



Deprivation is associated with worse physical and mental health beyond income poverty: a population-based household survey among Chinese adults

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Accepted: 25 April 2018
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Abstract

Purpose In studying health inequality, poverty as measured by income is frequently used; however, this omits the aspects of non-monetary resources and social barriers to achieving improved living standard. Therefore, our study aimed to examine the associations of individual-level deprivation of material and social necessities with general physical and mental health beyond that of income poverty.

Methods A territory-wide two-stage stratified random sample of 2282 community-dwelling Hong Kong adults was surveyed between 2014 and 2015. Income poverty and a Deprivation Index were used as the main independent variables. General health was assessed using the validated 12-item Short-Form Health Survey version 2, from which physical component summary and mental component summary were derived.

Results Our results in multivariable ordinal logistic regressions consistently showed that, after adjusting for income poverty, socio-demographic and lifestyle factors, being deprived was significantly associated with worse physical (OR 1.66; CI 1.25–2.20) and mental health (OR 1.83; CI 1.43–2.35). Being income poor was also significantly associated with worse mental health (OR 1.63; CI 1.28–2.09) but only marginally with physical health (OR 1.34; CI 1.00–1.80) after adjustments.

Conclusions Income does not capture all aspects of poverty that are associated with adverse health outcomes. Deprivation of non-monetary resources has an independent effect on general health above and beyond the effect of income poverty. Policies should move beyond endowment and take into account the multidimensionality of poverty, in order to address the problem of health inequality.

Keywords Deprivation · Poverty · Physical health · Mental health · Chinese adults · Hong Kong

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11136-018-1863-y>) contains supplementary material, which is available to authorized users.

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Introduction

Health inequality has become a burgeoning field of research especially in the Western world [1]. A major field of health inequality research focuses on the effects of poverty on health that poorer people around the world tend to have worse health outcomes than the better off. Substantial evidence supports that health inequality arises from inequalities in money, resources and power; therefore, achieving equitable distribution of social determinants of health, both across the life course and in wider societal and economic levels, is the key to reducing health inequality [2]. While the association between poverty and health is generally regarded as bilateral and dynamic [3], a growing number of studies focused on understanding the underlying mechanisms, particularly the materialistic and psychosocial mechanisms [1]. However, limited studies about

the effects of poverty on health beyond socio-economic factors were found in the Asian regions. A few Japanese studies suggested that relative income deprivation was associated with functional disability and self-rated health [4, 5], while several Indonesian studies supported the adverse impact of poverty on non-psychotic mental disorders and depression [6, 7]. In China, a meta-analysis found a 1.58 times greater pooled relative risk of mortality after stroke in low-income patients than high-income patients [8]. Several Chinese cross-sectional studies also showed that income poverty was associated with worse self-rated health and psychiatric disability [9, 10].

Hong Kong, as one of the highly developed economies with greatest income inequality, is no exception to this worldwide pattern. It has been found that less advantaged people tend to have greater risks of multi-morbidity [11]. However, a local review by Chung and Wong [12] on health inequality in Hong Kong found that most studies were not designed to examine health inequality as their primary research objective, but took the common approach of examining health differences between social groups pre-defined by various proxy indicators of socio-economic status (e.g. educational level, occupational status, household income). Not only could such an approach make meaningful comparisons difficult, it also omits important aspects of poverty such as non-monetary resources and social barriers to achieving improved living standard. In view of these limitations, deprivation, which results from a lack of financial resources, is increasingly used in international studies.

In this study, we followed Townsend's theory of relative deprivation [13–15] which defines poverty as lack of command over sufficient resources over time, and social and material deprivation as an outcome of poverty, i.e. 'a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs'. [15]. This deprivation concept has been previously adopted in local research [16–18]. Recent reviews on deprivation and poverty in Hong Kong suggested a low overlap between income poverty and deprivation, indicating that both measures play distinct roles in identifying vulnerable social groups [17, 18]. Nevertheless, few studies, if any, have specifically examined the link between deprivation and health independent of income poverty, thereby leaving a research gap for an in-depth investigation. Therefore, our study aims to determine the effects of deprivation on health beyond that of income poverty. We hypothesised that greater deprivation is associated with worse physical and mental health.

Methods

Study design and participants

We used data collected from a random sample of households in Hong Kong via face-to-face survey interviews from June 2014 to August 2015. A sample of 25,000 addresses and 200 segments was obtained from the Census and Statistics Department (C&SD) of the Hong Kong Government, based on the C&SD frame of living quarters (i.e. dwellings). A two-stage stratified sample design was adopted, with the records in the frame of living quarters first stratified by geographical area (i.e. the respondents' living areas by District Council) and then by type of living quarters (i.e. public and private housing). Systemic replicate sampling technique with fixed sampling intervals and non-repetitive random numbers was used to select sampling units. For the first stage, a random sample of living quarters was selected. For the living quarters selected, all households residing in the living quarters were randomly selected for the survey. For the second stage, a respondent aged 18 years or above within each household was recruited, and if the household had more than one adult, the one whose birthday was coming up next would be selected. A household was defined as people living alone or living together, but not necessarily related, in the same living quarter who make common provision for essentials for living. In this study, a total of 4947 addresses were sampled with 3791 valid cases, as 1156 cases were deemed invalid due to unoccupied living quarters, removal, emigration or travelling during the survey period. With a response rate of 60.2%, 2282 household respondents were successfully enumerated.

Measurements

Standard structured questionnaires were administered by trained interviewers to obtain information related to socio-demographic characteristics, lifestyles, poverty and deprivation measures and health outcomes.

Socio-demographic factors

Information on age, gender, marital status, educational level and occupation of the participants was collected. Marital status was categorised as married (including cohabitation) or unmarried (including never married, divorced, separated or widowed). Education level was classified into 'primary or below' or 'secondary and tertiary or above'. Occupation of subjects' current or last jobs was divided into three groups based upon the assumed required skill levels as suggested by the International Labour Organization [19] (i.e. Skill level 1:

elementary occupations/others; Skill level 2: clerical support workers/service and sales workers/craft and related workers/plant and machine operators and assemblers; Skill levels 3 or 4: managers and administrators/professionals/associate professionals). In addition, students and the persons looking after family/home were also included as occupation categories since they referred to the participants' economic activity.

Lifestyle factors

Smoking status was categorised as non-smoker and past/current smoker. Alcohol drinking was categorised as non-risky drinker and risky drinker using Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) [20] which was derived from the first three questions of the AUDIT instrument. Subject with a score of five or above out of 12 was identified as a potentially risky drinker [21]. Physical activity was assessed by the International Physical Activity Questionnaire short form, which was designed for population surveillance of physical activity among adults [22]. Three levels of physical activity (active, minimally active and inactive) were used for classification.

Poverty measures

Income is the most widely used measure of poverty; however, it omits important aspects of poverty, such as non-monetary resources or social barriers that hinder people from achieving the standard of living that is customary in a given society [23]. Therefore, in this study, income poverty and deprivation are two interrelated but distinct measures of poverty included in the analysis as the independent variables. We used equivalised household income to measure income poverty. This is a relative poverty concept, which defines poverty in terms of its relation to the standards that exist elsewhere in the society [24]. Equivalised household income was derived by dividing household income by the square root of the number of people in the household to allow for economies of scale when comparing households of different sizes [25]. People whose equivalised monthly household incomes fell below half of the median equivalised household monthly income in this study (i.e. HK\$6059.2) were classified as 'poor'.

A Deprivation Index (DI) was used to assess if respondents could not afford a range of items which are considered to be necessities of life that no one in Hong Kong should have to go without. 301 respondents in our sample were randomly selected to answer whether they consider items adapted from past studies [23, 26, 27] as necessities, and 21 items that were perceived by 50% or more of the respondents as necessities were included in the construction of DI. Four of these items were measures of social deprivation, while

the remaining 17 items were measures of material deprivation and sub-divided into six groups, 'food deprivation' (3 items), 'clothing deprivation' (3 items), 'medical care deprivation' (3 items), 'household facilities and equipment' (5 items), 'repair and maintenance' (2 items) and 'finance' (1 item). We followed the convention set by Mack and Lansley [28] and considered only those lacking an item due to affordability, but not to personal preference, to be deprived of that particular item. The Cronbach's alpha was high at 0.832, indicating a high reliability for the DI. Referring to the weighted mean DI score of the ten deciles of equivalised household income, the deprivation level was much higher in the lowest income decile (2.66) and dropped sharply in the second and third deciles (1.55 and 1.32, respectively). Therefore, a DI score of 2 was considered 'Deprived' in this study. Further details on the development of DI are presented in Supplementary Material 1.

Health-related quality of life as outcome

Health-related quality of life was assessed using the 12-item Short-Form Health Survey version 2 (SF-12 v2) validated in the Hong Kong Chinese population [29]. The instrument consists of eight domains which were used to derive two distinct summary scores—i.e. physical component summary (PCS) for physical health and mental component summary (MCS) for mental health. We applied a norm-based scoring algorithm with reference to the data from a Hong Kong general population survey [30]. Subjects were categorised into four quartiles based on their corresponding SF-12 v2 PCS and MCS.

Statistical analysis

Continuous variables are presented as mean with their standard deviations (SD) and categorical variables as percentages. Weighting factors based on the distributions of age and gender of the mid-2014 population in Hong Kong were applied for analyses to ensure that the results are representative of the Hong Kong household population (Supplementary Material 2). Three respondents without information on age or gender were excluded as weighting factors could not be applied. Hence, 2279 respondents were included in the following analyses, of which 301 respondents were randomly selected to confirm the items for measuring deprivation and define its threshold value, while the remaining 1978 respondents were included for affordability assessment and multivariable analyses. Multivariable ordinal logistic regressions were performed to examine the association of deprivation with PCS and MCS, with the 4th quartile as the reference group, separately after adjusting for socio-demographic and lifestyle factors. Age and gender were not included in the analysis since component scores were standardised using *z* score transformations for age

and gender. Multiple imputation by chained equations (MICE) was adopted for the multivariable analyses to estimate a set of plausible values for the missing data based on the distribution of the observed data [31]. The statistical package Stata version 14 was employed. All statistical tests were two-tailed with a significance level of p value < 0.05 .

Results

Both unweighted and weighted characteristics on socio-demographic, lifestyle and poverty measures of the final sample, stratified by the first 301 and the remaining 1978 respondents, are shown in Table 1. Comparable profiles were generally observed between the two groups.

Table 2 lists the 21 deprivation items and the weighted percentages of respondents who perceived them as necessities. All 21 items were perceived as necessities by over half of the 301 respondents in this random sub-sample. Percentages of the remaining 1978 respondents who lacked an item due to affordability, further stratified by deprivation status, are also presented in Table 2.

The adjusted odds ratios in ordinal logistic regressions with 4th quartile of the SF-12 scores as the reference group are shown in Table 3 for PCS and MCS. Participants who were deprived (OR 1.66; CI 1.25–2.20) and minimally educated (OR 1.55; CI 1.12–2.15), and those who have ever smoked (OR 1.29; CI 1.04–1.61) had a significantly greater risk of worse physical health (i.e. lower PCS) after adjustments. The association between income poverty and worse physical health was only marginally significant (OR 1.34; CI 1.00–1.80). By contrast, subjects who had a less skilled job and were looking after family/home and students were significantly associated with higher PCS (i.e. decreased risk of worse physical health). The results of MCS in the adjusted model were similar to those of PCS—i.e. participants who were deprived (OR 1.83; CI 1.43–2.35) and minimally educated (OR 2.25; CI 1.59–3.18) had significantly increased risk of worse mental health—except that being income poor (OR 1.63; CI 1.28–2.09) and unmarried (OR 1.25; CI 1.01–1.54) was also significantly associated with greater risk of worse mental health. Moreover, smoking status was not associated with MCS, and no significant association was found between occupation and MCS except for a lower risk among students. In general, being more deprived had an inverse dose–response relationship with both PCS and MCS independent of income poverty (Supplementary Material 3).

Discussion

This is the first study in Hong Kong that examined the association of income poverty and deprivation with health status, in which the two poverty indicators were objectively

measured, while previous studies mainly tested the association between self-perceived poverty and socio-economic conditions with health [32, 33]. Our study results consistently showed that, being deprived was significantly associated with worse physical and mental health, even after adjusting for the effects of income poverty, socio-demographic and lifestyle factors. Our findings are consistent with the international literature, which generally showed that deprivation is associated with poorer health outcomes, particularly with self-rated health status and functioning [34, 35], health-related behaviours [36] and hospitalisation [37]. A Japanese study found that non-monetary poverty was a more powerful predictor than monetary poverty of low self-rated health scores, supporting our findings that poverty is a multidimensional concept that also captures material-based, non-monetary conditions [38]. While it may seem that deprivation was measured differently with varying and highly contextual questions used for index development across studies, there is good evidence that different deprivation indices developed [39–41] have good concordance. However, these area-level deprivation indices, although valuable, may not be able to reflect the actual deprivation situations of each individual who may live in the same area. Therefore, the development of an individual-level index based on Townsend's concept is regarded as a major strength of our study.

Another novel feature of this study was that following Townsend, we conceptualised income poverty and deprivation as two interrelated but distinct indicators of vulnerability in society [42, 43]. We did not incorporate poverty as measured by monetary income into the DI, and therefore were able to delineate the effects of deprivation on health separately from the effects of income poverty on health.

The results confirmed our hypothesis that being deprived of necessities seems to affect people's health above and beyond the influence of income poverty. In fact, as suggested by Sen, poverty should be seen as failures of basic capabilities in terms of both material and social achievements rather than low income per se [44]. Income can only indirectly proxy the materials and social activities that their income can be spent on, while DI directly measures the circumstances of material and social deprivation. Also, using income as the sole measurement of poverty may create bias against retirees and the non-employed, because the fact that they do not have income does not necessarily mean that they are deprived of the necessities of life. Moreover, DI has an additional value to income poverty as it is much less influenced by people's income management. Nevertheless, the effect of income poverty, especially on mental health, remained, given similar affordability of necessities. This could be attributed to greater subjective feelings of personal relative deprivation, as opposed to the deprivation of basic necessities objectively measured by our DI, as a result of upward social comparison [45].

Table 1 Characteristics of subjects ($N=2279$)

	Sample for DI construction ($N=301$)		Sample for multivariable analyses ($N=1978$)	
	Unweighted % (mean \pm SD)	Weighted % (mean \pm SD)	Unweighted % (mean \pm SD)	Weighted % (mean \pm SD)
Health-related quality of life				
Physical component score ^a	(50.9 \pm 9.8)	(51.5 \pm 9.7)	(51.5 \pm 9.0)	(51.8 \pm 8.8)
Mental component score ^b	(55.3 \pm 8.4)	(56.4 \pm 9.0)	(54.9 \pm 8.5)	(55.5 \pm 8.7)
Socio-demographic characteristics				
Age (years)	(55.1 \pm 19.1)	(47.2 \pm 17.6)	(51.6 \pm 17.7)	(47.2 \pm 17.6)
18–30	14.6%	20.9%	13.8%	21.0%
31–40	10.3%	17.9%	14.6%	19.2%
41–50	15.9%	21.2%	21.1%	19.1%
51–60	16.6%	17.4%	18.8%	18.7%
61–70	16.9%	11.5%	16.3%	11.3%
71 or above	25.6%	11.2%	15.5%	10.6%
Gender				
Male	38.2%	45.3%	41.2%	45.3%
Female	61.8%	54.7%	58.8%	54.7%
Marital status ^c				
Married/cohabit	57.1%	58.6%	63.7%	62.4%
Single/divorced/separated/widowed	42.9%	41.4%	36.3%	37.6%
Educational level ^d				
Primary or below	42.0%	28.3%	32.0%	25.1%
Secondary	45.7%	53.0%	53.2%	55.1%
Tertiary or above	12.3%	18.7%	14.8%	19.9%
Occupation ^e				
Skill levels 3 or 4	9.0%	17.3%	11.8%	14.3%
Skill level 2	36.2%	36.5%	35.1%	37.9%
Skill level 1	18.6%	16.0%	21.4%	18.7%
Student	4.5%	5.6%	5.4%	5.6%
Looking after family/home	31.7%	24.6%	26.3%	23.5%
Lifestyle factors				
Smoking status ^f				
Non-smoker	82.7%	83.2%	81.8%	80.7%
Past smoker/current smoker	17.3%	16.8%	18.2%	19.3%
Alcohol drinking ^g				
Non-risky drinker	99.3%	99.3%	96.6%	95.8%
Risky drinker	0.7%	0.7%	3.4%	4.2%
Physical activities				
Active	6.0%	5.3%	11.0%	10.6%
Minimally active	17.6%	11.9%	14.1%	12.8%
Inactive	76.4%	82.8%	74.9%	76.6%
Poverty measures				
Income poverty ^h				
Equivalent household income > half of median	74.8%	82.2%	82.7%	85.6%
Equivalent household income \leq half of median	25.2%	17.8%	17.3%	14.4%
Deprivation ⁱ				
Non-deprived	NA	NA	80.7%	83.1%
Deprived	NA	NA	19.3%	16.9%

Missing data (sample for DI construction/sample for multivariable analyses)—^a7/45; ^b7/45; ^c0/4; ^d1/12; ^e11/61; ^f0/3; ^g5/19; ^h39/152; ⁱ0/1

Table 2 Weighted percentages of respondents who perceived the 21 items as necessities ($N=301$) and those who lacked the 21 items due to affordability ($N=1978$)

Domains and items	% Perceived as a necessity ($N=301$)		% Lacked due to affordability ($N=1978$)	
	Total (%)	Total (%)	Deprived (%)	Non-deprived (%)
Material deprivation				
Food deprivation				
Three meals a day	96.9	0.6	3.6	0.0
Fresh fruit or vegetables every day	94.8	1.0	6.0	0.0
Eat fresh/frozen poultry for special occasions	85.8	2.0	11.4	0.1
Clothing deprivation				
One or two pieces of new clothes in a year	86.0	2.1	11.7	0.1
Enough warm clothes for cold weather	97.8	0.4	2.4	0.0
One set of decent clothes	88.9	2.2	12.4	0.1
Medical care deprivation				
Able to consult private doctor when you are sick	82.1	12.8	60.0	3.2
Able to consult Chinese medicine practitioner when you are sick and purchase prescribed medicines	64.3	7.9	45.2	0.2
Can pay for spectacles if needed	65.7	4.1	21.1	0.6
Household facilities and equipment				
Have toilet inside a self-contained apartment, with no need to share with other residents	98.9	1.0	4.8	0.2
A mobile phone or telephone landline	98.2	0.4	2.1	0.0
A washing machine	94.7	2.0	10.8	0.2
An air-conditioner	93.6	2.0	11.7	0.1
A computer device with internet connection at home	75.6	1.7	9.3	0.1
Repair and maintenance				
Able to replace worn out furniture	77.0	9.4	50.9	1.0
Able to replace/repair broken electrical goods	93.2	7.7	43.3	0.3
Finance				
Some amount of money to spend each week on yourself, not on your family	95.5	4.1	21.8	0.4
Social deprivation				
Celebrations on special occasion	92.6	2.3	12.3	0.2
A meal out with friends or family at least once a month	77.9	7.9	35.4	2.3
Can offer a gift of money on occasion of wedding	78.1	4.0	22.2	0.3
Give red pocket money (<i>laisee</i>) during Chinese New Year	77.7	2.4	13.5	0.2

Two major mechanisms have been postulated in the health inequality literature to explain the associations between deprivation and health, namely material circumstances and psychosocial factors associated with being deprived [1]. We mainly took into account the dimension of material circumstances in our DI, which was constructed using items of material necessities, but we did not fully test the effect of psychosocial factors on the physical and mental health status of our participants in our analyses. However, even though our DI is mainly concerned with material circumstances, it remains difficult to disentangle the material and psychosocial effects on health from one another, and these two explanations are usually not mutually exclusive in reality and their interaction is likely

to be complex. For instance, being materially deprived may have significant psychosocial effects on health directly through allostatic load from stress or indirectly through risky lifestyle behaviours [1, 46]. In our adjusted multivariable analyses, we factored out the effects of major lifestyle factors (i.e. smoking, risky alcohol drinking and physical inactivity) on health by adjustments; hence, we were able to identify deprivation of material circumstances as an important explanation of the health inequalities in Hong Kong, above and beyond their indirect effect on harmful health behaviours. However, further studies are warranted to understand the psychosocial mechanisms of deprivation on health, e.g. whether stress and lifestyle behaviours are mediators of deprivation on health.

Table 3 The associations between poverty and SF-12 ($N=1978$)

	Physical component		Mental component	
	Adjusted OR ^a (95% CI)	<i>p</i> value	Adjusted OR ^a (95% CI)	<i>p</i> value
Poverty measures				
Deprivation Index				
Non-deprived	1		1	
Deprived	1.66 (1.25–2.20)***	<0.001	1.83 (1.43–2.35)***	<0.001
Income poverty				
Non-poor	1		1	
Poor	1.34 (1.00–1.80)	0.052	1.63 (1.28–2.09)***	<0.001
Socio-demographic characteristics				
Marital status				
Married/cohabit	1			1
Single/divorced/separated/widowed	1.14 (0.94–1.38)	0.192	1.25 (1.01–1.54)*	0.038
Educational level				
Tertiary or above	1			1
Secondary	0.95 (0.72–1.24)	0.687	1.23 (0.90–1.69)	0.197
Primary or below	1.55 (1.12–2.15)**	0.009	2.25 (1.59–3.18)***	<0.001
Occupation				
Skill levels 3 or 4	1		1	
Skill level 2	0.64 (0.48–0.85)**	0.002	0.93 (0.67–1.29)	0.660
Skill level 1	0.68 (0.49–0.94)*	0.021	1.04 (0.74–1.47)	0.812
Student	0.53 (0.35–0.79)**	0.002	0.46 (0.26–0.82)**	0.008
Looking after family/home	0.62 (0.45–0.85)**	0.003	1.04 (0.72–1.49)	0.847
Lifestyle factors				
Smoking status				
Non-smoker	1			1
Past smoker/current smoker	1.29 (1.04–1.61)*	0.021	1.09 (0.87–1.37)	0.470
Alcohol drinking				
Non-risky drinker	1		1	
Risky drinker	0.78 (0.50–1.22)	0.277	1.71 (1.00–2.93)	0.052
Physical activities				
Active	1		1	
Minimally active	1.24 (0.87–1.76)	0.236	0.82 (0.57–1.19)	0.299
Inactive	1.23 (0.94–1.61)	0.136	0.88 (0.66–1.18)	0.403

^aORs of all listed variables were mutually adjusted

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; 4th quartile as the reference group

This study was analysed using the first-wave data from a longitudinal study; thus, the analyses were cross-sectional by nature. Further follow-up studies are warranted to identify the strength of the longitudinal associations between poverty, deprivation and health outcomes among different population groups. Questions were self-reported, so there might be some recall bias. Also, there might be some selection bias since the participants being sampled tend to be female, less skilled, older and most likely to be at home during office hours; nevertheless, weighting factors based on the distribution of age and gender of the general Hong Kong population were applied for data analyses to ensure generalisability and unbiased point estimates. Yet, potential over- or

under-representation of certain sampling areas might exist as the single age population data by district are not available for geographical weighting. Furthermore, a subset of sample was enumerated with missing data; however, multiple imputation was adopted to account for these missing data for the multivariable analyses.

Conclusion

Any economic, social or healthcare policymakers should not treat income poverty as the only socio-economic indicator of low living standards. In fact, deprivation of non-monetary

and social resources may have independent effects on health above and beyond income poverty. In order to address health inequality, policies should move beyond endowment of giving money to the poor and take into account the multidimensionality of poverty, e.g. raising living standards through high-quality service provision (such as affordable health care access) also seems to be important.

Acknowledgements We acknowledge Prof Peter Saunders and Prof Jonathan Bradshaw for their invaluable inputs to this project. We would also like to thank Ms Suffy Yeung, Ms Stephanie Chan and Mr Philip Yeung for their assistance earlier in the project.

Author contributions RYC was responsible for literature search, study design, data collection, data analysis, data interpretation and writing. GKC was mainly responsible for literature search, writing, data analysis and data interpretation. DG contributed to literature search, study design, data collection, data interpretation and writing. SYW actively participated in the study design, data collection, data analysis, as well as data interpretation and commented on write-up. DC performed data analysis, data interpretation, generation of tables and writing. ML contributed to literature search, study design, data collection, data interpretation, generation of tables and comments on write-up. VT conducted literature search, data collection, data analysis, as well as data interpretation and commented on write-up. HW was responsible for literature search, study design, data collection, data interpretation and comments on write-up. All authors read and approved the final manuscript.

Funding The work described in this paper was fully supported by a Grant from the Central Policy Unit of the Government of the Hong Kong Special Administrative Region and the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. 4003-SPPR-11).

Data availability The datasets generated and/or analysed during the current study are not publicly available due to agreement with the subjects to safeguard confidentiality, but are available from the corresponding author on reasonable request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

Ethical approval The study has been approved by the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong in June 2012.

Informed consent Informed consent was obtained from all individual participants included in the study.

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