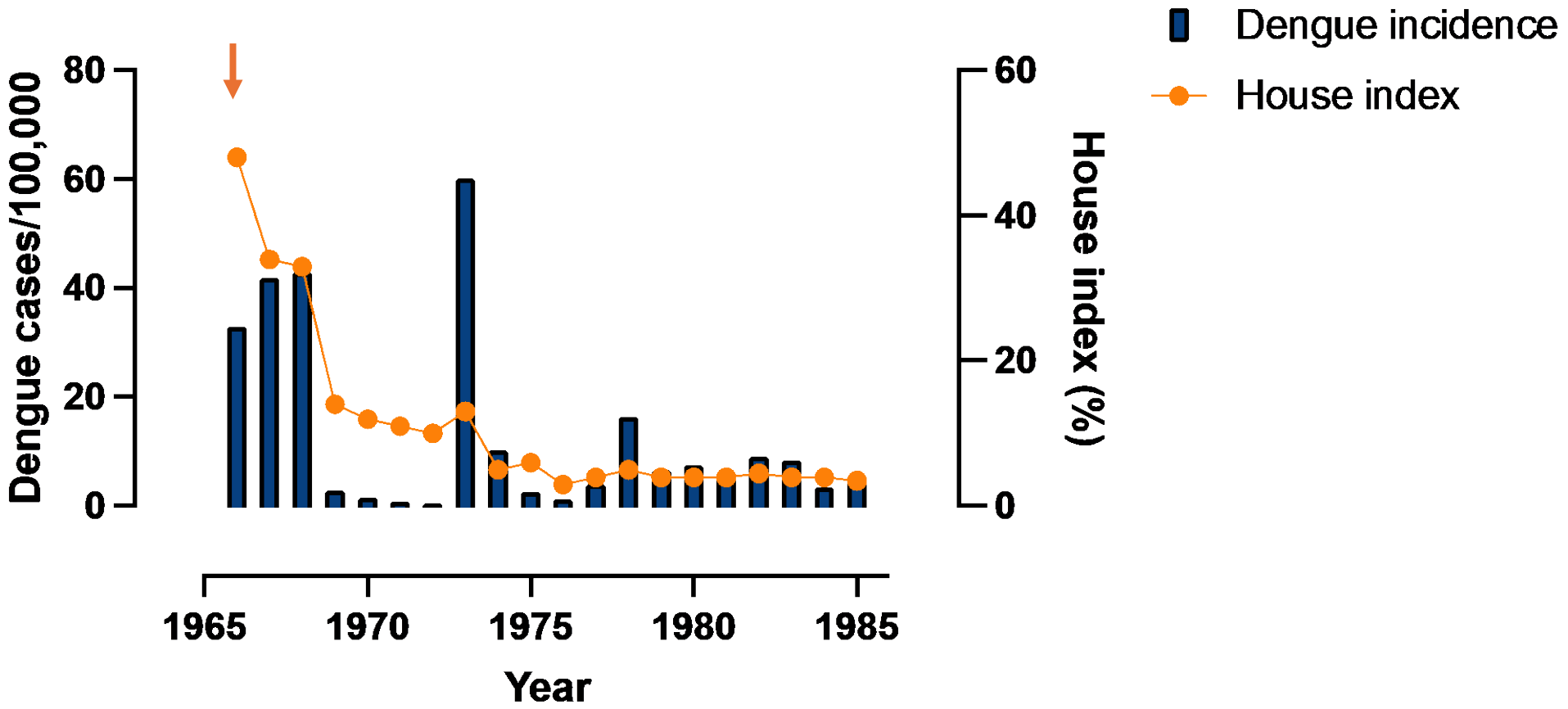
However, despite the new strategy to nip outbreaks in the bud, 1978 saw yet another DHF outbreak of 384 cases with 2 deaths (Goh, 1983). Again, it was through a post-mortem assessment and evaluation of the prevailing factors that new insight was gained into the origin of DHF transmission from a focus. It was found, for example, that the 1978 outbreak had started from a slum area with high *Ae. aegypti* density, that DHF epidemics had followed a 5-year cycle, and that an *Ae. aegypti* "threshold" density of about 0.2 ♀♀/house was sufficient to cause an outbreak even though the combined *Aedes* house index had not exceeded 5%. New emphasis from then on was therefore given to the "threshold" density of *Ae. aegypti* in all areas known to be highly

1966-1972: "… a loosely knitted integrated system"

"Only a post-mortem assessment… 1973 outbreak was it possible for a new control strategy to be developed."

Chan KL (1985), Singapore's Dengue Haemorhagic Fever Control Programme. SEAMIC Publication

What else led to the dramatic decline in house index?

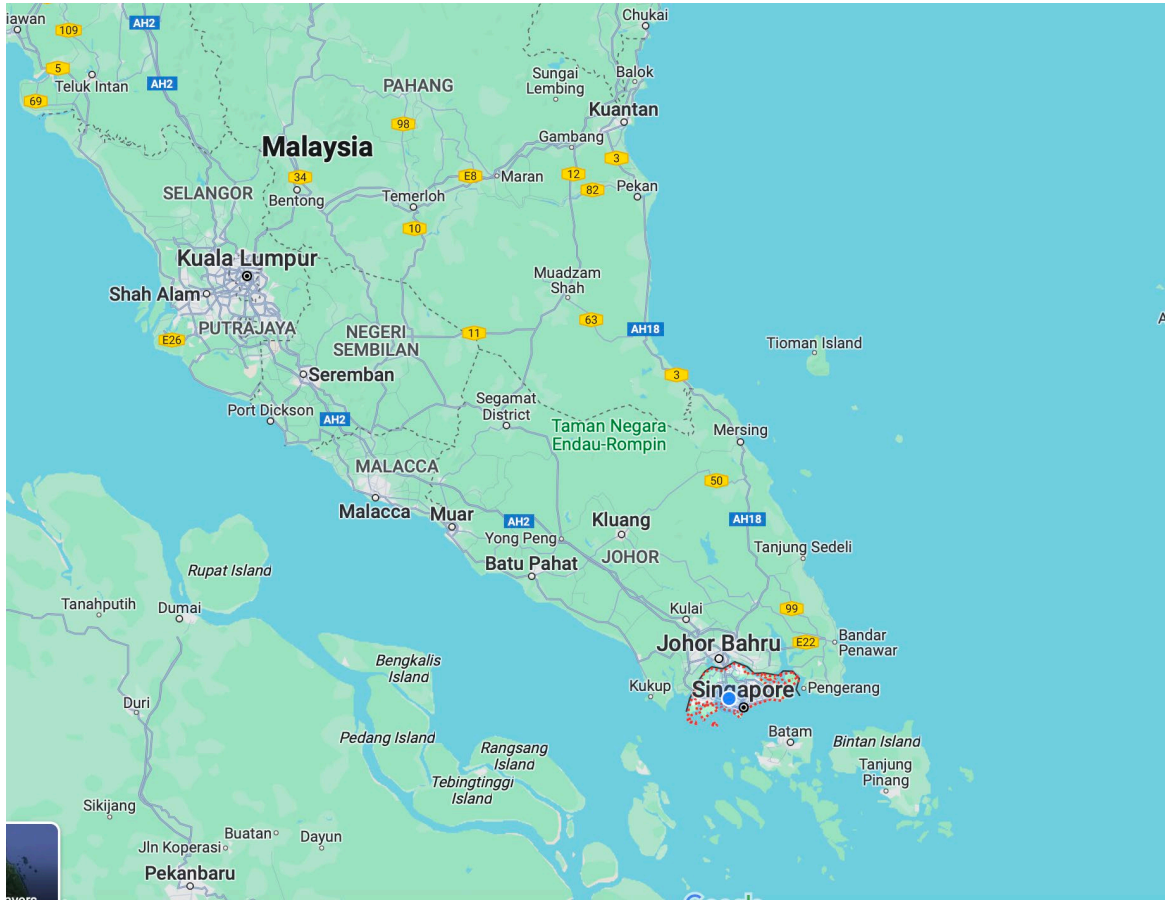


The history of Singapore

Straits Settlements Crown Colony, 1867-1941

Independence from British rule – 1959
Independence from Malaysia -1965

Independent Republic (1965)



- Main island – then 580 km^2 (220 sq miles)
- No natural resource
- Grow the economy through human capital

  "… find a secure and enduring basis for ourselves and our posterity…"

  PM Lee Kuan Yew, 11th December 1965.

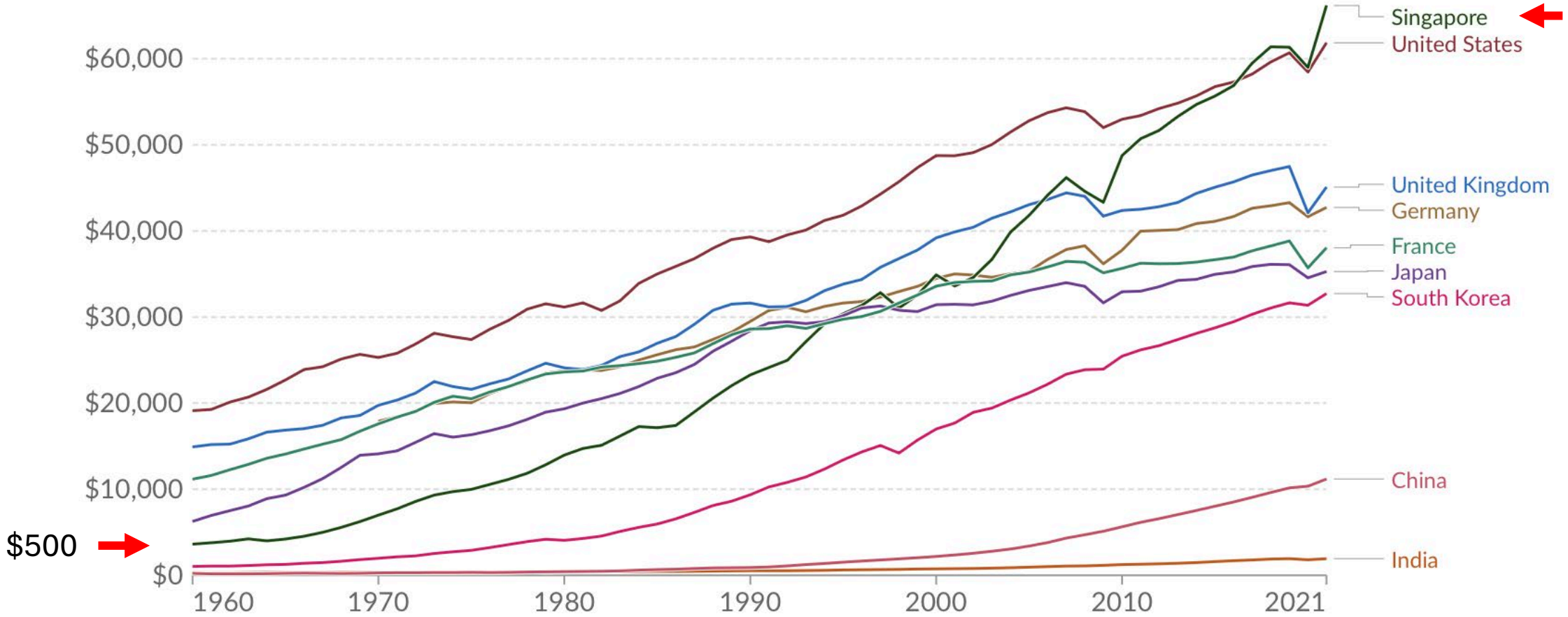
GDP per capita

This data is expressed in US dollars. It is adjusted for inflation but does not account for differences in the cost of living between countries.

Our World in Data

Table | Map | Chart

Edit countries and regions | Settings

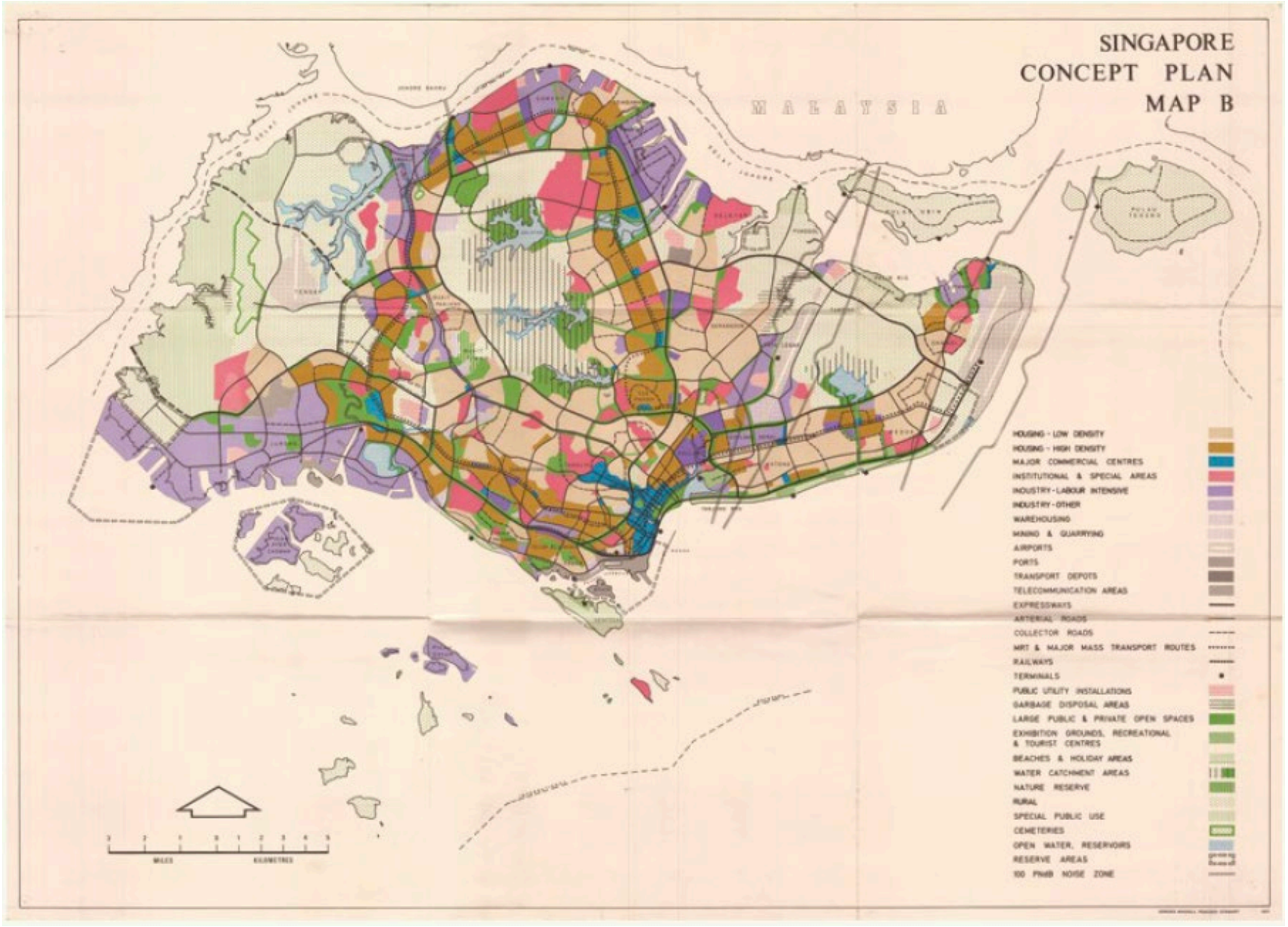


$500

Urban planning – maximizing limited resource

1971 Concept Plan for modern Singapore

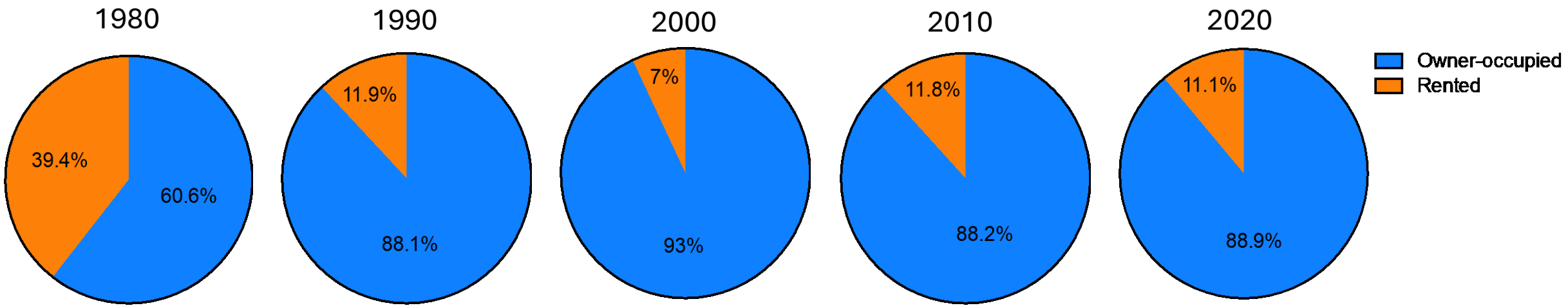
(developed with help from UNDP)



Ministry of National Development
https://www.mnd.gov.sg/docs/default-source/mnd-documents/5_from-mudflats-to-metropolis_early-years-of-self-governance-and-independence.pdf

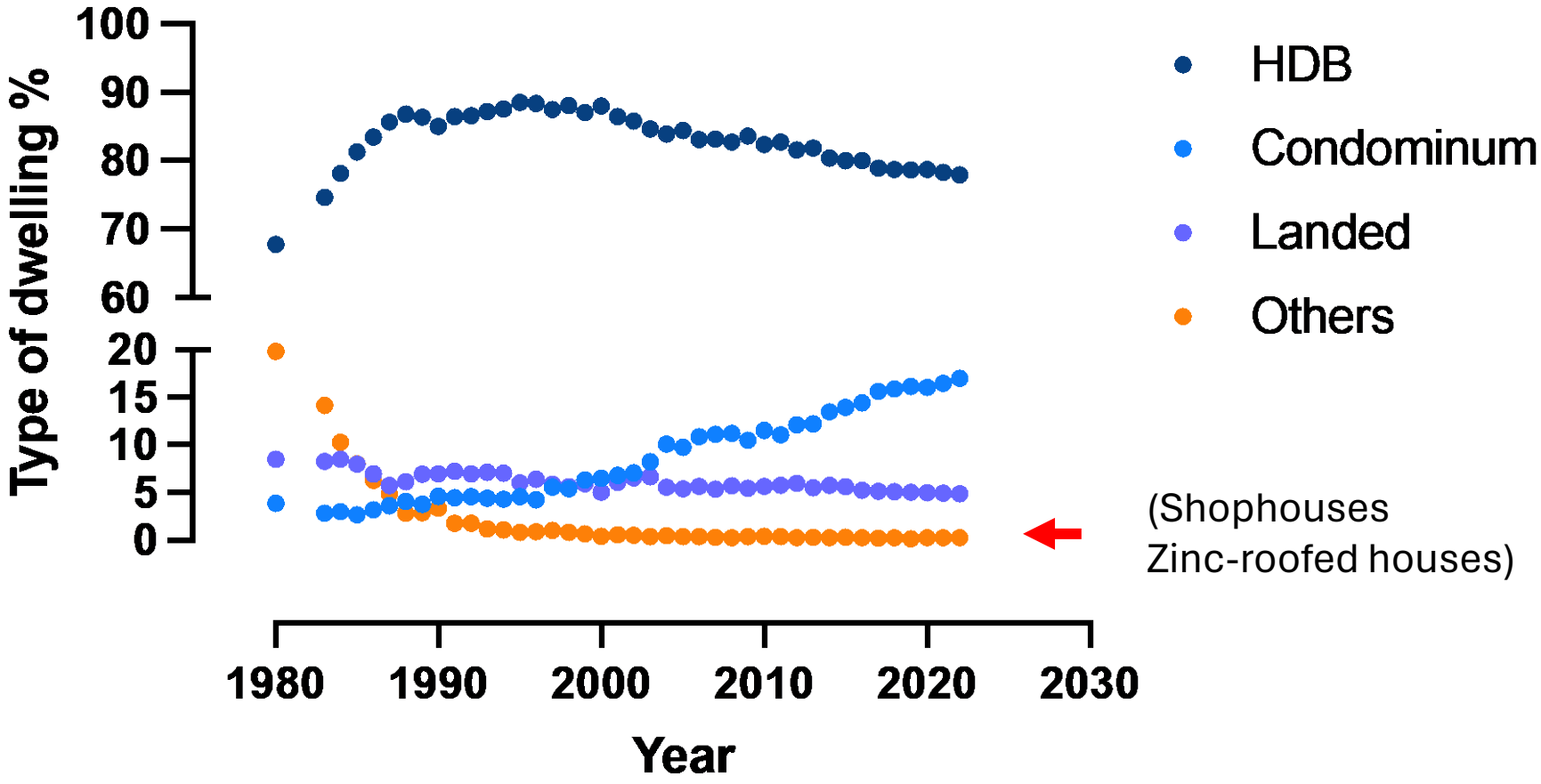
Housing a population in a small island

- 1959: ~550,000 out of 1.6 million (>33%) lived in slum housing
  - Source (bibioasia.nlb.gov.sg)
- 1960: Housing Development Board (HDB) formed
  - Affordable homes for high ownership rate



Data from Singapore Statistics

Population housing in Singapore, 1980-2022



Data from Singapore Statistics

1960s

1970s

Table 2. Distribution and density of *Ae. aegypti* in three types of housing

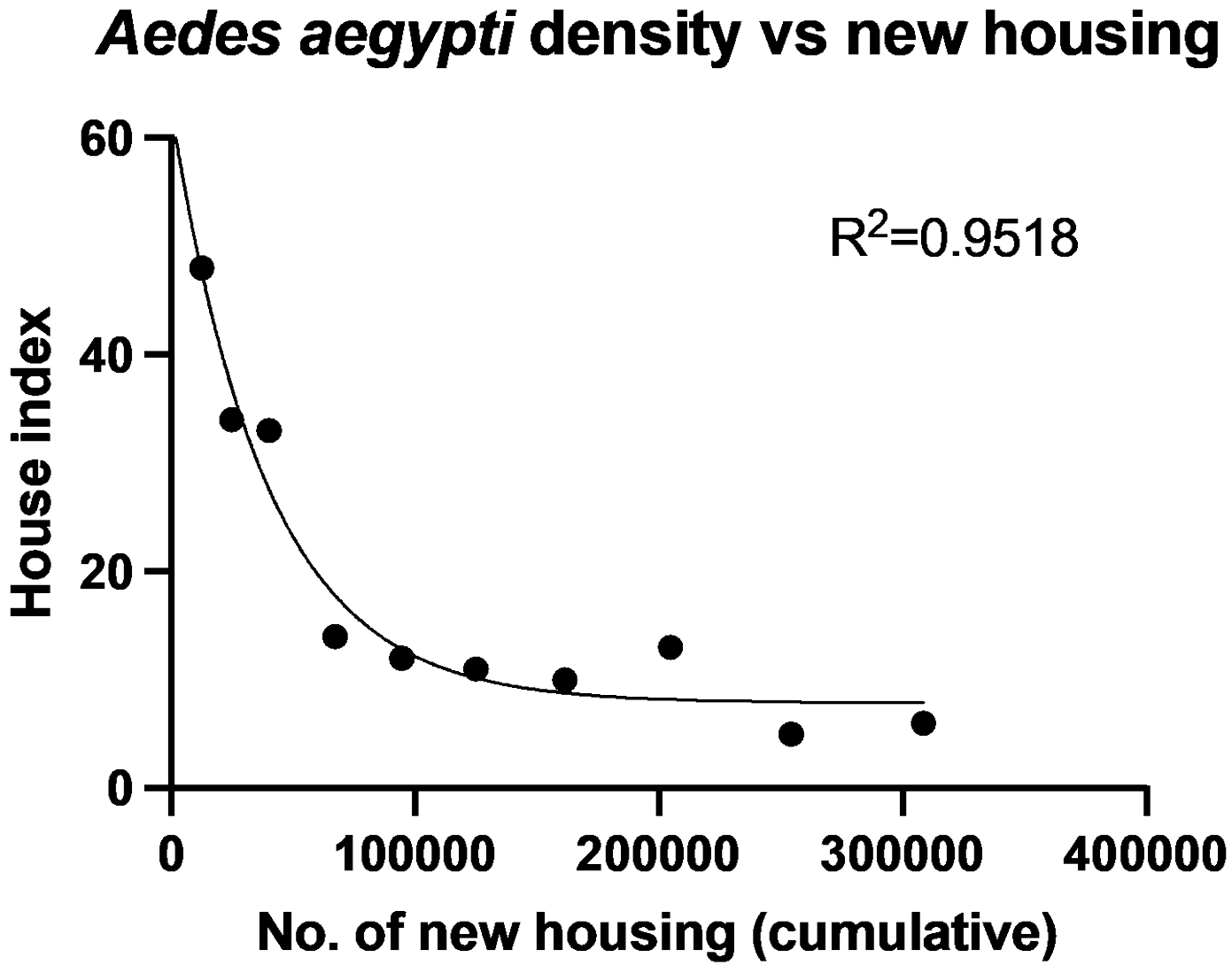
Housing type	No. of housing units surveyed	Premise index (%)		Larval density index [a]	
		Range	Mean	Range	Mean
Slum house	1 377	24.9–29.6	27.2	2.93–8.11	5.52
Shop house	17 480	14.8–18.6	16.4	1.90–2.59	2.31
Flat	11 730	2.3– 9.5	5.0	0.20–1.86	0.81

[a] Average number of larvae per housing unit.

Chan YC et al, Bull Wld Hlth Org 1971

Housing and *Aedes* population density (1966-1975)

- Data from Chan KL (1985), Singapore's Dengue Haemorhagic Fever Control Programme. SEAMIC Publication



Aedes breeding habitats in Singapore households, 1966-1968

Chan KL et al, Bull Wld Hlth Org 1971

Table 2. Common breeding habitats of *Ae. aegypti* and *Ae. albopictus* and their percentage distribution

Habitat	*Ae. aegypti*	*Ae. albopictus*
Ant traps	27.8	12.8
Earthenware jars	19.4	16.5
Bowls	10.8	6.6
Tanks	8.3	3.3
Tin cans	7.0	15.9
Drums	6.2	5.8
Pots	3.4	3.5
Bottles	2.7	4.7
Rubber tires	2.3	9.9
Vases	2.1	1.7
Basins	1.9	2.5
Plates	1.8	2.8
Pails	1.3	2.6
Others [a]	5.0	11.4
Total number of habitats with larvae	6 915	1 872

[a] Including 17 different items.

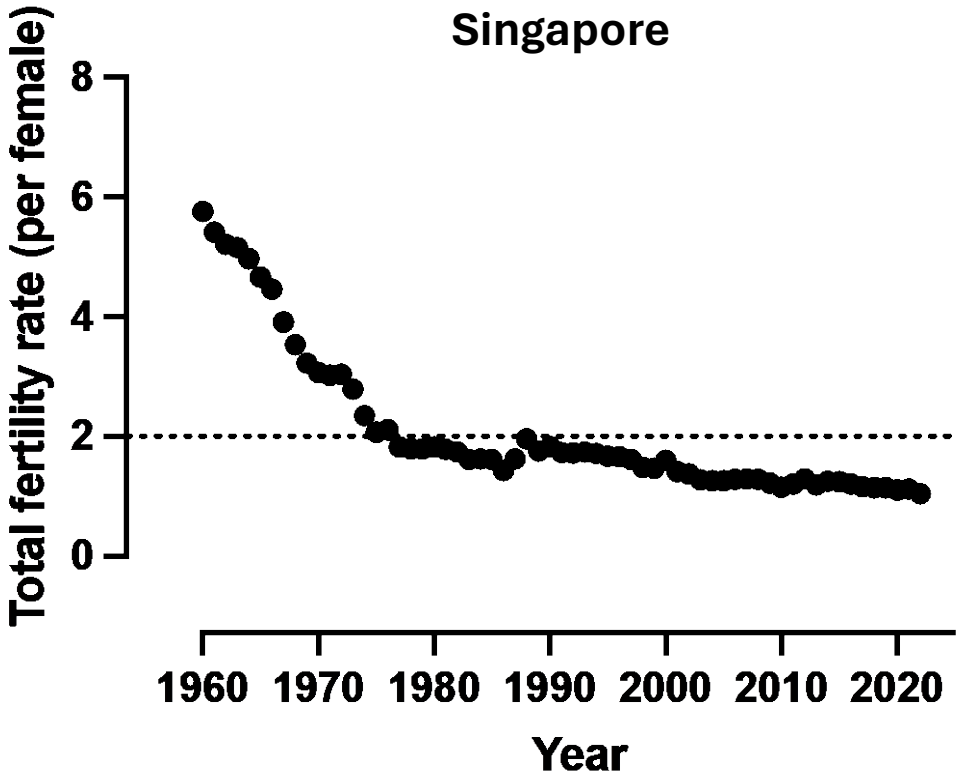
New housing reduced but not eliminated *Aedes* mosquitoes

The finished product

The reality

Growing economy and birth rates

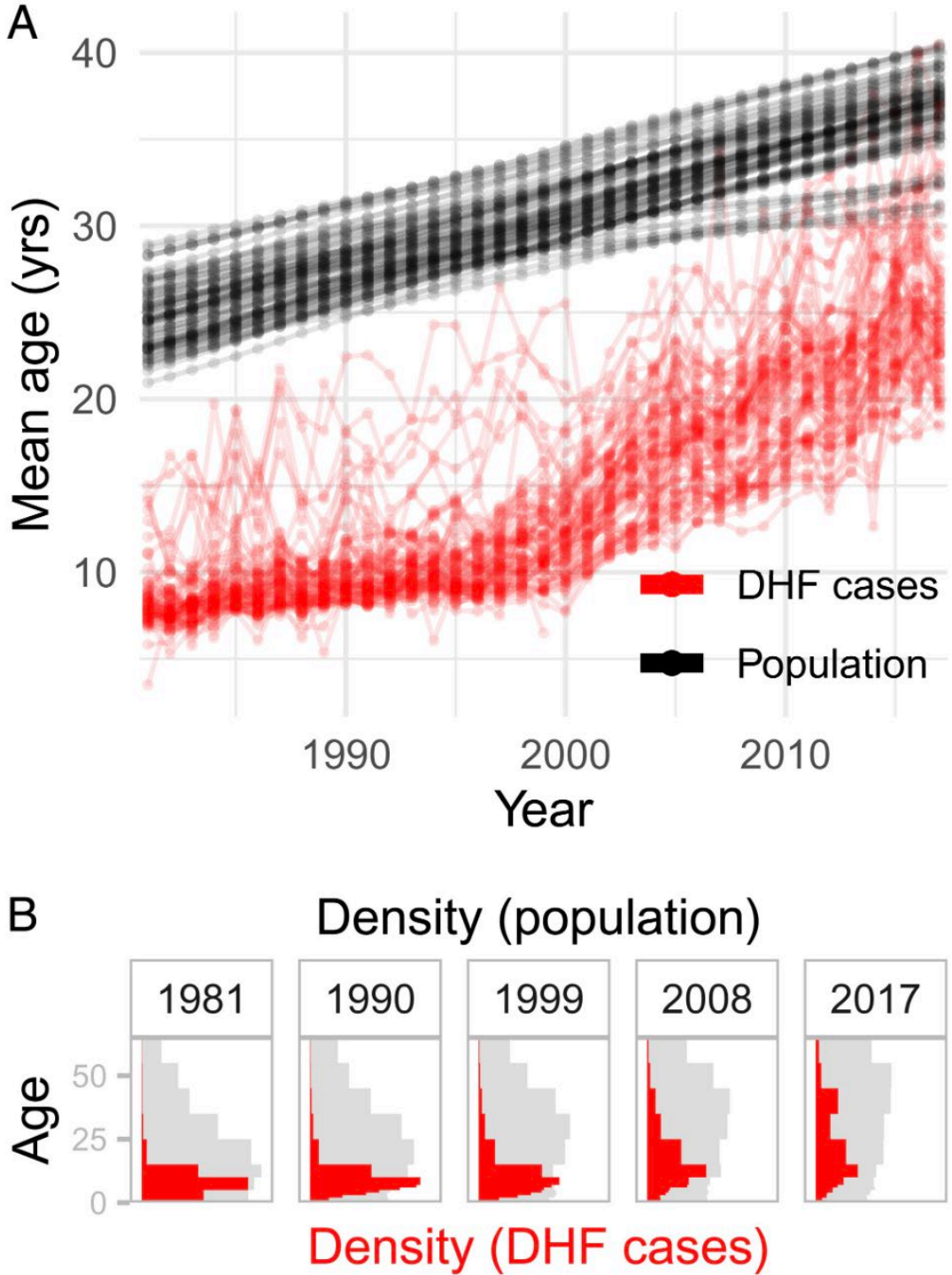
Inverse correlation between economy and birth rates



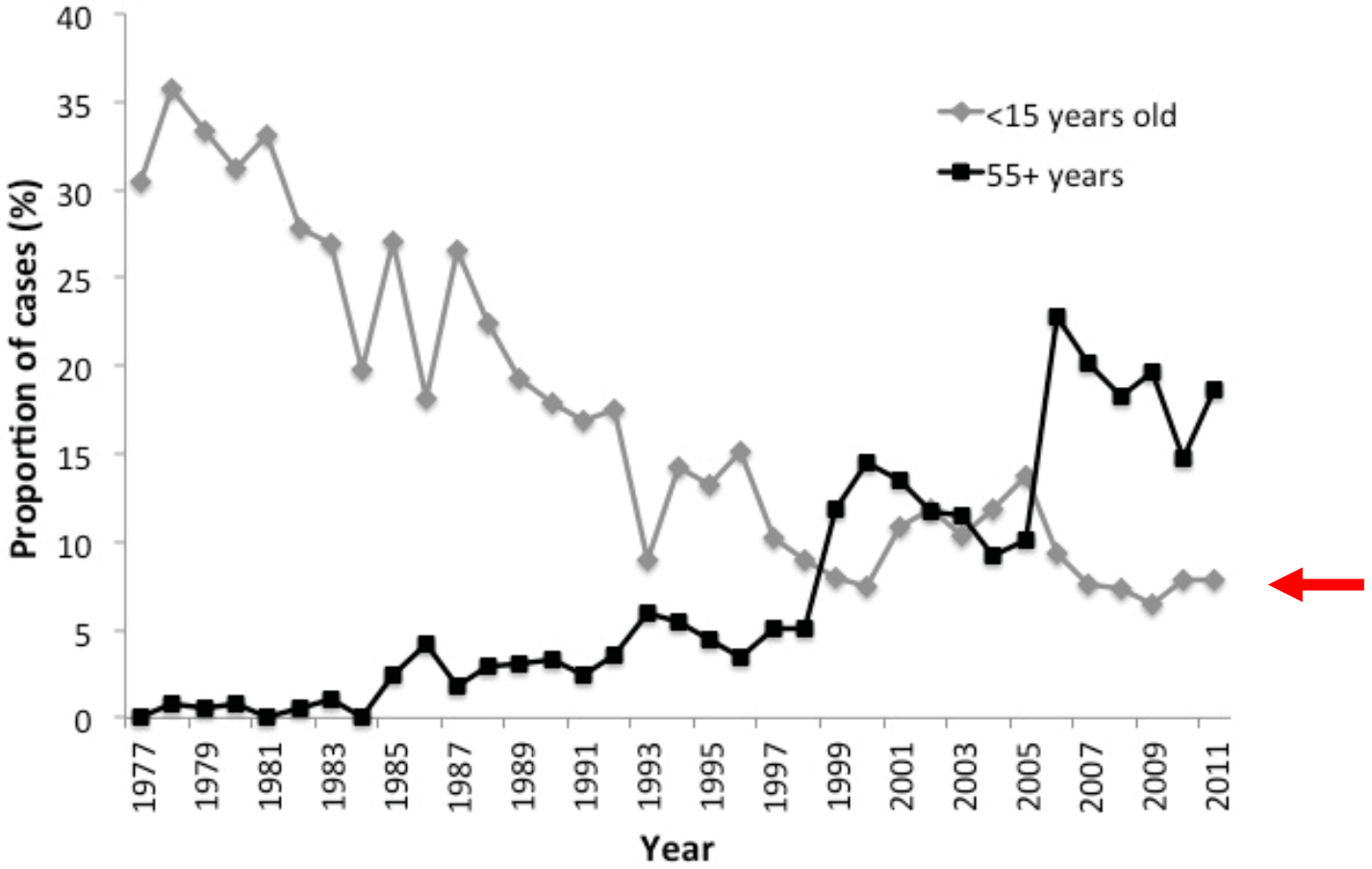
Data from Singapore Statistics

Population demographic transition drives rise in age of dengue cases

Huang et al, Proc Natl Acad Sci USA 2022



Dengue in older adults



Low and Ooi, Ann Acad Med Singapore 2013

Age-related changes in microvascular permeability

Gamble et al. Clin Science (London) 2000;98:211-16

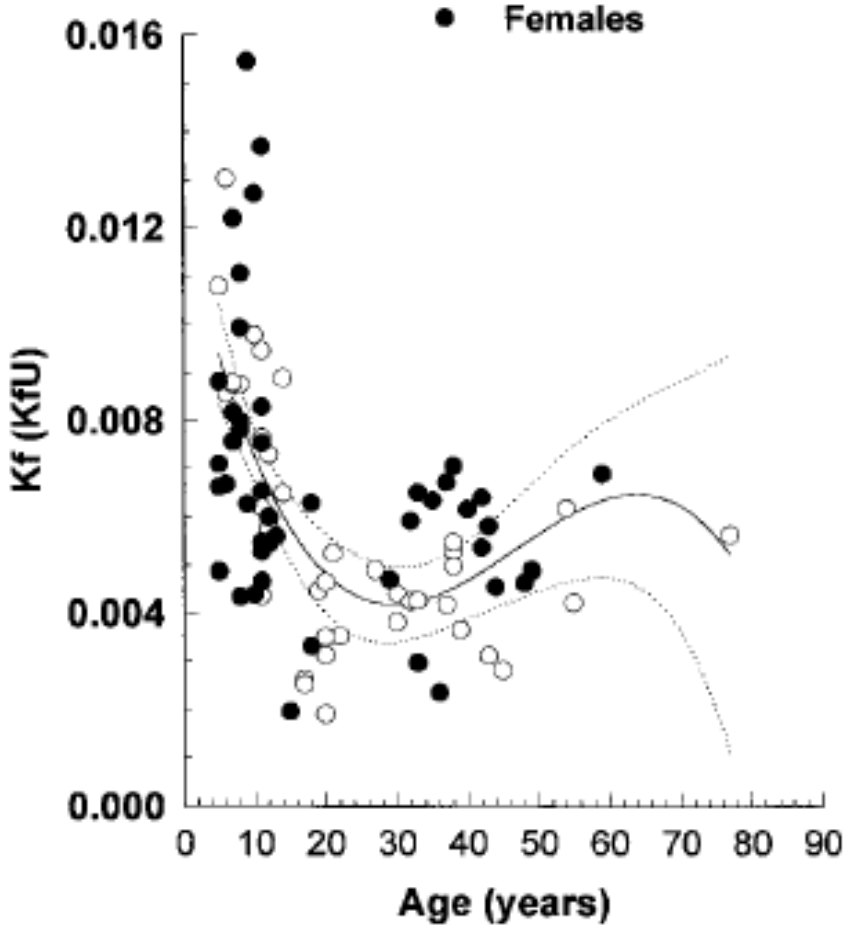
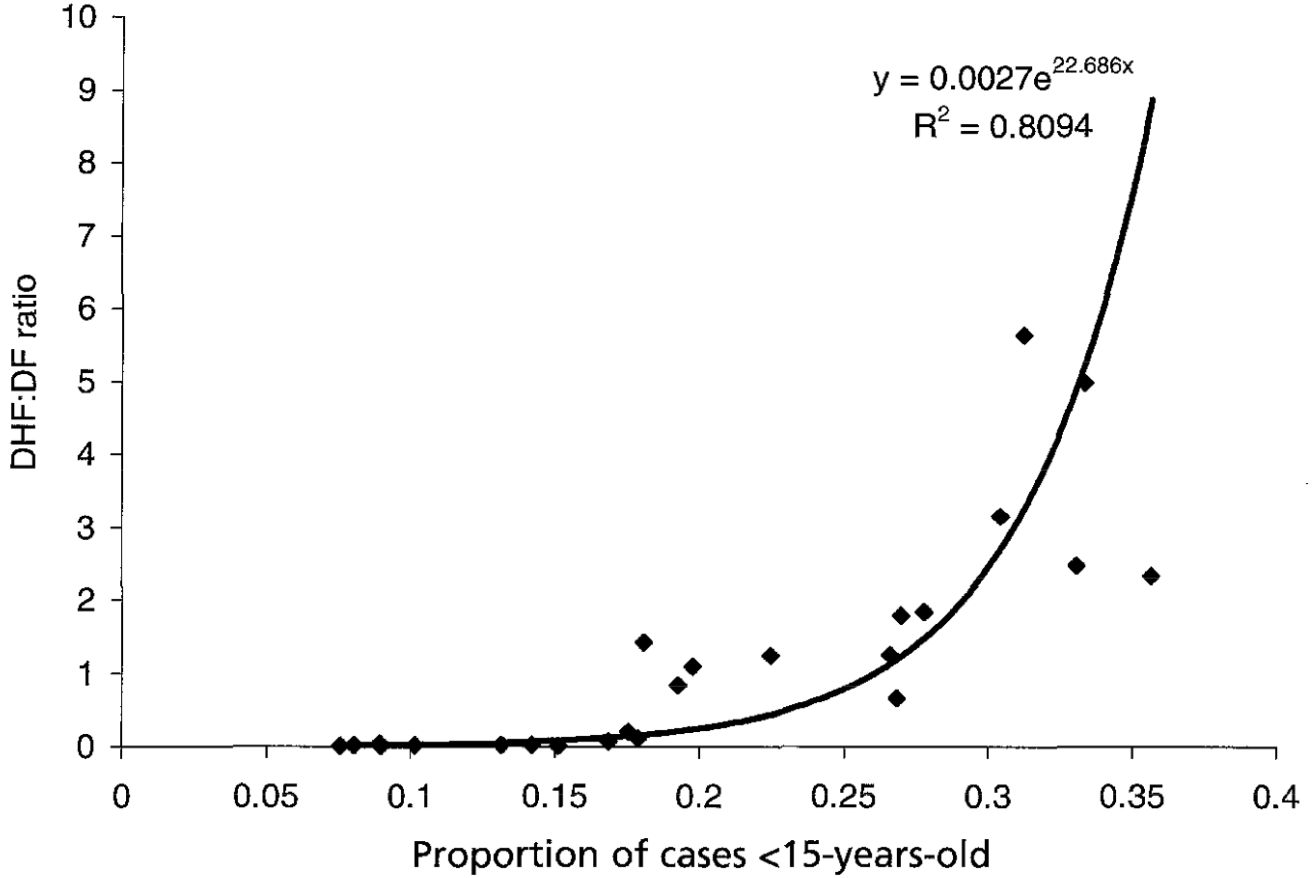


Figure 3 K_f **data obtained from 89 healthy Vietnamese volunteers aged 5 to 77 years**

Each data point represents either the value from a single study ($n = 30$) or the average of two studies performed 14 days apart ($n = 59$). ○, male subjects; ●, female subjects. The solid line represents a third-order polynomial fit for these data and the dotted lines the 95% confidence limits for that fit. More information on the fit is given in the Methods and procedures section.

Proportion of children to adult dengue cases affect dengue burden



Calculated from:
Annual DHF and DF cases in Singapore, 1977-2000

Ooi et al, Int J Infect Dis 2003

Summary – beyond vector control…

- Dengue prevention indirectly benefited from:
  - Rehousing of population
    - Motivated by economic reasons
    - Not dengue control
    - But likely & significantly reduced dengue
  - Economic growth and low birth rate
    - Altered dengue case demographics
    - Lowered risk of plasma leakage
    - Lower burden of dengue hemorrhagic fever
      - But higher rates of long dengue?

Message: Growing the economy vs controlling dengue?