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Life-Course Socioeconomic Status and Obesity Among Older Singaporean Chinese Men and Women

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Objectives. To elucidate the association between life-course socioeconomic status (SES) and obesity among older (aged 60 and older) Singaporean Chinese men and women.

Methods. Data from the Social Isolation, Health and Lifestyles Survey (single-stage stratified random sampling design) was utilized. Obesity (body mass index >27.4 kg/m^2) was assessed for 1,530 men and 2,036 women. Childhood (family financial status while growing up), adult (education), and older adult (housing type) SES indicators were used to define the accumulation of risk (cumulative socioeconomic disadvantage), social mobility (8 trajectories using the 3 SES indicators), and sensitive period (independent effect of each SES indicator) conceptual models. Association between the 3 life-course SES conceptual models and obesity was assessed using logistic regression analysis.

Results. Among women and men, low childhood SES lowered the odds of obesity. Low adult SES increased the odds of obesity only among women. There was no association between cumulative socioeconomic disadvantage and obesity. Women experiencing upward social mobility had lower odds of obesity relative to both those experiencing low SES and high SES through the life-course.

Discussion. Association of the life-course SES conceptual models with obesity among older Singaporeans is different from that reported among younger Western populations, suggesting the association to be context specific. The different conceptual models complement each other.

Key Words: Aged—Obesity— Southeast Asia—Social class—Social mobility.

SOCIOECONOMIC status (SES) is a well-documented distal determinant of obesity (Gonzalez, Nazmi, & Victora, 2009; McLaren, 2007; Monteiro, Moura, Conde, & Popkin, 2004; Pollitt, Rose, & Kaufman, 2005; Senese, Almeida, Fath, Smith, & Loucks, 2009). There is increasing recognition that SES through the life-course is not stable (Braveman et al., 2005; Galobardes, Shaw, Lawlor, Lynch, & Davey Smith, 2006a, 2006b). Childhood SES may influence adult health outcomes independent of or in combination with adult SES—the presence and strength of such an influence varying by health outcome (Braveman et al., 2005). This has resulted in interest in assessing the role that SES at a particular age, or stability or change in SES over the life-course, plays in the etiology of health conditions in adulthood. Three different, but complementary and somewhat overlapping, conceptual models have been suggested for studying the association of life-course SES with adult health outcomes. The "*sensitive period*" conceptual model posits that certain ages or periods in the life-course are independently important for adult health outcomes. The "*accumulation of risk*" conceptual model posits that the accumulated socioeconomic disadvantage (or advantage) through the life-course, rather than SES at any particular age, is associated with adult health outcomes. And, the "*social mobility*" conceptual model posits that stability or mobility across SES levels through the life-course is associated with adult health outcomes (Berkman, 2009; Cohen, Janicki-Deverts, Chen, & Matthews, 2010; Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003; Loucks et al., 2010; Pollitt et al., 2005; Shavers, 2007).

Most researchers assessing the association of SES and adult obesity, however, utilize only adult SES indicators, and often measured once (McLaren, 2007; Monteiro et al., 2004). Some, in recent studies, utilize life-course SES conceptual models, either implicitly or explicitly, for assessing the association (Gonzalez et al., 2009; Heraclides & Brunner, 2010; Kavikondala et al., 2009; Pollitt et al., 2005; Senese et al., 2009). However, most utilize just one, most commonly, the sensitive period conceptual model, and report an inverse or no association of childhood SES with adult obesity (Gonzalez et al., 2009; Pollitt et al., 2005; Senese et al., 2009). Simultaneous application of more than one conceptual model has been suggested to better understand how well the different conceptual models fit the same data (Pollitt et al., 2005). Only in one recent study did researchers apply both the accumulation of risk and social mobility conceptual models for adult overweight and obesity, concluding that both operate simultaneously (Heraclides & Brunner, 2010). However, none has ascertained if all the three conceptual models are helpful

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in explaining adult obesity and whether their concurrent application can be more meaningful than applying just one. It is reported that at least when considering myocardial infarction as an outcome, all three conceptual models may be operating and are conflated (Hallqvist, Lynch, Bartley, Lang, & Blane, 2004).

Additionally, the few researchers to date who have taken a life-course SES perspective for examining the association of SES and obesity have done so among Caucasians from the United States and Europe and among middle-aged individuals (Gonzalez et al., 2009; Heraclides & Brunner, 2010; Pollitt et al., 2005; Senese et al., 2009). Very few have studied Asian populations (Kavikondala et al., 2009), which have experienced economic development more recently and at a different pace than most Western populations, or older adults (Regidor, Gutierrez-Fisac, Banegas, Lopez-Garcia, & Rodriguez-Artalejo, 2004), who have experienced childhood and adulthood in an earlier and different period than those middle aged. In fact, the authors of a recent review suggested an assessment of the association of childhood SES with adult obesity among non-Caucasians as an important future research area (Senese et al., 2009). Further, researchers have observed the association of childhood and adult SES with adult obesity to differ across developing and developed economies and across men and women (Gonzalez et al., 2009; McLaren, 2007; Senese et al., 2009). Although a positive association of adult SES with obesity is reported to be more common in developing economies, an inverse association is more common in developed economies (McLaren, 2007). Differences in affordability of food, patterns of energy expenditure, and perception of body size and shape for those in similar socioeconomic strata in developed and developing economies have been suggested as reasons for this discrepancy (McLaren, 2007). Nearly all studies assessing the association of childhood SES with adult obesity are from developed economies and report an inverse association (Gonzalez et al., 2009; Senese et al., 2009). Also, these associations are reported to be stronger for women than men (Gonzalez et al., 2009; McLaren, 2007; Senese et al., 2009).

Singapore offers a unique opportunity to address the issues discussed earlier. It is a rapidly aging Asian country with a population of 5.1 million (Singapore Department of Statistics, 2010a). Its urban landscape consists primarily of high-rise high-density public housing, where more than 80% of Singaporeans reside (Yuen, 2009). Older Singaporeans, aged 60 years or older constitute 14.1% of the resident population (Singapore Department of Statistics, 2010b). And obesity, defined as a body mass index (BMI) greater than 27.4 kg/m^2 (Health Promotion Board, 2005; Singapore: Ministry of Health. Singapore Association for the Study of Obesity, 2004; WHO Expert Consultation, 2004), has a high prevalence (18.6%) among older Singaporeans (Ostbye, Malhotra, & Chan, 2011), higher than that reported from developing Asian countries like China (Zhang et al., 2008). Singapore has witnessed a relatively rapid transition from a developing to a developed economy. Consequently, older Singaporeans experienced childhood in a period when Singapore was a developing economy and their young adulthood or their middle age when the country was rapidly developing or had transitioned to a developed economy. Utilizing the sensitive period conceptual model therefore, offers a unique opportunity to ascertain whether the association of childhood SES with obesity matches the positive association (though for adult SES) observed in developing economies and if adult and older adult SES with obesity matches the inverse association observed in developed economies, and whether these patterns are stronger for women than men. As the accumulation of risk and social mobility conceptual models are built upon SES at various lifetime points, it is also of interest to assess the association of these conceptual models with obesity.

Utilizing a recent survey of community-dwelling older Singaporeans, we describe the association of life-course SES and obesity among older Singaporean Chinese men and women applying the sensitive period, accumulation of risk and social mobility conceptual models. We restrict our analyses to the Chinese elderly people who participated in the survey for two reasons. First, they constitute the clear majority ethnic group of elderly people in the country, comprising 83.2% of the elderly resident population (Singapore Department of Statistics, 2010b). Second, although ethnicity is a potential confounder of the association between life-course SES and obesity (Housing and Development Board, 2010; Singapore Department of Statistics, 2010b; Singapore: Ministry of Health. Epidemiology and Disease Control Division, 2005), it is also related to lifestyle practices, such as dietary intake, physical activity, and smoking (Health Promotion Board, 2004; Singapore: Ministry of Health. Epidemiology and Disease Control Division, 2005), which are considered to be "on the pathway" or mediating the relationship between SES and obesity (Gonzalez et al., 2009). Thus, inclusion of other ethnic groups such as Malays and Indians and adjusting for ethnicity will be comparable, to an extent, to adjust for lifestyle practices, which is not recommended (Pollitt et al., 2005).

We assess the following hypotheses among older Singaporean Chinese men and women in these analyses: (a) Older adults with low (vs high) childhood SES have a lower risk of obesity (sensitive period conceptual model); (b) Older adults with low (vs high) adult and older adult SES have a higher risk of obesity (sensitive period conceptual model); (c) Contingent upon the opposite effects of childhood SES and adult and older adult SES on obesity, there is no association of cumulative socioeconomic disadvantage with obesity (accumulation of risk conceptual model); (d) Contingent upon the opposite effects of childhood SES and adult and older adult SES on obesity, those following a downward socioeconomic trajectory from childhood to adulthood and older adulthood (high to low to low) have a higher risk of obesity than those they leave behind (i.e., those with high

SES through the life-course) as well as those they join (i.e., those with low SES through the life-course). And, those with an upward socioeconomic trajectory from childhood to adulthood and older adulthood (low to high to high) have a lower risk of obesity than those they leave behind (i.e., those with low SES through the life-course) as well as those they join (i.e., those with high SES through the life-course; social mobility conceptual model). We also assess whether the hypothesized associations of the three conceptual models with obesity are stronger among women than men.

Methods

Social Isolation, Health and Lifestyles Survey (SIHLS) 2009

SIHLS, a representative survey of community-dwelling older Singaporeans, was conducted by the Ministry of Community Development, Youth and Sports in 2009. The survey employed single-stage stratified random sampling to select the survey sample. A random sample of 8,400 older adults, stratified by gender, ethnic group (Chinese, Malay, Indian, others), and 5-year age groups based on the 2007 population distribution was drawn from a national database. Adults aged 75 years or older, and Malays and Indians were oversampled by a factor of 2. A total of 1,195 (14.2%) addresses were found to be invalid. A total of 5,000 older Singaporeans were interviewed face to face, at their residence, after informed consent, yielding a response rate of 69.4%. Nonresponders were more likely to be younger than 70 years and belong to "other" (i.e., not Chinese or Malay or Indian) ethnic groups but were similar in gender distribution compared with those who responded.

The current analyses, involving de-identified data from the SIHLS, were exempted from full review by the Institutional Review Boards of the National University of Singapore and Duke University Health System.

Outcome: Older Adult Obesity

Height and weight measurements of the participants have been described elsewhere (Ostbye et al., 2011). Briefly, height (barefoot; in cm, one decimal point) and weight (in kg, one decimal point; electronic scale: Tanita HD-355) were measured by trained interviewers. Obesity, based on the measured weight and height, was defined as per the Asian classification (Health Promotion Board, 2005; Singapore. Ministry of Health. Singapore Association for the Study of Obesity, 2004; WHO Expert Consultation, 2004) that is, those with a BMI (weight [kg]/height [m^2]) greater than 27.4 kg/m^2 were considered to have obesity.

Childhood SES

Childhood SES was based on the participant's (self-reported) family financial status while growing up. Based on the response to "Now think about your family when you were growing up, from birth to age 16. Would you say your family during that time was pretty well off financially, about average, or poor?," childhood SES was classified as low (response of "poor") or high (response of "pretty well off" or "about average"). Although parental occupation is the most commonly used indicator of childhood SES (Senese et al., 2009), the survey did not capture it; family financial status while growing up has been previously used as a childhood SES indicator (Luo & Waite, 2005; Moody-Ayers, Lindquist, Sen, & Covinsky, 2007).

Adult SES

Education, which reflects the transition from childhood or parental SES to one's own SES, and is associated with subsequent adult SES (Galobardes et al., 2006a), was used as an indicator of adult SES. Based on participant-reported highest education level completed, adult SES was categorized as low (no formal education or less than or equal to primary level) or high (greater than or equal to secondary level).

Older Adult SES

Nearly 90% of older Singaporeans reside with their spouse and/or their children (Chan, Malhotra, Malhotra, & Ostbye, 2011). Thus, any indicator of their current SES should be reflective of the SES of the household. In Singapore, the type of housing one resides in (i.e., private or public), and within public housing, the number of rooms (ranging from 1 to 5) in the house can be considered as a proxy of household SES. It has been used as an indicator of SES in previous studies from Singapore (Malhotra, Chan, Malhotra, & Ostbye, 2010; Ng, Hui, & Tan, 1994; Sabanayagam, Shankar, Wong, Saw, & Foster, 2007). Further, data from the SIHLS suggests that 70.3% of older Singaporeans own the house they reside in. Public housing in Singapore consists primarily of high-rise apartment blocks. Although subsidized by the government, this does not translate into low income housing, especially for bigger flats. For example, the price range for a two-room public housing flat released for sale in January 2012 was 83,000–112,000 Singapore dollars (SGD; approximately 65,000–88,000 U.S. dollars [USD]), whereas a four-room public housing flat in the same development was SGD283,000–376,000 (approximately US$224,000–297,000; Housing and Development Board, 2012). Most public flats are owner occupied and are considered large and comfortable by international standards (e.g., the average size of a four-room flat is about 90 square meters; Yuen, 2009). The latest figures (for 2008) from the Housing Development Board, responsible for provision of public housing in Singapore, suggests that the number of rooms of public housing in Singapore is correlated with monthly household income, the larger units reflecting a higher income: average monthly household income for

2-, 3-, 4- and 5-room flat residents was SGD 1,267, 3,187, 4,954 and 7,285, respectively (Housing and Development Board, 2010). Thus, based on the type of housing participants resided in, older adult SES was classified as low (1–3 room public housing) or high (more than three room public housing or private housing). Although total monthly household income was also assessed in the survey, based on our past experience, and as reported by previous researchers (Ofstedal, Reidy, & Knodel, 2003), many individuals, especially women, are likely to underreport it. Further, it was missing for 20.4% of those included in the analysis sample. Thus, household income was not used as an indicator of older adult SES.

Life-Course SES Conceptual Models

Paralleling previous researchers (James, Fowler-Brown, Raghunathan, & Van Hoewyk, 2006; Loucks et al., 2010; Otero-Rodriguez et al., 2011; Pollitt et al., 2005; Regidor et al., 2004), the sensitive period conceptual model was operationalized by examining the independent association of each of the three lifetime point SES indicators, that is after adjusting for the other two SES indicators. The accumulation of risk conceptual model was constructed by calculating a cumulative socioeconomic disadvantage score. Each of the three SES indicators was assigned a value of "1" for low and "0" for high and was then added to arrive at a total score, with possible values of 0, 1, 2, and 3. A higher value on this score was indicative of greater cumulative socioeconomic disadvantage. Calculation of a cumulative socioeconomic disadvantage score is the most common method for operationalizing the accumulation of risk conceptual model (Hallqvist et al., 2004; Heraclides & Brunner, 2010; Loucks et al., 2009, 2010; Luo & Waite, 2005; Otero-Rodriguez et al., 2011; Pollitt et al., 2005). The social mobility conceptual model, similar to other researchers (Hallqvist et al., 2004; Heraclides & Brunner, 2010; James et al., 2006; Kavikondala et al., 2009; Loucks et al., 2010; Luo & Waite, 2005; Otero-Rodriguez et al., 2011), was defined by creating eight mutually exclusive and exhaustive social mobility trajectories, based on the status of the participants on the three lifetime point (childhood to adult to older adult) SES indicators: "low to low to low" (LLL), "low to high to low" (LHL), "low to low to high" (LLH), "low to high to high" (LHH), "high to low to low" (HLL), 'high to high to low" (HHL), "high to low to high" (HLH), and "high to high to high" (HHH).

Analytical Sample

Of the 5,000 SIHLS participants, 3,576 (71.5%) were of Chinese ethnicity, the ethnic group included in the current analyses. Among them, information on BMI, childhood SES, and adult SES were not available for 449 (12.6%), 311 (8.7%), and 10 (0.3%) individuals, respectively. For the primary analysis, the latter 10 individuals were excluded resulting in an analytical sample of 3,566 comprising 1,530 (42.9%) men and 2,036 (57.1%) women. Then, multiple imputation procedures were used to impute values for BMI and childhood SES (Horton & Lipsitz, 2001; Yuan, 2011). The covariates used for imputing BMI were age, gender, marital status, self-reported disease status (cardiovascular disease, hypertension, diabetes, and chronic back pain), smoking status, height, and weight. As smoking status, weight and height had missing values, resulting in an arbitrary pattern of missing data, a Markov Chain Monte Carlo method was used to impute BMI (Yuan, 2011). A monotone logistic regression model was utilized for imputing the childhood SES variable incorporating age, gender, marital status, and SES at the other two lifetime points (Yuan, 2011). The missing values were imputed 10 times resulting in 10 complete data sets. All estimates (correlation or proportion or odds or interactions) were calculated separately for each complete data set. The estimates from each data set were then combined into a single estimate with confidence intervals (CIs) and/or p values adjusted for the missing data uncertainty (Horton & Lipsitz, 2001; Yuan, 2011). In a sensitivity test, the various estimates were also calculated only among the 1,286 men and 1,687 women without missing data on BMI, childhood SES, and adult SES (complete case analysis).

Statistical Analysis

Given the gender differences in the association of SES and obesity, (Gonzalez et al., 2009; McLaren, 2007; Senese et al., 2009) all analyses were stratified by gender. Tetrachoric correlation coefficient was calculated to assess the correlation between the three dichotomous SES indicators. The weighted prevalence of age groups (60–69, 70–79, and 80 or more), obesity, of the three life-course SES conceptual models and of obesity by the three life-course SES conceptual models was calculated. Unadjusted logistic regression analysis was used to determine if the prevalence of obesity was significantly different between men and women. Association between the three life-course SES conceptual models and obesity was assessed using logistic regression analysis. For testing the first two hypotheses, in the context of the sensitive period conceptual model, the unadjusted and adjusted odds of obesity for those with a low, relative to a high status on each of the three SES indicators were calculated. For a particular SES indicator, the unadjusted regression analysis did *not* control for the other two SES indicators or for age, whereas the adjusted regression analysis controlled for the other two SES indicators and for age. For the third hypothesis (accumulation of risk conceptual model), the odds of obesity for those with a cumulative socioeconomic disadvantage score of 3, 2, and 1, relative to 0, were calculated, with (adjusted regression) and without (unadjusted regression) adjusting for age. For the fourth hypothesis (social mobility conceptual model), the odds of obesity for those with HLL and LHH (and other trajectories), relative to HHH as well as to LLL, were calculated, with (adjusted regression) and without (unadjusted regression) adjusting for age. Age, when included in a particular regression analysis, was treated as a continuous variable. We also assessed whether the hypothesized associations of the three life-course SES conceptual models with obesity were stronger among women than men. In the context of the sensitive period conceptual model, this was done by assessing the significance of interaction terms between gender and each of the three SES indicators in the adjusted logistic regression analysis. Similarly, significance of interaction terms between gender and cumulative socioeconomic disadvantage score of 3, 2, and 1, and between gender and social mobility trajectories were assessed using adjusted logistic regression analysis for the accumulation of risk and social mobility conceptual models, respectively. All analyses (SAS for Windows, version 9.2, SAS Institute Inc, Cary, NC) included survey sampling weights to adjust for oversampling and nonresponse. A p value of less than .05 was considered statistically significant.

Results

Most men and women in the analysis sample were aged 60–69 years. The prevalence of obesity was higher among women (17.0%) than among men (13.0%; Table 1) This translated into an odds ratio (OR) of 1.37 (95% CI: 1.14, 1.65). There was a moderate degree of correlation between the three SES indicators for both men and women. Among men, the tetrachoric correlation coefficient for the correlation between childhood and adult SES was 0.35 (95% CI: 0.28–0.41, $p < .0001$), between childhood and older adult SES was 0.02 (0.0–0.10; $p = .59$), and between adult and older adult SES was 0.37 ($p < .0001$). The corresponding tetrachoric correlation coefficients among women were 0.48 (0.42–0.54, $p < .0001$), 0.27 (0.20–0.34, $p < .0001$), and 0.34 ($p < .0001$), respectively.

Table 1. Weighted Prevalence of Age Groups and Obesity Among Older Singaporean Chinese Men and Women, Social Isolation, Health and Lifestyles Survey (SIHLS) 2009

	Men (N = 1,530)	Women (N = 2,036)
Characteristics	Weighted %[a]	Weighted %[a]
Age group (years)		
60–69	61.5	54.3
70–79	28.9	29.9
80 or more	9.6	15.8
Obesity		
Yes	13.0[b]	17.0[c]

Notes. [a]Weighted by survey sample weights.
[b]95% confidence interval (CI): 11.2–14.8. It accounts for variation in estimates in each of the 10 imputed data sets, which differed in the imputed body mass index (BMI) values. These 10 estimates were combined to arrive at the single estimate presented in the table.
[c]95% CI: 15.3–18.7. It accounts for variation in estimates in each of the 10 imputed data sets, which differed in the imputed BMI values. These 10 estimates were combined to arrive at the single estimate presented in the table.

The distribution of the life-course SES conceptual models and the prevalence of obesity by the conceptual models, among men and women, are presented in Table 2. Among both men and women, the largest proportion of study participants had a low childhood SES (55.6% and 62.2%, respectively), a low adult SES (54.5% and 77.2%, respectively), and a high older adult SES (69.2% and 66.6%, respectively). The proportion with the most cumulative socioeconomic disadvantage (13.7%) was lower than the proportion with the least disadvantage (20.7%) among men. The reverse was observed among women (22.3% vs 12.8%). Both men and women did experience social mobility in SES during their life-course, more experiencing upward (LLH, LHH; men: 38.2%, women: 37.8%) than downward (HLL, HHL; men: 13.5%, women: 8.9%) mobility. Smaller groups of participants experienced more than one change in SES in their life-course (LHL, men: 3.7%, women: 2.2%; HLH, men: 10.3%, women: 16.0%). Among men, prevalence estimates of obesity were higher among those of high (vs low) childhood SES and similar across levels of adult and older adult SES. Among women, prevalence estimates of obesity were higher among those of high (vs low) childhood SES, of low (vs high) adult SES, and of low (vs high) older adult SES. These estimates were the lowest for men with the highest cumulative socioeconomic disadvantage and for women with the lowest cumulative socioeconomic disadvantage. In both men and women, those in the HLL and HLH trajectories had the highest prevalence of obesity. The lowest prevalence of obesity among men was observed for those in the stable low (LLL) trajectory and among women for those in an upward (LHH) trajectory.

Results from the logistic regression analyses for the association of the life-course SES conceptual models with obesity, by gender, are presented in Table 3. In the context of the first and second hypotheses (sensitive period conceptual model), among men, those with a low (vs high) childhood SES had lower odds of obesity in both the unadjusted and adjusted models. Among women, in the unadjusted (for age or for other SES indicators) model, there was no association of childhood or older adult SES with obesity, whereas those with a low (vs high) adult SES had higher odds of obesity. However, after adjusting for the other SES indicators and age, an association of childhood SES with obesity was observed—women with low (vs high) childhood SES had lower odds of obesity. The inverse association of adult SES remained significant and became stronger. Further, the interaction term of gender with adult SES, but not with childhood SES and older adult SES, was significant ($p = .02$). There was no association of cumulative socioeconomic disadvantage over the life-course with obesity among both men and women (third hypothesis; accumulation of risk conceptual model). The interaction term between gender and a cumulative disadvantage score of 3 (maximum

Table 2. Weighted Prevalence of the Three Socioeconomic Status (SES) Indicators, Four Cumulative Socioeconomic Disadvantage Score Categories, Eight Social Mobility Trajectories, and of Older Adult Obesity by Life-Course SES Indicators Among Older Singaporean Chinese Men and Women, Social Isolation, Health and Lifestyles Survey (SIHLS) 2009

	Men (*N* = 1,530)		Women (*N* = 2,036)	
		Prevalence of older adult obesity		Prevalence of older adult obesity
SES indicator	Weighted column % (95% CI)[a]	Weighted row % (95% CI)[b]	Weighted column % (95% CI)[a]	Weighted row % (95% CI)[b]
Childhood SES				
Low	55.6 (53.0, 58.1)	11.1 (8.8, 13.5)	62.2 (60.1, 64.4)	16.4 (14.3, 18.6)
High	44.4 (41.9, 47.0)	15.3 (12.5,18.1)	37.8 (35.6, 40.0)	17.9 (15.1, 20.8)
Adult SES				
Low	54.5 (52.3, 56.8)[c]	13.0 (10.6, 15.4)	77.2 (75.5, 79.0)[c]	18.5 (16.5, 20.4)
High	45.5 (43.2, 47.7)[c]	13.0 (10.1, 15.8)	22.8 (21.0, 24.5)[c]	12.1 (8.7, 15.4)
Older adult SES				
Low	30.8 (28.7, 32.9)[c]	12.8 (9.7, 16.0)	33.4 (31.5, 35.4)[c]	17.7 (14.6, 20.7)
High	69.2 (67.1, 71.3)[c]	13.1 (10.9, 15.3)	66.6 (64.7, 68.5)[c]	16.7 (14.6, 18.7)
Cumulative socioeconomic disadvantage				
3 (maximum disadvantage)	13.7 (11.9, 15.4)	9.6 (5.4, 13.7)	22.3 (20.4, 24.1)	17.6 (14.1, 21.1)
2	34.3 (31.8, 36.7)	13.3 (10.2, 16.4)	41.1 (38.9, 43.4)	18.0 (15.2, 20.8)
1	31.4 (29.0, 33.7)	13.5 (10.2, 16.8)	23.8 (21.9, 25.7)	16.2 (12.8, 19.6)
0 (minimum disadvantage)	20.7 (18.6, 22.7)	14.0 (9.8, 18.3)	12.8 (11.3, 14.2)	14.4 (9.7, 19.2)
Social mobility trajectory[d]				
LLL (stable low)	13.7 (11.9, 15.4)	9.6 (5.4, 13.7)	22.3 (20.4, 24.1)	17.6 (14.1, 21.1)
LHL	3.7 (2.8, 4.7)	13.1 (3.0, 23.3)	2.2 (1.6, 2.8)	16.6 (3.4, 29.8)
LLH	22.2 (20.1, 24.3)	12.0 (8.4, 15.7)	31.8 (29.7, 33.9)	17.6 (14.7, 20.5)
LHH	16.0 (14.1, 17.8)	10.8 (6.2, 15.4)	6.0 (4.9, 7.0)	5.8 (0.7, 10.9)
HLL	8.4 (6.9, 9.8)	16.7 (9.8, 23.3)	7.1 (6.0, 8.3)	20.0 (12.6, 27.4)
HHL	5.1 (4.0, 6.2)	15.4 (6.9, 23.9)	1.8 (1.2, 2.4)	10.7 (0.0, 22.1)
HLH	10.3 (8.8, 11.9)	16.8 (10.5, 23.1)	16.0 (14.4, 17.7)	20.6 (16.3, 25.0)
HHH (stable high)	20.7 (18.6, 22.7)	14.0 (9.8, 18.3)	12.8 (11.3, 14.2)	14.4 (9.7, 19.2)

Notes. CI = confidence interval; H = high; L = low.
[a]Unless otherwise specified, 95% CI around the estimate accounts for variation in estimates in each of the 10 imputed data sets, which differed in the imputed childhood SES values. These 10 estimates were combined to arrive at the single estimate presented in the table.
[b]95% CI around single estimate accounts for variation in estimates in each of the 10 imputed data sets, which differed in the imputed body mass index (BMI) values. These 10 estimates were combined to arrive at the single estimate presented in the table.
[c]Because these variables were not imputed, the 95% CI reflects the Wald confidence limits.
[d]First, second, and third letters represent childhood, adult, and older adult SES, respectively.

disadvantage) was marginally significant ($p = .057$). With regard to the fourth hypothesis (social mobility conceptual model), among men and women, the age-adjusted odds of obesity for those in the downward (HLL) trajectory, relative to the stable high (HHH) trajectory and to the stable low (LLL) trajectory, were higher but not significant. The interaction terms between gender and HLL trajectory were not significant in either regression model. The age-adjusted odds of obesity for those in the upward (LHH) trajectory, relative to the stable high (HHH) trajectory and to the stable low (LLL) trajectory, were significantly lower only among women. Related, although the interaction term between gender and LHH trajectory was significant ($p = .01$) in the regression model with LLL trajectory as the reference, it was not ($p = .16$) in the regression model with HHH trajectory as the reference. In addition, men in the HLH trajectory had higher odds of obesity, relative to the LLL trajectory and women in the HLH trajectory had higher odds of obesity, relative to the HHH trajectory. However, the corresponding interaction terms were not significant ($p > .10$). The results of the sensitivity test, using complete case analysis, parallel those presented previously (results not shown; available on request).

Discussion

This study, based on a large representative sample, is among the few from Asia assessing the association of life-course SES and obesity. In the context of the sensitive period conceptual model, we observed low childhood SES to be associated with lower odds of obesity among both women and men. However, low adult SES increased the odds of obesity only among women. There was no association between cumulative socioeconomic disadvantage and obesity. The results also support the social mobility conceptual model among women—those experiencing upward social mobility had lower odds of obesity relative to both those experiencing low SES and high SES through the life-course.

Sensitive Period Conceptual Model

The findings of the current analyses supported our first hypothesis, that men and women with a low (vs high)

Table 3. Association of Life-Course Socioeconomic Status (SES) Conceptual Models With Older Adult Obesity Among Older Singaporean Chinese Men and Women: Unadjusted and Adjusted Odds Ratio (OR) Estimates With 95% Confidence Intervals (CI), Social Isolation, Health and Lifestyles Survey (SIHLS) 2009

	Men (*N* = 1,530)		Women (*N* = 2,036)	
	OR (95% CI)[a] for obesity		*OR* (95% CI)[a] for obesity	
Life-course SES conceptual model	Unadjusted	Adjusted[b]	Unadjusted	Adjusted[b]
Sensitive period				
Low (vs high) childhood SES	0.69* (0.51, 0.93)[c]	0.67* (0.50, 0.92)[d]	0.90 (0.72, 1.13)[c]	0.78* (0.62, 1.00)[d]
Low (vs high) adult SES	1.00 (0.75, 1.35)[c]	1.16 (0.84, 1.60)[d]	1.65* (1.23, 2.21)[c]	1.89* (1.36, 2.61)[d]
Low (vs high) older adult SES	1.00 (0.73, 1.37)[c]	0.97 (0.70, 1.34)[d]	1.07 (0.85, 1.35)[c]	1.01 (0.97, 1.01)[d]
Accumulation of risk (Cumulative socioeconomic disadvantage)				
3 vs 0	0.65 (0.36, 1.15)	0.67 (0.38, 1.20)	1.27 (0.84, 1.90)	1.29 (0.86, 1.95)
2 vs 0	0.94 (0.63, 1.39)	0.96 (0.65, 1.43)	1.30 (0.88, 1.91)	1.33 (0.90, 1.97)
1 vs 0	0.96 (0.64, 1.43)	0.97 (0.65, 1.44)	1.15 (0.76, 1.72)	1.16 (0.77, 1.75)
Social mobility trajectory[e]				
LLL vs HHH	0.65 (0.36, 1.15)	0.68 (0.38, 1.22)	1.27 (0.84, 1.90)	1.32 (0.88, 1.99)
LHL vs HHH	0.92 (0.39, 2.14)	0.92 (0.39, 2.15)	1.18 (0.52, 2.68)	1.15 (0.51, 2.61)
LLH vs HHH	0.84 (0.53, 1.32)	0.87 (0.55, 1.37)	1.27 (0.86, 1.88)	1.34 (0.90, 2.00)
LHH vs HHH	0.74 (0.45, 1.22)	0.73 (0.44, 1.20)	0.36* (0.16, 0.86)	0.36* (0.15, 0.84)
HLL vs HHH	1.22 (0.71, 2.09)	1.25 (0.73, 2.15)	1.48 (0.85, 2.58)	1.54 (0.88, 2.70)
HHL vs HHH	1.11 (0.56, 2.19)	1.13 (0.57, 2.23)	0.71 (0.24, 2.01)	0.70 (0.24, 2.04)
HLH vs HHH	1.24 (0.73, 2.11)	1.30 (0.76, 2.24)	1.54* (1.01, 2.35)	1.63* (1.06, 2.50)
HHH vs LLL	1.55 (0.87, 2.76)	1.47 (0.82, 2.63)	0.79 (0.53, 1.18)	0.76 (0.50, 1.14)
LHL vs LLL	1.42 (0.59, 3.42)	1.35 (0.56, 3.27)	0.93 (0.43, 2.04)	0.87 (0.39, 1.91)
LLH vs LLL	1.30 (0.74, 2.27)	1.28 (0.73, 2.25)	1.00 (0.74, 1.36)	1.01 (0.74, 1.37)
LHH vs LLL	1.15 (0.62, 2.13)	1.07 (0.57, 2.01)	0.29* (0.13, 0.64)	0.27* (0.12, 0.61)
HLL vs LLL	1.88 (0.95, 3.72)	1.84 (0.93, 3.65)	1.17 (0.71, 1.92)	1.16 (0.70, 1.92)
HHL vs LLL	1.72 (0.82, 3.61)	1.66 (0.79, 3.45)	0.56 (0.20, 1.57)	0.53 (0.19, 1.50)
HLH vs LLL	1.91* (1.06, 3.45)	1.91* (1.06, 3.45)	1.22 (0.86, 1.73)	1.23 (0.87, 1.74)

Notes. H = high; L = low.

[a]*p* Value for and 95% CI around single estimate of the *OR* account for variation in *OR* estimates in each of the 10 imputed data sets. These 10 OR estimates were combined to arrive at the single estimate presented in the table.

[b]Adjusted for current age.

[c]Unadjusted *OR* for a particular SES indicator, in the sensitive period conceptual model, is not adjusted for the other two SES indicators or for current age.

[d]Adjusted *OR* for a particular SES indicator, in the sensitive period conceptual model, is adjusted for the other two SES indicators as well as for current age.

[e]First, second, and third letters indicative of childhood, adult, and older adult SES, respectively.

$*p < .05$.

childhood SES have lower odds of obesity, after controlling for adult and older adult SES. The absence of an interaction between gender and childhood SES also suggested this direct association to be present in both men and women. This finding is contrary to the inverse association between childhood SES and adult obesity (i.e., low childhood SES is associated with a higher odds of obesity) reported in most previous studies (Gonzalez et al., 2009; Pollitt et al., 2005; Senese et al., 2009). It is important to contextualize our hypothesis and finding, in terms of the setting (country) and time when the participants experienced "childhood." The majority of the age cohort represented by our analysis sample, aged 60–101 years in 2009 (born 1908–1949), would have been born and spent all of most of their childhood (0–16 years) in what is today Singapore or Malaysia (Singapore Department of Statistics, 2010b). Both these countries were developing economies during the period (1912–1965) and under foreign or colonial (British [part of British Malaya until 1962] and Japanese [1942–45]) rule or administration for most part of this period. Further, in their lifetimes, these elderly people experienced periods of economic and food insecurity. These periods include the early 1930s when the region experienced effects of the worldwide economic depression (Huff, 2001; Seng, 2006), the early 1940s when the region was under Japanese occupation, during which rationing of rice, the staple food, was implemented (Kratoska, 1988, 1998; Nicholls, 1948) and the years post–World War II when the region witnessed limitations in food availability (Kratoska, 1988). Although all social classes would have been affected during these years, poorer families would have been disproportionately exposed to a calorie-deficient diet. A previous study suggests adult lower limb length to be a marker of early childhood energy intake (Wadsworth, Hardy, Paul, Marshall, & Cole, 2002). Using SIHLS data, we observed the average lower limb length for those with low childhood SES (men: 81.02 cm and women: 73.66 cm) to be shorter than those with high childhood SES (men: 81.76 cm and women: 73.88 cm), though significantly different only among men. This lends support to our conjecture. The continuing influence of caloric inadequacy, experienced during childhood, may account for lower odds of obesity among older

Singaporean men and women with low childhood SES, even after adjusting for adult and older adult SES.

There are alternative explanations for discordance between our and previous findings. Although we adjusted for education and housing type, we cannot rule out residual confounding by other adult or older adult SES measures. A "healthy" survivor bias is another possible explanation. Although most previous studies reporting an inverse association of childhood SES and adult obesity association define obesity at age less than 60 years (Gonzalez et al., 2009; Senese et al., 2009), all our participants were older. An inverse association of childhood SES and adult obesity may have existed when the population cohort represented in the SIHLS were middle aged. However, as obesity-related mortality occurs mostly during or after middle age, with the absolute mortality risk increasing up to the age of 75 years (Stevens et al., 1998; Villareal, Apovian, Kushner, & Klein, 2005), the proportion of such deaths, and thus, of healthy (nonobese) survivors attaining "old age" is likely to be disproportionately higher among those with low childhood SES.

Given that older Singaporeans of today experienced most of their young adulthood or middle age when the country was rapidly developing or had transitioned to a developed economy, our second hypothesis was of an inverse association of adult and older adult SES with obesity, based on the findings from developed societies (McLaren, 2007). Our findings provided partial support for this hypothesis. Older adult SES was not associated with obesity in either gender. Adult SES, operationalized by educational status, was associated with obesity in the hypothesized (inverse) direction among men and women, though the association was significant only among women. The inverse association is likely, as suggested previously (McLaren, 2007), reflective of lower knowledge and adoption of healthy lifestyles and greater consumption of cheaper but calorie dense foods by those of low educational status in developed settings. The presence of a stronger and significant inverse association of adult SES and obesity among women, relative to men, supported by a significant interaction between gender and adult SES, also mirrors that reported from other developed countries (McLaren, 2007). This gender difference has been attributed to gender differences in the value of body size and shape among those of higher SES in developed settings, based on Bourdieu's theory of the body—although women of high SES place value on thinness, men of high SES may value a larger body size as a sign of physical dominance and prowess (McLaren, 2007).

Among women, the direct association of childhood SES with obesity became significant and stronger, and the significant inverse association of adult SES with obesity became stronger once SES at the other lifetime points was adjusted for. However, among men, the change in these point estimates was not as dramatic. This suggests that the influence of sensitive periods on obesity is stronger among women relative to men. However, differences in the point estimates for childhood SES and adult SES between men and women suggest that, in the context of obesity, childhood SES is more important for men and adult SES is more important for women.

Accumulation of Risk Conceptual Model

Building upon our first and second hypothesis (the opposing effects of low childhood SES and of low adult or older adult SES on obesity), our third hypothesis, for the accumulation of risk conceptual model, was for the lack of association of cumulative socioeconomic disadvantage with obesity. This was supported by our findings. Previous studies, from Western populations, testing this conceptual model, however, report an increased risk of obesity or adverse cardiovascular outcomes with accumulation of socioeconomic disadvantage (Heraclides & Brunner, 2010; Pollitt et al., 2005). Their findings are reflective of the consistent inverse association of low SES at various lifetime points, which contribute to cumulative socioeconomic disadvantage, with the adverse health outcome of interest. The discrepancy between the findings of these studies and our study suggests that the accumulation of health disadvantage (or advantage) posed by low SES over the life-course occurs only when the detrimental (or beneficial) health effect of a low SES is consistent through the life-course.

It was of interest to note that, among men, compared with those with the least cumulative disadvantage, those with the highest cumulative disadvantage had lower odds of obesity. The reverse was observed among women. The marginally significant interaction between gender and the highest cumulative disadvantage score was also reflective of this gender difference. This discrepancy may be explained by the gender difference in the relative importance of the influence of low childhood SES and low adult SES on obesity, as alluded to before in the sensitive period conceptual model. Among women, the advantage (low risk for obesity) gained from a low childhood SES was overcome by the disadvantage (high risk of obesity) posed by a low adult SES, which was not the case among men.

Although the use of a cumulative socioeconomic disadvantage score for the accumulation of risk conceptual model parallels the work done by previous researchers (Hallqvist et al., 2004; Heraclides & Brunner, 2010; Loucks et al., 2009, 2010; Luo & Waite, 2005; Otero-Rodriguez et al., 2011; Pollitt et al., 2005), it has its limitations. It does not capture the intensity of advantage or disadvantage posed by a particular SES or the duration for which an individual experiences a particular SES. A better measure of SES over the life-course is required to overcome these limitations. Building upon newer analytical methods available to analyze longitudinal data, a recent commentary by Tilling, Howe, and Ben-Shlomo (2011) suggested the utilization of group-based trajectory modeling for a better operationalization of life-course influences on health. This method, which requires longitudinal data with at least three waves or time points, groups individuals following a similar pattern over time in the variable of interest (SES in the current context). Once like individuals are grouped, the associations of such groups can be assessed with the health outcome of interest. Although we were unable to utilize this method, given the cross-sectional nature of the data used in this article, it will be of interest to utilize this method in future studies that have at least three, or preferably more, waves or time points of longitudinal data for SES.

Social Mobility Conceptual Model

Social mobility is reported to play a role in development of cardiovascular risk factors, including obesity (Heraclides & Brunner, 2010; Pollitt et al., 2005). We too observed differences in the prevalence and odds of obesity between SES trajectories. The independent association of SES at different ages with obesity aids in understanding the observed social mobility conceptual model associations. The trajectory from childhood to adult SES appeared to be especially important, and more so among women. Among women, those moving down from high childhood to low adult SES (both obesogenic) had the highest prevalence of obesity (HLH: 20.6%; HLL: 20.0%). And, those moving up from low childhood to high adult SES (both protective against obesity) had the lowest prevalence of obesity (LHH: 5.8%). Although women in another upward trajectory (LHL) had a much higher prevalence (16.6%), the estimate had a wide CI (3.4%, 29.8%) owing to a small sample size and may not be reliable. Among men, the results were similar but not as consistent. The lowest prevalence of obesity was for those in the stable low (LLL) trajectory (9.6%) followed by those with an upward trajectory (10.8%). The highest prevalence of obesity was for those in downward SES trajectories, from childhood to adulthood (HLH: 16.8%; HLL: 16.7%).

The results provided support for our social mobility conceptual model hypotheses: Among women, those with the upward socioeconomic trajectory of interest (LHH) had a significantly lower risk of obesity than those they left behind (i.e., those with low SES through the life-course) as well as those they joined (i.e., those with high SES through the life-course). The significant interaction between gender and the upward LHH trajectory, in the regression analysis with low SES through the life-course as the reference, also suggests a greater role of upward social mobility among women. And, men and women with the downward socioeconomic trajectory of interest (HLL) had a higher risk of obesity than both those they left behind (i.e., those with high SES through the life-course) and those they joined (i.e., those with low SES through the life-course), though the association was not significant. These findings suggest that, among those experiencing social mobility, the health advantage (or disadvantage) offered by childhood SES persists even in the face of the advantage (or disadvantage) offered by SES in later life, a phenomenon referred to as "social protection" (Heraclides & Brunner, 2010), especially among women.

Limitations

In addition to limitations mentioned earlier, the retrospective recall of childhood SES should be noted (Heraclides & Brunner, 2010; Mckenzie & Carter, 2009; Pollitt et al., 2005). However, this is likely to result in greater error or variability in its measurement (Mckenzie & Carter, 2009; Pollitt et al., 2005), leading to a null effect or an estimate "too close to unity" (Phillips & Smith, 1991). However, we observed a strong direct association of childhood SES with obesity among both men and women. Individuals with obesity, more likely to have adverse health conditions (Peytremann-Bridevaux & Santos-Eggimann, 2008), may be influenced by "negative affectivity" (Mckenzie & Carter, 2009) and thus be more likely to report adverse childhood conditions. Although this may explain the observed association to some extent, it is unlikely to explain it in full. Some previous researchers have utilized multiple indicators for assessing childhood SES (Loucks et al., 2010; Luo & Waite, 2005; Pollitt et al., 2005). However, the data collected in the SIHLS allowed us the use of only a single indicator. Researchers from other Asian countries that have undergone relatively rapid development should verify our results using multiple measures of childhood SES, preferably not based on recall. Although there may be a considerable variation in SES at the three ages, we dichotomized each SES indicator to aid in the formation of a manageable number of groups, with sufficient numbers in each, for use in the social mobility conceptual model (even three levels of SES at each time point would have led to a very complex pattern of results). It may be contended that, in our setting and age cohort, education is a good measure of adult SES for men but not for women. We did consider using alternative indicators, however, each had its limitations for women: longest occupation—31.7% women were homemakers, making distinction by occupation difficult; husband's education or longest occupation—data not available for women who were widowed, separated, divorced, or never married (58.3%).

As discussed earlier, the three life-course SES conceptual models, as operationalized in this analysis, and similar to that done by researchers previously (Hallqvist et al., 2004; Heraclides & Brunner, 2010; Loucks et al., 2009, 2010; Otero-Rodriguez et al., 2011; Pollitt et al., 2005), are related and conflated. The independent association of the three lifetime point SES indicators with obesity, as observed in the sensitive period conceptual model, informed the results of the accumulation of risk and social mobility conceptual models. The same has been demonstrated by Hallqvist and colleagues (2004).

Although our findings are applicable only to Singaporean elderly people of Chinese ethnicity, they comprise the largest proportion (83.2%) of the elderly resident population in

Singapore (Singapore Department of Statistics, 2010b). We also acknowledge that an indicator of obesity status from early life would be helpful, and that, in spite of our "pseudolongitudinal" design (with indicators of SES from different life stages), reverse causality cannot be fully excluded.

Strengths

Other than its novel geographical setting, this study is possibly the first to simultaneously apply the three life-course SES conceptual models in the context of older adult obesity. More studies of the longitudinal SES–obesity association, among older adults, can be expected in future as the birth cohorts being studied in various countries age (Heraclides & Brunner, 2010). It will also be useful to further study the issue of life-course SES and obesity in younger cohorts, since their history would be different from the older cohorts.

Conclusion

The three conceptual models complement each other by providing different insights into the life-course SES–obesity relationship. Association of the three conceptual models with obesity among older Singaporeans is different from that reported among younger Western populations. The association of life-course SES with obesity in late adulthood is likely context (time and location) specific, and the three conceptual models can be simultaneously utilized to gain a broader understanding of this association.

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Conflict of Interest

None declared.

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