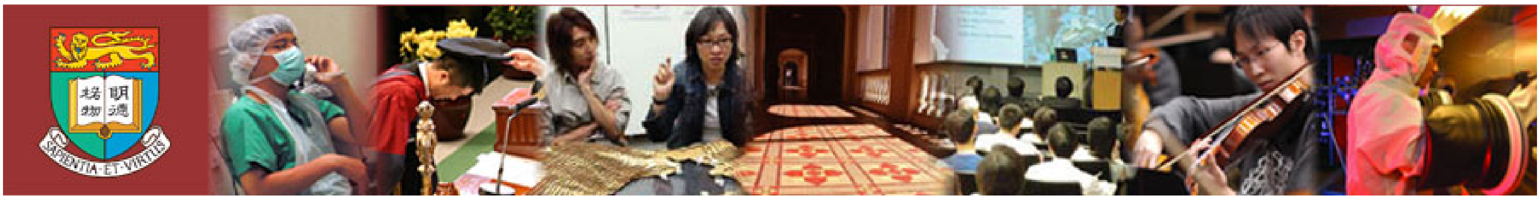

Discrepancy in socioeconomic status does not fully explain the variation in diet quality between consumers of different coffee types

Tommy Hon Ting, Wong[1],

Zhixian, Sui[2],

Anna, Rangan[2],

Jimmy Chun Yu, Louie[1, 2]

[1]School of Biological Sciences, Faculty of Science, The University of Hong Kong, Hong Kong Special Administrative Region, People's Republic of China

[2]Charles Perkins Centre, School of Life and Environmental Sciences, The University of Sydney, Camperdown, NSW, Australia

Authors' last names: Wong, Sui, Rangan, and Louie

Address for correspondence

Dr. Jimmy Chun Yu Louie

5S-14 Kadoorie Biological Sciences Building

The University of Hong Kong

1 Pokfulam Road, Pokfulam, Hong Kong SAR

T: +852 2299 0677

F: +852 2559 9114

E: jimmyl@hku.hk

Discrepancy in socioeconomic status does not fully explain the variation in diet quality between consumers of different coffee types

Abstract

Purpose: Habitual consumers of different coffee types may vary in socioeconomic status (SES), which is an important determinant of diet quality. Nonetheless, research on diet quality among coffee consumers was scarce. We aimed to compare the diet quality of coffee consumers with different preferences towards coffee type and additive usage.

Methods: In this cross-sectional analysis, intake data of food, coffee, and additive usage from the adult respondents of the 2011-12 Australian Health Survey were used. Participants were grouped according to the type of coffee (espresso and ground coffee, E&G; coffee made from coffee mixes and instant coffee, M&I; non-consumers, NC) and additives (milk, sugar, and intense sweetener) consumed. Adjusted food group intake was compared between consumption groups using general linear model.

Results: E&G drinkers had better SES than M&I and NC. After adjusting for covariates, the mean dairy intake of E&G drinkers was 22.2% higher than M&I drinkers (p<0.001) and 33.1% higher than NC (p < 0.001). Mean discretionary food intake of E&G drinkers was 12.1% lower than M&I (p = 0.003) and 12.3% lower than NC (p = 0.001). In terms of additive usage, non-users of coffee additive had the lowest dairy food intake and the highest discretionary food intake.

Conclusions: Coffee consumers' different preferences towards coffee type and additive usages reflected significant variations in their diet quality, even after adjustment of SES. Therefore, future epidemiological studies should consider separating coffee drinkers according to their habitual consumption of different types of coffee.

Keywords: coffee type, diet quality, sugar, Australia, coffee additive, coffee

Introduction

Habitual coffee consumption has been associated with lower risk of type 2 diabetes mellitus (T2DM) [1,2], cardiovascular diseases (CVD) [3], and all-cause mortality [4] in epidemiological studies. However, these positive effects were not consistently observed - some studies found no significant association, or even an increased risk, between coffee consumption and health outcomes [5,6]. One reason behind these discrepancies may be a lack of consideration of the subjects' coffee consumption habits in previous studies. Consumers' choices in the type of coffee and the addition of sugar, intense sweetener and/or milk may reflect variations in socioeconomic status (SES) and diet quality, thereby affecting their risk profile for the health outcomes of interest.

The costs of different types of coffee, such as espresso, instant coffee, and filtered coffee vary, thus it is possible that people with different coffee preferences differ in SES. It has been reported that instant coffee was preferred by households of lower income, while whole bean coffee was more popular among high-income households [7]. As higher SES has been associated with increased health-consciousness and better diet quality [8], it is possible that when comparing dietary intake of consumers who habitually drink different types of coffee, variations in usual diet could be observed.

Coffee consumers' habit of adding sugar, milk and intense sweeteners may also reveal differences in their diet quality. Previous studies have linked the consumption of added sugar to lower SES, a lack of health consciousness and poor diet quality [8,9]. In contrast, the consumption of intense sweeteners was linked to a better diet quality and a better lifestyle [10]. Nonetheless, cross-sectional studies have found that people who habitually consumed sugar-sweetened coffee had a lower body weight than those who did not add sugar [11] or habitually consumed coffee with intense sweetener [12]. These conflicting results have raised questions regarding the association between the habitual use of additives in coffee and the variations in diet quality.

As past epidemiological studies seldom collect detailed information regarding the types of coffee consumed and what was added to the coffee, the association between these variations and diet quality has not been widely investigated. Nonetheless, given the significant effect that diet quality [13] and SES [8] have on various health outcomes, it is important to study these factors among coffee drinkers. The current study aimed to examine the associations between consumption of different types of coffee, as well as the different habits of additive usage, and diet quality in the general Australian population. We hypothesized that habitually consuming different types of coffee and different habits of additive usage are associated with differences in diet quality of habitual coffee drinkers.

Methods

Data source

In the current secondary analysis, data from the National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-2012 Australian Health Survey (AHS) were used, which was conducted by the

Australian Bureau of Statistics (ABS). In this survey, sample households were selected using a stratified multistage area sample of private dwellings, and the response rate was 77.0%. Trained interviewers conducted face-to-face interviews with a selected adult member of the selected households. Information on demographics, anthropometry, and dietary intake was collected.

Dietary data were collected using a computer-assisted, multiple-pass 24-hour recall from participants (n = 12153) aged 2 years and over in a face-to-face interview. At least eight days later, a subset of participants (n = 7753) was contacted for another dietary recall, which was conducted through telephone interviews. Food and beverage intake were then translated into energy and nutrient intake using the Australian Food and Nutrient (AUSNUT) 2011-13 food composition database [14].

Assessment of coffee intake

The term ‘coffee’ as used herein included coffee prepared by ground coffee beans, instant coffee powder or dry product which contained coffee powder. We used the food name and details in the AUSNUT 2011-13 database to determine whether a particular food code is counted as coffee or additive or not. The term ‘additives’ used herein referred to milk, sugar and intense sweetener. In the dataset, we identified the coffee and additives consumed by matching the survey identifier with the AUSNUT 2011-13 database [14]. All items found to be consumed in the same time and in combination were treated as components of a single composite coffee beverage.

Participants’ usual intake of coffee and additives were calculated using the Multiple Source Method [15] based on two days of recall data. The volume of one cup of coffee was defined as 120 ml, which is the volume of a small keep cup according to the AUSNUT 2011-13 database [14]. The volume of one cup of espresso was defined as 50 ml, according to the AUSNUT 2011-13 database [14]. Participants were considered as habitual consumers of a particular coffee type and additive if more than one cup of that beverage combination was consumed. Each participant was allocated to only one coffee type and additive group, according to which was consumed the most. Two coffee type groups were created for the analysis: “espresso and ground coffee”, which included espresso and all coffee produced from ground coffee beans; and “instant and mixed coffee”, which consisted of coffee made from instant powder and those made by adding hot water into pre-mixed coffee powder product. Three additive groups were created: milk only, sugar-sweetened, and intense-sweetened. Participants who reported adding milk only were classified as milk users, while those adding both milk and sugar were classified as sugar users.

Covariates

The NNPAS provided information on the covariates used in the current analyses, and the collection methods were as follows: weight and height were measured without shoes and heavy clothing where possible, using a digital scale and a stadiometer respectively; body mass index (BMI) was calculated as weight in kilograms divided by square of height in meters; participants' country of birth was classified according to whether the participants were born in Australia, other English-speaking countries, or others; the highest education attained and smoker status were self-reported by participants; urbanity was determined using the Australian Standard Geographical Classification (ASGC) [16], and those households with their locations categorized into 'major cities of Australia' and 'inner regional Australia' were considered as living in urban areas; employment status was self-reported by participants and both full-time and part-time employment was considered as employed in this study; the Socio-Economic Indices of Disadvantage for Areas (SEIFA) [17] were derived according to the geographical location of households, where the first SEIFA quintile indicates the most disadvantaged areas; for physical activity level of the previous week, participants were categorized according to the type and time spent on the physical activities in the week prior to the survey [18]; status of T2DM, high cholesterol, and cardiovascular diseases, as well as whether the participants were on diet or not, were self-reported.

Data cleaning

All participants who were aged under 19 years old were excluded from the analysis to match the grouping of adults in published AHS results. To enable a more accurate interpretation of dietary data, potential under- and over-reporters were identified based on the Goldberg cut-off criteria [18] and were removed from the analysis. The Goldberg cut-off criteria have been validated for use with data from 24-h recall [19]. As data for physical activity level were not available from the survey, the value of 1.55 was assigned to all subjects as per the advice of ABS [18]. The final sample size is 6232.

Food intake assessment

All food items in the 24h recalls were classified into the five core food groups and discretionary foods/beverages according to the Australian Guide to Healthy Eating (AGHE) [18,20]. All mixed dishes were disaggregated based on the AUSNUT2011-13 recipe file [14]. Food intake data of a single 24h recall was used, and this was deemed appropriate to describe dietary intake at a population level [21].

Statistical analysis

All statistical analyses were performed using SPSS version 23.0 (IBM Corp., Armonk, NY). Data were weighted to represent the overall Australian population [18]. General linear model for continuous variables and Pearson Chi-Square tests for categorical variables were carried out to examine the differences of potential confounding variables between the coffee consumption groups, with $p < 0.05$ to be considered as statistically significant. Estimated marginal means (EMM) and the SEM of food group intakes in each consumption group were calculated using general linear model, with confounding variables that were significantly different between groups included as covariates. Participants with missing data in any of the confounding variables were excluded from the analysis of food group intake. Due to the multiple comparisons made, when testing the differences of food groups intake between different consumption groups, $p < 0.001$ was regarded as statistically significant. Sensitivity analysis was performed by repeating the analysis with the inclusion of all implausible reporters.

Result

The demographics of the participants are shown in **Table 1**. There were slightly more mixed and instant coffee (M&I) drinkers than espresso and ground coffee (E&G) drinkers in this cohort (28.1% *vs*. 23.0% of the whole cohort). The mean BMI of the M&I group was higher than both the E&G group and the non-consumers. When compared with the other two groups, E&G drinkers were more likely to have a higher level of education, be more physically active, be employed, and at the highest SEIFA quintile. In contrast, M&I drinkers were most likely to be smokers at the time of the survey.

The demographic features of habitual coffee drinkers classified according to additive usage are shown in **Table 2**. Sugar was the most commonly used additive, which habitual usage was reported by 54.1% of coffee drinkers, followed by milk users (27.2% of coffee drinkers). Intense sweetener users had the highest BMI, were oldest among coffee drinkers, and had the lowest energy intake. Both sugar and intense sweetener users were more likely to be smokers and sedentary, and less likely to have high education level and in the highest SEIFA quintile.

Table 3 shows the adjusted food group intake of habitual coffee drinkers as classified by coffee types. E&G drinkers reported significantly higher intake of dairy products than both M&I drinkers (355.0 g *vs*. 290.4 g, $p < 0.001$) and non-consumers (355.0 g *vs*. 266.7 g, $p < 0.001$). The fruit intake of E&G drinkers was also marginally significantly higher than M&I drinkers (224.8 g *vs*. 187.8 g, $p = 0.001$). For discretionary food and beverage, E&G drinkers had a lower intake than both M&I drinkers (696.3 g *vs*. 792.5 g, $p = 0.003$) and non-consumers (696.3 g *vs*. 794.4 g, $p = 0.001$). On the other hand, the food groups intake of M&I drinkers was mostly similar with non-consumers, except the fact that they reported a lower fruit intake than the non-consumers, which the difference was marginally significant (187.8 g *vs*. 215.6 g, $p = 0.003$).

Table 4 shows the food group intake of habitual coffee drinkers, classified according to additive usage after adjusted for covariates. Coffee drinkers who reported not habitually using any additive had a significantly lower dairy intake than the other coffee drinkers ($p < 0.001$), yet the difference was no longer statistically significant after excluding the dairy intake from coffee ($p = 0.044$). Sugar users had the lowest fruit intake among coffee drinkers and the differences reached marginal statistical significance when compared with non-additive users (187.0 g *vs*. 235.2 g, $p = 0.002$) and milk users (187.0 g *vs*. 223.7 g, $p = 0.006$). For the intake of both overall discretionary food and alcoholic beverages, non-additive users had the highest intake, although the differences reached statistical significance only when compared with milk users and intense-sweetener users respectively.

Sensitivity analyses were done by including also the implausible reporters in the analysis models. There was no material difference in the results (online resources 1). To account for the fact that some participants may habitually drink more than one type of coffee, those who consume more than one cup of coffee in both coffee type groups were excluded and the analyses were repeated. The results did not change significantly (data not shown).

Discussion

Results of this study showed great variation in SES and diet quality between coffee drinkers consuming different types of coffee. In general, E&G drinkers had better SES, a healthier lifestyle, and better diet quality than M&I drinkers and non-habitual coffee consumers. In addition, different additive groups also showed marked differences in SES and food group intakes. When compared with non-users of coffee additives and milk users, sugar and intense sweetener users had lower SES. In terms of food group intake, non-users of coffee additives had the lowest dairy intake, highest discretionary food and beverage intake, and highest alcohol intake. To the knowledge of the authors, the current study is the first to assess the differences in dietary intake among adult coffee consumers.

The distinct differences in several SES attributes and lifestyle factors, such as education levels, smoking status, and employment status, between the two coffee type groups have received little attention in past epidemiological studies, as coffee drinkers were often treated as a single group. The observation that M&I drinkers being more socioeconomically disadvantaged when compared to both E&G and non-consumers, was similar to a recent study conducted in Korea [22], which compared instant coffee drinkers with filtered coffee drinkers (who belonged to E&G group according to the definition in the present study). In fact, the distinct variation in these attributes of SES between different groups of coffee drinkers did not come as a surprise, as espresso coffee is several times more expensive than instant coffee in Australia (AU$ 3.5-5.0/cup of espresso-type coffee *vs*. AU$ 2.5-8.0/100 g instant coffee powder). As a result, coffee drinkers habitually drinking different types of coffee may have distinctly different SES. Since higher SES has been shown to be associated with better health conditions and vice versa [23], the marked variations in SES between different groups of coffee drinkers may well affect the results of analyses concerning health outcomes of coffee consumption.

The diet quality of people who habitually consumed different types of coffee also varied markedly. When compared with both M&I drinkers and non-consumers, E&G drinkers consumed higher quantities of core food, which is necessary for a healthy diet [20]. This finding is partly in line with a previous study conducted on an Italian cohort, which found that people in the highest consumption category of espresso coffee ate more fruit and vegetables than those in the lowest category [6]. Our analysis also found that the dairy intake of E&G drinkers wassignificantly higher than both non-consumers and M&I drinkers. This is probably due to the popularity of espresso-type coffees, such as latte and flat white in Australia, which include at least 60% of milk by volume [14].

Previous studies have found conflicting results with habitual coffee consumers, as a single group, was reported to have both a less favorable [24,25] and a healthier diet [26] when compared with non-consumers. In the current study, the observed variations in diet quality between different groups of coffee drinkers may provide an explanation for this inconsistency. While some previous studies have controlled for several attributes of SES, such as income level and employment status, our analysis showed that controlling for these factors may not adequately explain the variations in diet quality between different types of coffee drinkers. Since diet has been established to be an important health determinant [13,27], it is important to account for the variation regarding the types of coffee consumed.

Regarding the use of additives in coffee, intense sweetener users had a higher BMI than the rest of the group, a finding that was also observed in previous studies [12,28]. It should be noted that the cross-sectional nature of the current study means that the causality of this finding could not be determined. Indeed, the use of intense sweetener had been regarded as a strategy by overweight individuals to control their weight [12], thus explaining the higher BMI of intense sweetener users. This may also explain the lowest energy intake of intense sweetener users among all coffee drinkers. On the other hand, sugar users in the current cohort were more likely to have unhealthy lifestyle habits, such as smoking and have a lower physical activity level. They were also less likely to have a high education level when compared with other user groups. These findings were in line with previous observations [9,29]. This significant difference in SES and lifestyle factors between users of different additives, if left unadjusted, may weaken the association identified in epidemiological studies, or even lead to erroneous conclusions.

The finding that non-users of coffee additives had the lowest dairy intake and the highest discretionary food intake has not been previously reported. Since energy intake was controlled in the analysis, it may be possible that discretionary food, mainly alcoholic drinks, displaced the dairy intake in the diet of this group of coffee drinkers. Nonetheless, the reason behind this is not known and more studies are needed to further elucidate this finding.

The present study has several strengths. First, a large representative sample of the Australian adult population was used. Second, anthropometric measures were objectively measured which excludes the possibility of reporting bias. Furthermore, all food intake entries were accounted for as all mixed dishes were disaggregated. The limitations of the present study included the fact that our results are from cross-sectional data and causal relationships cannot be inferred. In addition, food intake on Saturdays was significantly under-represented in the AHS. This might lead to an underestimation of discretionary food or beverage consumption, since eating behaviors on weekdays and weekends may vary. Moreover, some of the covariates (e.g. T2DM and cardiovascular diseases status) were self-reported and may subject to recall bias. It should also be noted that in the current analysis, each participant was assumed to habitually consume one group of coffee, according to the coffee types which they had the greatest intake and had more than one cup of it. This assumption was also made in previous work [22], and we showed that including participants who habitually consume more than one type of coffee did not significantly change the results. Caution should also be practiced for attempts to generalize the results of the current study, as coffee culture and consumption habits may vary markedly between different countries.

To conclude, the current analysis showed the differences in diet quality between different groups of coffee drinkers existed even after adjusting for SES and lifestyle factors. Therefore, it would be beneficial for future epidemiological studies to separate coffee consumers base on their habitual consumption coffee types. This can be done by collecting data regarding the types of coffee consumed by the participants and their habits of additive usage. Doing so will allow more meaningful associations between coffee consumptions and health outcomes to be identified.

List of abbreviations: SES, socioeconomic status; T2DM, type 2 diabetes mellitus; E&G, espresso and ground coffee; M&I, mixed and instant coffee.

Declarations

Ethics approval and consent to participate: ethics approval for the NNPAS was granted by the Australian Government Department of Health and Ageing Departmental Ethics Committee in 2011. Ethics approval was not required for the current secondary data analysis. *Consent for publication:* not applicable. *Availability of data and materials:* the datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. *Competing interests:* this research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors declare that there are no competing interests.
Authors' contributions: T.H.T.W, Z.S. and J.C.Y.L were responsible for data analysis, and together with A.R. interpreted the data and wrote the manuscript. J.C.Y.L has the primary responsibility for the final content of this manuscript. The Australian Bureau of Statistics is not responsible for the current secondary analysis.
Acknowledgments: The authors thank the Australian Bureau of Statistics for permission to use the 2011-12 NNPAS data.

References

1. Ding M, Bhupathiraju SN, Chen M, van Dam RM, Hu FB (2014) Caffeinated and Decaffeinated Coffee Consumption and Risk of Type 2 Diabetes: A Systematic Review and a Dose-Response Meta-analysis. Diabetes Care 37 (2):569-586. doi:10.2337/dc13-1203
2. Jiang X, Zhang D, Jiang W (2014) Coffee and caffeine intake and incidence of type 2 diabetes mellitus: a meta-analysis of prospective studies. Eur J Nutr 53 (1):25-38. doi:10.1007/s00394-013-0603-x
3. Ding M, Bhupathiraju SN, Satija A, van Dam RM, Hu FB (2014) Long-Term Coffee Consumption and Risk of Cardiovascular Disease: A Systematic Review and a Dose–Response Meta-Analysis of Prospective Cohort Studies. Circulation 129 (6):643-659. doi:10.1161/circulationaha.113.005925
4. Crippa A, Discacciati A, Larsson SC, Wolk A, Orsini N (2014) Coffee consumption and mortality from all causes, cardiovascular disease, and cancer: a dose-response meta-analysis. American Journal of Epidemiology:763-775
5. Mesas AE, Leon-Muñoz LM, Rodriguez-Artalejo F, Lopez-Garcia E (2011) The effect of coffee on blood pressure and cardiovascular disease in hypertensive individuals: a systematic review and meta-analysis. Am J Clin Nutr 94 (4):1113-1126. doi:10.3945/ajcn.111.016667
6. Grioni S, Agnoli C, Sieri S, Pala V, Ricceri F, Masala G, Saieva C, Panico S, Mattiello A, Chiodini P (2015) Espresso coffee consumption and risk of coronary heart disease in a large Italian cohort. PloS one 10 (5):e0126550
7. Agriculture and Agri-Food Canada (2013) Coffee in the United States: Sustainability Trends. Canada
8. Pampel FC, Krueger PM, Denney JT (2010) Socioeconomic disparities in health behaviors. Annual Review of Sociology 36:349
9. Galobardes B, Morabia A, Bernstein MS (2001) Diet and socioeconomic position: does the use of different indicators matter? International Journal of Epidemiology 30 (2):334-340
10. Drewnowski A, Rehm CD (2014) Consumption of low-calorie sweeteners among US adults is associated with higher healthy eating index (HEI 2005) scores and more physical activity. Nutrients 6 (10):4389-4403
11. Gyntelberg F, Hein HO, Suadicani P, for the COPENHAGEN MALE STUDY (2009) Sugar in coffee or tea and risk of obesity: A neglected issue. Int J Food Sci Nutr 60 (sup3):56-64
12. Bouchard DR, Ross R, Janssen I (2010) Coffee, tea and their additives: association with BMI and waist circumference. Obesity Facts 3 (6):345-352

13. Rayner M, Scarborough P (2005) The burden of food related ill health in the UK. Journal of Epidemiology and Community Health 59 (12):1054-1057. doi:10.1136/jech.2005.036491

14. Food standards Australia New Zealand (2014) AUSNUT 2013 - Australian Food Composition Tables. FSANZ, Canberra

15. Harttig U, Haubrock J, Knüppel S, Boeing H (2011) The MSM program: web-based statistics package for estimating usual dietary intake using the Multiple Source Method. Eur J Clin Nutr 65:S87-S91

16. Australian Bureau of Statistics (2011) Australian Standard Geographical Classification (ASGC), cat. no. 1216.0. Australian Bureau of Statistics, Canberra

17. Australian Bureau of Statistics (2011) Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), cat. no. 2033.0.55.001. Australian Bureau of Statistics, Canberra

18. Australian Bureau of Statistics (2013) Australian Health Survey: Users' Guide, 2011-13, cat. no. 4363.0.55.001. Australian Bureau of Statistics,,, Canberra

19. Rennie KL, Coward A, Jebb SA (2007) Estimating under-reporting of energy intake in dietary surveys using an individualised method. Br J Nutr 97 (06):1169-1176

20. National Health and Medical Research Council (2013) Australian Dietary Guidelines. National Health and Medical Research Council, Canberra

21. Thompson FE, Kirkpatrick SI, Subar AF, Reedy J, Schap TE, Wilson MM, Krebs-Smith SM (2015) The National Cancer Institute's Dietary Assessment Primer: A Resource for Diet Research. Journal of the Academy of Nutrition and Dietetics 115 (12):1986-1995. doi:https://doi.org/10.1016/j.jand.2015.08.016

22. Kim H-J, Cho S, Jacobs DR, Park K (2014) Instant coffee consumption may be associated with higher risk of metabolic syndrome in Korean adults. Diabetes Research and Clinical Practice 106 (1):145-153

23. Smith GD, Bartley M, Blane D (1990) The Black report on socioeconomic inequalities in health 10 years on. BMJ : British Medical Journal 301 (6748):373-377

24. Van Dam RM, Feskens EJ (2002) Coffee consumption and risk of type 2 diabetes mellitus. The Lancet 360 (9344):1477-1478

25. An R (2016) Beverage consumption in relation to discretionary food intake and diet quality among us adults, 2003 to 2012. Journal of the Academy of Nutrition and Dietetics 116 (1):28-37

26. Heuer T, Krems C, Moon K, Brombach C, Hoffmann I (2015) Food consumption of adults in Germany: results of the German National Nutrition Survey II based on diet history interviews. Br J Nutr 113 (10):1603-1614

27. Kant AK, Schatzkin A, Graubard BI, Schairer C (2000) A prospective study of diet quality and mortality in women. JAMA 283 (16):2109-2115. doi:10.1001/jama.283.16.2109

28. O'Connor L, Imamura F, Lentjes MA, Khaw K-T, Wareham NJ, Forouhi NG (2015) Prospective associations and population impact of sweet beverage intake and type 2 diabetes, and effects of substitutions with alternative beverages. Diabetologia 58 (7):1474-1483

29. Drewnowski A (2004) Obesity and the food environment: dietary energy density and diet costs. American journal of preventive medicine 27 (3):154-162

Table 1 - demographics of participants classified according to types of coffee consumed[a]

	Espresso and ground coffee (*n* = 1436)	Mixed and instant coffee (*n* = 1749)	Non-habitual coffee consumers (*n* = 3047)	*P*
BMI[b], kg/m^2	26.4±0.2	27.4±0.1	26.6±0.1	<0.001
Age, years	44.5±0.5	51.6±0.5	43.3±0.5	<0.001
Energy intake, kJ	9972.2±103.7	9450.6±91.4	9587.1±77.9	0.001
Caffeine intake, mg	278.8±8.1	196.1±4.0	97.3±2.5	<0.001
Male, %	53.1	54.1	51.2	0.307
Born in English-speaking countries, %	81.2	84.0	78.7	0.007
Attained bachelor or above, %	40.0	17.4	25.7	<0.001
Physical activity level of the previous week[c], %				<0.001
Sedentary	12.9	26.6	19.7	
Low	30.8	34.9	36.3	
Moderate	32.5	29.7	27.1	
High	23.8	8.8	16.9	
Current smoker, %	14.0	23.3	14.5	<0.001
Lived in urban area, %	94.2	87.8	91.1	<0.001
Employed, %	77.4	63.3	68.2	<0.001
SEIFA, %				<0.001
Lowest quintile	9.0	20.0	19.3	
Second quintile	14.7	23.2	20.0	
Third quintile	21.1	24.3	19.4	
Fourth quintile	23.1	15.4	18.3	
Highest quintile	32.1	17.2	22.9	
History of or ongoing T2DM, %	3.3	6.3	5.7	<0.001
History of or ongoing cardiovascular diseases, %	15.4	28.2	18.4	<0.001
History of or ongoing high cholesterol, %	12.7	17.4	11.7	<0.001
Was on diet at the time of survey, %	14.4	9.4	12.1	<0.001

[a] Values are means ± SEM or percentage. Differences in continuous variables across consumption groups were tested using general linear model, while differences in categorical variables were tested using chi-square test. Statistical significance was set at $p < 0.05$. SEIFA, Socio-Economic Indices of Disadvantage for Areas.

[b] n = 1431, 1738, 3036 due to missing values.

[c] n = 1412, 1730, 3015 due to missing values.

Table 2 – demographics of participants classified according to additive usages[a]

	No additive (*n* = 413)	Milk only (*n* = 867)	Sugar-sweetened (*n* = 1723)	Intense-sweetened (*n* = 182)	*P*
BMI[b], kg/m^{2}	26.9±0.3	26.7±0.2	26.8±0.1	28.8±0.4	<0.001
Age, years	50.9±1.1	48.8±0.7	46.8±0.5	55.5±1.7	<0.001
Energy intake, kJ	9483.0±195.3	9773.2±136.5	9772.5±92.2	8907.1±246.9	0.007
Caffeine intake, mg	288.7±12.9	240.6±7.2	217.9±6.3	220.2±12.1	<0.001
Male, %	56.8	44.8	57.9	48.8	<0.001
Born in English-speaking countries, %	78.0	85.6	81.6	91.1	0.008
Attained bachelor or above, %	32.3	38.7	21.1	24.4	<0.001
Current smoker, %	12.0	9.9	25.4	20.2	<0.001
Lived in urban area, %	91.6	91.7	89.6	93.5	0.262
Employed, %	69.9	70.6	70.6	54.7	0.004
Physical activity level of the previous week[c], %					<0.001
Sedentary	16.1	13.6	24.0	30.0	
Low	33.6	31.4	33.6	34.0	
Medium	32.6	32.3	30.5	25.0	
High	17.8	22.7	11.9	11.0	
SEIFA, %					<0.001
Lowest quintile	12.5	10.4	17.9	15.6	
Second quintile	15.5	15.1	22.3	20.7	
Third quintile	22.4	20.3	24.4	21.1	
Fourth quintile	21.7	21.9	16.3	21.4	
Highest quintile	28.0	32.2	19.0	21.2	
History of or ongoing T2DM, %	6.8	5.1	2.9	19.1	<0.001
History of or ongoing cardiovascular diseases, %	26.6	20.0	21.0	38.5	<0.001
History of or ongoing high cholesterol, %	15.0	15.2	15.1	17.6	0.852
Was on diet at the time of survey, %	10.2	15.9	8.2	26.9	<0.001

[a] Values are means ± SEM or percentage. Differences in continuous variables across consumption groups were tested using general linear model, while differences in categorical variables were tested using chi-square test. Statistical significance was set at $p < 0.05$. SEIFA, Socio-Economic Indices of Disadvantage for Areas.

[b] n = 410, 862, 1715, 182 due to missing values.

[c] n = 411, 853, 1698, 180 due to missing values.

Table 3 – Food groups intake of habitual coffee consumers classified according to types of coffee consumed[a]

	Espresso and ground coffee	**Mixed and instant coffee**	**Non-habitual coffee consumers**	***P***
Grain, g				
Age- and sex-adjusted	245.3±7.3	237.2±6.3	258.5±5.9	0.048
Multivariate-adjusted	233.0±6.4	247.3±5.9	257.7±5.4	0.017
Meat and alternatives, g				
Age- and sex-adjusted	195.1±5.7[a]	172.2±4.4[b]	177.7±3.6[a, b]	0.005
Multivariate-adjusted	191.1±5.5	175.5±4.5	178.5±3.4	0.080
Dairy products, g				
Age- and sex-adjusted	363.2±9.3[a]	287.3±8.6[b]	263.9±7.1[b]	<0.001
Multivariate-adjusted	355.0±9.6[a]	290.4±8.6[b]	266.7±7.0[b]	<0.001
Vegetables, g				
Age- and sex-adjusted	252.3±7.0	231.8±6.5	240.5±5.5	0.100
Multivariate-adjusted	243.4±7.0	238.9±6.7	239.8±5.3	0.893
Fruits, g				
Age- and sex-adjusted	235.3±8.2[a]	175.3±6.8[b]	218.4±6.7[a]	<0.001
Multivariate-adjusted	224.8±8.4	187.8±6.9	215.6±6.4	0.001
Discretionary food/beverage, g				
Age- and sex-adjusted	686.9±24.5[a]	847.6±23.7[b]	773.6±19.9[a, b]	<0.001
Multivariate-adjusted	696.3±22.8	792.5±21.4	794.4±18.2	0.001
Alcoholic drinks, g				
Age- and sex-adjusted	311.5±20.6[a, b]	346.1±20.1[a]	263.1±15.1[b]	0.003
Multivariate-adjusted	303.8±20.1	313.3±19.3	280.2±15.0	0.367

[a] Values are mean ± SEM. Differences in food groups intakes across consumption groups were tested using general linear model. Values in the same row without a common superscript letter are significantly different, $p < 0.001$; rows with no letters have no significant difference between values. The following variables were included as covariates in the multivariate-adjusted model: age (continuous), BMI (continuous), employment status (employed/unemployed), sex (binary), urbanity (urban/rural), country of birth (English-speaking country/non-English speaking country), bachelor attainment (Yes/No), smoker status (Yes/No), energy intake (continuous), SEIFA (quintiles), physical activity level (sedentary, low, medium, and high), history or ongoing type 2 diabetes (Yes/No), history or ongoing cardiovascular diseases (Yes/No), history or ongoing high cholesterol (Yes/No), and whether or not was the participant on diet at the time of survey (Yes/No). For age- and sex-adjusted values, n = 1436, 1749, 3047 respectively; for multivariate-adjusted values, n = 1409, 1717, 3003 respectively.

Table 4 – Food groups intake of habitual coffee consumers classified according to additives used[a]

	No additive	Milk only	Sugar-sweetened	Intense-sweetened	*P*
Grain, g					
Age- and sex-adjusted	255.1±14.5[a, b]	255.5±9.8[a]	229.6±5.9[a, b]	203.4±11.5[b]	0.001
Multivariate-adjusted	248.9±12.9	241.9±8.0	234.5±5.5	222.4±11.1	0.371
Meat and alternatives, g					
Age- and sex-adjusted	198.1±10.9	195.1±6.5	172.4±4.6	172.9±11.7	0.012
Multivariate-adjusted	196.6±10.1	190.6±6.3	175.9±4.7	176.8±11.0	0.134
Dairy products, g					
Age- and sex-adjusted	194.5±15.3[a]	390.4±11.5[b]	310.2±8.4[c]	374.7±24.9[b, c]	<0.001
Multivariate-adjusted	198.6±14.8[a]	378.2±12.0[b]	316.1±8.4[c]	379.5±25.2[b, c]	<0.001
Dairy products from non-coffee drinks, g					
Age- and sex-adjusted	162.4±14.7	208.6±9.1	191.7±7.0	226.3±20.5	0.017
Multivariate-adjusted	166.6±14.2	198.5±9.1	194.5±6.9	233.3±20.1	0.044
Vegetables, g					
Age- and sex-adjusted	254.7±13.6[a, b]	262.1±9.5[a]	232.8±6.3[b]	224.5±18.9[a, b]	0.039
Multivariate-adjusted	255.9±13.6	254.6±9.4	236.4±6.2	233.4±19.4	0.296
Fruits, g					
Age- and sex-adjusted	252.3±17.8[a]	232.0±10.4[a]	179.3±6.5[b]	209.5±20.0[a, b]	<0.001
Multivariate-adjusted	245.2±17.8	223.7±10.9	187.0±6.6	217.9±20.5	0.003
Discretionary food/beverage, g					
Age- and sex-adjusted	810.4±54.0[a, b]	648.7±29.1[a]	803.5±23.2[b]	707.4±52.1[a, b]	0.004

Multivariate-adjusted	864.7±50.5[a]	686.6±25.5[b]	776.2±21.3[a, b]	702.5±50.6[a, b]	0.002
Alcoholic drinks, g					
Age- and sex-adjusted	436.5±52.7[a]	306.6±24.7[a, b]	334.3±18.5[a]	233.0±33.8[b]	0.004
Multivariate-adjusted	464.2±50.7[a]	302.2±22.5[a, b]	321.1±18.3[a, b]	247.0±36.1[b]	0.002

[a] Values are mean ± SEM. Differences in food groups intakes across consumption groups were tested using general linear model. Values in the same row without a common superscript letter are significantly different, $p < 0.001$; rows with no letters have no significant difference between values. The following variables were included as covariates in the multivariate-adjusted model: age (continuous), BMI (continuous), employment status (employed/unemployed), sex (binary), urbanity (urban/rural), country of birth (English-speaking country/non-English speaking country), bachelor attainment (Yes/No), smoker status (Yes/No), energy intake (continuous), SEIFA (quintiles), physical activity level (sedentary, low, medium, and high), history or ongoing type 2 diabetes (Yes/No), history or ongoing cardiovascular diseases (Yes/No), history or ongoing high cholesterol (Yes/No), and whether or not was the participant on diet at the time of survey (Yes/No). For age and sex-adjusted values, n = 413, 867, 1723, 182 respectively; for multivariate-adjusted values, n = 408, 848, 1690, 180 respectively.

Supplementary table 1 – food groups intake of habitual coffee consumers classified according to types of coffee consumed, including all adult participants in the dataset[a]

	Espresso and ground coffee		Mixed coffee and instant coffee		Non-habitual coffee consumers		
	Mean	SEM	Mean	SEM	Mean	SEM	*P*
Grain, g							
Age- and sex-adjusted	223.3	5.9	216.9	4.9	230.8	4.4	0.110
Multivariate-adjusted	216.6	5.6	225.9	5.0	237.9	4.5	0.012
Meat and alternatives, g							
Age- and sex-adjusted	176.4	4.7	161.1	3.9	163.6	2.9	0.270
Multivariate-adjusted	173.4	4.6	166.7	4.1	168.9	3.0	0.567
Dairy products, g							
Age- and sex-adjusted	343.2[a]	8.4	263.2[b]	6.7	240.2[b]	5.5	<0.001
Multivariate-adjusted	333.6[a]	8.4	271.3[b]	7.2	243.2[b]	5.8	<0.001
Vegetables, g							
Age- and sex-adjusted	237.9	6.0	217.5	5.3	222.8	4.3	0.034
Multivariate-adjusted	230.8	6.4	227.0	5.8	225.3	4.6	0.790
Fruits, g							
Age- and sex-adjusted	215.2[a]	6.6	169.2[b]	5.5	201.4[a]	5.1	<0.001
Multivariate-adjusted	207.5	7.2	181.3	6.1	202.2	5.3	0.009
Discretionary food/beverage, g							
Age- and sex-adjusted	617.6[a]	19.7	757.1[b]	19.4	676.6[a]	14.9	<0.001
Multivariate-adjusted	635.5[a]	19.1	713.0[a, b]	18.3	726.8[b]	15.2	0.001
Alcoholic drinks, g							
Age- and sex-adjusted	266.9[a, b]	15.7	294.9[a]	15.9	211.3[b]	10.7	<0.001

Multivariate-adjusted	268.4	16.5	273.4	16.3	239.9	12.1	0.175

[a] Values are mean ± SEM. Differences in food groups intakes across consumption groups were tested using general linear model. Values in the same row without a common superscript letter are significantly different, $p < 0.001$; rows with no letters have no significant difference between values. The following variables were included as covariates in the multivariate-adjusted model: age (continuous), BMI (continuous), employment status (employed/unemployed), sex (binary), urbanity (urban/rural), country of birth (English-speaking country/non-English speaking country), bachelor attainment (Yes/No), smoker status (Yes/No), energy intake (continuous), SEIFA (quintiles), physical activity level (sedentary, low, medium, and high), history or ongoing type 2 diabetes (Yes/No), history or ongoing cardiovascular diseases (Yes/No), history or ongoing high cholesterol (Yes/No), and whether or not was the participant on diet at the time of survey (Yes/No). For age- and sex-adjusted values, n = 2068, 2549, 4724; for multivariate-adjusted values, n = 1783, 2177, 3935.

Supplementary table 2 – food groups intake of habitual coffee consumers classified according to additives used, including all adult participants in the dataset[a]

	No additive		milk only		sugar sweetened		intense sweetened		
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	*P*
Grain, g									
Age- and sex-adjusted	228.5[a, b]	10.9	232.1[a]	8.1	212.4[a, b]	4.8	188.9[b]	8.8	0.001
Multivariate-adjusted	234.9	10.5	223.2	6.9	218.8	4.9	205.8	10.1	0.218
Meat and alternatives, g									
Age- and sex-adjusted	186.8[a, b]	9.9	180.9[a]	5.8	157.1[b]	3.7	164.2[a, b]	12.0	0.001
Multivariate-adjusted	193.9	9.7	176.4	5.4	164.1	4.0	171.6	11.7	0.023
Dairy products, g									
Age- and sex-adjusted	172.2[a]	11.5	381.4[b]	10.8	284.2[c]	6.7	347.6[b, c]	19.6	<0.001
Multivariate-adjusted	180.1[a]	12.0	368.5[b]	10.6	295.1[c]	7.2	362.0[b, c]	21.0	<0.001
Dairy products from non-coffee drinks, g									
Age- and sex-adjusted	144.1[a]	10.8	196.9[b]	9.1	171.9[a, b]	5.5	209.3[b]	15.3	<0.001
Multivariate-adjusted	152.0[a]	11.3	186.6[a, b]	7.9	179.0[a, b]	5.9	218.0[b]	17.0	0.006
Vegetables, g									
Age- and sex-adjusted	238.3	11.5	245.7	7.8	219.3	5.3	208.8	14.1	0.015
Multivariate-adjusted	242.0	11.8	239.5	8.2	228.1	5.7	219.1	15.9	0.422
Fruits, g									
Age- and sex-adjusted	220.1[a]	13.2	216.5[a]	8.5	172.4[b]	5.4	192.0[a, b]	15.1	<0.001
Multivariate-adjusted	221.3	14.6	209.7	9.5	182.7	5.9	200.6	17.2	0.029
Discretionary food/beverage, g									
Age- and sex-adjusted	711.2[a, b]	40.5	612.4[a]	23.5	726.5[b]	19.3	639.3[a, b]	40.2	0.001

Multivariate-adjusted	794.0[a]	41.4	625.5[b]	22.0	705.4[a, b]	17.8	650.1[a, b]	43.0	<0.001
Alcoholic drinks, g									
Age- and sex-adjusted	352.2[a]	37.5	261.1[a, b]	19.1	294.8[a]	15.1	187.3[b]	24.6	<0.001
Multivariate-adjusted	397.3[a]	40.2	268.8[a, b]	19.1	285.5[a, b]	15.3	222.7[b]	30.4	0.002

a Values are mean ± SEM. Differences in food groups intakes across consumption groups were tested using general linear model. Values in the same row without a common superscript letter are significantly different, $p < 0.001$; rows with no letters have no significant difference between values. The following variables were included as covariates in the multivariate-adjusted model: age (continuous), BMI (continuous), employment status (employed/unemployed), sex (binary), urbanity (urban/rural), country of birth (English-speaking country/non-English speaking country), bachelor attainment (Yes/No), smoker status (Yes/No), energy intake (continuous), SEIFA (quintiles), physical activity level (sedentary, low, medium, and high), history or ongoing type 2 diabetes (Yes/No), history or ongoing cardiovascular diseases (Yes/No), history or ongoing high cholesterol (Yes/No), and whether or not was the participant on diet at the time of survey (Yes/No). For age- and sex-adjusted values, *n* = 638, 1215, 2490, 274 respectively; for multivariate-adjusted values, *n* = 556, 1045, 2121, 238 respectively.