Fracture incidence and fracture-related mortality decreased with decreases in population mobility during the early days of the COVID-19 pandemic: an epidemiological study

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A B S T R A C T

Introduction: We investigated the impact of coronavirus disease 2019 (COVID-19) social distancing measures on fracture incidence and fracture-related mortality, as well as associations with population mobility.

Methods: In total, 47 186 fractures were analysed across 43 public hospitals from 22 November 2016 to 26 March 2020. Considering the smartphone penetration of 91.5% in the study population, population mobility was quantified using Apple Inc's Mobility Trends Report, an index of internet location services usage volume. Fracture incidences were compared between the first 62 days of social distancing measures and corresponding preceding epochs. Primary outcomes were associations between fracture incidence and population mobility, quantified by incidence rate ratios (IRRs). Secondary outcomes included fracture-related mortality rate (death within 30 days of fracture) and associations between emergency orthopaedic healthcare demand and population mobility.

Results: Overall, 1748 fewer fractures than projected were observed during the first 62 days of COVID-19 social distancing (fracture incidence: 321.9 vs 459.1 per 100 000 person-years, P<0.001); the relative risk was 0.690, compared with mean incidences during the same period in the previous 3 years. Population mobility exhibited significant associations with fracture incidence (IRR=1.0055, P<0.001), fracture-related emergency department attendances (IRR=1.0076, P<0.001), hospital admissions (IRR=1.0054, P<0.001), and subsequent surgery (IRR=1.0041, P<0.001). Fracture-related mortality decreased from 4.70 (in prior years) to 3.22 deaths per 100 000 person-years during the COVID-19 social distancing period (P<0.001).

Conclusion: Fracture incidence and fracture-related mortality decreased during the early days of the COVID-19 pandemic; they demonstrated significant temporal associations with daily population mobility, presumably as a collateral effect of social distancing measures.

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New knowledge added by this study

- A significant reduction in fracture incidence was observed during the early days of the coronavirus disease 2019 pandemic.
- Daily fracture incidence was temporally associated with population mobility.

Implications for clinical practice or policy

- Data regarding population mobility could facilitate estimation of fracture incidence and be used (along with many other factors) to estimate clinical service demand for timely management of public health responses involving changes in population mobility.
- As digital literacy increases, population digital usage patterns could support epidemiological investigations and address gaps in conventional data sources.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, which began in early 2020, has resulted in unprecedented large-scale public health responses. Stringent regional social distancing measures (eg, quarantine, school closures, and restrictions at work and recreation destinations) were rapidly implemented during the early days of

骨折發病率及與骨折有關的死亡率隨2019冠狀病毒病疫情初期人流趨勢下降而減少：流行病學研究

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引言：我們調查了2019冠狀病毒病的社交距離措施對骨折發病率及與骨折有關的死亡率的影響，以及與人流趨勢的關聯。

方法：本研究分析了43所公營醫院於2016年11月22日至2020年3月26日期間共47 186例骨折個案。考慮到研究群組的智能電話滲透率達91.5%，我們使用蘋果公司的人流趨勢報告（Mobility Trends Report），以這個互聯網定位服務使用流量指標量化人流趨勢。本研究比較了社交距離措施實施的首62日及早前相對應的同一時期之骨折發病率，主要結果是骨折發病率比率（IRR）及人流趨勢之間的關聯，次要結果包括與骨折有關的死亡率（在骨折後30日內死亡）及緊急骨科醫療保健需要與人流趨勢之間的關聯。

結果：整體而言，本研究發現，在2019冠狀病毒病的社交距離措施實施的首62日，骨折個案較預測數目少1748例（骨折發生率為每100 000人年321.9對比459.1，P<0.001）；與前三年同期的平均發病率比較，相對風險為0.690。人流趨勢與以下參數在統計學上有顯著關聯：骨折發病率（IRR=1.0055，P<0.001）、因骨折有關疾病到急症室求診（IRR=1.0076，P<0.001）、入院（IRR=1.0054，P<0.001）及後續手術（IRR=1.0041，P<0.001）。在2019冠狀病毒病的社交距離措施實施期間，與骨折有關的死亡率由每100 000人年4.70人（前三年）下降至3.22人（P<0.001）。

結論：骨折發病率及與骨折有關的死亡率在2019冠狀病毒病疫情初期減少；兩者與每日人流趨勢在時間上有顯著關聯，大概是受社交距離措施間接影響。

the pandemic as forms of non-pharmacological intervention.[1] Although there is evidence that such measures can temporarily contain the spread of severe acute respiratory syndrome coronavirus 2,[2] collateral effects among non–COVID-19–related conditions have also been reported.[3] Trauma is the leading cause of death and disability among young adults worldwide,[4] but the effects of the COVID-19 pandemic on injuries and fracture incidence within Hong Kong have not been fully elucidated. This uncertainty has hindered healthcare resource deployment and clinical service demand estimation in times of stringency. We sought to address this problem using 'big data' sources and regional clinical data repositories, which allow researchers to rapidly delineate epidemiological associations with potential applications in forecasting models, while avoiding resource-intensive collection of conventional epidemiological information and protecting patient anonymity.

We presumed that restrictions on citizen mobility, in concert with social distancing, were associated with reductions in musculoskeletal injuries during the early days of the COVID-19 pandemic. Specifically, we hypothesised that reduced population mobility was associated with reductions in fracture incidence and fracture-related healthcare needs during the early days of the pandemic. We investigated these relationships by analysing daily multicentre hospital data registries in Hong Kong, along with digital population mobility datasets published by a technology company. Our main outcome measurement was skeletal fractures, which served as a specific surrogate for musculoskeletal trauma.

Methods

Data collection

This study was conducted in Hong Kong, a high-income region (with gross domestic product per capita of HK$357 667 in 2020[5]) that was among the first areas affected by COVID-19; social distancing measures were implemented during the early days of the pandemic.

Using the Clinical Data Analysis and Reporting System of the Hospital Authority, anonymised patient records were retrieved from all 43 public hospitals in Hong Kong for the period from 22 November 2016 to 20 May 2020. In Hong Kong, up to 90% of hospital bed-days occur in public hospitals, which manage nearly all critical emergencies in the region.[6] Anonymised clinical data were retrieved, including time of initial injury presentation, emergency department triage, trauma category, hospital admission, diagnosis, and surgical procedures. Diagnoses and procedures were encoded in accordance with the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) by treating physicians based on clinical and radiological investigations, intraoperative findings, and date of hospital discharge. The ICD-9-CM codes that met the inclusion criteria (which included fractures under the purview or commonly admitted under the care of orthopaedic and traumatology service) were all codes from 805 to 829 (inclusive). Duplicate records from fracture reassessment related to follow-up attendances, hospitalisation after emergency department attendance, and elective hospital re-admissions (ie, episodes assigned to the same patient unique identifier with identical diagnostic codes, which occurred within 30 days of the index episode) were regarded as a single event to avoid double counting. Pathological fractures and records with missing diagnosis codes or admission times were excluded from the analysis.

Time intervals

The 'COVID-19 epoch' was defined as 25 January 2020 (activation of the government's 'emergency' response and commencement of social distancing policies[7]) to 26 March 2020; this arbitrarily chosen 62-day period included all patients with fractures who presented during that period. This epoch was compared with the 9 weeks preceding the onset of the COVID-19 pandemic (ie, 22 November 2019 to 24 January 2020), as well as the same period over the past 3 years to adjust for seasonality-related variations[8] (ie, 25 January to 26 March in 2017, 2018, and 2019). Differences between actual and projected daily fracture incidences were calculated based on mean values at the same time of year over the past 3 years. Fracture-related mortality rates, defined as the numbers of deaths within 30 days after initial fracture presentation per 100 000 person-years, were compared. The Chi squared test was used to detect differences in fracture incidence and fracture-related mortality during the COVID-19 pandemic and pre-pandemic epochs.

Quantifying population mobility

Surrogate data concerning population mobility were retrieved from Mobility Trends Reports[9]—an aggregate daily measure of geographical direction requests on Apple Maps, a service established by Apple Inc, which holds the largest market share of electronic mobile devices (including smartphones and tablets) in Hong Kong.[10] Walking index was regarded as an index of population mobility, considering the smartphone penetration of 91.5%[11] among the 7.50 million residents of Hong Kong.[12]

Data analysis

Associations between daily fracture incidence and population mobility were determined by incidence rate ratios (IRRs) using quasi-Poisson regression. Secondary analysis involved associations between mobility index and fracture repair surgeries, all types of orthopaedic emergency department attendances, orthopaedic hospital admissions, and emergency orthopaedic surgeries.

Because medical records were timestamped in Hong Kong time (8 hours ahead of Greenwich Mean Time), they were converted to Pacific Time to match the time intervals listed in Mobility Trends Reports; this conversion ensured that data were temporally matched for analysis.

To determine whether mobility associations simply reflected health-seeking behaviour, we included analyses of diseases which lacked a physiological basis and were not associated with population mobility—these 'controls' included appendicitis, cellulitis, and abscess (ICD-9-CM diagnosis codes 540 and 682). Statistical analysis was performed using R software, version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria). Quasi-Poisson regression was used to model the relationship between the population mobility index and the daily incidences of fractures and fracture-related events; the population mobility index was the explanatory variable, whereas the daily incidences of various events were response variables. A quasi-Poisson distribution was preferred over a Poisson distribution, considering the presence of significant overdispersion among some response variables (in the form of count data) when a dispersion parameter was included. In accordance with standard statistical methods, the natural logarithm was utilised as the link function. Incidence rate ratios were reported and represented by the following formula:

$$\text{Estimated incidence} = \text{IRR}^{\text{PMI}} \times \text{BIR}$$

where IRR represents the incidence rate ratio, PMI represents the population mobility index, and BIR represents the baseline incidence rate. The IRR, which quantifies the relationship between the mobility index and fracture incidence, is multiplicative in nature—for every unit increase in the mobility index, there is a corresponding multiplicative increase in the IRR. If the IRR is <1, it is expected to decrease in a multiplicative manner for every unit decrease in the mobility index. Multiple comparisons were adjusted by Bonferroni correction, and the threshold for statistical significance was regarded as $P<0.00227$ (0.05/22).

Results

In total, 59 931 fracture-related medical records from orthopaedic emergency department attendances, hospital admissions, and surgeries were reviewed. After exclusion of 11 498 linked episodes, 284 pathological fractures, 786 follow-up attendances, 175 hospital re-admissions, and two episodes with missing admission times, 47 186 fractures were included in the analysis. Descriptive statistics regarding daily fracture incidences, controls, and fracture-related surgeries during COVID-19 social distancing are shown in Table 1. Intra-year and inter-year comparison cohorts are presented in Table 2.

Fracture incidence during COVID-19 social distancing

A reduction of 1748 fractures in the actual versus projected incidence (321.9 vs 459.1 per 100 000 person-years, $P<0.001$) was observed during the COVID-19 epoch; the relative risk was 0.690 (95% confidence interval [CI]=0.678-0.702), compared with mean incidences in the previous 3 years (ie, inter-year cohort) [Table 2]. Differences in fracture incidence between the pandemic and pre-pandemic epochs are shown in Figure 1.

Fracture incidences, population mobilities, and controls are depicted in Figure 2. The first two COVID-19 cases in Hong Kong were reported on 23 January 2020[13]; three additional cases were reported on 24 January 2020. Social distancing measures were implemented on 25 January 2020; these included suspension of schools, initiation of 'work from home' measures among civil servants, and suspension of hospital visitations. Mandatory border quarantine was enforced on 8 February 2020. The sharpest decrease in mobility was observed on 24 January 2020; population mobility subsequently remained at low levels, in conjunction with cancellations of large-scale social and sporting events, as well as the imposition of travel restrictions with quarantine measures for returning travellers.[7]

TABLE 1. Incidences of fractures and surgeries during the early days of the coronavirus disease 2019 social distancing (25 January to 26 March 2020)

	Total	Daily incidence, median (interquartile range)	Mean incidence (per 100 000 person-years)
All fractures	4101	66 (61.3-73)	321.9
Upper limb fractures	1752	29 (24-32.8)	137.5
Clavicle fractures	114	2 (1-3)	8.9
Scapula fractures	15	0 (0-0)	1.2
Humerus fractures	359	6 (4-7)	28.2
Radius and ulna fractures	807	13 (10-16)	63.3
Hand and finger fractures	457	7 (6-9)	35.9
Spine fractures	191	3 (2-4)	15.0
Pelvic fractures	152	2 (1-3)	11.9
Lower limb fractures	2006	31.5 (28.3-37)	157.4
Hip and proximal femur fractures	945	15 (12.3-17.8)	74.2
Femur fractures (other than hip)	117	2 (1-3)	9.2
Patella fractures	163	3 (2-3)	12.8
Tibia and fibula fractures	176	2 (2-4)	13.8
Ankle fractures	224	4 (2-5)	17.6
Foot fractures	381	6 (4-8)	29.9
'Control' diseases for comparison			
Cellulitis	656	10 (8-13)	51.5
Abscess	687	10.5 (9-13.8)	53.9
Appendicitis	409	6 (5-8)	32.1
Operations for fractures	1723	27 (24-30.8)	135.2

Associations of fracture incidence with population mobility

Fracture incidence was positively associated with the population mobility index (IRR=1.0055, 95% CI=1.0044-1.0066, P<0.001). Analyses of fracture incidence according to anatomical location revealed associations of the population mobility index with upper limb fractures (IRR=1.0073, 95% CI=1.0057-1.0088, P<0.001) and lower limb fractures (IRR=1.0045, 95% CI=1.0030-1.0060, P<0.001) [Fig 3].

The population mobility index was associated with the incidences of fractures involving the radius and ulna (IRR=1.0079, 95% CI=1.0057-1.0101, P<0.001), hand and fingers (IRR=1.0069, 95% CI=1.0039-1.0098, P<0.001), femoral neck (IRR=1.0065, 95% CI=1.0035-1.0095, P<0.001), and tibia and fibula (IRR=1.0097, 95% CI=1.0044-1.0151, P<0.001) [Fig 4]. However, after Bonferroni correction, the population mobility index did not exhibit statistically significant associations with trochanteric hip fractures (IRR=1.0008, P=0.683), spine fractures (IRR=0.996, P=0.183), or pelvic fractures (IRR=1.0064, P=0.00799).

Stronger associations were observed among fractures, such that some patients presented at a younger age (eg, patients with tibia, fibula, hand, and finger fractures), whereas other patients presented at an older age (eg, patients with femoral neck fractures). Digital literacy, manual dexterity and visual acuity, and higher internet and smartphone usage among younger residents[11] are among the factors that cause the population mobility index to have increased sensitivity for analysis in such age-groups.

TABLE 2. Incidences of fractures before and during the early days of the coronavirus disease 2019 pandemic

	Total fractures	Daily fracture incidence, mean (interquartile range)	Incidence (per 100 000 person-years)	Percentage change in daily incidence from COVID-19 epoch	P value
COVID-19 epoch (25 Jan to 26 Mar 2020)	4101	66 (61.3-73)	321.9	-	-
Pre-COVID-19 epochs					
Intra-year cohort (22 Nov 2019 to 24 Jan 2020)	6591	106 (96.8-116.3)	501.2	-35.8%	<0.001
Inter-year cohort (same period over past 3 years)	17 373	95 (88-102)	459.1	-29.8%	<0.001
2017 (25 Jan to 26 Mar)	5938				
2018 (25 Jan to 26 Mar)	5803				
2019 (25 Jan to 26 Mar)	5632				

Abbreviation: COVID-19 = coronavirus disease 2019

The incidences of cellulitis, abscesses, and appendicitis were not associated with the population mobility index (P>0.00227). These findings support the hypothesis that changes in associations between fracture incidence and population mobility were not solely caused by changes in health-seeking behaviour; if they had been caused by changes in such behaviour, corresponding reductions in those conditions would have been observed.

Secondary exploratory analysis of surgeries, emergency department attendances, and hospital admissions

The daily population mobility index was associated with the number of patients admitted on a particular day who subsequently underwent fracture repair surgeries (IRR=1.0041, 95% CI=1.0020-1.0062, P<0.001). The population mobility index was also associated with all types of emergency orthopaedic surgeries (IRR=1.0040, 95% CI=1.0021-1.0058, P<0.001), attendances at orthopaedic emergency departments (IRR=1.0076, 95% CI 1.0064-1.0087, P<0.001), and emergency orthopaedic hospital admissions (IRR=1.0054, 95% CI=1.0043-1.0064, P<0.001). Additionally, the numbers of orthopaedic patients triaged as critical, emergent, and urgent (ie, patients who require physician attention within 30 minutes of attendance) were also associated with the population mobility index (IRR=1.0063, 95% CI=1.0054-1.0073, P<0.001). Whereas the numbers of traffic-related and sports-related trauma cases were associated with the population mobility index (IRR=1.008, 95% CI=1.0063-1.0097 and IRR=1.013, 95% CI=1.0092-1.0158, respectively, both P<0.001), the number of assault-related trauma cases was not (P=0.238).

Fracture-related mortality rate

Forty-nine patients with fractures died within 30 days of presentation during the COVID-19 epoch. This constituted a mortality rate of 3.22 deaths per 100 000 person-years, which was lower than the rate of 4.70 deaths per 100 000 person-years during the period before the pandemic (P<0.001); thus, there were around 19 fewer fracture-related deaths in the Hong Kong population during the 62-day study period. Four patients with fractures had COVID-19 (ie, they had positive results in nasopharyngeal swab reverse transcriptase-polymerase chain reaction tests for severe acute respiratory syndrome coronavirus 2) and survived beyond 30 days after initial fracture presentation. The change in mortality was presumably explained by reduced fracture incidence: 30-day mortality among patients with fractures did not significantly differ between the COVID-19 epoch (1.2%, 49 deaths in 4101 patients) and the preceding period (1.0%, 175 deaths in 17 198 patients) [P=0.305].

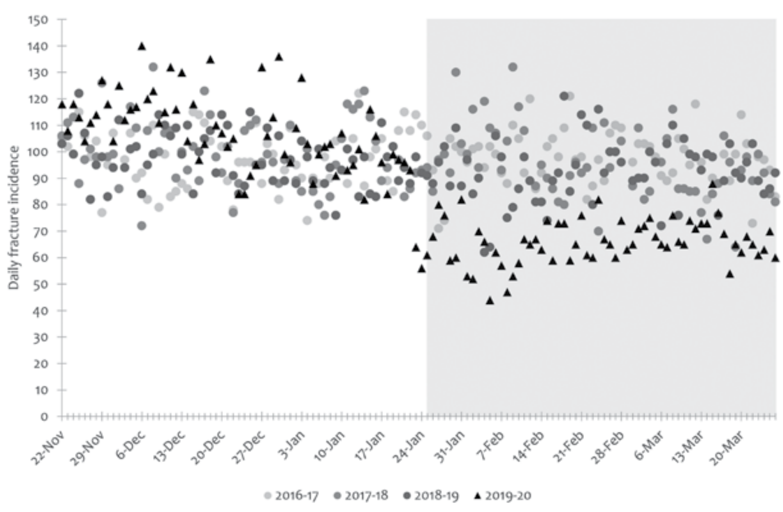

FIG 1. Daily fracture incidences (triangles) before (22 November 2019 to 24 January 2020) and during (25 January to 26 March 2020) the early days of coronavirus disease 2019 social distancing, with comparison to the same period in the previous 3 years (dots in different shades of grey). There were 1748 fewer fractures than projected

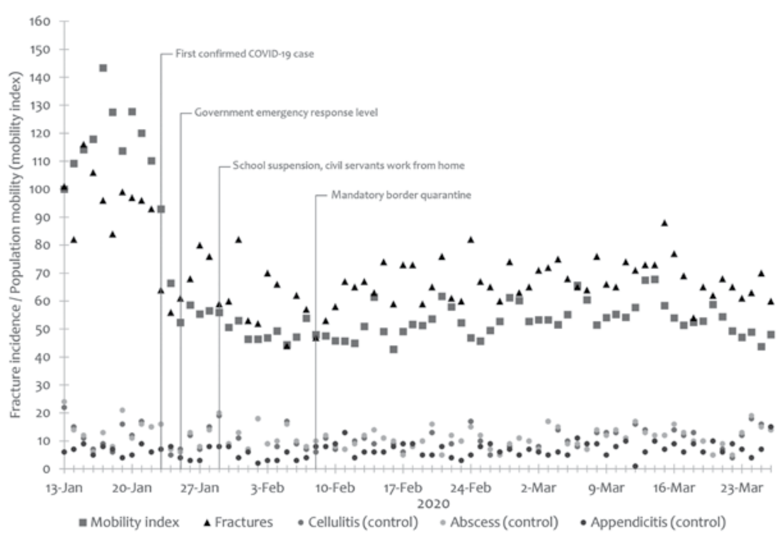

FIG 2. Fracture incidences, population mobilities (based on mobility index data from Apple Inc's Mobility Trend Reports), and controls over time in the study population. The largest decrease in population mobility coincided with the first confirmed case of coronavirus disease 2019 in Hong Kong
Abbreviation: COVID-19 = coronavirus disease 2019

Discussion

This study analysed 47 186 fractures in Hong Kong, prior to and during the early days of the COVID-19 pandemic. Population mobility was assessed through aggregate digital footprints using the volume of location service requests as a surrogate marker,

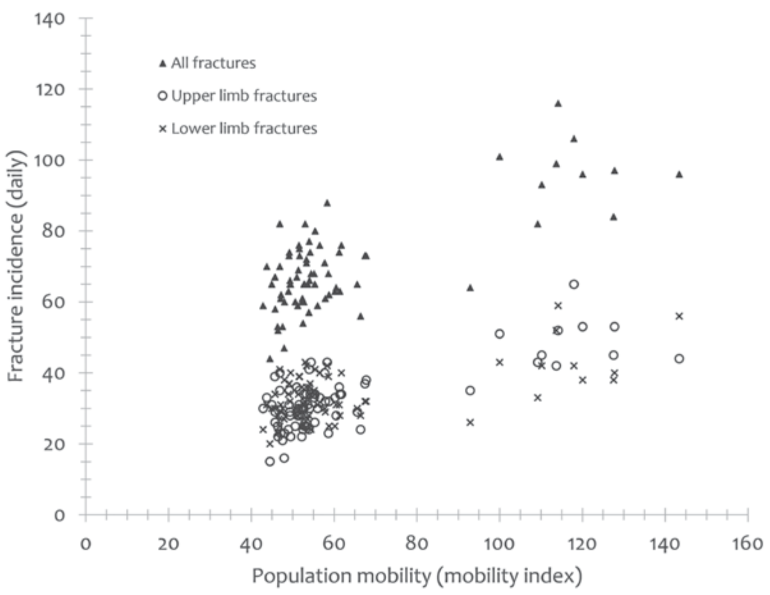

FIG 3. Associations of fracture incidence with population mobility. Fracture incidence was associated with mobility index according to quasi-Poisson regression, with incidence rate ratios of 1.0055 (95% confidence interval [CI]=1.0044-1.0066) for all fractures, 1.0073 (95% CI=1.0057-1.0088) for upper limb fractures, and 1.0045 (95% CI=1.0030-1.0060) for lower limb fractures (all P<0.001)

considering the high smartphone and internet penetration in Hong Kong[11]; importantly, datasets of aggregate digital footprints have been published to facilitate efforts to control COVID-19.[9] The findings support our hypothesis in terms of the relationship between fracture incidence and population mobility.

Fractures incur substantial healthcare costs; for example, fragility fracture-related costs incurred costs of 37.5 billion euros, along with the loss of 1.0 million quality-adjusted life years, among the six largest European countries in 2017.[14] Some fractures (eg, hip fractures) warrant early surgical management to mitigate the morbidity and mortality associated with surgical delays.[15] Guidance regarding early surgical management remained in effect, even during the early days of the COVID-19 pandemic.[16] Despite the best available tools, fracture prediction remains difficult; there are additional challenges associated with epidemiological projections of specific time points when such fractures occur. Accordingly, hospitals and public health entities experience difficulties in terms of estimating emergency trauma service load and allocating limited healthcare resources. Our findings suggest that population mobility indices, which are freely and publicly accessible, can provide insights regarding fracture

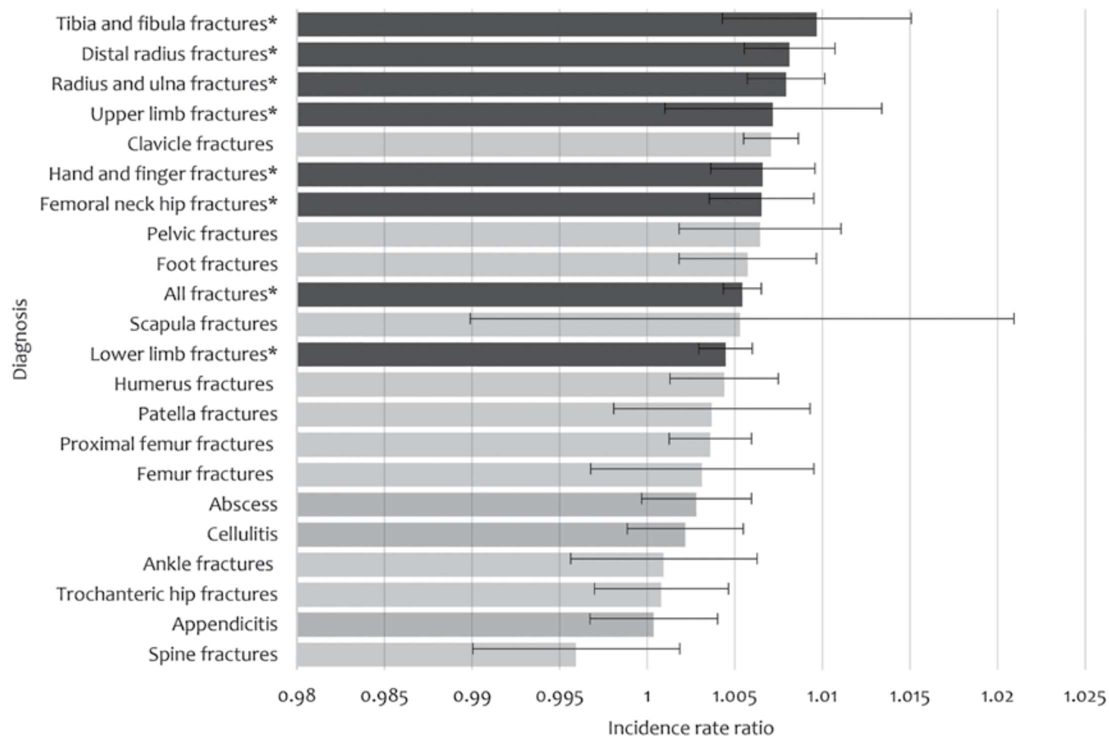

FIG 4. Incidence rate ratios indicating relationships between fracture incidence and population mobility index. Incidence rate ratios of fractures are grouped according to anatomical locations with 95% confidence intervals indicated on each bar. Bars in dark grey and asterisks in y-axis labels indicate statistically significant associations (P<0.00227). Note 'control groups' of diseases in grey, which were included to investigate possibility of confounding between mobility index and disease incidence by alterations in health-seeking behaviour; no statistically significant associations were present in these groups

incidence. Population mobility may be useful in quantitative modelling of fracture-related inpatient and surgical theatre service demand, using the IRRs described in this study.

Although there is evidence to support the efficacy of social distancing measures with respect to COVID-19 transmission,[2] our findings emphasise the collateral impacts of pandemic-related interventions on non-communicable diseases. We found that fracture incidence decreased when population mobility was hindered by social distancing measures; the relative reduction in overall fractures appeared to be similar to the effect of established pharmacological interventions on fragility fractures.[17] Although this relationship appears to contradict the common notion that physical activity confers a protective effect against fractures in both young and old age-groups,[18,19] associations of increased fracture risk with specific types of exercises (eg, bicycling), or regular participation in other exercise and sports activities, have been described.[20] Thus, long-term benefits (eg, increased bone mineral density) may be accrued at the expense of increased exposure to fracture risk when engaging in physical activity. Although the long-term impact of reduced population mobility on fracture incidence remains unclear, vitamin D deficiency caused by prolonged time indoors (ie, without sunlight exposure) is an established risk factor for future fractures.[21]

The strengths of our study include its inclusion of data from all public hospitals in Hong Kong, which allowed extensive analysis of rare events such as fractures. Our database has a high (>96%) positive predictive value for fractures,[22] presumably because data entry is conducted by impartial registered medical practitioners. Furthermore, high internet and smartphone penetration increased the sensitivity of the population mobility analysis, such that the mobility index was geographically specific to the study population. Pedestrian and road traffic densities, which are indirectly represented by the population mobility index, could also precipitate accidents, falls, and subsequent fracture risk. Additionally, potential confounding based on health-seeking behaviour was partially mitigated by the inclusion of 'control' groups. Fortunately, all hospitals involved in the study maintained full emergency service during the early days of the COVID-19 pandemic[23]; this maintenance of emergency service minimised potential confounding by hospitals that were unable to provide service to patients with fractures.

Limitations of the study involved deficiencies in the population mobility index. For example, travel between familiar places and travel where navigation guidance is unnecessary, as well as the usage of alternative electronic service providers, were not considered. Therefore, the population mobility index served as a more specific (rather than sensitive) tool for assessment of population mobility. Global positioning system (GPS)–based mobility tracking would theoretically allow more extensive data collection, thus providing greater detection sensitivity; however, such mobility tracking would cause substantial privacy issues, resulting in legal and ethical challenges.

Notably, older adults are less adept in smartphone usage (62.2% of residents aged ≥65 years reported internet usage in 2020[11]), and the digital population mobility index does not adequately illustrate this division in the population. Furthermore, fractures in older adults are largely caused by osteoporosis, whereas high-energy injury mechanisms are observed in younger individuals.[24] Therefore, social distancing may have a negligible effect on the incidences of osteoporotic fractures sustained indoors. We caution against using population mobility data as the sole source of estimates for health service planning because that approach could underestimate fragility fracture service demand.

Additionally, the use of fracture incidence data from a public healthcare database only included approximately 90% of the population health demand. During the early days of the COVID-19 pandemic, instances of diversion to the private sector, attendances in private clinics, and visits to alternative practitioners were not coded; the lack of these data may have led to underestimation of total fracture incidence. Finally, we caution against generalising these findings to regions with less internet and smartphone penetration.

Conclusion

During the early days of the COVID-19 pandemic, fracture incidence and fracture-related mortality considerably decreased with the implementation of government social distancing measures that targeted population mobility. This unique opportunity enabled the identification of collateral associations and revealed that population mobility could be used (along with many other factors) to estimate clinical service demand.

Author contributions

Concept or design: JSH Wong, DKH Yee.
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Analysis or interpretation of data: JSH Wong, ALH Lee, DKH Yee, CX Fang.
Drafting of the manuscript: JSH Wong, ALH Lee, CX Fang.
Critical revision of the manuscript for important intellectual content: CX Fang, DKH Yee, FKL Leung, KMC Cheung.

All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Ethics approval

Ethics approval was granted by the Institutional Review Board of The University of Hong Kong/ Hospital Authority Hong Kong West Cluster (HKU/HA HKW IRB Ref No.: UW 20-275), and investigations were carried out in accordance with the Declaration of Helsinki. The requirement for patient informed consent was waived by the Board because the study used anonymised data and the risk of identification was low.

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