Deprivation is associated with anxiety and stress. A population-based longitudinal household survey among Chinese adults in Hong Kong

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ABSTRACT

Background Mental illness is a major disease burden in the world and disproportionately affects the socially disadvantaged, but studies on the longitudinal association of poverty with anxiety and stress are rare, especially in Asia. Using data from Hong Kong, we aimed to (1) assess the cross-sectional association of poverty with anxiety and stress at baseline, and (2) to examine whether baseline poverty and change in poverty status over time are associated with a subsequent change in anxiety and stress.

Methods Data were obtained from two waves of a territory-wide longitudinal survey in Hong Kong, with sample sizes of n=1970 and n=1224 for baseline and follow-up, respectively. Poverty was measured with a Deprivation Index and income-poverty. Anxiety and stress symptoms were assessed using Chinese Depression, Anxiety and Stress Scale—21 Items. We conducted cross-sectional and longitudinal analyses on the association of poverty with anxiety and stress.

Outcomes Deprivation, but not income-poverty, was significantly associated with both outcomes at baseline. Increased deprivation over time was associated with greater score and increased risk of anxiety and stress. Persistent deprivation over time was associated with greater anxiety and stress, and increased risk of incident anxiety.

Interpretation Deprivation could have significant independent effects on anxiety and stress, even after adjusting for the effects of income-poverty. Greater attention should be paid to deprivation in policymaking to tackle the inequalities of mental health problems, especially since stress and anxiety are precursors to more severe forms of mental illness and other comorbidities.

INTRODUCTION

Mental illness is a major disease burden in the world.[1] Globally, it has been reported that almost one in five of the general population have a common mental disorder, including mood, anxiety and substance-use disorders.[2] Despite its high prevalence, it has been consistently found that mental illness disproportionately affects the socially disadvantaged.[3] A social gradient of mental illnesses has been demonstrated, especially in the developed regions of the world, via various analytical approaches.[4–7] In addition to the conventional socioeconomic factors, including education and occupation, the effect of income on mental illnesses

has been consistently reported at both individual and neighbourhood levels.[4–7] However, the use of socioeconomic factors or income as social indicators has limitations. Both approaches omit important aspects of poverty, such as non-monetary resources and social barriers to achieving improved living standards, as highlighted by some recent studies.[8–10] Also, the use of different socioeconomic proxy indicators in different studies makes meaningful comparisons difficult.

With these limitations, relative deprivation which results from a lack of financial resources is becoming more common in the literature. Since the non-monetary items customary in society are relative to the social norm within a given population, it is necessary to develop a context-specific measurement of material and social deprivation. In the present study, we followed the theory of relative deprivation proposed by Townsend, which defines poverty as lack of command over sufficient resources over time and social and material deprivation as an outcome of poverty; in other words, deprivation is '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.'[11] Recent local reviews suggest a low overlap between income-poverty and deprivation in identifying vulnerable social groups.[12]

As all tangible resources relevant to our daily life carry some psychosocial meanings in practice,[13] it is likely that relative deprivation of material and social necessities exerts an effect on mental well-being. There has been growing evidence in Western populations to show that material hardship or deprivation is strongly and independently associated with poorer mental health status, above the effects of other social indicators, including socioeconomic status, household income and neighbourhood deprivation.[14–17] However, few studies have examined the impact of deprivation on mental illnesses independent of socioeconomic factors and income in Asia. We previously found, in a cross-sectional study, that deprivation was associated with worse general mental well-being, however specific mental health outcomes were not tested in that analysis.[10] There has also been another cross-sectional study in Hong Kong which showed a positive association between deprivation and depressive symptoms among older adults,[18] but it did not assess mental health problems in the general

population. While previous studies that showed the effect of deprivation on mental illnesses focused on depression,[14 18 19] few studies have considered other mental health-related problems such as anxiety and stress. Anxiety disorder is one of the most common mental disorders, with a lifetime prevalence of nearly 3%,[20] and has been linked to substantial psychosocial impairment[21] and poorer quality of life.[22] Psychological stress is associated with a suppressed immune system[23] and an increased risk of various diseases including depression, cardiovascular disease and HIV/AIDS.[24] Moreover, studies on the longitudinal associations of multidimensional poverty with anxiety and stress are rare, especially in Asia. Therefore, it is of interest to understand the cross-sectional and longitudinal associations of deprivation with anxiety and stress.

In this study, we used data from Hong Kong to first assess the cross-sectional baseline association of deprivation with anxiety and stress symptoms, adjusting for the effects of income-poverty, and then examine whether baseline poverty status and change in poverty over time were associated with subsequent changes in anxiety and stress symptoms at follow-up. Hong Kong, despite being a highly developed metropolitan city located in Southern China, has severe income inequality, where the Gini coefficient was 0.539 in 2016.[25] Moreover, approximately 15% (ie, over one million) of Hong Kong's population was living in poverty.[26] We hypothesised that being deprived is associated with a higher risk of anxiety and stress, even after adjusting for the effect of income-poverty, and that change in deprivation will have a greater effect on the subsequent risk of anxiety and stress than baseline deprivation.

METHODS
Study design and sampling
Data were obtained from the two waves of the 'Trends and Implications of Poverty and Social Disadvantages in Hong Kong: A Multi-disciplinary and Longitudinal Study', a territory-wide survey assessing health inequalities in Hong Kong. At the beginning of the study, a sample of 25 000 addresses and 200 segments were obtained from the Census and Statistics Department of the Hong Kong Government, based on the frame of living quarters (ie, dwellings). A two-stage stratified sampling method was adopted, with records in the frame of living quarters stratified by geographical areas and type of living quarters. In the first stage, all households residing in the selected random sample of living quarters were included while, in the second stage, a respondent who aged 18 years or above from each household was selected for the interview. If there was more than one adult in the household, the one whose birthday was coming up next was selected. In total, there were 3791 valid cases out of the 4947 sampled addresses, and face-to-face interviews were conducted at two time points. Baseline interviews were performed between June 2014 and August 2015 and we successfully recruited 2282 household respondents, with a response rate of just over 60%. Follow-up interviews were conducted between February 2016 and March 2017, during which 1444 individuals were re-interviewed (around 64% of those at baseline). Written informed consent was obtained from all subjects. The present analysis excluded those cases without information on age, gender and anxiety and stress symptoms, as well as those previously selected for the construction of the Deprivation Index (DI), resulting in sample sizes of n=1970 and n=1224 for baseline and follow-up, respectively. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human research and with the Helsinki Declaration of 1975, as revised in 2008. This study was approved by the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong in June 2012.

Poverty measures
Income-poverty was defined by a cut-off of equivalised household income, using the relative poverty concept. Equivalised household income was calculated 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.[27] Those with equivalised monthly household income lower than half of the median value in this study (ie, HK$6059.2) were considered as 'income-poor'.

We followed Townsend's theory of relative deprivation[11] and constructed a DI to assess whether respondents could afford a range of items regarded as life necessities in Hong Kong. We first randomly selected 301 respondents to answer whether they thought that a list of possessions and activities were necessities. Twenty-one items which were perceived by at least half of the respondents as necessities were included. Of the 21 items, 4 were measures of social deprivation, while 17 were measures of material deprivation including '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 list out the 21 items of the DI in online appendix table 1. We then compared the weighted mean DI scores among individuals in the 10 deciles of equivalised household income. As the mean DI score was much higher in the lowest income decile (2.66) than in the second and third deciles (1.55 and 1.32, respectively), we considered those with a DI score ≥2 as 'Deprived'. Details on the development and validation of the DI including the list of the 21 items have been described previously.[10]

Outcome measures
Anxiety and stress symptoms were assessed at both time points, using a Chinese version of the Depression, Anxiety and Stress Scale—21 Items (DASS-21).[28] In this study, we included the anxiety domain (DASS-A) and stress domain (DASS-S). Each domain contains seven items scored on a 4-point Likert scale (from 0 to 3) in which respondents were asked to indicate the presence and severity of these symptoms over the past week. Scores from each domain were then summed up and multiplied by 2.[29] We defined anxiety and stress symptoms as those having a sub-score of ≥8 and ≥15, respectively, according to the DASS manual,[29] with a higher score indicating worse mental well-being.

Covariables
A number of variables that were likely to be associated with the above poverty measures (as well as anxiety and stress) were included as covariables in the analyses. These include socio-demographic factors (age, sex, marital status, educational level and occupation); health status (number of chronic disease and self-rated health); and lifestyle factors (smoking, alcohol drinking and physical activity). Educational level was categorised into three groups as primary or below, secondary and tertiary or above. Occupation of respondents (current or last jobs) was defined by the assumed required skill levels according to the International Labour Organisation and was classified as having

skill level 1, 2, 3 and 4 (with 4 being the highest level), being a student and a homemaker. Number of self-reported chronic disease and the first question of the 12-item Short-Form Health Survey version 2 (ie, a self-rated health measure of individuals) were used as proxy measures of the health status of the respondents. Smoking status was grouped as non-smoker and past/current smoker. Alcohol drinking was assessed by the Alcohol Use Disorders Identification Test-Consumption, in which respondents who scored 5 or above out of 12 in the first 3 questions of the instrument were identified as potentially risky drinkers.[30] Physical activity was assessed by the International Physical Activity Questionnaire short form and respondents were categorised into three levels as active, minimally active and inactive.[31]

Statistical analyses

At baseline, the mean DASS-A and DASS-S scores and their corresponding SD were compared across categories of the variables, using either t-tests or ANOVA. Descriptive statistics were also compared between individuals with and without anxiety (DASS-A≥8) or stress (DASS-S≥15) symptoms, using Pearson's χ^2 tests. Cross-sectional associations of poverty measures with (1) DASS-A and DASS-S scores were assessed using linear regression models with β-coefficients and their corresponding 95% CIs presented, while those with (2) anxiety and stress symptoms were assessed using logistic regression models with ORs and their corresponding 95% CIs presented. Interaction effects between deprivation status and income-poverty status were also tested.

For the longitudinal analyses, two types of outcomes were tested—(1) anxiety and stress symptom scores at follow-up and (2) incident anxiety and stress at follow-up. Anxiety and stress symptom scores were modelled as continuous outcome variables. For incident anxiety and stress symptoms at follow-up, we excluded individuals who already had anxiety and stress symptoms at baseline. Linear regression was used for anxiety and stress scores as the outcome, while logistic regression was used for

incident cases of anxiety and stress as the outcome. There are three sets of models—Model 1 tested the associations of baseline poverty status with the outcomes, Model 2 tested the associations of changes in actual DI and income level with the outcomes and Model 3 tested the associations of changes in poverty status with the outcomes. For Model 3, we categorised individuals according to their changes in status of the two poverty measures across the two time points. Those who transitioned from being deprived to being non-deprived were categorised as 'reduced deprivation', and those who transitioned from being income-poor to being income-non-poor were categorised as 'reduced income-poverty'. Conversely, those who transitioned from being non-deprived to being deprived were categorised as 'increased deprivation', and those who transitioned from being non-income-poor to being income-poor were categorised as 'increased income-poverty'. Also, those who stayed deprived and stayed income-poor were categorised as having 'persistent deprivation' and 'persistent income-poverty', respectively. Finally, those who remained non-deprived and non-income-poor across time were categorised as having 'persistent non-deprivation' and 'persistent non-income-poverty', respectively. All models were adjusted for sociodemographic characteristics, health status and lifestyle factors, in addition to being mutually adjusted for deprivation and income-poverty, as well as their interaction term. The linear regression models were also adjusted for baseline anxiety and stress scores.

All statistical analyses were performed by Stata Version 14.2 (StataCorp, College Station, Texas). A p value <0.05 was regarded as statistically significant.

RESULTS

Table 1 summarises the baseline characteristics of respondents by anxiety and stress symptoms. At baseline, the respondents averaged a DASS-A score of 2.0 (SD=4.7), with 196 (10%) having anxiety symptoms, while they averaged a DASS-S score of 2.6 (SD=6.0), with 108 (5.5%) having stress symptoms.

Table 1 Descriptive statistics of anxiety and stress by respondent characteristics at baseline

Variable	Total number (%)	Anxiety symptoms					Stress symptoms				
		DASS-A score		DASS-A≥8			DASS-S score		DASS-S≥15		
		Mean±SD	P value*	No, n (%)	Yes, n (%)	P†	Mean±SD	P*	No, n (%)	Yes, n (%)	P†
Total	1970 (100)	2.0±4.7		1774 (90.0)	196 (10.0)		2.6±6.0		1862 (94.5)	108 (5.5)	
Poverty measures											
Deprivation index			<0.001			<0.001		<0.001			<0.001
Non-deprived (<2)	1592 (80.9)	1.6±3.9		1469 (82.9)	123 (62.8)		2.0±5.0		1531 (82.3)	61 (56.5)	
Deprived (≥2)	377 (19.2)	3.9±6.9		304 (17.2)	73 (37.2)		5.2±8.6		330 (17.7)	47 (43.5)	
Income-poverty			0.006			0.014		0.020			0.073
Non-income-poor	1509 (82.8)	1.8±4.6		1371 (83.5)	138 (76.2)		2.4±5.7		1436 (83.2)	73 (76.0)	
Income-poor	314 (17.2)	2.6±5.1		271 (16.5)	43 (23.8)		3.3±6.4		291 (16.9)	23 (24.0)	
Socio-demographic characteristics											
Age			0.591			0.128		<0.001			0.012
18–30	272 (13.8)	2.2±4.4		239 (13.5)	33 (16.8)		3.5±6.7		252 (13.5)	20 (18.5)	
31–40	289 (14.6)	1.9±4.5		266 (15.0)	23 (11.7)		3.1±6.4		273 (14.7)	16 (14.8)	
41–50	416 (21.1)	2.1±5.2		371 (20.9)	45 (23.0)		3.0±6.2		387 (20.8)	29 (16.9)	
51–60	370 (18.8)	2.1±4.9		330 (18.6)	40 (20.4)		2.4±5.8		352 (18.9)	18 (16.7)	
61–70	320 (16.2)	2.1±5.2		284 (16.0)	36 (18.4)		2.6±6.3		299 (16.1)	21 (19.4)	
71 or above	303 (15.4)	1.6±3.9		284 (16.0)	19 (9.7)		1.4±4.1		299 (16.1)	4 (3.7)	

Continued

Table 1   Continued

Variable	Total number (%)	Anxiety symptoms					Stress symptoms				
		DASS-A score		DASS-A≥8			DASS-S score		DASS-S≥15		
		Mean±SD	P value*	No, n (%)	Yes, n (%)	P†	Mean±SD	P*	No, n (%)	Yes, n (%)	P†
Sex			<0.001			0.001		<0.001			0.007
Male	812 (41.2)	1.5±3.9		753 (42.5)	59 (30.1)		2.0±5.2		781 (41.9)	31 (28.7)	
Female	1158 (58.8)	2.4±5.2		1021 (57.5)	137 (69.9)		3.1±6.4		1081 (58.1)	77 (71.3)	
Marital status			0.002			0.052		0.005			0.097
Single/divorced/separated/widowed	716 (36.4)	2.4±5.2		633 (35.7)	83 (42.8)		3.1±6.6		669 (36.0)	47 (43.9)	
Married/cohabit	1250 (63.6)	1.7±4.3		1139 (64.3)	111 (57.2)		2.3±5.6		1190 (64.0)	60 (56.1)	
Educational level			0.364			0.234		0.243			0.430
Primary or below	629 (32.1)	2.2±5.1		557 (31.6)	72 (36.7)		2.4±5.9		593 (32.0)	36 (33.3)	
Secondary	1041 (53.1)	2.0±4.7		940 (53.3)	101 (51.5)		2.6±5.9		989 (53.4)	52 (48.2)	
Tertiary or above	289 (14.8)	1.8±3.9		266 (15.1)	23 (11.7)		3.2±6.7		269 (14.5)	20 (18.5)	
Occupation			0.100			0.057		0.181			0.173
Skill level 3 or 4	227 (11.9)	1.2±3.0		217 (12.6)	10 (5.3)		2.5±5.3		219 (12.1)	8 (7.6)	
Skill level 2	671 (35.2)	2.0±4.6		603 (35.0)	68 (36.4)		2.5±5.9		636 (35.3)	35 (33.3)	
Skill level 1	408 (21.4)	2.1±5.0		366 (21.3)	42 (22.5)		2.4±5.7		388 (21.5)	20 (19.1)	
Student	103 (5.4)	2.2±3.9		90 (5.2)	13 (6.9)		3.9±7.4		93 (5.2)	10 (9.5)	
Looking after family/home	500 (26.2)	2.3±5.5		446 (25.9)	54 (28.9)		2.9±6.3		468 (25.9)	32 (30.5)	
Health status											
Number of chronic disease			<0.001			<0.001		<0.001			0.002
0	1428 (72.9)	1.6±4.2		1314 (74.5)	114 (58.8)		2.3±5.5		1366 (73.8)	62 (58.5)	
1	402 (20.5)	2.4±5.0		353 (20.0)	49 (25.3)		3.1±6.4		371 (20.0)	31 (29.3)	
≥2	128 (6.5)	5.0±7.6		97 (5.5)	31 (16.0)		5.0±8.5		115 (6.2)	13 (12.3)	
Self-rated health			<0.001			<0.001		<0.001			<0.001
Poor	104 (5.3)	7.1±8.5		64 (3.6)	40 (20.4)		7.3±9.0		82 (4.4)	22 (20.4)	
Fair	492 (25.1)	3.0±5.6		406 (22.9)	86 (43.9)		3.9±7.0		444 (24.9)	48 (44.4)	
Good	840 (42.8)	1.5±3.9		789 (44.5)	51 (26.0)		2.1±5.5		811 (43.6)	29 (26.9)	
Very good	461 (23.5)	1.0±3.0		443 (25.0)	18 (9.2)		1.5±4.1		454 (24.4)	7 (6.5)	
Excellent	65 (3.3)	0.3±1.1		65 (3.7)	0 (0.0)		1.2±3.8		64 (3.4)	1 (0.9)	
Lifestyle factors											
Smoking status			0.289			0.308		0.959			0.855
Non-smoker	1608 (81.8)	2.0±4.6		1453 (82.0)	155 (79.1)		2.6±5.9		1519 (81.7)	89 (82.4)	
Past smoker/current smoker	359 (18.2)	2.3±5.3		318 (18.0)	41 (20.9)		2.6±6.6		340 (18.3)	19 (17.6)	
Alcohol drinking			0.141			0.589		0.197			0.213
Non-risky drinker	1884 (96.6)	2.0±4.7		1697 (96.6)	187 (95.9)		2.6±6.0		1782 (96.7)	102 (94.4)	
Risky drinker	67 (3.4)	2.9±5.8		59 (3.4)	8 (4.1)		3.6±7.4		61 (3.3)	6 (5.6)	
Physical activity level			0.007			<0.001		0.057			0.071
Inactive	1477 (75.0)	2.2±5.0		1307 (73.7)	170 (86.7)		2.8±6.2		1386 (74.4)	91 (84.3)	
Minimally active	276 (14.0)	1.6±3.8		260 (14.7)	16 (8.2)		2.2±5.3		266 (14.3)	10 (9.3)	
Active	217 (11.0)	1.3±3.3		207 (11.7)	10 (5.1)		1.9±4.9		210 (11.3)	7 (6.5)	

*p values were obtained by t-tests or ANOVA.
†p values were obtained by χ^2-tests.
DASS, Depression Anxiety Stress Scales.

Those with anxiety symptoms were more likely to be deprived, income-poor, female, physically inactive, multimorbid and had poorer self-rated health, while those with stress symptoms tended to be deprived, younger, female, multimorbid and had poorer self-rated health. Comparisons of baseline characteristics between censored and non-censored respondents are shown in online appendix table 2, while comparisons between our sample population and the Hong Kong general population are shown in online appendix table 3, which shows that our sample was generally comparable to the Hong Kong general population, with slightly more older persons, female, married or cohabit persons, and less tertiary-educated persons. We also present the baseline characteristics of our sample by deprivation status in online appendix table 4, which shows that the overlap between the deprived and the income-poor was low in our sample.

Table 2 Cross-sectional associations of poverty measures with anxiety and stress at baseline

| | Anxiety symptoms | | | | Stress symptoms | | | |
| | DASS-A score | | DASS-A≥8 | | DASS-S score | | DASS-S≥15 | |
Variable	β-Coefficient (95% CI)†	P value	OR (95% CI)†	P value	β-coefficient (95% CI)†	P value	OR (95% CI)†	P value
Poverty measures								
Deprivation								
Non-deprived	0	–	1	–	0	–	1	–
Deprived	**2.10 (1.44 to 2.76)**	**<0.001**	**1.83 (1.15 to 2.91)**	**0.011**	**3.20 (2.36 to 4.05)**	**<0.001**	**3.42 (1.93 to 6.05)**	**<0.001**
Income-poverty								
Non-income-poor	0	–	1	–	0	–	1	–
Income-poor	0.06 (−0.68 to 0.80)	0.873	0.71 (0.34 to 1.46)	0.349	0.42 (−0.52 to 1.36)	0.384	1.25 (0.51to 3.10)	0.624

†Outcome ~ baseline sociodemographic characteristics (age, sex, marital status, educational level and occupation), health status (number of chronic disease, self-rated health), lifestyle factors (smoking status, alcohol drinking and physical activity), poverty measures (deprivation and income-poverty) and deprivation*income-poverty interaction.
Bold typeface indicates statistical significance.
DASS, Depression Anxiety Stress Scales.

Table 2 presents the cross-sectional associations of poverty measures with anxiety and stress at baseline. Deprivation was significantly associated with greater DASS-A score (β-coefficient=2.10; 95% CI=1.44 to 2.76) and higher risk of having anxiety symptoms (OR=1.83; 95% CI=1.15 to 2.91). Similarly, deprivation was significantly associated with greater DASS-S score (β-coefficient= 3.20; 95% CI=2.36 to 4.05) and higher risk of having stress symptoms (OR=3.42; 95% CI=1.93 to 6.05). No significant association was observed between income-poverty and anxiety and stress symptoms. The interaction terms between deprivation status and income-poverty status were also not significant. Attrition analysis (online appendix table 5) was also conducted for robustness check, and we found that the directions of the results were all consistent, and the magnitudes of the results were largely comparable with overlapping CIs. The only exception to the consistency is that the association between being deprived and incident anxiety was non-significant for the censored sample, but the direction of the association was still consistent.

Table 3 shows the longitudinal associations between poverty measures and anxiety and stress across the two time points. In

Model 1, baseline deprivation and income-poverty did not have significant associations with any of the outcomes for anxiety and stress at follow-up.

In Model 2, where change in DI and income level across time were treated as predictors, increase in DI was consistently and significantly associated with worse mean DASS-A score (β=3.40 95% CI=1.43 to 5.38) and increased risk of incident anxiety (OR=4.42; 95% CI=1.06 to 18.51) as compared with no change in DI. No significant results were observed for stress or income level change.

In Model 3, where change in deprivation and income-poverty status across time were treated as predictors, as compared with persistent non-deprivation, increased deprivation was significantly associated with worse mean DASS-A score (β=1.89; 95% CI=0.17 to 3.62) and worse mean DASS-S score (β=3.08; 95% CI=0.98 to 5.19), while persistent deprivation was also significantly associated with worse mean DASS-A score (β=3.06; 95% CI=1.04 to 5.08) and worse mean DASS-S score (β=3.46; 95% CI=1.00 to 5.93). The results were also quite consistent for incident anxiety and stress as outcomes. As compared with persistent non-deprivation, increased deprivation was significantly

Table 3 Longitudinal associations of poverty measures with DASS scores and incident anxiety and stress at follow-up

| | | Anxiety symptoms | | | | Stress symptoms | | | |
| | | DASS-A score at follow-up | | Incident anxiety at follow-up* | | DASS-S score at follow-up | | Incident stress at follow-up* | |
Poverty measure	n (%)	β-coefficient (95% CI)†	P value	OR (95% CI)‡	P value	β-coefficient (95% CI)†	P value	OR (95% CI)‡	P value
Model 1: Baseline deprivation and income-poverty§									
Deprivation									
Non-deprived	983 (80.3)	0	–	1	–	0	–	1	–
Deprived	241 (19.7)	0.34 (−0.57 to 1.24)	0.467	1.14 (0.54 to 2.44)	0.728	0.36 (−0.74 to 1.46)	0.516	0.71 (0.26 to 1.95)	0.509
Income-poverty									
Non-income-poor	934 (81.6)	0	–	1	–	0	–	1	–
Income-poor	211 (18.4)	−0.52 (−1.48to 0.44)	0.292	0.99 (0.46 to 2.15)	0.990	−1.02 (−2.19 to 0.14)	0.085	0.14 (0.02 to 1.08)	0.059
Model 2: Change in DI and income§									
DI change									
Decrease	250 (20.4)	−0.10 (−2.07 to 1.88)	0.924	0.70 (0.07 to 7.00)	0.760	0.43 (−1.99 to 2.84)	0.728	1.42 (0.12 to 17.47)	0.782
No change	753 (61.5)	0	–	1	–	0	–	1	–
Increase	221 (18.1)	**3.40 (1.43 to 5.38)**	**0.001**	**4.42 (1.06 to 18.51)**	**0.042**	2.11 (−0.31 to 4.52)	0.087	2.11 (0.25 to 17.49)	0.490
Income change									
Decrease	525 (47.4)	0.25 (−0.98 to 1.47)	0.695	0.94 (0.29 to 3.04)	0.911	0.63 (−0.87 to 2.13)	0.408	0.83 (0.17 to 4.13)	0.824

Continued

Table 3 Continued

Poverty measure	n (%)	Anxiety symptoms				Stress symptoms			
		DASS-A score at follow-up		Incident anxiety at follow-up*		DASS-S score at follow-up		Incident stress at follow-up*	
		β-coefficient (95% CI)†	P value	OR (95% CI)‡	P value	β-coefficient (95% CI)†	P value	OR (95% CI)‡	P value
No change	131 (11.8)	0	–	1	–	0	–	1	–
Increase	451 (40.7)	0.26 (−0.99 to 1.51)	0.683	0.99 (0.30 to 3.26)	0.983	0.79 (−0.74 to 2.32)	0.311	1.27 (0.26 to 6.20)	0.765
Model 3: Change in deprivation and income-poverty status§									
Deprivation									
Persistent non-deprivation	920 (75.2)	0	–	1	–	0	–	1	–
Reduced deprivation	162 (13.2)	−0.59 (−1.66, 0.48)	0.278	0.53 (0.15 to 1.85)	0.321	−0.52 (−1.82 to 0.78)	0.434	0.51 (0.11 to 2.37)	0.392
Increased deprivation	65 (5.3)	**1.89 (0.17 to 3.62)**	**0.032**	**4.73 (1.68 to 13.32)**	**0.003**	**3.08 (0.98 to 5.19)**	**0.001**	**7.07 (2.28 to 21.92)**	**0.001**
Persistent deprivation	77 (6.3)	**3.06 (1.04 to 5.08)**	**0.003**	**5.52 (1.68 to 18.15)**	**0.005**	**3.46 (1.00 to 5.93)**	**0.006**	2.08 (0.40 to 10.86)	0.384
Income-poverty									
Persistent non-income-poverty	848 (76.6)	0	–	1	–	0	–	1	–
Reduced income-poverty	66 (6.0)	−0.78 (−2.28 to 0.73)	0.310	0.29 (0.04 to 2.23)	0.232	−1.14 (−2.98 to 0.69)	0.221	3.34 (0.20 to 54.89)	0.399
Increased income-poverty	60 (5.4)	0.20 (−1.60 to 2.00)	0.825	0.61 (0.07 to 5.35)	0.653	0.59 (−1.60 to 2.78)	0.597	1.56 (0.28 to 8.59)	0.607
Persistent income-poverty	133 (12.0)	−0.20 (−1.60 to 1.20)	0.777	1.23 (0.40 to 3.80)	0.725	−1.21 (−2.92 to 0.50)	0.165	0.20 (0.02 to 2.23)	0.189

*Individuals with anxiety/stress symptoms at baseline were excluded.
†Outcome ~ baseline sociodemographic characteristics (age, sex, marital status, educational level, and occupation), health status (number of chronic disease and self-rated health), lifestyle factors (smoking status, alcohol drinking and physical activity), poverty measures (deprivation and income-poverty), deprivation*income-poverty interaction and baseline DASS sub-scores.
‡Outcome ~ baseline sociodemographic characteristics (age, sex, marital status, educational level and occupation), health status (number of chronic disease and self-rated health), lifestyle factors (smoking status, alcohol drinking and physical activities), poverty measures (deprivation and income-poverty) and deprivation*income-poverty interaction.
§Interaction term for Model 1—baseline deprivation status*baseline income-poverty status; Model 2—change in DI*change in income; Model 3—change in deprivation status*change in income-poverty status.
Bold typeface indicates statistical significance.
DASS, Depression Anxiety Stress Scales.

associated with increased risk of incident anxiety (OR=4.73; 95% CI=1.68 to 13.32) and of incident stress (OR=7.07; 95% CI=2.28 to 21.92) at follow-up. Persistent deprivation was significantly associated with only incident anxiety (OR=5.52; 95% CI=1.68 to 18.15) but not incident stress (OR=2.08; 95% CI=0.40 to 10.86) at follow-up. None of the changes in income-poverty status was significantly associated with any longitudinal outcomes of anxiety and stress. Moreover, the interaction terms between deprivation and income were also not significant across all three models (data not shown).

DISCUSSION

To our knowledge, this is the first study in Hong Kong and Asia that examines the association of multidimensional poverty with specific mental health-related outcomes of anxiety and stress, and in which the two poverty indicators (deprivation and income-poverty) were objectively measured.

The results confirmed our first hypothesis that being deprived is associated with a higher risk of anxiety and stress, even after adjusting for the effect of income-poverty, as consistently shown in the cross-sectional analyses. In the longitudinal analyses, the findings were more complicated but largely consistent. Baseline deprivation or income-poverty did not significantly predict the mental health-related outcomes at follow-up; however, increase in DI over time was associated with greater anxiety score and greater risk of incident anxiety at follow-up, but not stress. Also, those who became deprived across the two time points (ie,

increased deprivation) were significantly associated with greater anxiety and stress scores, and greater risk of incident anxiety and stress. Those who remained to be deprived across time (ie, persistent deprivation) were significantly associated with greater anxiety and stress scores, and greater risk of incident anxiety but not stress.

Generally, the associations between deprivation and mental health are much more apparent and consistent than the ones between income-poverty and mental health. Our findings imply that it was not the income-poverty that stressed people out or led people into anxiety, but it was deprivation that mattered much more to mental health. This is plausible because income can only indirectly act as a proxy of the material and social circumstances of the person at stake. For instance, retirees and the non-employed without income may not be deprived of the necessities of life, especially when they have liquid assets that are not adequately accounted for by conventional income measurement. This is reflected by our sample, where there was a low overlap between deprivation and income-poverty as mentioned earlier, and where 25.9% of the retired were deprived but a higher proportion of 43.9% of the retired were income-poor. It may also be that persistently income-poor individuals have better adjusted to their lifestyles and expectations. A Japanese study, which found that non-monetary poverty predicts low self-rated health scores more powerfully than monetary poverty, also supports our findings that poverty is a multidimensional concept that cannot be adequately captured by monetary measures alone.[9] This

conceptualisation of poverty has also been postulated by Sen, who sees poverty as failures of basic capabilities in terms of both material and social achievements rather than low income per se.[32] This is an important finding that echoes the arguments made by Case and Deaton[33]: 'many of the things that people have reason to care about are not reducible to money or measurable in monetary terms. It is true that those other things are more difficult when money is scarce, so the decline in material well-being is a cause of distress in other aspects of life. Being left behind financially is a key part of the story but it is only the beginning'. Moreover, the consistent absence of significant interaction effects between deprivation and income shows that the association of deprivation with the mental health-related outcomes is consistent for different income levels or income-poverty status, establishing the robustness of deprivation as a predictor of mental health-related conditions.

Our study findings also confirmed the second hypothesis that the exacerbation of deprivation does have a negative effect on mental health and that the predictive power of baseline deprivation on subsequent mental health is not as apparent. This has significant public health implications—in order to protect mental health, the circumstances of deprived individuals should not be made worse. However, the findings of significant associations of persistent deprivation with worse anxiety and stress, and increased risk of incident anxiety, suggested that it is also insufficient to not aggravate the circumstances of deprivation alone; deprived individuals who stayed deprived over time also had generally worse mental health-related outcomes. Furthermore, reduction in deprivation level across time was linked to less anxiety and stress; however, the results were not significant, implying that poverty may have a long-lasting effect on health that does not wane after the circumstances have improved. This is alarming because it is essentially saying that the reduction of deprivation may not have any immediate positive effect on subsequent mental health. Nevertheless, we should not conclude that efforts to reduce deprivation are futile as there may be longer lag effect on mental health that cannot be picked up by the current analyses. Also, for those who have suffered from deprivation, they could still be genuinely worried about what will happen in the future even when their deprivation level had fallen. While we did not ask about their concern over material and social circumstances in the future in our current survey, later studies can certainly explore whether worry for the future has any nullifying effect on the supposedly positive outlook of the reduction of deprivation level.

Moreover, the results were more sensitive for change in deprivation status (ie, deprived vs non-deprived) than for change in actual DI. This is an important finding, implying that there may be a threshold effect for deprivation; in other words, the status of being deprived is more predictive of anxiety and stress than the change in the index score itself. This is also reasonable because the distribution of DI tends to be skewed, making the presentation of linear results for the association between deprivation and mental health-related outcomes less meaningful.

Limitations

There are caveats to our study. First, the results are based on self-reported questions which may be subject to recall bias. Second, selection bias may also be present since our sample tended to be those who stayed home during normal office hours. Nevertheless, we are interested in examining the association between factors but not the actual prevalence. Also, analyses using age- and gender-weighted factors produced similar results (data not shown), ensuring the generalisability of our findings. Third, potential over- or under-representation of certain sampling areas might still exist, since the single age population data by district were not available for geographical weighting. However, as mentioned, we are interested in examining the association between factors and it is unlikely that the association would be systematically different across the districts of Hong Kong. Last, the study did not look at depression because it was not collected in the survey, leaving a research gap for future studies.

CONCLUSION

Taken together, our cross-sectional and longitudinal findings consistently showed that deprivation of non-monetary material and social resources could have significant independent effects on mental health in terms of anxiety and stress even after taking the effects of the common indicators of income-poverty into account. Also, in order not to exacerbate mental health, deprivation should be reduced. Our findings lend support to the concept of deprivation being given greater attention in policymaking in order to tackle the inequalities of mental health problems, especially since stress and anxiety are often precursors to the more severe forms of mental illness and other comorbidities.

What is already known on this subject

► Mental illness is a major disease burden in the world and disproportionately affects the socially disadvantaged. Previous studies have focused on Western populations and depression, but not Asia and other mental health-related conditions. More importantly, the mechanism of the longitudinal association between multidimensional poverty and mental health (ie, baseline poverty vs changes of poverty status) was also not thoroughly tested in the literature.

What this study adds

► To our knowledge, this is the first longitudinal study that examines the association of multidimensional poverty with specific mental health-related outcomes of anxiety and stress, and in which two poverty indicators (deprivation and income-poverty) were objectively measured. Taken together, our findings consistently showed that deprivation of non-monetary material and social resources could have significant independent effects on mental health in terms of anxiety and stress even after adjusting for the effects of income-poverty. Also, it is the exacerbation or persistence of deprivation over time, not baseline deprivation, that has a longitudinal effect on mental health at follow-up. Greater attention should be paid to deprivation in policymaking to tackle the inequalities of mental health problems, especially since stress and anxiety are precursors to more severe forms of mental illness and other comorbidities.

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