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Dietary intake in male and female smokers, ex-smokers, and never smokers: The INTERMAP Study

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Abstract

This report examines dietary intakes in smokers, ex-smokers, and never smokers in INTERMAP. The 4680 participants aged 40–59 years—from 17 population samples in four countries (China, Japan, UK, USA)—provided four 24-h recalls to assess nutrient intakes and two 24-h urine collections to assess excretion of urea, sodium (Na), potassium (K), etc. Compared to never smokers, current smokers generally consumed more energy from alcohol and saturated fats (SFA), less energy from vegetable protein and carbohydrates, less dietary fibre, vitamin E, beta carotene, vitamin C, thiamine, riboflavin, folate, vitamin B₆, calcium, iron, phosphorus, magnesium (Mg), and K per 1000 kcal, excreted less K and urea (marker of dietary protein), had a lower ratio of polyunsaturated fat (PFA) to SFA intake, higher Keys dietary lipid score, and higher dietary and urinary Na/K. There were few differences between smokers and never smokers for total energy intake, energy from total and animal protein, monounsaturated fats, PFA, omega 3 and omega 6 PFA, dietary cholesterol, total vitamin A, retinol, vitamin D, vitamin B₁₂, and urinary and dietary Na. Compared to ex-smokers, smokers generally consumed less energy from vegetable protein, omega 3 PFA, carbohydrates, less dietary fibre, beta carotene, vitamin E, vitamin C, thiamine, riboflavin, folate, vitamin B₆, iron, phosphorus, Mg, had lower PFA/SFA, and excreted less urea and K. In conclusion, INTERMAP results are consistent with other reports indicating that smokers have less healthful diets than nonsmokers. Public health interventions in smokers should focus not only on helping them to quit smoking but also on improving their diets to further reduce cancer and cardiovascular disease risks.

Keywords

diet; smoking; international population study

Introduction

Data from many studies indicate that smokers have less healthful diets than nonsmokers.^{1–57} A recent meta-analysis of the associations of smoking with nutrient intakes, using data from 51 surveys in 15 countries, found that smokers had significantly higher intakes of energy, total fat, saturated fat, dietary cholesterol, and alcohol, and significantly lower intakes of polyunsaturated fatty acids (PFA), fibre, vitamin C, vitamin E, beta carotene, iron, and calcium than nonsmokers.³ Protein and carbohydrate intakes did not differ significantly between smokers and nonsmokers.³ Consistent with the results of this meta-analysis, smokers have also reported consuming fewer fruits and vegetables than nonsmokers in many studies.^{1,5,6,8,9,11,12,15,16,18,20,24,27,28,34–36,41,42,50–57}

While the associations of smoking with nutrient intakes and consumption of specific foods have been examined in samples from several countries, most reports have been on samples from the United States (US),^{1–4,7,8,10,30,32,33,35,36,41–44,46–48,54,56} United Kingdom (UK),^{3,17,26,28,29,31,37,38,45,49,51–53} other European countries,^{3,6,9,12,13,15,18,20–22,25–27,34,40,50,57} Canada,^{3,5,16} or Australia.^{3,19,39} Only two studies have reported results from Chinese or Japanese samples.^{11,55} In addition, associations of smoking with several nutrients have not been examined extensively in other studies, including intakes of omega 3 and omega 6 PFA, animal and vegetable protein, vitamin D, thiamine, riboflavin, niacin, folate, vitamin B₆, vitamin B₁₂, phosphorus, magnesium, potassium, and sodium.

The present report examines dietary intakes in smokers, ex-smokers, and never smokers in the INTERMAP study of nutrients and blood pressure. INTERMAP, with its 17 population samples from Japan, People's Republic of China (PRC), UK, and US and its high-quality, standardized methods of dietary data collection, represents a unique opportunity to examine and compare associations of smoking with nutrient intakes across four countries, including associations with several nutrients not extensively examined previously.

Participants and methods

Participants

INTERMAP is an international epidemiologic study on relations of macronutrients, micronutrients, other dietary factors to blood pressure.^{58–60} It involves 4680 men and women aged 40–59 years from 17 population samples, four in Japan, three in the PRC, two in the UK, and eight in the US. Each sample was selected randomly from a population list, stratified by age and gender, to give approximately equal numbers in each of four 10-year age–gender groups.

Each participant attended the local INTERMAP research centre on four occasions: two visits were on consecutive days, with a further two visits on consecutive days 3–6 weeks later. Wherever possible, one visit by each participant included a weekend day (or an equivalent rest day) according to work schedule.

A supplementary participant was recruited from the same sample age and sex group, if: diet data were considered unreliable by the diet interviewer and the centre nutritionist; energy

intake from any 24-h dietary recall was below 500 kcal/day or inordinately high (≥ 5000 kcal/day for women and ≥ 8000 kcal for men); two complete urine collections were not available; or data on blood pressure and other key variables were incomplete or missing.

Data collection

All data were collected by trained and certified staff.⁵⁸ Dietary data were collected at each of the four visits with the 24-h recall method.⁵⁹ All foods and drinks consumed in the previous 24 h, including dietary supplements, were recorded in an interview by a trained dietary interviewer. To aid accurate recall, food and drink models, measuring devices, and photographs were used. Interviewers used neutral probing techniques to check completeness. In the US, dietary information was directly computerized, with use of a program to guide on-screen coding;⁵⁹ in the other three countries, data were first entered onto standard forms, then coded and computerized. The Nutrition Coordinating Center (NCC) in Minneapolis provided nutrient content of foods not included in national nutrient databases in each of the four countries, and checked and updated data on other foods.

Daily alcohol consumption over the previous 7 days—and, for abstainers, information on previous drinking—was obtained by interview twice, at the first and third visits. Consumption during the previous 24 h was also obtained during each of the four 24-h dietary interviews.

Two timed 24-h urine specimens were collected for measurement of urinary sodium (Na), potassium (K), creatinine, urea, amino acids, microalbuminuria, magnesium, calcium, etc.^{58,59} Timed collections were started at the research centre on the first and third visits, and completed at the centre the following day. Urine aliquots were stored frozen at -20°C , before being shipped frozen to the Central Laboratory at St Raphael University in Leuven, Belgium, where analyses were performed with strict internal and external quality control. Sodium and potassium concentrations were measured by emission flame photometry,⁶¹ creatinine by the modified Jaffe method,⁶² and urea by auto-analyzer, with use of an adaptation of the Fearon condensation method. Individual sodium, potassium, and urea excretion values were the product of concentrations in the urine and urinary volume corrected to 24 h.

Height and weight without shoes were measured at first and third visits. Body mass index (BMI) was calculated at each of the two visits as weight divided by height squared (kg/m^2).

Data on demographic and other factors, including education, occupation, leisure-time and work physical activity, smoking, previous medical history, current special diet, medication use, and—for women—data on contraceptive pill use, menopause, and parity, were collected by interviewer-administered questionnaire.

Statistical methods

Dietary data were converted into nutrients with use of country-specific food tables enhanced by NCC. Total energy intake was estimated from conversion factors—fat: 9 kcal/g; protein: 4 kcal/g; available carbohydrate: 4 kcal/g; alcohol: 7 kcal/g. For these analyses, dietary data were expressed as nutrient densities, calculated as follows: for nutrients supplying energy, as

per cent of total kilocalories, that is, $(\text{kcal from nutrient}/\text{total kcal}) \times 100$; for other nutrients, per 1000 kcal, that is, $(\text{amount per day}/\text{total kcal}) \times 1000$. Keys dietary lipid score was calculated as

$$1.35 (2 \text{ SFA} - \text{PFA}) + 1.5 \text{ CHOL}^{1/2}$$

where SFA is per cent energy from saturated fatty acids (SFA), PFA is per cent energy from PFA, and CHOL is dietary cholesterol per 1000 kcal. Dietary protein was partitioned into animal and vegetable sources. Urinary urea (g/24 h) was converted into urinary urea nitrogen (g/24 h) with the multiplier 0.4667 and then multiplied by 7.99 to estimate dietary total protein.^{58,63,64}

Smoking status was categorized as never smoker, ex-smoker, or current smoker for men from Japan and the PRC and for men and women from the UK and US. For Japanese women, ex-smokers were combined with never smokers since there were only 13 ex-smokers. Results are not presented for PRC women, since there were only four ex-smokers and 21 smokers among the 423 PRC women.

Means for age, years of education, and 7-day alcohol intake were compared across smoking categories for each of the seven gender–country subgroups using one-way analysis of variance, and proportions of participants on special diets were compared using the χ^2 test. Means for dietary and urinary variables were compared across smoking categories using the general linear model in SPSS with adjustment for age, years of education, and field sample within each gender–country subgroup.⁶⁵ Dietary variables were also adjusted for total energy intake through use of nutrient densities. In the general linear model analyses, where means differed significantly across the three smoking categories at the 5% level, pairwise comparisons were conducted, also at the 5% level of significance, without adjustment for multiple comparisons (Fisher's least significant difference procedure⁶⁶). In addition, if the *P*-value from the general linear model was between 0.05 and 0.10, pairwise comparisons were considered 'nominally' significant for comparisons with *P*<0.05. In describing the results of these analyses, any other pairwise comparison with *P*<0.10 is described as nonsignificantly lower or higher, depending on the direction of the difference. Variables for which no *P*-values were less than 0.10 are described as having no differences across smoking categories.

As noted above, *P*-values were not adjusted for the number of comparisons made, and thus those cited should be viewed only as guides.

Results

Descriptive statistics by smoking status, country, and gender

For six of seven gender–country subgroups, ex-smokers were older on average than never smokers or current smokers (Table 1). With the exception of current smokers in Japanese women, smoking status was inversely related to years of education, with never smokers having more education than ex-smokers, who had more education than current smokers. Mean BMI was also generally highest in ex-smokers, with never smokers having higher

mean BMI than current smokers in four subgroups. Never smokers and ex-smokers were also more likely to be consuming a special diet than current smokers.

PRC men—nutrient intake by smoking status

For PRC men, smokers consumed significantly less energy from carbohydrates and significantly more energy from alcohol than never smokers (Table 2). Smokers also excreted significantly less urinary Na than never smokers and significantly less urinary urea and K than ex-smokers, while ex-smokers consumed significantly more total and animal protein than never smokers. Smokers also had lower total energy intake, lower urea and K excretion, and higher animal protein intake, retinol intake per 1000 kcal, and dietary Na/K than never smokers. In addition, smokers consumed less omega 3 PFA and phosphorus, and had lower urinary Na excretion than ex-smokers, while ex-smokers had lower total energy intake and higher energy from PFA than never smokers. There were no differences by smoking status in energy from total fat, vegetable protein, SFA, monounsaturated fatty acids (MUFA), and omega 6 PFA, PFA/SFA, Keys score, dietary cholesterol, urinary Na/K, and intakes per 1000 kcal for total dietary fibre, total vitamin A, beta carotene, vitamin E, vitamin C, calcium, iron, magnesium (Mg), K, and Na.

Japanese men and women—nutrient intake by smoking status

For Japanese men, smokers consumed significantly less energy from vegetable protein and carbohydrates, significantly more energy from alcohol, significantly lower dietary fibre, beta carotene, vitamin C, calcium, iron, phosphorus, Mg, and K per 1000 kcal, excreted significantly less urinary urea and K, and had significantly higher dietary and urinary Na/K than never smokers (Table 3). Smokers also consumed significantly less vegetable protein, dietary fibre, calcium, phosphorus, Mg, and K, and excreted significantly less urea than ex-smokers, while ex-smokers consumed significantly less energy from carbohydrates, significantly more energy from alcohol, significantly less dietary fibre and iron, and had significantly higher dietary Na/K than never smokers. Smokers also consumed less energy from PFA and omega 6 PFA than never smokers, less energy from total fat and MUFA than ex-smokers, and less vitamin E than never smokers or ex-smokers, while ex-smokers had lower values for vegetable protein, beta carotene, calcium, and dietary and urinary K than never smokers. There were no differences by smoking status for total energy, total protein, animal protein, omega 3 PFA, PFA/SFA, dietary cholesterol, Keys score, total vitamin A, retinol, or dietary and urinary Na in Japanese men.

For Japanese women, smokers consumed significantly less energy from total protein, vegetable protein, and SFA, significantly more energy from alcohol, significantly less dietary fibre, beta carotene, calcium, iron, phosphorus, Mg, and dietary K, excreted significantly more urinary Na, and had significantly higher dietary and urinary Na/K than nonsmokers (Table 3). Smokers also consumed less animal protein, total fat, and vitamin E than nonsmokers. There were no differences in total energy intake, MUFA, PFA, omega 3 and omega 6 PFA, carbohydrates, PFA/SFA, Keys score, dietary cholesterol, total vitamin A, retinol, vitamin C, dietary Na, or urea and K excretion for smokers and nonsmokers in Japanese women.

UK men and women—nutrient intake by smoking status

For UK men, smokers consumed significantly less energy from vegetable protein, PFA, omega 6 PFA, and carbohydrates, significantly more energy from alcohol, had significantly lower PFA/SFA and significantly higher Keys score, and consumed significantly less dietary fibre, vitamin E, and phosphorus than never smokers (Table 4). Smokers also consumed significantly less vitamin C and had lower urinary Na/K than ex-smokers, while ex-smokers consumed significantly less energy from vegetable protein than never smokers. Smokers also consumed less Mg and excreted less urea than never smokers, consumed less omega 3 PFA and vitamin E, excreted less urea and K, and had higher dietary Na/K than ex-smokers. Ex-smokers consumed more animal protein, less carbohydrate and dietary fibre, and had lower PFA/SFA, than never smokers. There were no differences by smoking status for total energy, total protein, total fat, SFA, MUFA, dietary cholesterol, total vitamin A, beta carotene, retinol, calcium, iron, dietary K, and dietary or urinary Na in UK men.

For UK women, smokers consumed significantly less energy from vegetable protein and carbohydrates, significantly more energy from animal protein, SFA, MUFA, and alcohol, had significantly lower PFA/SFA, consumed significantly more dietary cholesterol, had significantly higher Keys score, and consumed significantly less dietary fibre, beta carotene, vitamin E, vitamin C, iron, Mg, and K per 1000 kcal, had significantly higher dietary Na/K and urinary K and Na/K than never smokers (Table 4). Smokers also consumed significantly less vegetable protein, dietary fibre, iron, and Mg than ex-smokers, while ex-smokers consumed significantly less dietary fibre and vitamin E, and had higher urinary Na/K than never smokers. Smokers also consumed more total fat and less phosphorus than never smokers, and consumed more animal protein and less carbohydrate and vitamin C than ex-smokers, while ex-smokers consumed less beta carotene and had higher dietary Na/K than never smokers. There were no differences by smoking status for total energy, total protein, PFA, omega 3 and omega 6 PFA, total vitamin A, retinol, calcium, urinary urea, or dietary and urinary Na in UK women.

US men and women—nutrient intake by smoking status

For US men, smokers consumed significantly more total energy, significantly more energy from SFA and alcohol, significantly less energy from vegetable protein, omega 3 PFA, and carbohydrates, had significantly lower PFA/SFA and significantly higher Keys score and dietary cholesterol intake, and consumed significantly less dietary cholesterol, dietary fibre, vitamin A, beta carotene, retinol, vitamin E, vitamin C, thiamine, riboflavin, niacin, folic acid, vitamin B₆, calcium, iron, phosphorus, Mg, and K per 1000 kcal, and had significantly lower urea, K, and Na excretion than never smokers (Table 5). Compared to ex-smokers, smokers also consumed significantly more energy from total protein and alcohol, had significantly lower PFA/SFA, consumed significantly less vegetable protein, PFA, omega 3 and omega 6 PFA, carbohydrate, dietary fibre, total vitamin A, retinol, vitamin E, vitamin C, thiamine, riboflavin, niacin, folic acid, vitamin B₆, calcium, iron, phosphorus, Mg, and dietary K and Na, and had significantly lower urinary urea, K, and Na excretion. Compared to never smokers, ex-smokers consumed significantly more total energy and energy from alcohol, significantly less carbohydrate, beta carotene, and vitamin C, and had significantly higher urea excretion. Smokers also consumed less PFA, omega 6 PFA, and dietary Na than

never smokers, and more dietary cholesterol and less beta carotene, and had a higher Keys score than ex-smokers, while ex-smokers consumed more SFA, dietary cholesterol, and dietary Na than never smokers. There were no differences by smoking status for animal protein, total fat, MUFA, vitamin D, vitamin B₁₂, and dietary and urinary Na/K in US men.

For US women, smokers—compared to never smokers—consumed significantly more energy from total fat, SFA, and alcohol, significantly less energy from vegetable protein and carbohydrates, had significantly lower PFA/SFA and significantly higher Keys score, and consumed significantly less dietary fibre, total vitamin A, beta carotene, retinol, vitamin C, thiamine, riboflavin, folate, vitamin B₆, calcium, and iron per 1000 kcal, and had significantly lower urea and K excretion, and higher urinary Na/K (Table 5). Compared to ex-smokers, smokers also consumed significantly more energy from alcohol, had significantly higher PFA/SFA and Keys score, and consumed significantly less vegetable protein, PFA, omega 3 PFA, dietary fibre, total vitamin A, beta carotene, vitamin E, vitamin C, thiamine, riboflavin, folate, vitamin B₆, calcium, and iron, and had significantly lower urea and K excretion, and higher urinary Na/K. Compared to never smokers, ex-smokers consumed significantly more total fat, PFA, omega 6 PFA, and energy from alcohol, had significantly higher PFA/SFA, consumed significantly less carbohydrate, vitamin E, vitamin C, and thiamine, and had significantly higher urea and K excretion. Smokers also consumed more MUFA and dietary cholesterol and less phosphorus than never smokers, and more SFA and less omega 6 PFA, carbohydrate, phosphorus, and dietary Na than ex-smokers, while ex-smokers consumed more omega 3 PFA and dietary cholesterol than never smokers. There were no differences by smoking status for total energy, total and animal protein, vitamin D, niacin, vitamin B₁₂, Mg, dietary K and Na/K, and urinary Na in US women.

Discussion

In this report of associations of smoking with dietary intakes involving seven gender–country subgroups from INTERMAP, current smokers—compared to never smokers—generally consumed more energy from alcohol and SFA, less energy from vegetable protein and carbohydrates, less dietary fibre, vitamin E, beta carotene, vitamin C, calcium, iron, phosphorus, Mg, and K per 1000 kcal, excreted less urea and K, had lower PFA/SFA, higher Keys dietary lipid scores, and higher dietary and urinary Na/K. In addition, among US men and women, smokers consumed less thiamine, riboflavin, folate, and vitamin B₆ than never smokers. For total energy intake, energy from total and animal protein, MUFA, PFA, omega 3 and omega 6 PFA, dietary cholesterol, total vitamin A, retinol, vitamin D, vitamin B₁₂, and urinary and dietary Na, there were few differences between smokers and never smokers. Compared to ex-smokers, smokers also generally consumed less energy from vegetable protein, omega 3 PFA, and carbohydrates, and less dietary fibre, beta carotene, vitamin E, vitamin C, thiamine, riboflavin, folate, vitamin B₆, iron, phosphorus, and Mg, and had lower PFA/SFA and excreted less urea and K. Dietary intakes of ex-smokers were generally similar to those of never smokers. However, ex-smokers generally consumed more energy from alcohol and less energy from carbohydrates than never smokers.

A previous meta-analysis of nutrient intakes in smokers and nonsmokers, based on 51 published nutritional surveys from 15 countries, found that smokers had significantly higher

intakes of energy, total fat, SFA, cholesterol, and alcohol, and lower intakes of PFA, fibre, vitamin C, vitamin E, beta carotene, calcium, and iron than nonsmokers.³ Smokers reported higher intakes of energy, total fat, and alcohol in 69.2, 68.6, and 100% of studies, respectively. Protein and carbohydrate intakes did not differ significantly between smokers and non-smokers. In INTERMAP, smokers also consumed significantly more energy from alcohol than never smokers in all seven gender–country subgroups. However, only US male smokers consumed significantly more energy than never smokers, and only US female smokers consumed significantly more energy from total fat than never smokers. Results in INTERMAP for energy from total protein were generally consistent with results of the meta-analysis, with six of seven subgroups showing no difference. For Japanese women, smokers consumed significantly less energy from protein than nonsmokers. However, in contrast to the meta-analysis, in six of seven gender–country subgroups in INTERMAP, smokers consumed significantly less energy from carbohydrates than never smokers, with only Japanese women showing no difference.

In the meta-analysis, SFA and cholesterol intakes were higher in smokers in 87.5 and 89.5% of studies, respectively, and PFA intake was lower in 62.5%.³ In INTERMAP, energy intake from SFA was significantly higher in smokers than never smokers for US men and women and UK women. There was no difference for men from the PRC, Japan, and UK. For Japanese women, energy from SFA was significantly lower in smokers than nonsmokers. Dietary cholesterol intake was higher in smokers than never smokers in US men and women and UK men, with no difference for men from the PRC, Japan, and UK, and Japanese women. Smokers consumed less energy from PFA than never smokers for men from Japan, the UK, and US, with no difference for any subgroup of women and PRC men.

In the meta-analysis, intakes of fibre, vitamin E, vitamin C, and beta carotene were lower in smokers than nonsmokers in 93.7, 88.9, 61.5, and 100% of studies, respectively.³ In INTERMAP, intake of fibre per 1000 kcal was significantly lower in smokers than never smokers in six of seven gender–country subgroups. Only PRC men did not show a significantly lower fibre intake for smokers. Vitamin E intake was lower in smokers for men and women from the UK and Japan and US men, but not for PRC men and US women. Vitamin C intake was significantly lower in smokers for US men and women, Japanese men, and UK women, with no difference for PRC and UK men and Japanese women. Beta carotene intake was significantly lower in smokers for men and women from the US and Japan and UK women, with no difference for PRC and UK men.

In the meta-analysis, calcium and iron intakes were also significantly lower in smokers than nonsmokers. In INTERMAP, calcium intake was significantly lower in smokers than never smokers in men and women from the US and Japan. There was no difference for UK men and women and PRC men. Iron intake was significantly lower in smokers in men and women from the US and Japan and UK women, while there was no difference for PRC men and UK men.

Nutrient intakes not included in the meta-analysis that have often been found to differ between smokers and nonsmokers include higher intakes of MUFA,^{1,2,5,6,9,10,22,27,34,39,46} lower vitamin A intake,^{1,2,5,20,35,36,42,43,45} lower thiamine intake,^{1,2,16,19,21,42,45} and lower

PFA/SFA.^{15,21,22,26,28,29,31,37–39,46} In INTERMAP, MUFA intake was higher in smokers than never smokers for UK and US women; vitamin A intake was significantly lower for US men and women; thiamine intake was significantly lower for US men and women, the only gender–country subgroups for which it was available; and PFA/SFA was significantly lower in smokers in UK and US men and women.

Other dietary variables examined here included vegetable and animal protein, omega 3 and omega 6 PFA, Keys score, retinol, phosphorus, Mg, K, Na, and Na/K, and in US samples only, vitamin D, riboflavin, niacin, folate, and vitamins B₆ and B₁₂. In INTERMAP, smokers consumed significantly less vegetable protein than never smokers in men and women from Japan, the UK, and US. Only PCR men showed no difference in vegetable protein intake between smokers and never smokers. Smokers were also found to have lower intakes of vegetable protein than nonsmokers in three other studies.^{6,15,27} Animal protein intake was higher in smokers for UK women and PRC men, but lower in smokers than nonsmokers for Japanese women. Animal protein intake has been higher in smokers than nonsmokers in some studies,^{6,9,22} with no difference in intake in others.^{21,25,27} No other studies have reported intakes of omega 3 and omega 6 PFA by smoking status. In INTERMAP, US male smokers consumed significantly less energy from omega 3 PFA than never smokers. There were no differences in intake for the other six gender–country subgroups. Consumption of omega 6 PFA was lower in smokers than never smokers for men from Japan, the UK, and US, with no difference for any subgroup of women and PRC men. Keys score was significantly higher for smokers for UK and US men and women. Three other studies also found a higher Keys score in smokers than nonsmokers.^{1,2,39,46}

Previous reports of retinol intake in smokers and nonsmokers have not shown a consistent pattern, with both higher^{25,34} and lower intakes^{9,28,38,45} for smokers, as well as no difference.^{1,2,15,17,21,26,28} In INTERMAP, retinol intake was nonsignificantly higher in smokers than never smokers for PRC men, significantly lower in smokers for US men and women, with no difference in intake for Japanese and UK men and women.

Few studies have examined intakes of phosphorus, Mg, and K by smoking status. In Multiple Risk Factor Intervention Trial (MRFIT) men, baseline intakes of phosphorus, magnesium, and K in mg/day were significantly higher in smokers than nonsmokers,^{1,2} while intakes of phosphorus and K per 1000 kcal were significantly lower in smokers, and Mg intake per 1000 kcal was also significantly higher in smokers. An Australian study reported significantly lower intakes of phosphorus and Mg in mg/day in smokers.¹⁹ A study from Italy reported no difference in K intake between smokers and non-smokers.²¹ In INTERMAP, smokers consumed significantly less phosphorus than never smokers for Japanese men and women and UK and US men, while UK and US women who smoked reported nonsignificantly lower intakes. Smokers also consumed significantly less Mg for Japanese men and women, UK women, and US men, with nonsignificantly lower intakes for UK men, and no difference in intakes for PRC men and US women. Potassium intake was significantly lower in smokers for Japanese men and women, UK women, and US men, with no difference in intakes for PRC men, UK men, and US women.

For nutrients available only for US samples in INTERMAP, intakes of vitamins D and B₁₂ did not differ by smoking status, while intakes of riboflavin, folate, and vitamin B₆ were significantly lower in smokers than never smokers for both men and women. Niacin intake was significantly lower in smokers only for US men. Other studies have reported both higher^{1,2,11} and lower^{1,2,13,17,35} intakes of vitamin D in smokers compared to nonsmokers. Vitamin B₁₂ intake has generally not varied by smoking status.^{1,2,17} Studies that have examined intakes of riboflavin by smoking status have been inconsistent, with higher intakes,^{1,2,14} lower intakes,^{19,42} and no difference^{11,16,21} for smokers compared to nonsmokers reported. Other studies have also reported lower intakes of folate and vitamin B₆ for smokers compared to nonsmokers.^{1,2,5,17,20,35,43} In MRFIT men, niacin intake in mg/day was significantly higher in smokers than nonsmokers, while intake per 1000 kcal was significantly lower.^{1,2}

Dietary Na intake in mg/day has also been found to be higher in smokers than nonsmokers in some studies.^{10,35} In MRFIT, Na intake in mg/day was significantly higher in smokers than nonsmokers, whereas intake per 1000 kcal was significantly lower.^{1,2} In INTERMAP, there were generally no differences in Na intake for smokers and never smokers. However, there was significantly higher dietary Na/K in smokers compared to never smokers for Japanese men and women and UK women, due primarily to significantly lower K intake in smokers for these three gender–country subgroups.

In INTERMAP, we also examined urinary excretion of urea, Na, K, and Na/K. In contrast to protein intake reported in 24-h recalls, urea excretion was lower in smokers than never smokers in PRC and Japanese men, UK women, and US men and women. Since urinary urea excretion is a marker for total protein intake,^{58,59,63,64} the difference between dietary and urinary results for protein could reflect differential dietary supplement intake between smokers and never smokers, since supplement intake was not included here as part of dietary intake. Results for urinary K were generally similar to those for dietary K, with significantly lower amounts for smokers compared to never smokers for both dietary and urinary K for Japanese men, UK women, and US men, although dietary values were expressed as intake per 1000 kcal, and excretion in amount per day. Urinary Na excretion was significantly higher in smokers than never smokers for Japanese women, but significantly lower for PRC and US men. In contrast, there were no significant differences between smokers and never smokers for dietary intakes of Na. Results for urinary Na/K were also generally similar to those for dietary Na/K with significantly higher values for both measures for smokers compared to never smokers for Japanese men and women and UK women.

With regard to dietary intakes of ex-smokers, previous reports that subdivided nonsmokers into never smokers and ex-smokers have shown that diets of ex-smokers more closely resemble those of never smokers than current smokers, with intakes of many nutrients either intermediate between those of smokers and never smokers or similar to those of never smokers.^{6,8–10,15–17,21,25,26,28,33,36,39,41,42,46,47} This was also true for INTERMAP participants. Nutrients for which there were differences in intakes between smokers and ex-smokers also generally showed differences in the same direction between smokers and never smokers, for example, in smokers compared to ex-smokers lower energy from vegetable protein and carbohydrates, lower intakes of dietary fibre, beta carotene, vitamin E, vitamin

C, thiamine, riboflavin, folate, vitamin B₆, calcium, iron, phosphorus, and Mg, and lower urinary excretion of urea and K. There were also relatively few significant differences in intakes between ex-smokers and never smokers. The only nutrients for which there was more than one gender–country subgroup for which intakes differed significantly between ex-smokers and never smokers were energy from alcohol intake, energy from carbohydrates, and dietary fibre.

Only two studies have examined dietary intakes of smokers and nonsmokers in Chinese or Japanese samples.^{11,55} In a sample of 500 men from Hong Kong, smokers had a lower mean daily consumption of fruits, lower carbohydrate intake, higher vegetable intake, higher total fat intake, and higher vitamin D intake than nonsmokers.¹¹ There were no differences for total energy, protein, calcium, iron, vitamin C, niacin, riboflavin, thiamine, or dietary cholesterol. For women, there were no differences in intakes, but there were only 19 smokers among 510 women. In a Japanese sample of 30 916 men and women aged 40 years and over, former smokers and nonsmokers consumed more bread, milk, vegetables, and fruit than current smokers.⁵⁵ In INTERMAP, male smokers and never smokers from the PRC showed fewer differences in intakes than men and women from the other three countries. Smokers did, however, consume less energy from carbohydrates and more energy from alcohol, and excrete less urea and K than never smokers, similar to most of the other gender–country subgroups. However, intakes of some nutrients generally found to be lower in smokers than nonsmokers or which were lower in smokers compared to never smokers in the other countries in INTERMAP, that is, dietary fibre, beta carotene, vitamin E, vitamin C, calcium, phosphorus, and Mg, generally showed no differences for PRC men. Differences in dietary intakes for smokers and never smokers for Japanese men and between smokers and nonsmokers for Japanese women were generally consistent with those found in men and women for the UK and US, for example, in smokers, lower intakes of energy from vegetable protein for men and women, lower energy from carbohydrates for men, lower intakes of dietary fibre, beta carotene, calcium, iron, phosphorus, Mg, and K in men and women, lower intake of vitamin C in women, and lower dietary Na/K for men and women.

The differences in nutrient intakes for smokers and never smokers observed in INTERMAP are consistent with those studies that have reported lower fruit and vegetable consumption in smokers compared to nonsmokers.^{1,5,6,8,9,11,12,15,16,18,20,24,27,28,34–36,41,42,50–57} However, INTERMAP did not find the consistently higher intakes for total energy, total fat, SFA, and dietary cholesterol, and lower intake of PFA for smokers compared to never smokers that have been reported for smokers compared to nonsmokers in other studies.³ Energy from carbohydrate intake was also lower in six of seven gender–country subgroups in INTERMAP, which is generally consistent with those studies reporting carbohydrate intake as per cent energy,^{1,2,6,9,11,15,22,42,46–48} but not with those studies reporting carbohydrate intake as g/day, which on average show no difference in intake for smokers and nonsmokers.³

In conclusion, INTERMAP results are consistent with many other reports indicating that smokers have less healthful diets than never smokers and ex-smokers. Public health interventions in smokers should not only focus on helping smokers to quit but also on improving their diets in the effort to reduce their cancer and cardiovascular disease risks.

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Table 1

Characteristics of INTERMAP men and women by smoking status and country

<i>Variable</i>	<i>Never^a smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
<i>PRC: Men</i>				
<i>Number</i>	67	65	284	
Age (years)	49.3	49.0	48.9	0.864
Education (years)	7.2	6.5	6.3	0.021
Body mass index (kg/m ²)	22.6	23.3	22.1	0.005
Special diet (%)	1.5	9.2	2.1	0.008
<i>Japan: Men</i>				
<i>Number</i>	133	144	297	
Age (years)	49.5	50.5	49.1	0.029
Education (years)	12.5	12.5	12.2	0.307
Body mass index (kg/m ²)	23.8	24.2	23.4	0.009
Special diet (%)	9.0	6.9	3.0	0.025
<i>Japan: Women</i>				
<i>Number</i>	522	—	49	
Age (years)	49.4	—	47.1	0.003
Education (years)	11.6	—	12.3	0.017
Body mass index (kg/m ²)	23.1	—	23.8	0.102
Special diet (%)	7.9	—	8.2	0.939
<i>UK: Men</i>				
<i>Number</i>	123	98	45	
Age (years)	48.8	50.8	49.3	0.032
Education (years)	13.9	12.6	12.1	<0.001
Body mass index (kg/m ²)	27.7	27.6	27.6	0.987
Special diet (%)	21.1	23.5	11.1	0.224
<i>UK: Women</i>				
<i>Number</i>	144	49	42	
Age (years)	48.8	49.1	47.4	0.276
Education (years)	12.5	12.0	11.6	0.192
Body mass index (kg/m ²)	27.0	28.5	26.6	0.157
Special diet (%)	21.5	30.6	14.3	0.169
<i>US: Men</i>				
<i>Number</i>	491	401	211	
Age (years)	48.3	50.3	48.4	<0.001
Education (years)	16.1	15.2	14.1	<0.001
Body mass index (kg/m ²)	29.0	29.7	28.2	0.002
Special diet (%)	14.7	15.7	10.0	0.138
<i>US: Women</i>				
<i>Number</i>	658	276	158	

<i>Variable</i>	<i>Never^a smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Age (years)	49.0	49.9	49.0	0.056
Education (years)	14.8	14.5	13.4	<0.001
Body mass index (kg/m ²)	28.6	28.9	28.6	0.850
Special diet (%)	22.0	24.6	20.3	0.533

^aNever smoker including 13 ex-smoker for Japanese women.

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Table 2
 Reported^a macronutrient and micronutrient (per 1000 kcal) intakes by smoking status in 416 men from the Peoples Republic of China

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Macronutrients				
Energy (kcal/day)	2459.42	2286.63	2339.23	0.129
Total protein (% kcal)	12.27	12.94	12.62	0.088 [*]
Animal (% kcal)	2.27	3.08	2.81	0.081 [*]
Vegetable (% kcal)	10.01	9.87	9.81	0.553
Total fat (% kcal)	20.11	20.96	20.49	0.695
SFA (% kcal)	5.14	5.22	5.19	0.972
MUFA (% kcal)	8.20	8.41	8.28	0.897
PEFA (% kcal)	5.67	6.27	5.98	0.218
Omega 3 PFA (% kcal)	0.55	0.60	0.54	0.157
Omega 6 PFA (% kcal)	5.11	5.65	5.42	0.236
PEFA/SFA	1.25	1.28	1.27	0.943
Cholesterol (mg/day)	198.11	226.86	220.44	0.678
Cholesterol (mg/1000kcal)	81.39	102.87	94.28	0.356
Keys dietary lipid score	18.29	19.09	18.83	0.891
Total available carb. (% kcal)	64.87	61.89	61.01	0.038 ^{**}
Alcohol (% kcal)	2.73	4.19	5.87	0.012 ^{**}
Micronutrients/1000 kcal				
Total dietary fibre (g)	13.63	13.41	13.00	0.389
Total vitamin A (RE)	225.73	249.71	256.05	0.447
Beta carotene (µg)	1140.06	1196.73	1185.71	0.928
Retinol (µg)	36.30	50.97	58.94	0.214
Vitamin E (mg)	5.03	5.44	5.27	0.288
Vitamin C (mg)	34.59	36.94	34.72	0.569
Calcium (mg)	150.52	158.85	152.41	0.590
Iron (mg)	7.73	8.15	7.78	0.304
Phosphorus (mg)	440.74	444.99	427.45	0.122

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Magnesium (mg)	154.56	152.48	149.03	0.367
Potassium (mmol)	22.90	22.78	22.67	0.918
Sodium (mmol)	82.45	85.06	86.86	0.461
Dietary Na/K	3.76	3.97	4.10	0.145
Urinary measures				
Urea nitrogen (g/24 h)	9.01	9.45	8.45	0.002 ^{***}
Potassium (mmol/24 h)	40.69	42.28	37.32	0.009 ^{***}
Sodium (mmol/24 h)	261.81	259.34	238.54	0.052 ^{**}
Urinary Na/K	6.92	6.88	6.82	0.947

^a Adjusted for age, years of education, and centre.

* $P \leq 0.05$, ex-smokers vs never smokers.

** $P \leq 0.05$, smokers vs never smokers.

*** $P \leq 0.05$, smokers vs ex-smokers.

Reported^a macronutrient and micronutrient (per 1000 kcal) intakes by smoking status in 574 men and 571 women from Japan

Table 3

Variable	Never smoker	Ex-smoker	Current smoker	P-value
<i>Men</i>				
Macronutrients				
Energy (kcal/day)	2237.08	2303.23	2290.18	0.385
Total protein (% kcal)	16.02	15.86	15.63	0.234
Animal (% kcal)	8.82	8.91	8.93	0.909
Vegetable (% kcal)	7.20	6.95	6.70	<0.001 ^{*,**}
Total fat (% kcal)	23.99	24.05	23.21	0.111
SFA (% kcal)	6.18	6.20	5.95	0.188
MUFA (% kcal)	8.63	8.76	8.40	0.174
PEA (% kcal)	6.34	6.27	6.07	0.164
Omega 3 PFA (% kcal)	1.33	1.37	1.32	0.395
Omega 6 PFA (% kcal)	4.98	4.87	4.72	0.153
PEA/SFA	1.07	1.06	1.07	0.965
Cholesterol (mg/day)	438.99	451.91	445.98	0.832
Cholesterol (mg/1000kcal)	195.90	196.16	194.39	0.959
Keys dietary lipid score	28.80	29.00	28.47	0.643
Total available carb. (% kcal)	54.01	51.69	52.03	0.016 ^{*,***}
Alcohol (% kcal)	5.90	8.30	9.05	<0.001 ^{*,***}
Micronutrients/1000 kcal				
Total dietary fibre (g)	7.62	7.07	6.51	<0.001 ^{*,**,*}
Total vitamin A (RE)	166.35	153.73	157.14	0.779
Beta carotene (µg)	1485.18	1345.98	1177.19	0.003 [*]
Retinol (µg)	168.10	159.76	196.44	0.559
Vitamin E (mg)	4.68	4.66	4.48	0.092
Vitamin C (mg)	61.16	58.43	52.96	0.070 [*]
Calcium (mg)	298.51	279.43	252.46	<0.001 ^{*,**}

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Iron (mg)	5.40	5.06	4.91	<0.001 ^{*,***}
Phosphorus (mg)	561.74	551.58	533.31	0.004 ^{*,***}
Magnesium (mg)	132.74	130.51	124.13	<0.001 ^{*,***}
Potassium (mmol)	34.77	33.45	32.07	<0.001 ^{*,***}
Sodium (mmol)	97.46	100.75	98.09	0.318
Dietary Na/K	2.93	3.18	3.20	<0.001 ^{*,***}
<i>Urinary measures</i>				
Urea nitrogen (g/24 h)	10.29	10.10	9.63	0.009 ^{*,***}
Potassium (mmol/24 h)	52.18	49.42	47.79	0.006 [*]
Sodium (mmol/24 h)	212.14	210.64	209.85	0.928
Urinary Na/K	4.30	4.48	4.56	0.142
<i>Women</i>				
<i>Macronutrients</i>				
Energy (kcal/day)	1799.58	—	1815.16	0.753
Total protein (% kcal)	16.21	—	15.22	0.005 [*]
Animal (% kcal)	8.85	—	8.24	0.090
Vegetable (% kcal)	7.36	—	6.99	0.019 [*]
Total fat (% kcal)	26.22	—	25.03	0.092
SFA (% kcal)	7.12	—	6.57	0.037 [*]
MUFA (% kcal)	9.43	—	9.17	0.409
PFA (% kcal)	6.63	—	6.37	0.242
Omega 3 PFA (% kcal)	1.35	—	1.31	0.454
Omega 6 PFA (% kcal)	5.25	—	5.04	0.278
PFA/SFA	0.98	—	1.02	0.334
Cholesterol (mg/day)	357.54	—	381.79	0.253
Cholesterol (mg/1000kcal)	198.20	—	208.07	0.330
Keys dietary lipid score	31.10	—	30.51	0.533
Total available carb. (% kcal)	56.25	—	55.83	0.650

Variable	Never smoker	Ex-smoker	Current smoker	P-value
Alcohol (% kcal)	1.27	—	3.91	<0.001*
Micronutrients/1000 kcal				
Total dietary fibre (g)	9.04	—	7.88	<0.001*
Total vitamin A (RE)	191.20	—	162.39	0.113
Beta carotene (μg)	1807.55	—	1306.13	0.004*
Retinol (μg)	176.45	—	188.06	0.748
Vitamin E (mg)	5.36	—	4.91	0.076
Vitamin C (mg)	75.57	—	74.66	0.884
Calcium (mg)	348.53	—	276.18	<0.001*
Iron (mg)	5.64	—	5.08	<0.001*
Phosphorus (mg)	585.58	—	526.46	<0.001*
Magnesium (mg)	141.47	—	133.53	0.038*
Potassium (mmol)	39.15	—	34.65	<0.001*
Sodium (mmol)	102.55	—	103.53	0.758
Dietary Na/K	2.75	—	3.14	<0.001*
Urinary measures				
Urea nitrogen (g/24 h)	8.40	—	8.26	0.614
Potassium (mmol/24 h)	48.77	—	46.67	0.322
Sodium (mmol/24 h)	184.57	—	205.20	0.009*
Urinary Na/K	4.01	—	4.66	<0.001*

^a Adjusted for age, years of education, and centre.

^b Includes 13 ex-smokers

* $P \leq 0.05$, smokers vs never smokers.

** $P \leq 0.05$, smokers vs ex-smokers.

*** $P \leq 0.05$, ex-smokers vs never smokers.

Reported^a macronutrient and micronutrient (per 1000 kcal) intakes by smoking status in 266 men and 235 women from the UK

Table 4

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
<i>Men</i>				
Macronutrients				
Energy (kcal/day)	2477.94	2476.75	2467.15	0.995
Total protein (% kcal)	15.47	15.74	15.55	0.810
Animal (% kcal)	9.07	9.89	9.91	0.137
Vegetable (% kcal)	6.40	5.86	5.64	0.002 ^{*,**}
Total fat (% kcal)	32.40	33.01	32.94	0.769
SFA (% kcal)	11.65	12.22	12.59	0.220
MUFA (% kcal)	11.08	11.30	11.31	0.774
PFA (% kcal)	6.61	6.29	5.89	0.097 [*]
Omega 3 PFA (% kcal)	0.75	0.77	0.68	0.194
Omega 6 PFA (% kcal)	5.87	5.52	5.21	0.094 [*]
PFA/SFA	0.62	0.56	0.51	0.030 [*]
Cholesterol (mg/day)	291.23	304.26	311.40	0.684
Cholesterol (mg/1000kcal)	116.91	122.06	126.05	0.512
Keys dietary lipid score	38.35	40.81	42.55	0.081 [*]
Total available carb. (% kcal)	48.20	46.24	45.11	0.029 [*]
Alcohol (% kcal)	3.87	4.90	6.35	0.066 [*]
Micronutrients/1000 kcal				
Total dietary fibre (g)	12.80	11.89	11.11	0.033 [*]
Total vitamin A (RE)	414.69	365.75	352.08	0.148
Beta carotene (µg)	1116.79	930.92	969.67	0.302
Retinol (µg)	226.64	210.20	189.96	0.438
Vitamin E (mg)	4.72	4.56	4.05	0.066 [*]
Vitamin C (mg)	36.31	40.35	31.30	0.078 ^{***}
Calcium (mg)	416.83	427.88	396.53	0.264

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Iron (mg)	6.22	6.21	5.78	0.214
Phosphorus (mg)	651.03	653.40	608.73	0.090 *
Magnesium (mg)	152.90	151.19	142.64	0.199
Potassium (mmol)	40.22	40.68	38.64	0.411
Sodium (mmol)	69.21	69.48	70.44	0.908
Dietary Na/K	1.86	1.83	2.00	0.207
<i>Urinary measures</i>				
Urea nitrogen (g/24 h)	10.10	10.14	9.29	0.131
Potassium (mmol/24 h)	73.87	77.49	69.84	0.134
Sodium (mmol/24 h)	162.28	159.22	157.49	0.834
Urinary Na/K	2.35	2.20	2.52	0.095 ***
<i>Women</i>				
<i>Macronutrients</i>				
Energy (kcal/day)	1787.55	1886.02	1892.82	0.202
Total protein (% kcal)	16.06	15.94	16.22	0.908
Animal (% kcal)	9.80	9.88	10.95	0.099 *
Vegetable (% kcal)	6.27	6.06	5.27	<0.001 *, ***, **
Total fat (% kcal)	32.05	32.71	34.35	0.141
SFA (% kcal)	11.91	12.39	13.17	0.092 *
MUFA (% kcal)	10.58	10.86	11.57	0.075 *
PFA (% kcal)	6.16	5.98	5.94	0.725
Omega 3 PFA (% kcal)	0.72	0.70	0.72	0.885
Omega 6 PFA (% kcal)	5.44	5.28	5.23	0.724
PFA/SFA	0.56	0.52	0.47	0.088 *
Cholesterol (mg/day)	204.86	229.12	256.54	0.017 *
Cholesterol (mg/1000kcal)	115.41	121.68	134.24	0.082 *
Keys dietary lipid score	39.59	41.67	44.66	0.024 *
Total available carb. (% kcal)	49.13	47.47	44.64	<0.001 *

Variable	Never smoker	Ex-smoker	Current smoker	P-value
Alcohol (% kcal)	2.47	3.54	4.43	0.046*
Micronutrients/1000 kcal				
Total dietary fibre (g)	13.00	11.78	9.80	<0.001***,***
Total vitamin A (RE)	410.99	395.64	362.92	0.355
Beta carotene (μ g)	1310.09	1072.61	819.98	0.004*
Retinol (μ g)	192.25	216.58	225.94	0.320
Vitamin E (mg)	4.69	4.05	3.86	0.002***
Vitamin C (mg)	56.53	48.56	35.53	0.002*
Calcium (mg)	478.48	478.84	458.95	0.663
Iron (mg)	6.54	6.22	5.22	<0.001***,***
Phosphorus (mg)	691.47	680.48	649.10	0.172
Magnesium (mg)	162.70	154.90	138.38	<0.001***,***
Potassium (mmol)	44.29	43.33	40.27	0.065*
Sodium (mmol)	69.90	71.69	70.98	0.781
Dietary Na/K	1.69	1.85	1.91	0.019*
Urinary measures				
Urea nitrogen (g/24 h)	7.76	8.18	7.75	0.356
Potassium (mmol/24 h)	62.46	60.08	55.66	0.035*
Sodium (mmol/24 h)	123.50	134.55	128.02	0.246
Urinary Na/K	2.08	2.40	2.40	0.009***

^a Adjusted for age, years of education, and centre.

* $P \leq 0.05$, smokers vs never smokers.

** $P \leq 0.05$, ex-smokers vs never smokers.

*** $P \leq 0.05$, smokers vs ex-smokers.

Table 5

Reported^a macronutrient micronutrient (per 1000 kcal) intakes by smoking status in 1103 men and 1092 women from the USA

Variable	Never smoker	Ex-smoker	Current smoker	P-value
<i>Men</i>				
Macronutrients				
Energy (kcal/day)	2542.17	2646.85	2701.57	0.010 ^{*,**}
Total protein (% kcal)	15.47	15.67	15.08	0.096 ^{***}
Animal (% kcal)	10.12	10.36	10.30	0.557
Vegetable (% kcal)	5.19	5.10	4.50	<0.001 ^{*,***}
Total fat (% kcal)	32.98	33.56	33.48	0.413
SFA (% kcal)	10.54	10.87	11.04	0.061 [*]
MUFA (% kcal)	12.28	12.39	12.61	0.382
PFA (% kcal)	6.99	7.08	6.66	0.081 ^{***}
Omega 3 PFA (% kcal)	0.74	0.75	0.68	0.014 ^{*,***}
Omega 6 PFA (% kcal)	6.35	6.44	6.05	0.088 ^{***}
PFA/SFA	0.71	0.69	0.63	0.002 ^{*,***}
Cholesterol (mg/day)	332.18	352.58	380.27	0.004 [*]
Cholesterol (mg/1000kcal)	130.93	131.71	141.25	0.083 [*]
Keys dietary lipid score	35.77	36.64	38.22	0.009 [*]
Total available carb. (% kcal)	49.65	48.07	46.29	<0.001 ^{*,***}
Alcohol (% kcal)	1.82	2.61	5.04	<0.001 ^{*,***}
Micronutrients/1000 kcal				
Total dietary fibre (g)	8.98	8.68	7.52	<0.001 ^{*,***}
Total vitamin A (RE)	506.25	478.26	390.29	<0.001 ^{*,***}
Beta carotene (µg)	1841.69	1593.03	1360.70	<0.001 ^{*,**}
Retinol (µg)	199.30	212.76	163.51	0.027 ^{*,***}
Vitamin E (mg)	4.40	4.53	4.02	0.002 ^{*,***}
Vitamin D (µg)	2.21	2.25	2.24	0.917

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Vitamin C (mg)	55.16	47.75	38.41	<0.001 ^{*,**,*}
Thiamin E (mg)	0.87	0.87	0.76	<0.001 ^{*,**,*}
Riboflavin (mg)	0.90	0.91	0.83	<0.001 ^{*,**,*}
Niacin (mg)	11.61	11.90	10.85	<0.001 ^{*,**,*}
Folate (μ g)	135.14	132.21	114.26	<0.001 ^{*,**,*}
Vitamin B ₆ (mg)	0.92	0.90	0.81	<0.001 ^{*,**,*}
Vitamin B ₁₂ (mg)	2.21	2.39	2.27	0.382
Calcium (mg)	347.94	352.60	322.53	0.022 ^{*,**,*}
Iron (mg)	7.84	7.85	6.85	<0.001 ^{*,**,*}
Phosphorus (mg)	586.60	589.82	558.40	0.005 ^{*,**,*}
Magnesium (mg)	146.39	145.85	138.61	0.027 ^{*,**,*}
Potassium (mmol)	34.10	33.96	32.04	0.008 ^{*,**,*}
Sodium (mmol)	71.43	73.63	68.93	0.004 ^{*,**,*}
Dietary Na/K	2.33	2.37	2.37	0.620
Urinary measures				
Urea nitrogen (g/24 h)	11.12	11.53	9.85	<0.001 ^{*,**,*}
Potassium (mmol/24 h)	64.44	67.04	59.01	<0.001 ^{*,**,*}
Sodium (mmol/24 h)	183.84	190.02	166.61	<0.001 ^{*,**,*}
Urinary Na/K	3.09	3.03	3.14	0.495
<i>Women</i>				
Macronutrients				
Energy (kcal/day)	1862.96	1905.24	1893.61	0.420
Total protein (% kcal)	15.56	15.73	15.30	0.391
Animal (% kcal)	10.06	10.22	10.19	0.760
Vegetable (% kcal)	5.37	5.35	4.84	<0.001 ^{*,**,*}
Total fat (% kcal)	32.19	33.18	33.51	0.037 ^{*,**,*}
SFA (% kcal)	10.41	10.67	11.21	0.007 [*]

Variable	Never smoker	Ex-smoker	Current smoker	P-value
MUFA (% kcal)	11.85	12.08	12.33	0.153
PFA (% kcal)	6.83	7.32	6.86	0.007****
Omega 3 PFA (% kcal)	0.76	0.80	0.72	0.041***
Omega 6 PFA (% kcal)	6.16	6.62	6.22	0.008**
PFA/SFA	0.69	0.74	0.64	0.003****
Cholesterol (mg/day)	236.99	252.82	257.25	0.056
Cholesterol (mg/1000kcal)	127.11	132.34	135.69	0.158
Keys dietary lipid score	35.41	35.76	38.10	0.008****
Total available carb. (% kcal)	51.33	49.65	48.25	<0.001***
Alcohol (% kcal)	0.85	1.34	2.77	<0.001****
Micronutrients/1000 kcal				
Total dietary fibre (g)	9.52	9.53	8.42	0.001****
Total vitamin A (RE)	634.35	606.74	445.33	<0.001****
Beta carotene (μ g)	2306.02	2278.09	1555.12	<0.001****
Retinol (μ g)	250.02	227.06	186.14	0.030*
Vitamin E (mg)	4.54	4.82	4.27	0.013****
Vitamin D (μ g)	2.44	2.37	2.36	0.807
Vitamin C (mg)	60.29	54.43	43.62	<0.001****
Thiamine (mg)	0.90	0.87	0.80	<0.001****
Riboflavin (mg)	0.95	0.93	0.88	0.004****
Niacin (mg)	11.72	11.63	11.34	0.321
Folate (μ g)	147.62	141.96	127.57	<0.001****
Vitamin B ₆ (mg)	0.94	0.93	0.83	<0.001****
Vitamin B ₁₂ (mg)	2.34	2.27	2.11	0.582
Calcium (mg)	383.14	388.43	356.47	0.068****
Iron (mg)	8.06	7.94	7.27	0.002****
Phosphorus (mg)	600.40	607.26	580.81	0.112

<i>Variable</i>	<i>Never smoker</i>	<i>Ex-smoker</i>	<i>Current smoker</i>	<i>P-value</i>
Magnesium (mg)	151.47	153.29	149.70	0.665
Potassium (mmol)	36.06	36.24	34.88	0.333
Sodium (mmol)	72.74	74.58	71.21	0.111
Dietary Na/K	2.27	2.32	2.30	0.547
<i>Urinary measures</i>				
Urea nitrogen (g/24 h)	8.10	8.52	7.69	<0.001 ^{*,**,*}
Potassium (mmol/24 h)	50.73	53.44	46.35	<0.001 ^{*,**,*}
Sodium (mmol/24 h)	141.34	145.45	140.94	0.460
Urinary Na/K	3.05	3.04	3.37	0.008 ^{*,**,*}

^a Adjusted for age, years of education, and centre.

* $P \leq 0.05$, smokers vs never smokers.

** $P \leq 0.05$, ex-smokers vs never smokers.

*** $P \leq 0.05$, smokers vs ex-smokers.