

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

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1 **Discrepancy in socioeconomic status does not fully explain the variation in diet quality between consumers** 2 **of different coffee types**

3 **Abstract**

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

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

13 **Results:** E&G drinkers had better SES than M&I and NC. After adjusting for covariates, the mean dairy intake
14 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
15 discretionary food intake of E&G drinkers was 12.1% lower than M&I ($p = 0.003$) and 12.3% lower than NC (p
16 $= 0.001$). In terms of additive usage, non-users of coffee additive had the lowest dairy food intake and the
17 highest discretionary food intake.

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

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

23 **Introduction**

24 Habitual coffee consumption has been associated with lower risk of type 2 diabetes mellitus (T2DM) [1,2],
25 cardiovascular diseases (CVD) [3], and all-cause mortality [4] in epidemiological studies. However, these
26 positive effects were not consistently observed - some studies found no significant association, or even an
27 increased risk, between coffee consumption and health outcomes [5,6]. One reason behind these discrepancies
28 may be a lack of consideration of the subjects' coffee consumption habits in previous studies. Consumers'

29 choices in the type of coffee and the addition of sugar, intense sweetener and/or milk may reflect variations in
30 socioeconomic status (SES) and diet quality, thereby affecting their risk profile for the health outcomes of
31 interest.

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

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

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

53 **Methods**

54 *Data source*

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

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

61 Dietary data were collected using a computer-assisted, multiple-pass 24-hour recall from participants ($n = 12153$)
62 aged 2 years and over in a face-to-face interview. At least eight days later, a subset of participants ($n = 7753$)
63 was contacted for another dietary recall, which was conducted through telephone interviews. Food and beverage
64 intake were then translated into energy and nutrient intake using the Australian Food and Nutrient (AUSNUT)
65 2011-13 food composition database [14].

66 *Assessment of coffee intake*

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

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

86 *Covariates*

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

101 *Data cleaning*

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

108 *Food intake assessment*

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

113 *Statistical analysis*

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

124 **Result**

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

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

136 **Table 3** shows the adjusted food group intake of habitual coffee drinkers as classified by coffee types. E&G
137 drinkers reported significantly higher intake of dairy products than both M&I drinkers (355.0 g vs. 290.4 g, $p <$
138 0.001) and non-consumers (355.0 g vs. 266.7 g, $p < 0.001$). The fruit intake of E&G drinkers was also
139 marginally significantly higher than M&I drinkers (224.8 g vs. 187.8 g, $p = 0.001$). For discretionary food and
140 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-
141 consumers (696.3 g vs. 794.4 g, $p = 0.001$). On the other hand, the food groups intake of M&I drinkers was

142 mostly similar with non-consumers, except the fact that they reported a lower fruit intake than the non-
143 consumers, which the difference was marginally significant (187.8 g vs. 215.6 g, $p = 0.003$).

144 **Table 4** shows the food group intake of habitual coffee drinkers, classified according to additive usage after
145 adjusted for covariates. Coffee drinkers who reported not habitually using any additive had a significantly lower
146 dairy intake than the other coffee drinkers ($p < 0.001$), yet the difference was no longer statistically significant
147 after excluding the dairy intake from coffee ($p = 0.044$). Sugar users had the lowest fruit intake among coffee
148 drinkers and the differences reached marginal statistical significance when compared with non-additive users
149 (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
150 discretionary food and alcoholic beverages, non-additive users had the highest intake, although the differences
151 reached statistical significance only when compared with milk users and intense-sweetener users respectively.

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

157 **Discussion**

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

166 The distinct differences in several SES attributes and lifestyle factors, such as education levels, smoking status,
167 and employment status, between the two coffee type groups have received little attention in past epidemiological
168 studies, as coffee drinkers were often treated as a single group. The observation that M&I drinkers being more
169 socioeconomically disadvantaged when compared to both E&G and non-consumers, was similar to a recent
170 study conducted in Korea [22], which compared instant coffee drinkers with filtered coffee drinkers (who

171 belonged to E&G group according to the definition in the present study). In fact, the distinct variation in these
172 attributes of SES between different groups of coffee drinkers did not come as a surprise, as espresso coffee is
173 several times more expensive than instant coffee in Australia (AU\$ 3.5-5.0/cup of espresso-type coffee *vs.*
174 AU\$ 2.5-8.0/100 g instant coffee powder). As a result, coffee drinkers habitually drinking different types of
175 coffee may have distinctly different SES. Since higher SES has been shown to be associated with better health
176 conditions and vice versa [23], the marked variations in SES between different groups of coffee drinkers may
177 well affect the results of analyses concerning health outcomes of coffee consumption.

178 The diet quality of people who habitually consumed different types of coffee also varied markedly. When
179 compared with both M&I drinkers and non-consumers, E&G drinkers consumed higher quantities of core food,
180 which is necessary for a healthy diet [20]. This finding is partly in line with a previous study conducted on an
181 Italian cohort, which found that people in the highest consumption category of espresso coffee ate more fruit and
182 vegetables than those in the lowest category [6]. Our analysis also found that the dairy intake of E&G drinkers
183 was significantly higher than both non-consumers and M&I drinkers. This is probably due to the popularity of
184 espresso-type coffees, such as latte and flat white in Australia, which include at least 60% of milk by volume
185 [14].

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

194 Regarding the use of additives in coffee, intense sweetener users had a higher BMI than the rest of the group, a
195 finding that was also observed in previous studies [12,28]. It should be noted that the cross-sectional nature of
196 the current study means that the causality of this finding could not be determined. Indeed, the use of intense
197 sweetener had been regarded as a strategy by overweight individuals to control their weight [12], thus explaining
198 the higher BMI of intense sweetener users. This may also explain the lowest energy intake of intense sweetener
199 users among all coffee drinkers. On the other hand, sugar users in the current cohort were more likely to have

200 unhealthy lifestyle habits, such as smoking and have a lower physical activity level. They were also less likely to
201 have a high education level when compared with other user groups. These findings were in line with previous
202 observations [9,29]. This significant difference in SES and lifestyle factors between users of different additives,
203 if left unadjusted, may weaken the association identified in epidemiological studies, or even lead to erroneous
204 conclusions.

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

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

224 To conclude, the current analysis showed the differences in diet quality between different groups of coffee
225 drinkers existed even after adjusting for SES and lifestyle factors. Therefore, it would be beneficial for future
226 epidemiological studies to separate coffee consumers base on their habitual consumption coffee types. This can
227 be done by collecting data regarding the types of coffee consumed by the participants and their habits of additive

228 usage. Doing so will allow more meaningful associations between coffee consumptions and health outcomes to
229 be identified.

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

232 **Declarations**

233 *Ethics approval and consent to participate:* ethics approval for the NNPAS was granted by the Australian
234 Government Department of Health and Ageing Departmental Ethics Committee in 2011. Ethics approval was not
235 required for the current secondary data analysis. *Consent for publication:* not applicable. *Availability of data and*
236 *materials:* the datasets used and/or analyzed during the current study are available from the corresponding author
237 on reasonable request. *Competing interests:* this research received no specific grant from any funding agency in
238 the public, commercial or not-for-profit sectors. The authors declare that there are no competing interests.

239 *Authors' contributions:* T.H.T.W, Z.S. and J.C.Y.L were responsible for data analysis, and together with A.R.
240 interpreted the data and wrote the manuscript. J.C.Y.L has the primary responsibility for the final content of this
241 manuscript. The Australian Bureau of Statistics is not responsible for the current secondary analysis.

242 *Acknowledgments:* The authors thank the Australian Bureau of Statistics for permission to use the 2011-12
243 NNPAS data.

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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 \pm 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 \pm 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	<i>P</i>
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 \pm 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		<i>P</i>
	Mean	SEM	Mean	SEM	Mean	SEM	
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
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^a Values are mean \pm 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		<i>P</i>
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	
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 \pm 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.