American Journal of Food Science and Nutrition Research
2017; 4(3): 104-111
http://www.openscienceonline.com/journal/fsnr
ISSN: 2381-621X (Print); ISSN: 2381-6228 (Online)

Open Science

Caffeine Daily Intake in a Population of Adults in Argentina

Susana Carnevali*, María Claudia Degrossi

Department of General and Food Microbiology and Parasitology, Healthcare Sciences University Institute, HA Barceló Foundation, Buenos Aires, Argentina

Email address

ascarnevali@gmail.com (S. Carnevali), mcdegrossi@gmail.com (M. C. Degrossi)

*Corresponding author

To cite this article

Susana Carnevali, María Claudia Degrossi. Caffeine Daily Intake in a Population of Adults in Argentina. *American Journal of Food Science and Nutrition Research.* Vol. 4, No. 3, 2017, pp. 104-111.

Received: March 14, 2017; **Accepted**: March 28, 2017; **Published**: June 15, 2017

Abstract

Caffeine is a methylxanthine (1,3,7–trimethyl-3,7-dihydro-1H-purine-2, 6-dione) which is found in several widely consumed food sources. Although moderate consumption has been shown not to imply health risks, excess intake may lead to adverse effects, including gastrointestinal disturbances, anxiety, irritability, palpitations and insomnia. The aim of this study was to determine the caffeine content in 5 beverages available in the Argentine market and with these data and others from bibliographic sources determine the daily intake of caffeine through dietary sources, in an adult population, ages 18 to 80, in Argentina, in the period August 2015 to April 2016. The participants filled up a questionnaire of indirect management through the Web. The caffeine determination was performed by high performance liquid chromatography (HPLC). Higher caffeine contents were found in espresso coffee (1.3 mg/mL) and mate cebado (0.95 mg/mL). 2690 participants who met the inclusion criterion had an average caffeine intake of 345.8 mg / day. The major contributors to total caffeine intake were mate cebado (52.5%) and coffee (30.2%), followed by cola beverages (7.6%) and tea (5%). The contribution of other drinks was very low. 31.7% of the participants exceed the recommended daily intake (400 mg/day) for healthy adults, with an average intake of 642.0 mg/day. 37.7% and 26.6% of women in childbearing age, between 18 to 40 years old, exceed the recommended caffeine daily intake of 200 mg and 300 mg respectively. At the 90th percentile, these groups consumed 775.2 mg/day and 850.9 mg/day of caffeine. Mate cebado and coffee, two very popular beverages in Argentina were the highest contributors to the caffeine daily intake. They might be the reasons for the elevated average daily intakes observed, especially in risk groups. The results obtained contribute with new data for caffeine intake from different dietary sources, in order to characterize the risk derived from its consumption.

Keywords

Argentina, Caffeine, Daily Intake, Adults, Health Risk, Mate

1. Introduction

Caffeine, a natural component of many foods and one of the most widely consumed food ingredients worldwide, is a methylxanthine (1,3,7–trimethyl-3,7-dihydro-1H-purine-2, 6-dione) which is found naturally in leaves, fruits and seeds of several plants, such as *Coffea arabica*, *Coffea robusta*, *Camellia sinensis*, *Theobroma cacao*, *Cola acuminate, Paullinia cupana* and *Ilex paraguayensis*, being the seeds of the first, its major source. Together with the other xanthines, theophylline and theobromine, they are present in plants of wide geographical distribution and are probably the most used psychostimulant substances [1], [2]-[3].

The largest source of caffeine comes from the consumption of beverages, like coffee, tea, mate, energy drinks, carbonated drinks, chocolate milk. The addition of caffeine in some beverages is due to its flavoring effect, imparting a slight bitter taste that modifies the flavors of other components, contributing to the sensory appeal of these beverages. The amount of caffeine contained in different food products varies depending on the portion, type of product, and method of preparation. In tea, mate and coffee, the plant variety, environmental growing conditions, the processing process or

the brewing method used, also affect the caffeine content [1], [4]-[5]. In Argentina, Uruguay, Paraguay and South of Brazil one of the most popular infusions is the "mate" that can be consumed hot or cold (tereré), prepared from the dried leaves of a native plant *Ilex paraguariensis* Saint Hilaire (yerba mate). "Mate cebado" is the typical way to consume yerba mate. This beverage is prepared in a small cup or "mate" which is used to fill it with mate leaves and hot water (80°C) in order to prepare the infusion. It is then drunk by using a metal straw or "bombilla". Water is poured over the yerba mate and this process is repeated several times. This peculiar method of brewing allows for a continuous extraction of the compounds present in the dried leaves. Another type of infusion using yerba mate is "mate cocido" (mate tea), which can be prepared with dried leaves or in the form of tea bags. The preparation is similar to that commonly practiced with black teas or other infusions. The bags or leaves are placed in a cup or teapot and boiled water is poured, then it is left to rest for five minutes.

Although mate is widely consumed in South America, its consumption has increased in other countries where it is exported due to its nutritional and functional properties attributed to the presence of bioactive compounds such as polyphenols, xanthines, purine alkaloids, amino acids, flavonoids, minerals and vitamins, some of which are associated with many relevant properties, such as antiallergic, diuretic, hypocholesterolemic, vasorelaxation and antioxidant activity [6], [7], [8]-[9].

In addition to these beverages, other foods products, such as chocolate and cacao containing foods like snacks contribute with small amounts of caffeine to the diet [1], [2]-[5].

Regarding its effects on human health, caffeine, a psychoactive substance acting as a central nervous system stimulant, has been the subject of numerous investigations and is one of the most widely studied substance in the food supply. At moderate doses, in the healthy adult population, a daily caffeine intake of ≤400 mg has not been demonstrated (according to risk assessments) to cause adverse effects on cardiovascular systems, and does not increase the risk of cancer or osteoporosis. Due to its stimulating effects at all levels of the Central Nervous System, it facilitates intellectual work, concentration capacity, attention and wakefulness, reduces the sensation of fatigue, produces a sensation of well-being and improves psychomotor coordination. It also has effects on the cardiovascular system, increases gastric acid secretion, increases diuresis, increases muscle performance during sport and stimulates glycogenolysis and lipolysis. Moreover, regular consumption of caffeine, according to epidemiological data, suggest it can aid in reducing the symptoms associated with Parkinson's disease, has a favorable effect on liver function, increases metabolic rate, and decreases the risk of developing certain cancers (endometrial, prostatic, colorectal, liver) [1], [3], [4], [10], [11]-[12].

High exposure to caffeine is associated with an increase in adverse effects such as nausea, dizziness, dyspnea, anxiety, irritability, palpitations, insomnia, tremors and depression. Other effects, which vary according to individual susceptibility, are: sleep disorders, behavioral disorders and sometimes arrhythmias and seizures. Abruptly discontinuing consumption of caffeine can lead, to withdrawal symptoms such as headache, lethargy and irritability. The amount of caffeine required to produce adverse effects varies from person to person depending on weight, sex, age, and individual susceptibility [1], [4]-[11].

Several government agencies in different countries have established recommended values for daily caffeine intake based on toxicological studies conducted in risk assessments in different population groups. According to Canadian recommendations [13] and other government agencies [14]-[15], daily caffeine intake should not exceed 400 mg in the adult population, except pregnant women. Other agencies [14]-[16] have adopted more conservative values (210 mg/day), value below which no effects related to anxiety are observed. During pregnancy, for its potential adverse effects on it and on the fetus [17], [18], [19], [20], [21]-[22], there are discrepancies in the adopted values, from less than 200 mg/day [23]-[24] to less than 300 mg/day [13].

The determination of the daily intake of caffeine, in different population groups and age groups, has been of interest and the object of many investigations [14], [16], [25], [26], [27], [28], [29], [30]-[31]. Latin American countries, due to consumption of yerba mate and coffee may show other patterns of caffeine consumption [1]. Through a review of the literature in the last decade, were found ten investigations made in Brazil, Ecuador and Argentina on the consumption of caffeine through different beverages in different population groups: athletes, children, adolescents, young adults and adults [32], [33], [34], [35], [36], [37], [38], [39], [40]-[41].

Therefore the aim of this study was to determine the caffeine content in five beverages available in the Argentinean market and with these data and others arisen from bibliographic sources determine the daily intake of caffeine through dietary sources, in an adult population in Argentina in order to update and expand existing data on exposure to this substance and set a key precedent for the characterization of risk to the health of this population.

2. Materials and Methods

2.1. Study Population and Survey Description

The data collection to estimate the daily caffeine intake in the sample population was conducted in the period from August 2015 to April 2016, through a questionnaire previously validated and approved by the Ethics Committee of the Institution, based on similar questionnaires obtained by literature reviewed [26].

A non-probabilistic sample was chosen for convenience. The inclusion criteria were: adults, ages 18 to 80, of both genders, who, regardless of nationality or educational level voluntarily answered the questionnaire administered on the Web. Participants who did not fit these criteria were excluded.

The instrument was answered voluntarily and anonymously by a population of adults of 18-80 years of age, regardless of

nationality or type of study, residing in Argentina.

The questionnaire, personal type and indirect administration via the Web through the application of Google Drive, was composed of questions that asked the socio-demographic characteristics (age, gender, nationality, educational level, occupation, residence place and weight), and the amount and frequency of consumption of beverages and food products containing caffeine. Caffeinated beverages were grouped into seven categories: coffee (e.g., brewed, instant), tea, cola beverages, chocolate drinks, energy drinks, mate cocido and mate cebado. The food products were chocolate and snacks.

Email and social networks were used to send 3000 invitations to participants. To access the questionnaire, participants had to accept an informed consent. A total of 2974 responses were obtained, with a response rate of 89%, excluding the outliers (those that did not meet the inclusion criteria and with unfinished or inconsistent completion). The sample consisted of 2690 participants.

2.2. Caffeine Content of Beverages and Food Products

With the data collected from the survey, a list of the most consumed drinks among the participants was drawn up. Espressos, instant coffee, tea, mate cebado and mate cocido were analyzed in order to obtain the concentration of caffeine that reflects the content of these products in the Argentine market.

Espresso coffee samples were analyzed: from different capsules used in the Espresso-machine with different caffeine content and, a sample of espresso coffee was purchase at the bar.

For instant coffee, tea, mate cocido and mate cebado were selected three commercial brands available in the market. In the case of mate, a simulation of the ingested portions by the consumers was carried out; finally taking the average concentration that arises from the collection of 500 mL, corresponding to 10 large mates containing 50 g of leaves, to compare the results with previous investigations which use these amounts [42], [43]-[44]. The caffeine determination was performed by high performance liquid chromatography (HPLC) using a caffeine standard from Sigma Aldrich to perform the calibration curve. Each sample was processed in duplicate.

For cola beverages, cappuccino, chocolate and snacks the caffeine content was taken from a literature review [26]-[34]. For energy drinks information was obtained from product labels. A default value of 0.3 mg/mL was used in cases where no brand was specified [26]. Table 1 presents the caffeine content of different sources.

2.3. Caffeine Consumption Study

Average daily intake of caffeine, is the daily dose of caffeine that the participants ingest through exposure to different beverages and food products. It was calculated multiplying the daily ingested volume or weight of each beverage and food product, informed by participant in the questionnaire, by its mean caffeine content (Table 1). Finally, the total average daily intake was obtained by adding all the caffeine sources, and expressed as milligrams per day (mg/day) and as milligrams per kilogram of body weight per day (mg/kg/day) using the body weight recorded by the participant in the survey. In Addition to that, the proportion of the population consuming caffeinated beverages and the contribution of each beverage/food product to the total caffeine daily intake were estimated.

Table 1. *Caffeine values used in this study by beverage and food category.*

Beverage/food category	Caffeinne content (mg/mL or mg/100g)		Data sources
	mean (SD)	Range	
Coffee			
Espresso	1.3 (0.24)	1.11-1.65	Analysis by HPLC
Instant	0.54 (0.16)	0.44-0.75	Analysis by HPLC
Brewed	0.39 (0.07)	0.26-0.53	Olmos et al
Cappuccino	0.25	----	Zucconi et al
Teas	0.13 (0.03)	0.09-0-15	Analysis by HPLC
Chocolate drinks	0.04 (0.002)	0.037-0.042	Olmos et al
Cola beverages	0.11 (0.01)	0.09-0.12	Olmos et al
Energy drinks	----	0.08-0.32	Product label
Mate cebado	0.95 (0.13)	0.81-1.05	Analysis by HPLC
Mate cocido	0.18 (0.02)	0.17-0.2	Analysis by HPLC
Chocolate	18	----	Zucconi et al
Snacks	14	----	Zucconi et al

2.4. Statistical Analysis

All data collected were examined with Excel for Windows and analyzed statistically using the Info-stat® statistical software for Windows (free version, Córdoba, Argentina).

Descriptive statistics included means, standard deviations, frequencies and percentages. Pearson's chi-square test was used to evaluate differences in frequencies or proportions between genders, age group, considering a reliability interval of 95%.

For average caffeine intake, the mean and 90th percentile was used as summary measures in order to compare with other risk assessments. The Kolmogorov-Smirnov test was used to verify the distribution of a set of data for the purpose of applying the appropriate statistical tests. Given the asymmetric distribution of the variable, the Mann-Whitney

test, was used to compare differences in mean caffeine intakes between gender and age group, and the non-parametric variance analysis (Kruskal-Wallis test) to compare the mean intakes of different beverages and food product among age groups, both with a 95% confidence level.

3. Results and Discussion

3.1. Sample Characteristics

2690 people (1947 women and 743 men), who met the inclusion criteria, responded the questionnaire. 2639 (98.1%) participants were from Argentine nationality, 1345 (50.2%) lived in the hinterland and 1332 (49.8%) in the Greater Buenos Aires (GBA), comprising the City of Buenos Aires and the districts of Greater Buenos Aires, constituting the largest urban area in the country. 13 participants didn't respond to the residence place question. The largest age group was between 21 to 30 years of age with 1178 (43.8%) participants, followed by the 31-40 age group with 719 (26.7%) participants. Asked about their Educational attainment, 46.7% completed high school and 50.0% college, university or graduate studies (including postgraduate degrees). As occupations, 49.3% of participants reported being employed, 25.5% were students, 2.0% study and work and 18.6% reported another occupation, among others, teachers, merchants, lawyers, doctors, dentists, nutritionists, psychologist and kinesiologists. 4.6% didn't respond to the occupation question.

3.2. Caffeine Content of Beverages and Food Products

The results of the analytical determination of caffeine in this study showed that the highest values were found in espresso coffee and mate cebado (Table 1). For coffee and teas the values found were within the range reported by [34] in Argentina from 460 to 1590 mg/L and 80 to 170 mg/L, who analyzed coffee espresso purchased at different coffee stores and five different tea samples of the Argentina market. The caffeine content in mate cocido is in good agreement with published data from [34] with values from 120 to 180 mg/L for three different mate bags. The observed variability in coffee and teas, including mate cocido, may be due to the different brands in the market, which can use different varieties of plant and different methods of production. Regarding the caffeine content found in mate cebado, it is higher than that reported by [34], probably due to the different form of extraction used. However [44]-[45] found similar contents, used similar methods to prepare the extracts, in three Argentineans brands (966 mg/L, 1081 mg/L and 659 mg/L), which occupy the second place in caffeine content, being the Uruguayan brands the ones containing the highest caffeine concentrations, and in third place the Brazilian brands [44].

3.3. Caffeine Consumption

Considering the different sources of caffeine, 74.2% of the entire sample took caffeine from coffee, 64.9% from tea, 33.7% from chocolate drinks, 54.5% from cola beverages, 23.2% from energy drinks, 87.2% from mate cebado, 32.2% from mate cocido and 74.3% from chocolate and snacks as shown in Table 2. These percentages are similar to those presented in a study carried out in Italy on a population of adults (300 women, 280 men) aged 18-60 recruited from universities and workplaces in northern and central Italy [31], except for energy drinks (7.5%). Statistically significant differences ($p<0.05$) were found in the proportion of drinkers of tea, energy drinks, chocolate drinks and cola beverages. For the first three, those who most consumed were young adults up to 30 years of age. For cola drinks this situation was in the group of 18 to 40 years of age. Considering gender, significant differences ($p<0.05$) were found for energy drinks and cola drinks with a higher percentage for men. For tea the percentage for women was higher than that for men ($p<0.05$). Similar results were found in [31].

The average daily intake for the total sample, showed in Table 3, was 345.8 mg/day (5.2mg/kg/day). No statistically significant differences were found between age groups and gender. However, when adjusted for body weight, women had higher intakes than men (5.5 mg/kg/day vs. 4.6 mg/kg/day), and the group of 51 to over 60 years of age consumed less than those aged 18 to 50 (5.0 to 5.7 mg/kg/day) ($p <0.05$). It was difficult to compare these data with other studies since in some [30], [39]-[41], the sample included children and adolescents and in others the mate was not included [30], [31]-[33], or they were performed in specific groups of the population [32], [37], [39]-[40]. However in Argentina, [34] reported an average intake of caffeine in adults of 288 mg/day (4.4 mg/kg/day). This difference may be due to the fact that in that study [34], the authors stated that mate contributed 50% to the total caffeine intake, using other caffeine content for mate beverage (mate cebado) to the present study.

Taking into account the average intakes from each of the sources of caffeine showed in Table 4, it was found that mate contributed to the total caffeine intake with a 52.5%, coffee with 30.2%, followed by cola beverages (7.6%) and tea (5.0%). The contribution of other drinks was very low. Comparable data were found in the study published by [34], who reported a contribution of 50% for mate y 36% for coffee in the entire sample. Mate is a traditional beverage widely consumed in Argentina, which has been popular for centuries and adopted by modern society in South America. It is consumed not only for its nutritional and functional properties but also because it plays a social and ritualistic role where the act of offering and share it can be compared to those of the tea ceremony for some oriental cultures [7]-[9]. For energy drinks, the mean daily intake for consumers aged 18 to 40 years of age ranged between 2.2 to 5.2 mg/day. It was lower than a previous study [40], where were found, for that age range, caffeine intakes between 12.4 to 7.5 mg/day.

The Kruskal-Wallis test, which compares the median (not shown in the Table 4) of each of the groups, was used in order to compare the intakes (mg/day) of each source of caffeine by age group. There were no significant differences ($p> 0.05$) between the mean intakes of caffeine from coffee and mate

cocido. However significant differences ($p<0.05$) were found for other sources. For tea, snacks and chocolates, cola drinks and energizing drinks, consumers from 18 to 30 years of age have the highest intakes. The age group of over 60 also presents higher intakes of tea. For chocolate drinks, the consumers from 18 to 20 years of age presented the highest intakes, while for mate cebado these were presented in consumers from 31 to 50 years of age. Regarding gender there were no significant differences ($p> 0.05$) between men and women according to their ingested caffeine from chocolate drinks, snacks and chocolates, mate cebado and mate cocido. Men consume more caffeine from cola beverage, energy drinks and coffee ($p<0.05$). However, women consume more caffeine than men from tea ($p<0.05$).

Table 2. *Percentage of participants consuming caffeine from each beverage and food category by gender and age group (%).*

Beverage/food category									
%Consumers	**n**	**Coffee**	**Tea**	**Chocolate drinks**	**Cola beverages**	**Energy drinks**	**Mate cebado**	**Mate cocido**	**Chocolate/ snacks**
Total	2690	74.2	64.9	33.7	54.5	23.2	87.2	32.2	74.3
Gender[a]									
Female	1947	72.9	67.7	33.6	51.0	19.5	87.6	33.8	75.0
Male	743	77.4	57.4	33.9	63.7	33.0	86.1	28.0	72.3
Age Group (years)[b]									
18-20	203	75.4	76.8	54.7	61.1	35.5	84.2	38.4	80.8
21-30	1178	74.8	71.1	43.5	59.7	29.3	86.5	31.7	79.1
31-40	719	75.4	60.0	25.9	55.5	20.9	91.8	33.1	74.0
41-50	315	70.8	54.3	19.7	47.3	13.7	85.1	30.5	64.4
51-60	192	72.9	51.6	14.1	38.5	6.3	84.4	31.8	61.4
>60	83	67.5	60.2	9.6	20.5	2.4	78.3	24.1	59.0

[a] Considering the proportion of consumers of caffeinated beverage and food product within gender.
[b] Considering the proportion of consumers of caffeinated beverage and food product within each age group.

Table 3. *Caffeine daily intake from all sources by gender and age group.*

Daily caffeine intake					
		mg/day		**mg/kg/day**	
Sample	n	mean	P90	mean	P90
Total	2690	345.8	663.3	5.2	10.0
Gender					
Female	1947	339.5	653.3	5.5	10.3
Male	743	362.4	688.4	4.6	8.3
Age group (years)					
18-20	203	346.4	715.6	5.7	12.2
21-30	1178	340.3	692.2	5.3	10.2
31-40	719	369.7	669.4	5.4	10.0
41-50	315	344.7	603.8	5.0	8.8
51-60	192	305.6	573.9	4.3	8.9
>60	83	312.2	623.5	4.2	9.7

From the entire sample (n=2690), 854 participants (31.7%) exceeded the recommended daily intake (400 mg/day) for healthy adults (Table 5). Of these 70.8% were women. The total caffeine intake was significantly different ($p< 0.05$) between participants from 18 to 20 years of age (703.9 mg/day) and consumers of caffeinated beverage from 31 to 60 (597.8 to 676.3 mg/day). No significant difference ($p> 0.05$) was found between genders. Intakes above 400 mg/day can lead to various disorders that depend on individual sensitivity [1]. Previous study [30] found lower intakes (420-467 mg/day) for adults aged ≥35 that exceeded such dose.

Of the total sample, 1013 (37.7%) and 716 (26.6%) women in childbearing age, between 18 and 40, exceeded the recommended caffeine daily intake of 200 mg and 300 mg, respectively. Reference [27] reports percentages of women (3.8%) over 19 years of age that exceed intakes of 300 mg/day, quite lower than those found in this study.

Many women consume caffeine-containing beverages and foods during pregnancy. However, because of possible effects on the fetus and pregnancy that can lead to miscarriages and low birth weight, it is recommended that pregnant women restrict their caffeine intake. Caffeine, upon ingestion, is rapidly absorbed and is easily transmitted through the placenta to the fetus. Cytochrome P450 1A2, the principal enzyme involved in caffeine metabolism is absent in the placenta and the fetus. The rate of caffeine metabolism decreases from the first to the third trimester and the half-life of caffeine doubles in the mother during pregnancy. This can lead to higher exposure for the fetus to maternally ingested caffeine. Epidemiologic studies, through literature review, have reported inconsistent conclusions about the effects of caffeine intake during pregnancy, probably due to difficulties in measuring caffeine intakes, assessment of association based on consumption in individual trimesters rather than throughout pregnancy, among other possible causes. Because of this the precise level of intake above which the risk is significantly higher is not well characterized [18], [19], [20], [21], [22]-[24]. The recommended daily caffeine intake during

pregnancy is different between current guidelines, from <100-200 mg/day [23]-[24] to <300 mg/day [13]-[15].

In the childbearing age women of this study, who exceeded 200 and 300 mg/day, the sources that most contributed to the total caffeine intake in these groups were mate cebado (55.2% and 55.4% respectively) followed by coffee (29.5% and 30.5% respectively) (data not shown). At the 90th percentile, these groups consumed 775.2 mg/day and 850.9 mg/day of caffeine. Different results were obtained in [30], where it was found that women of childbearing age, between 18 and 24 consumed, at the 90th percentile, 228 mg/day of caffeine and women aged 25–34 consumed, at the 90th percentile, 284 mg/day. The difference is probably due to the fact that the study [30] did not take into account the intake of mate cebado that in the present study had an important contribution to the total intake of caffeine and a high content of it.

Table 4. *Caffeine daily intake from each source by age group.*

	Caffeine daily intake (mg/day)													
	Age groups (years)													
Caffeine source	Total		18-20		21-30		31-40		41-50		51-60		>60	
	m	P90	m	P90	m	P90	m	P90	m	P90	m	P90	m	P90
Cofee	104.3	276.0	98.2	260.2	103.3	267.6	113.1	305.3	94.8	260.0	97.8	312.0	107.9	287.1
Tea	17.4	54.6	25.0	54.6	18.5	54.6	15.2	54.6	15.3	54.6	13.0	54.6	22.8	54.6
Chocolate drinks	1.5	4.3	3.2	8.6	2.1	8.6	0.9	2.1	0.9	1.4	0.2	0.7	0.5	--
Cola beverages	26.2	65.3	48.9	143.0	27.3	66.0	24.1	66.0	24.8	47.1	14.0	27.9	6.8	22.0
Energy drinks	2.6	8.1	5.2	11.4	3.1	11.4	2.2	8.1	1.3	5.7	1.1	---	0.4	---
Mate cebado	181.6	407.1	152.4	427.5	174.0	403.8	201.2	407.1	196.2	427.5	169.8	380.0	163.2	475.0
Mate cocido	8.6	30.9	9.0	30.9	8.0	25.7	9.7	36.0	9.0	25.7	7.4	25.7	8.7	36.0
Snacks	3.5	9.1	4.4	9.1	4.1	9.1	3.4	9.1	2.4	7.1	2.3	5.1	2.0	4.6

Table 5. *Caffeine daily intake over 200, 300, 400 mg/day by gender and age group.*

Daily caffeine intake						
	Over 200 mg/day		**Over 300 mg/day**		**Over 400 mg/day**	
Sample	n	mean	n	mean	n	mean
Total	1794	460.5	1275	545.7	854	642.0
Gender						
Female	1294	451.7	911	535.9	605	629.5
Male	500	483.3	364	570.2	249	672.2
Age group (years)						
18-20	121	506.6	88	605.4	63	703.9
21-30	768	461.5	524	559.9	360	656.7
31-40	517	464.9	393	531.3	257	626.9
41-50	226	437.1	165	504.7	102	597.8
51-60	112	437.5	74	532.2	51	610.8
>60	50	445.3	31	569.5	21	676.3

4. Conclusion

In the current study it was possible to characterize the average daily intake of caffeine in the sample from different dietary sources, as well as the contribution of each of them to the total intake, updating existing data in Argentina. As regards to sources of caffeine in the diet, the study shows that mate cebado and coffee are commonly consumed among most participants, including childbearing women, of which more than a quarter exceeded the recommended intakes for pregnant women. Although in this study the participants were not consulted about their pregnancy status, these data may contribute to identify potential groups at risk. Just one of the characteristics of risk assessments is precisely to identify specific population groups that may be at an increased risk of adverse effects related to an excessive intake of caffeine. In this sense, it would be extremely useful for the scientific community and risk managers to extend this study to populations of pregnant women in order to obtain an estimate of their caffeine intakes and expand the results of previous studies in Argentina.

68.3% of the adults interviewed consumed moderate doses of caffeine below the recommended intakes for a healthy adult population, except pregnant women, so no significant risk was detected for this group. The average intake of caffeine from all beverages and food products in the entire sample is higher than that reported in other studies in our country and in the United States and the United Kingdom and resembles that found in Italy, although in the latter three countries mate was not evaluated as a source of caffeine.

Finally, the results obtained in this study contribute with new data for caffeine intake from different dietary sources, in order to characterize the risk derived from its consumption. It also constitutes a relevant antecedent as a basis on which risk managers can identify the problem, make decisions and propose actions to manage it. This will provide risk communicators information to propose strategies to warn consumers, especially groups at risk, about potential adverse effects resulting from excessive intake of caffeine.

5. Strengths and Limitations

This study used cross-sectional data, which, although allowed to collect actual information and in a shorter time, limits the ability to assess causal relationships.

Internet surveys are recognized as an efficient method for data collection and allowed, in our study, the inclusion of different geographical areas of our country and reach a large number of people, with a high response rate. This makes the collected information extremely useful in detecting different patterns of consumption, which is very important for implementing risk reduction actions and strategies, for example through reduced exposure to caffeine, especially in populations at risk. However the distribution of the questionnaire on-line has the disadvantage that only participate in it those who have access to the Internet, either

through personal computers and other mobile devices, limiting the number and quality of participants.

The strength of the study was to estimate the caffeine intake based on analytically determined caffeine content in the products available in the Argentine market, and especially in the preparation of the infusion for the analysis according to the methods more usually employed in our country.

Acknowledgements

This study was financially supported by the Héctor Alejandro Barceló Foundation for the development of Biomedical Science in Argentina.

We also wish to thank the students of the 2nd year of the Bachelor's Degree in Nutrition of the year 2015 that collaborated in the collection of the data.

References

[1] Heckman, M. A., Weil, J., & Gonzalez de Mejia, E. Caffeine (1, 3, 7- trimethylxanthine) in foods: A comprehensive review on consumption, functionality, safety, and regulatory matters. Journal of Food Science 2010; 75(3): 77–87.

[2] Moratalla R. Neurobiología de las metilxantinas. Trastornos Adictivos 2008; 10(3): 201-207.

[3] Barreda-Abascal, R., Molina, L., Haro-Valencia, R., Alford, C. y Verster, J. C. Actualización sobre los efectos de la cafeína y su perfil de seguridad en alimentos y bebidas. Revista Médica del Hospital General de México 2012; 75(1): 60-67.

[4] International Food Information Council Foundation (IFIC). Caffeine & Health: Clarifying the controversies. IFIC Review 2008; 7(98): 1-8.

[5] Knight, C. A., Knight, I., Mitchell, D. C., Zepp, J. E. Beverage caffeine intake in U.S. consumers and subpopulations of interest: estimates from the Share of Intake Panel survey. Food and Chemical Toxicology 2004; 42: 1923–1930.

[6] Dartora N., De Souza L. M., Santana-Filho A. P., Lacomini M., Valduga A. T., Gorin P. A. J., Sassaki G. L. UPLC-PDA–MS evaluation of bioactive compounds from leaves of Ilex paraguariensis with different growth conditions, treatments and ageing. Food Chemistry 2011; 129: 1453–1461.

[7] Holowaty S. A, Surkan S. A, Trela V. D, Byczko G. D, Schmalko M. E. Variation of Physicochemical and Sensory Properties during the Aging of Yerba Mate. International Journal of Food Studies 2014; 3: 228-238.

[8] Valduga A. T, Gonçalves I. L, Piovezan Borges A. C, Mielniczki-Pereira A. A, Picolo A. P. Cytotoxic / antioxidant activity and sensorial acceptance of yerba mate development by oxidation process. Acta Scientiarum. Technology 2016; 38(1): 115-121.

[9] Bracesco N., Sanchez A. G., Contreras V., Menini T., Gugliuccib A. Recent advances on Ilex paraguariensis research: Minireview. Journal of Ethnopharmacology 2011; 136:378–384.

[10] Nawrot, P., Jordan, S., Eastwood, J., Rotstein, J., Hugenholtz, A., Feeley, M. Effects of caffeine on human health. Food Additives & Contaminants 2003; 20: 1–30.

[11] Gonzalez de Mejia E., Ramirez-Mares M. V. Impact of caffeine and coffee on our health. Trends in Endocrinology & Metabolism 2014; 25(10):489-554.

[12] Cano-Marquina A., Tarín J. J., Cano A. The impact of coffee on health. Maturitas 2013; 75:7– 21.

[13] (2013). Health Canada, Government of Canada. Health Canada Reminds Canadians to Manage Their Caffeine Consumption. Identification number: RA-34021. [Online]. Available: http://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2013/34021a-eng.php

[14] (2012). Conseil Supérieur de la Santé de la Belgique (CSS). "Avis du Conseil supérieur de la Santé N° 8689 - Utilisation de la caféine dans les denrées alimentaires - Avis du 11 janvier 2012." [Online]. Available: http://www.west-info.eu/files/caffeina.pdf

[15] Hamburg M., Taylor M. R. The past, present and future of Caffeine regulation in the United States. In Institute of Medicine (IOM). Caffeine in Food and Dietary Supplements: Examining Safety: Workshop Summary. Washington, DC: The National Academies Press 2014.

[16] Thomson, B., Schiess, S. Risk Profile: Caffeine in Energy Drinks and Energy Shots. Institute of Environmental Science & Research Limited, New Zealand Food Safety Authority, Project CFS/09/04 2011.

[17] Sengpiel V, Elind E, Bacelis J, Nilsson S, Grove J, Myhre R, Haugen M, Meltzer HM, Alexander J, Jacobsson B: Maternal caffeine intake during pregnancy is associated with birth weight but not with gestational length: results from a large prospective observational cohort study. BMC Med 2013; 11:42.

[18] Chen L. W, Wu Y., Neelakantan N., Foong-Fong Chong M., Pan A., van Dam R. M. Maternal caffeine intake during pregnancy is associated with risk of low birth weight: a systematic review and dose–response meta-analysis. BMC Medicine 2014; 12:174.

[19] Chen L. W, Wu Y., Neelakantan N., Foong-Fong Chong M., Pan A., van Dam R. M. Maternal caffeine intake during pregnancy and risk of pregnancy loss: a categorical and dose–response meta-analysis of prospective studies. Public Health Nutrition 2015; 19(7): 1233–1244.

[20] Jarosz M., Wierzejska R., Siuba M. Maternal caffeine intake and its effect on pregnancy outcomes. European Journal of Obstetrics & Gynecology and Reproductive Biology 2012;160(2):156-60.

[21] Rhee J., Kim R., Kim Y., Tam M., Lai Y., Keum N., et al. Maternal Caffeine Consumption during Pregnancy and Risk of Low Birth Weight: A Dose-Response Meta-Analysis of Observational Studies. PLoS ONE 2015; 10(7): e0132334.

[22] CARE Study Group: Maternal caffeine intake during pregnancy and risk of fetal growth restriction: a large prospective observational study. BMJ 2008; 337:a2332. Corrections BMJ 2010;340:c2331.

[23] (2011) Norwegian Food Safety Authority: Dietary advice for pregnant women [Kostråd til gravide, in Norwegian]. [Online]. Available: http://www.matportalen.no/rad_til_spesielle_grupper/tema/gravide/.

[24] ACOG: Committee Opinion No. 462 (Reaffirmed 2016): moderate caffeine consumption during pregnancy. Obstet Gynecol 2010, 116:467–468.

[25] Frary C. D, Johnson R. K, Wang M. Q. Food sources and intakes of caffeine in the diets of persons in the United States. Journal of the American Dietetic Association 2005; 105:110–3.

[26] (2013). Zucconi, S., Volpato, C., Adinolfi, F., Gandini, E., Gentile, E., Loi, A., Fioriti L. Gathering consumption data on specific consumer groups of energy drinks. Supporting Publications 2013:EN-394, [190 pp.]. [Online]. Available: http://www.efsa.europa.eu/en/supporting/pub/394e.htm.

[27] Fitt E., Pell D., Cole D. Assessing caffeine intake in the United Kingdom diet. Food Chemistry 2013; 140(3): 421-426.

[28] (2013). French Agency for Food, Environmental and Occupational Health & Safety (ANSES). Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on the assessment of risks concerning the consumption of so-called "energy drinks". ANSES Opinion Request no. 2012-SA-0212, 1-108. [Online]. Available: http://www.anses.fr/en/documents/NUT2012sa0212EN.pdf.

[29] Knight C. A., Knight I., Mitchell D. C., Zepp J. E. Beverage caffeine intake in U.S. consumers and subpopulations of interest: estimates from the Share of Intake Panel survey. Food and Chemical Toxicology 2004; 42: 1923–1930.

[30] Mitchell D. C., Knight C. A., Hockenberry J., Teplansky R., Hartman T. J. Beverage caffeine intakes in the U.S. Food and Chemical Toxicology 2014; 63: 136–142.

[31] Penolazzi B., Natale V., Leone L., Russo P. M. Individual differences affecting caffeine intake. Analysis of consumption behaviours for different times of day and caffeine sources. Appetite 2012; 58: 971–977.

[32] Penafort A. G., Carneiro I. B. P., Carioca A. A. F., Sabry M. O. D., Pinto F. J. M., de Carvalho Sampaio H. A. (2016) Coffee and Caffeine Intake among Students of the Brazilian Northeast. Food and Nutrition Sciences 2016; 7:30-36.

[33] Del Brutto O. H., Merab R. M., Zambrano M., Castillo P. R. Caffeine intake has no effect on sleep quality in community dwellers living in a rural Ecuadorian village (The Atahualpa Project). Sleep Science 2016; 9:35–39.

[34] Olmos V., Bardoni N., Ridolfi A. S., Villaamil Lepori E. C. Caffeine levels in beverages from Argentina's market: application to caffeine dietary intake assessment. Food Additives and Contaminants 2009; 26(3): 275-281.

[35] Bardoni N., Contartese C. M., Olmos V., Ridolfi, A. S., Villaamil Lepori, E. C. Evaluación de la ingesta diaria de cafeína en niños y adolescentes de Argentina. Acta Toxicológica Argentina 2010; 18: 26-72.

[36] Bardoni N., Contartese C. M., Olmos V. Evaluación de la ingesta diaria de cafeína en niños y adolescentes de Argentina. Acta Toxicológica Argentina 2015; 23(1):5-14.

[37] Onzari M., Krupitzky H., CilloF., Cámera K. Consumo de cafeína en deportistas. Revista electrónica de Ciencias Aplicadas al Deporte 2010; 3(11):1-9.

[38] Moyano, N, Raimondo, E, Gattás, I, Gallar, S. (2010). Consumo de Cafeína a Través de Bebidas Energizantes en Personas de 18 a 30 Años de Edad de la Ciudad de Mendoza. En II Jornadas de Investigación 2010 - Universidad Juan Agustín Maza (p.17). Mendoza, Argentina: Universidad Juan Agustín Maza.

[39] Cúneo F., Schaab N. Hábitos de consumo de bebidas en adolescentes y su impacto en la dieta. Diaeta 2013; 31(142): 34-41.

[40] Carnevali de Falke S., Degrossi M. C. Bebidas energizantes: características de consumo e ingesta de cafeína en adultos jóvenes en Argentina. Acta Toxicológica Argentina 2015; 23(3):105-117.

[41] Giovanini de Oliveira Sartori A., Vieira da Silva M. Caffeine in Brazil: intake, socioeconomic and demographic determinants, and major dietary sources. Nutrire 2016 41:11

[42] Braghini F., Giane de Carli C., Bonsaglia B., dos Santos Silveira Junior J. F, Francielly de Oliveira D., Tramujas J., Benedetti Tonial I. Composição físico-química de erva-mate, antes e após simulação do chimarrão. Pesquisa Agropecuária Gaúcha 2014; 20(1,2):7-15.

[43] Sabbatella O. P., Pokolenko, J. J., Schmalko, M. E.. Influencia de la Composición en la Extracción de los Solubles de la Yerba Mate. Revista de Ciencia y Tecnología 2009. [Online]. Available: http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1851-75872009000100007

[44] Colpo A. C., Hemerson R., Lima M. E., Pazzini C. E. F., de Camargo V. B., Bassante F. E. M., Puntel R., Silva Ávila D., Mendez A., Folmer V. Yerba mate (Ilex paraguariensis St. Hill.)-based beverages: How successive extraction influences the extract composition and its capacity to chelate iron and scavenge free radicals. Food Chemistry 2016; 209:185–195.

[45] Colpo A. C., Hemerson R., Lima M. E., Pazzini C. E. F., de Camargo V. B., Bassante F. E. M., Puntel R., Silva Ávila D., Mendez A., Folmer V. Unpublished. Data associated with [44]. Universidade Federal do Pampa, Uruguaiana, RS, Brazil, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil.