Impact of community mental health services on the adult psychiatric admission through the emergency unit: a 20-year population-based study

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Summary

Background There is a lack of real-life population-based study examining the effect of community mental health services on psychiatric emergency admission. In Hong Kong, Integrated Community Center for Mental Wellness (ICCMW) and telecare service were introduced in 2009 and 2012, respectively. We examined the real-life impact of these services on psychiatric emergency admissions over 20 years.

Methods Number of psychiatric emergency admissions between 2001 and 2020 was retrieved from the Hong Kong Clinical Data Analysis & Reporting System. We used an interrupted time series analysis to examine monthly psychiatric admission trend before and after service implementation, considering socioeconomic and environmental covariates.

Findings A total of 108,492 psychiatric emergency admissions (47.8% males; 64.9% aged 18–44 years) were identified from the study period, of which 56,858, 12,506, 12,295, 11,791, and 15,051 were that for schizophrenia-spectrum disorders, bipolar affective disorders, unipolar mood disorders, neuroses, and substance use disorders. ICCMW introduction has an immediate effect on psychiatric emergency admission (adjusted estimate per 100,000: −10.576; 95% CI, −16.635 to −4.518, $p < 0.001$), particularly among adults aged 18–44 years (−8.543; 95% CI, −13.209 to −3.877, $p < 0.001$), females (−5.843; 95% CI, −9.647 to −2.039, $p = 0.003$), and with neuroses (−3.373; 95% CI, −5.187 to −1.560, $p < 0.001$), without a significant long-term effect. Unemployment, seasonality, and infectious disease outbreak were significant covariates.

Interpretation ICCMW reduced psychiatric emergency admission, but no further reduction following full implementation. Community mental health services should be dynamically tailored for different populations and socioeconomic variations over time.

Funding None.

Keywords: Psychiatric emergency admission; Unemployment; Pandemic; Community mental health services; Seasonality

Introduction

The deinstitutionalisation movement has been evolving since the 1950s in the UK, US, Australia, and other high-income countries, promoting psychiatric service users' reintegration into the community to facilitate recovery. Studies have reported the beneficial impact of

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Research in context

Evidence before this study

Community mental health care may reduce psychiatric emergency admission. We searched PubMed for research articles in English, published between 1 January 2002 and 31 December 2021, using the search terms [public mental health (tiab) OR community mental health (tiab)] AND [psychiatric admission (tiab) OR psychiatric hospitalization (tiab) OR hospital admission (tiab) OR hospital visit (tiab) OR relapse (tiab)]. Most outcome studies of community mental health initiatives included home-based treatment and assertive community treatment, and most were carried out in Western countries. A few of them reported the outcome of hospital admission, and three systematic reviews revealed that the effect of community mental health programmes on hospital admission was equivocal. Most previous studies targeted people with severe mental illnesses, and only a few studies reported the effectiveness of community mental health centres. No real-life population-based studies have done to exam in the immediate and long-term impact of territory-wide community mental health service implementation.

Added value of this study

This is the first population-based study to examine the effect of territory-wide community mental health services on psychiatric emergency admission over a 20-year period, considering key socioeconomic and environmental factors. This study highlighted the differential effect of the current community mental health service model on the psychiatric emergency admission of different age, gender and diagnosis groups, as well as the significant independent effect of socioeconomic and environmental factors on the psychiatric emergency admission.

Implications of all the available evidence

Community mental health care as part of a deinstitutionalization movement has some evidence of impacts in reducing psychiatric emergency admission, although the impacts can be enhanced by more nuanced design. Governments should plan, review, and update their community mental health development strategies dynamically tailored for the needs of different populations and socioeconomic variations over time.

the integrated community mental health service model in improving psychiatric symptoms.[1] However, the evidence to support the community mental health team approach was inconclusive, especially for outcomes of hospital admission and relapse.[2–4] Psychiatric emergency admission has been considered as one of the quality indicators of community mental health services,[5,6] because of its possible proxy indication of illness severity as well as relapse of psychiatric illnesses.[7–9] A US study revealed that after receiving a year of service from a community mental health integrated care centre, the number of psychiatric admissions of severe mental illnesses was reduced by 18%.[10] Similar finding was also reported in Chile, with at most of a 21% reduction in psychiatric emergency visits after establishing community mental health services.[11] Some studies have also reported on the effect of the integrated community mental health service on both general and psychiatric hospital admission reduction.[10,11] However, an earlier review did not find community mental health team reducing emergency psychiatric admission.[2] A more recent review on intensive case management for severe mental illnesses found very low-to moderate-quality evidence only on reduced hospitalisation.[3] Another recent review found no association between community mental health nursing care service and psychiatric admission among people with severe mental illnesses.[4] To the best of our knowledge, no studies have examined the immediate and long-term effect of community mental health service implementation on psychiatric hospital admission at the population level.

In Hong Kong, the Hospital Authority provided the majority of acute and extended psychiatric care. A deinstitutionalisation movement had begun in the early part of the millennium and has been continued in the last two decades.[12] A territory-wide, publicly funded, one-stop Integrated Community Centre for Mental Wellness (ICCMW) programme was introduced in 2009,[13,14] followed by the introduction of a 24-h mental health hotline service Mental Health Direct (MHD) operated by the Hospital Authority centrally in 2012.[15] ICCMWs provide multidisciplinary support, drop-in services, day training/psychoeducation, peer support services, counselling, and specialist referral services to discharged service users, people at-risk of mental illness, and their family members. Each centre has seventeen social workers, two psychiatric nurses, one occupational therapist, and six supporting staff to offer community psychiatric support and non-pharmacological care in their living districts.[16] MHD traces patients who default psychiatric out-patient appointments, supports appointment scheduling, answers enquiries, and provides telecare for discharged service users and family caregivers to help community reintegration. There is some evidence on improving depressive and anxiety symptoms, expanding social network and support with the implementation of the ICCMW service.[17,18] Evidence of the immediate and long-term impacts of ICCMWs and MHD on psychiatric admission is lacking, particularly admissions through the Accident and Emergency unit as these admissions are usually unplanned and representing presence of an

urgent need. Multiple factors may contribute to the variation of the psychiatric emergency admission, including socioeconomic and environmental factors, including unemployment rate,[19–21] social unrest,[22] seasonality,[23,24] infectious disease outbreaks,[25–28] and availability of hospital beds as well as the community supported accommodation/hostel services.[29–31] The impact of these factors on the psychiatric emergency admission may be particularly prominent over a long period of time. Therefore, a comprehensive and ecological understanding of the impact of community mental health services on the psychiatric emergency admission over a long-period of time can only be appreciated by examining a population-based data and taking into the consideration of these socioeconomic and environmental factors.

The current study aimed to examine the impacts of the introduction of integrated community mental health services, including both the ICCMWs and MHD, on psychiatric emergency admission, taking into consideration of the longitudinal variations of the relevant socioeconomic and environmental factors, using population-representative data over 20 years in Hong Kong. There have been multiple major socioeconomic events occurred in Hong Kong in the past 20 years including severe acute respiratory syndrome (SARS) in 2003 and coronavirus disease 2019 (COVID-19) pandemic in 2020, several major social unrest periods and the period of economic fluctuation. The unique impact of these factors as well as seasonality and changes of numbers of psychiatric inpatient beds and community rehabilitation beds on the psychiatric emergency admission over this period will also be explored.

Methods

Study design

This is a retrospective longitudinal population-based study utilising the electronic health records over 20 years (January 2001–December 2020) in Hong Kong.

Data sources

Adult psychiatric emergency admission

Anonymous psychiatric emergency admission data was retrieved from the public sector healthcare Clinical Data Analysis and Reporting System (CDARS), an electronic medical database of all the public hospitals governed by the Hospital Authority which is the only institution providing psychiatric inpatient care in Hong Kong. CDARS has been used in other cost-effectiveness and population-based studies,[32–34] including longitudinal research on self-harm outcome of psychiatric diagnoses.[35] Information of psychiatric emergency admission of adults aged from 18 to 64 years and with a principal diagnosis by International Classification Diseases tenth revision of schizophrenia-spectrum disorders (F20–F29), bipolar affective disorders (F30, F31), unipolar mood disorders (F32–39), neuroses (F40–48), or substance use disorders (F10–19), and without comorbidity of learning disabilities (F70–79), organic or neurological disorders (F00–F09) between January 2001 and December 2020 were obtained from the CDARS. Information of age, gender and psychiatric diagnoses upon admission were obtained for the subgroup analyses. The age group was divided into younger (18–44 years old) and older adults (45–64 years old), the cut-off of age 45 was used as it is the median age of Hong Kong population.[36] Diagnostic groups explored including schizophrenia-spectrum disorders, bipolar affective disorders, substance use disorders, neuroses, and unipolar mood disorders.

Community mental health interventions

The pilot period of the ICCMW service was from March 2009 to September 2010 where it was introduced in one administrative district out of 18 in Hong Kong (covers 15% of overall population) and the territory-wide implementation was in October 2010.[13,14] The MHD service was introduced in January 2012.[15] Since the ICCMW and MHD service periods overlapped from January 2012 onwards, we defined four exposure periods in the current analysis; pre-intervention period (Jan 2001–Feb 2009), ICCMW pilot period (March 2009–September 2010), ICCMW period (October 2010–December 2011), and ICCMW and MHD period (January 2012–December 2020). These four periods represented the development of the two territory-wide community mental health intervention programmes in Hong Kong.

Sociopolitical and environmental factors

The unemployment rate, consumer price index, number of psychiatric hospital beds and number of community psychiatric rehabilitation beds were retrieved from the statistical reports from the Census and Statistics Department and the Hospital Authority.[37] Determination of seasonality was based on the Hong Kong Observatory, and four seasons, spring (March–May), summer (June–August), autumn (September–November), and winter (December–February) are categorised in a year.[38] Social unrest periods were identified based on the occurrence of large-scale social events lasting for three months or more. There were three social unrest events identified over the 20-year period, including the Moral and National Education Protest (July–September 2012), Umbrella Revolution (September–December 2014), and Anti-Extradition Law Amendment Bill Movement (March–December 2019).[39,40] Infection outbreak periods were determined based on occurrence of life-threatening infectious disease epidemics, in which two outbreaks, SARS (March–June 2003) and COVID-19 (January–December 2020, the end of data collection for this study).

Statistical analysis

All variables of the 20-year period (January 2001–December 2020) were collected and treated as monthly data units, as this data unit is commonly available for all variables and would provide a reasonable time resolution over the 20-year-period. To allow international comparisons and monitor population changes over 20 years,[41–43] the number of psychiatric beds, community rehabilitation beds, and the number of psychiatric emergency admissions were converted into the concerned numbers per 100,000 population according to local census data (2001–2020).[44] The unemployment rate was found to have a 12-month lead effect on the psychiatric emergency admission in the cross-correlation plot and subsequent lagged regression in the current study.[45] Therefore, the unemployment rate of year 2000 was post-hoc retrieved and a new dataset with the preceding 12-month unemployment rate was created to perform the statistical analysis. An interrupted time series (ITS) multiple linear segmented regression was used with four time-segments to examine the association between territory-wide community mental health interventions (ICCMW and MHD services) and the number of psychiatric emergency admission.[46] The establishment of the ICCMW centres was based on the administrative district. The emergency hospital admissions, however, depends on where the incidence occur. Therefore, aggregate territory-wide emergency psychiatric admission data was used in the current study. Given the substantial duration of the pilot ICCMW, this was considered as one of the four time-segments in the analysis. Both mental health services were assumed to have immediate and continuous effects on psychiatric emergency admissions, and thereby using both step change and slope change models of ITS to estimate the impact of the interventions.[47] The associations between unemployment rate, social unrest events, infectious disease outbreaks, number of psychiatric beds, number of community rehabilitation beds, and the number of psychiatric admissions were examined first. Secondly, seasonal factor was added to the regression to adjust for the seasonality effect using a time stratified model.[48] Finally, the ICCMW and MHD service periods were added to examine the associations between the implementation of these services and the number of psychiatric emergency admission across the 20-year period. Subgroup analyses by age (18–44 and 45–64), gender (male and female), and diagnoses (F20–F29, F30–F31, F32–F39, F40–F48, and F10–F19) were done by repeating the aforesaid regressions of using psychiatric emergency admission of the respective subgroups. Model assumptions including normality, linearity, and homoscedasticity were checked by visual inspections of the residual plot of the fitted model. Moreover, the residuals over time plots were produced to examine the stationarity of the pre-intervention period and the whole period (Figs. S1 and S2). Augmented Dickey–Fuller test was also used to confirm that there was no unit root or that the models were stationary ($p < 0.01$). Autocorrelation was checked by Breusch–Godfrey test with visual inspection of the autocorrelation plot (ACF) ($p = 0.476$). Besides, our preliminary analysis identified a sharp increase of community psychiatric rehabilitation beds and a reduction of psychiatric hospital beds occurred between 2006 and mid-2009, and then remained largely steady subsequently. In this context, a sensitivity analysis was carried out by changing the number of psychiatric beds and community rehabilitation beds into categorical variables based on these beds-to-population ratios. Moreover, a lagged regression was run to rule out the possible delayed exposure effect of ICCMW service on psychiatric emergency admission. Akaike Information Criterion (AIC) was used to compare the models of best fit to the data.[49] Model with an additional parameter would be only selected when the reduction of AIC is greater than a value of two, and otherwise, the uninformative parameters should be excluded.[50] Another sensitivity analysis was also conducted to examine the stability of the ICCMW effect after removing the pilot ICCMW period. To reduce Type I error from multiple testing, Bonferroni correction was used.[51] The Bonferroni-corrected significance level of models with sixteen variables [two continuous variables and four categorical variables with three to four levels each] was 0.0031 (0.05/16 = 0.0031) for the primary outcome. The number of psychiatric emergency admission per 100,000 population was computed and its 95% confidence intervals were imputed. A plot with a regression line was produced to clearly illustrate the adjusted effect of territory-wide community mental health interventions across 20 years on psychiatric emergency admission. All the statistical inferences and plots were computed and produced by R language. This report was prepared in accordance with the RECORD statement.[52] Ethics approval of the study was obtained from the University of Hong Kong/Hospital Authority Hong Kong West Cluster Institutional Review Board (UW20-854).

Role of the funding source

None.

Results

A total of 108,492 psychiatric emergency admission, of which 56,858 (52.4%), 12,506 (11.5%), 12,295 (11.3%), 11,791 (10.9%), and 15,051 (13.9%) were for schizophrenia-spectrum disorders, bipolar affective disorders, mood disorders, neuroses, and substance use disorders, respectively were identified between 1 January 2001 and 31 December 2020. 47.8% and were males and 64.9% were aged 18–44. The descriptive data of the continuous explanatory and outcome variables were summarised in Table S1. The relationship between

the preceding 12-month unemployment rate and psychiatric emergency admissions was plotted in Fig. S3. The relationship between numbers of community rehabilitation beds and psychiatric emergency admission was plotted in Fig. S4. The relationship between numbers of psychiatric hospital beds and psychiatric emergency admission was plotted in Fig. S5. The trend of psychiatric emergency admission was projectile, increasing since mid-2003, peaking in mid-2006, and decreasing to a stable phase in 2009, and it became steady until the COVID-19 outbreak in 2020, when a dramatic reduction in psychiatric emergency admission was seen.

Main findings

The number of psychiatric emergency admission across 20-year in Hong Kong was plotted in Fig. 1. The significant covariates included 12-month lead unemployment rate, seasonality, infectious disease outbreaks, and the number of community rehabilitation beds. The number of psychiatric hospital beds (AIC = 261.18), consumer price index (AIC = 253.13), and social unrest events (AIC = 262.99) were not significant and were excluded from the primary model based on significantly higher AIC. After adjustment of these factors, a regression line was produced to illustrate the trend of psychiatric emergency admission.

In Table 1, the associations between the explanatory variables and psychiatric emergency admission were listed.

The immediate effect (adjusted estimate = 6.195, 95% CI = 2.314, 10.076, p = 0.002) and long-term effect (adjusted estimate = –0.066, 95% CI = –0.102, –0.030, p < 0.001) of pilot ICCMW were statistically significant but in opposite magnitude. In addition, the immediate effect of ICCMW service on reduction of psychiatric emergency admission was statistically significant (adjusted estimate = –10.576, 95% CI = –16.635, –4.518, p < 0.001), whereas the long-term effect of ICCMW service was not, suggesting the number of psychiatric emergency admission did not significantly decrease further. The ICCMW and MHD service (overlapping period) had also no further reduction effect on overall psychiatric emergency admission. The goodness-of-fit of the model was satisfactory (adjusted R^2 = 0.739, p < 0.001), and this model explains 73.9% of the variability in the number of psychiatric emergency admission. The findings of the model of sensitivity analysis were in the same direction with similar magnitude (Table S2). The immediate effect of ICCMW service was alike to that of the primary model (adjusted estimate = –9.666, 95% CI = –15.821, –3.511, p = 0.002), and the long-term effect was also statistically insignificant. The goodness-of-fit of the model of sensitivity analysis was comparable with that of the primary model (adjusted R^2 = 0.728, p < 0.001), but with a significantly higher AIC value (Table S2). The possible delayed effect of the pilot ICCMW and ICCMW with 1–6 months was also examined with lagged regressions (Figs. S6 and S7), and no significant associations between the lagged variables and the outcome were found. The AICs of these models ranged from 252.38 to 258.45, which were not 2 AIC lower than that of the original one (AIC: 253.38) and were rejected. In addition, another sensitivity analysis, in which the pilot ICCMW period was removed, we found the same direction in both short- and long-term

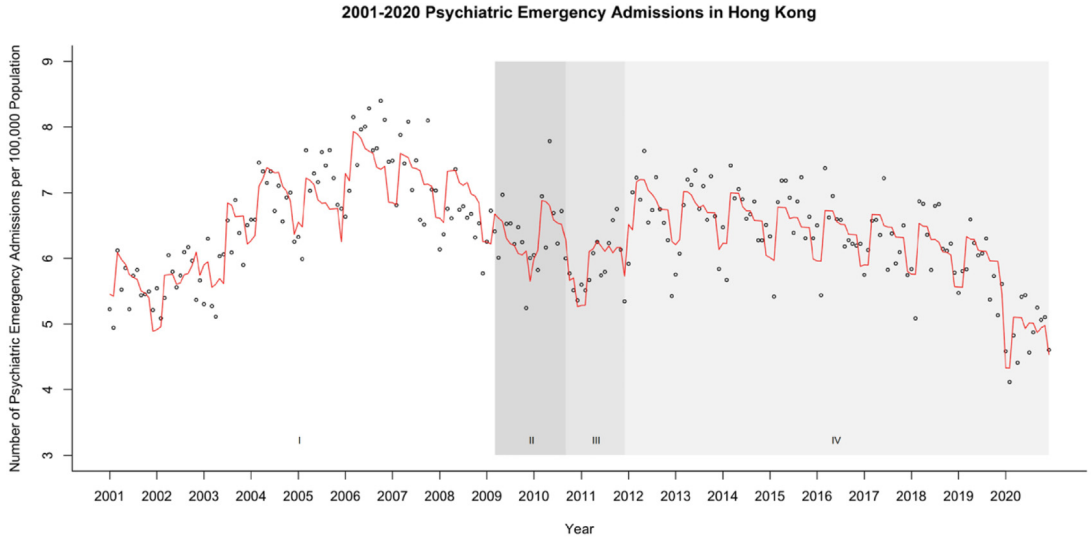

***Fig. 1:* 2001–2020 psychiatric emergency admission per 100,000 population**. Circles = observed number of admission; solid red line = modelled number of admission fitted to the data. Unshaded area I = pre-intervention period; Grey shaded area II = pilot ICCMW service period; Grey shaded area III = ICCMW service period; Grey shaded area IV = ICCMW and MHD service period.

	Adjusted estimate	95% CI	P value
12-month lead unemployment rate	0.389	(0.314, 0.464)	**<0.001**
Seasonal factor			
Spring	Reference group		
Summer	−0.159	(−0.305, −0.012)	0.034
Autumn	−0.300	(−0.449, −0.152)	**<0.001**
Winter	−0.778	(−0.925, −0.631)	**<0.001**
Infectious disease outbreak			
Absence	Reference group		
SARS	−1.246	(−1.667, −0.825)	**<0.001**
COVID-19	−1.298	(−1.599, −0.998)	**<0.001**
Community psychiatric rehabilitation beds per 100,000 population	0.161	(0.107, 0.214)	**<0.001**
Step change of community mental health services			
Absence	Reference group		
Pilot ICCMW service	6.195	(2.314, 10.076)	**0.002**
ICCMW service	−10.576	(−16.635, −4.518)	**<0.001**
ICCMW and MHD service	1.021	(0.148, 1.893)	0.022
Slope change of community mental health services			
Pilot ICCMW service	−0.066	(−0.102, −0.030)	**<0.001**
ICCMW service	0.072	(0.023, 0.121)	0.004
ICCMW and MHD service	−0.010	(−0.018, −0.003)	0.009
	Adjusted R^2		**P value**
Fitted Model	0.739		**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = 2019 Coronavirus disease; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Large-scale social events were not statistically significant for overall psychiatric emergency hospitalization and was excluded from the model; the Eta-squared (η2) of the unemployment rate and rehabilitation bed number is 0.20 [0.12, 0.29] and 0.42 [0.33, 0.50] respectively; Bonferroni-corrected threshold of this model was 0.0031. The Akaike Information Criterion value of this model was 253.38. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 1: **Associations between exploratory variables and overall psychiatric emergency admission across twenty years in Hong Kong based on ITS.**

intervention effect of ICCMW on psychiatric emergency admissions, with a slightly more long-term effect of the full ICCMW on increase psychiatric emergency admission (Fig. S8 and Table S3). Besides, in Table 1, the findings suggested that the 12-month lead unemployment rate was positively associated with psychiatric emergency admission (adjusted estimate = 0.389, 95% CI = 0.314, 0.464, $p < 0.001$), while autumn (adjusted estimate = –0.300, 95% CI = –0.449, –0.152, $p < 0.001$), winter (adjusted estimate = –0.778, 95% CI = –0.925, –0.631, $p < 0.001$), SARS (adjusted estimate = –1.246, 95% CI = –1.667, –0.825, $p < 0.001$), and COVID-19 (adjusted estimate = –1.298, 95% CI = –1.599, –0.998, $p < 0.001$) were negatively associated with the psychiatric emergency admission.

Subgroup analyses

The subgroup analyses by age, gender, and diagnoses were summarised in Tables 2–6.

Age and gender effects

The associations between infectious disease outbreaks, unemployment rate and psychiatric emergency admission of all age and gender groups were significant (Tables 2 and 3). Autumn and winter were significantly associated with reduced psychiatric emergency admissions of all age and gender groups, except that of males. Psychiatric emergency admission of males was not significantly associated with autumn (adjusted estimate = –0.121, 95% CI = –0.213, –0.029, $p = 0.01$), in which the significance level did not pass the threshold of the Bonferroni correction of 0.0031 (Table 2). Moreover, the immediate effect of ICCMW service on reducing psychiatric emergency admission was significant in younger adults (adjusted estimate = –8.543, 95% CI = –13.209, –3.877, $p < 0.001$) and females (adjusted estimate = –5.843, 95% CI = –9.647, –2.039, $p = 0.003$) but not for older adults (adjusted estimate = –2.033, 95% CI = –5.015, –0.948, $p = 0.180$) and males (adjusted estimate = –4.733, 95% CI = –8.492, –0.975, $p = 0.014$). However, the long-term effect of ICCMW service on psychiatric emergency admission was only observed in younger adults with an opposite direction (adjusted estimate = 0.060, 95% CI = 0.022, 0.098, $p = 0.002$). Furthermore, the immediate effect of ICCMW and MHD services was positively associated with admissions of females and older adults, but the long-term effect was negatively associated with admissions of females and older adults. There was no effect of ICCMW and MHD services on admissions of males and younger adults. The goodness-of-fit of models of younger adults (adjusted $R^2 = 0.771$, $p < 0.001$) and of older adults

	Adjusted estimate	95% CI	P value	Adjusted estimate	95% CI	P value
	Younger adults (18–44)			Older adults (45–64)		
12-month lead unemployment rate	0.279	(0.222, 0.337)	**<0.001**	0.110	(0.073, 0.146)	**<0.001**
Seasonal factor						
Spring	Reference group					
Summer	−0.156	(−0.269, −0.043)	0.007	−0.002	(−0.074, −0.070)	0.946
Autumn	−0.190	(−0.305, −0.076)	**0.001**	−0.110	(−0.183, −0.037)	**0.003**
Winter	−0.537	(−0.650, −0.423)	**<0.001**	−0.241	(−0.313, −0.169)	**<0.001**
Infectious disease outbreak						
Absence	Reference group					
SARS	−0.931	(−1.256, −0.607)	**<0.001**	−0.314	(−0.522, −0.107)	**0.003**
COVID-19	−0.804	(−1.036, −0.573)	**<0.001**	−0.494	(−0.642, −0.346)	**<0.001**
Community psychiatric rehabilitation beds per 100,000 population	0.099	(0.058, 0.140)	**<0.001**	0.061	(0.035, 0.087)	**<0.001**
Step change of community mental health services						
Absence	Reference group					
Pilot ICCMW service	4.629	(1.640, 7.618)	**0.003**	1.566	(−0.344, 3.476)	0.108
ICCMW service	−8.543	(−13.209, −3.877)	**<0.001**	−2.033	(−5.015, 0.948)	0.180
ICCMW and MHD service	0.366	(−0.306, 1.038)	0.285	0.655	(0.226, 1.085)	**0.003**
Slope change of community mental health services						
Pilot ICCMW service	−0.049	(−0.076, −0.021)	**<0.001**	−0.017	(−0.035, 0.000)	0.056
ICCMW service	0.060	(0.022, 0.098)	**0.002**	0.012	(−0.012, 0.036)	0.318
ICCMW and MHD service	−0.004	(−0.010, −0.002)	0.176	−0.006	(−0.010, −0.002)	**0.001**
	Adjusted R^2		**P value**	**Adjusted R^2**		**P value**
Fitted Model	0.771		**<0.001**	0.755		**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = 2019 Coronavirus disease; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Large-scale social events were not statistically significant for overall psychiatric emergency admissions and was excluded from the model. Bonferroni-corrected thresholds of these models were 0.0031. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 2: **Associations between exploratory variables and overall psychiatric emergency admission across twenty years in Hong Kong based on ITS, by age group.**

(adjusted R^2 = 0.755, p < 0.001) were comparable. However, the goodness-of-fit of the model of males (adjusted R^2 = 0.550, p < 0.001) was lower than that of females (adjusted R^2 = 0.725, p < 0.001), which suggested that data for admission of males was moderately fitted to the model.

Effect of psychiatric diagnoses

The immediate effect of pilot ICCMW service was positively associated with psychiatric emergency admission of unipolar mood disorders (adjusted estimate = 1.816, 95% CI = 0.692, 2.941, p = 0.002), whereas the long-term effect was negatively associated (adjusted estimate = –0.018, 95% CI = –0.028, –0.007, p < 0.001) (Table 5). Moreover, the immediate effect of ICCMW service was negatively associated with admission of neuroses (adjusted estimate = –3.373, 95% CI = –5.187, –1.560, p < 0.001), but the long-term effect was positively associated (adjusted estimate = 0.025, 95% CI = 0.011, 0.040, p < 0.001) (Table 5). However, the goodness-of-fit of the models of unipolar mood disorders (adjusted R^2 = 0.494, p < 0.001) and neuroses (adjusted R^2 = 0.454, p < 0.001) were modest. Furthermore, the immediate effect of ICCMW and MHD services was positively associated with admission of substance use disorders (adjusted estimate = 1.016, 95% CI = 0.811, 1.221, p < 0.001), whereas the long-term effect was negative (adjusted estimate = –0.007, 95% CI = –0.008, –0.005, p < 0.001) (Table 6). There were no significant immediate and long-term intervention effects of community mental health interventions on psychiatric emergency admissions for patients with schizophrenia-spectrum disorders and bipolar affective disorders (Table 4).

Besides, there were great variations between the fitted models by diagnoses. Among five diagnoses, only psychiatric emergency admission of bipolar affective disorders was not associated with seasonality (Table 4). Significant decreases in psychiatric emergency admissions in winter were observed for all conditions, apart from that of bipolar affective disorders. Only psychiatric emergency admission of schizophrenia-spectrum disorders was associated with both the SARS and COVID-19 outbreaks (Table 4). Emergency admissions of bipolar affective disorders, unipolar mood disorders, and substance use disorders were associated with COVID-19 outbreak (Tables 4–6), whereas that of neuroses was associated with SARS (Table 5). Only emergency admission of substance use disorders was not associated with 12-month lead unemployment rate (Table 6). In addition, only admission of substance use disorders was not positively associated with the number

	Adjusted estimate	95% CI	P value	Adjusted estimate	95% CI	P value
	Males			Females		
12-month lead unemployment rate	0.156	(0.109, 0.202)	**<0.001**	0.233	(0.186, 0.280)	**<0.001**
Seasonal factor						
Spring	Reference group					
Summer	−0.061	(−0.152, −0.029)	0.184	−0.097	(−0.189, −0.005)	0.038
Autumn	−0.121	(−0.213, −0.029)	0.010	−0.180	(−0.273, −0.086)	**<0.001**
Winter	−0.351	(−0.442, −0.260)	**<0.001**	−0.427	(−0.519, −0.335)	**<0.001**
Infectious disease outbreak						
Absence	Reference group					
SARS	−0.404	(−0.666, −0.143)	**0.003**	−0.841	(− 1.106, −0.577)	**<0.001**
COVID-19	−0.513	(−0.699, −0.326)	**<0.001**	−0.786	(−0.974, −0.597)	**<0.001**
Community psychiatric rehabilitation beds per 100,000 population	0.068	(0.035, 0.101)	**<0.001**	0.093	(0.059, 0.126)	**<0.001**
Step change of community mental health services						
Absence	Reference group					
Pilot ICCMW service	2.610	(0.203, 5.018)	0.034	3.585	(1.148, 6.022)	0.004
ICCMW service	−4.733	(−8.492, −0.975)	0.014	−5.843	(−9.647, −2.039)	**0.003**
ICCMW and MHD service	0.121	(−0.420, 0.662)	0.660	0.900	(0.352, 1.448)	**0.001**
Slope change of community mental health services						
Pilot ICCMW service	−0.028	(−0.050, −0.006)	0.013	−0.038	(−0.060, −0.015)	**0.001**
ICCMW service	0.033	(0.002, 0.063)	0.034	0.040	(0.009, 0.070)	0.012
ICCMW and MHD service	−0.002	(−0.007, 0.003)	0.443	−0.009	(−0.013, −0.004)	**<0.001**
	Adjusted R^2		**P value**	**Adjusted R^2**		**P value**
Fitted Model	0.550		**<0.001**	0.725		**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = 2019 Coronavirus disease; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Large-scale social events were not statistically significant for overall psychiatric emergency admissions and was excluded from the model. Bonferroni-corrected thresholds of these models were 0.0031. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 3: **Associations between exploratory variables and overall psychiatric emergency admission across twenty years in Hong Kong based on ITS, by gender.**

of community psychiatric rehabilitation beds (Table 6). Only that of unipolar mood disorders were associated with large-scale social events, although it finally could not pass the threshold of the Bonferroni correction of this model (p = 0.0025) (Table 5). Psychiatric emergency admission of schizophrenia-spectrum disorders was the most susceptible to seasonality among the five diagnoses (Table 4). It was negatively associated with summer (adjusted estimate = −0.145, 95% CI = −0.235, −0.055, p = 0.002), autumn (adjusted estimate = −0.223, 95% CI = −0.314, −0.132, p < 0.001), and winter (adjusted estimate = −0.383, 95% CI = −0.474, −0.293, p < 0.001). Admission of individuals with the other four diagnoses was only negatively associated with winter. Moreover, the goodness-of-fit of the model of schizophrenia-spectrum disorders (adjusted R^2 = 0.674, p < 0.001) was the highest among that of the other four diagnoses, which suggested that the admission of schizophrenia-spectrum disorders could be better explained by the model.

Discussion

To the best of our knowledge, this is the first population-based study to examine the effect of territory-wide community mental health services on psychiatric emergency admission over a 20-year period considering key socioeconomic and environmental factors, to provide a real-world perspective of the effect of the clinical service development. The findings revealed that 12-month lead unemployment rate, seasonality, and infectious disease outbreaks were significantly associated with psychiatric emergency admission. After adjusting for these covariates, the immediate effect of ICCMW service was significant in reducing the number of psychiatric emergency admission. However, there was no further reduction following the full-service implementation. There was no effect on psychiatric emergency admission with the addition of a 24-h hotline service. There were differential impacts of these programs on the psychiatric emergency admission with populations of different gender, age, and diagnoses: the current service has possible benefits for people who are younger, females, and adults with neuroses, but not for those who are older, males, and adults with schizophrenia-spectrum, bipolar affective disorders, unipolar mood disorders, and substance use disorders.

Though the ICCMW and MHD differ from the community psychiatric services that are part of the tertiary psychiatric care, our findings on the effect of the standalone community psychiatric centres on hospitalisation add to the current literature on the effect of community psychiatric services on preventing

	Adjusted estimate	95% CI	P value	Adjusted estimate	95% CI	P value
	Schizophrenia-spectrum disorders			Bipolar affective disorders		
12-month lead unemployment rate	0.134	(0.088, 0.180)	**<0.001**	0.044	(0.025, 0.064)	**<0.001**
Seasonal factor						
Spring	Reference group					
Summer	−0.145	(−0.235, −0.055)	**0.002**	NS		
Autumn	−0.223	(−0.314, −0.132)	**<0.001**			
Winter	−0.383	(−0.474, −0.293)	**<0.001**			
Infectious disease outbreak						
Absence	Reference group					
SARS	−0.442	(−0.701, −0.183)	**<0.001**	−0.152	(−0.261, −0.044)	0.006
COVID-19	−0.628	(−0.813, −0.443)	**<0.001**	−0.179	(−0.257, −0.101)	**<0.001**
Community psychiatric rehabilitation beds per 100,000 population	0.068	(0.035, 0.101)	**<0.001**	0.021	(0.007, 0.035)	**0.003**
Step change of community mental health services						
Absence	Reference group					
Pilot ICCMW service	2.568	(0.180, 4.955)	0.035	0.531	(−0.474, 1.536)	0.299
ICCMW service	−5.047	(−8.774, −1.320)	0.008	−0.196	(−1.770, 1.378)	0.806
ICCMW and MHD service	−0.219	(−0.756, 0.318)	0.422	−0.109	(−0.336, 0.117)	0.341
Slope change of community mental health services						
Pilot ICCMW service	−0.028	(−0.049, −0.006)	0.014	−0.006	(−0.015, 0.004)	0.223
ICCMW service	0.034	(0.004, 0.064)	0.026	0.001	(−0.012, 0.013)	0.913
ICCMW and MHD service	−0.002	(−0.007, 0.003)	0.475	0.000	(−0.002, 0.002)	0.880
	Adjusted R^2		**P value**	**Adjusted R^2**		**P value**
Fitted Model	0.674		**<0.001**	0.318		**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = Coronavirus disease 2019; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Large-scale social events was not statistically significant for these psychiatric emergency admissions and was excluded from the model; Seasonal factor was not statistically significant for emergency admission of bipolar affective disorders and was excluded from the model; NS=Not significant; Bonferroni-corrected thresholds of models of schizophrenia-spectrum disorders and bipolar affective disorders were 0.0031 and 0.0042. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 4: **Associations between exploratory variables and psychiatric emergency admissions of schizophrenia and bipolar affective disorders across twenty years in Hong Kong based on ITS.**

hospitalisation in general.[2–4] Our findings revealed that the immediate effect of ICCMW could greatly reduce psychiatric emergency admission, with lack of obvious long-term effect. In fact, in the sensitivity analysis by removing the pilot ICCMW period, we found a slight effect of full ICCMW on increase of admission. Furthermore, both the immediate and long-term effects of ICCMW and MHD services had no further reduction on psychiatric emergency admission, which may be explained by the floor effect of community-based mental health interventions. ICCMW or MHD is largely a referral-based community service model, where service provision depends on patients or their caregivers or other gatekeepers to reach out to the service. Improvement of patient identification might be a major impact of the services and might explain for the lack of further reduction of psychiatric emergency admission or even an increase. Our finding also suggested that this community service model may be helpful for a specific group of patients who are younger, female, or with neuroses. It is possible that these populations tend to be proactive in their help-seeking to manage their mental health conditions. Furthermore, these population may also be more amenable to community mental health care. Service users with severe psychiatric illnesses such as schizophrenia and bipolar affective disorders, however, tend to have compromised insight into their illness,[53] and likely to have relatively inactive or indirect help-seeking actions.[54] Recent quasi-experimental findings suggested that both generic community psychiatric service and assertive community treatment may help reduce the re-hospitalisation risk of people with severe mental illnesses, who may have more complex service needs.[55,56] Furthermore, compared to females, males are also more hesitant in reaching out to others when facing mental health difficulties.[57] Reluctance or inability to reaching out to others and poor mental health literacy may also be barriers of help-seeking for older population. Inequality in access to health-care related information and knowledge might also be a difficulty for older population to receive community mental health service.[58] On the other hand, younger people with first-episode psychosis might be benefiting more intensive specialized community psychiatric service. Local study has revealed that an early intervention programme for first-episode psychosis of age 15 to 25 could reduce the number of psychiatric re-hospitalisation.[59] Therefore, the community psychiatric services should be tailored to

	Adjusted estimate	95% CI	P value	Adjusted estimate	95% CI	P value
	Unipolar mood disorders			Neuroses		
12-month lead unemployment rate	0.086	(0.064, 0.108)	**<0.001**	0.080	(0.057, 0.102)	**<0.001**
Seasonal factor						
Spring	Reference group					
Summer	−0.014	(−0.056, −0.029)	0.529	−0.036	(−0.008, −0.080)	0.106
Autumn	−0.019	(−0.062, −0.025)	0.404	−0.010	(−0.034, −0.055)	0.644
Winter	−0.130	(−0.173, −0.087)	**<0.001**	−0.106	(−0.150, −0.062)	**<0.001**
Infectious disease outbreak						
Absence	Reference group					
SARS	−0.172	(−0.294, −0.050)	0.006	−0.245	(−0.371, −0.119)	**<0.001**
COVID-19	−0.214	(−0.310, −0.118)	**<0.001**	−0.123	(−0.213, −0.034)	0.007
Social events						
Absence	Reference group					
Moral and National Education Protest	0.099	(−0.043, 0.024)	0.172	NS		
Umbrella Revolution	−0.040	(−0.160, 0.080)	0.514			
Anti-Extradition Law Amendment Bill Movement	−0.117	(−0.208, −0.026)	0.012			
Community psychiatric rehabilitation beds per 100,000 population	0.020	(0.004, 0.035)	0.012	0.036	(0.020, 0.052)	**<0.001**
Step change of community mental health services						
Absence	Reference group					
Pilot ICCMW service	1.816	(0.692, 2.941)	**0.002**	1.255	(0.093, 2.416)	0.034
ICCMW service	−0.197	(−1.952, −1.557)	0.825	−3.373	(−5.187, −1.560)	**<0.001**
ICCMW and MHD service	−0.247	(−0.028, 0.052)	0.078	−0.143	(−0.118, 0.405)	0.280
Slope change of community mental health services						
Pilot ICCMW service	−0.018	(−0.028, −0.007)	**<0.001**	−0.013	(−0.024, −0.002)	0.018
ICCMW service	0.000	(−0.014, 0.014)	0.961	0.025	(0.011, 0.040)	**<0.001**
ICCMW and MHD service	−0.002	(−0.005, −0.001)	0.048	−0.001	(−0.003, 0.001)	0.411
	Adjusted R^2		**P value**	**Adjusted R^2**		**P value**
Fitted Model	0.494		**<0.001**	0.454		**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = Coronavirus disease 2019; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Large-scale social events was not statistically significant for psychiatric emergency admission of neuroses and was excluded from the model; NS=Not significant; Bonferroni-corrected thresholds of models of unipolar mood disorders and neuroses were 0.0025 and 0.0031. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 5: **Associations between exploratory variables and psychiatric emergency admission of unipolar mood disorders and neuroses across twenty years in Hong Kong based on ITS.**

the different help-seeking characteristics of different population groups.

In the current study, unemployment rate, seasonality, and infectious disease outbreak were significantly associated with psychiatric emergency admission. These results were consistent with the existing literature. In Australia, time series studies found that the monthly unemployment rate was positively associated with psychiatric emergency visits,[19] and psychiatric hospital admission of substance abuse.[20] It was also found in the US that the yearly unemployment rate was positively associated with alcohol abuse.[21] In Denmark, it revealed that compared with healthy adults, long-term unemployment of adults in a preceding year would have about 70% higher risk to have first psychiatric admission.[60] In Italy, a significant association was also found between one year preceding unemployment rate and admission of adults with major depressive disorder.[61] The finding of this study suggested that one-year preceding unemployment rate was positively associated with all subgroups of psychiatric admissions, except for substance use disorders. Unemployment is an adjustment process that results in income loss, reduced social contact and interaction, accompanied by stress, anxiety, identity crisis, and stigma of working ability,[60,61] which may explain its negative effect on mental state and leading to illness onset or relapse and subsequent psychiatric admissions. This highlighted the close link between the economic status of the society and mental wellbeing of the population and thus the significance of ensuring stable employment and calling for targeted investment of government to mental health service during the economic downturn.

Our findings indicated that when compared with spring, winter could lead to reductions in psychiatric emergency admissions of all diagnoses, except that of bipolar affective disorders. Furthermore, all the other three seasons had lower emergency admission of schizophrenia-spectrum disorders than that in spring. The research findings across the globe suggested that

	Adjusted estimate	95% CI	P value
	Substance use disorders		
12-month lead unemployment rate	0.031	(0.009, 0.054)	0.006
Seasonal factor			
Spring	Reference group		
Summer	−0.023	(−0.075, 0.029)	0.375
Autumn	−0.039	(−0.092, −0.013)	0.141
Winter	−0.117	(−0.170, −0.065)	**<0.001**
Infectious disease outbreak			
Absence	Reference group		
SARS	−0.213	(−0.363, −0.062)	0.006
COVID-19	−0.185	(−0.288, −0.082)	**<0.001**
Step change of community mental health services			
Absence	Reference group		
Pilot ICCMW service	−0.164	(−1.519, 1.191)	0.812
ICCMW service	−1.453	(−3.578, 0.671)	0.179
ICCMW and MHD service	1.016	(0.811, 1.221)	**<0.001**
Slope change of community mental health services			
Pilot ICCMW service	−0.001	(−0.013, 0.012)	0.917
ICCMW service	0.009	(−0.008, 0.026)	0.282
ICCMW and MHD service	−0.007	(−0.008, −0.005)	**<0.001**
		Adjusted R^2	**P value**
Fitted Model		0.606	**<0.001**

SARS=Severe Acute Respiratory Syndrome; COVID19 = Coronavirus disease 2019; ICCMW=Integrated Community Centre of Mental Wellness; MHD = Mental Health Direct; ITS = interrupted time series; Number of community psychiatric rehabilitation beds and large-scale social events were not statistically significant for emergency admission of substance use disorder and were excluded from the model; Bonferroni-corrected thresholds of model of substance use disorders was 0.0033. Bold indicate p values that have passed the Bonferroni-corrected threshold of the model.

Table 6: **Associations between exploratory variables and psychiatric emergency admission of substance use disorders across twenty years in Hong Kong based on ITS.**

ambient temperature was one of the important meteorological variables explaining the seasonal factor on psychiatric emergency admissions. Higher daily temperature or heat wave was significantly associated with increased psychiatric emergency admissions or visits.[23,62–66] Moreover, the COVID-19 pandemic significantly reduced psychiatric admission in Spain,[24] Germany,[25] and Italy.[26,27] In our previous study, both SARS and COVID-19 outbreaks were found to significantly reduce psychiatric admission.[67] In this study, both SARS and COVID-19 outbreaks were also significantly associated with reduced psychiatric emergency admission. It was suggested that the help-seeking behaviours of service users changed, as they may be afraid of infection by coronavirus at hospitals and stayed away from hospitals regardless of their medical needs.[68,69] All these above findings highlighted the significant influence of socioeconomic and environmental factors on psychiatric emergency admission. Governments should regularly review psychiatric service provision and mental health policy, including inpatient and emergency psychiatric service as well as the community psychiatric service to be tailored to the societal changes.

There were several merits of this research study. Firstly, the psychiatric admission data covered the whole region of Hong Kong over 20 year period, comprising two hundred and forty timepoints (months) as a longitudinal analysis, substantially more than what has been reported.[70–72] Secondly, the interrupted time series analysis took account of both step change and slope change models in the effectiveness of community mental health interventions on psychiatric emergency admission, allowing the observation of both the immediate and long-term impact of these interventions.[47] Thirdly, several important covariates including community rehabilitation psychiatric beds, seasonality, and infectious disease outbreaks were regressed into the analysis to make the findings more precise and relevant to the real-world setting. The numeric explanatory variables were standardised by biannual population size (per 100,000 population) to control for the temporal change of population across 20 years. Finally, the Bonferroni correction and sensitivity analysis were carried out to ensure the direction and validity of the final model. However, results should still be interpreted by taking the limitations into consideration. Firstly, the actual number of reduced psychiatric emergency admission was underestimated, as the admission data only included five main diagnoses of mental illnesses and excluded comorbidity of learning disabilities,

organic or neurological disorders hospitalised during the captured period.[73] Secondly, due to the assumption of both step change and slope change models, the counterfactual plot without either ICCMW or MHD service could not be produced to clearly illustrate the impact of these services in a diagram. However, this assumption was more realistic and appropriate for public mental health policy and the possible presence of lagged effect as well as the waning effect.[49] Thirdly, the impact of possible other community mental health programmes was not taken into consideration in this study.[74] Fourthly, the Gini coefficient, an economic inequality index of the society, was not included in our analysis as it was only reported every five years in Hong Kong population census reports. And there was no open source of this Hong Kong data in the World Bank. In addition, the Gini coefficients were steady over time, which may not, therefore, be a confounding variable. In 2001, 2006, 2011, and 2016, the coefficients were 0.525, 0.533, 0.537, and 0.539.[75] Finally, the COVID-19 outbreak in Hong Kong has not ended in 2020 and the subsequent impact of infectious disease outbreak on psychiatric emergency admission could not be estimated. Further research can be initiated to follow up on this missing period and may use weekly timepoint with a control group to investigate the COVID-19 impact on psychiatric emergency admission.[48]

Conclusion

Community mental health care as part of a deinstitutionalisation movement has some evidence of impacts in reducing psychiatric emergency admission, although the impacts can be enhanced by more nuanced service design, considering age, gender, diagnosis, and socioeconomic and environmental factors. In Hong Kong, ICCMW is serving around 330,000 catchment population,[13] with an estimated expenditure of US$ 54.7 million, about 3.2 times of that in 2010 upon service commencement.[76] Future development will see increasingly complex collaborative design. In the UK, for example, National Health Service proposed a new framework for adult community mental health services in 2019, in which it coordinates, collaborates, and builds community connections with different community stakeholders such as education, housing, and social services to maintain and improve primary and secondary mental health care at a local community level of 30,000 to 50,000 residents or wider community level of 250,000 to 500,000 residents for more complex cases.[77] World Psychiatric Association supported more collaboration between hospitals, NGOs, and primary care in East and South East Asia.[78,79] Governments should plan, review, and update the community mental health strategies, with coordinated service taking into consideration help-seeking behaviours of different population groups and socioeconomic and environmental changes of the society.

Contributors

CFM formulated research questions, designed the study, analysed data, and prepared the manuscript drafts. SKWC formulated research questions, designed the study, analysed data, reviewed, and commented on all the manuscript drafts. Both CFM and SKWC have access to the data and verify the results. HL contributed statistical expert support. All authors reviewed and revised the manuscript and supported the interpretation of data and findings. All authors approved the final version of the manuscript. SKWC and CFM were responsible for the decision of paper submission.

Data sharing statement

The CDARS dataset is managed and protected by the Hospital Authority of Hong Kong. Hospital Authority Data Sharing Portal is open to share Hong Kong clinical data for research purpose upon successful application. The website (https://www3.ha.org.hk/data/Home/Index) is provided for more information.

Declaration of interests

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100814.

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