



Health and health behaviors in China: Anomalies in the SES-health gradient?

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ABSTRACT

Objectives: Fundamental Cause Theory (FCT) predicts that higher socioeconomic status (SES) leads to better health outcomes, through mechanisms including health-promoting behaviors. Most studies supporting FCT use data from Western countries. However, limited empirical studies from China, as well as theoretical considerations suggested by China's unique history and culture, raise questions about the generalizability of FCT to the Chinese context. This study explores whether the associations between SES, health behaviors, and health status in Western countries are also observed in China, and to what extent behavioral risk factors explain socioeconomic disparities in Chinese health.

Data and method: Using data on adults age 45+ from the nationally-representative 2015 China Health and Retirement Longitudinal Study (CHARLS; n = 14,420), we conduct regressions of multiple health outcomes (self-rated health, disease count, and several common chronic conditions) on demographic characteristics, SES (measured via education and wealth), and behavioral risk factors (smoking, high-frequency drinking, and overweight). To assess whether behavioral risk factors mediate the SES-health association, we use the Karlson, Holm and Breen (KHB) mediation analysis method.

Results: Supporting FCT, both education and wealth predict higher self-rated health and lower risk of arthritis. However, inconsistent with FCT, neither education nor wealth predict disease count, diabetes, or hypertension; education shows some positive association with cardiovascular disease; and higher SES is strongly associated with higher risk of dyslipidemia. Prevalence of smoking and high-frequency drinking are flat by wealth and inversely U-shaped by education, while overweight is somewhat concentrated in the highest SES groups. Results of mediation analyses show both suppression and mediation effects.

Conclusion: High prevalence of behavioral risk factors across SES groups appears to damage health in much of the Chinese population, and thus attenuates social gradients in health. A broader range of cultural, historical, and political factors should be incorporated into FCT's theoretical framework, particularly in non-Western contexts.

1. Introduction

Ample research over several decades has documented socioeconomic gradients in health. The positive association between education and health, in particular, has been called "one of the strongest, pervasive, and most robust [associations] in the social sciences" (Montez & Friedman, 2015, p. 1). Fundamental Cause Theory (FCT), a prominent theoretical framework to explain the persistence of socioeconomic disparities in health over time, has been supported by rich evidence (Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2010), including empirical studies showing that socioeconomic differences in health behaviors (e. g., smoking, high-frequency drinking) are major drivers of health

disparities (Cutler & Lleras-Muney, 2010).

However, the vast majority of research on these topics has used data from Western countries—despite theoretical and empirical reasons, described in more detail below, to suspect that health patterns may differ in non-Western contexts, including China. The present study uses China Health and Retirement Longitudinal Study (CHARLS) data to provide a comprehensive portrait of the relationships among socioeconomic status (SES), health behaviors, and health outcomes in China. Practically, our findings point towards interventions to improve health in the world's most populous country. Theoretically, we invite expansion of FCT to more thoroughly consider the role of historical and sociocultural contexts in shaping (and sometimes weakening or reversing)

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the SES-health link, particularly in non-Western countries.

2. Background

2.1. Fundamental Cause Theory (FCT)

Fundamental Cause Theory was developed to explain the persistence of socioeconomic disparities in health and mortality across time (Link & Phelan, 1995; Phelan et al., 2010). The theory proposes that higher SES bestows flexible resources, such as knowledge, money, power, and social networks, which can be deployed in varied circumstances to avoid risks, adopt preventive strategies, minimize disease, and promote good health. Ample empirical studies support key claims of FCT, including that 1) SES affects multiple disease outcomes, and 2) SES is associated with multiple health-related risk factors. However, most data supporting FCT come from Western countries, particularly the U.S. (Phelan et al., 2010).

A major mechanism underlying health disparities is socioeconomic differences in health behaviors (Cutler & Lleras-Muney, 2010; Phelan et al., 2010). Individuals with higher-level education may have greater knowledge, ability, and sense of control, enabling them to avoid unhealthy lifestyles (Link, 2008; Phelan et al., 2010). Indeed, the well-educated are less likely to abuse substances (e.g., alcohol and tobacco) and more likely to exercise (Cutler & Lleras-Muney, 2010). Income and wealth, too, are related to life risks and opportunities: economic hardship may prevent individuals from cultivating healthy lifestyles (Braveman & Egerter, 2008; Phelan et al., 2010).

Phelan et al. (2010) acknowledge that the association between SES and health predicted by FCT is not absolute. First, when knowledge about specific health risks is lacking, *no* SES group can act on the (non-existent) knowledge. In the U.S., information on the risks of smoking was not widely disseminated until the 1960s; only then did substantial educational gradients in smoking emerge, as the more educated acted more quickly on the new information (Link, 2008). Second, even when clear information about health risks is available, other goals may compete with health goals to weaken the SES-health link. Lutfey and Freese (2005) term these competing goals “countervailing mechanisms,” and describe “status pursuit” as one prominent category thereof. For example, young, high-SES diabetes patients, typically women, may deliberately let their blood sugar run high to stay thin (Lutfey & Freese, 2005). Courtenay’s (2000) description of men engaging in high-risk, health-threatening behaviors to demonstrate masculinity serves as another example. Lutfey and Freese (2005) argue that countervailing mechanisms do not threaten the fundamental SES-health association, because “the effects of [countervailing] mechanisms are cumulatively smaller than the effects of mechanisms producing the fundamental relationship” (p.1365).

However, it is unclear if countervailing mechanisms are *always* too weak to undermine the fundamental SES-health relationship. This is especially true given criticisms that FCT often overlooks the critical roles of culture and context. As Kagawa Singer (2012) argues, “the powerful construct of socioeconomic status ... emerges to trump culture” (p.1). This is despite evidence that social networks influence health behaviors via social norms, modeling, rewards, etc. (Latkin & Knowlton, 2015), and that sociocultural and political contexts shape how individuals’ SES affects health (Montez, Hayward, & Zajacova, 2019). Although FCT sometimes highlights the role of social context, Freese and Lutfey (2011) argue that the theory is agent-centered, i.e., it assumes that agents freely deploy resources to gain health advantages, regardless of time- and place-specific details of habitus and institutional context.

Recent cross-national studies in Europe and North America support the idea that SES-health associations are context-dependent and vary by country-level characteristics, such as welfare state regimes and social policies (Álvarez-Gálvez & Jaime-Castillo, 2018; Rydland, Solheim, & Eikemo, 2020). Little research has examined health gradients in non-Western countries, however, including in China, despite both theoretical and empirical reasons to suspect that associations among

SES, health behaviors, and health outcomes might be different in China than in the West.

2.2. Potential anomalies among middle-aged and older adults in China

The dramatic history of the People’s Republic of China in the latter half of the 20th century profoundly shaped the life course and health patterns of our population of interest: those born before or up to 1970 (age 45+ in 2015). Most of this cohort was exposed to the Great Leap Forward in the 1960s, which plunged the nation into deep recession and led to widespread starvation (Smil, 1999); all lived through the Cultural Revolution in the 1970s, which contributed to the (temporary) devastation of China’s educational system. Education may thus be a less reliable predictor of social position and economic circumstance for Chinese of this era vis-à-vis their Western peers. Even after resumption of the National Higher Education Entrance Examination in 1977, the recovery of higher education was slow: in 1990, only 3 million were enrolled in the higher education system—a gross enrollment rate of 3.4% (British Council, 2020). Many members of this generation missed the opportunity to obtain a college degree—while still sometimes experiencing upward social mobility. Consequently, social stratification in China became more financially- and politically-based, rather than education-based (Bian, Breiger, Galaskiewicz, & Davis, 2005).

Moreover, middle-aged and older adults were the backbone of the rapid economic growth begun in the late 1990s, and were the first to enjoy the sudden increase in personal wealth and availability of consumer goods. While their Western peers were becoming increasingly aware of the negative health impacts of tobacco, alcohol, and high-calorie foods, this group of Chinese were enjoying the newly wide availability of these goods. Rapid modernization in China was accompanied by a nutritional transition and an increase in sedentary lifestyles, yielding an epidemic of overweight/obesity (henceforth “overweight”) (Chooi, Ding, & Magkos, 2019; Y. He et al., 2017; Tang et al., 2013). Indeed, prevalences of smoking, drinking, and overweight have all been increasing steadily and substantially, and have become the leading health risk factors in China (Chooi et al., 2019; Y. He et al., 2017; Tang et al., 2013; Zhou et al., 2019). Over 27.7% of Chinese adults (c. 316 million people) were smokers in 2015 (H. He et al., 2020), compared to 15.1% of American adults (Ward, Clarke, Nugent, & Schiller, 2016). Chinese aged 15–69 saw a greater increase in alcohol consumption than in most other countries (Jiang, Room, & Hao, 2015); 35.7% were regular drinkers in 2007 (Li et al., 2011). The prevalence of overweight more than tripled from 7.8% in 1980 to 29.9% in 2015 (Chooi et al., 2019).

Cigarettes and alcoholic beverages, deemed the two most desirable gifts in Chinese society, have been put at the center of social courtesy (Tang et al., 2013; Yang, Wang, Wu, Yang, & Wan, 2015). Exchanging cigarettes is a common way to facilitate interpersonal relationships in daily interactions (Q. Wang, Shen, Sotero, Li, & Hou, 2018). For the socioeconomically privileged in particular, gifting luxurious cigarettes and alcoholic beverages is a prevailing way to display social position, build social networks, and benefit business affairs (Hao, Chen, & Su, 2005; Q.; Wang et al., 2018). The critical cultural meanings embedded in smoking and drinking in China may complicate the association between SES and these risky behaviors.

Finally, a key mechanism through which education is proposed to affect health is increased health knowledge, which shapes individuals’ behaviors (Elo, 2009). In China, however, the cultural characteristics of Confucian ideology, which emphasizes familial unity and collectivism, may render kinship and social networks more influential than individuals’ education in shaping health-related decisions (Lowry & Xie, 2009). The importance of alcohol and smoking in social relationships (Hao et al., 2005; Q.; Wang et al., 2018), and the association of “affluence” attached to overweight in Chinese society (Y. Wu, 2006), may outweigh individuals’ incentives to enhance their health by deploying knowledge gained through education. Thus, the “social lubricants” of alcohol, cigarettes, and excess food may be used even when they are

known to be unhealthy.

2.3. The SES-health association in China

Despite ample theoretical reasons to suspect that the SES-health association in China may differ from that in the West, relatively few studies address this topic. Some show similar, positive SES-health associations, some do not, and some report mixed findings. For instance, both [Strauss et al. \(2010\)](#) and [Lei et al. \(2014\)](#) find that, although greater education predicts better self-rated health in China, economic characteristics are only weakly linked with health. [Lei, Yin, and Zhao \(2012\)](#) find that both education and wealth are weakly associated with hypertension. [Wu and colleagues' \(2017\)](#) systematic review on diabetes prevalence finds some evidence that low education predicts higher diabetes risk, but no clear evidence of association between income and diabetes.

Moreover, few studies explore the role or socioeconomic distribution of health behaviors. [Wang et al. \(2018\)](#) find that education is negatively associated with smoking, but income is not. [Wu, Mao, Rockett, and Yue \(2008\)](#) report that education predicts lower alcohol use, but income predicts higher use. Some studies find that high SES is associated with higher prevalence of overweight/obesity (e.g., [Y. He et al., 2017](#); [Y. Wang, Mi, Shan, Wang, & Ge, 2007](#)). Even fewer studies have directly tested whether smoking, drinking, and/or overweight mediate the associations between SES and health in China.

2.4. Study goals

This study examines whether the positive associations between SES and health predicted by FCT and widely observed in Western countries are also observed in China; in the process it also tests whether behavioral risk factors mediate the SES-health link. Using a nationally-representative sample of middle-aged and older Chinese adults, a variety of health outcomes, and formal tests of mediation, this study sheds light on the state of population health and health disparities in the world's most populous country. It also demonstrates how widely-used Western medical sociological theories may need refinement when exported to non-Western contexts.

3. Data and method

3.1. Data

This study uses data from the 2015 China Health and Retirement Longitudinal Study (CHARLS), wave 3, which surveyed a nationally-representative sample of people aged 45 and above living in China. Designed to resemble the U.S. Health and Retirement Study (HRS), CHARLS is considered an HRS "sister study." CHARLS collects data on demographic characteristics, health status and functioning, income, and biomarkers. The CHARLS baseline survey was conducted in 2011. Using a multi-stage stratified proportional probability sampling technique, it surveyed approximately 17,500 individuals in 10,000 households, 28 provinces, 150 districts/counties, and 450 villages across the country. The baseline sample was followed, refreshed, or augmented every two years ([Zhao, Hu, Smith, Strauss, & Yang, 2014](#)). CHARLS has several advantages over other Chinese datasets: it aims to be nationally representative of adults age 45+, it is publicly available, and it provides richer socioeconomic and health-related information. These features allow us to examine the impact of socioeconomic and behavioral risk factors on general health status and specific chronic diseases in China as a whole.

3.2. Analytic sample

In 2015 (wave 3), CHARLS interviewed 19,717 individuals age 45 years or above. Respondents' biomarkers were measured by interviewers, with a response rate of 79.8% ([Zhao et al., 2014](#)). Because

this study uses biomarkers to calculate body mass index (BMI), we restricted the analytic sample to respondents with biomarker weights provided by CHARLS, and used the weights to correct for non-response. Hukou (a legal residential permit in China denoting either rural or urban residence), education, wealth, all other health measures, and behavioral risk factors were missing in 0.03–3.37% of cases (5.77% in total). While no respondents were missing information on education, 129 respondents (0.9%) were missing on wealth. To maintain sample size, we created a "don't know" (DK) variable for individuals missing on wealth and included it in all models. Overall, our final analytic sample comprised 14,420 individuals, representing a population of 518,802, 601 after sample-weight adjustment.

3.3. Dependent variables

Self-rated health. —The general self-rated health (SRH) item is one of the most widely used health status indicators in both developed and developing countries. It integrates information about respondents' functional ability, medical diagnoses, and psychosocial factors, and robustly predicts mortality ([Idler & Benyamini, 1997](#)). CHARLS asks respondents to rate their general health twice, once at the beginning and once at the end of the survey, with two slightly different response scales (in randomized order): "very good, good, fair, poor, or very poor," or "excellent, very good, good, fair, or poor." We accommodate both scales by quantifying SRH as 1 = excellent, 2 = very good, and so on, until 6 = very poor. We average the values of the two assessments, and then create a dichotomous measure in which poor SRH = 1 when mean SRH ≥ 4.5 ; and poor SRH = 0 when mean SRH < 4.5 . We chose a cutpoint of 4.5, between fair and poor, because levels of health below this are strongly associated with mortality ([Idler & Benyamini, 1997](#); [Latham & Peek, 2013](#)), and because this indicates that respondents never reported good or better health on the survey. Overall, 27.67% of respondents fell in the "poor health" category.

Disease count. — As another summary health measure, we include the count of up to thirteen major chronic conditions, based on self-reported diagnosis. The conditions comprise hypertension/high blood pressure, dyslipidemia (i.e., high cholesterol or triglyceride levels), diabetes/high blood sugar, cardiovascular disease (including stroke, heart disease, angina and other heart problems), cancer, lung disease, liver disease, kidney disease, stomach or other digestive diseases, psychiatric conditions, memory-related diseases, arthritis, and asthma (for similar measures, see [Homan, 2019](#)).

Specific common conditions. — To closely examine the SES-health association, five chronic conditions from the "disease count" list are also analyzed individually: arthritis, cardiovascular disease (CVD), diabetes, dyslipidemia, and hypertension. These conditions are associated with amenable behavioral risk factors, and are the most prevalent conditions among older Chinese adults ([World Health Organization, 2015](#)).

3.4. Independent variables

We analyze wealth and education separately, given evidence that these aspects of SES may have different effects on health behaviors (e.g., [Grol-Prokopczyk, 2019](#)).

Education. — As many CHARLS respondents have not finished primary school or formal education (N = 6134; 37% of sample after weighting), standard educational benchmarks used in the U.S. (e.g., beginning with "less than high school") are inappropriate for this population. We classify education into four categories: "less than primary school or no formal education", "primary school", "secondary education" (including middle school, high school, and other equivalent levels of education), and "college degree or above."

Wealth. — Wealth, especially in later life, has a stronger link to social class than income, as it reflects the value of accumulated assets and financial resources ([Berkman & Macintyre, 1997](#)). We generated five

quintiles of individuals' total wealth (including cash, deposits, stocks, bonds, and various funds; net of debt and housing value) based on our analytical sample and using sample-weight adjustment. As noted, a "DK" (don't know) category was created for individuals missing on wealth, to maintain sample size.

3.5. Potential mediators

We created three dummy variables for behavioral risk factors to be evaluated as potential mediators.

Smoking. — Respondents who reported a habit of using any type of tobacco product in the survey year (2015) were classified as smokers. (CHARLS does not ask respondents how much they smoke, e.g., how many cigarettes per day.)

High-frequency drinking. — CHARLS asked respondents how often they consumed alcohol (including wine, beer, and liquor) over the past year. Respondents who reported drinking at least once per day were classified as high-frequency drinkers.

Overweight. — Although overweight is not a health behavior, we treat it as a proxy for nutritional and exercise habits and sedentary lifestyles, as supported by ample research (e.g., Hu, 2003; Wolongevicz et al., 2010). Respondents' biomarkers, including height and weight, were recorded by CHARLS researchers. We calculated respondents' BMIs (weight in kilograms divided by squared height in meters), and classified those with BMIs ≥ 25 as overweight.

3.6. Covariates

We control for age, gender, and hukou as covariates in all models. Hukou has historically been a source of inequalities, as residents with urban hukous may receive better resources (e.g., health care, retirement pensions, education) than those with rural hukous (Sheehan, 2017).

3.7. Descriptive statistics

Table 1 presents the sociodemographic and health characteristics of the analytic sample, with and without sample-weight adjustment.

3.8. Analysis

We ran regressions to examine the associations among SES, behavioral risk factors, and health outcomes (see Fig. 1). First, we conducted multivariable regressions, including all independent variables and demographic controls, to analyze patterns of health behaviors by SES (Model 1: SES \rightarrow health behaviors). Next, using the same independent and control variables, we estimated the associations between SES and health outcomes (Model 2: SES \rightarrow health outcomes). Logistic regressions were used to examine predictors of poor SRH and multiple chronic conditions, but because disease count is a zero-inflated count variable, we used negative binomial regressions for this outcome. Third, given that nested logistic models, as nonlinear models, cannot be compared in parallel or used to examine mediation effects, we used the Karlson, Holm and Breen (KHB) method to conduct mediation analyses (Model 3: SES \rightarrow health behaviors \rightarrow health outcomes). The KHB method allows researchers to decompose the total effect of a variable into direct and indirect (i.e., mediated) components (Kohler, Karlson, & Holm, 2011). Specifically, we use KHB to assess how health behaviors may help explain differences in health outcomes between the lowest-SES group (i.e., individuals with below primary education or in wealth quintile 1) and the highest-SES group (i.e., individuals with college or above education or in wealth quintile 5). Because positive and negative mediators

Table 1
Characteristics of analytic sample (N = 14,420).

	Proportion or mean (sample-weight adjusted)	Proportion or mean (unadjusted)	N
Age in 2015			
Age 45-54	0.35	0.33	4706
Age 55-64	0.34	0.35	4996
Age 65-74	0.22	0.24	3444
Age 75+	0.09	0.09	1274
Gender			
Female	0.49	0.47	6839
Male	0.51	0.53	7581
Hukou Type			
Rural hukou	0.30	0.20	2955
Urban hukou	0.70	0.80	11,465
Education			
Less than primary school	0.37	0.43	6134
Primary school	0.28	0.28	4010
Secondary education	0.32	0.28	4070
College or above	0.03	0.01	206
Wealth, 2015 (see note)			
Quintile 1	0.19	0.22	3136
Quintile 2	0.23	0.25	3540
Quintile 3	0.19	0.20	2848
Quintile 4	0.19	0.18	2622
Quintile 5 (wealthiest)	0.19	0.20	2766
DK (missing)	0.01	0.01	129
Health Status			
Poor SRH	0.25	0.28	3976
Disease count (mean)	1.59	1.60	14,420
Arthritis	0.32	0.34	4957
Cardiovascular disease	0.17	0.17	2413
Diabetes	0.09	0.09	1256
Dyslipidemia	0.16	0.14	2045
Hypertension	0.30	0.30	4339
Risk Factors			
Smoking	0.28	0.29	4065
High-frequency drinking	0.13	0.13	1897
Overweight	0.37	0.36	5145

Note: Wealth quintiles are not exactly 20% each, because respondents unwilling to provide exact amounts were asked unfolding bracket questions (e.g., 300/500/1000 yuan), leading to heaping at certain quantities. "DK" = don't know (missing on wealth). Weighted using CHARLS's biomarker weights with individual and household response adjustment.

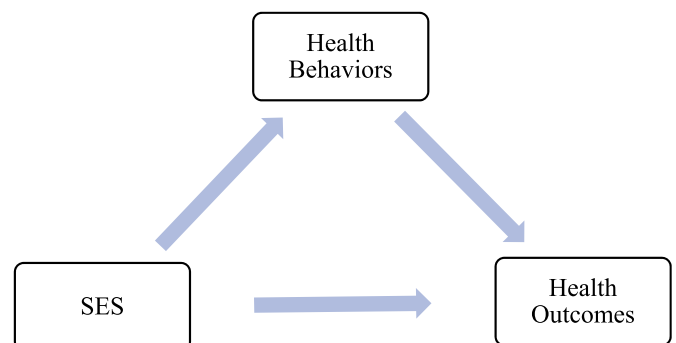


Fig. 1. Hypothesized relationships among SES, health behaviors, and health outcomes.

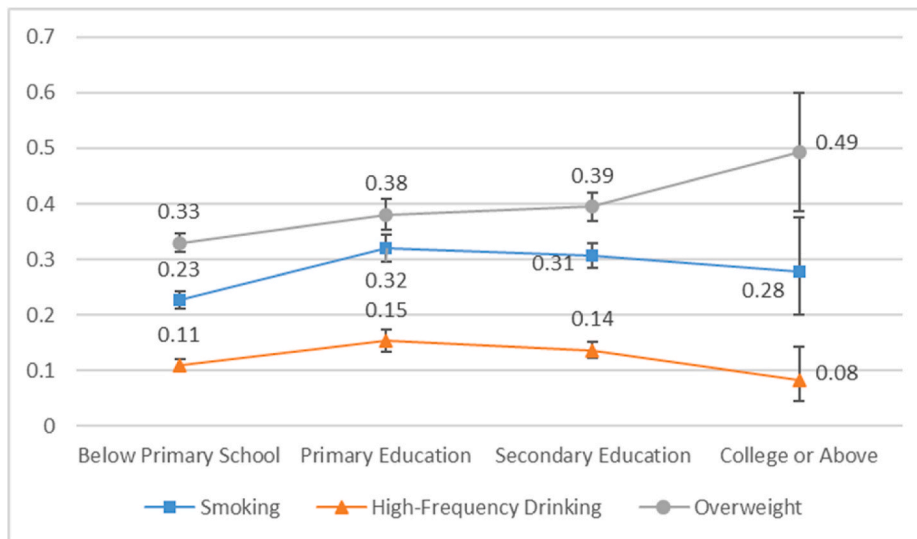


Fig. 2. Sample-weight adjusted proportion of smoking, high-frequency drinking, and overweight by educational attainment.

may cancel each other out, we identify the unique contribution of each mediator (i.e., each health behavior) while controlling for all other variables (MacKinnon, Krull, & Lockwood, 2000). All models were adjusted using CHARLS’s “biomarker weights” with individual and household response adjustment. Tests of collinearity (VIF) were conducted and confirm that multicollinearity is not a problem in these models.

4. Results

4.1. The relationship between SES and behavioral risk factors

Figs. 2 and 3 show the sample-weight adjusted prevalence of health behavioral risk factors for each educational level and wealth quintile respectively. In Fig. 2, the prevalence of smoking and high-frequency drinking by education is somewhat inversely “U-shaped” (highest

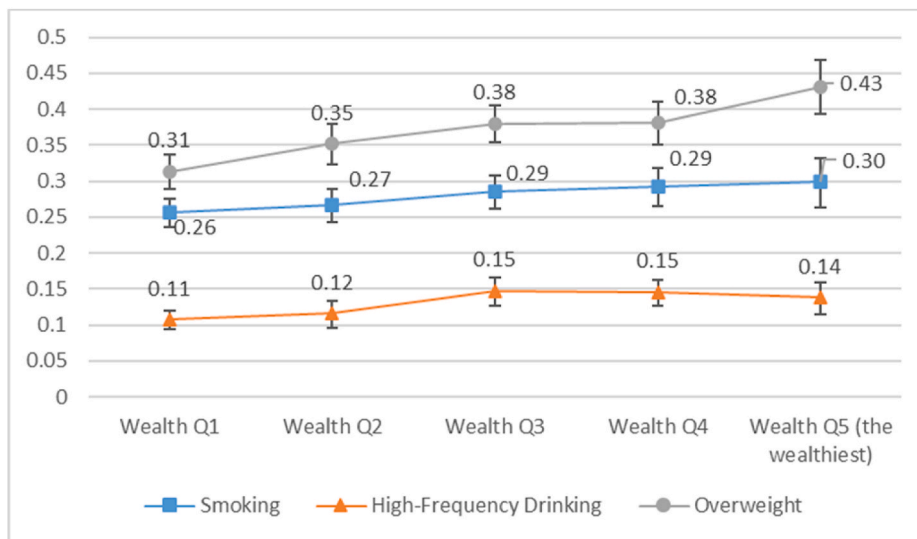


Fig. 3. Sample-weight adjusted proportion of smoking, high-frequency drinking, and overweight by wealth quintile.

Table 2
Sample-weight adjusted logistic regression of smoking, high-frequency drinking, and overweight on sociodemographic characteristics and SES (model 1; N = 14,420).

	Smoking	High-Frequency Drinking	Overweight
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age, 2015 (ref: 45–54)			
Age 55–64	1.04 (0.86–1.27)	1.49*** (1.21–1.83)	0.96 (0.83–1.11)
Age 65–74	0.75** (0.62–0.92)	1.49*** (1.20–1.86)	0.80** (0.68–0.93)
Age 75+	0.51*** (0.39–0.68)	1.41† (0.97–2.05)	0.57*** (0.45–0.72)
Gender (ref: Male)			
Female	0.04*** (0.03–0.04)	0.07*** (0.06–0.09)	1.35*** (1.19–1.53)
Hukou Type (ref: Rural hukou)			
Urban hukou	1.16 (0.94–1.43)	1.09 (0.86–1.38)	0.77** (0.65–0.90)
Education (ref: Below primary school or no formal education)			
Primary school	0.79** (0.68–0.93)	0.93 (0.76–1.12)	1.16* (1.00–1.35)
Secondary education	0.65*** (0.54–0.79)	0.75** (0.62–0.91)	1.14 (0.97–1.33)
College degree or above	0.66† (0.41–1.06)	0.41** (0.21–0.80)	1.44 (0.91–2.28)
Wealth, 2015 (ref: Quintile 1)			
Quintile 2	0.96 (0.77–1.20)	1.03 (0.81–1.32)	1.16† (0.98–1.38)
Quintile 3	0.93 (0.75–1.14)	1.32* (1.06–1.65)	1.27** (1.09–1.50)
Quintile 4	0.77* (0.59–0.98)	1.15 (0.92–1.43)	1.25* (1.04–1.49)
Quintile 5 (wealthiest)	0.74* (0.56–0.98)	1.11 (0.85–1.44)	1.40** (1.14–1.73)

Note: OR = odds ratio; CI = confidence interval. Analyses also include "DK" wealth category (indicating missing values for wealth); not shown.
***p < 0.001 **p < 0.01, *p < 0.05, †p < 0.1; two tailed.

among people with intermediate levels of education), while overweight is positively associated with education, peaking among the college-plus group. Fig. 3 indicates that health behaviors have a fairly flat association with wealth, although risk of overweight in particular appears to increase with wealth.

Table 2 shows that after controlling for age, gender, and hukou and including both education and wealth simultaneously (Model 1), higher education predicts lower odds of smoking and drinking but has little association with overweight. Greater wealth predicts significantly lower likelihood of smoking but significantly greater likelihood of being overweight. Drinking shows a non-linear association with wealth, with wealth quintile 3 associated with the highest odds of drinking. Overall, health behaviors in China show complex associations with SES, which sometimes depend on which measure of SES is considered.

4.2. The relationship between SES and health outcomes

Table 3 presents sample-weight adjusted regressions of seven health outcomes on education, wealth, and demographic controls (Model 2).

Net of other factors, higher levels of education and wealth both predict lower odds of poor SRH. In particular, secondary education (OR = 0.77; p < 0.001) and wealth quintiles 4 and 5 (ORs of 0.62 and 0.51, respectively; p < 0.001) predict significantly lower odds of poor health. However, no similar association between SES measures and disease count is observed; indeed, secondary education predicts a slightly higher disease count (IRR = 1.07; p < 0.5).

For specific chronic conditions, the associations with education and wealth vary by disease. Higher education and higher wealth both strongly predict reduced odds of arthritis, but higher odds of dyslipidemia. Secondary education is significantly associated with cardiovascular disease, but otherwise neither education nor wealth have significant relationships with CVD, diabetes, or hypertension.

To show these relationships visually, Figs. 4 and 5 present sample-weight adjusted predicted probabilities of poor SRH and specific chronic conditions by education and wealth, controlling for all covariates in Model 2. (Since the predicted value of disease count is not a probability, we do not include it in these figures.) Within each figure, the top panel shows socioeconomic gradients consistent with FCT: higher-SES individuals are less likely to report poor health and to have arthritis. In contrast, the lower panel of each figure presents “anomalies” which are inconsistent with FCT’s predictions: the likelihood of having these chronic conditions (CVD, diabetes, dyslipidemia, and hypertension) is either flat by SES, or increases with increasing education and/or wealth.

4.3. Mediation analyses

Tables 4 and 5 show formal mediation analyses using the KHB method, controlling for all other variables. Although some results (e.g., for diabetes and hypertension) in Model 2 (Table 3) showed no significant disparities across SES groups, we conduct mediation tests on all seven health outcomes to identify suppression effects, which may result in insignificant relationships between independent and dependent variables (MacKinnon et al., 2000).

Table 4 (Model 3A) presents whether health behaviors mediate the associations between education (less than primary school vs. college degree or above) and health outcomes. Results show that health behaviors can function as mediators, suppressors, or neither, depending on health outcome. Specifically, the three health behaviors jointly suppress 7.98% of the association between education and SRH (p < 0.05), while explaining 46.14% of the association between education and CVD (p < 0.05). Examined as an individual mediator, high-frequency drinking suppresses 8.50% (p < 0.01) of the education-SRH association and explains 18.99% of the education-CVD association (p < 0.05).

Table 5 (Model 3B) presents similar mediation analyses for the association between wealth (quintile 1 vs. quintile 5) and health outcomes. Results show that collectively the three health behaviors are not significant mediators of wealth differences in health. Analyzed individually, overweight appears to suppress 46.72% of the association between wealth and disease count (p < 0.01) and 47.54% of the wealth-hypertension association (p < 0.01), while also being a significant mediator of the relationship of wealth with CVD, diabetes, and dyslipidemia (p < 0.01 in all cases). That is, overweight helps explain why the wealthiest individual have higher rates of CVD, diabetes, and dyslipidemia than the least wealthy individuals. However, the suppression

Table 3

Sample-weight adjusted logistic/negative binomial regressions of health outcomes on demographic characteristics and SES (model 2; N = 14,420).

	Poor SRH OR (95%CI)	Disease Count IRR (95% CI)	Arthritis OR (95%CI)	CVD OR (95%CI)	Diabetes OR (95%CI)	Dyslipidemia OR (95% CI)	Hypertension OR (95% CI)
Age, 2015 (ref: 45–54)							
Age 55 - 64	1.26*** (1.10–1.44)	1.37*** (1.28–1.47)	1.39*** (1.20–1.60)	1.74*** (1.41–2.16)	1.81*** (1.43–2.31)	1.81*** (1.48–2.21)	1.76*** (1.50–2.07)
Age 65 -74	1.64*** (1.40–1.93)	1.73*** (1.61–1.87)	1.92*** (1.65–2.24)	3.08*** (2.46–3.86)	1.95*** (1.53–2.49)	2.06*** (1.68–2.53)	2.61*** (2.22–3.08)
Age 75 +	1.75*** (1.45–2.12)	1.62*** (1.49–1.77)	1.48*** (1.20–1.83)	3.07*** (2.36–4.01)	1.87*** (1.36–2.59)	1.04 (0.79–1.38)	2.85*** (2.31–3.52)
Gender (ref: male)							
Female	1.25*** (1.11–1.41)	1.17*** (1.11–1.23)	1.52*** (1.35–1.71)	1.60*** (1.38–1.85)	1.29** (1.08–1.55)	1.29** (1.09–1.51)	1.23** (1.08–1.40)
Hukou Type (ref: Rural hukou)							
Urban hukou	1.31*** (1.12–1.52)	0.86*** (0.80–0.92)	1.18* (1.01–1.38)	0.59*** (0.51–0.68)	0.50*** (0.40–0.63)	0.51*** (0.43–0.62)	0.74*** (0.64–0.86)
Education (ref: Below primary school or no formal education)							
Primary school	0.94 (0.82–1.07)	0.97 (0.92–1.02)	0.77*** (0.67–0.88)	1.08 (0.90–1.29)	1.09 (0.86–1.40)	1.26* (1.04–1.53)	1.03 (0.88–1.19)
Secondary education	0.77*** (0.66–0.90)	1.07* (1.00–1.14)	0.83** (0.72–0.95)	1.41** (1.15–1.74)	1.04 (0.79–1.37)	1.58*** (1.28–1.94)	1.03 (0.87–1.21)
College degree or above	0.64 (0.37–1.11)	1.07 (0.90–1.28)	0.47** (0.28–0.77)	1.17 (0.71–1.93)	1.49 (0.84–2.66)	2.79*** (1.63–4.79)	1.49 (0.90–2.48)
Wealth, 2015 (ref: Quintile 1)							
Quintile 2	0.98 (0.85–1.12)	1.04 (0.98–1.11)	0.97 (0.84–1.12)	1.15† (0.98–1.35)	1.17 (0.94–1.47)	1.27* (1.04–1.54)	1.10 (0.94–1.29)
Quintile 3	0.87† (0.76–1.00)	0.98 (0.92–1.05)	0.82** (0.72–0.95)	1.02 (0.86–1.22)	1.13 (0.89–1.42)	1.31** (1.08–1.58)	1.06 (0.91–1.24)
Quintile 4	0.62*** (0.52–0.72)	0.95 (0.88–1.03)	0.75*** (0.64–0.88)	0.98 (0.81–1.19)	1.28 (0.94–1.73)	1.33* (1.05–1.68)	0.97 (0.82–1.15)
Quintile 5 (wealthiest)	0.51*** (0.41–0.64)	0.96 (0.87–1.06)	0.67** (0.53–0.85)	1.03 (0.77–1.39)	1.07 (0.81–1.43)	1.67*** (1.30–2.15)	0.85 (0.70–1.04)

Note: Analyses also include "DK" wealth category (indicating missing values for wealth); not shown. All models are logistic regressions except for disease count, which uses a negative binomial regression. All models control for all indicated variables simultaneously. CVD = cardiovascular disease; OR = odds ratio; IRR = incidence-rate ratio; CI = confidence interval.

***p < 0.001 **p < 0.01, *p < 0.05, †p < 0.1; two tailed.

findings indicate that, were it not for differences in excess weight, disparities in disease count and hypertension by wealth would be stronger.

5. Discussion

5.1. Main findings

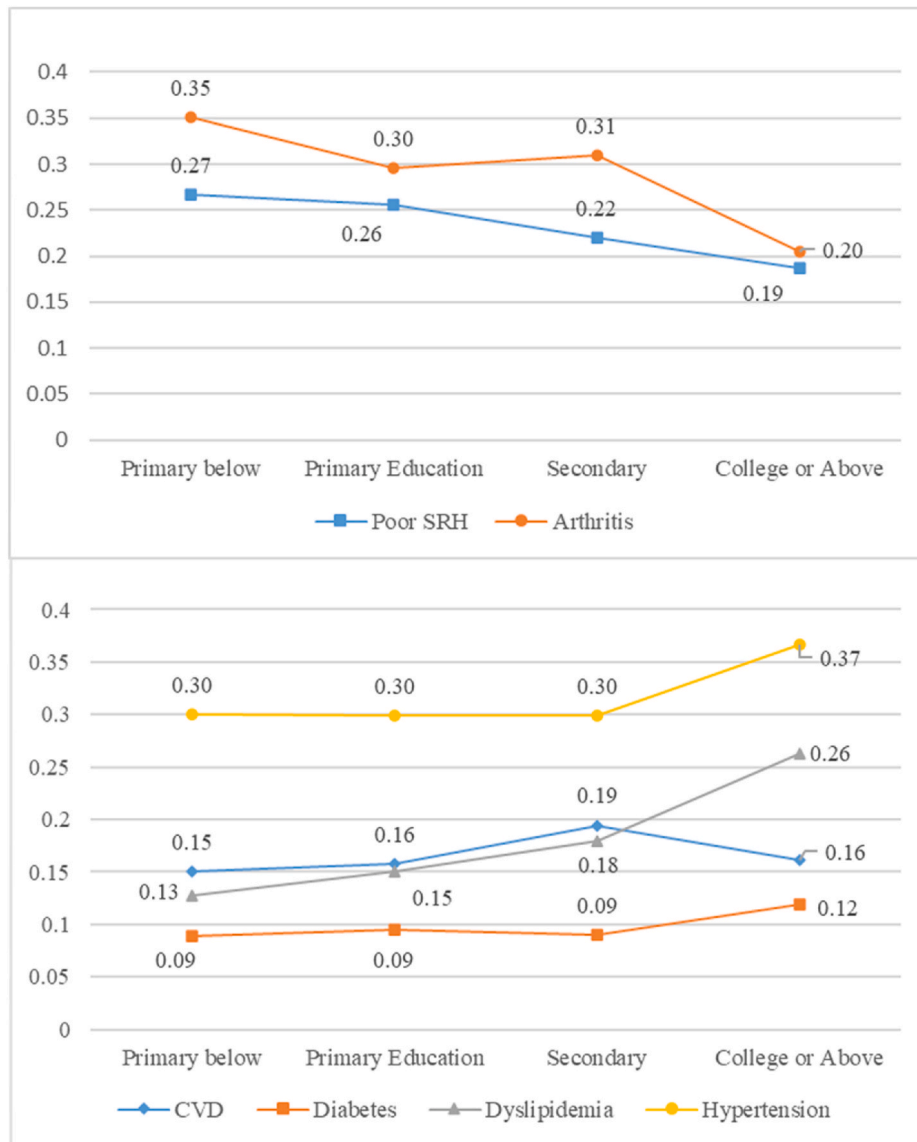
Driven by the theoretical framework of Fundamental Cause Theory, we examined the relationships among SES, health behaviors, and health outcomes to better understand health disparities in China. FCT proposes that higher-SES individuals attain better health outcomes in part due to more favorable, socioeconomically-patterned health behaviors. Our study partially supports the theory but simultaneously powerfully challenges it in the Chinese context.

Our findings regarding health behavioral risk factors—smoking, high-frequency drinking, and overweight/obesity—are to some degree consistent with previous studies in China. Net of other variables, higher education predicts lower odds of smoking and drinking—but also some greater tendency towards overweight. Wealth, in multivariable models, predicts reduced risk of smoking, but also some higher odds of frequent drinking, and, especially, higher odds of overweight (compare with Y. He et al., 2017; Q. Wang et al., 2018; B. Wu et al., 2008). Simple

bivariate associations of SES measures and behavioral risk factors fail to show the straightforward inverse socioeconomic gradient predicted by FCT (Phelan et al., 2010). The higher risk of excess weight among wealthier groups could reflect China’s nutrition transition, characterized by high-calorie diets and sedentary lifestyles among the middle and higher classes (Chooi et al., 2019). Potential explanations for smoking and drinking behaviors are discussed in the next section.

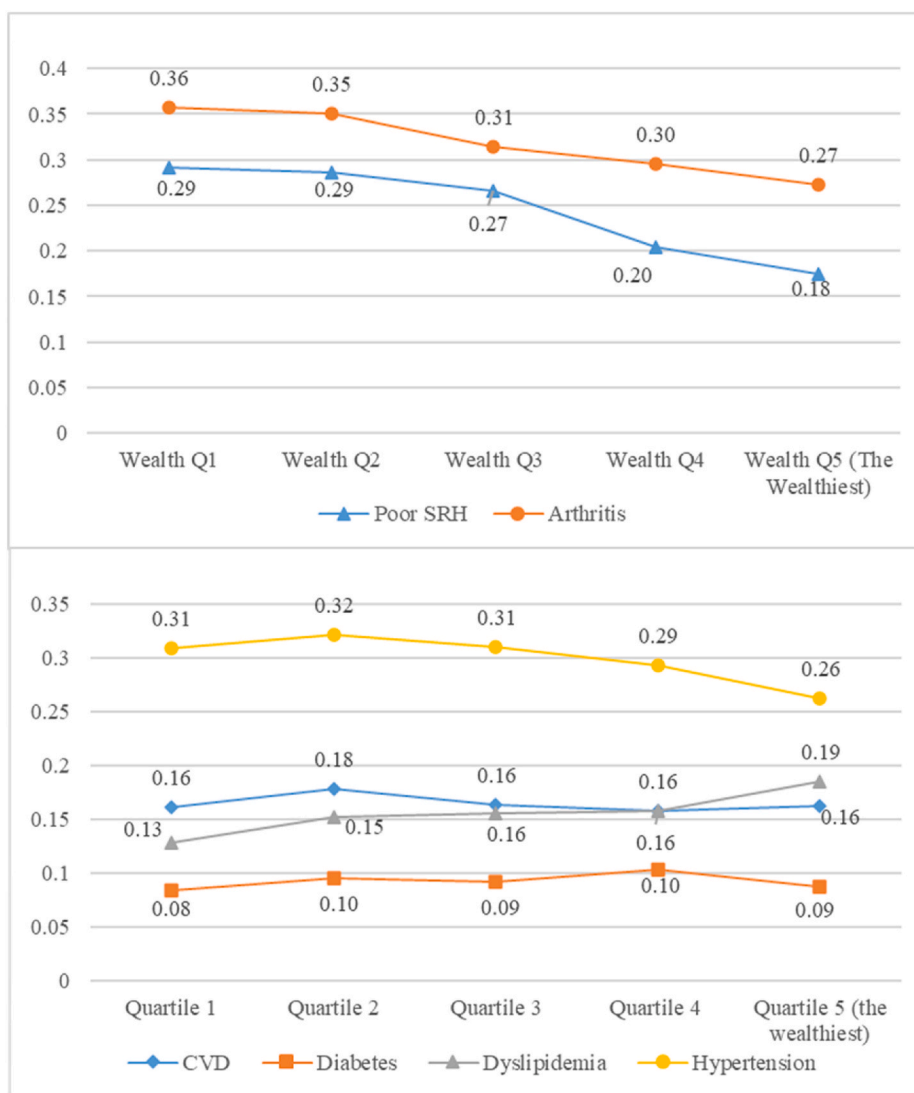
Regarding associations between SES and key health outcomes, our findings (from multivariable Model 2) are consistent with FCT insofar as higher education and wealth strongly predict better SRH and reduced risk of arthritis. However, for most tested health outcomes, our findings challenge FCT. We found little or no significant socioeconomic disparities in disease count, diabetes, and hypertension; some positive association between education and cardiovascular disease; and a strong, very consistent positive association between SES (both education and wealth) and risk of dyslipidemia.

Our tests of mediation, designed to formally test whether behavioral risk factors help explain socioeconomic disparities in health, revealed a complex mix of mediation and suppression effects. Specifically, the health behaviors jointly helped explain educational disparities in CVD, but suppressed educational disparities in SRH. Overweight was the most crucial characteristic helping to explain wealth-health associations,



Note: CVD = cardiovascular disease

Fig. 4. Sample-weight adjusted predicted probability of SRH and various common chronic conditions by education, controlling for all other covariates.



Note: CVD = cardiovascular disease

Fig. 5. Sample-weight adjusted predicted probability of SRH and various common chronic conditions by wealth, controlling for all other covariates.

Table 4

Sample-weight adjusted KHB mediation analyses for health outcome differences between low and high education groups (model 3A; N = 14,420).

	Poor SRH	Disease Count	Arthritis	CVD	Diabetes	Dyslipidemia	Hypertension
Total % of education-health relationship explained by all mediators.	-7.98*	38.97	-0.27	46.14*	16.83	9.42	22.16
% of the education-health relationship explained by each mediator							
Smoking	0.68	3.84	0.08	-0.99	1.57	0.28	1.03
High-freq. drinking	-8.50**	8.34†	0.59	18.99*	3.50	2.34†	-0.32
Overweight	-0.17	26.80	-0.93	28.14	11.76	6.80	21.46

Note: All models use the logit link function except the disease count model, which uses negative binomial regression. All models control for age category, sex, hukou, and wealth quintiles. "Low education" = below primary education; "high education" = college education or above. CVD = cardiovascular disease. Findings significant at 0.05 or less are bolded.

***p < 0.001, **p < 0.01, *p < 0.05, †p < 0.1; two tailed.

serving as mediator or suppressor depending on health outcome.

5.2. Countervailing mechanisms

According to FCT, "countervailing mechanisms are likely to be embedded in strong social norms and support" (Phelan et al., 2010), but nonetheless are too weak or too rare to threaten the fundamental SES-health relationship (Lutfeij & Freese, 2005).

Results from this study, however, challenge this claim. We argue that

countervailing mechanisms may override the fundamental relationship, and in fact do so in the Chinese context, yielding absent or reverse social gradients for the majority of health outcomes we examined. This is partially because deleterious health behaviors, embodying strong cultural meanings, are socially accepted and even encouraged. The critical roles of smoking and drinking in people's social lives (Hao et al., 2005; Q. Wang et al., 2018) and the persistent image of "affluence" attached to excess weight (Y. Wu, 2006) may outweigh the protective impact of higher SES. Additional political and historical factors may also shape

Table 5

Sample-weight adjusted KHB mediation analyses for health outcome differences between low and high wealth groups (model 3B; N = 14,420).

	Poor SRH	Disease Count	Arthritis	CVD	Diabetes	Dyslipidemia	Hypertension
Total % of wealth-health relationships explained by all mediators.	0.79	-50.16	-1.57	86.65	56.05	11.76	-49.38
% of the wealth-health relationships explained by each mediator							
Smoke	0.30	-5.17	0.10	-2.64	5.41	0.38	-1.76
High-frequency Drink	0.58	1.72	-0.12	-7.77	-1.85	-0.48	-0.09
Overweight	-0.10	-46.72**	-1.55	97.06**	52.49**	11.87**	-47.54**

Note: All models use the logit link function except the disease count model, which uses negative binomial regression. All models control for age category, sex, hukou, and wealth quintiles. "Low wealth" = the bottom wealth quintile; "high wealth" = the top wealth quintile. CVD = cardiovascular disease. Findings significant at 0.05 or less are bolded.

***p < 0.001, **p < 0.01, *p < 0.05, †p < 0.1; two tailed.

health behaviors and outcomes. For example, government restrictions on alcohol and tobacco consumption are relatively loose in China (Li et al., 2011; Q. Wang et al., 2018). The nutrition transition model and the "diseases of affluence" paradigm (Ezzati et al., 2005) predict that China's rapid economic development would lead to increases in obesity, hypertension, cholesterol, etc., especially among the middle and upper classes. In this context, higher positioning on the social ladder in China is not necessarily predictive of better health behaviors or health outcomes.

In our mediation analyses, most of the time, *suppression* effects appear when low-SES groups are prone to have worse health (e.g., when the least-educated have higher odds of poor SRH) and mediation effects appear when high-SES groups are prone to have worse health (e.g., when wealthier individuals have higher risk of dyslipidemia; Tables 3–5). These results are not completely unexpected. High prevalence of smoking, drinking, and overweight, particularly among the socioeconomically privileged, somewhat narrows the expected health gaps across SES groups. However, the diminished disparities in health do not indicate that disadvantaged groups possess relatively better health in China than elsewhere; rather, they indicate that risky health behaviors considerably damage population health in China *including* among (and sometimes especially among) people at the top of social hierarchy (see also Y. He et al., 2017; Tang et al., 2013; Zhou et al., 2019).

5.3. Limitations

We acknowledge several limitations of this study. First, health conditions in this study are measured by self-reported diagnosis. Their prevalence may be underestimated if some respondents are undiagnosed. If undiagnosed respondents are disproportionately of lower SES, our estimates of socioeconomic disparities in health would be biased. However, because China has universal health care (Yu, 2015), the risk of such bias is likely lower than in the U.S. or many developing countries. Moreover, our findings were similar for conditions that could potentially go undiagnosed long-term (e.g., hypertension) and for conditions with acute symptoms that make long-term lack of diagnosis unlikely (e.g., diabetes). This suggests that diagnostic bias is unlikely to be large. Second, due to data limitations (e.g., lack of data about daily number of cigarettes smoked), we measure both current smoking and high-frequency alcohol consumption as dichotomous variables. Future studies with different data could explore how the amount of smoking or drinking is patterned by SES and/or affects health. (We acknowledge that the relationship between alcohol use and health is complicated and varies based on quality and quantity of alcoholic beverages consumed.) Third, current findings show that, except for overweight, women have better health behaviors but worse health outcomes than men. Sensitivity tests (not shown) indicate that overweight explains only part of the sex differences in health outcomes. Future research could investigate whether social factors (e.g., structural sexism [Homan, 2019]) might lead to different SES-associated health returns for women than men. Fourth, the small number of respondents in the "college or above" group (n = 206) leads to less precision in our estimates, as shown by large confidence intervals in Fig. 2. These estimates may be less reliable than those for the other educational categories. Fifth, we lacked data to assess

how much earlier-life adversities shape later-life health in China, although both biomedical literature and China's tumultuous mid-20th century history suggest that such links are very plausible, via mechanisms such as allostatic load (Shonkoff, Boyce, & McEwen, 2009). Lastly, since this study uses cross-sectional data, reverse causality is a possibility in our assessments of the SES-health link and the mediating role of health behaviors. For example, poor health could affect earnings or deplete savings, leading to lower wealth. (This is a smaller concern for education, which is typically completed early in life, before onset of chronic conditions.) As another example, if a disease diagnosis prompts people to quit smoking, the association between smoking and disease will appear attenuated. Longitudinal analyses could clarify the causal relationships among SES, health behaviors, and health outcomes in China. Our study can only identify associations.

5.4. Policy and practice implications

China has made remarkable progress in public health in recent decades (Zhou et al., 2019). However, the rising rates of alcohol use, tobacco consumption, and overweight/obesity accompanying China's rapid economic development are threatening population health. Our findings confirm that these risk factors are epidemic in China. Government policies have aimed to promote healthier lifestyles, but with limited success (Zhou et al., 2019).

Kagawa Singer (2012) argues that policy makers and health care providers should understand how culture affects health behaviors in order to design effective health-promotion programs. Our study can support this goal. We find that many unhealthy behaviors do not show socioeconomic gradients and some are more common among socioeconomically *advantaged* groups. Chinese public health policies may need to target socioeconomically broad populations, and to strategize about how to address the "countervailing" cultural mechanisms that make smoking, alcohol use, and unhealthy lifestyles appealing even in (or sometimes especially among) advantaged social groups. Strategies may include restricting marketing of tobacco and alcohol to avoid reinforcing unhealthy traditional values; large-scale, culturally-sensitive education campaigns to encourage healthier lifestyles; and making relevant resources (e.g., smoking/drinking cessation services) more accessible. While our study focuses on China, other rapidly modernizing countries (and/or countries in which cigarettes, alcohol, etc., serve important social or symbolic functions) may experience similar health-related patterns. This topic merits further research.

6. Conclusion

This study has shown that the associations among SES, health behaviors, and health outcomes predicted by FCT are only observed sometimes in the Chinese context. Indeed, patterns in China are sometimes the opposite of those predicted by FCT. This may reflect the later timing of China's epidemiological and nutritional transitions, but also likely reflects other culture-specific factors. In general, health theories developed in one world region should not be assumed to hold universally, as health is shaped by a broad range of cultural, historical, and

political factors.

Ethical statement

This research uses publicly available data from the China Health and Retirement Longitudinal study. This research has not received any financial support. We have no conflict of interest to disclose.

Author statement

Rui Huang: Conceptualization, Data curation, Formal analysis, Writing- Original draft, Visualization, Methodology, Validation; Writing – review and editing. **Hanna Grol-Prokopczyk:** Conceptualization, Methodology, Validation; Writing-review and editing.

Declaration of competing interest

None.

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