ABSTRACT

Objectives To highlight the prevalence of sleep problems and identify associated risk factors among a representative sample recruited from the general population of Hong Kong.

Design, setting and participants Participants included 12 022 individuals (aged 15 or above) who took part in the Population Health Survey 2014/15, a territory-wide survey conducted by the Department of Health of the Government of the Hong Kong Special Administrative Region.

Primary and secondary outcome measures Outcomes were the prevalence of (1) insufficient sleep (<6 hours sleep per day) and (2) any sleep disturbance (difficulty initiating sleep, intermittent awakenings, early awakening) ≥3 times per week in the past 30 days. Multivariable logistic regression identified associations between sleep problems and sociodemographic, clinical and lifestyle factors.

Results 9.7% of respondents reported insufficient sleep and 10.5% reported sleep disturbances ≥3 times a week. Female gender, monthly household income <$12 250 (Hong Kong dollar), lower education level, mental health condition and physical health condition were significantly associated with both insufficient and disturbed sleep (all p<0.05). Unemployment, homemaker, insufficient physical activity, current/former smoking status and harmful alcohol consumption were associated with sleep disturbances only (all p<0.01).

Conclusions Sleep problems are highly prevalent in Hong Kong. As such problems are associated with a range of health conditions, it is important to facilitate improvements in sleep. Our results show that harmful alcohol consumption, insufficient physical activity and current smoking are modifiable risk factors for sleep disturbances. Public health campaigns should focus on these risk factors in order to promote a healthy lifestyle and ultimately reduce sleep disturbances. Targeted interventions for high-risk groups may also be warranted, particularly for those with doctor-diagnosed physical and mental health conditions.

INTRODUCTION

Sleep is a normal and important physiological function as it enables the body and mind to recover. However, sleep problems are increasingly recognised as a serious public health concern. Such problems can include insufficient sleep, too much sleep and sleep disturbances (eg, difficulty in falling or staying asleep, early morning awakenings). In addition to being detrimental to well-being and quality of life, a growing body of literature has found that poor sleep is strongly associated with the increased risk of a number of adverse health outcomes. These outcomes include cardiovascular issues, obesity, hypertension, development of type 2 diabetes and cancer. Sleep deprivation can also impair the immune system, which can increase susceptibility to infectious diseases and reduce response to vaccines. In addition to higher healthcare costs, a recently published meta-analysis reported that sleep problems can increase the likelihood of work absenteeism by up to 23%.

A particular concern is that sleep issues are likely to become even more common due to...
a rise in 24-hour ‘round-the-clock’ societies with a corresponding increase in shift work, longer commute times as well as higher use of mobile phones and computers later in the evening.1 7 To inform the development of public health interventions and policy, valid and reliable data from nationally representative samples should be routinely collected in order to assess the prevalence of sleep problems among populations, detect any changes in such problems over time and identify associated risk factors. By knowing these risk factors, policymakers, employers and individuals can develop targeted measures to improve sleep. For example, it has been shown in a systematic review that employer-sponsored interventions can improve sleep and sleep-related outcomes such as reduced absenteeism and better overall quality of life.1 8 These interventions included educational programmes that emphasised sleep hygiene or fatigue management, timed napping before or after work, increasing daytime activity, modifying workplace environments and screening for sleep problems.8

The current study reports on sleep among the general population of Hong Kong, a region that has become known as one of the most sleep-deprived places in the world with a number of local studies reporting a high prevalence of sleep problems (range: 11.9% to 61.2%).3–18 These figures are alarming, particularly as such problems have been associated with negative outcomes, as described above. However, it is important to note that the generalisability of much of this research is limited, which could result in errors in the estimates of the prevalence rates. For example, the majority of these studies included small sample sizes or only recruited particular participant groups that were not randomly selected from the general population (eg, adolescents or elderly people only).11–15 18 Furthermore, the two studies that included the largest (N=9851 and N=5001), and most representative samples, analysed data collected in 19989 and 2007,10 which are likely out of date. This study therefore aimed to (1) highlight the prevalence of insufficient and disturbed sleep among a more recent representative sample obtained from the Hong Kong Population Health Survey 2014/15 (PHS 2014/15), and (2) identify associated risk factors.

METHODS

Study design and setting

Data were derived from the PHS 2014/15. The PHS 2014/15 is a cross-sectional population-based study conducted by the Department of Health of the Government of the Hong Kong Special Administrative Region between December 2014 and October 2015. It is the most recent population health survey available. Systematic replicated sampling was applied to select a representative sample that covered the land-based non-institutional population (aged ≥15 years). Domestic helpers from outside of Hong Kong and visitors were excluded.19 A total of 5435 of the 7205 households who were contacted agreed to be interviewed (household response rate: 75.4%). Of the recruited households, 12022 individuals completed the face-to-face interview, which recorded sociodemographic information and included measures of health-related quality of life, health status, lifestyle, injury prevention, preventive health practices and healthcare utilisation.

Outcome variables

The outcomes of interest for the current analysis were insufficient sleep (sleep quantity) and disturbed sleep (sleep quality). For sleep quantity, respondents were asked to report, on average, how many hours of sleep they had per day in the preceding 30 days. Insufficient sleep was defined as <6 hours of sleep on average per day, the definition adopted by a recently published local study.17 For sleep quality, respondents reported how often they experienced each of the following sleep disturbances in the past 30 days: (1) difficulty initiating sleep (DIS), (2) intermittent awakenings or difficulty maintaining sleep (DMS) during the night and (3) early morning awakening (EMA) and unable to sleep again. Responses to each of the three items were recorded on a 4-point Likert scale (1=Not during the past 30 days, 2=Less than once a week, 3=Once or twice a week, 4=Three or more times a week). For analysis, disturbed sleep was defined as having DIS, DMS or EMA for at least three times a week over the past 30 days.20

Predictor variables

The selection of predictor variables was based on the results of previous studies. Sociodemographic variables included gender (male, female), age group (<35 years, 35–54 years, 55–74 years, 75 years or above), employment status (employed, unemployed, retired, homemaker, student), marital status (never married, married, divorced/separated, widowed), immigrant background (born in Hong Kong, immigrant living in Hong Kong for ≥7 years, immigrant living in Hong Kong for <7 years), educational background (no schooling/preprimary, primary, secondary, tertiary) and monthly household income. Income was classified as follows: (1) <50% of the Hong Kong median, (2) ≥50% of the Hong Kong median – Hong Kong median and (3) ≥2Hong Kong median. This was based on the Hong Kong median household income in the second quartile of 2015 (HK$24 500 (Hong Kong dollar)). Clinical variables were doctor-diagnosed chronic conditions (excluding mental health conditions) and doctor-diagnosed mental health conditions. Finally, the following lifestyle variables were assessed: physical activity (sufficient as performing at least 150 min of moderate-intensity physical activity, 75 min of vigorous-intensity physical activity per week or an equivalent combination of moderate-intensity and vigorous-intensity physical activity achieving at least 600 MET-minutes, as recommended by the Global Physical Activity Questionnaire of the WHO21), smoking status (never, current, former) and alcohol consumption (never, former, non-harmful current, harmful current). Harmful alcohol consumption
was defined as an Alcohol Use Disorders Identification Test score of ≥8 by WHO.²²

**Statistical analyses**

Descriptive statistics (eg, number of respondents (N) and proportion (%)) were used to describe the characteristics of respondents. Any statistically significant differences between groups was checked by χ² tests. In addition to the analysis at the sample level, weighting factors were applied to estimate the results with respect to the distribution of gender and age group of the land-based non-institutional population of Hong Kong in the second quarter of 2015.¹⁹ Univariate and multivariable logistic regressions were used to assess the single and adjusted effect of sociodemographic and lifestyle factors on the likelihood of insufficient sleep and disturbed sleep, respectively. A total of 64 respondents were excluded from the regression analyses due to small sample sizes. Those excluded were 28 individuals (0.2%) with a non-employment status (eg, long-term health condition, disability, occupational injury or those whom received financial assistance from the government) and 36 individuals (0.3%) who did not provide a response for monthly household income. Statistical analyses were performed using Stata V.13.0 (StataCorp LP, College Station, Texas, USA). All tests of significance were two-tailed and a p value of <0.05 was considered statistically significant.

**Patient and public involvement**

This study is a secondary data analysis so no patient and public involvement took place.

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**RESULTS**

**Subjects**

Total respondents sampled in the PHS 2014/15 were 12 022. After applying the statistical weights to project the estimates to the Hong Kong general population, 52.4% were women and those aged between 35 and 54 years formed the largest proportion among the age groups (36.3%) (table 1). For clinical factors, 39.1% reported a doctor-diagnosed chronic condition (excluding mental health condition) and 1.6% reported a doctor-diagnosed mental health condition. It was found that 87.3% had sufficient physical activity, 72.9% had never smoked cigarettes and 57.9% were categorised as being a non-harmful current drinker. Prolonged sleep duration was reported in 2.9% of the respondents (>9 hours of sleep on average per day).

**Prevalence and predictors of insufficient sleep**

The preceding 30-day weighted prevalence of insufficient sleep, as defined by reporting an average of <6 hours of sleep per day, was estimated to be 9.7% (online supplemental table 1). At the sample level (table 2), respondents with insufficient sleep were more likely to be women, older in age, retirees, homemakers, divorced or separated, immigrants living in Hong Kong for ≥7 years,

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Table 1 Characteristics of study participants

|                          | Sample level | Projected population of the second quarter of 2015* |
|--------------------------|-------------|------------------------------------------------------|
|                          | N=12 022    | N=6 080 200                                          |
| Gender                   |             |                                                      |
| Male                     | 47.1%       | 47.6%                                                |
| Female                   | 52.9%       | 52.4%                                                |
| Age group                |             |                                                      |
| <35                      | 28.6%       | 29.0%                                                |
| 35–54                    | 35.4%       | 36.3%                                                |
| 55–74                    | 27.5%       | 26.8%                                                |
| 75 or above              | 8.5%        | 8.0%                                                 |
| Employment status        |             |                                                      |
| Employed                 | 56.8%       | 58.4%                                                |
| Unemployed               | 3.1%        | 3.1%                                                 |
| Retired                  | 18.7%       | 17.7%                                                |
| Homemaker                | 13.5%       | 13.2%                                                |
| Student                  | 7.7%        | 7.4%                                                 |
| Other                    | 0.2%        | 0.2%                                                 |
| Marital status           |             |                                                      |
| Single                   | 29.7%       | 29.8%                                                |
| Married                  | 59.5%       | 60.0%                                                |
| Divorced/separated       | 4.4%        | 4.2%                                                 |
| Widowed                  | 6.3%        | 6.0%                                                 |
| Immigrant background     |             |                                                      |
| Born in Hong Kong        | 60.7%       | 61.5%                                                |
| Immigrant living in Hong Kong for 7 years or more | 35.1% | 33.8% |
| Immigrant living in Hong Kong for less than 7 years | 4.3%   | 4.6% |
| Educational background   |             |                                                      |
| No schooling/preprimary  | 4.6%        | 4.4%                                                 |
| Primary                  | 16.6%       | 15.4%                                                |
| Secondary                | 52.2%       | 51.9%                                                |
| University or above      | 26.5%       | 28.3%                                                |
| Monthly household income |             |                                                      |
| <HK$12 250               | 18.7%       | 17.8%                                                |
| HK$12 250–24 499         | 24.6%       | 23.9%                                                |
| ≥HK$24 500               | 56.4%       | 58.1%                                                |
| Unanswered               | 0.3%        | 0.3%                                                 |
| Doctor-diagnosed chronic condition (excluding mental health condition) | | |
| Yes                      | 39.9%       | 39.1%                                                |
| No                       | 60.1%       | 60.9%                                                |
| Doctor-diagnosed mental health condition | | |
| Yes                      | 1.7%        | 1.6%                                                 |

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have a lower education level (primary school or below), lower monthly household income, a diagnosis of a physical health condition, a diagnosis of a mental health condition, insufficient physical activity and not consuming alcohol (all p values<0.05 from χ² tests).

The results of the multivariable analysis, where each variable is adjusted for all other variables in the model, are presented in table 3. Women had 1.37 times higher odds of reporting insufficient sleep when compared with men (OR 1.37, 95% CI 1.18 to 1.60, p<0.001). Those aged 75 years or above had a 1.53-fold increase in the odds of reporting insufficient sleep when compared with respondents below 35 years of age (OR 1.53, 95% CI 1.06 to 2.19, p=0.022). In terms of employment, retirees had 35% lower odds of having insufficient sleep than those who were employed (OR 0.65, 95% CI 0.52 to 0.81, p<0.001). Respondents who were divorced had a 1.37-fold increase in odds of insufficient sleep (no schooling/preprimary: OR 1.83, 95% CI 1.33 to 2.52, p<0.001; primary: OR 1.73, 95% CI 1.38 to 2.17, p<0.001). Respondents with a monthly household income below HK$12 250 had 1.27 times higher odds of insufficient sleep than those with an income ≥HK$24 500 (OR 1.27, 95% CI 1.07 to 1.51, p=0.007). For clinical variables, it was found that respondents with doctor-diagnosed chronic conditions or mental health conditions had significantly higher odds of having insufficient sleep than those without such conditions (chronic conditions: OR 1.77, 95% CI 1.54 to 2.04, p<0.001; mental health conditions: OR 1.95, 95% CI 1.37 to 2.78, p<0.001).

Prevalence and predictors of disturbed sleep

Overall, 10.5% of respondents reported sleep disturbances, defined as having DIS, DMS or EMA for at least three times a week over the past 30 days (online supplemental table 1). The most common type of sleep disturbance among respondents was DMS (7.3%), followed by DIS (6.8%) and EMA (6.0%) (online supplemental table 2). Similar to respondents with insufficient sleep, it was found that women, those older in age, retirees, homemakers, divorced or separated, immigrant living in Hong Kong for ≥7 years, educated to primary level or below, lower monthly household income, having a doctor-diagnosed chronic condition, a mental health condition, insufficient physical activity and not consuming alcohol were potential predictors of sleep disturbances (all p values<0.05 from χ² tests, as shown in table 2).

From table 4, multivariable regression analyses showed that women had significantly higher odds of reporting disturbed sleep than men (OR 1.51, 95% CI 1.29 to 1.76, p<0.001). Respondents who were unemployed, or who were homemakers, had higher odds of having disturbed sleep than those who were employed (unemployed: OR 1.51, 95% CI 1.09 to 2.10, p=0.014; homemaker: OR 1.69, 95% CI 1.40 to 2.04, p<0.001). Respondents with an educational background lower than tertiary education also had higher odds of reporting sleep disturbances (no schooling/preprimary: OR 1.54, 95% CI 1.13 to 2.10, p=0.006; primary: OR 1.58, 95% CI 1.26 to 1.98, p<0.001; secondary: OR 1.20, 95% CI 1.01 to 1.44, p=0.044). In terms of monthly household income, respondents with an income below HK$12 250 had 1.25 times higher odds of disturbed sleep than respondents with an income ≥HK$24 500 (OR 1.25, 95% CI 1.07 to 1.48, p=0.008). Respondents with doctor-diagnosed chronic conditions or mental health conditions had significantly higher odds of reporting sleep disturbances than those without such conditions (chronic condition: OR 2.21, 95% CI 1.92 to 2.55, p<0.001; mental health condition: OR 3.06, 95% CI 2.23 to 4.19, p<0.001). Respondents with an insufficient physical activity level had a 1.27-fold increase in odds of reporting sleep disturbances when compared with those with sufficient physical activity levels (OR 1.27, 95% CI 1.08 to 1.50, p=0.005). It was also found that respondents who were current or former smokers had a greater...
Table 2  Characteristics of study subjects by insufficient sleep and disturbed sleep in the preceding 30 days

|                                      | Sufficient sleep† | Insufficient sleep† | Without any sleep disturbance‡ | With any sleep disturbance‡ |
|--------------------------------------|-------------------|----------------------|-------------------------------|-----------------------------|
|                                      | (N=10 836, 90.1%) | (N=1186, 9.9%)       | (N=10 733, 89.3%)             | (N=1289, 10.7%)             |
| Gender                               |                   |                      |                               |                             |
| Male                                 | 48.1%             | 38.2%                | 48.4%                         | 36.5%                       |
| Female                               | 51.9%             | 61.8%                | 51.6%                         | 63.5%                       |
| Age group                            | <0.001*           |                      |                               |                             |
| <35                                  | 29.6%             | 19.3%                | 29.9%                         | 17.3%                       |
| 35–54                                | 35.9%             | 31.5%                | 36.1%                         | 29.6%                       |
| 55–74                                | 26.7%             | 34.9%                | 26.4%                         | 37.1%                       |
| 75 or above                          | 7.8%              | 14.2%                | 7.5%                          | 16.0%                       |
| Employment status                    | <0.001*           |                      |                               |                             |
| Employed                             | 57.6%             | 49.7%                | 58.6%                         | 41.3%                       |
| Unemployed                           | 3.2%              | 2.4%                 | 3.0%                          | 4.0%                        |
| Retired                              | 18.1%             | 23.8%                | 17.6%                         | 27.4%                       |
| Homemaker                            | 12.9%             | 18.8%                | 12.3%                         | 23.3%                       |
| Student                              | 8.0%              | 4.9%                 | 8.2%                          | 3.4%                        |
| Other                                | 0.2%              | 0.5%                 | 0.2%                          | 0.5%                        |
| Marital status                       | <0.001*           |                      |                               |                             |
| Single                               | 30.7%             | 21.2%                | 31.1%                         | 18.2%                       |
| Married                              | 59.3%             | 61.7%                | 59.2%                         | 62.8%                       |
| Divorced/separated                   | 4.1%              | 7.0%                 | 4.1%                          | 6.7%                        |
| Widowed                              | 5.9%              | 10.0%                | 5.6%                          | 12.2%                       |
| Immigrant background                 | <0.001*           |                      |                               |                             |
| Born in Hong Kong                    | 61.1%             | 57.2%                | 61.4%                         | 54.5%                       |
| Immigrant living in Hong Kong for 7 years or more | 34.5%       | 39.8%                | 34.2%                         | 42.2%                       |
| Immigrant living in Hong Kong for less than 7 years | 4.4%        | 3.0%                 | 4.4%                          | 3.3%                        |
| Educational background               | <0.001*           |                      |                               |                             |
| No schooling/preprimary              | 4.2%              | 8.9%                 | 4.1%                          | 9.3%                        |
| Primary                              | 15.6%             | 26.1%                | 15.4%                         | 26.8%                       |
| Secondary                            | 52.9%             | 46.1%                | 52.8%                         | 47.2%                       |
| University or above                  | 27.4%             | 19.0%                | 27.7%                         | 16.8%                       |
| Monthly household income             | <0.001*           |                      |                               |                             |
| <HK$12 250                           | 17.9%             | 26.3%                | 17.4%                         | 29.3%                       |
| HK$12 250–24 499                     | 24.6%             | 24.6%                | 24.8%                         | 23.3%                       |
| ≥HK$24 500                           | 57.2%             | 48.7%                | 57.5%                         | 47.1%                       |
| Unanswered                           | 0.3%              | 0.4%                 | 0.3%                          | 0.3%                        |
| Doctor-diagnosed chronic condition (excluding mental health condition) | <0.001*         |                      |                               |                             |
| Yes                                  | 38.0%             | 57.4%                | 37.1%                         | 63.3%                       |
| No                                   | 62.0%             | 42.6%                | 62.9%                         | 36.7%                       |
| Doctor-diagnosed mental health condition | <0.001*         |                      |                               |                             |
| Yes                                  | 1.4%              | 3.8%                 | 1.2%                          | 5.7%                        |
| No                                   | 98.6%             | 96.2%                | 98.8%                         | 94.3%                       |

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risk of sleep disturbances than never smokers (current smoker: OR 1.36, 95% CI 1.12 to 1.65, p=0.002; former smoker: OR 1.33, 95% CI 1.10 to 1.61, p=0.003). Finally, those who were harmful current drinkers had 2.11 times higher odds of sleep disturbances than those who had never consumed alcohol (OR 2.11, 95% CI 1.53 to 2.92, p<0.001).

**DISCUSSION**

Overall, 16.6% of respondents reported sleep problems. The estimated prevalence of insufficient sleep (<6 hours per night on average) and disturbed sleep (≥3 times a week) were 9.7% and 10.5%, respectively. Based on the estimate of the local population at the second quarter of 2015, this corresponds to 588 200 individuals (aged ≥15 years) with insufficient sleep and 640 100 individuals with sleep disturbances. These findings indicate that sleep problems are highly prevalent among the general population of Hong Kong. For other countries (Finland, Sweden, Italy and the Netherlands), population-based studies have reported insufficient sleep prevalence to be in the range of 12% to 43%23–26 and for disturbed sleep to be in the range of 29.5% to 32.1%.25–26 This suggests that Hong Kong has a lower prevalence of sleep problems when compared with other countries; however, caution should be used when comparing results due to the use of different methods to assess sleep problems. In addition, our prevalence estimate is slightly lower than that identified in a previous population-based local study conducted in 1998 (N=9851), where it was found that 11.9% of respondents reported sleep disturbances (either DIS, DMS or EMA) ≥3 times per week.10 This suggests that sleep in Hong Kong has improved slightly over time, although the prevalence rate is still high. Our results differ from the other population-based study (N=5001) where the estimated prevalence of sleep disturbances was 39.4%.9 However, this is likely due to differences in how sleep problems were measured and defined as the other study administered the 19-item Chinese version of the Pittsburgh Sleep Quality Index (PSQI). The PSQI items generate seven component scores where a total score of >5 (score range: 0–21) is a marker for sleep disturbance.9 The PSQI functions as a more in-depth measure of sleep as it incorporates not only sleep duration and sleep disturbances, but also subjective sleep quality, sleep efficiency, daytime dysfunction and use of sleep medications.27 The inclusion of these additional variables is likely to increase the prevalence rate.

There are a number of explanations that could account for the high prevalence of insufficient and disturbed sleep. First, a high-stressed, ‘round-the-clock’ environment that is typical of many urban areas is not conducive to good sleep quality. Long working hours, which are very common in Hong Kong, have also been found to negatively impact sleep.28 Another possible explanation is help-seeking among the Hong Kong Chinese. For example, a study of both adults (N=2231) and children (N=2186) found that the prevalence of help-seeking for

| Table 2 Continued |
|-------------------|
| **Sufficient sleep†** | **Insufficient sleep†** | **Without any sleep disturbance‡** | **With any sleep disturbance‡** |
| (N=10 836, 90.1%) | (N=1186, 9.9%) | (N=10 733, 89.3%) | (N=1289, 10.7%) |
| **P value** | **P value** |
| Physical activity | 0.004* | 0.001* |
| Sufficient | 87.5% | 84.5% | 87.7% | 82.7% |
| Insufficient | 12.5% | 15.5% | 12.3% | 17.3% |
| Smoking status | 0.236 | 0.004* |
| Never smoker | 72.8% | 73.4% | 73.2% | 70.0% |
| Former smoker | 12.3% | 13.4% | 12.1% | 15.3% |
| Current smoker | 14.8% | 13.2% | 14.7% | 14.7% |
| Alcohol consumption | <0.001* | <0.001* |
| Never drinker | 22.0% | 27.2% | 22.0% | 26.8% |
| Former drinker | 16.9% | 17.6% | 16.8% | 18.2% |
| Non-harmful current drinker§ | 57.7% | 51.6% | 57.9% | 50.0% |
| Harmful current drinker§ | 3.4% | 3.5% | 3.2% | 5.0% |

*Significant at 0.05 level by χ² test.
†Sufficient sleep was defined as ≥6 hours per night and insufficient sleep as <6 hours per night.
‡Sleep disturbance was defined as having difficulty in falling asleep, maintaining sleep or early morning awakenings for at least three times a week.
§Harmful drinking was defined as Alcohol Use Disorders Identification Test scores of ≥8.
HK$, Hong Kong dollar.
|                                | Likelihood of having insufficient sleep |
|--------------------------------|-----------------------------------------|
|                                | Adjusted OR (95% CI)                    | P value     |
| **Gender**                     |                                         |             |
| Male                           | Ref                                     |             |
| Female                         | 1.37 (1.18 to 1.60)                     | <0.001*     |
| **Age group**                  |                                         |             |
| <35                            | Ref                                     |             |
| 35–54                          | 1.01 (0.81 to 1.27)                     | 0.900       |
| 55–74                          | 1.20 (0.92 to 1.56)                     | 0.172       |
| 75 or above                    | 1.53 (1.06 to 2.19)                     | 0.022*      |
| **Employment status**          |                                         |             |
| Employed                       | Ref                                     |             |
| Unemployed                     | 0.70 (0.46 to 1.05)                     | 0.085       |
| Retired                        | 0.65 (0.52 to 0.81)                     | <0.001*     |
| Homemaker                      | 1.00 (0.82 to 1.22)                     | 0.981       |
| Student                        | 0.86 (0.62 to 1.19)                     | 0.347       |
| **Marital status**             |                                         |             |
| Married                        | Ref                                     |             |
| Never married                  | 0.97 (0.79 to 1.20)                     | 0.786       |
| Divorced/separated             | 1.37 (1.06 to 1.78)                     | 0.017*      |
| Widowed                        | 0.90 (0.71 to 1.16)                     | 0.421       |
| **Immigrant background**       |                                         |             |
| Born in Hong Kong              | Ref                                     |             |
| Immigrant living in Hong Kong for 7 years or more | 0.91 (0.79 to 1.04) | 0.169 |
| Immigrant living in Hong Kong for less than 7 years | 0.85 (0.60 to 1.22) | 0.389 |
| **Educational background**     |                                         |             |
| No schooling/preprimary        | 1.83 (1.33 to 2.52)                     | <0.001*     |
| Primary                        | 1.73 (1.38 to 2.17)                     | <0.001*     |
| Secondary                      | 1.12 (0.94 to 1.34)                     | 0.206       |
| Tertiary                       | Ref                                     |             |
| **Monthly household income**   |                                         |             |
| <HK$12 250                     | 1.27 (1.07 to 1.51)                     | 0.007*      |
| HK$12 250–24 499               | 1.08 (0.93 to 1.27)                     | 0.318       |
| ≥HK$24 500                     | Ref                                     |             |
| **Doctor-diagnosed chronic condition (excluding mental health condition)** | | |
| No                             | Ref                                     |             |
| Yes                            | 1.77 (1.54 to 2.04)                     | <0.001*     |
| **Doctor-diagnosed mental health condition** | | |
| No                             | Ref                                     |             |
| Yes                            | 1.95 (1.37 to 2.78)                     | <0.001*     |
| **Physical activity (defined by the Global Physical Activity Questionnaire)** | | |
| Sufficient                     | Ref                                     |             |
| Insufficient                   | 1.12 (0.94 to 1.33)                     | 0.199       |
| **Smoking status**             |                                         |             |
| Never                          | Ref                                     |             |
| Current                        | 1.07 (0.87 to 1.31)                     | 0.519       |

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insomnia symptoms was only 40% for adults and 10% for children. Furthermore, a study of local adolescents (N=290) reported that, although troubled by sleep difficulties, only 22% of those with symptoms tried to get help and only 32% used approaches to improve their sleep. It was found that listening to music was the most commonly reported approach (9.5%) followed by relaxation (6.0%), reading (4.3%), earlier bedtimes (4.3%), drinking milk (3.4%), counting (2.6%), improving bedroom environment (1.7%), taking a hot bath (0.9%), exercising (0.9%) and reducing napping during the day (0.9%). It should be noted that a number of other evidence-based and theoretically sound approaches are either not among the strategies listed (eg, avoiding caffeine closer to bedtime, regular sleep schedules) or are not as commonly used (eg, exercise, reduced daytime napping), which emphasises the importance of increasing sleep hygiene education. Such education should actively promote knowledge of sleep and could be widely and easily delivered through various media channels.

In terms of risk factors, doctor-diagnosed mental health conditions were most strongly associated with both insufficient and disturbed sleep. Although we are unable to specify the causal relationship in this study, the available evidence seems to suggest that there is a complex bidirectional relationship between sleep disturbances and mental health problems that must be further explored. Indeed, there is robust evidence that depression and anxiety are associated with an increased risk of developing sleep disturbances. On the other hand, insomnia has been significantly associated with an increased risk of subsequent depression as well as anxiety, alcohol abuse and psychosis. Research also shows that early treatment of sleep problems can potentially prevent or reduce depressive symptoms, again highlighting the importance of promoting sleep among the general population.

In line with previous research, we also found a strong relationship between doctor-diagnosed chronic conditions and sleep problems. Furthermore, potential indicators of low socioeconomic status (low education level, unemployment, income below HK$12 250) were all significantly associated with greater odds of disturbed sleep, which again reflects observations from other studies. When compared with men, women were found to have a higher risk of both insufficient and disturbed sleep. The reasons for this are varied and could include biological factors as well as increased vulnerability to mental health problems. Those aged 75 years or above had a higher odds of reporting insufficient sleep when compared with respondents below 35 years of age, which might be the result of observed reductions in sleep time as people age. Indeed, the variation of normal and disturbed sleep is much wider among elderly people with a majority of older people reporting fewer hours of sleep than younger people. Homemakers were also found to have greater odds of sleep disturbances, which is in line with the results of the two previous population-based studies conducted in Hong Kong. For lifestyle, we found that harmful current alcohol consumption, current or former smoking status and insufficient physical activity were all significantly associated with an increased risk of sleep disturbances. However, we cannot determine the causal relationships among these variables. For example, it is unclear if alcohol disrupts sleep or if those with sleep difficulties consume more alcohol as a sleeping aid. For physical activity, cross-sectional studies have reported that frequent exercise is associated with better sleep quality whereas no physical activity is associated with poorer sleep. Furthermore, a systematic review and meta-analysis of randomised trials found that formal exercise training programmes had a positive impact on sleep quality in middle aged and older adults with sleep problems. Such findings suggest that physical activity could be independently associated with sleep, however, it has been emphasised that further prospective studies are required to confirm this association.

Strengths and limitations
A key strength of this study is that it includes a large sample of individuals randomly selected from the general population. A key limitation of this study is that the cross-sectional design prevents the identification of causal relationships among the variables studied. The study was conducted in Hong Kong, and the findings may not be generalisable to other populations. The study also did not include measures of sleep quality, which could be important in understanding the relationship between sleep disturbances and other variables.
| Table 4  | Factors associated with disturbed sleep in the preceding 30 days by multivariable logistic regression model |
|----------|----------------------------------------------------------------------------------------------------------|
|          | Likelihood of having disturbed sleep                                                                 |
|          | Adjusted OR (95% CI)  | P value     |
| Gender   |                                                                                                         |
| Male     | Ref                                                                                                     |
| Female   | 1.51 (1.29 to 1.76)  | <0.001*     |
| Age group|                                                                                                         |
| <35      | Ref                                                                                                     |
| 35–54    | 0.87 (0.70 to 1.09)  | 0.232       |
| 55–74    | 1.03 (0.80 to 1.34)  | 0.798       |
| 75 or above | 1.20 (0.85 to 1.70)  | 0.292       |
| Employment status |                                                                                                           |
| Employed | Ref                                                                                                     |
| Unemployed | 1.51 (1.09 to 2.10)  | 0.014*     |
| Retired  | 0.97 (0.78 to 1.20)  | 0.776       |
| Homemaker | 1.69 (1.40 to 2.04)  | <0.001*    |
| Student  | 0.76 (0.53 to 1.08)  | 0.129       |
| Marital status |                                                                                                           |
| Married  | Ref                                                                                                     |
| Never married | 0.92 (0.74 to 1.14)  | 0.428       |
| Divorced/separated | 1.23 (0.95 to 1.60)  | 0.111       |
| Widowed  | 1.09 (0.87 to 1.37)  | 0.437       |
| Immigrant background |                                                                                                           |
| Born in Hong Kong | Ref                                                                                                   |
| Immigrant living in Hong Kong for 7 years or more | 0.94 (0.82 to 1.08)  | 0.369       |
| Immigrant living in Hong Kong for less than 7 years | 1.01 (0.72 to 1.41)  | 0.969       |
| Educational background |                                                                                                           |
| No schooling/preprimary | 1.54 (1.13 to 2.10)  | 0.006*     |
| Primary  | 1.58 (1.26 to 1.98)  | <0.001*     |
| Secondary | 1.20 (1.01 to 1.44)  | 0.044*     |
| Tertiary | Ref                                                                                                     |
| Monthly household income |                                                                                                           |
| <HK$12 250   | 1.25 (1.06 to 1.48)  | 0.008*     |
| HK$12 250–24 499 | 0.99 (0.84 to 1.15)  | 0.858       |
| ≥HK$24 500  | Ref                                                                                                     |
| Doctor-diagnosed chronic condition (excluding mental health condition) |                                                                                                           |
| No       | Ref                                                                                                     |
| Yes      | 2.21 (1.92 to 2.55)  | <0.001*     |
| Doctor-diagnosed mental health condition |                                                                                                           |
| No       | Ref                                                                                                     |
| Yes      | 3.06 (2.23 to 4.19)  | <0.001*     |
| Physical activity (defined by the Global Physical Activity Questionnaire) |                                                                                                           |
| Sufficient | Ref                                                                                                   |
| Insufficient | 1.27 (1.08 to 1.50)  | 0.005*     |
| Smoking status |                                                                                                           |
| Never    | Ref                                                                                                     |
| Current  | 1.36 (1.12 to 1.65)  | 0.002*     |

Continued
population of Hong Kong, which maximises generalisability. The statistical power is high due to a good survey response rate (75.4%) and data completion rate. In addition, we were able to assess the impact of a wide range of potential risk factors. A number of important limitations also need to be considered. First, the cross-sectional design prevents us from drawing causal conclusions. All study variables were self-reported, which could have introduced bias and led to under-reporting. For example, the full impact of mental health problems on sleep cannot be fully determined, or controlled for in multivariable analyses, as the number of respondents who reported such diagnoses were very small (n=201, 1.7%). This could be due to the stigma surrounding mental health in Hong Kong, which could deter people from accessing help or disclosing a doctor-diagnosed mental health condition. The findings obtained through self-reported sleep data could also be different from those using objective measures of sleep, such as actigraphy and polysomnography. Furthermore, characteristics of non-responders were not examined so it cannot be determined whether those who chose to participate differed from those who did not take part. For example, it is possible that individuals with poorer health may have been more inclined to take part in the PHS, so the prevalence rates for a number of study variables (eg, doctor-diagnosed chronic conditions, sleep problems) could be overestimated. Finally, it is also important to note that respondents were only asked to report on sleep during the previous 30 days, so we are unable to assess (or control for) differences between those with the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) definition of insomnias where symptoms must be present for >3 months and those with temporary sleep difficulties.

**Implications for future research**

Future research should examine the associations identified in the current study using a longitudinal design in order to identify causal associations, bidirectional associations and examine the interactions among risk factors. Qualitative studies should also be conducted to explore the associations found in more depth, for example, to identify why exactly homemakers are more likely to report poor sleep, which aspects of chronic conditions have the largest impact on sleep as well as local understanding of sleep problems, treatment preferences and perceived barriers and facilitators to service access. It is also recommended that the economic impacts of poor sleep in Hong Kong are identified as, to our knowledge, this has not yet been investigated.

Moreover, it is important to note that the current COVID-19 pandemic is likely to have a negative impact on the factors that influence sleep quality (eg, mental health, physical activity). Worldwide, people have been exposed to a very worrying situation of an unknown duration, have experienced substantial changes to their daily life and are likely to be anxious about their health as well as the future repercussions of the pandemic. It is also important to note that good sleep quality helps to strengthen and maintain the immune system, hence any pandemic-induced sleep disturbances could compromise recovery from COVID-19. Further research, both quantitative (longitudinal) and qualitative, should be done to investigate any changes in sleep quality during the pandemic. Such studies will be especially important in order to guide the development and implementation of population-based approaches to help manage sleep problems as well as inform pandemic management.

**Public health implications**

It is a public health imperative to develop campaigns and interventions that promote and improve sleep, particularly during the COVID-19 pandemic. Indeed, it has been suggested that increasing sleep duration could be a more acceptable and an easier means by which to achieve good individual and societal health when
compared with other health-promoting behaviours, such as healthy eating and increased physical activity. Such campaigns could include messages adapted from cognitive–behavioural therapy for insomnia guidelines, for example, keeping a regular night-time and wake-up schedule, not napping during the day, avoiding caffeine or alcohol later in the evening, exercising in the afternoon or early evening.

CONCLUSION

To summarise, sleep problems are highly prevalent in Hong Kong. Doctor-diagnosed mental health conditions, lower education level, doctor-diagnosed chronic conditions, female gender and low-income were found to be significantly associated with both insufficient sleep and sleep disturbances. Furthermore, unemployment, being a homemaker, insufficient physical activity level, current or former smoking status and harmful alcohol consumption were associated with sleep disturbances only. Therefore, it can be said that there are different risk factors for the duration and quality of sleep and that harmful drinking, lack of physical activity and current smoking are modifiable risk factors for sleep disturbances. The findings from this study are also particularly timely as the COVID-19 pandemic has the potential to exacerbate sleep problems. Therefore, there is a pressing need to monitor sleep patterns among populations and continue to conduct research that enables the development of evidence-based strategies to promote and improve sleep.

REFERENCES

1. Fernis JE, Kumari M, Salo P, et al. Sleep epidemiology—a rapidly growing field. Int J Epidemiol 2011;40:1431–7.
2. Institute of Medicine Committee on Sleep Medicine and Research. The National Academies Collection: Reports funded by National Institutes of Health. In: Colten HR, Altevogt BM, eds. Sleep disorders and sleep deprivation: an unmet public health problem. Washington (DC: National Academies Press (US)), 2006.
3. Krittanaawong C, Tunhasiriwet A, Wang Z, et al. Association between short and long sleep durations and cardiovascular outcomes: a systematic review and meta-analysis. Eur Heart J 2019;8:762–70.
4. Lyuyster FS, Strollo PJ, Zee PC, et al. Sleep: a health imperative. Sleep 2012;35:727–34.
5. Irwin MR. Why sleep is important for health: a psychoneuroimmunology perspective. Annu Rev Psychol 2015;66:143–72.
6. Amiri S, Behnezhad S. Sleep disturbances and risk of sick leave: systematic review and meta-analysis. Sleep Biol Rhythms 2020;18:283–95.
7. Gradisar M, Wolfson AR, Harvey AG, et al. The sleep and technology use of Americans: findings from the National sleep Foundation’s 2011 sleep in America Poll. J Clin Sleep Med 2013;9:1291–9.
8. Redeker NS, Caruso CC, Hashmi SD, et al. Workplace interventions to promote sleep health and an alert, healthy workforce. J Clin Sleep Med 2019;15:649–57.
9. Li FHY, Wing YK, Ho SC, et al. Gender differences in insomnia—a study in the Hong Kong Chinese population. J Psychosom Res 2002;53:601–9.
10. Wong WS, Fielding R. Prevalence of insomnia among Chinese adults in Hong Kong: a population-based study. J Sleep Res 2011;20:117–26.
11. Chung KF, Tang MK. Subjective sleep disturbance and its correlates in middle-aged Hong Kong Chinese women. Maturitas 2006;53:396–404.
12. Wong WS, Fielding R. The co-morbidity of chronic pain, insomnia, and fatigue in the general adult population of Hong Kong: prevalence and associated factors. J Psychosom Res 2012;73:28–34.
13. Chung K-F, Cheung M-M. Sleep-Wake patterns and sleep disturbance among Hong Kong Chinese adolescents. Sleep 2008;31:185–94.
14. Chiu HF, Leung T, Lam LC, et al. Sleep problems in Chinese elderly in Hong Kong. Sleep 1999;22:717–26.
15 Chung K-F, Yeung W-F, Yu Y-M, et al. A population-based 2-year longitudinal study of insomnia disorder in a Chinese population in Hong Kong. *Psychol Health Med* 2018;23:505–10.

16 Zhang J, Lam SP, Li SX, et al. Long-Term outcomes and predictors of chronic insomnia: a prospective study in Hong Kong Chinese adults. *Sleep Med* 2012;13:455–62.

17 Zhao SZ, Wang MP, Visswanath K, et al. Short sleep duration and insomnia symptoms were associated with lower Happiness levels in Chinese adults in Hong Kong. *Int J Environ Res Public Health* 2019;16:2079.

18 Chung K-F, Kan KK-K, Yeung W-F. Insomnia in adolescents: prevalence, help-seeking behaviors, and types of interventions. *Child Adolesc Ment Health* 2014;19:57–63.

19 Department of Health of the Government of Hong Kong Special Administrative Region. *Report of population health survey 2014/15*. Hong Kong, 2017.

20 American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 5th edn. Washington, DC: American Psychiatric Publishing, 2013.

21 World Health Organization. *Global recommendations on physical activity for health*. Geneva, Switzerland, 2010.

22 Saunders JB, Aslani OG, Babor TF, et al. Development of the alcohol use disorders identification test (audit): who Collaborative project on early detection of persons with harmful alcohol Consumption-II. *Addiction* 1993;88:791–804.

23 Hublin C, Kaprio J, Partinen M, et al. Insufficient sleep—a population-based study in adults. *Sleep* 2001;24:392–400.

24 Broman JE, Lundh LG, Hetta J. Insufficient sleep in the general population. *Neuropsychol Clin* 1996;26:30–9.

25 Varghese NE, Lugo A, Ghislandi S, et al. Sleep dissatisfaction and insufficient sleep duration in the Italian population. *Sci Rep* 2020;10:17943.

26 Kerkhof GA. Epidemiology of sleep and sleep disorders in the Netherlands. *Sleep Med* 2017;30:229–39.

27 Tsai P-S, Wang S-Y, Wang M-Y, et al. Psychometric evaluation of the Chinese version of the Pittsburgh sleep quality index (CPSQI) in primary insomnia and control subjects. *Qual Life Res* 2005;14:1943–52.

28 Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. *Scand J Work Environ Health* 2014;40:5–18.

29 Liu Y, Zhang J, Lam SP, et al. Help-Seeking behaviors for insomnia in Hong Kong Chinese: a community-based study. *Sleep Med* 2016;21:106–13.

30 Irish LA, Kline CE, Gunn HE, et al. The role of sleep hygiene in promoting public health: a review of empirical evidence. *Sleep Med Rev* 2015;22:23–36.

31 Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectional between sleep disturbances, anxiety, and depression. *Sleep* 2013;36:1059–68.

32 Fang H, Tu S, Sheng J, et al. Depression in sleep disturbance: a review on a bidirectional relationship, mechanisms and treatment. *J Cell Mol Med* 2019;23:2324–32.

33 Smagula SF, Stone KL, Fabio A, et al. Risk factors for sleep disturbances in older adults: evidence from prospective studies. *Sleep Med Rev* 2016;25:21–30.

34 Hertenstein E, Feige B, Gmeiner T, et al. Insomnia as a predictor of mental disorders: a systematic review and meta-analysis. *Sleep Med Rev* 2019;43:96–105.

35 Franzen PL, Buysse DJ. Sleep disturbances and depression: risk relationships for subsequent depression and therapeutic implications. *Dialogues Clin Neurosci* 2008;10:473–81.

36 Zhang H-S, Li Y, Mo H-Y, et al. A community-based cross-sectional study of sleep quality in middle-aged and older adults. *Qual Life Res* 2017;26:923–33.

37 Patel NP, Grandner MA, Xie D, et al. "Sleep disparity" in the population: poor sleep quality is strongly associated with poverty and ethnicity. *BMC Public Health* 2010;10:475.

38 Zhang B, Wing Y-K. Sex differences in insomnia: a meta-analysis. *Sleep* 2006;29:85–93.

39 Ohayon MM, Carskadon MA, Guilleminault C, et al. Meta-Analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep* 2004;27:1255–73.

40 Li J, Vitiello MV, Gooneratne NS. Sleep in normal aging. *Sleep Med Clin* 2018;13:1–11.

41 Ancoli-Israel S, Ayalon L, Saltzman C. Sleep in the elderly: normal variations and common sleep disorders. *Harv Rev Psychiatry* 2008;16:279–86.

42 National Sleep Foundation. *2003 sleep in America Poll*. Washington, DC, 2003.

43 Li Y, Bai W, Zhu B, et al. Prevalence and correlates of poor sleep quality among college students: a cross-sectional survey. *Health Qual Life Outcomes* 2020;18:210.

44 Yang P-Y, Ho K-H, Chen H-C, et al. Exercise training improves sleep quality in middle-aged and older adults with sleep problems: a systematic review. *J Physiother* 2012;58:157–63.

45 Unruh ML, Redline S, An M-W, et al. Subjective and objective sleep quality and aging in the sleep heart health study. *J Am Geriatr Soc* 2008;56:1219–27.

46 Altena E, Baglioni C, Espie CA, et al. Sleep dissatisfaction and obesity: risk factors for obesity and adiposity. *Cell Mol Med* 2019;23:2501–10.

47 Gula KK, Kumar VM. Importance of sleep for health and wellbeing amidst COVID-19 pandemic. *Sleep Vigil* 2020;4:49–50.

48 Morin CM. Cognitive-Behavioral approaches to the treatment of insomnia. *J Clin Psychiatry* 2004;65 Suppl 16:33–40.