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Associations between commuting and well-being in the context of a compact city with a well-developed public transport system

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ABSTRACT

Introduction: Negative impacts of long commuting time on people's well-being have been found in many suburbanized private car-dominant cities. However, there is a dearth of evidence regarding this association in a compact city with a well-developed public transport system. Taking Hong Kong as an example, the current study aims to explore the associations between modes of transport and commuting time with well-being.

Methods: The study used the data of 990 commuters from the first wave of the Hong Kong Panel Survey for Poverty Alleviation in 2015. Multivariate logistic and linear regressions were used to test the associations of commuting time and commuting modes with well-being. The well-being outcomes included obesity measured by self-reported body mass index (BMI), mental distress (CHQ-12), self-rated health (SRH) and satisfaction with life (SWLS-5).

Results: After the confounding variables were adjusted, significant association have been found between commuting time and satisfaction with life [-0.14, 95% CI: (−0.03, −0.00)]. More specifically, those who commute 60–89 min [-1.57, 95% CI: (−2.98, −0.16)], 90–119 min [-2.36, 95% CI (−4.56, −0.16)] and 120 min or more [-4.85, 95% CI (−9.11, −0.59)] report significantly lower satisfaction with life than those who commute within 30 min. Moreover, excessive commuting time (90–119 min) has been found significantly associated with obesity with an odd ratio of 2.80 [95% CI: (1.30–6.04)].

Conclusions: In Hong Kong, commuting time over 60 min is associated with negative satisfaction with life, and commuting time over 90 min is associated with higher risk of obesity. Policymakers of a compact city with a well-developed transport system should be informed of the negative impacts of long commuting time on well-being.

1. Introduction

Increasing commuting distance and time has become a widespread concern in modern societies. It sometimes occupies too much of individuals' daily lives, reducing their engagement in other forms of activities such as physical activities and social participation, thereby threatening their health and satisfaction with life (Christian, 2012; Mattisson et al., 2015). Long commuting time has been

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found to be associated with bad perceived physical health (Hansson et al., 2011; Künn-Nelen, 2016; Oliveira et al., 2015), poor mental health (Chng et al., 2016; Feng and Boyle, 2014; Hansson et al., 2011; Ohta et al., 2007; Roberts et al., 2011) and low life satisfaction (Chng et al., 2016; Hilbrecht et al., 2014; Kroesen, 2014; Nie and Sousa-Poza, 2016; Stutzer and Frey, 2008). It is noteworthy however, that the negative effects on well-being are mostly caused by commuting by private vehicle, while active commuting such as walking, cycling and travelling by public transport, can potentially improve commuters' physical health through commuting-related physical activities. For example, it has been reported that active commuters have lower BMI than those who commute by private vehicles (Flint and Cummins, 2016; Flint et al., 2014; Flint et al., 2016; Mytton et al., 2016; Tajalli and Hajbabaie, 2017). Some studies have further discovered that active commuters have better mental health than their counterparts using private vehicles (Martin et al., 2014; Ohta et al., 2007; Roberts et al., 2011). In addition, walking, compared to using cars as a mode of commuting, has been found to be associated with higher life satisfaction (Chng et al., 2016).

Increasing mobility among commuters resulting in extending the regions of their jobs is the most cost-effective approach to increase material wealth by better linking jobs and residences to create more working opportunities (Ihlanfeldt and Sjoquist, 1998). Therefore, transport policies mainly driven by mobility strategy have prevailed in many countries, resulting in an increase in overall commuting (European Policy Brief, 2008). Over the past decades, well-being has become an important issue in government agendas, and thus measures of well-being are increasingly included in policy evaluations. Well-being consists of multiple dimensions, including physical, mental, and subjective well-being (Naci and Ioannidis, 2015). Life satisfaction level reflects people's thoughts and feelings about life and therefore serves as a major domain of subjective well-being (Pénard et al., 2013). Researchers focusing on transport and well-being tend to use life satisfaction as their sole measure of subjective well-being (De Vos et al., 2013). Based on the comprehensive definitions of well-being and the previous studies on its relationship with commuting, well-being is conceptualized in three dimensions in this study, including physical health, mental health and life satisfaction.

Active transport has become a tool to promote well-being in daily routines such as commuting to work. However, active transport to key destinations will only be possible when cities are compact and equipped with developed transportation infrastructures. Hong Kong is a prototype compact city with a well-developed transport system. Hong Kong is among the most densely-populated regions across the world, with a population of 7 million living in around 70 square kilometres. It is also a transit-based city that provides its residents with sufficient mobility and accessibility. Compared to other developed cities, commuting by private vehicles is much less popular among Hong Kong residents. Only 15.1 per cent of households possess private vehicles while 88 per cent of daily commuting are dependent on the public transport system (Hong Kong SAR Transport Department, 2014). Studies exploring the effect of commuting on well-being are mostly conducted in suburbanized private car-dominant cities, while the situation of compact cities with developed transport systems is largely unknown. This study supplements the literature in this field by investigating into the effect of commuting on well-being in a compact city with a well-developed transport system like Hong Kong.

2. Methods

2.1. Data source and sample

In this study, data from the Hong Kong Panel Survey for Poverty Alleviation, a longitudinal study of households in Hong Kong that began in 2015, were used. The study was funded by the Jockey Club Charities Trust with the aim to understand the poverty situation in Hong Kong. A stratified random sampling method was used in this study to select a regional representative sample of 2,002 households. Face-to-face interviews were conducted to collect the individuals and households' information, information on the commuting patterns, poverty and social stratification, and also their physical and subjective well-being. Detailed descriptions of this survey were reported by previous studies (Peng et al., 2018a; Peng et al., 2018b). Samples in this study have been restricted to 990 working individuals who have reported in their questionnaires that they have fixed workplace in Hong Kong. This survey was approved by the Human Research Ethics Committee for Non-Clinical Faculties, the University of Hong Kong (Ref: EA1506006). The respondents with missing values are excluded in the models, and the missing pattern was found to be at random because the excluded samples were not significantly different from the remaining samples in terms of demographic characteristics.

2.2. Outcome measures

In this study, well-being was operationalized in terms of obesity, which was measured by body mass index (BMI), mental distress, which was measured by the Chinese Health Questionnaire-12 (CHQ-12), self-rated health (SRH) and satisfaction with life measured, which was measured by the Satisfaction with Life Scale-5 (SWLS-5).

Weight status, measured by BMI, could be treated as an objective health indicator. BMI is estimated by dividing self-reported weight (kilograms) by the square of self-reported height (metres) (World Health Organization, 2000). Although some may argue it is a lifestyle factor (Prosper et al., 2009), researchers often dichotomize weight status according to certain cut-off values of BMI as obese (versus normal or overweight) and interpret it as an objective dimension of health (Singh-Manoux et al., 2006). As Asians often have smaller body frames than the Caucasians, Hong Kong people may have abnormal body fat with lower BMI than the people from western countries. In a study based on body fat assessment in Hong Kong, G. T. Ko et al. (2001) suggest using 26 kg/m^2 as the cut-off value of BMI to define obesity in the Hong Kong population instead of using the 30 kg/m^2 cut-off value suggested by the WHO (World Health Organization, 2000). In this study, the cut-off value suggested by G. T. Ko et al. (2001) is adopted.

Mental distress was measured by the 12-item Chinese Health Questionnaire (CHQ-12), which is the Chinese version of the General Health Questionnaire, a widely used and validated instrument to assess general psychological health in the Chinese population

(Chong and Wilkinson, 1989; Shek, 1987, 1989). Each question has a choice of four options in which the presence or intensity of the state over the last few weeks is related to its usual frequency or intensity, thereby adding a total of 36 points on the Likert scale (each question scoring from 0 to 3).

Self-rated health was measured by asking the interviewees how they felt in terms of their general state of health, the responses ranging from “very poor” (0) to “very good” (4). This is one of the widely used validated indicators of health in the field of social sciences (Idler and Benyamini, 1997).

Life satisfaction was measured by the Satisfaction with Life Scale-5, which is a short five-item instrument designed to measure global cognitive judgement of satisfaction with one's life (Kobau et al., 2010), and this was validated in the Chinese population (Bai et al., 2011). There are 5 items in the scale: ‘I am satisfied with my life’; ‘So far I have gotten the important things I want in life’; ‘In most aspects, my life is close to my ideal’; ‘The conditions of my life are excellent’; ‘If I could live my life over, I would almost change nothing’. Based on the respondents' agreement with the descriptions of each item, the responses range from “strongly disagree” (0) to “strongly agree” (6). As suggested by Diener et al. (1985), the total score of the SWLS was calculated for each participant. The total score ranges from 0 to 30 with higher scores indicating higher levels of life satisfaction.

2.3. Exposure measures

The key explanatory variable is commuting time, derived from the question ‘How much time do you spend on a round-trip between home and workplace?’ Commuting time instead of commuting distance is selected as the foci of this study in consistence with the common practice in the transportation, public health and urban economics literature. Because both economically and emotionally, time is more directly associated with the cost of commuting (Roberts et al., 2011). In the present study, the measurement of round-trip commuting time in minutes was used. In accordance with most of the literature (Dickerson et al., 2014; Oliveira et al., 2015; Roberts et al., 2011; Stutzer and Frey, 2008), commuting time was analysed in terms of minutes spent on a one-way daily travel, and commuting time was recoded into five groups: 0–29 min, 30–59 min, 60–89 min, 90–119 min and 120 min and more.

There is no universally accepted definition as to what constitutes a long journey to work. The definition of a long journey varies in different countries. Studies have suggested that 20 min (Besser et al., 2008), 45 min (Van Ham, 2001) and 60 min (Hansson et al., 2011) are commonly perceived as acceptable travelling time for most workers. In order to test the sensitivity of the present results, several commuting time dummy variables have also been used to define the commuting time more than 20, 45 and 60 min. Another primary element of interest derives from the question “What is your usual main means of travel to work (the one by which you travel the longest distance)?” One categorical variable (mass transit railway, bus/coach, walk/cycle, ref = car/taxi) and four mode-specific binary variables (e.g. ‘walk/cycle’ = 1, other = 0) were created. The former was used to test the main effect of the commuting mode and the latter to create interactions with the commuting time and gender.

2.4. Covariates

To account for potentially observable confounding variables, covariates included in the fully adjusted models were gender (ref = male), age, age squared, marital status (ref = married), education level (ref = lower secondary or below), working hours in the past week, housing tenure (public housing tenants, private housing tenants, others; ref = house owners), monthly income quintiles (10,000–13,999, 14,000–19,999, 20,000–31,999, highest > 32,000, ref = lowest < 9,999) and living locations by three major geographic areas, i.e., Kowloon, New Territory; ref = Hong Kong Island. The cutoffs of income were based on the Hong Kong monthly income quintiles, which had been used in many similar studies in this field (Chng et al., 2016; Hilbrecht et al., 2014; Kroesen, 2014; Nie and Sousa-Poza, 2016; Stutzer and Frey, 2008). This study used the same cutoffs to make the results more comparable to other studies.

2.5. Statistical analyses

Multivariable logistic regressions were used to investigate into the associations of commuting time and commuting mode with obesity, which was indicated by BMI, and multivariable linear regression models for the other three outcome variables. Three series of models were conducted for each of the outcome variables. To begin with, the unadjusted model was tested for a bivariate association for all the explanatory variables and outcome variables. Then, the adjusted models 1 and 2 controlled all the covariates (gender, age, age squared, marital status, education attainment, working hours in the past week, housing tenure, monthly income quintiles and living locations). In adjusted model 1, commuting time was treated as a continuous variable, while in adjusted model 2, commuting time was divided into five groups to explore the cut-off points to facilitate further discussion. Interactions between the commuting modes, time and gender were also tested in adjusted model 1 and model 2. SAS 9.4 was used to conduct the data analyses.

3. Results

3.1. Descriptive statistics of the commuters in Hong Kong

Table 1 shows the descriptive statistics of the commuters by their main commuting modes. The socioeconomic characteristics of car/taxi commuters are very different from those who travel by other means. They work relatively long hours (49.2 h in the past

Table 1
Descriptive statistics of the commuters in Hong Kong by their main commuting modes.

	Car/taxi	Mass transit railway	Bus/coach	Walk/cycle
Number of commuters (%)	41 (4.2%)	405 (41.5%)	395 (40.5%)	134 (13.7%)
Outcome variables				
Obesity (%)	13 (30.2%)	69 (17.0%)	70 (17.7%)	22 (16.4%)
Self-rated Health: mean (SD)	2.38 (0.13)	2.40 (0.04)	2.39 (0.04)	2.40 (0.08)
CHQ-12: mean (SD)	4.95 (0.53)	6.28 (0.24)	6.13 (0.22)	6.84 (0.40)
Life satisfaction: mean (SD)	24.8 (0.97)	21.63 (0.38)	20.96 (0.37)	22.23 (0.62)
Covariates				
Average age (years)	44.1	40.8	43.4	43.9
Average working hours in the past week (hours)	49.2	44.9	45.7	43.5
Gender (%)				
Male	37 (86.0%)	207 (50.9%)	243 (61.4%)	60 (44.8%)
Female	6 (14.0%)	200 (49.1%)	153 (38.6%)	74 (55.2%)
Marital status (%)				
Married/cohabiting	38 (88.4%)	246 (60.4%)	236 (59.6%)	80 (59.7%)
Single	4 (9.3%)	127 (31.2%)	102 (25.8%)	32 (23.9%)
Divorced/separated/widowed	1 (2.3%)	34 (8.4%)	58 (14.6%)	22 (16.4%)
Education level (%)				
Lower secondary or below	10 (23.3%)	107 (26.4%)	141 (35.7%)	69 (51.5%)
Upper secondary	15 (34.9%)	135 (33.3%)	150 (38.0%)	44 (32.8%)
Tertiary (non-degree)	2 (4.7%)	42 (10.3%)	35 (8.9%)	10 (7.5%)
Tertiary (degree) or above	16 (37.2%)	122 (30.0%)	69 (17.5%)	11 (8.2%)
Monthly income quintiles (%)				
1 lowest < 9,999	3 (7.3%)	65 (16.7%)	98 (25.3%)	54 (40.6%)
2 10,000–13,999	3 (7.3%)	70 (18.0%)	69 (17.8%)	32 (24.1%)
3 14,000–19,999	7 (17.1%)	93 (23.9%)	93 (24.0%)	28 (21.1%)
4 20,000–31,999	5 (12.2%)	94 (24.2%)	78 (20.1%)	12 (9.0%)
5 highest > 32,000	23 (56.1%)	67 (17.2%)	50 (12.9%)	7 (5.3%)
Housing tenure (%)				
Public housing tenants	8 (18.6%)	170 (41.8%)	210 (53.0%)	73 (54.5%)
Private housing tenants	8 (18.6%)	54 (13.3%)	40 (10.1%)	18 (13.4%)
House owners	23 (53.5%)	181 (44.5%)	139 (35.1%)	39 (29.1%)
Others*	4 (9.3%)	2 (0.5%)	7 (1.8%)	4 (3.0%)
Living locations (%)				
Hong Kong Island	9 (20.9%)	88 (21.6%)	70 (17.7%)	27 (20.1%)
Kowloon	17 (39.5%)	128 (31.4%)	192 (48.5%)	51 (38.1%)
New Territories	17 (39.5%)	191 (46.9%)	134 (33.8%)	56 (41.8%)

Note: *Others include housing in the rural areas, dormitories and temporary housing.

week), have a high monthly income (56.1 per cent in the highest quintiles), are mostly male (86 per cent), better educated (37.2 per cent have a tertiary degree or above) and are house owners (53.5 per cent). In contrast, those who walk to work earn less (40.6 per cent in the lowest quintiles), are comparatively lower educated (51.5 per cent) and are public housing tenants (54.5 per cent). For the outcome variables, car/taxi commuters report higher percentage of obesity (30.2 per cent), yet they have lower CHQ-12 score (4.95) and higher score in satisfaction (24.8). Table 2 shows descriptive statistics of the commuters by their main commuting time. For the outcome variables, those who commute more than 90 min report higher percentage of obesity (29.8%). Besides obesity, they also have a higher average score in CHQ (6.7) and lower score in life satisfaction (20.2).

3.2. The associations between commuting and health outcomes

In the unadjusted models (Table 3), the public transport and active commuters have significantly lower risks of being obese than those who travel by car/taxi. After the commuting time and all the covariates are adjusted, the associations between being obese and commuting modes disappear in both adjusted model 1 and model 2. In the adjusted model 2 however, those who commute for 90–119 min report a higher risk of being obese— [1.03; 95% CI: (0.27, 1.80)] with an odd ratio of 2.80 [95% CI: (1.30–6.04)]—compared to those who commute within 30 min. Except that the active commuters have significantly higher CHQ-12 scores than the private car travellers in the unadjusted models, there are no significant associations between the commuting modes and the other two health outcomes (Tables 3 and 4), but this is not significant in the adjusted model. No significant interactions between the commuting time, modes and gender are detected.

3.3. The associations between commuting and satisfaction with life

In the unadjusted model, the public transport and active commuters are significantly less satisfied with life than those who travel by car/taxi (Table 4). After the commuting time and all the covariates are adjusted, the association between satisfaction with life and commuting modes become not significant in both adjusted model 1 and model 2. A significant association is found between

Table 2
Demographic and Well-being outcomes of the commuters by commuting-time categories (single trip).

	< 30 min	30–59 min	60–89 min	90–150 min
Number of commuters (%)	307 (31.0%)	420 (42.8%)	197 (20.1%)	57 (5.8%)
Outcome variables				
Obesity (%)	54 (17.6%)	74 (17.6%)	28 (14.2%)	17 (29.8%)
Self-rated Health: mean (SD)	2.41 (0.90)	2.39 (0.86)	2.41 (0.81)	2.39 (0.90)
CHQ-12: mean (SD)	6.35 (4.16)	6.29 (4.67)	5.93 (4.32)	6.68 (4.71)
Life satisfaction: mean (SD)	22.31 (6.97)	21.19 (7.18)	21.48 (7.50)	20.23 (7.27)
Covariates				
Average age (years)	46.47	44.87	44.31	43.93
Average working hours in the past week (hours)	43.78	46.64	44.16	44.46
Gender (%)				
Male	154 (50.2%)	238 (56.7%)	122 (61.9%)	33 (57.9%)
Female	153 (49.8%)	182 (43.3%)	75 (38.1%)	24 (42.1%)
Marital status (%)				
Married/cohabiting	196 (63.8%)	248 (59.0%)	120 (60.9%)	37 (64.9%)
Single	66 (21.5%)	119 (28.3%)	63 (32.0%)	17 (29.8%)
Divorced/separated/widowed	45 (14.7%)	53 (12.6%)	14 (7.1%)	3 (5.3%)
Education level (%)				
Lower secondary or below	113 (36.8%)	140 (33.4%)	60 (30.6%)	13 (22.8%)
Upper secondary	113 (36.8%)	151 (36.0%)	59 (30.1%)	23 (40.4%)
Tertiary (non-degree)	23 (7.5%)	34 (8.1%)	25 (12.8%)	7 (12.3%)
Tertiary (degree) or above	58 (18.9%)	94 (22.4%)	52 (26.5%)	14 (24.6%)
Monthly income quintiles (%)				
1 lowest < 9,999	95 (32.2%)	82 (20.1%)	28 (14.5%)	15 (26.8%)
2 10,000–13,999	61 (20.7%)	78 (19.2%)	28 (14.5%)	7 (12.5%)
3 14,000–19,999	56 (19.0%)	100 (24.6%)	57 (29.5%)	8 (14.3%)
4 20,000–31,999	40 (13.6%)	83 (20.4%)	52 (26.9%)	14 (25.0%)
5 highest > 32,000	43 (14.6%)	64 (15.7%)	28 (14.5%)	12 (21.4%)
Housing tenure (%)				
Public housing tenants	144 (46.9%)	209 (49.8%)	80 (40.6%)	28 (49.1%)
Private housing tenants	41 (13.4%)	52 (12.4%)	20 (10.2%)	7 (12.3%)
House owners	133 (36.8%)	154 (36.7%)	96 (48.7%)	20 (35.1%)
Others*	9 (2.9%)	5 9 (1.2%)	1 (0.5%)	2 (3.5%)
Living locations (%)				
Hong Kong Island	81 (26.4%)	75 (17.9%)	36 (18.3%)	3 (5.3%)
Kowloon	116 (37.8%)	195 (46.4%)	59 (29.9%)	18 (31.6%)
New Territories	110 (35.8%)	150 (35.7%)	102 (51.8%)	36 (63.2%)

Note: *Others include housing in the rural areas, dormitories and temporary housing.

commuting time and satisfaction with life [-0.14; 95% CI: (−0.03, −0.00)] in model 1; in model 2, those who commute for 60–89 min [-1.57; 95% CI: (−2.98, −0.16)], 90–119 min [-2.36; 95% CI (−4.56, −0.16)] and 120 min or more [-4.85; 95% CI (−9.11, −0.59)] are significantly less satisfied with life than those who commute for less than 30 min. No significant interactions between commuting time, modes and gender are detected.

4. Discussion

4.1. Commuting time and obesity

In this study, it is worth noting that those who commute for between 90 and 119 min are associated with a 180 per cent higher risk of being obese than those who commute for less than 30 min. Probably due to the small sample size, a positive yet not significant relationship between commuting for over 120 min and obesity is also detected. This finding is consistent with those studies in the western societies. Understandably, there are trade-offs between commuting time and health-related activities: those who have long commuting time may spend less time on physical activities (Christian, 2012; Hoehner et al., 2012), food preparation (Christian, 2012; Strazdins et al., 2011) and sleeping (Christian, 2012; Nie and Sousa-Poza, 2016; Walsleben et al., 1999).These health-related behaviours may lead to poor physical health outcomes, especially obesity (Christian, 2012). There is ample evidence on the impacts of physical activity (Bouchard et al., 2007; Maksimović et al., 2016; Wareham et al., 2005), food consumption (Fraser et al., 2012; Maksimović et al., 2016) and sleeping time (Chaput et al., 2006; Cizza et al., 2005; Sekine et al., 2002) on obesity. Moreover, in many car-dominant cities, long-time commuting is also a form of sedentary behaviour that may lead to obesity (Owen et al., 2010). Hoehner et al. (2012) found that commuting distance was negatively associated with body mass index (BMI) even when physical activity is controlled. Therefore, they concluded that sitting during the long-distance commuting time may lead to obesity. This phenomenon may also be the result of the comparatively sedentary lifestyles of the suburban dwellers, which form the major group of the car commuters (Owen et al., 2010).

In Hong Kong, physical activity is also found to be closely linked to obesity (Chow, 2008; Mak et al., 2010), but whether long

Table 3
Results of the regression models investigating into the associations between commuting and physical and mental health among the Hong Kong commuters.

		Obesity (BMI ≥ 26)[a]			CHQ (higher score = higher mental distress)[b]		
		Unadjusted (n = 924)[d]	Adjusted[c] model 1 (n = 882)[e]	Adjusted[c] model 2 (n = 882)[e]	Unadjusted (n = 947)[d]	Adjusted[c] model 1 (n = 905)[e]	Adjusted[c] model 2 (n = 905)[e]
Commuting time		0.00 (−0.00, 0.00)	0.00 (0.00,0.01)		−0.00 (−0.01, 0.01)	0.00 (−0.00, 0.01)	
Commuting time	0–29mins (reference)						
	30–59 min	−0.00 (−0.38, 0.39)		−0.13 (−0.34, 0.60)	−0.06 (−0.73, 0.60)		0.14 (−0.62, 0.90)
	60–89 min	−0.25 (−0.75, 0.24)		−0.06 (−0.65, 0.53)	−0.42 (−1.23, 0.39)		−0.06 (−0.98, 0.87)
	90–119 min	0.79 (0.11, 1.47)*		1.03 (0.27, 1.80)**	0.28 (−1.10, 1.66)		0.76 (−0.69, 2.20)
	120–150 min	0.16 (−1.42, 1.74)		0.60 (−1.06, 2.26)	0.55 (−2.25, 3.35)		0.72 (−2.08, 3.51)
Commuting modes	Car/taxi (reference)						
	Mass transit railway	−0.75 (−1.45, −0.05)*	−0.11 (−0.96, 0.73)	−0.08 (−0.93, 0.77)	1.31 (−0.09, 2.71)	0.54 (−0.98, 2.05)	0.57 (−0.95, 2.09)
	Bus/coach	−0.70 (−1.40, −0.00)*	−0.27 (−1.12, 0.57)	−0.39 (−1.11, 0.59)	1.21 (−0.20, 2.61)	0.27 (−1.25, 1.79)	0.30 (−1.22, 1.83)
	Walk/cycle	−0.79 (−1.59, −0.00)*	−0.21 (−1.14, 0.73)	−0.45 (−1.18, 0.69)	2.03 (0.49, 3.57)**	0.94 (−0.70, 2.59)	0.93 (−0.72, 2.57)

Notes:
*Indicates statistical significance at the $p < 0.05$ level.
**Indicates statistical significance at the $p < 0.01$ level.
[a] Logistic regression models are used to estimate the risk of being obese.
[b] Linear regression models are used to estimate CHQ.
[c] Adjusted for gender, age, age squared, marital status, education level, working hours in the past week, housing tenure, monthly income (quintiles) and living locations.
[d] Changes in n are due to missing values in the outcome variables.
[e] Changes in n are due to missing values in the following variables: gender, age, marital status, education level, housing tenure, household income (quintiles), working hours in the past week and living locations.

Table 4
Results of the regression models investigating into the associations between commuting and self-rated health and well-being among the Hong Kong commuters.

		SRH (higher score = better perceived physical health)			SWLS (higher score = better satisfaction with life)		
		Unadjusted (n = 970)[d]	Adjusted[c] model 1 (n = 925)[e]	Adjusted[c] model 2 (n = 925)[e]	Unadjusted (n = 954)[d]	Adjusted[c] model 1 (n = 910)[e]	Adjusted[c] model 2 (n = 910)[d]
Commuting time		0.00 (0.00,0.00)	0.00 (0.00, 0.00)		−0.01 (−0.02, 0.00)	−0.14 (−0.03, −0.00)[a]	
Commuting time	0–29 min (reference)						
	30–59 min	−0.03 (−0.15, 0.10)		−0.02 (−0.17, 0.12)	−0.04 (−2.18, −0.05)[a]		−0.87 (−2.02, 0.29)
	60–89 min	0.00 (−0.16, 0.15)		−0.00 (−0.18, 0.17)	−0.82 (−2.13, 0.48)		−1.57 (−2.98, −0.16)[a]
	90–119 min	0.06 (−0.21, 0.32)		0.02 (−0.26, 2.94)	−1.57 (−3.79, 0.66)		−2.36 (−4.56, −0.16)[a]
	120–150 min	−0.41 (−0.95, 0.13)		−0.46 (−1.00, 009)	−4.41 (−8.92, 0.11)		−4.85 (−9.11, −0.59)[a]
Commuting modes	Car/taxi (reference)						
	Mass transit railway	−0.01 (−0.28, 0.26)	−0.05 (−0.34, 0.25)	−0.05 (−0.35, 0.24)	−3.26 (−5.54, 0.99)[b]	−1.93 (−4.26, 0.41)	−1.89 (−4.24, 0.45)
	Bus/coach	−0.04 (−0.32, 0.23)	−0.06 (−0.35, 0.24)	−0.06 (−0.36, 0.24)	−3.93 (−6.21, −1.66)[b]	−1.36 (−3.71, 0.99)	−1.30 (−3.64, 1.05)
	Walk/cycle	−0.03 (−0.33, 0.26)	−0.01 (−0.33, 0.31)	0.01 (−0.33, 0.31)	−2.66 (−5.14, −0.17)[a]	−0.71 (−3.71, 1.83)	−0.71 (−3.24, 1.83)

Note.
[a] Indicates statistical significance at the $p < 0.05$ level.
[b] Indicates statistical significance at the $p < 0.01$ level.
[c] Adjusted for gender, age, age squared, marital status, education level, housing tenure, monthly income (quintiles), working hours in the past week and living locations.
[d] Changes in n are due to missing values in the outcome variables.
[e] Changes in n are due to missing values in the following variables: gender, age, marital status, education level, housing tenure, household income (quintiles), working hours in the past week and living locations.

commuting time compromises one's exercise time is unknown. 81.2 per cent of Hong Kong commuters travel by public transport and 12.4 per cent travel on foot (Table 1). Moreover, the compact infrastructure design of Hong Kong enables easy access to different destinations, including shops, restaurants, and gyms, potentially motivating people to conduct more physical activities. Long commuting itself could well be a kind of moderate physical activity as it involves walking between stations and destinations (job locations or home) and standing during the journeys on the MTR or the bus. Previous studies have found strong evidence on the association between active or public transport commuting and reduced risk of obesity (Flint and Cummins, 2016; Flint et al., 2014, 2016; Mytton et al., 2016). Therefore, in Hong Kong, the scarcity of time for physical activities caused by long commuting time may not fully explain its association with obesity.

Lack of time to prepare food at home is another possible explanation for the higher risk of being obese among those who spend a long time commuting. Among the Hong Kong working population, long working hours and long commuting time may result in a lack of time and energy to prepare food at home. Also, restaurants, especially fast food delicatessens, are quite affordable and accessible for the working population, and thus many long-distance commuters may either choose to have their meals on the way to their workplace or on the way home or have takeaway dinners at home. Higher frequency of eating out, especially in fast food restaurants, and consumption of food high in fat, protein and refined carbohydrates with low fibre, may cause chronic positive energy imbalance that eventually results in obesity among long-distance commuters (Chow, 2008). Moreover, the scarcity of time due to the long commuting time to work may also give rise to other unhealthy eating behaviours such as skipping breakfast, late-night eating and eating quickly that may be associated with obesity (Lee et al., 2016). Late-night snacking is very popular among the working people in urban cities, like those in Hong Kong. Due to long working hours, Hong Kong people are already used to late dinners, which may further be postponed by the long commuting time. Although the evidence regarding late-night eating and obesity is mixed (Gallant et al., 2012), nonetheless, late-night eating may cause a loss of appetite during breakfast time and skipping breakfast has been proven to be associated with obesity in Hong Kong (Tin et al., 2011).

Obesity is also found to be associated with short sleeping hours among the working population in Hong Kong (G. Ko et al., 2007). Therefore, the link between long commuting and obesity may also be explained by a lack of adequate sleep among those spending a long time commuting in Hong Kong. Moreover, stress from work (Fortunato and Harsh, 2006) and commuting may also impair sleep quality (Walsleben et al., 1999).

4.2. Commuting time and other health outcomes

No significant links between commuting time and other outcome variables, including mental distress and self-rated health have been found. Previous studies have shown that a long journey to work could be a stressful event, so a long commuting time was a stressor for working people (Legrain et al., 2015; Novaco et al., 1990). However, studies on the associations between commuting time and mental distress only found significant results among the females. Heavy domestic responsibilities on the females were used to explain why the females were more sensitive to commuting stress (Feng and Boyle, 2014; Roberts et al., 2011). Probably due to the availability of live-in help provided by the foreign domestic workers (FDWs), in this study, no such gender-specific association has been found. It is estimated that in 2018, there are 351,513 FDWs in Hong Kong, mostly from the Philippines and Indonesia (Census and Statistics Department, 2017). They make up about five per cent of the Hong Kong population, one FDW in every eight households. It is very common for working couples with young children or older adults to hire a FDW to share their burden of housework and care for their young children and/or older adults (Census and Statistics Department, 2017). Moreover, Hong Kong is a very competitive city with long working hours. Work pressure and heavy workload are the most common stressors for the Hong Kong working population (Siu et al., 1997; Wang et al., 2011). Even though working men and women may have developed better coping skills and higher resilience towards commuting stress, yet it is also possible that in the high-pressure working environment, Hong Kong people are already used to experiencing high levels of stress, which may marginally eclipse the effect of commuting time.

Although commuting for more than 90 min is found to be significantly associated with obesity, nonetheless, no association is found between commuting time with self-rated health in Hong Kong. These results however are different from a previous study that found a significant negative impact of commuting time on self-rated health (Künn-Nelen, 2016). They also contradict previous evidence of the negative impacts of obesity on self-rated health (Cullinan and Gillespie, 2016; Krause and Lampert, 2015; Prosper et al., 2009). Self-rated health is a widely used validated indicator to measure health status, but there are both objective and subjective components in this measurement (Altman et al., 2016; Jylhä, 2009). People sharing a similar health condition may have different opinions about their health status.

A previous study has found that in Hong Kong, self-rated health is associated with some objective measurements of health, including physical illnesses, depressive symptoms and fewer physical activities (Leung et al., 2016). This may explain the fact that although commuters with long commuting time are more susceptible to obesity, they showed no difference in self-rated health, as long commuting time may not yet have caused depressive symptoms on them or the commuters have not yet been diagnosed with physical illnesses.

This finding suggests that although obesity is increasingly considered as an objective dimension of health, people in Hong Kong may not regard obesity itself as a signal of poor health condition (Singh-Manoux et al., 2006), and this has been found to be a major cause of mortality and morbidity, such as diabetes, high blood pressure, high cholesterol, asthma and arthritis (Mokdad et al., 2003). The relationship between obesity and self-rated health is thus socially and culturally constructed (Altman et al., 2016; Krause and Lampert, 2015). Though some may argue that it is a lifestyle choice (Prosper et al., 2009), it is still important to raise the awareness of the risk of obesity in the society.

4.3. Commuting time and satisfaction with life

In Hong Kong, commuting time is found to be significantly associated with satisfaction with life. Those who commute for more than 60 min have lower satisfaction with life than their counterparts who complete their commuting time within 30 min. This result is in agreement with a Chinese study which found that extreme commuters, defined as those who commute for 60 min or more in urban China, are more likely to be less satisfied with life (Nie and Sousa-Poza, 2016). The US Census Bureau defined those who travel for more than 90 min to work as extreme commuters (Rapino and Fields, 2013). Different from their definitions of a certain specific long commuting time as a cut-off point of extreme commuters, this study proposes to define extreme commuters in Hong Kong as those whose satisfaction with life is impaired by the long commuting time.

However, the mechanisms of how commuting influences life satisfaction are still to be explored. There are three possible pathways for commuting time to influence life satisfaction. The first path is via people's health. This study has found a significant association between commuting time and obesity; therefore, it is possible that in Hong Kong, commuters' satisfaction with life is compromised when long commuting time leads to obesity, and later poorer health condition. However, only those who commute for more than 90 min report a higher risk of being obese, while those who commute between 60 and 89 min also have lower satisfaction with life. This suggests that the impact of commuting time on life satisfaction is not fully mediated by obesity. The second path is via satisfaction with their residential and occupational domains. For example, the commuting stress generated from the commuting domain may lead to stress or dissatisfaction with their jobs and residences, thus negatively affecting the people's overall life satisfaction (Novaco et al., 1991; So et al., 2001; Stutzer and Frey, 2008). As there is no empirical evidence of commuting stress in Hong Kong, it is still unknown if commuting has an inter-domain transfer effect on people's satisfaction with jobs and residences in Hong Kong. A third path is through a person's social life. Long commuting time may reduce the amount of time the individuals spend with their families and friends (Christian, 2012), in their socially-oriented trips (Besser et al., 2008) and social participation (Mattisson et al., 2015), and in their satisfaction with social contacts (Kroesen, 2014). However, modern information and communication technologies may enable a virtual mobility which serves as an alternative to an increase in physical mobility (Kenyon et al., 2002). In Hong Kong, through online games and social network platforms, people may use their commuting time to connect with their families and friends and participate in virtual communities on the bus or train. Therefore, further studies are needed to determine the specific mechanism of how long commuting time influences people's life satisfaction.

4.4. Commuting modes

In Hong Kong, there is huge heterogeneity in socioeconomic status across different commuting modes. People in general do not have many options in terms of how they want to travel to and from work. Only people with a very high income can afford to commute by private vehicle or taxi. In Hong Kong, the disadvantaged tend to commute short distances to work (Cho-Yam, 2010; Hui and Yu, 2013), the low-income earner, less educated and public rental housing tenants are more likely to walk to and from their workplace (Table 1). In addition to those who commute on foot or by private vehicle, those who travel by bus and MTR are similar in terms of their socioeconomic characteristics. However, the MTR commuters are slightly better off than bus commuters in terms of income and education level, because they are more likely to live near the MTR stations where the housing cost is higher (Tse and Chan, 2003).

In the unadjusted models of this study, those who commute by private vehicle have been found to have a higher risk of being obese. This finding is in tune with western literature (Flint and Cummins, 2016; Flint et al., 2014, 2016; Mytton et al., 2016; Tajalli and Hajbabaie, 2017), yet the reasons behind may be different. Most western transport literature attributes this risk to the commuting mode, and recommend switching to active commuting, including walking, cycling and travelling by public transport. However, the situation for commuters living in a compact city like Hong Kong is different. It is found that commuting by private vehicle is no longer associated with higher risk of obesity when commuting time and socioeconomic status are controlled. In other words, commuting mode alone does not explain the risk of obesity faced by private vehicle commuters. Local scholars have suggested that the higher risk of being obese among private vehicle commuters may primarily be due to their longer working hours and consequential lack of physical activity (Tse and Chan, 2003). In terms of life satisfaction, private car commuters are more satisfied with life than those who commute by other modes, but the associations again disappear after commuting time and socioeconomic status are controlled. This result is different from prior literature in the western context, which contends that commuting by walking is associated with higher life satisfaction than the use of car (Chng et al., 2016). This suggests that in Hong Kong, the different socioeconomic status of active commuters and private car commuters may be the major reason for the difference in their life satisfaction levels.

4.5. Implications

Findings from this study suggest that the influence of commuting on well-being is context-specific. Previous research exploring such influence are mainly conducted in the suburbanized private vehicle dominant western cities, whereas this is the first study to investigate the situation in a compact city in Asia with a well-developed transport system. While most scholars in this field attributed the negative impacts of long commuting time to the lack of physical activities resulting from long driving time, we have found that in Hong Kong, however, active commuters suffer from as much risk of obesity and decreased life satisfaction as private car or taxi commuters if commuting time surpasses a certain amount. Several possible explanations for this are provided in this study, yet the mechanisms behind the associations between long commuting time and well-being are still in need of further exploration. Commuting mode is not a matter of choice but a reflection of the travellers' socioeconomic status in a compact city like Hong Kong. Driving private vehicles to or from work is only possible among the high-income groups. Compared to the huge heterogeneity across different

commuting modes, the main effect of the commuting mode itself is rather weak. Therefore, researchers should take into consideration the dynamic sociocultural contexts when investigating into the impact of commuting on well-being.

Increasing the residents' mobility has long been the central goal of transport policies in a city like Hong Kong, and world-class transport system has been built to achieve this goal. The Hong Kong government has launched a series of transport subsidy policies such as the Transport Support Scheme, the Work Incentive Transport Subsidy Scheme and the Public Transport Fare Subsidy Scheme to better connect those residents in need to remote job opportunities. Although the mobility strategy may reduce the unemployment rate by promoting cross-district employment, according to the present findings, the subsequent increased commuting time may however negatively influence these cross-district employees' well-being. Thus, it is suggested that policy makers should not only assess the economic costs and benefits of the transport policies, but also evaluate their social values by considering their impacts on the individuals' well-being.

4.6. Limitations

There are several limitations in this study. First, as this study is a cross-sectional design, the empirical evidence derived from this study cannot prove a causal relationship between commuting time, health and well-being. Therefore, the findings could be bidirectional. Second, due to the small sample size of the whole study and in each subgroup, some of the findings may be subject to a type two error—the null hypothesis cannot be rejected when it is wrong. For example, in this study, those who spend between 90 and 119 min commuting are more likely to be obese, yet those who travel for 120 min or more are not, probably because the sample size in the 120 min and more group is so small that it boosts the standard deviation of the estimations. Thirdly, as the questionnaire is not tailor-made for this study, not all the interviewees are included in this study, and it also lacks other health variables such as diseases and physical activities. Therefore, the results cannot be definitive. Moreover, subject to incorrect recall or information that is not up-to-date, self-reported height and weight may not be as reliable as when measured by the trained interviewers. According to a recent study, self-reported BMI values tend to overestimate the measured BMI values at the low end of the BMI scale and underestimate the BMI values at the high end (Stommel and Schoenborn, 2009). Lastly, in this study, only the major commuting modes is studied; in many cases though, the commuters may use several different commuting modes in their trips to and from work.

5. Conclusions

In Hong Kong, longer commuting time is found to be significantly associated with a higher risk of obesity and lower satisfaction with life. Compared to those who commute within 30 min, those who commute between 90 and 119 min are associated with a 180 per cent higher risk of being obese, and those who commute for more than 60 min have lower satisfaction with life. No significant links have been detected between commuting time and other outcome variables, including mental distress and self-rated health. Commuting mode is also found not to be associated with all the well-being outcomes. Policy makers of a compact city with a well-developed transport system should be informed of the possible negative impacts of long commuting time on well-being, and the mechanisms behind the associations should be further explored.

Declaration of interest statement

The authors declare that they have no competing interests.

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