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Original Article

Prevalence of sleep disturbances during COVID-19 outbreak in an urban Chinese population: a cross-sectional study



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ABSTRACT

Objective: The COVID-19 pandemic is a large-scale public health emergency that likely precipitated sleep disturbances in the community. This study aimed to investigate the prevalence and correlates of sleep disturbances during the early phase of COVID-19 pandemic.

Methods: This web-based cross-sectional study recruited 1138 Hong Kong adults using convenience sampling over a two-week period from 6th April 2020. The survey collected data on sleep disturbances, mood, stress, stock of infection control supplies, perceived risk of being infected by COVID-19, and sources for acquiring COVID-19 information. The participants were asked to compare their recent sleep and sleep before the outbreak. The Insomnia Severity Index (ISI) was used to assess their current insomnia severity. Prevalence was weighted according to 2016 population census.

Results: The weighted prevalence of worsened sleep quality, difficulty in sleep initiation, and shortened sleep duration since the outbreak were 38.3%, 29.8%, and 29.1%, respectively. The prevalence of current insomnia (ISI score of ≥ 10) was 29.9%. Insufficient stock of masks was significantly associated with worsened sleep quality, impaired sleep initiation, shortened sleep duration, and current insomnia in multivariate logistic regression (adjusted OR = 1.57, 1.72, 1.99, and 1.96 respectively, all $p < 0.05$).

Conclusion: A high proportion of people in Hong Kong felt that their sleep had worsened since the COVID-19 outbreak. Insufficient stock of masks was one of the risk factors that were associated with sleep disturbances. Adequate and stable supply of masks may play an important role to maintain the sleep health in the Hong Kong general population during a pandemic outbreak.

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1. Introduction

A novel coronavirus disease (COVID-19) was initially reported in China in December 2019. In a few months, the virus spread rapidly across the globe, and on 30 January 2020 the World Health Organization (WHO) declared the outbreak to be a Public Health Emergency of International Concern [1]. As of 26 April 2020, the epidemic had caused over 190,000 deaths globally [2]. In Hong Kong, the first case of COVID-19 was reported on 23 January 2020, and the number of confirmed and probable cases of infection has

been increasing since then. As of 28 May, 1067 cases have been reported so far, four of them fatal [3].

Based on experiences of previous epidemics, including severe acute respiratory syndrome (SARS) and Ebola, it is recognized that COVID-19 poses a significant threat to the mental health of people around the world [4]. The WHO predicted that elevated rates of stress and anxiety would be the main psychological impact during the COVID-19 pandemic [5]. Currently, a promising treatment for COVID-19 has yet to be developed, and many people around the world are still subject to quarantine. The feeling of loss of control and loneliness from social isolation could lead to stress and even panic [4,6]. In addition, increased reporting by the media and the overwhelming amount of information from social media has led to unnecessary fear and confusion among the public, as reflected in

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the recent incidences of panic buying that has occurred in Hong Kong and other countries [7]. During the COVID-19 outbreak, the public has been exposed to unprecedented levels of stress.

It is well researched that stressful events may precipitate insomnia [8]. The enforcement of home confinement policies and regulations to prevent mass gatherings around the globe likely further escalated incidences of daytime stress and disrupted sleep patterns [9]. Recently, a number of surveys had been conducted to assess the sleep condition under the COVID-19 outbreak. A web-based survey (N = 603) in China found 18.1% of the respondents reported poor sleep quality during the COVID-19 outbreak [10]. In particular, healthcare workers were more likely to have poor sleep quality (OR = 1.34, 95% CI: 1.18, 2.30). A nationwide online survey on 1563 medical staff members in China revealed that one-third of the medical staff suffered from insomnia symptoms, which related to low education level, isolated working environment as well as worries about the COVID-19 outbreak [11]. Another nationwide survey conducted in Feb 2020 in China found a higher prevalence of sleep problems among isolated populations, especially those medically isolated, in which over 70% reported difficulty to fall asleep and waking up early at least once over the past one-week [12]. In Hong Kong, a web-based cross-sectional survey was conducted within 36 h after the first case of COVID-19 was reported. About 97% of the respondents were worried about the outbreak and their overall anxiety level bordered on the abnormal [13]. However, the impacts of COVID-19 outbreak on sleep were not assessed.

In the previous outbreak of SARS in 2003, deterioration in sleep quality was reported by 11–18% of respondents, who said that they had trouble falling or staying asleep or experienced restless sleep because they were preoccupied with thoughts related to SARS [14]. The COVID-19 outbreak has raised significant concern among citizens in Hong Kong and may have affected their sleep conditions. Sleep plays a significant role in maintaining both physical and mental health [15]. A cross-sectional survey was therefore conducted to assess the impacts of the COVID-19 outbreak on sleep and to explore the factors associated with sleep disturbance of Hong Kong people. The intention was to explore some specific factors and reactions related to the COVID-19 outbreak, such as mask supply, worries about being infected, and sources for acquiring information on COVID-19. The findings of this survey can be utilized by healthcare professionals and policy makers to identify individuals who are vulnerable to sleep impairments during an outbreak. This will make possible the taking of preemptive action to reduce the impact of epidemics on the public's mental health in the future.

2. Methods

2.1. Study design and participants

A cross-sectional, internet-based survey was conducted among an urban Chinese population during the COVID-19 pandemic. On 11 March 2020, the WHO declared COVID-19 to be a pandemic. The survey was carried out in Hong Kong over a 2-week period from 6 April 2020, which covered the first phase of the pandemic. At the time of the WHO declaration, Hong Kong was experiencing a slight drop in the number of infections compared to the weeks immediately prior to the declaration, but this was followed by a rapid increase in the number of confirmed cases later in March. The spread of the virus in local clusters was controlled, such that out of a total of 111 newly confirmed cases during the survey period, 88.2% were imported cases [3]. During the data collection period (from 6 April to 20 April 2020), the Hong Kong government had implemented a series of measures to control the transmission of COVID-19 in Hong Kong. These included the suspension of classes, work-from-home arrangements for civil servants, a 14-day compulsory quarantine

period for inbound travelers, a prohibition on gatherings of four or more people in public places, the compulsory closure of sports and leisure facilities such as fitness centers bathhouses, and karaoke establishments; and ordering catering businesses to step up epidemic control measures [16].

Hong Kong Chinese residents who were aged 18 years or above and able to read traditional Chinese characters were recruited using convenience sampling via the instant messaging application WhatsApp and a Facebook page. The questionnaire was first piloted in a native Chinese-speaking sample (N = 10) to test the readability. Their feedback on the language structure and grammar was then discussed by the research team members. The wordings were refined according to the comments. An anonymous web-based platform (Google form) was adopted to distribute the finalized questionnaire. Sample size calculation was conducted using G*Power 3.1 based on the estimated prevalence of insomnia with a 3% margin of error. An estimated sample of 1065 was suggested under the 95% confidence interval. Over a two-week survey period, a total of 1212 respondents had returned the internet-based questionnaire, and 74 (6.1%) of them failed to provide sociodemographic data, and hence the final sample size was 1138.

The present study was approved by the Institutional Review Board of the Hong Kong Polytechnic University (ref: HSEARS20200226003). The participants received a link to access the survey and took approximately 10 min to complete it. This study followed the STROBE recommendations on the design and reporting of a study (Appendix i) [17].

2.2. Questionnaire

The questionnaire covered sleep conditions, stores of infection control supplies, mood and stress, usage of social media and sources of acquiring COVID-19 information, risk perception, and sociodemographic data (Appendix ii).

The respondents' symptoms of insomnia and daytime impairment in the recent two weeks were assessed using the Chinese version of Insomnia Severity Index (ISI) which had been validated previously [18]. A cut-off of 10 points on the ISI (sensitivity: 86.1%; specificity: 87.7%) was optimal for detecting cases of insomnia in the community sample [19]. In addition, the respondents were also asked to compare their sleep quality, sleep initiation, and total sleep duration in the recent two weeks with the time before the first confirmed case of COVID-19 in Hong Kong (23 January 2020), on a 5-point Likert-like scale (ie, much worse, worse, about the same, better, much better). The change in sleep quality was the primary outcome of this survey. The respondents' sleep-wake parameters in last two weeks, including their sleep onset latency (SOL), wake time after sleep onset (WASO), early morning awakening (EMA), duration of insomnia symptoms if any, total sleep time (TST), and usual bed time and rise time were obtained using the items adapted from the Chinese version of the Brief Insomnia Questionnaire (BIQ) which was developed and validated for the use of telephone-based survey in the native Chinese speaking sample before [20,21]. The language structure of these BIQ items were modified into written expression in this study. Their total time in bed (TIB) was then calculated with the figures that were provided on bed time and rise time, and their sleep efficacy (SE) was determined using the equation $SE = TST/TIB \times 100\%$.

To assess the participants' sources of acquiring information related to COVID-19, they were asked about the frequency with which they used different sources to obtain the latest information on COVID-19, with the three possible responses being "No," "Sometimes," and "Frequently." A list of commonly used sources was included, namely information provided by the health organizations, governmental press conferences, press conferences of

health professional bodies, conventional media (ie, newspapers, radio), or social media. In addition, the levels of stress and mood of the respondents during the outbreak were assessed from their responses of “Not at all” to “Very much stressful/depressed” (5-point Likert-like scale). Their worries about being infected and about their family members being infected were also assessed (“Not at all” to “Very much,” on a 5-point Likert-like scale). Different aspects of risk perceptions were evaluated, including whether the respondents perceived that they had sufficient masks and infection control supplies for a period of 1 month (Yes/No), their perception of the risk of being infected, as well as their confidence in the ability of health professionals and the government to fight against COVID-19 (5-point Likert-like scale). Basic demographic data, including information on the age, gender, marital status, and occupation of the respondents, were also collected without identifying information.

2.3. Data analyses

Responses were collected using Google form. The statistical package SPSS 25.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the data. The demographic data of the respondents were summarized using descriptive statistics expressed in terms of mean and standard deviation (SD) or number and percentage (%). The ISI score of the respondents was coded into binary data according to the recommended clinical cut-off point for current insomnia sufferers. Estimates of the prevalence of the deterioration in sleep and current levels of insomnia, respondents' sleep parameters, store of infection control supplies, as well as sources of acquiring COVID-19 information were calculated by weighting the cases according to the 2016 Hong Kong population by-census distribution of sex and age. Univariate analyses were performed with the pre-designated variables to explore possible covariates in further analyses of the prevalence of deterioration of sleep and current insomnia during the COVID-19 pandemic. The pre-designated variables included age, gender, educational attainment, marital status, employment status, youngest child in the household, sources of acquiring COVID-19 information, social media use, stores of infection control supplies, worries about oneself and one's family being infected, interference in daily life, and stress and mood during the pandemic. Variables that were significant predictors ($p < 0.10$) in the univariate analysis would be considered in the multivariate analysis. The identified covariates were presented in terms of Odds Ratios (ORs) and 95% confidence intervals (95% CI). The factors associated with the worsening of sleep quality and sleep initiation, shortened total sleep time after the outbreak, and current insomnia were then examined using a multivariate logistic regression.

3. Results

3.1. Characteristics of the respondents and the weighted prevalence of sleep problems

The final sample consisted of 391 men and 747 women. About half of them were young-aged (55.0%) and married (49.1%). In terms of social media use, 57.8% spent more than 2 h per day. The majority were recruited from the more educated working population. Details of the characteristics of the respondents are presented in Table 1. With regard to sleep deterioration after the COVID-19 outbreak (Table 2), the weighted proportions of those who reported worsening sleep quality, worsening sleep initiation, and shortened sleep duration were 38.3% (95% CI = 35.5–41.1), 29.8% (95% CI = 27.1–32.4), and 29.1% (95% CI = 26.5–31.7), respectively. The weighted prevalence of current clinical insomnia (ISI ≥ 10) was estimated at 29.9% (95% CI = 27.2–32.5), equaling 1.89 million of

Table 1
Characteristics of the respondents (total sample = 1138).

Variable	N (%)
Female	747 (65.6%)
Age	
18–39	626 (55.0%)
40–59	435 (38.2%)
60 or above	77 (6.8%)
Marital Status	
Never married/Cohabiting	525 (46.1%)
Married	559 (49.1%)
Divorced/Separated/Widowed	54 (4.8%)
Youngest Child in the Household	
No child	870 (76.4%)
Kindergarten	140 (12.3%)
Primary school	85 (7.5%)
Secondary School	43 (3.8%)
Living Condition	
Live alone	77 (6.8%)
With family members	1021 (89.7%)
With others	40 (3.5%)
Educational Attainment	
S3 or below	34 (3.0%)
S4 – S7	212 (18.6%)
Tertiary education	892 (78.4%)
Employment Status	
Employed	858 (75.4%)
Unemployed	42 (3.7%)
Economically inactive	238 (20.9%)
Time Spent on Social Media per day	
Non-user	4 (0.4%)
2 h or less	476 (41.8%)
More than 2 h	658 (57.8%)
Time Spent on Watching News from Different Media per Day	
Non-user	7 (0.6%)
2 h or less	816 (71.7%)
More than 2 h	315 (27.7%)

the Hong Kong population. The respondents reported an average SOL of 26.7 min and average WASO of 22.4 min. Their average TST and TIB were 6.8 h and 7.7 h, respectively. The mean SE was 87.5%. Of those who reported insomnia symptoms (N = 596), the mean duration of sleep problems was 6.9 months.

3.2. Preparation and reactions to COVID-19

Most of the respondents had sufficient infection control supplies (Table 3). Only 10.6% of the respondents reported they had insufficient masks for one month and less than 4% reported they had insufficient alcohol-based handrubs (3.6%) and sterilizing products (2.7%). In terms of acquiring COVID-19 information, conventional media (62.0%) and social media (59.3%) were most frequently used, followed by governmental press conference (27.4%) and press conference hosted by health professionals (23.8%). Over half of the respondents worried about themselves being infected (53.4%) and their family members being infected (58.4%). Most of the respondents had confidence in self-protection (67.6%) and health professionals (83.0%) against COVID-19, but only 37.5% had confidence in the government to control the outbreak.

3.3. Univariate analyses

The univariate analyses of the pre-designed factors with $p < 0.10$ are presented in Supplementary Table. Potential confounding factors for worsening sleep after the outbreak or current insomnia included insufficient stores of masks and sterilized products, frequent reliance on press conferences featuring health professionals as a common source of relevant information, worries

Table 2
Sleep and mood states of the respondents (total sample = 1138).

Variable ^a	N (Weighted %)/Weighted Mean ± SD	95% CI
Sleep Condition since COVID-19 Outbreak		
Sleep Quality (worse, or much worse)	436 (38.3)	35.5–41.1
Sleep Initiation (worse, or much worse)	339 (29.8)	27.1–32.4
Sleep Duration (shorter, or much shorter)	331 (29.1)	26.5–31.7
Clinical Insomnia (ISI ≥ 10)	340 (29.9)	27.2–32.5
Used Sleep Medication in the Past 1 Month	105 (9.3)	7.6–10.9
ISI, ranged 0–28	7.2 ± 5.2	6.9–7.5
Sleep Parameters		
SOL, minutes (N = 1126)	26.7 ± 32.8	24.8–28.6
WASO, minutes (N = 1091)	22.4 ± 44.5	19.8–25.1
EMA, minutes (N = 1121)	20.1 ± 37.4	17.9–22.3
Duration of Insomnia, months (N = 596) ^b	6.9 ± 18.7	5.4–8.4
TST, hours (N = 1127)	6.8 ± 1.3	6.7–6.9
TIB, hours (N = 1114)	7.7 ± 1.4	7.6–7.8
SE, % (N = 1028)	87.5 ± 12.9	86.7–88.3
Interfered with Daily Life due to COVID-19 (much, very much)	898 (78.9)	76.4–81.3
Low Mood (much, very much)	435 (38.3)	35.4–41.1
Experiencing Stress (much, very much)	512 (45.0)	42.1–47.9

Abbreviations: N, number; SD, standard deviation; CI, confidence interval; COVID-19, Coronavirus Disease 2019; ISI, Insomnia Severity Index; SOL, sleep onset latency; WASO, wake after sleep onset; EMA, early morning awakening; TST, total sleep time; TIB, total time in bed; SE, sleep efficiency.

^a Data presented in Number (Weighted Percentage) or Weighted Mean ± Standard Deviation with 95% confidence interval.

^b Those who reported no insomnia symptoms were not included.

Table 3
Self-sufficiency in personal protective products, exposure to information from different sources, and risk perceptions (total sample = 1138).

Variable ^a	N (Weighted %)	95% CI
Store of Infection Control Supplies for 1 month		
Insufficient masks	120 (10.6)	8.8–12.4
Insufficient alcohol-based handrubs	42 (3.6)	2.6–4.7
Insufficient sterilizing products	31 (2.7)	1.8–3.6
Usage of COVID-19 Information Source (No/Sometimes/Frequently)		
Governmental press conference	227 (19.9)/600 (52.7)/312 (27.4)	17.7–22.4/49.8–55.7/24.8–30.1
Health organization (eg, World Health Organization, Centers for Disease Control and Prevention)	439 (38.5)/528 (46.4)/171 (15.0)	35.7–41.5/43.5–49.3/13.0–17.2
Press conference hosted by health professionals	246 (21.6)/621 (54.6)/271 (23.8)	19.3–0.2/51.6–57.5/21.4–26.4
Information disseminated at workplace	437 (38.4)/501 (44.1)/200 (17.6)	35.6–41.3/41.1–47.0/15.4–19.9
Conventional media (eg, Newspapers)	37 (3.3)/396 (34.8)/705 (62.0)	2.3–4.5/32.0–37.7/59.1–64.8
Social media	62 (5.5)/401 (35.3)/674 (59.3)	4.2–6.9/32.5–38.1/56.3–62.1
Risk Perceptions on COVID-19		
Worrying about own self being infected (Somewhat, Much, or Very much)	607 (53.4)	50.4–56.3
Worrying about family members being infected (Somewhat, Much, or Very much)	664 (58.4)	55.4–61.2
Confidence in self-protection against COVID-19 (Somewhat, Much, or Very much)	770 (67.6)	64.9–70.4
Confidence in health professionals against COVID-19 (Somewhat, Much, or Very much)	945 (83.0)	80.7–85.2
Confidence in government to control the outbreak (Somewhat, Much, or Very much)	427 (37.5)	34.7–40.4

Abbreviations: N, number; CI, confidence interval; COVID-19, Coronavirus Disease 2019.

^a Data presented in Number (Weighted Percentage) with 95% confidence interval.

about oneself and one's family members being infected, lack of confidence in the government and health professionals against COVID-19, interference in one's daily life by COVID-19, the presence of low mood and stress, having tertiary education, and economically inactive individuals (housewives, students, and retirees) (all $p < 0.10$). All of these significant factors were included in the full model.

3.4. Multivariate analyses

3.4.1. Preparations for the COVID-19 outbreak

The multivariate logistical regression on the potential confounding factors is summarized in Table 4. After adjusting for other confounders, only insufficient store of masks was a significant predictor of the presence of all sleep problems (worsened sleep quality: adjusted OR = 1.57, 95% CI = 1.03–2.37; worsened sleep initiation: adjusted OR = 1.72, 95% CI = 1.13–2.61; decline in TST: adjusted OR = 1.99, 95% CI = 1.32–3.01; current insomnia: adjusted OR = 1.96, 95% CI = 1.28–3.00; all $p < 0.05$).

3.4.2. Sociodemographic factors

In the multivariate model, females were found to have a higher likelihood of experiencing reduced sleep quality (adjusted OR = 1.77, 95% CI = 1.35–2.33, $p < 0.001$) and increased difficulties in initiating sleep (adjusted OR = 1.81, 95% CI = 1.35–2.43, $p < 0.001$) since the local outbreak, taking into account other confounding factors. Respondents who had tertiary education were less likely to have worsened sleep quality (adjusted OR = 0.73, 95% CI = 0.53–0.99, $p < 0.05$), decreased TST (adjusted OR = 0.69, 95% CI = 0.50–0.96, $p < 0.05$), and current insomnia (adjusted OR = 0.66, 95% CI = 0.48–0.92, $p < 0.05$) when compared to those with secondary education or below. Compared to those who were employed, economically inactive respondents were less likely to have experienced a decline in TST after adjusting for other confounding factors (adjusted OR = 0.55, 95% CI = 0.38–0.78, $p < 0.001$).

3.4.3. Mood and stress

Individuals with low mood and perceived high level of stress tended to report current insomnia (low mood: adjusted OR = 2.10,

Table 4
Factors associated with sleep deterioration and current insomnia by multivariate logistic regression.

Variable	Worsened sleep quality	Worsened sleep initiation	Decrease in total sleep time	Current insomnia
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Insufficient store of masks	1.57 (1.03–2.37) *	1.72 (1.13–2.61) *	1.99 (1.32–3.01) **	1.96 (1.28–3.00) **
Worry about family members being infected	1.74 (1.22–2.47) **	1.61 (1.11–2.34) *	1.37 (0.94–1.98)	1.24 (0.85–1.82)
Lack of confidence in the government to control the outbreak	1.46 (1.10–1.95) **	1.43 (1.05–1.94) *	1.15 (0.85–1.55)	1.25 (0.92–1.71)
Daily life being interfered due to COVID-19	1.73 (1.22–2.46) **	1.81 (1.21–2.69) **	1.17 (0.81–1.69)	1.55 (1.03–2.33) *
Low mood	1.25 (0.91–1.73)	1.24 (0.88–1.74)	1.13 (0.80–1.60)	2.10 (1.50–2.96) ***
Stress	1.54 (1.11–2.15) *	1.79 (1.26–2.54) **	1.39 (0.97–1.97)	1.65 (1.16–2.35) **
Female	1.77 (1.35–2.33) ***	1.81 (1.35–2.43) ***	N/A	N/A
Tertiary education	0.73 (0.53, 0.99) *	N/A	0.69 (0.50–0.96) *	0.66 (0.48–0.92) *
Employment Status ^a				
Economically inactive	0.89 (0.65–1.22)	N/A	0.55 (0.38–0.78) **	1.20 (0.87–1.66)
Unemployed	1.49 (0.77–2.90)	N/A	1.18 (0.61–2.31)	0.55 (0.26–1.18)

Abbreviations: aOR, adjusted Odds Ratio; CI, confidence interval; COVID-19, Coronavirus Disease 2019.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^a The reference group is being employed.

95% CI = 1.50–2.96, $p < 0.001$; stress: adjusted OR = 1.65, 95% CI = 1.16–2.35, $p < 0.01$, after controlling for all other covariates. Stress was correlated with both worsened sleep quality (adjusted OR = 1.54, 95% CI = 1.11–2.15, $p < 0.05$) and sleep initiation (adjusted OR = 1.79, 95% CI = 1.26–2.54, $p < 0.01$) since local outbreak in the multivariate model.

3.4.3.1. Reactions to the COVID-19 outbreak. Adjusting for all of the confounders, greater odds of worsened sleep quality and sleep initiation, as well as current insomnia, were observed in those who reported that the COVID-19 outbreak had interfered with their daily life (adjusted OR for worsened sleep quality = 1.73, 95% CI = 1.22–2.46, $p < 0.01$; adjusted OR for worsened sleep initiation = 1.81, 95% CI = 1.21–2.69, $p < 0.01$; adjusted OR for current insomnia = 1.55, 95% CI = 1.03–2.33, $p < 0.05$), those who worried about family members being infected (adjusted OR for worsened sleep quality = 1.74, 95% CI = 1.22–2.47, $p < 0.01$; adjusted OR for worsened sleep initiation = 1.61, 95% CI = 1.11–2.34, $p < 0.05$), or those who lacked confidence in the ability of the government to control the outbreak (adjusted OR for worsened sleep quality = 1.46, 95% CI = 1.10–1.95, $p < 0.01$; adjusted OR for worsened sleep initiation = 1.43, 95% CI = 1.05–1.94; all $p < 0.01$).

4. Discussion

This study showed a high prevalence of sleep disturbances in Hong Kong residents during the COVID-19 pandemic. Around 30–40% of the respondents felt that their sleep quality worsened, sleep initiation became more difficult, and sleep duration shortened after the first confirmed local case of COVID-19. After adjusting for other confounding factors, only insufficient stores of masks were associated with a worsening in sleep quality, sleep initiation, and shortened sleep duration since the local outbreak, and with current insomnia. Other factors associated with worsened sleep quality and initiation since the local outbreak included worrying about family members being infected, lack of confidence in the government, daily life being interfered due to COVID-19, having stress, and female gender as revealed by the multivariate model.

An insufficient store of masks for use for one month was associated with insomnia during the COVID-19 outbreak. This is a new finding that adds to the literature on the COVID-19 pandemic. The universal wearing of face masks, also called mass masking, was highly recommended by a number of experts and health authorities [22]. Many commentaries and preliminary studies have put forward that mass masking contributed to the low rate of COVID-19 infections in Hong Kong, despite Hong Kong's status as an

international travel hub and its proximity to Wuhan, China [23,24]. To achieve such a large-scale public health intervention requires that attention be paid to resource allocation and to ensuring a stable supply of quality face masks [25]. However, regional studies and local news reports indicated that the market was flooded with fake face masks, the price of masks escalated, and even that there were occasional shortages of face masks for a period of time in February and March [26]. Such problems led to a high level of stress in the general public, and associated with a deterioration in sleep quality and insomnia. This finding echoes that of another population-based study on depressive symptoms in Hong Kong during the COVID-19 pandemic, involving 11,072 subjects, which estimated that over 45% of the general public suffered from depression in relation to the reusing and safety of masks [27].

In this study, the prevalence of clinical insomnia using ISI cutoff-score ≥ 10 was 29.9%. It is hard to make a direct comparison with the previous studies as there have been no studies using ISI to detect insomnia in Hong Kong. A population-based survey in 2012 found that 39.4% of the population were poor-sleepers defined by the Pittsburgh Sleep Quality Index global score >5 [28]. The prevalence of insomnia found in this study was similar to a recent survey on insomnia in Greek. An online questionnaire survey conducted in April 2020 in Greek found that 37.6% of the participants scored above the cut-off score for insomnia using the Athens Insomnia Scale [29].

As a global human disaster, the COVID-19 pandemic has had a detrimental impact on mental health [30]. The perception of control—an individual's perceived ability to exert control over situations—is known to be important for effectively coping with stressful life events [31,32]. In the present study, individuals who lacked confidence in the government's ability to curb the transmission of COVID-19 were more likely to experience worsening in sleep. It was reported that as of March 2020 a very high proportion of people in Hong Kong took precautionary measures to protect themselves, such as by using face masks (98.8%), performing hand sanitation (93%), and adopting social distancing (85.1%) [33], which showed that they were well-prepared to protect themselves. During the surveyed period, most of the new cases were imported cases, which could only be minimized by the government. It was thought that individuals with less confidence in the ability of the government to take effective preventive measures would feel a greater loss of control over the situation. The perception of a lack of control suggests a higher level of distress and negative appraisal of stressful and anxiety-provoking events, eventually resulting in a greater risk of developing insomnia [32,34,35].

Both worries about oneself and about one's family members being infected were associated with sleep deterioration after the outbreak and with current insomnia, but only worry about one's

family members being infected remained significant after controlling for other factors. This shows that worrying that one's family members were at risk of being infected contributed to a larger source of stress than worrying about one's own risk. A possible explanation for this finding is that families in Hong Kong come from the traditional Chinese cultures that value the importance of family membership, providing assistance to parents and siblings, and respecting the authority of the family [36]. Chinese people are perceived to be obligated to take care of family members, due to the core values in Confucianism and collectivism [37]. They have a stronger sense of responsibility towards the family. Another possible explanation is that one usually has more control over oneself than over one's family members in taking preventive actions to minimize the risk of being infected, for example, by wearing masks and practicing social distancing.

This study has several strengths. To the best of our knowledge, this is the first study to assess sleep problems and behaviors and reactions related to the COVID-19 outbreak in Hong Kong. We also explored the associations between outbreak-related behaviors and factors with sleep problems, and the findings are highly relevant to policy makers and healthcare professionals. Our study also has several limitations. First, the results of this survey study were derived from a sample that was relatively young, female-dominated, and educated. Older or less educated people may have been under-represented. The respondents in this survey were therefore weighted to achieve a proportionally reflective sample compared to the 2016 population-by-census. Limited by an online approach to collecting data, only individuals with internet access were recruited, and most of the respondents were familiar with the use of social media and capable of accessing information relevant to COVID-19 from sources other than traditional media (eg, newspapers, radio). However, an online platform is the best means of collecting timely data, given the prohibition on gathering in groups. In addition, due to the cross-sectional design of this study sleep deterioration during the COVID-19 pandemic was assessed by asking the respondents to recall the changes in their sleep after the first confirmed local case. The retrospective sleep data that were collected may have been subject to recall bias. At the same time, no causality could be determined. Tracing changes in sleep using standard and validated instrument as the COVID-19 epidemic progresses may be a focus of further studies. A further consideration is the comorbidity of psychiatric and insomnia symptoms. Individuals with a history of psychiatric conditions would be vulnerable to experiencing sleep deterioration during the COVID-19 pandemic. Unfortunately, this survey did not thoroughly assess this factor. Although the current mood and level of stress of the respondents were controlled in the multivariate regression analyses, it is suggested that, in future, standard instruments be used to evaluate mood.

In summary, the findings showed that about 30–40% of Hong Kong people felt that their sleep quality, sleep initiation, and sleep duration had worsened since the outbreak of COVID-19. Insomnia was prevalent in Hong Kong during the COVID-19 outbreak. An insufficient store of masks was associated with sleep problems. Policy makers should ensure that the supply of masks is adequate during the outbreak to maintain the sleep health of the population.

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CRediT authorship contribution statement

Branda Yee-Man Yu: Conceptualization, Methodology, Formal analysis, Writing - original draft. **Wing-Fai Yeung:** Conceptualization, Methodology, Writing - original draft, Supervision. **Jason**

Chun-Sing Lam: Writing - original draft. **Sam Chun-Sum Yuen:** Writing - original draft. **Simon Ching Lam:** Writing - review & editing. **Vincent Chi-Ho Chung:** Writing - review & editing. **Ka-Fai Chung:** Writing - review & editing. **Paul Hong Lee:** Formal analysis. **Fiona Yan-Yee Ho:** Writing - review & editing. **Janice Yuen-Shan Ho:** Writing - review & editing.

Conflict of interest

No conflict of financial interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2020.07.009>.

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