香港中文大學
The Chinese University of Hong Kong

香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong

Investigation of Hong Kong's early detection, assessment and response (S-EDAR) system to the new emerging infectious disease outbreak COVID-19

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賽馬會公共衛生及基層醫療學院
The Jockey Club School of Public Health and Primary Care

Centre for Health Systems & Policy Research

Investigation of Hong Kong's early detection, assessment and response (S-EDAR) system to the new emerging infectious disease outbreak COVID-19

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Yeoh EK[1,2] , Chong KC[1,2] , Chung VC[2] , Dong D[2] , Hung CT[1,2] , Leung EYM[2] , Wong ELY[1,2] , Wong SYS[2] , Yang ZY[2] , Wang Z[2]

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Aims

- To investigate how Hong Kong's system of early detection, assessment and response (S-EDAR) to the new emerging infectious disease outbreak can be enhanced in preventing, control and eradication of the COVID-19 epidemic

Methods

- Scoping review and document analysis
- Key informant interviews
- Comparative study of government responses from six jurisdictions
- DH & HA data analysis for transmission risks
- Systemic dynamic modelling for effectiveness of responses
- Expert workshops – international experts
- Delphi survey (On-going)

Inputs from:

- Comparative study of government responses in Hong Kong, Japan, Malaysia, South Korea, Shanghai, and Singapore;
- 35 local key informants including policy-makers, healthcare administrators and professionals in public and private sectors, business organizations, and general public/patients;
- 17 local and international experts;
- Analysis of infection surveillance and control data from Centre of Health Protection and Hospital Authority: assessing community transmission risks and effectiveness of screening strategies for inbound travellers

Findings from scoping reviews

Implementation and Effectiveness of Social Distancing Measures

Results from scoping reviews:

- **Mapping facilitators and barriers in implementing physical distancing measures for COVID-19 to the Consolidated Framework for Implementation Research to inform policy making** *(Revising for Implementation Science Communications)*

- **Effectiveness of different levels of social distancing measures in controlling COVID-19 pandemic: a scoping review** *(Invited by BMJ Open to submit revised version)*

Implementation barriers and facilitators to social distancing measures mapped onto Consolidated Framework for Implementation Research (CFIR)

CFIR Domain	CFIR Construct	Barriers	Facilitators
Intervention Characteristics	**Evidence credibility**	• Unclear messages from the government • Lack of trust in government's advice • Misleading and confusing advice from social media • Insufficient "sense making"	• Perceived good effectiveness of measures • **Trust in authorities and formal sources**
	Adaptability	• Difficulty for physical distancing in food manufacturing setting • Infeasibility for physical distancing in overcrowded areas • Overcrowded accommodation for migrant workers • Difficulties in self-isolation	• **Language adaptability of guidelines for ethnic minorities** • Work shift and break arrangement
	Cost	• Socio-economic cost • Business operation disruption	
Outer Setting	**Public needs and resources**	• Concerns about job income • Psychological needs	• **Business rescue package** • **Statutory sick pay for self-quarantine**
Inner Setting	**Culture**	• Individualism	• Collectivism
	Implementation climate	• Fatigue in compliance with measures • Negative attitudes towards lockdown • Negative attitudes on restaurant/bar measures • Lower compliance with social distancing in workplace	• Community transmission phase • Supportive attitudes towards measures
	Readiness for implementation	• Delayed measures from the government	• **Quick response from the government** • **Adequate quarantine arrangement**

CFIR Domain	CFIR Construct	Barriers	Facilitators
Characteristics of Individuals	**Knowledge and beliefs about the intervention**	• Low health literacy • Underestimation of the risk of COVID-19 • Uncertainty about the severity of COVID-19	• **Higher health literacy** • **Higher infection risk perceptions** • **Higher awareness about COVID-19** • Awareness of preventive measures • Fear of COVID-19 • Fear of uncertainty • Living in districts near border
	Self-efficacy	• Difference between attitude and actual compliance • Fair self-efficacy towards working at home	• **Higher self-efficacy** • Higher cognitive function
	Other personal attributes	• Male • Low-income • Younger • Ethnic minorities • Extrovert personality • Smoking/drinking habits	• Female • Being older • High socioeconomic status • **Healthy lifestyle habits** • Sense of social responsibility
Process	**Engaging**	• Politicians' conflict of interest in making recommendations • Inequality in economic stabilization strategies to favor large companies	• **Support from local communities**
	Executing	• Milder degree of implementation	• **Mandatory orders**

Effectiveness of different types and levels of social distancing

	Social distancing between individuals	School closure	Workplace measures	Public transport restriction	"Partial" lockdown	Full lockdown
Evidence level	**Adequate**	**Inconsistent**	**Limited**	**Limited**	**Adequate**	**Adequate**
Infectivity: **(Rt, effective reduction number)**	Physical distancing of ≥1 meter could reduce the transmission risk by 5 times and the protective impact was double for every extra meter Estimated R_t reduced by 36%, 28% and 12% when gatherings were limited to 10, 100 and 1,000 people respectively		Estimated 29% R_t reduction by closing most of non-essential businesses while 20% by closing high risk businesses	No difference in reduction in R_t	In Mainland China excluding Hubei (province of Wuhan), R_t dropped from 3.34 to 0.89 In 58 cities of China, R_t dropped by 54.3%	From data of 41 countries, estimated R_t reduced by 10% by stay-at-home orders China R_t reduced from 2.35 to 1.05 during the lockdown
Incidence: **(Infection incidence/ ratio of incidence rate ratio/ attack rate/ bed occupancy rate)**	In the US, COVID-19 infection was less likely among the public who always practiced social distancing (aOR for indoor social distancing, 0.32; aOR for outdoor social distancing, 0.10)	In the US, school closure decreased COVID-19 incidence (adjusted relative change per week, −62%) Data from EU countries suggested that re-opening of schools was NOT associated with increase incidence			In the US, mean daily COVID-19 case growth rate decreased by 0.9% per day four days after lockdown	Data from 32 countries showed decreased incidence of COVID-19 (pooled incident rate ratio, IRR 0.87, 0.84 to 0.91) Growth rate of daily confirmed cases reduced by 5.4% after 1-5 days, 6.8% after 6-10 days, 8.2% after 11-15 days, 9.1% after 16-20 days

Findings from comparative study of government responses

Six jurisdictions including HKSAR, Singapore, Shanghai, Malaysia, South Korea and Japan

Health System Impact Subgroup

Study Lead: **Professor EK Yeoh**

Member:

- **Professor Soonman Kwon**, School of Public Health, Seoul National University, South Korea
- **Professor Chiu-Wan Ng & Professor Sanjay Rampal**, Department of Social and Preventive Medicine, Faculty of Medicine, University of Malaya, Malaysia
- **Professor Vernon Lee & Dr Calvin J Chiew**, Saw Swee Hock School of Public Health, National University of Singapore & Singapore Ministry of Health, Singapore
- **Professor Weibing Wang**, School of Public Health, Fudan University, Shanghai, China
- **Professor Hideki Hashimoto**, School of Public Health, The University of Tokyo, Japan

Findings from Six Jurisdictions including HKSAR, Singapore, Shanghai, Malaysia, South Korea and Japan

Government Response Measures to COVID-19 - Key Policy Lessons

A Technical Report:
From Experiences of Six Middle/ High-Income Jurisdictions in the Western Pacific Region in Period 2: 1st June - 30th November 2020

World Health Organization R&D Blueprint Novel Coronavirus: Health System Impact Subgroup of the COVID-19 Social Science Working Group

Health System Impact Subgroup of the COVID-19 Research Roadmap Social Science Working Group

This report was led by Professor EK Yeoh[1] (CHSPR, CUHK; Hong Kong SAR) supported by the Centre for Health Systems and Policy Research in the Faculty of Medicine, the Chinese University of Hong Kong in collaboration with Professor Soonman Kwon[2] (SPH, SNU; South Korea), Professor Chiu-Wan Ng & Professor Sanjay Rampal[3] (DSPM, UM; Malaysia), Professor Vernon Lee & Dr Calvin J Chiew [4] (SSHSPH, NUS & MOH; Singapore), Professor Weibing Wang[5] (SPH, FU; Shanghai) and Prof Hideki Hashimoto[6] (SPH, UT; Japan).

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Impact of non-pharmaceutical interventions in the Western Pacific Region

One Health 12 (2021) 100213

Contents lists available at ScienceDirect

One Health

journal homepage: www.elsevier.com/locate/onehlt

Assessing the impact of non-pharmaceutical interventions on the transmissibility and severity of COVID-19 during the first five months in the Western Pacific Region

Eng Kiong Yeoh [a], Ka Chun Chong [a,*], Calvin J. Chiew [b], Vernon J. Lee [b, c], Chiu Wan Ng [d], Hideki Hashimoto [e], Soonman Kwon [f], Weibing Wang [g], Nancy Nam Sze Chau [a], Carrie Ho Kwan Yam [a], Tsz Yu Chow [a], Chi Tim Hung [a]

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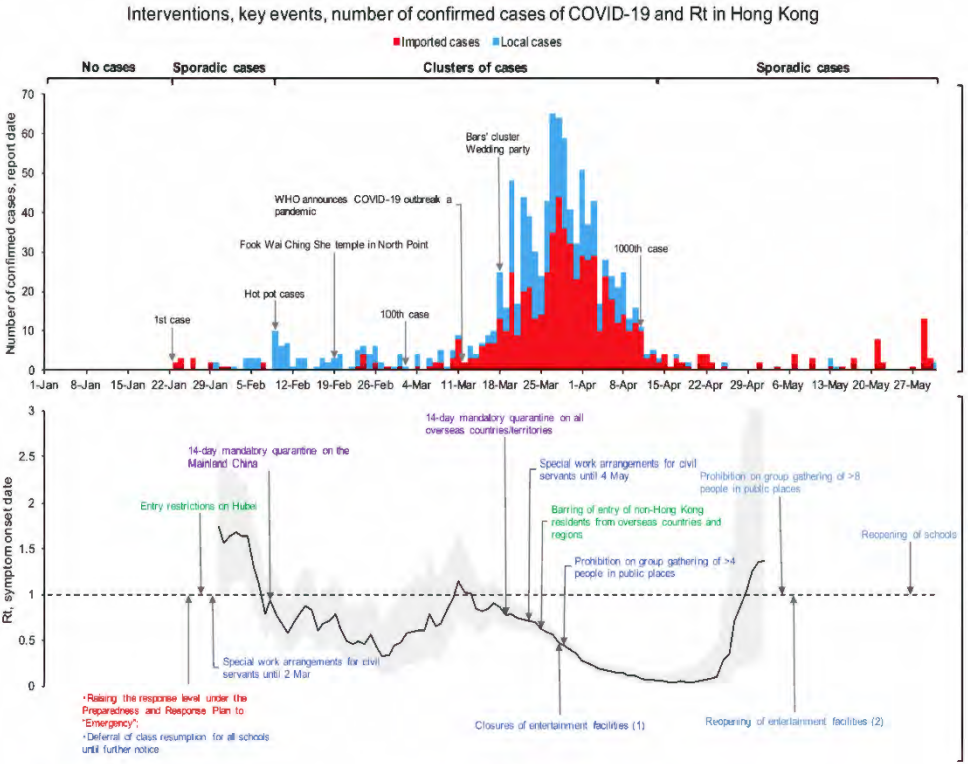
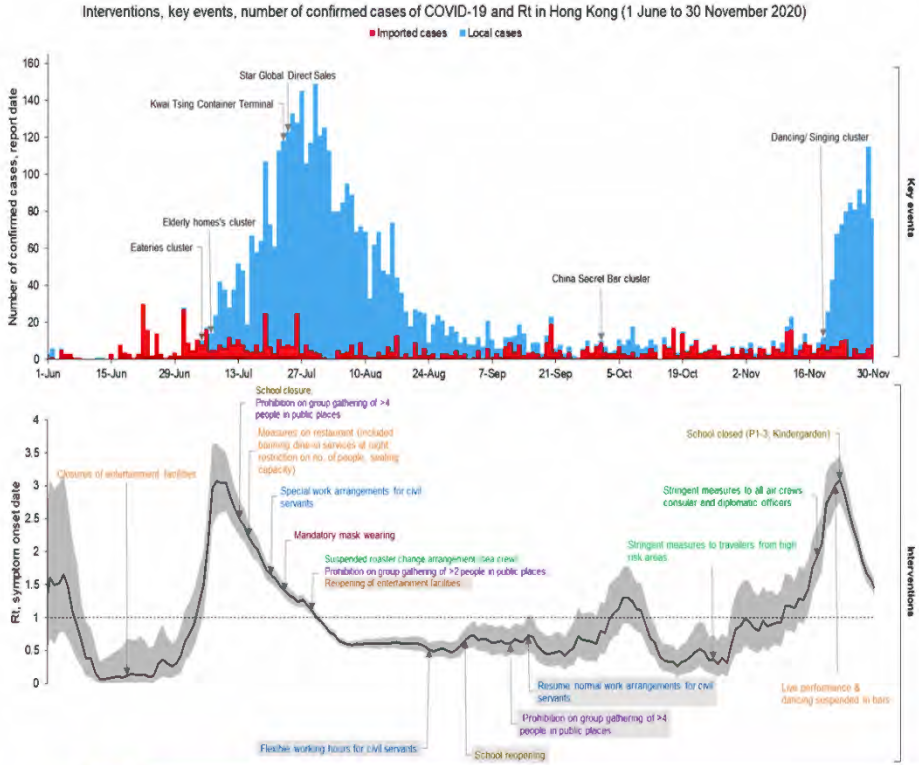
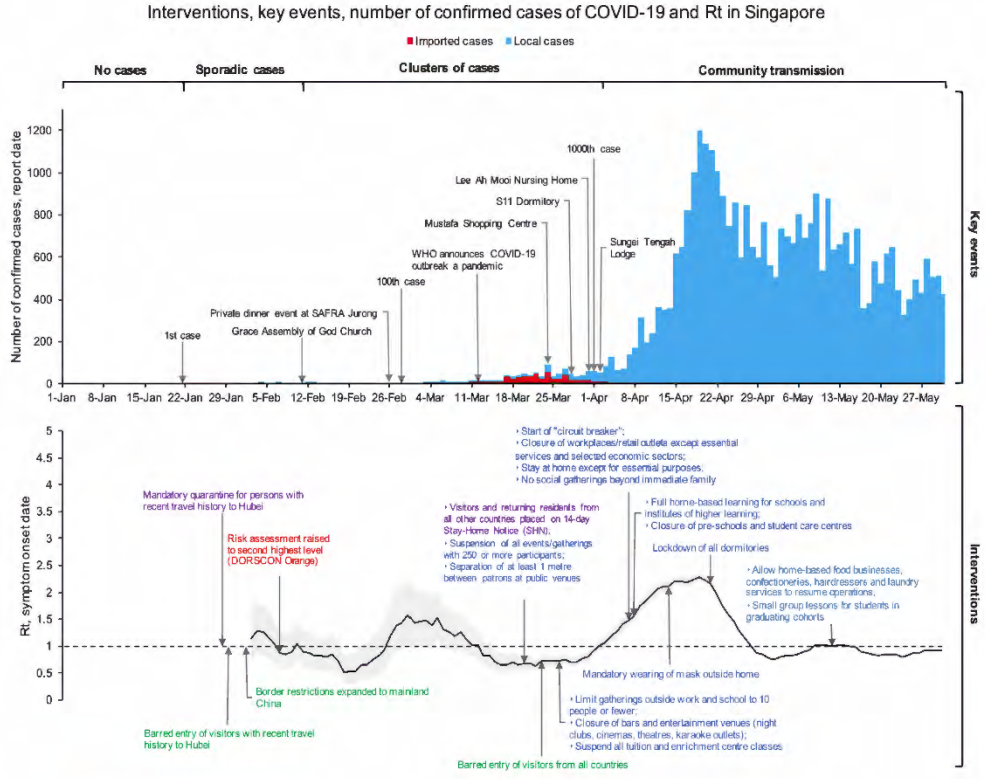
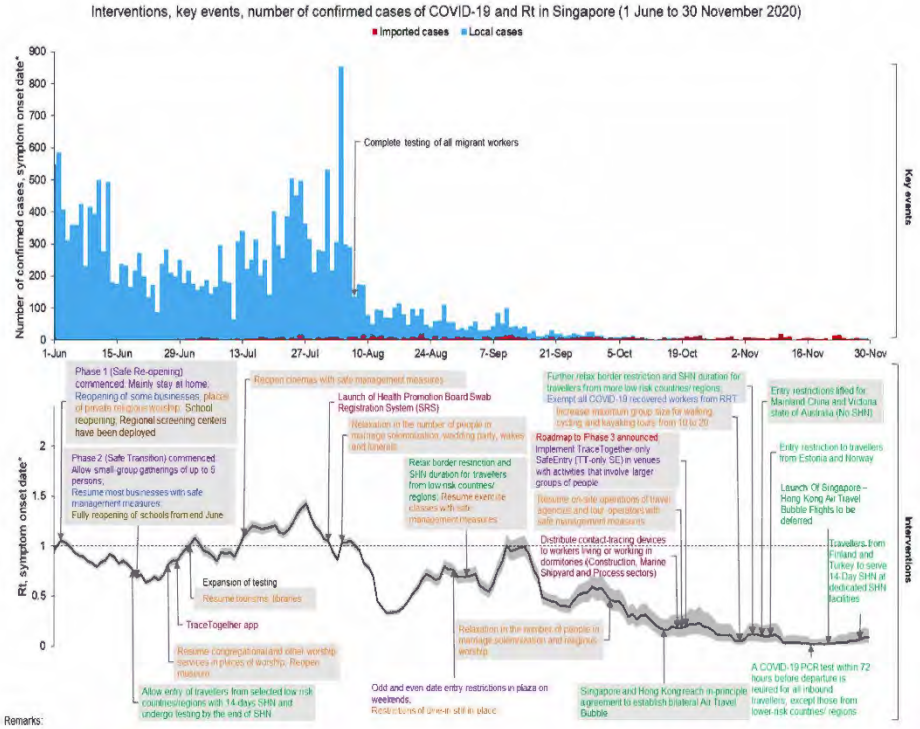
Hong Kong



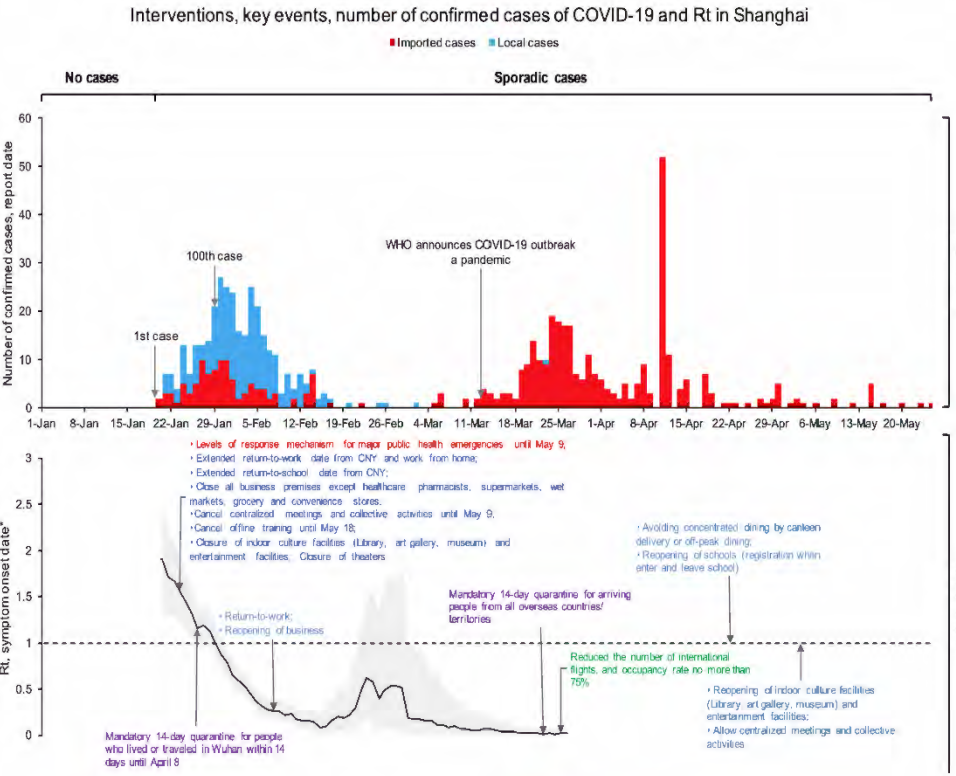


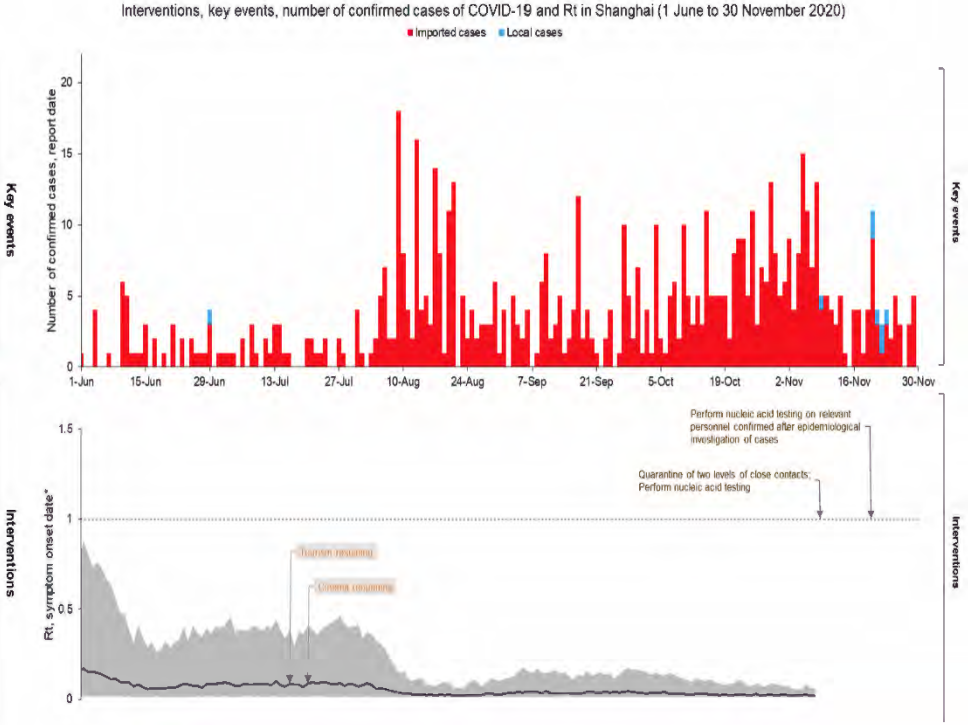
Singapore



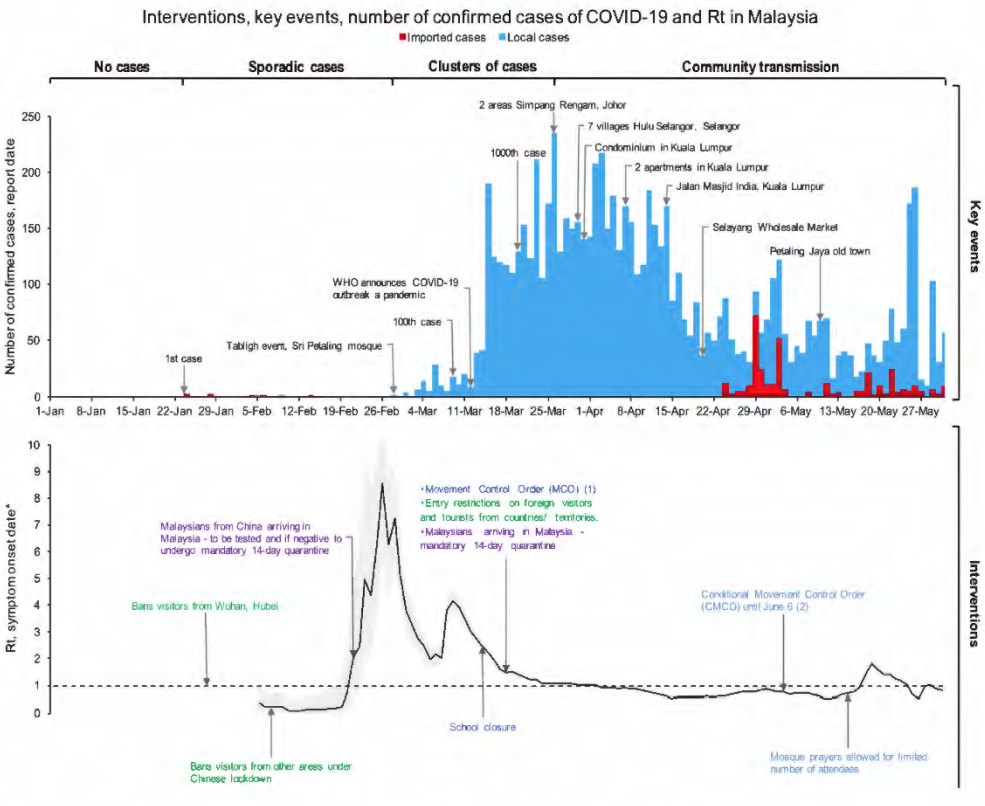


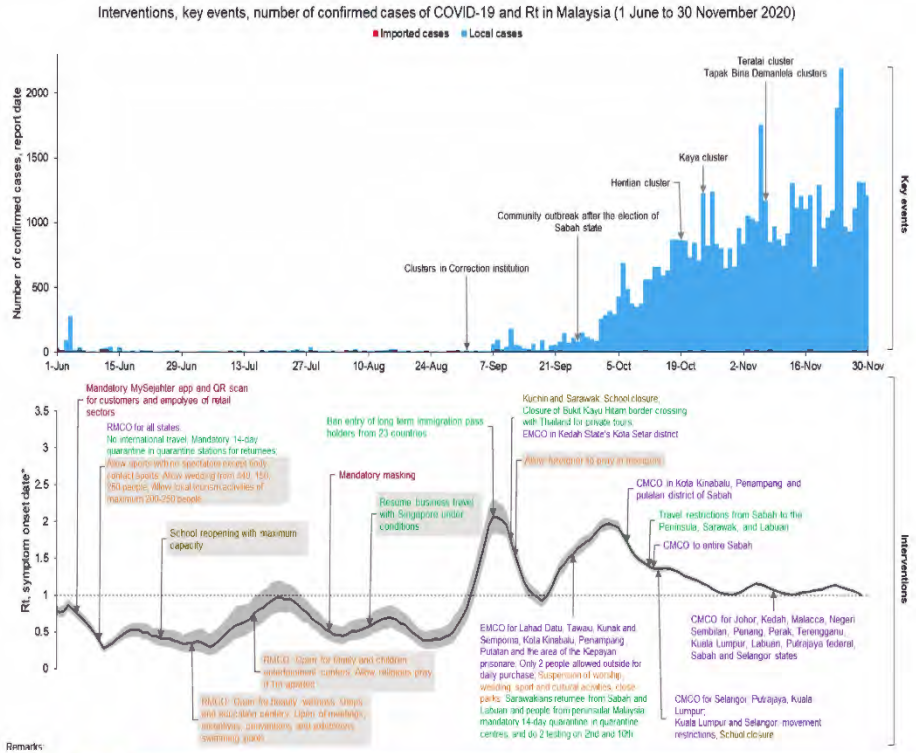
Shanghai



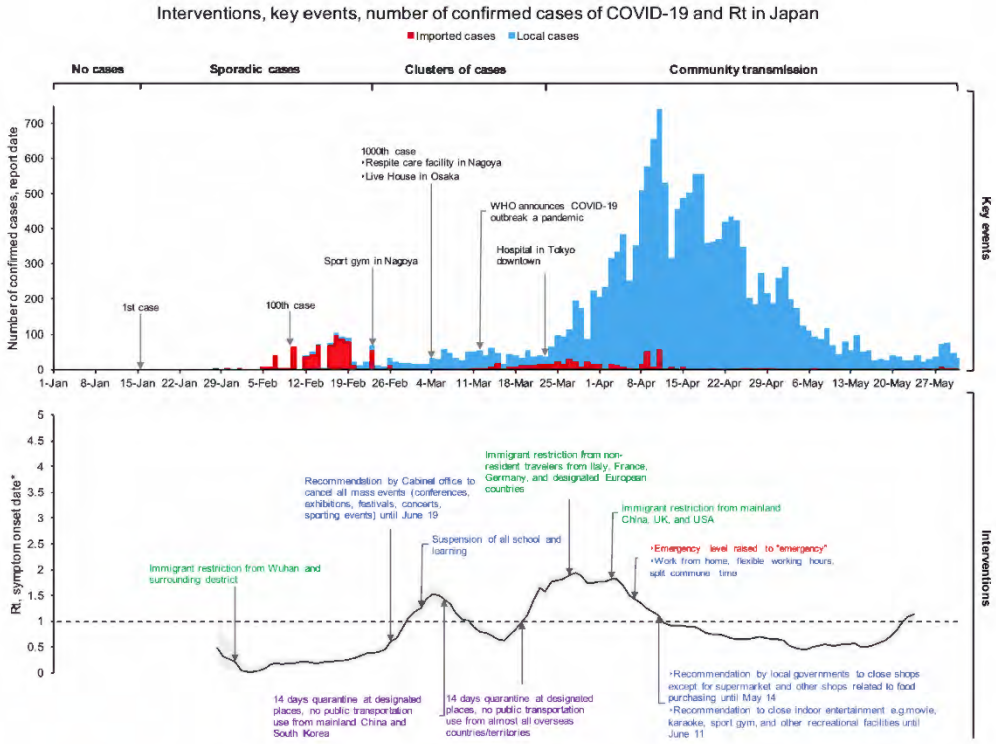


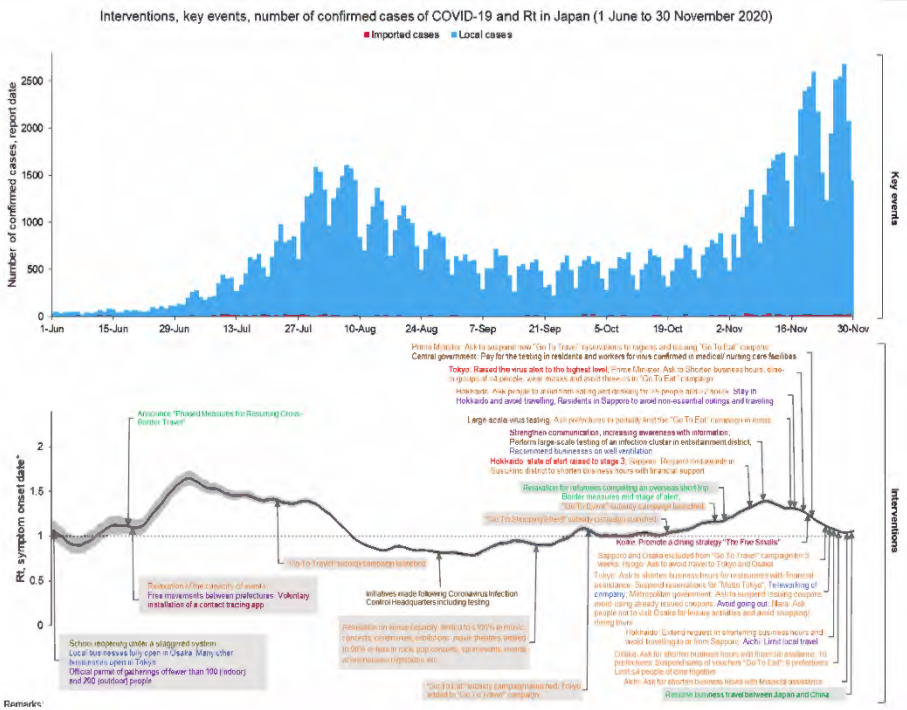
Malaysia



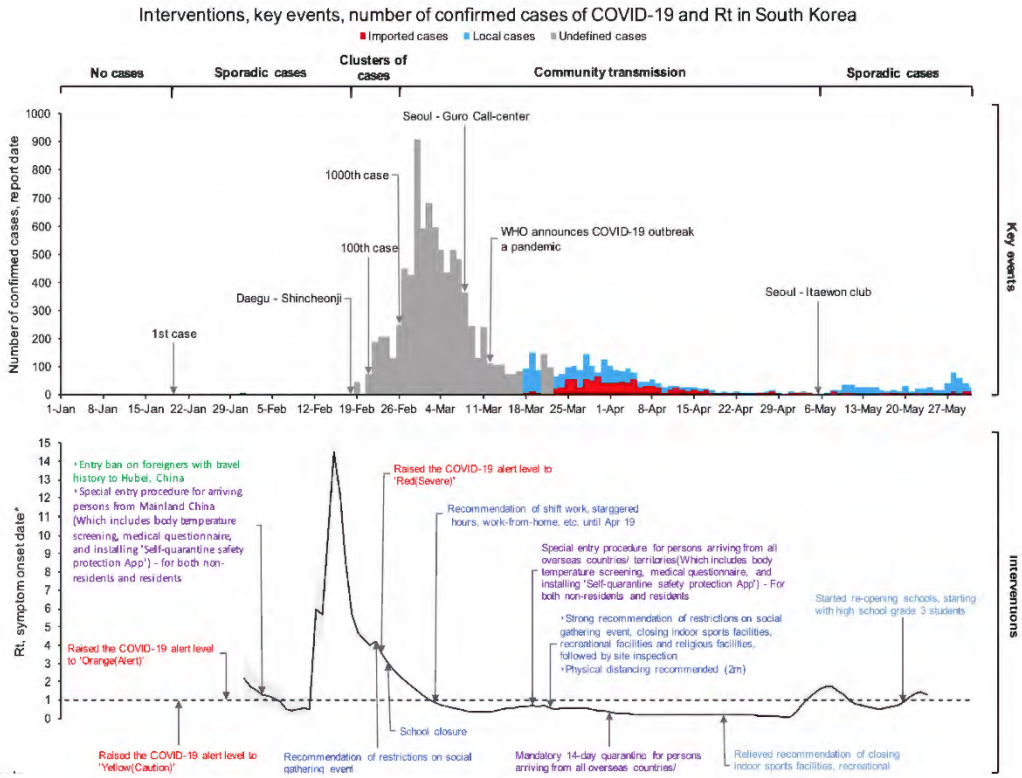


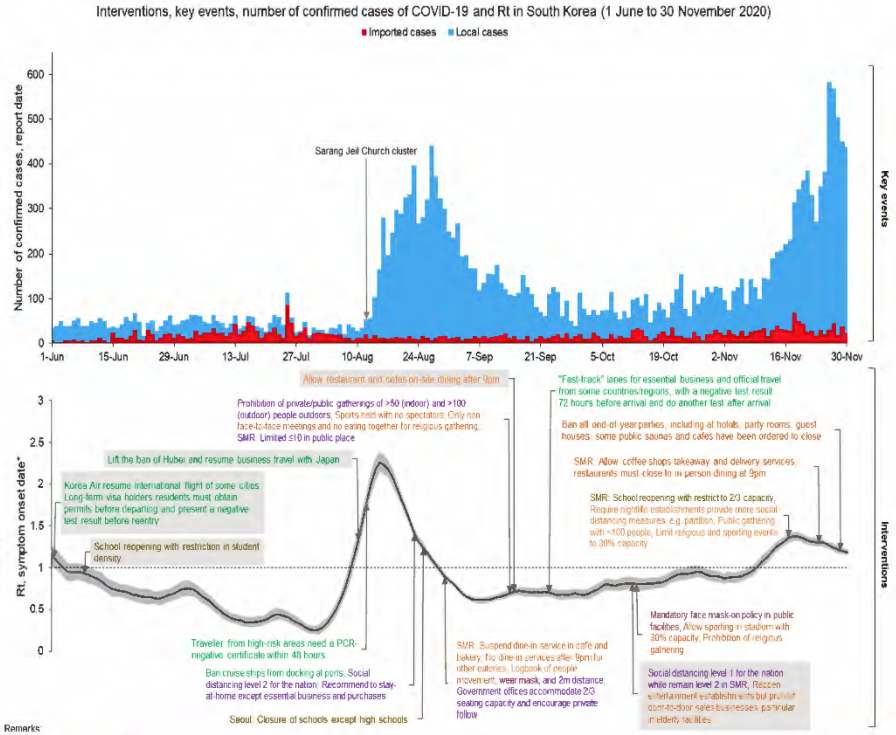
Japan



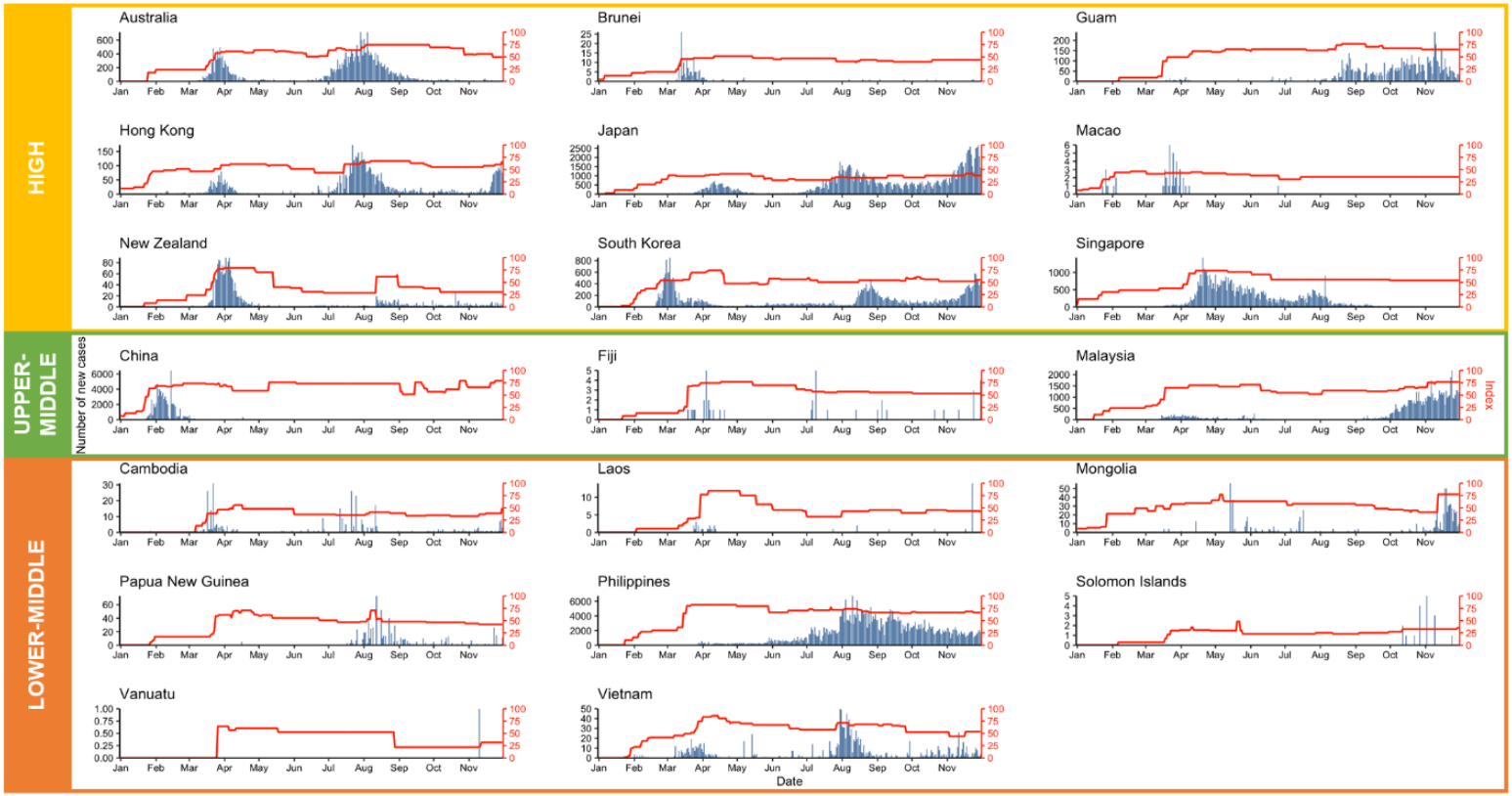


South Korea





COVID-19 Epidemics in the Western Pacific Region (WPR)



X-axis: Date; Y-axis on the left: Number of new cases; Y-axis on the right: Containment and Health Index

Key Lessons Learnt

Stage 1: 1st Jan – 31st May 2020

1. It is **critical** to set up and **invest** in an **on-going surveillance system** which is **updated** to take into account the **latest scientific knowledge** and the **experience** acquired at the **different transmission stages** of the epidemic as a tool for early detection and risk assessment necessary to facilitate rapid response actions
2. **Comprehensive preparedness plans and regular** drills enable **rapid and effective implementation of responses**
3. When **risk of an outbreak is imminent**, securing **and ramping up diagnostic testing and contact tracing capacity** would be crucial for timely case detection and containment can prevent large-scale community outbreaks
4. Risk identification and case finding processes should be planned in tandem with those for border control, quarantine and case management
5. Information technology is critical in supporting effective and efficient surveillance, contact tracing (e.g. travel history reporting) and ensuring compliance for measures such as quarantine and physical distancing
6. Introduce or broaden screening as early as possible for travelers coming from outbreak areas
7. Build **capacity for isolation and quarantine facilities to prepare for outbreaks** and **review capacity early** in the **epidemic before the system gets overwhelmed** by large number of confirmed cases
8. Physical distancing measures at the individual level cause less disruption to society as opposed to those at the community level, but enforcing physical distancing measures is challenging and can be leveraged with legal tools e.g. promulgation of new legislation to ensure compliance

Key Lessons Learnt

Stage 1: 1st Jan – 31st May 2020 (cont'd)

9. Set up communication channels including social media platforms to disseminate and push clear, consistent, timely and transparent messages about the COVID-19 outbreak

10. **Engage the communities including the private and non-governmental sectors to mobilize available resources** by calibrating them **to meet the surge in demands** in human resources, physical quarantine facilities for treatment and quarantine, and other resources e.g. masks and medical supplies production for outbreak control

11. Outbreak control measures have many unintended socio-economic impacts on the society and economy, such as unemployment, delay or suspension of social services, particularly for vulnerable groups, which could last long after the outbreak is over

12. The priority in **implementation of the different combinations of measures** depend **on the source of the cases and nature of transmissions**, and should be **proportionate to the risks and stages of the outbreak**

13. As jurisdictions design **exit strategies** to transition society back to a degree of normalcy, the relaxation of physical distancing and community quarantine measures and restoration of socioeconomic activities **need to be planned based on risk assessment, implemented in stages, monitored and evaluated to minimise the likelihood of large-scale resurgences** which **would require reinstatement of the measures**

Key Lessons Learnt
Stage 2: 1st Jun – 30th November 2020

- **Sources and risks of local transmission**
  - break through infections at a border control sites and in hotels designated for quarantine
  - setting specific risks of cluster outbreaks: worksites, home environment, bars and nightlife places

- **Response and control measures based on risk assessment**
  - risk assessments for exit roadmap from restriction to economic life
  - supported by pilot programs investigating risk or feasibility of relaxing the activities
  - risk assessment based exit roadmaps: clearly communicated to the public associated with better acceptance from the public

  Surveillance system were revised regular and rigorous testing protocols were introduced for humans, imported goods, and environment e.g. wastewater

  Targeting response measures based on risk assessment limited to a certain residential area or worksite

Key Lessons Learnt
Stage 2: 1st Jun – 30th November 2020 (cont'd)

- **Social mobilization and participation**

- **Cost on society**
  - social and economic impact on society cycles of outbreaks, re-imposition of restriction and control
  - compliance with the physical distancing

  Questions on whether measures imposed have been proportionate to the risks

  Clear roadmap to recovery helpful in incentivising the public to be compliant with the measures

Implications

1. Early interventions of border control, case identification, isolation and management, and contact tracing and quarantine were effective in averting the need for widespread community quarantine or lockdown when the infection became dispersed in the community
2. Need for a more precise risk assessment methodology that captures social costs calibrated with the effectiveness of interventions. Mitigate the longer-term socio-economic impact
3. Criticality of reflecting on our mechanisms of community and business engagement in strengthening our system

DH & HA data analysis

DH-HA database - Transmission Risk (1)

The Lancet Regional Health - Western Pacific 4 (2020) 100052

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The Lancet Regional Health - Western Pacific

journal homepage: www.elsevier.com/locate/lanwpc

Research paper

Settings of virus exposure and their implications in the propagation of transmission networks in a COVID-19 outbreak

Ngai Sze Wong [a,1], Shui Shan Lee[a,1], Tsz Ho Kwan [a], Eng-Kiong Yeoh[b,c,*]

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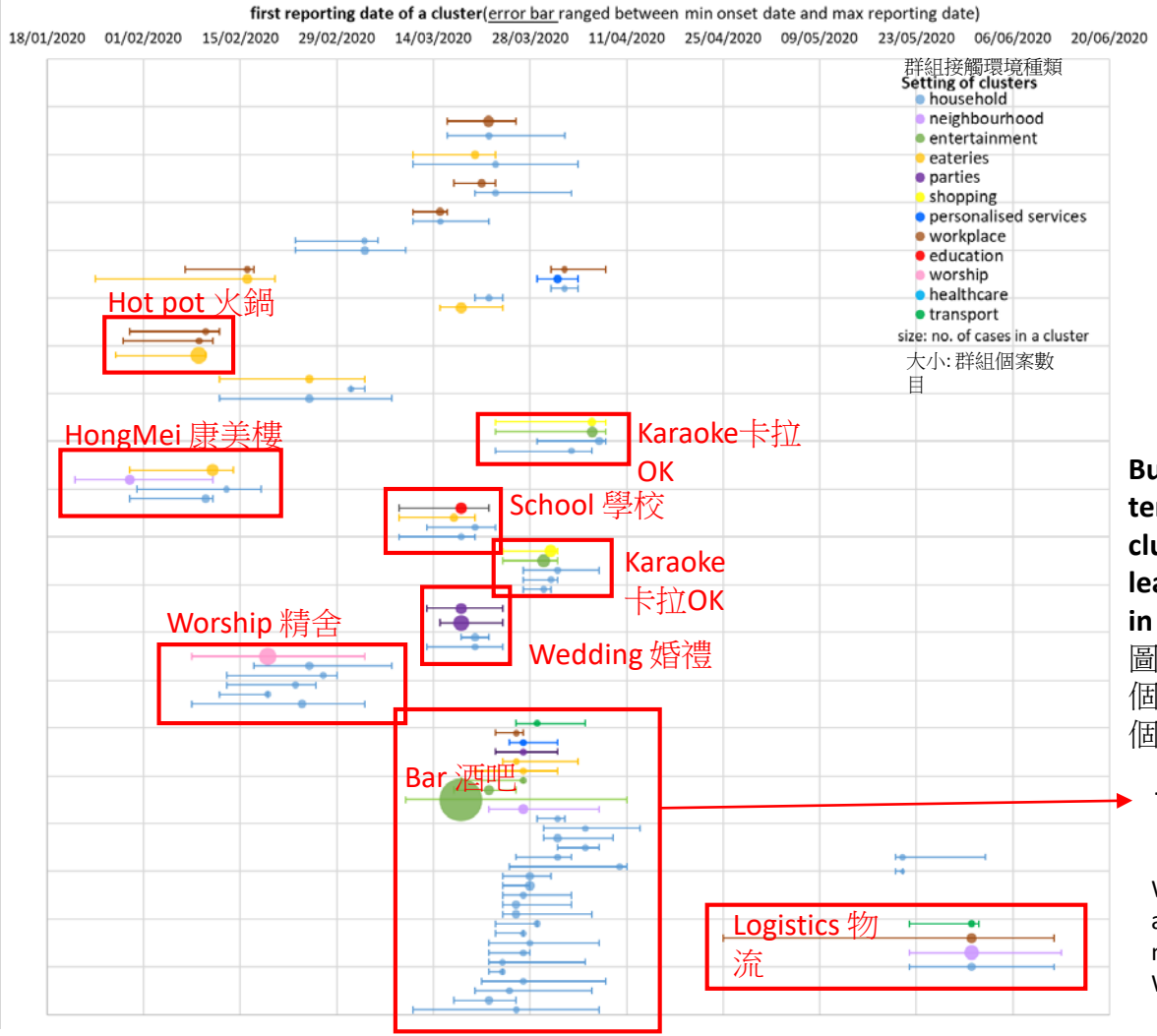
[b] *Centre for Health Systems and Policy Research, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong, China*
[c] *Jockey Club School of Public Health and Primary Care, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, Hong Kong, China*

From cases, clusters to transmission cascades
由個案、群組到傳播鏈

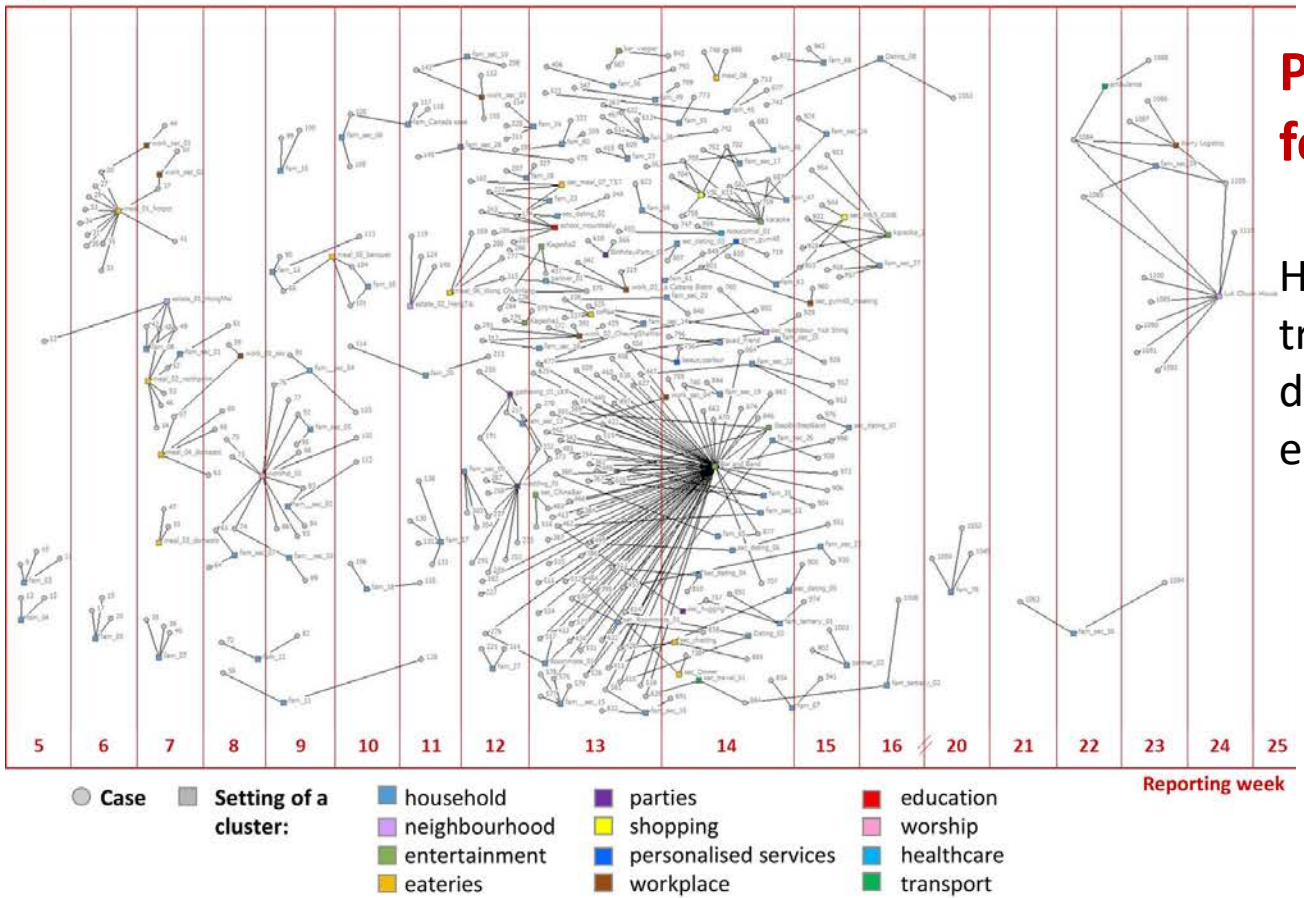


Bubble diagram shows the temporal distribution of clusters in 19 cascades (at least 2 clusters per cascade) in wave I/II
圖中顯示第一、二波期間19個傳播鏈(每傳播鏈最少有2個群組)的時間分佈

The longest cascade 最長傳播鏈

Wong NS, Lee SS, TH Kwan, Yeoh EK. Settings of virus exposure and their implications in the propagation of transmission networks in a COID-19 outbreak. Lancet Regional Health – Western Pacific. 220 Vol 4.

Transmission cascades of 324 linked cases



Policy implications for risk assessment:

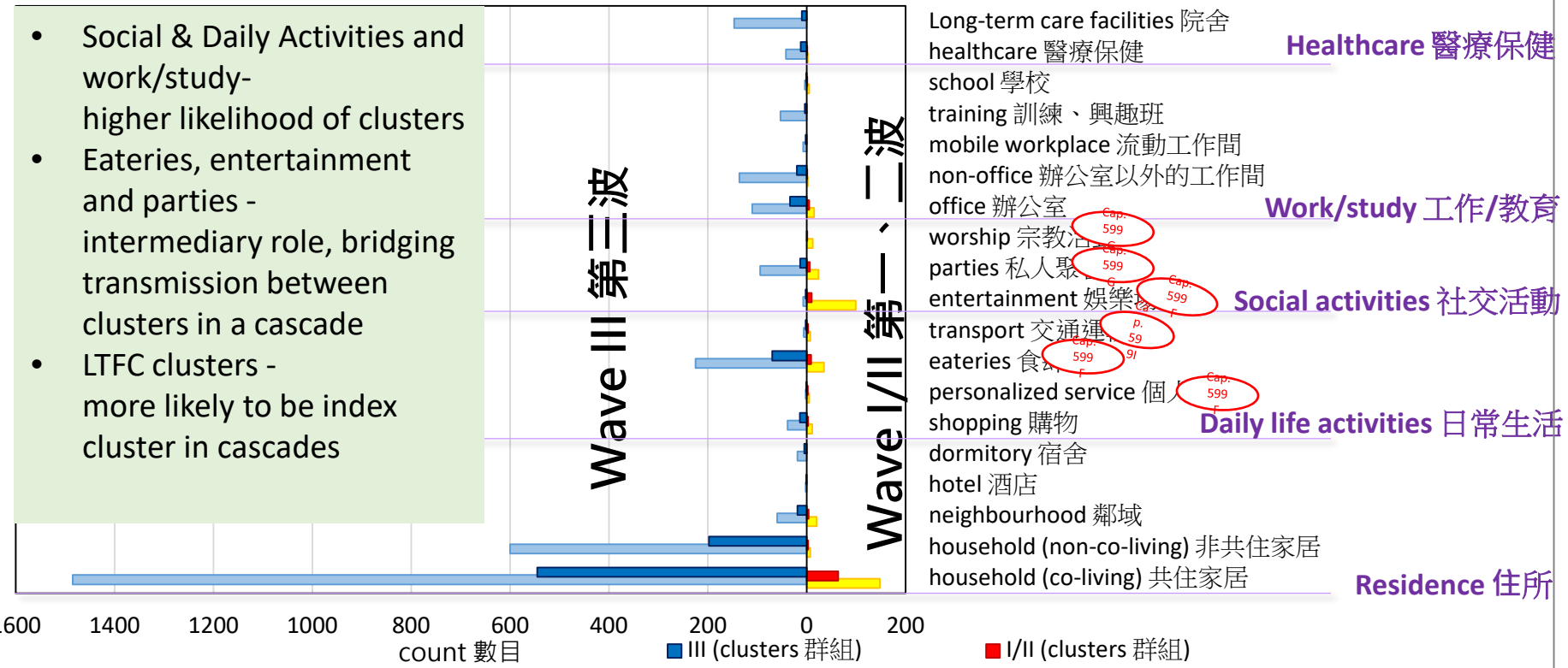
Heterogeneous transmission risks of different types of socio-economic settings

Wong NS, Lee SS, TH Kwan, Yeoh EK. Settings of virus exposure and their implications in the propagation of transmission networks in a COID-19 outbreak. Lancet Regional Health – Western Pacific. 220 Vol 4.

Analyses on exposure settings in Wave III

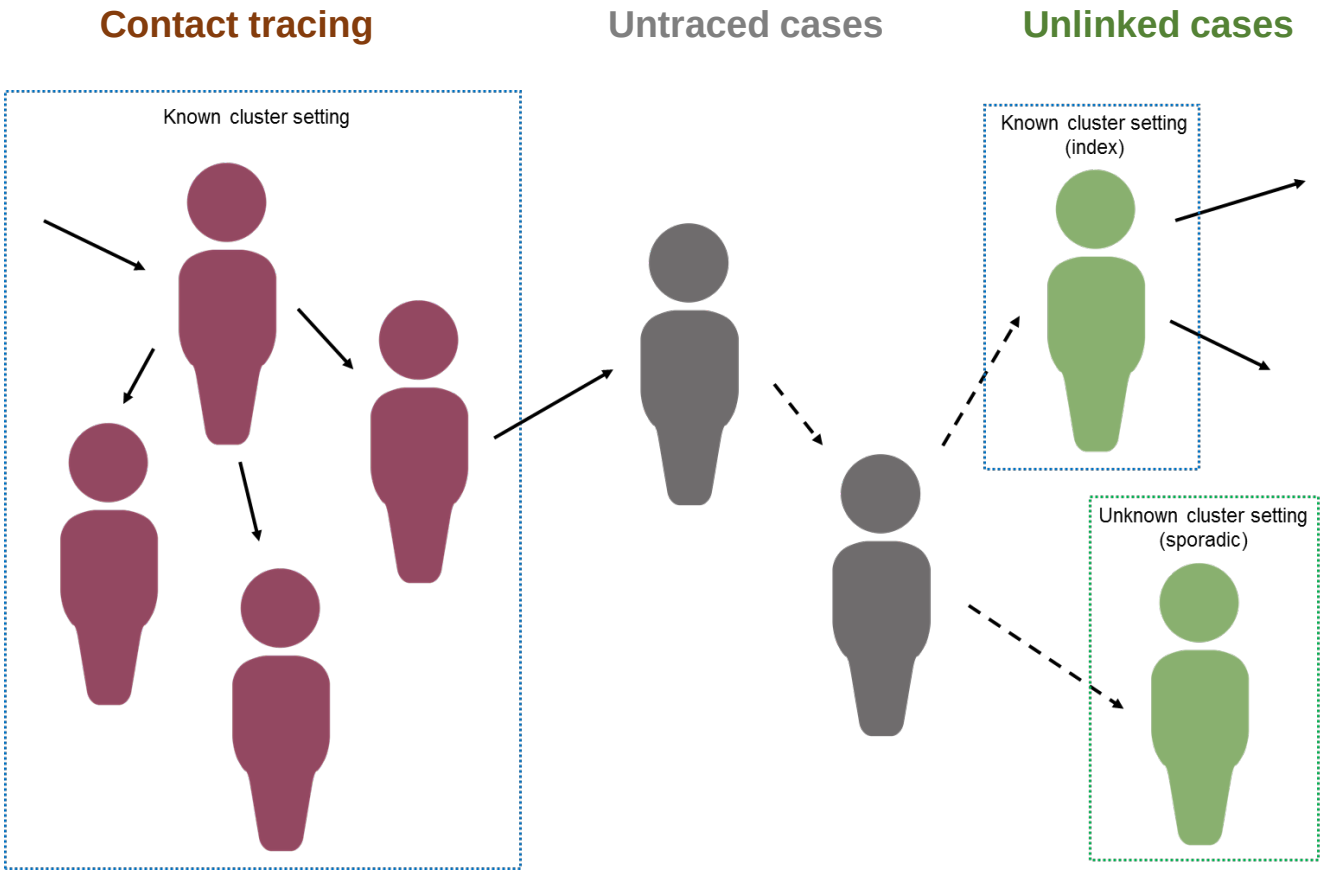
第三波接觸環境初步分析

- Social & Daily Activities and work/study-
  higher likelihood of clusters
- Eateries, entertainment and parties -
  intermediary role, bridging transmission between clusters in a cascade
- LTFC clusters -
  more likely to be index cluster in cascades



Kwan TH, Wong NS, Yeoh EK, Lee SS. Shifts of SARS-CoV-2 exposure settings in the transmission clusters of 2 epidemic waves in Hong Kong. Submitted to Journal of Infection

DH-HA database - Transmission Risk (2)

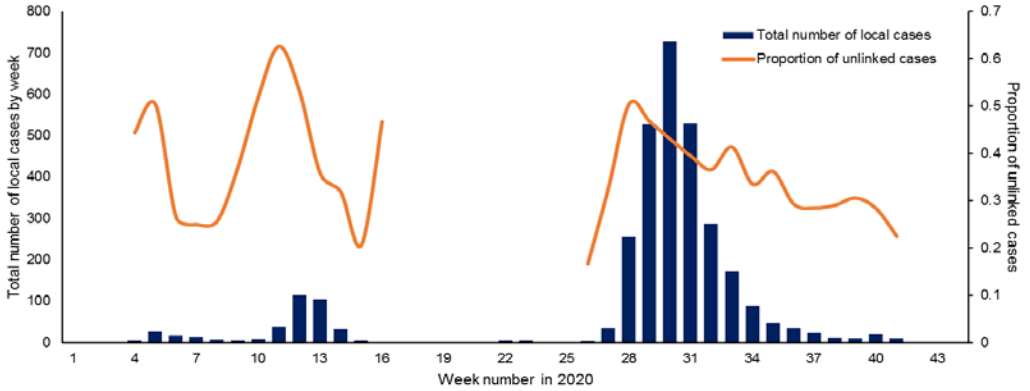


Heterogeneity of Social Contact:

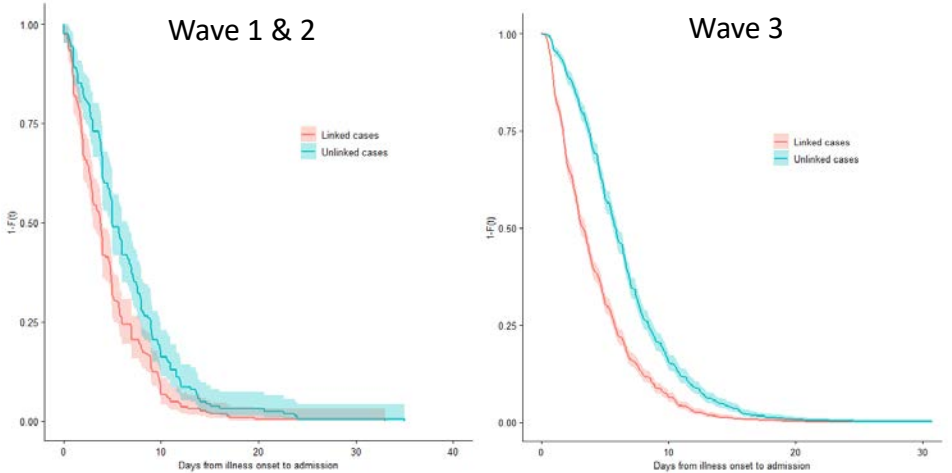
- Fortnight average contacts - 217, Median - 90, 3% >1,000; Close contact: 27%, average 57
- Estimated 15% of secondary infections cannot be identified - 'unlinked'

Proportion of linked cases to total no local cases

r=0.39; *p*=0.049

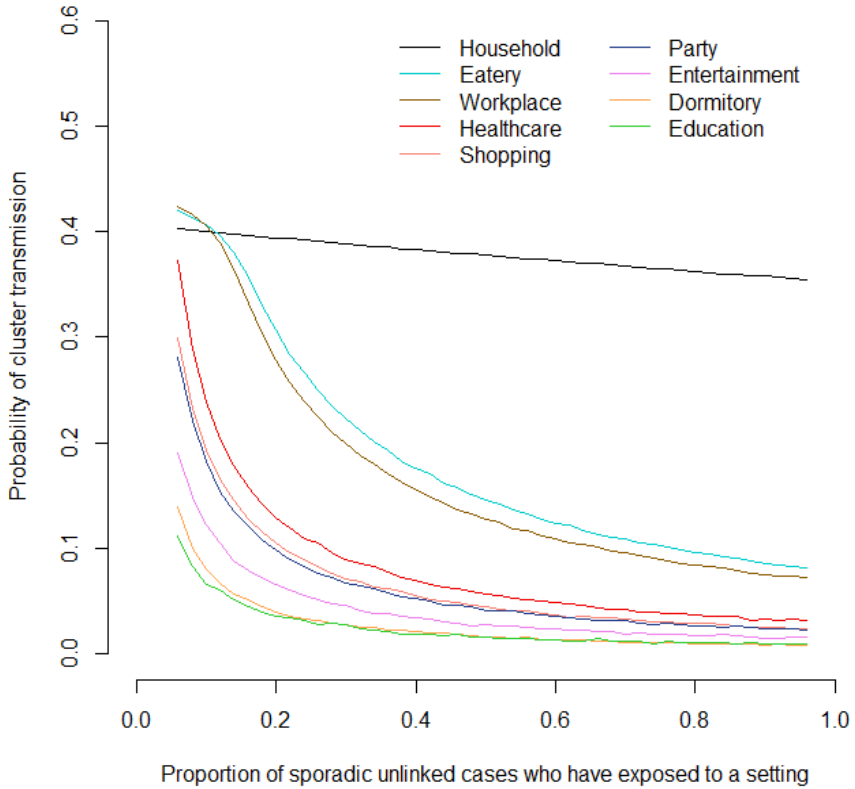


Survival analysis of delays in admission in Wave 1 & 2; and Wave 3.



Chong et al. Characterization of unlinked cases of COVID-19 for an implication on contact tracing measures. (To Submit)

Probability of cluster transmissions



Policy Implications of unlinked cases:

Transmission Risks:

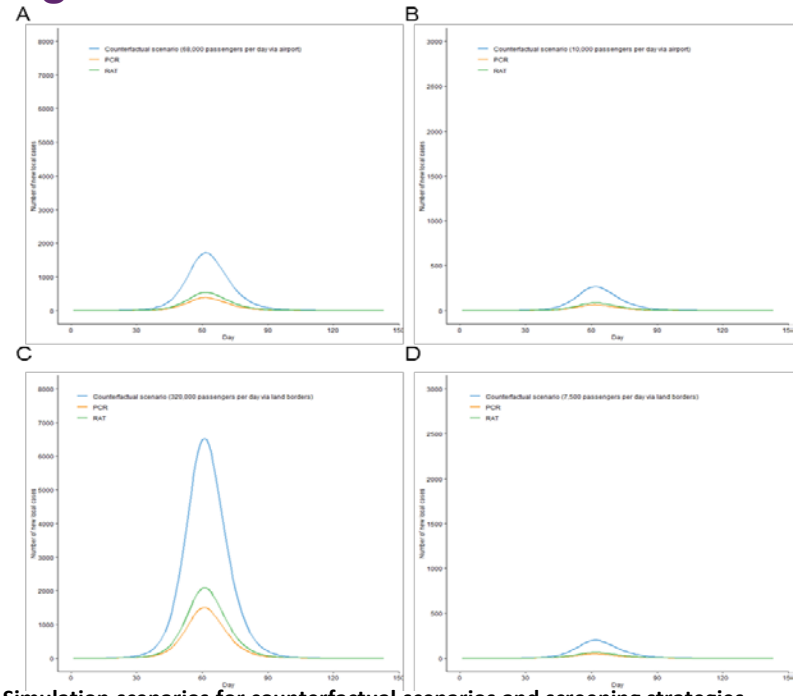
- Eateries and Workplaces - highest probability
- Party, LTC/healthcare, Shopping - higher probability

Chong et al. Characterization of unlinked cases of COVID-19 for an implication on contact tracing measures. (To Submit)

Systemic dynamic modelling

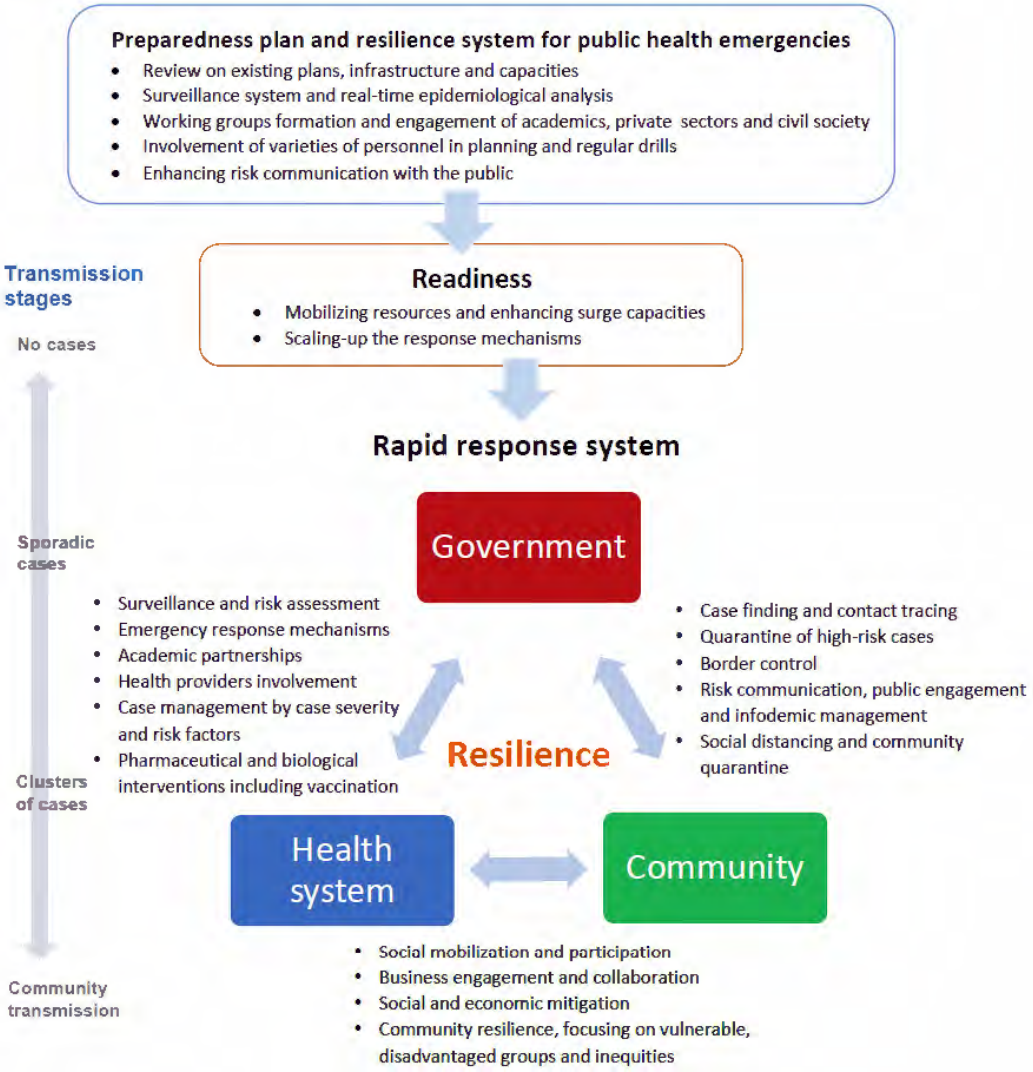
Assessing the risk of local COVID-19 outbreaks among different border screening strategies and inbound passenger volume

- The simulation suggested that both PCR (with a 7-day quarantine) and rapid antigen test screening for inbound travelers are insufficient to control local transmissions at travel volumes in 2019.
- However, travel volumes at the lower level, 1 month before the entry ban of all countries can be controlled.



Simulation scenarios for counterfactual scenarios and screening strategies.
(A) Daily number of inbound travellers via airports was fixed as 68,000 per day (i.e. an average value in 2019) and (B) 10,000 per day (i.e. an average value over a month before compulsory entry ban from all oversea countries). (C) Similar distribution of imported infection was assumed for cases entering via land borders. The daily number of inbound travellers via land borders was fixed as 320,000 per day (i.e. an average value in 2019) and (D) 7,500 per day (i.e. an average value over a month before compulsory entry ban from all oversea countries).

Development of an Enhanced S-EDAR


Preparedness plan and resilience system for public health emergencies
Review on existing plans, infrastructure and capacities
Surveillance system and real-time epidemiological analysis
Working groups formation and engagement of academics, private sectors and civil society
Involvement of varieties of personnel in planning and regular drills
Enhancing risk communication with the public
Transmission stages
No cases
Sporadic cases
Clusters of cases
Community transmission
Readiness
Mobilizing resources and enhancing surge capacities
Scaling-up the response mechanisms
Rapid response system
Government
Surveillance and risk assessment
Emergency response mechanisms
Academic partnerships
Health providers involvement
Case management by case severity and risk factors
Pharmaceutical and biological interventions including vaccination
Case finding and contact tracing
Quarantine of high-risk cases
Border control
Risk communication, public engagement and infodemic management
Social distancing and community quarantine
Resilience
Health system
Community
Social mobilization and participation
Business engagement and collaboration
Social and economic mitigation
Community resilience, focusing on vulnerable, disadvantaged groups and inequities

Implementation strategies based on key informants from Government, academic, healthcare and community sectors, plus WHO documents

Preparedness plan and system for public health emergencies	**Review on existing infrastructure and capacities** ❖ Evaluate and update the contingency plan which was based on SARS experience and influenza H1N1 ❖ Review on the gaps between the existing plan and the real responses during the process ❖ Legislation to be reviewed to suit the future outbreak other than COVID ❖ Review on CHP's function and capacities ❖ Resources for CHP should be expanded ❖ Review on the format, frequency and scale of regular drills ❖ Enhance the "incident management system capacity" with tra ❖ Focus on health security enabling a potential capacity to proc ❖ Review on logistics support, legislation, scientific assessmen Service Provision **Surveillance system and real-time epidemiological analysis** ❖ To develop a real-time assessment on pandemic situation an ❖ Information system to be linked across different units for loca ❖ A basic framework for a preparedness plan which could be m Hong Kong experiences ❖ Simulated scenarios, with different scale of outbreaks and le incorporated ❖ Modelling to guide the control within the scientific expert grou ❖ Existing surveillance systems should be reviewed for identify transmission phases (3) ❖ Data from laboratories should be used routinely for surveillar **Working group formation and engagement of academic sect** ❖ Improvement of the current funding system for the research : ❖ Investigation of resources for mobilization in the community, ❖ Formation of a working group to conduct meetings, fine-tune following the updates and guidelines of Public Health Emerg ❖ Assembly of a scientific expert group with structure of input f government administrators, e.g. Diagnostic Test Service Prov **Involvement of varieties of personnel in planning and regula** ❖ Involvement of more people across government departments

	❖ Engaging more people inside and outside the government in participation of the drills which should be carried out more frequently ❖ Examination on how to make personnel familiar with the plans despite personnel change ❖ Regular tabletop drills to cover all the possible scenarios and relate to higher level of decision-making ❖ Engagement of the highest level of government officials in the drills ❖ **Promoting risk communication with the public** ❖ Public education to enhance risk communication ❖ Provide easy-to-understand messages to the public
Readiness	❖ Priority plan for allocation of resources in different scenario ❖ Figure out the process how to triage the patients with different level of care provided and how to redeploy or provide further training for the available manpower ❖ More frequent communication with experts in universities, in addition to medical experts included in the government ❖ Ensure availability of all sectors and multi-sectoral coordination mechanisms to facilitate a whole-of-society approach (3) ❖ An all-hazards response plan for guiding the health sector to work with other sectors (3) ❖ Healthcare facility plans and business continuity plans to supplement the generic response plan (3) ❖ Ensure authority and clarity of sector and agency roles and responsibilities through legislation, interagency agreements and operating procedures (3) ❖ Conduct simulation exercises to test for surge capacity, and with participation in external quality assessment programmes (3)

Response system	**Government level**	**Health system level**	**Community level**
Emergency response mechanisms	❖ Interdepartmental plan ❖ Regular exercise drills in CHP twice a year ❖ Development of a mechanism like the one used in "Typhoon signals" ❖ Inclusion of the private sector in preparedness plan ❖ Hardware preparedness including quarantine facilities, testing centres, temporary treatment facilities	❖ 3-tier response system in public hospitals ❖ Response plans in all private hospitals on infectious diseases as required in ACHS accreditation ❖ Staff training forum and digital assistance to frontline healthcare staff ❖ Continual update of infection control guidelines	❖ A pool of trained personnel in contact tracing ❖ A pool of community quarantine sites (over 30 hotels) for inbound travelers quarantine

	other infectious disease, instructed by CCIDER ❖ Automated system of DH's database to facilitate timely analysis and sharing of data (3) ❖ A mechanism to be developed to correlate different kind of surveillance systems, with experts responsible to detect unusual signals, make further assessment and carry out relevant control	❖ Legal empowerment of doctor to issue compulsory testing direction (Cap 599J) ❖ Regular testing for staff and visitors in a private hospital ❖ Mandatory testing when hospital transmission occurred ❖ Training field epidemiologists (3)	❖ Outbreak analysis for risk assessment ❖ Using environmental surveillance data (e.g. sewage data) to determine site of enhanced surveillance and testing ❖ Bring home tests in supermarkets to be regulated ❖ Repeated testing every 14 days for high-risk occupation, such as catering service, schools, frontline health staff ❖ ❖ A community-based event surveillance system in different community settings of religious, schools, long term care facilities, public utilizes and NGOs. Reporting can be reached via hotlines, websites and healthcare facilities (4)

Conclusion

- The Enhanced S-EDAR will be a resilient evolutionary system for public health emergencies to enable preparedness, readiness and timely response to the rapidly changing transmission scenarios in the control of COVID-19 and the dynamic context emerging infectious diseases.

- The validity & comprehensiveness will be assessed by international experts.

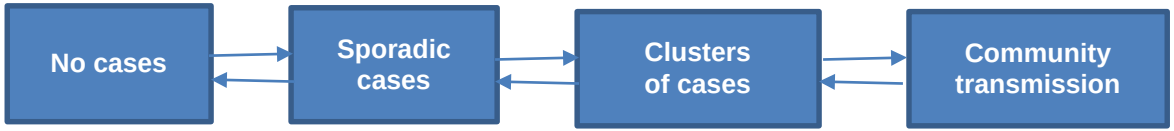
- Its feasibility and applicability will be scrutinized in the Delphi survey of local experts.

HMRF COVID-19 3-year study

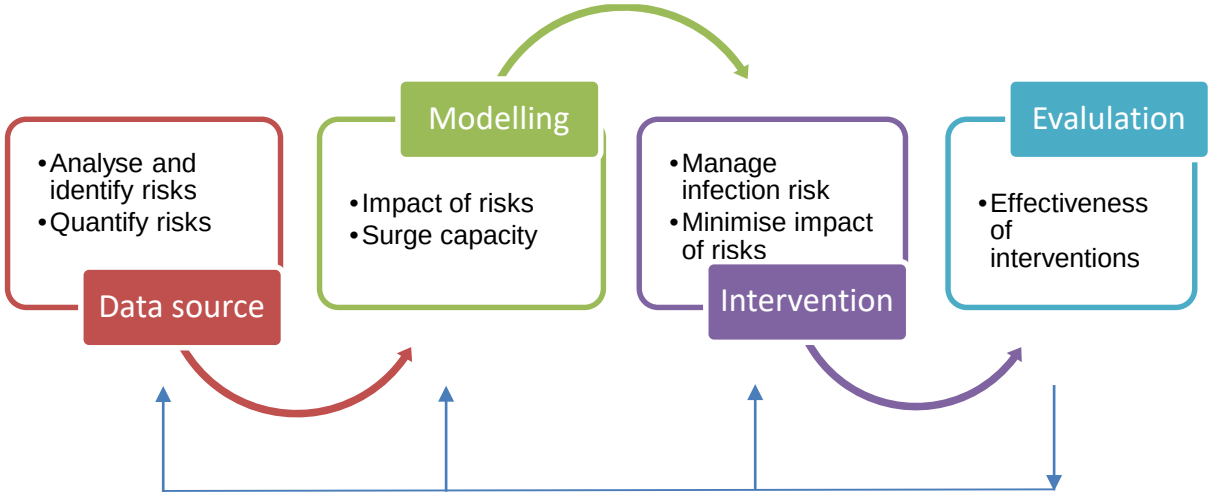
Epidemic Intelligence and a data informed risk assessment system to inform policy decisions critical for maintaining systems control of COVID-19 in strategies to enhance recovery

SARS-CoV2 Endemicity and Health System Resilience

Different transmission stages of the epidemic



Evidence gaps – Epidemic intelligence



Covid-19 Risk Assessment Framework