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Dietary glycemic load, glycemic index, and carbohydrate intake on the risk of lung cancer among men and women in Shanghai

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Abstract

To investigate the potential influence of dietary glycemic index, glycemic load or carbohydrate intake and lung cancer risk in Shanghai. We prospectively investigated the associations among 130,858 participants in the Shanghai Women's and Men's Health Studies. Diet was assessed using validated food frequency questionnaires. Lung cancer cases were ascertained through annual record linkage and every 2-3 years in-home visits. Cox proportional hazard regression model was used to calculate hazard ratios (HRs) and 95% confidence intervals (CIs). After excluding the first two years of observation, 1312 participants (including 649 women and 663 men) developed lung cancer during an average follow-up of 14.8 (SD: 2.0) years for SWHS and 9.3 (SD: 1.6) years for SMHS. In multivariable analysis, no statistically significant associations were observed between glycemic index, glycemic load and carbohydrate intake and lung cancer risk for either men or women. Similar results were observed among never smokers, and participants without history of lung disease, diabetes or hypertension. Stratification by body mass index or menopause status also did not alter the findings. Our studies, conducted in populations who habitually have high carbohydrate diets, provide no evidence that dietary glycemic index, glycemic load, or carbohydrate intake is associated with lung cancer risk.

Keywords

lung cancer; glycemic load; glycemic index; carbohydrate; cohort study

Introduction

Lung cancer is the most commonly diagnosed cancer among males and the fourth among females globally, and has a high fatality rate[1]. In China, lung cancer is ranked as the first both in cancer incidence and death among men, while ranked as the second in cancer incidence but first in cancer death among women [2]. Apart from cigarette smoking, which is the principal risk factor for lung cancer, numerous studies have suggested that lifestyle and dietary factors may also be of etiologic importance.

Carbohydrates are the main dietary component affecting insulin secretion and postprandial glycemia[3], and such affecting varies substantially and depends largely on both the amount and type of carbohydrates consumed[4]. Glycemic index (GI) is a ranking of carbohydrate-containing foods based on their postprandial blood glucose responses relative to a reference food (white bread or glucose); generally, the lower the GI, the smaller the rise in postprandial glucose and insulin concentrations[4, 5]. Glycemic load (GL) is a measure that incorporates both the quality, measured by the GI value, and quantity of dietary carbohydrates[6], and consequently, may be a better measure than GI to characterize the glycemic effect of the diet. Cumulative epidemiologic evidence suggests that higher dietary GI or GL may increase the risk of diabetes or metabolic syndrome[7–10]. Diabetes has been found to play a role in the etiology of certain cancers[11, 12], including lung cancer[13], we, therefore, hypothesized that dietary GI, GL, and carbohydrates may also be associated with lung cancer.

Although the potential associations of carbohydrates, GI, GL with various cancers have been investigated in previous studies and meta-analysis[14–18], the associations of these dietary factors with lung cancer have not been adequately evaluated. Only four studies (three case-control studies and one cohort study) have been conducted to assess the association between carbohydrates, GI, GL and lung cancer, which produced inconsistent results[19–22]. In addition, previous studies were primarily conducted in western societies, where bread, potatoes, sugar-sweetened soft drinks and desserts are the main sources of dietary GL; little is known about such association in detail in China, where dietary patterns substantially differ from a western diet, and the majority of carbohydrates are from processed grains, predominantly white rice[23, 24]. Therefore, we prospectively investigated associations of dietary GI, GL, and carbohydrate intake with lung cancer risk in middle-aged and older Chinese adults by using data collected in the Shanghai Women's Health Study (SWHS) and the Shanghai Men's Health Study (SMHS).

Methods

Study population

Participants included in this study were enrolled in either the SWHS or SMHS. Details regarding the designs and methods used in these studies have been published previously[23–25]. Briefly, of the 81,170 eligible women who lived in the study communities during the time period of the baseline survey (from March 1997 to May 2000), 75,221 participated in the study, with a participant proportion of 92.7%. One duplicate women and 279 women who were later found to be younger than age 40 or older than age 70 years at the time of

baseline interview were excluded from the cohort. The remaining 74,941 women aged 40–70 years were enrolled in the SWHS. For the SMHS, of the 83,033 eligible men, 61,480 men aged 40–74 years with no previous history of cancer were enrolled from April 2002 to June 2006, with a participant proportion of 74.0%. In-person interviews were conducted to obtain information on socio-demographic characteristics, dietary and lifestyle habits, physical activity and medical history using structured questionnaires. Anthropometrics, including current weight, height, and hip circumferences, were also measured according to standard protocols at baseline. Both studies were approved by all relevant Institutional Review Boards and an informed consent was obtained from each participant.

Dietary assessment

Semi-quantitative food frequency questionnaires (FFQs) were used to assess dietary intake in each cohort. The FFQ used in the SWHS included 77 items that covered 85.6% of foods commonly consumed in urban Shanghai in 1996[24]. A similar but extended FFQ with 81 items was used in the SMHS, and it captured 88.8% of commonly consumed foods[23]. During the in-person interviews, each participant was asked about the frequency of consumption (daily, weekly, monthly, yearly or never) and amount of consumption in liang (1 liang=50g) per unit of time for each food item during the preceding year. Daily nutrient intake was calculated by multiplying the daily intake of each food by the nutrient content per gram of that food derived from the Chinese Food Composition Tables[26]. Carbohydrate-rich foods mentioned in our FFQs included rice and wheat products (noodles, steamed bread). The reproducibility and validity of FFQs in the SMHS/SWHS were determined using monthly (SMHS; n=12) or biweekly (SWHS; n=24) 24-hour dietary recall evaluation over a 1-year period. The correlation coefficients in the SWHS and SMHS comparing intakes from FFQs to those on 24-hour dietary recalls were 0.66 and 0.64 for all carbohydrates, and 0.65 and 0.63 for rice, respectively [23, 24].

The GI values of carbohydrate-containing foods were obtained from the Chinese Food Composition Tables [26] and international tables for GI values[27]. Each food's GL was calculated by multiplying the carbohydrate content of the food by its GI value and the average amount of food consumed per day. Dietary GL was then produced by summing these products over all of the food items. Overall dietary GI was obtained by dividing dietary GL by the total carbohydrates consumed, thus yielding a weighted average GI for each individual's diet[28].

Follow-up and outcome ascertainment

Incident lung cancer cases were identified through a combination of annual record linkage with the Shanghai Cancer Registry and the Shanghai Municipal Vital Statistics Registry and every 2–3 years in-home interviews. For the SWHS, the response proportions for the first (2000–2002), second (2002–2004), third (2004–2007), and fourth (2008–2011) in-person surveys were 99.8%, 98.7%, 96.7% and 92.3%, respectively. For the SMHS, the response proportions for the first (2004–2008), and second (2008–2011) in-person surveys were 97.6% and 93.7%, respectively. The incident lung cancer cases were defined as a primary tumor with an International Classification of Diseases (ICD-9) code of 162, and all possible cancer cases were verified by home visits and review of medical charts from the diagnosing

hospital. Outcome data through December 31, 2013 for both men and women were used for the present analysis.

Statistical analysis

We present risk estimates separately for men and women. Person-years of follow-up for each participant were calculated as the interval between baseline recruitment to the diagnosis of lung cancer, censored at death, lost to follow-up or end of follow-up (December 31, 2013), whichever occurred first. Hazard ratios (HRs) and 95% confidence intervals (95% CIs) for lung cancer risk with carbohydrate intake, GI, and GL were estimated with Cox proportional hazard models, with person-years as the underlying time metric; results calculated with age as the underlying time metric were similar.

Carbohydrate and GL were adjusted for total energy intake using the nutrient density method [29] (GI was not highly correlated with energy, $r=0.02$ for SMHS, and -0.16 for SWHS). Dietary intakes were categorized by quartile distribution, with the lowest quartile serving as the reference group. In minimally adjusted models, we included age (continuous), energy intake (continuous) and smoking status (men only, three categories: never, ever, current) as covariates. In multivariable-adjusted models, we further adjusted for the following confounders: education (four categories: elementary school or less, middle school, high school, and college or above), income (four categories, for men: <500 , $500-999$, $1000-1999$, ≥ 2000 yuan/month; for women: <10000 , $10000-19999$, $20000-29999$, ≥ 30000 yuan/year), body mass index (BMI, continuous), physical activity (measured by metabolic equivalent task hours per week per year, four categories), smoking pack-years (men only, calculated as the number of cigarettes per day multiplied by the number of years smoking, five categories: 0, 1-12, 13-21, 22-31, ≥ 32 pack-years), drinking status (men only, three categories: never, ever, current), history for lung diseases (yes/no, including asthma, tuberculosis and chronic bronchitis for women, and further including emphysema for men), history of hypertension (yes/no), history of diabetes (yes/no), family history of cancer (yes/no) and menopausal status (women only: pre-/post-menopausal). We evaluated the proportional hazards assumption by including an interaction between dietary GI, GL, or carbohydrate with the time of follow-up, and no major violation was observed. *P* values for trend across quartiles were estimated by assigning the median intake value for the quartile to each person and including this as a continuous variable in the regression model.

To explore the potential effect modification, we also performed stratified analysis by BMI (<18.5 , $18.5-23.99$, $24.0-27.99$, ≥ 28 kg/m², according to Chinese standards[30]), smoking status (for men: never, ever, or current; for women: ever/never), family history of cancer (yes/no) and menopausal status (women only, pre- or post-menopausal). Considering that dietary habits might have been influenced by baseline disease, we further performed a sensitivity analysis by excluding the participants who had a history of diabetes, lung disease or hypertension at baseline from the analyses. All statistical analyses were performed using SAS V.9.2 (SAS Institute, Cary, North Carolina USA), and a two-sided *P*-values less than 0.05 was considered statistically significant.

Results

We excluded 1,919 participants from the SWHS and 424 participants from the SMHS from the analysis because of a diagnosis of cancer before enrollment (1561 women), lost shortly after study enrollment (5 women and 14 men), death from cancer without information on cancer type or diagnosis date (149 women and 141 men), cancer diagnosis that could not be confirmed (79 women and 41 men), and extreme values for total energy intake (<500 or >3500 kcal/d for 125 women; <800 or >4,200 kcal/d for 228 men). We also excluded participants having missing data for any of the covariates of interest (997 women and 1,185 men). We additionally excluded participants who died or were lost to follow-up within the first 2 years to reduce the potential bias of reverse causality (362 women and 676 men), because their dietary habits might have been influenced by preclinical diseases. The sample size for the final analysis was 130,858 participants (71,663 women and 59,195 men).

During an average follow-up of 14.8 (SD: 2.0) years in the SWHS and 9.3 (SD: 1.6) years in the SMHS, 1,312 (649 women and 663 men) incident lung cancers were documented. Table 1 presents the baseline characteristics for the two cohorts by quartiles of GL. For women, dietary GL was positively associated with the intake of carbohydrates and GI, but inversely associated with total energy intake. Participants in the higher quartiles of GL were more likely to be older and post-menopausal, had higher physical activity, but had lower income and educational levels. They were also more likely to have a history of hypertension, but were less likely to drink alcohol and have a history of lung disease and diabetes. A similar pattern was also observed for men with higher GL intake.

Table 2 shows sex-specific age-energy-adjusted and multivariable HRs (95% CI) for lung cancer risk according to quartiles of GI, GL and carbohydrate intake. The multivariate adjusted HRs (95% CI) for the highest versus lowest quartiles for women were 1.16 (0.92 to 1.47; $P_{\text{for trend}}=0.24$) of GI, 1.09 (0.86 to 1.37; $P_{\text{for trend}}=0.41$) of GL, and 1.17 (0.93 to 1.49; $P_{\text{for trend}}=0.21$) of carbohydrate intake. The respective multivariate adjusted HRs (95% CI) for men were 0.83 (0.67 to 1.03; $P_{\text{for trend}}=0.22$), 0.85 (0.68 to 1.05; $P_{\text{for trend}}=0.12$), and 0.87 (0.70 to 1.08; $P_{\text{for trend}}=0.13$).

We repeated the analysis after exclusion of participants with a history of hypertension, diabetes or chronic lung disease at baseline to minimize the possible effect of dietary pattern changes caused by subclinical diseases, but the results did not change materially (Supplementary Table S1-S3). In stratified analyses by smoking status (among women and men) (Supplementary Table S4-S5), BMI category (Supplementary Table S6-S7), family history of cancer (Supplementary Table S8-S9) or menopausal status (among women, Supplementary Table S10), similar results were also observed.

Discussion

In this analysis of two large population-based cohort studies involving 130,858 participants living in Shanghai, China, we found that diet characterized by high GI or GL or by a high intake of carbohydrates was not associated with increased risk of lung cancer. Stratification analyses did not give a strong indication for effect modification by smoking status, BMI,

family history of cancer or menopausal status (women only). Excluding participants with hypertension, diabetes and chronic lung diseases at baseline from the analysis yielded similar results.

To our knowledge, this is the first study considering the association of dietary GI, GL and carbohydrate intake with lung cancer risk among Chinese adults. Our findings contrasted with results from two hospital-based case-control studies [19, 22]. For example, in a Uruguayan study, involving 463 cases and 465 hospitalized controls, De Stefani et al. [19] found a significant elevated RR of lung cancer with the highest dietary GI (2.77; 95%CI: 1.28, 5.97). However, our non-significant findings are consistent with those from one population-based case-control study conducted in Canada [20] and one prospective study originating from the NIH–AARP Diet and Health Study[21]. Together, these studies and ours suggest that dietary GI, GL and carbohydrate intake might not be related with lung cancer risk. Selection bias, recall bias, measurement errors, or change may explain differences in findings between studies.

Previous observational studies have shown that diets of high GI, GL or carbohydrates might increase insulin- or hormone-related cancer risk, such as pancreatic[16], endometrial[17], and breast cancer[18]. Potential biological explanations for the link include the role of hyperinsulinaemia (mainly due to insulin resistance), hyperglycaemia, sex hormones and inflammatory cytokines in the neoplastic process[31]. Although our findings do not support the hypothesis that a high GI, GL or carbohydrate diet may increase lung cancer risk, we cannot rule out the possibility that lung cancer shares some of the same biological mechanisms with insulin- or hormone-related cancers. Our findings suggest, however, that GI, GL or carbohydrates might be major contributors to aspects of insulin resistance or hyperglycaemia, but do not influence lung cancer risk[32].

Strengths of our study included prospective and population-based design, high participation and follow-up, detailed information on diet, and the capability to control for numerous potentially confounding factors. Furthermore, by excluding participants with chronic disease at baseline and by additionally excluding those whose follow-up time was less than 2 years, we minimized the potential effect of reverse causality. Our study also has some limitations. First, as with any nutritional epidemiologic studies using FFQs, dietary measurement errors could have occurred in the study, since dietary data were self-reported, which may have introduced measurement errors from participants overestimating healthy eating patterns and underestimating intakes of unhealthier food. However, our FFQs have been shown to assess carbohydrates and rice with fairly high validity and reproducibility, but the validity of GI and GL assessment was not evaluated. Second, preservation and cooking method might also influence GIs[4]. Thus, misclassification in dietary GI or GL is an important concern, which may reduce the statistical power of the study and inevitably lead to underestimation of the associations. Third, to control for the confounding effects, we have carefully evaluated and adjusted for a wide range of socio-demographic characteristics and lifestyle factors. However, because dietary factors interact in complex ways with each other, we cannot entirely separate the effect of dietary GI, GL and carbohydrates from those of other nutrients and foods and thus cannot completely rule out a residual confounding effect. Fourth, due to the availability of nutrients considered in the Chinese Food Composition Tables, we could

not analyze the effect of specific types of carbohydrates, such as fructose. Fifth, information on lifetime exposure was not available as GI, GL, and carbohydrates were assessed at baseline, and changes over time in dietary habits may also have affected our results.

In conclusion, our prospective cohort studies do not support an association between GI, GL or carbohydrates and lung cancer risk among Chinese men and women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References:

1. Jemal A, Bray F, Center MM, Ferlay J, Ward E, et al. Global cancer statistics. *CA Cancer J Clin* 2011; 61: 69–90 [PubMed: 21296855]
2. Chen W, Zheng R, Zeng H, Zhang S, He J. Annual report on status of cancer in China, 2011. *Chin J Cancer Res* 2015; 27: 2–12 [PubMed: 25717220]
3. Brand-Miller JC. Postprandial glycemia, glycemic index, and the prevention of type 2 diabetes. *Am J Clin Nutr* 2004; 80: 243–244 [PubMed: 15277141]
4. Atkinson FS, Foster-Powell K, Brand-Miller JC. International Tables of Glycemic Index and Glycemic Load Values: 2008. *Diabetes Care* 2008; 31: 2281–2283 [PubMed: 18835944]
5. Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, et al. Glycemic index of foods: a physiological basis for carbohydrate exchange. *Am J Clin Nutr* 1981; 34: 362–366 [PubMed: 6259925]
6. Ludwig DS. The glycemic index: physiological mechanisms relating to obesity, diabetes, and cardiovascular disease. *JAMA* 2002; 287: 2414–2423 [PubMed: 11988062]
7. Dong J, Zhang L, Zhang Y, Qin L. Dietary glycaemic index and glycaemic load in relation to the risk of type 2 diabetes: a meta-analysis of prospective cohort studies. *Br J Nutr* 2011; 106: 1649–1654 [PubMed: 22017823]
8. Silva FIVM, Steemburgo T, de Mello VD, Tonding SF, Gross JL, et al. High dietary glycemic index and low fiber content are associated with metabolic syndrome in patients with type 2 diabetes. *J Am Coll Nutr* 2011; 30: 141–148 [PubMed: 21730222]
9. Hall GC, Roberts CM, Boulis M, Mo J, MacRae KD. Diabetes and the Risk of Lung Cancer. *Diabetes Care* 2005; 28: 590–594 [PubMed: 15735193]
10. Villegas R, Liu S, Gao Y, Yang G, Li H, et al. Prospective study of dietary carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle-aged Chinese women. *Arch Intern Med* 2007; 167: 2310–2316 [PubMed: 18039989]
11. Giovannucci E, Harlan DM, Archer MC, Bergenstal RM, Gapstur SM, et al. Diabetes and cancer: a consensus report. *CA Cancer J Clin* 2010; 60: 207–221 [PubMed: 20554718]
12. Joost HG. Diabetes and cancer: epidemiology and potential mechanisms. *Diab Vasc Dis Res* 2014; 11: 390–394 [PubMed: 25268021]
13. Lee J, Jeon I, Lee JM, Yoon J, Park SM. Diabetes mellitus as an independent risk factor for lung cancer: a meta-analysis of observational studies. *Eur J Cancer* 2013; 49: 2411–2423 [PubMed: 23562551]

14. Gnagnarella P, Gandini S, La Vecchia C, Maisonneuve P. Glycemic index, glycemic load, and cancer risk: a meta-analysis. *Am J Clin Nutr* 2008; 87: 1793–1801 [PubMed: 18541570]
15. Aune D, Chan DSM, Lau R, Vieira R, Greenwood DC, et al. Carbohydrates, glycemic index, glycemic load, and colorectal cancer risk: a systematic review and meta-analysis of cohort studies. *Cancer Causes Control* 2012; 23: 521–535 [PubMed: 22418776]
16. Aune D, Chan DSM, Vieira AR, Navarro Rosenblatt DA, Vieira R, et al. Dietary fructose, carbohydrates, glycemic indices and pancreatic cancer risk: a systematic review and meta-analysis of cohort studies. *Ann Oncol* 2012; 23: 2536–2546 [PubMed: 22539563]
17. Nagle CM, Olsen CM, Ibiebele TI, Spurdle AB, Webb PM. Glycemic index, glycemic load and endometrial cancer risk: results from the Australian National Endometrial Cancer study and an updated systematic review and meta-analysis. *Eur J Nutr* 2013; 52: 705–715 [PubMed: 22648201]
18. Dong J, Qin L. Dietary glycemic index, glycemic load, and risk of breast cancer: meta-analysis of prospective cohort studies. *Breast Cancer Res Treat* 2011; 126: 287–294 [PubMed: 21221764]
19. De Stefani E, Deneo-Pellegrini H, Mendilaharsu M, Ronco A, Carzoglio JC. Dietary sugar and lung cancer: a case-control study in Uruguay. *Nutr Cancer* 1998; 31: 132–137 [PubMed: 9770725]
20. Hu J, La Vecchia C, Augustin LS, Negri E, de Groh M, et al. Glycemic index, glycemic load and cancer risk. *Ann Oncol* 2012; 24: 245–251 [PubMed: 22831983]
21. George SM, Mayne ST, Leitzmann MF, Park Y, Schatzkin A, et al. Dietary Glycemic Index, Glycemic Load, and Risk of Cancer: A Prospective Cohort Study. *Am J Epidemiol* 2008; 169: 462–472 [PubMed: 19095757]
22. Melkonian SC, Daniel CR, Ye Y, Pierzynski JA, Roth JA, et al. Glycemic Index, Glycemic Load, and Lung Cancer Risk in Non-Hispanic Whites. *Cancer Epidemiology Biomarkers & Prevention* 2016; 25: 532–539
23. Villegas R, Yang G, Liu D, Xiang Y, Cai H, et al. Validity and reproducibility of the food-frequency questionnaire used in the Shanghai Men's Health Study. *Br J Nutr* 2007; 97: 993–1000 [PubMed: 17381986]
24. Shu XO, Yang G, Jin F, Liu D, Kushi L, et al. Validity and reproducibility of the food frequency questionnaire used in the Shanghai Women's Health Study. *Eur J Clin Nutr* 2004; 58: 17–23 [PubMed: 14679362]
25. Zheng W, Chow WH, Yang G, Jin F, Rothman N, et al. The Shanghai Women's Health Study: rationale, study design, and baseline characteristics. *Am J Epidemiol* 2005; 162: 1123–1131 [PubMed: 16236996]
26. Yang YX, Wang GY, Pan XC. China food composition 2002, Beijing, Peking University Medical Press, 2002, 395
27. Foster-Powell K, Holt SH, Brand-Miller JC. International table of glycemic index and glycemic load values: 2002. *Am J Clin Nutr* 2002; 76: 5–56 [PubMed: 12081815]
28. Liu S, Manson JE, Stampfer MJ, Holmes MD, Hu FB, et al. Dietary glycemic load assessed by food-frequency questionnaire in relation to plasma high-density-lipoprotein cholesterol and fasting plasma triacylglycerols in postmenopausal women. *Am J Clin Nutr* 2001; 73: 560–566 [PubMed: 11237932]
29. Willett WC, Howe GR, Kushi LH. Adjustment for total energy intake in epidemiologic studies. *Am J Clin Nutr* 1997; 65: 1220S–1228S [PubMed: 9094926]
30. Zhou BF. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults—study on optimal cut-off points of body mass index and waist circumference in Chinese adults. *Biomed Environ Sci* 2002; 15: 83–96 [PubMed: 12046553]
31. Shi Y, Hu FB. The global implications of diabetes and cancer. *The Lancet* 2014; 383: 1947–1948
32. Strayer L, Jacobs DR, Schairer C, Schatzkin A, Flood A. Dietary carbohydrate, glycemic index, and glycemic load and the risk of colorectal cancer in the BCDDP cohort. *Cancer Causes Control* 2007; 18: 853–863 [PubMed: 17605083]

Baseline Characteristics by Energy-adjusted Quartile of Glycemic Load in the SWHS (1997–2000) and SMHS (2002–2006)

Table 1

	Energy-adjusted Quartile of Glycemic Load								P value
	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	Mean/%	SD	Mean/%	SD	Mean/%	SD	Mean/%	SD	
Shanghai Women's Health Study									
Number of subjects	17,846		17,952		17,956		17,909		
Age, years	50.68	8.36	51.31	8.51	52.41	8.87	55.21	9.27	<0.0001
High educational level (%) ^a	6.68	-	5.45	-	4.45	-	2.06	-	<0.0001
High family income (%) ^b	23.25	-	19.90	-	16.27	-	11.46	-	<0.0001
Body mass index, kg/m ²	23.71	3.22	23.72	3.29	23.96	3.43	24.65	3.63	<0.0001
Waist-to-hip ratio	0.80	0.05	0.81	0.05	0.81	0.05	0.82	0.05	<0.0001
Physical activity, MET-h/w/ y ^c	105.81	45.60	105.76	44.33	106.63	45.02	108.29	44.97	<0.0001
Total energy intake, kcal/day	1787.48	438.13	1713.70	357.51	1645.33	360.98	1556.25	374.60	<0.0001
Glycemic index, g/d	64.79	4.65	69.52	3.00	72.33	2.59	75.97	2.54	<0.0001
Glycemic load, g/1,000kcal/d	97.72	10.00	115.69	3.56	127.60	3.51	144.80	8.50	<0.0001
Carbohydrate, g/1,000kcal/d	150.89	12.80	166.66	7.55	176.58	6.71	190.58	8.40	<0.0001
Ever smoker (%)	2.44	-	1.99	-	2.58	-	3.89	-	<0.0001
Alcohol drinking (ever) (%)	3.46	-	1.97	-	1.73	-	1.85	-	<0.0001
Tea drinking (ever) (%)	38.48	-	33.28	-	28.65	-	19.91	-	<0.0001
History of lung disease (%) ^d	13.66	-	13.61	-	13.27	-	12.82	-	0.0958
History of hypertension (%)	19.9	-	21.67	-	23.71	-	28.75	-	<0.0001
Family history of cancer (%)	27.96	-	27.68	-	27.00	-	23.81	-	<0.0001
History of diabetes (%)	4.96	-	3.73	-	4.07	-	4.00	-	<0.0001
Postmenopausal (%)	40.62	-	43.69	-	48.97	-	60.99	-	<0.0001
Shanghai Men's Health Study									
Number of subjects	14,788		14,818		14,813		14,776		
Age, years	54.97	9.63	55.15	9.69	55.19	9.61	55.60	9.80	<0.0001
High educational level (%) ^a	15.02	-	13.54	-	10.61	-	6.89	-	<0.0001

	Energy-adjusted Quartile of Glycemic Load								P value
	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	Mean/%	SD	Mean/%	SD	Mean/%	SD	Mean/%	SD	
High family income (%) ^b	13.57	-	11.14	-	8.90	-	5.43	-	<0.0001
Body mass index, kg/m ²	23.73	3.10	23.71	3.05	23.71	3.04	23.75	3.09	0.4724
Waist-to-hip ratio	0.903	0.06	0.901	0.06	0.899	0.06	0.898	0.06	<0.0001
Physical activity, MET-h/w/ y ^c	59.14	35.25	59.19	33.49	59.45	33.55	61.02	34.28	<0.0001
Total energy intake, kcal/day	1941.81	501.82	1905.14	459.41	1905.89	468.73	1897.52	465.59	<0.0001
Glycemic index, g/d	65.37	4.94	70.00	2.98	72.78	2.53	76.26	2.40	<0.0001
Glycemic load, g/1,000kcal/d	95.79	11.46	114.79	3.62	126.92	3.60	143.77	8.09	<0.0001
Carbohydrate, g/1,000kcal/d	146.55	14.98	164.23	7.58	174.55	6.57	188.51	8.08	<0.0001
Smoking status (%)									<0.0001
Never	29.13	-	31.41	-	31.04	-	29.69	-	
Past	10.93	-	10.83	-	10.69	-	10.80	-	
Current	59.94	-	57.76	-	58.27	-	59.51	-	
Current alcohol consumption (%)	41.30	-	30.08	-	25.15	-	20.38	-	<0.0001
Current tea consumption (%)	69.92	-	66.12	-	62.91	-	57.89	-	<0.0001
Smoking pack-years	18.25	18.39	16.29	16.97	16.40	17.15	17.03	17.29	<0.0001
History of lung disease (%) ^d	11.64	-	11.19	-	10.16	-	10.12	-	<0.0001
Family history of cancer (%)	29.38	-	29.28	-	28.02	-	27.15	-	<0.0001
History of diabetes (%)	9.07	-	6.55	-	4.96	-	3.99	-	<0.0001
History of hypertension (%)	28.64	-	28.90	-	29.80	-	30.98	-	<0.0001

Continuous variables are presented as the mean ± standard error.

^aHigh educational level was defined as having a college degree or above.

^bHigh income was defined as a family income greater than 30,000 Yuan per year for women or a personal income greater than 2,000 Yuan per month for men.

^cPhysical activity: metabolic equivalent (MET)-hours per week per year (1 MET h=15 min of moderate intensity activity).

^dLung disease includes asthma, tuberculosis and chronic bronchitis for women, and further includes emphysema for men.

Table 2.

Multivariable-adjusted association between dietary glycemic load, glycemic index, and carbohydrates intake and risk of lung cancer in the Shanghai Women's Health Study (1997-2000) and Shanghai Men's Health Study (2002-2006)

	Quantile category				<i>P</i> for trend ^d
	1	2	3	4	
Shanghai Women's Health Study					
GI (g/d)					
Median	63.63	69.47	72.77	76.74	
Cases/person-years	128/266032	157/266779	164/266732	200/262379	
Model 1 ^a	1.00(reference)	1.13(0.90-1.43)	1.10(0.87-1.39)	1.14(0.91-1.43)	0.32
Model 2 ^b	1.00(reference)	1.15(0.91-1.46)	1.12(0.89-1.42)	1.16(0.92-1.47)	0.24
GL (g/1,000kcal/d) ^c					
Median	97.72	115.69	127.6	144.8	
Cases/person-years	140/265288	139/267561	157/266750	213/262323	
Model 1 ^a	1.00(reference)	0.93(0.73-1.18)	0.96(0.76-1.21)	1.07(0.86-1.33)	0.45
Model 2 ^b	1.00(reference)	0.94(0.74-1.19)	0.97(0.77-1.22)	1.09(0.86-1.37)	0.41
Carbohydrates (g/1,000kcal/d) ^c					
Median	148.86	166.55	177.32	192	
Cases/person-years	129/265541	152/267090	160/266399	208/262892	
Model 1 ^a	1.00(reference)	1.11(0.87-1.40)	1.08(0.86-1.37)	1.16(0.93-1.46)	0.22
Model 2 ^b	1.00(reference)	1.11(0.88-1.41)	1.09(0.86-1.38)	1.17(0.93-1.49)	0.21
Shanghai Men's Health Study					
GI (g/d)					
Median	64.13	70	73.24	77.02	
Cases/person-years	182/138319	139/138152	178/137398	164/136912	
Model 1 ^a	1.00(reference)	0.79(0.63-0.99)	1.01(0.82-1.24)	0.88(0.71-1.08)	0.45
Model 2 ^b	1.00(reference)	0.81(0.65-1.01)	0.99(0.81-1.23)	0.83(0.67-1.03)	0.22
GL (g/1,000kcal/d) ^c					

	Quantile category				<i>P</i> for trend ^d
	1	2	3	4	
Median	95.79	114.79	126.92	143.77	
Cases/person-years	188/139194	153/138213	153/137249	169/136125	
Model 1 ^a	1.00(reference)	0.83(0.67-1.03)	0.82(0.66-1.02)	0.86(0.70-1.06)	0.14
Model 2 ^b	1.00(reference)	0.86(0.69-1.06)	0.84(0.68-1.05)	0.85(0.68-1.05)	0.12
Carbohydrates (g/1,000kcal/d) ^c					
Median	144.54	164.21	175.3	189.8	
Cases/person-years	181/139313	169/138662	146/137055	167/135750	
Model 1 ^a	1.00(reference)	0.93(0.76-1.15)	0.82(0.66-1.01)	0.87(0.70-1.07)	0.10
Model 2 ^b	1.00(reference)	0.98(0.79-1.21)	0.85(0.68-1.06)	0.87(0.70-1.08)	0.13

Abbreviations: CI, confidence interval; HR, hazard ratio.

^a Adjusted for age, total energy intake and smoking status.

^b Adjusted for age, education, income, body mass index, physical activity, total energy intake, smoking status, smoking pack-years (men only), drinking status (men only), history of lung disease, history of hypertension, history of diabetes, family history of cancer, menopausal status (women only).

^c Dietary intakes were adjusted for energy intake using nutrient density method, and expressed as per gram per 1000 kcal per day.

^d *P* values for trend were estimated by assigning the median intake value for the quantile to each person and including this as a continuous variable in the model.