Western-Style Fast Food Intake and Cardio-Metabolic Risk in an Eastern Country

Running title: Odegaard et al.; Fast food and cardio-metabolic risk

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Abstract:

**Background** - Western-style fast food contributes to a dietary pattern portending poor cardio-metabolic health in the US. With globalization, this way of eating is becoming more common in developing and recently developed populations.

**Methods and Results** - We examined the association of western-style fast food intake with risk of incident type 2 diabetes (T2D) and coronary heart disease (CHD) mortality in Chinese Singaporeans. This analysis included men and women aged 45-74 who enrolled in the Singapore Chinese Health Study from 1993-1998. For CHD mortality 52,584 participants were included and 1,397 deaths were identified through 12/31/2009 via registry linkage. For T2D 43,176 participants were included and 2,252 cases were identified during the follow-up interview (1999-2004) and validated. Hazard ratios for incident T2D and CHD mortality were estimated with thorough adjustment for demographic, lifestyle and dietary factors. Chinese Singaporeans with relatively frequent intake of western-style fast food items (≥2 times per week) had an increased risk of developing type 2 diabetes (HR=1.27, 95% CI= 1.03-1.54) and dying from CHD (HR=1.56, 95% CI= 1.18-2.06) relative to their peers with little or no reported intake. These associations were not materially altered by adjustments for overall dietary pattern, energy intake, and body mass index.

**Conclusions** - Western-style fast food intake is associated with increased risk of developing type 2 diabetes and of CHD mortality in an eastern population. These findings suggest the need for further attention to global dietary acculturation in the context of ongoing epidemiologic and nutrition transitions.

**Key words:** coronary disease, diabetes mellitus type 2, epidemiology, mortality, nutrition
Western-style fast food is a factor in dietary patterns portending poor cardio-metabolic outcomes in the United States,\textsuperscript{1-3} and more recently in Southeast Asia.\textsuperscript{4} The food is calorically dense and served in large portion sizes, typically features meat and processed meat, highly refined carbohydrates, is generally high in sodium and cholesterol, and has a poor dietary fatty acid profile.\textsuperscript{5-7} Thus, the nutritional profile aligns with the historical evidence linking diet with epidemic cardiovascular disease\textsuperscript{8} and type 2 diabetes.\textsuperscript{9} Despite being widely linked with poor cardio-metabolic health in both popular and scientific press,\textsuperscript{6,10} few studies have directly examined western-style fast food with cardio-metabolic risk,\textsuperscript{5,11,12} making this connection largely speculative.

With globalization, western-style fast-food intake is becoming more common in developing and recently developed areas of the world.\textsuperscript{13-16} Research on cross-cultural factors contributing to the rising incidence of type 2 diabetes and coronary heart disease (CHD) mortality rates in recently developed populations may provide insight into global public health issues. Furthermore, there is a lack of research examining the association of western-style fast food with any outcomes in populations outside the US. We therefore examined associations between western-style fast food intake habits and risk of CHD mortality and type 2 diabetes incidence in a cohort of middle-aged and older Chinese Singaporeans.

Methods

The design of the Singapore Chinese Health Study has been previously described.\textsuperscript{17} Briefly, the cohort was drawn from men and women, aged 45 to 74 years, who belonged to one of the major dialect groups (Hokkien or Cantonese) of Chinese in Singapore. Between April 1993 and December 1998, 63,257 individuals completed an in-person interview that included questions on
usual diet, demographics, height and weight, use of tobacco, usual physical activity, menstrual and reproductive history (women only), medical history, and family history of cancer. A follow-up telephone interview took place between 1999 and 2004 for 52,322 cohort members (83% of recruited cohort). The institutional review boards at the National University of Singapore and the University of Minnesota approved this study.

Assessment of diet and covariates
A semi-quantitative food frequency questionnaire (FFQ), specifically developed for this population, assessed usual dietary intake through 165 commonly consumed food and beverage items during the baseline interview. The respondent was asked to select from eight food frequency categories (ranging from “never or hardly ever” to “two or more times a day”) and three portion sizes with accompanying photographs. The FFQ has been validated against 24-hour dietary recall interviews and biomarkers. A section from the FFQ specifically inquired about intake of western-style fast food items (hamburgers/cheeseburgers, French fries, pizza, other sandwiches, deep fried chicken, and hot dogs); and another section specifically queried 19 foods considered eastern snacks and dim sum. Most dim sum foods are savory pastries such as steamed or deep fried dumplings, filled buns, noodles, or sweet pastries, and meat dishes. In conjunction with this cohort, the Singapore Food Composition Database was developed, a food-nutrient database accounting for raw and cooked foods that allows computation of the mean daily intakes of nutrients for each subject.

Other risk factors assessed with the baseline questionnaire included: age (years), smoking habits/status, highest educational level reached, BMI (kg/m²) calculated using self-reported height and weight, amount (hours) of moderate (e.g. brisk walking) and strenuous (e.g. jogging) physical activity on a weekly basis, and sleep duration.
Assessment of Diabetes

Self-reported diabetes as diagnosed by a physician was evaluated at baseline and participants with a history of diagnosed diabetes were excluded from analysis. Diabetes status was assessed again by the following question asked during the follow-up interview: “Have you been told by a doctor that you have diabetes (high blood sugar)?” If yes: “Please also tell me the age at which you were first diagnosed?” Participants were classified as having incident diabetes if they reported developing diabetes anytime between the initial enrollment interview and the follow-up interview that occurred between July 1999 and October 2004.

A validation study of the incident diabetes mellitus cases used two different methods and was reported in detail previously. Based on linkage with hospital-based discharge summary database and subsequent interviews using a supplementary questionnaire regarding symptoms, diagnostic tests and hypoglycemic therapy, we observed a positive predictive value of 99% with our interview question about the diagnosis of diabetes. Alternatively, 2,625 randomly selected participants who answered “no” to the question of diabetes diagnosis at baseline and follow-up, and provided blood samples at their follow-up interview were analyzed for HbA1c % (glycated hemoglobin). A total of 148 subjects (5.6% of the sample) had an HbA1c ≥ 6.5%, meeting the most recent diagnostic guidelines for the presence of diabetes. Thus, an estimated 94.4% of this sample who reported being free of diabetes at baseline and follow-up were below the HbA1c threshold for diabetes.

Assessment of Mortality

Information on date and cause of death was obtained through linkage with the nation-wide registry of birth and death in Singapore. Up to six different international classification of disease codes version 9 (ICD-9) were recorded in the registry. Primary cause of death was used for
analysis. Vital status for cohort participants was updated through December 31, 2009. Follow-up for mortality is considered virtually complete due to linkage analysis and negligible emigration (0.0004%). The end point of the analysis is death due to CHD (ICD-9 = 410.0-414.9, 427.5).

**Analysis**

For the analysis examining CHD mortality as the endpoint we excluded 1,936 subjects with a history of invasive cancer (except non-melanoma skin cancer) or superficial, papillary bladder cancer at baseline since they did not meet study inclusion criteria. We further excluded those with a reported history of diabetes (5,469) or CVD (2,399) at baseline, plus 869 who reported extreme sex-specific energy intakes (<600 or >3,000 kcal women) (<700 or >3,700 kcal men). The analysis included 52,584 participants. For the analysis examining type 2 diabetes incidence further exclusions occurred for those who died before the follow-up interview (n=7,722), migrated out of Singapore (n=17), had an unclear diabetes status after the validation effort (n=20), or did not participate in the follow-up interview leaving 43,176 participants in the analysis.

Intake frequencies of the six different western-style fast food items were standardized, summed, and divided into categories that allowed for logical cut points with a sufficient number of subjects. Report of any but less than monthly intake of western-style fast food was categorized as 1-3 x / month. Baseline and dietary characteristics were calculated across intake frequency categories of western-style fast food. Proportional hazards (Cox) regression was used to examine the association between categories of intake and CHD mortality and incident type 2 diabetes. We estimated the hazard ratio (HR) and corresponding 95 % confidence interval (CI). For the outcome of CHD mortality, person-years were counted from the date of baseline
interview to the date of death, date of last contact (for the few subjects who migrated out of Singapore) or December 31, 2009, whichever occurred first. For type 2 diabetes person-years for each participant were calculated from the year of recruitment to the year of reported type 2 diabetes diagnosis, or year of follow-up interview for those who did not report diabetes diagnoses. A tiered modeling approach was applied for both outcomes. The base model for both included adjustments for age (<50, 50-54, 55-59, 60-64, 65+), sex, year of interview (1993-95 and 1996-98), dialect (Hokkien vs. Cantonese), level of education (no formal schooling, primary school, secondary school or above), smoking (never, ever), alcohol intake (1-14 drinks/week, none or > 2 drinks a day), sleep (< 6 or ≥ 9 hr/day, 6-8 hr/day), physical activity (< 2 hr/week of moderate and no strenuous, ≥ 2 hr/week moderate and/or any strenuous), and also BMI for CHD mortality, which was categorized as previously published.\textsuperscript{23} The second model further adjusted for nutritional factors including soft drinks and juice (drinks/month), intake frequencies per month of eastern snacks and dim sum, vegetables (excluding white potato), fruit, soy, rice and noodle intake (separate from dim sum), pork and red meat intake separate from western-style fast food, plus total energy intake. A third model for type 2 diabetes further adjusted for BMI as a continuous variable with a quadratic term. Sensitivity analyses included adjustment for hypertensive status (yes/no) and sodium (mg/1000 kcal) for both outcomes. Effect modification of the associations was considered by age, sex, BMI, smoking status, and educational level. We also examined whether weight change between baseline and follow up mediated the associations for type 2 diabetes. Lastly, to reduce potential bias in the CHD mortality analysis participants who died within 3 and 5 years were excluded in sensitivity analyses. Similarly, excluding cases with less than two years of follow-up were also carried out to account for confounding due to antecedent disease with type 2 diabetes.
There was no evidence that proportional hazards assumptions were violated for either outcome as indicated by the lack of significant interaction between the western-style fast food variable and a function of survival time in the models. Tests for trend were performed by assigning the median value of intake to the category and entering this as a continuous variable into the models. All analyses were conducted using SAS statistical software version 9.2 (SAS institute, Cary, NC).

Results

We identified 1,397 deaths due to CHD during 707,200 person-years of follow-up in the analysis of 52,584 participants, and 2,252 incident cases of type 2 diabetes during 246,898 person-years follow-up in the analysis of 43,176 participants. Baseline characteristics according to western-style fast food intake are presented in Table 1 for participants in the CHD mortality analysis. The baseline characteristics for those in the type 2 diabetes analysis mirrored the CHD analysis across all factors and are not presented. Participants who reported more frequent intake of western-style fast food were younger, less likely to be hypertensive, more educated, smoked less, and more likely to be physically active. Nutritionally, with more frequent intake of western-style fast food, participants reported consuming less vegetables (excluding white potatoes), dairy products, rice, and overall less carbohydrate and dietary fiber. Conversely, there were higher intakes of noodles, eastern snacks and dim sum, and sugar-sweetened beverages accompanied nutrient wise by greater intakes of protein, saturated fatty acids and polyunsaturated fatty acids, dietary cholesterol, sodium, and total energy intake.

Hazard ratios for incident type 2 diabetes are presented in Table 2. In the fully adjusted model, relatively frequent intake of western-style fast food items (≥ 2 times per week) was
associated with a modest but significant 27% increased risk of developing type 2 diabetes compared with no intake of western-style fast food (HR=1.27, 95% CI 1.03-1.54). Similarly, as presented in Table 3, intake of western-style fast food items ≥ 2 times per week was significantly associated with a stronger 56% increased risk of dying from CHD relative to no intake after full adjustment (HR=1.56, 95% CI 1.18-2.06). In Figure 1 we present data from a further evaluation of the dose-response association with CHD mortality and extended the highest category to ≥ 4 times per week. In the 811 participants who reported eating western-style fast food items ≥ 4 a week, there were 17 deaths due to CHD, and this group of participants had a nearly 80% greater risk of dying due to CHD relative to their peers with no western-style fast food consumption (HR=1.79, 95% CI 1.09-2.93). Of note, the levels of baseline characteristics of those in this extended top category of western-style fast food intake are consistent with the data presented in Table 1. We did not observe a similar further dose-response association with type 2 diabetes (data not presented).

There was no evidence that the associations materially differed by age, sex, BMI, smoking status, educational level, or length of follow-up time for risk of either diabetes incidence or CHD death. Adjustment for self-reported physician diagnosed hypertension did not materially alter the results for CHD mortality, nor type 2 diabetes. Furthermore, adjustment for weight change between baseline and follow up did not alter the results for type 2 diabetes.

Compared to the referent of no western-style fast food intake, the hazard ratios for frequencies of 1-3 / month, 1 / week, and ≥ 2 / week after adjustment for weight change were respectively HR (95% CI) (1.01 (0.93-1.11), 1.17 (0.96-1.41), 1.26 (1.03-1.54). Consideration of type 2 diabetes case status based upon the validation study did not vary the results. Of note, there was no association between increasing intake of eastern snacks and dim sum with either outcome.
Lastly, in a sensitivity analysis we aimed to account for the overall dietary pattern, and whether the results observed may be due to residual confounding by other dietary factors, and that greater western-style fast food intake was merely a marker of a poorer overall dietary pattern. Thus, we derived an empirical dietary pattern from the 159 non-western-style fast foods and beverages surveyed at baseline using principal components analysis as previously described. In line with our previous published work, a vegetable, fruit, and soy rich pattern, where a high adherence to the pattern is characterized by high intake of those respective foods, and lower intake of meats, dim sum, and sugared soft drinks (and vice-versa for a low score on the pattern) was included as a covariate in quintiles in the models instead of the aforementioned dietary adjustments. This approach yielded similarly significant estimates for both outcomes. For example, the HR associated with intake of western-style fast food items ≥ 2 times per week relative to none was 1.50 (95% CI 1.13-1.96) for CHD mortality, and 1.23 (95% CI 1.01-1.50) for type 2 diabetes (overall data not presented).

Discussion

Chinese Singaporeans with relatively frequent intake of western-style fast food items (≥ 2 times per week) have an increased risk of developing type 2 diabetes and dying from CHD relative to their peers with little or no reported intake of western-style fast food. Of note, an overall dietary pattern, energy intake and BMI (kg/m²) did not explain the associations between western-style fast food intake and incident type 2 diabetes or CHD mortality.

Research examining western-style fast food intake in relation to cardio-metabolic outcomes is scant compared to the ubiquity and contribution of the food to usual dietary patterns in populations around the globe. One relevant study on the topic examined fast food data from
the CARDIA study and observed strong, positive associations with weight gain and insulin resistance.\(^5\) Related, the Black Women’s Health Study found that greater frequency of burger and fried chicken meals in restaurants was associated with an increased risk of developing type 2 diabetes.\(^24\) The Nurses’ Health Study found that frequent French fry consumption was associated with a modest increased risk of type 2 diabetes.\(^25\) A combined analysis of the Nurses’ Health Study and Health Professionals Follow-Up Study found that French Fried potatoes, processed meats, and unprocessed meats, all usual components to typical western-style fast food fare, were among the greatest dietary contributions to weight gain.\(^26\) A small systematic review examined research on fast food consumption with caloric intake and weight gain and concluded that there was a positive association with both.\(^12\)

The poor nutritional profile of western-style fast food\(^8\) is the underlying hypothesized mechanism whereby risk of type 2 diabetes and CHD mortality may be increased. Evidence that frequent western-style fast food intake contributes to insulin resistance and weight gain are pathways central to both type 2 diabetes and cardiovascular risk.\(^5\) Related research has linked typical components of western-style fast food such as processed meats with increased risk of type 2 diabetes and CHD,\(^27\) red meat and high fat dairy as protein sources with greater risk of CHD,\(^28\) and the glycemic properties of fried potatoes and processed grains central to most western-style fast food intake as components that could increase risk of diabetes and CHD.\(^25, 29\) The decreasing dietary fiber intake may also contribute to cardio-metabolic risk.\(^30\) Others have proposed that the high sodium content in most western-style fast foods is another pathway leading to increased CHD risk.\(^14\) However, in a sensitivity analysis adjustment for sodium intake did not affect the estimates for either outcome.

A more reductionist aspect to consider is that trans-fatty acids (TFA) are still a
component of fast food, especially in un-regulated developing areas of the globe.\textsuperscript{31} Indeed, there is no historical documentation of trans-fat being regulated or required to be labeled in Singapore. The association of TFA with increased risk of CHD is considered established through a number of pathways,\textsuperscript{32} whereas the association with type 2 diabetes is plausible, but the evidence is less clear.\textsuperscript{32,33} We were unable to address whether TFA intake in the cohort mediated the associations observed in this study due to the aforementioned point and lack of measurement. Alternative reasons for our findings may be that frequent western-style fast food intake is a prominent marker of a poor diet and lifestyle and not truly causal by itself. The lifestyle and demographic data, and in particular our sensitivity analysis aiming to account for the overall dietary pattern, suggest this may not be the case.

The findings from our study may provide context for populations who have recently undergone or are undergoing nutrition transitions and experiencing the parallel changes in health.\textsuperscript{13} Current and preceding generations in the U.S. have been widely exposed to western-style fast foods throughout their lifecourse.\textsuperscript{14,15} Yet, western-style fast food intake in east and southeast Asia only started becoming somewhat prominent in the late 80’s and early 90’s, providing a chance to participate in American culture,\textsuperscript{14,15} a much different culture from the historical dietary culture of these populations. Indeed, rapid international expansion of western-style fast food outlets is ongoing and is a major contribution to the growth and prosperity of western-style fast food holding companies in the US.\textsuperscript{34} This increase in availability may be desirable to some people from a cultural perspective, but as noted,\textsuperscript{13} this aspect of the nutrition transition may have downside due to acculturation and increased non-communicable disease risk as previously reflected.\textsuperscript{35,36}

This study has a number of strengths including a large, non-western population with
ample events, prospective data, and use of a food frequency questionnaire that was specifically developed for and validated in this population. Other strengths include the high participant response rate, detailed collection of data through face-to-face interview, thorough assessment of potential lifestyle and demographic confounders, very low level of participants lost to follow-up, nearly complete mortality assessment with objectively obtained records on time and cause of death, and validated diabetes case status.

Limitations include some level of measurement error with the dietary assessment, although this would most likely result in non-differential misclassification with respect to disease status and likely under-estimation of risk. The self report of other lifestyle related data may also result in some misclassification and residual confounding in our models. Repeated assessment of dietary intake and other lifestyle factors would have allowed for examining change in western-style fast food habits in relation to the outcomes and would have complemented our data. Furthermore, the study lacked the ability to carry out further sensitivity analyses related to blood lipid levels. The results for the type 2 diabetes outcome may only apply to physician-diagnosed diabetes. Even with high levels of validity, there is potential for numerous undiagnosed cases of type 2 diabetes due to the nature of the disease. If western-style fast food intake led to increased or decreased physician diagnosis, the associations could be affected.

In conclusion, Chinese Singaporeans with relatively frequent intake of western-style fast food items have a modest increased risk of developing type 2 diabetes and a strong and graded risk of dying from CHD. These findings suggest the need for further attention to global dietary acculturation in the context of the epidemiologic and nutrition transitions. The ubiquity of western-style fast food intake, and the emerging evidence that it contributes to the global type 2 diabetes and CHD/CVD epidemic, merits closer attention to, and further research on the topic.
Acknowledgements: We thank Siew-Hong Low of the National University of Singapore for supervising the field work of the Singapore Chinese Health Study, and Kazuko Arakawa and Renwei Wang for the development and maintenance of the cohort study database. Finally, we acknowledge the founding, long-standing Principal Investigator of the Singapore Chinese Health Study – Mimi C. Yu.

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Conflict of Interest Disclosures: None

References:


33. Aronis KN, Joseph RJ, Blackburn GL, Mantzoros C. Trans-Fatty acids, insulin resistance/diabetes, and cardiovascular disease risk: should policy decisions be based on observational cohort studies, or should we be waiting for results from randomized placebo-controlled trials? *Metabolism.* 2011;60:901-905.


**Table 1.** Participant Characteristics at Baseline According to Intake Frequency of Western-Style Fast Food Items

<table>
<thead>
<tr>
<th>Outcome - CHD mortality</th>
<th>None (N=25,810)</th>
<th>1-3 / Month (N=21,133)</th>
<th>1 / Week (N=3,006)</th>
<th>≥ 2 / Week (N=2,635)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
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<tr>
<td>Age, years</td>
<td></td>
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<tr>
<td>Sex, female (%)</td>
<td></td>
<td></td>
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<tr>
<td>Hypertension (%)</td>
<td></td>
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<tr>
<td>Education (%)</td>
<td></td>
<td></td>
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<tr>
<td>Smoking (%)</td>
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<tr>
<td>Alcohol (%)</td>
<td></td>
<td></td>
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<tr>
<td>BMI (kg/m²)</td>
<td></td>
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<tr>
<td>Physical activity (%)</td>
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</tbody>
</table>

**Dietary**

<table>
<thead>
<tr>
<th>Fast Food Items</th>
<th>None (Mean (SD))</th>
<th>1-3 / Month (Mean (SD))</th>
<th>1 / Week (Mean (SD))</th>
<th>≥ 2 / Week (Mean (SD))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables (g/1000 kcal)</td>
<td>69.6 (35.1)</td>
<td>69.2 (31.2)</td>
<td>69.1 (30.2)</td>
<td>67.0 (30.6)</td>
</tr>
<tr>
<td>Fruit (g/1000 kcal)</td>
<td>128.6 (101.4)</td>
<td>132.1 (93.8)</td>
<td>139.4 (90.2)</td>
<td>132.2 (88.9)</td>
</tr>
<tr>
<td>Dairy (g/1000 kcal)</td>
<td>47.9 (78.9)</td>
<td>42.0 (66.1)</td>
<td>44.9 (62.2)</td>
<td>44.8 (60.6)</td>
</tr>
<tr>
<td>All Red Meats (g/1000 kcal)</td>
<td>16.9 (19.9)</td>
<td>20.0 (10.6)</td>
<td>22.9 (10.1)</td>
<td>25.2 (11.9)</td>
</tr>
<tr>
<td>Rice (g/1000 kcal)</td>
<td>289.9 (98.5)</td>
<td>264.9 (89.7)</td>
<td>228.8 (80.4)</td>
<td>213.1 (80.7)</td>
</tr>
<tr>
<td>Noodles (g/1000 kcal)</td>
<td>32.8 (26.9)</td>
<td>35.3 (24.8)</td>
<td>37.3 (23.2)</td>
<td>36.0 (22.9)</td>
</tr>
<tr>
<td>Snacks/Dim Sum</td>
<td>11.0 (11.0)</td>
<td>14.9 (12.7)</td>
<td>21.8 (15.0)</td>
<td>23.9 (18.2)</td>
</tr>
<tr>
<td>Soft Drinks</td>
<td>1.7 (7.5)</td>
<td>3.0 (9.5)</td>
<td>5.1 (11.9)</td>
<td>5.6 (12.1)</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>60.7 (7.3)</td>
<td>58.4 (6.8)</td>
<td>56.1 (6.4)</td>
<td>53.8 (6.5)</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>14.9 (2.6)</td>
<td>15.3 (2.3)</td>
<td>15.5 (2.1)</td>
<td>16.0 (2.2)</td>
</tr>
<tr>
<td>Saturated fat (%)</td>
<td>8.3 (2.5)</td>
<td>9.2 (2.4)</td>
<td>10.1 (2.3)</td>
<td>10.8 (2.4)</td>
</tr>
<tr>
<td>Polyunsaturated fat (%)</td>
<td>4.9 (2.5)</td>
<td>5.1 (1.8)</td>
<td>5.5 (1.8)</td>
<td>5.8 (1.8)</td>
</tr>
<tr>
<td>Omega-3 fat (g/day)</td>
<td>0.82 (0.39)</td>
<td>0.91 (0.40)</td>
<td>1.07 (0.43)</td>
<td>1.21 (0.51)</td>
</tr>
<tr>
<td>Cholesterol (mg/1000 kcal)</td>
<td>102.1 (47.1)</td>
<td>113.9 (43.2)</td>
<td>123.5 (40.1)</td>
<td>132.7 (46.0)</td>
</tr>
<tr>
<td>Dietary Fiber (g/1000 kcal)</td>
<td>8.3 (2.8)</td>
<td>8.1 (2.5)</td>
<td>8.2 (2.3)</td>
<td>7.9 (2.2)</td>
</tr>
<tr>
<td>Sodium (mg/1000 kcal)</td>
<td>651.7 (208.3)</td>
<td>715.1 (194.4)</td>
<td>811.8 (184.4)</td>
<td>864.6 (195.8)</td>
</tr>
<tr>
<td>Total Energy</td>
<td>1450 (483)</td>
<td>1599 (508)</td>
<td>1828 (527)</td>
<td>2005 (591)</td>
</tr>
</tbody>
</table>

- Data are means (SD) unless noted as percentages (%)
- Definitions of characteristics:
  - Education: (% with secondary or greater)
  - Smoking: (% ever-smokers)
  - Alcohol: (% light to moderate consumption: any up to 1 drink day female, 2 drinks day male)
  - Hypertension: (% self reported physician diagnosed)
  - Physical activity: (% 2+ hours moderate a week or any strenuous physical activity)
  - Vegetables (g/1000 kcal): (excluding white potato)
  - Snacks/Dim Sum and Soft drinks: Frequency per month
Table 2. Hazard Ratio and 95% Confidence Interval of Incident Type 2 Diabetes According to Intake Frequency of Western-Style Fast Food Items: SCHS

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>1-3 / Month</th>
<th>1 / Week</th>
<th>≥ 2 / Week</th>
<th>P for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Cases / N</td>
<td>1102 / 20,761</td>
<td>901 / 17,615</td>
<td>131 / 2,586</td>
<td>118 / 2,214</td>
<td></td>
</tr>
<tr>
<td>Rate</td>
<td>918</td>
<td>934</td>
<td>987</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Model 1: HR (95% CI)</td>
<td>1.00</td>
<td>1.03 (0.94-1.13)</td>
<td>1.18 (0.97-1.40)</td>
<td>1.22 (1.00-1.47)</td>
<td>0.019</td>
</tr>
<tr>
<td>Model 2: HR (95% CI)</td>
<td>1.00</td>
<td>1.02 (0.95-1.14)</td>
<td>1.21 (1.00-1.47)</td>
<td>1.29 (1.05-1.57)</td>
<td>0.005</td>
</tr>
<tr>
<td>Model 3: HR (95% CI)</td>
<td>1.00</td>
<td>1.02 (0.93-1.11)</td>
<td>1.17 (0.97-1.41)</td>
<td>1.27 (1.03-1.54)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

SCHS: Singapore Chinese Health Study
Rate= Crude Incident type 2 diabetes rate per 10,000 person years
Model 1: Adjusted for age, sex, year of interview, dialect, education, smoking, alcohol, sleep, physical activity
Model 2: Model 1 + adjustment for nutritional factors (intake of soft drinks, juice, eastern snacks and dim sum, vegetables, fruit, soy, rice, noodles, other pork and red meat, and total energy)
Model 3: Model 2 + BMI (kg/m²)

Table 3. Hazard Ratio and 95% Confidence Interval of CHD Mortality According to Intake Frequency of Western-Style Fast Food Items: SCHS

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>1-3 / Month</th>
<th>1 / Week</th>
<th>≥ 2 / Week</th>
<th>P for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>N CHD deaths / N</td>
<td>784 / 25,810</td>
<td>503 / 21,133</td>
<td>51 / 3,006</td>
<td>59 / 2,635</td>
<td></td>
</tr>
<tr>
<td>Rate</td>
<td>256</td>
<td>245</td>
<td>235</td>
<td>313</td>
<td></td>
</tr>
<tr>
<td>Model 1: HR (95% CI)</td>
<td>1.00</td>
<td>0.99 (0.89-1.11)</td>
<td>1.09 (0.82-1.45)</td>
<td>1.36 (1.04-1.78)</td>
<td>0.046</td>
</tr>
<tr>
<td>Model 2: HR (95% CI)</td>
<td>1.00</td>
<td>1.02 (0.92-1.16)</td>
<td>1.19 (0.89-1.59)</td>
<td>1.56 (1.18-2.06)</td>
<td>0.0026</td>
</tr>
</tbody>
</table>

SCHS: Singapore Chinese Health Study
Rate= Crude CHD mortality rate per 10,000 person years
Model 1: Adjusted for age, sex, year of interview, dialect, education, smoking, alcohol, sleep, physical activity, and BMI (kg/m²)
Model 2: Model 1 + adjustment for nutritional factors (intake of soft drinks, juice, eastern snacks and dim sum, vegetables, fruit, soy, rice, noodles, other pork and red meat, and total energy)
Figure Legend:

**Figure 1.** Hazard ratio and 95% confidence interval of CHD mortality according to intake frequency of Western-style Fast Food Items- Further dose-response evaluation: SCHS. N=52,584 (1,397 deaths due to CHD), Respective n (CHD deaths) for None, 1-3 Month, 1x / Week, 2-3x / Week and ≥ 4x / Week: 25,810 (784), 21,133 (503), 3,006 (51), 1,824 (42), 811 (17). Results represent fully adjusted model (age, sex, year of interview, dialect, education, smoking, alcohol, sleep, physical, activity, BMI (kg/m²), and nutritional factors (intake of soft drinks, juice, eastern snacks and dim sum, vegetables, fruit, soy, rice, noodles, other pork and red meat, and total energy).
Frequency of Intake

None  1-3 / Month  1 / Week  2-3 / Week  ≥ 4 / Week

HR (95% CI)

- None: 1.00
- 1-3 / Month: 1.03
- 1 / Week: 1.19
- 2-3 / Week: 1.49
- ≥ 4 / Week: 1.79

P trend = 0.0015
Western-Style Fast Food Intake and Cardio-Metabolic Risk in an Eastern Country
Andrew O. Odegaard, Woon Puay Koh, Jian-Min Yuan, Myron D. Gross and Mark A. Pereira

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