Caffeine Consumption Behaviors of the Working-Age Population in Rural Communities in Northeastern Thailand

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Background: *Caffeine use is on the rise among working-age population in Thailand. Little is known about caffeine consumption and potential risk practices of the population group in a rural setting in northeastern Thailand.*
Objective: *Examine caffeine-consumption behaviors (CCB) and contributing factors catering to potential risk practices of CCB pattern among the working-age population.*
Material and Method: *This cross-sectional analytical research study used multi-stage random sampling included 1,321 out of 3,332 working-age participants in rural communities in northeastern Thailand. Data collection used a caffeine consumption survey interview guide and a seven-day-caffeine consumption diary. Data analysis used descriptive and inferential statistics, frequency, percentage, mean, standard deviation, binary logistic regression, odds ratio, and 95% confidence interval (95% CI).*
Results: *The results showed that 39.6% of the working-age population in the rural communities consumed caffeine. Their age ranged from 15 to 59 years with a mean ± SD of 40.2±8.3 years. The woman comprised 49.4% of the group. They consumed caffeine on an average ± SD of 302.5±176.9 mg/day. Sixty-seven point four percent of them were everyday caffeine users. Their caffeine sources were from coffee, energy drinks, chocolate milk, cocoa drinks, carbonated soft drinks, and tea drinks. Their potential "at risk" practices of CCB included excessive consumption of caffeine greater than 300 mg/day (44.7%), frequent consumption of caffeine (67.4%), modification of caffeine consumption method by mixing it with other substances (44.4%), and consumption of caffeine while having illness (29.1%). Income, status in a household, and occupation were factors contributing to "at risk" practices of CCB of this population group ($p<0.01$-0.05).*
Conclusion: *Rural working-age residents in northeastern Thailand were potentially vulnerable for adverse effects from their "at risk" practices of CCB. Modification solutions for suitable caffeine consumption behavior should be targeted to higher income individuals and household members of certain occupations.*

Keywords: *Working-age population, Caffeine consumption behavior, Rural community, Thailand*

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Caffeine consumption in Thailand is on the rise. The International Coffee Council indicated that Thailand's caffeine consumption had increased nearly two-folds, from 510 to 950 grams per capita between 2002 and 2012[1]. Caffeinated beverages, particularly coffee, were once perceived as drinks for adults. However, nowadays they are likely to be consumed by people at all ages including children[2] and adolescents[3]. In Thailand, coffee and energy drinks are the major forms of caffeine consumed by working-age adults[4-6], whereas soft drinks and energy drinks are the main sources among adolescents[7].

Caffeine, a mild psychoactive substance, is primarily found in coffee, tea, cola, cacao, and many plant species. Caffeine has been associated with physiological effects, such as stimulating central nervous system (CNS), anti-oxidation, and modulation of some cellular lipids and proteins[8-11]. Positive effects of moderate caffeine consumption in healthy adults include restoring energy, increasing alertness, enhancing physical reaction, cognitive function, and judgment[3,8,10,12]. Other positive effects of caffeine are liver protection, diabetes and Parkinson risk reduction, decreased long-term mortality, and cancer prevalence[8,10,13-17]. After ingesting, caffeine stimulatory effects in human body ranges from 15 minutes to six hours or more dependently on physiological conditions, for example, it takes longer period in pregnant women and individuals with impaired liver functions. An individual can possibly develop caffeine tolerance, a declined responsiveness to caffeine dose after repeated consumption, consequently, one is in need of greater doses to achieve the same positive

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effect initially experienced. Adverse effects among habitual caffeine users include withdrawal syndrome[8]. Caffeine withdrawal has been newly listed in the DSM-5 released on May 22, 2013[18], as a mental disorder resulting from abruptly cutting out caffeine consumption. It includes such symptoms as headache, restlessness, nervousness, sleeplessness, upset stomach, and a rapid heartbeat. These adverse effects usually occur within 12 to 16 hours and peak within 18 to 25 hours after cessation and last for three to seven days[8,19]. Caffeine withdrawal syndrome mechanism might be from adenosine up regulation leading to hypersensitivity during caffeine abstinence, thereby increasing an individual's desire to repeat consumption of caffeine[9]. The well recognized toxic effects of caffeine are vomiting, abdominal pain, and afflicted CNS related symptoms such as altered consciousness, agitation, irritability, and seizures. Cardiovascular effects include supraventricular, ventricular tachyarrhythmia, and ventricular fibrillation. Despite its health benefits[8,19,20], caffeine has been associated with increased cholesterol concentration and elevated blood pressure in adults[8], as well as induced bone loss in postmenopausal women and increased serum homocysteine, which is a risk factor for cardiovascular disease in general population[21].

Recent recommendations[22] coupled with empirical studies[23-26] about pharmacological dose of caffeine indicated that caffeine consumption of 0.5 to 100.0 mg/day caused few toxic effects in humans, 101.0 to 200.0 mg/day could affect sleeping pattern, and a dose of 140.0 to 210.0 mg/day or 2.0 to 3.0 mg/kg could stimulate CNS activity, 201.0 to 300.0 mg/day or 3.0 to 4.0 mg/kg could increase anxiety and blood pressure in sensitive individuals, 301.0 to 400.0 mg/day or 4.0 to 6.0 mg/kg could affect CNS and cause dizziness, rapid heartbeat, irritability, and tremors, 401.0 to 500.0 mg/day led to increased anxiety, 501.0 and over was considered a high dose resulting in increased anxiety, impaired sleeping pattern, impaired fine motor control, impulsivity, and poor mental health, and finally, 1,200.0 mg/day, or more than 170.0 mg/kg for healthy adults with 70 kg body weight is considered as an acute fatal dose of caffeine. Empirically, a Swedish study involving screening of forensic autopsies for caffeine and drugs revealed that caffeine negatively contributed to 0.02% of the fatal cases (20 out of 83,580 forensic autopsies, with 95.0% of all cases undergoing forensic autopsy) and consumers of 100.0 mg caffeine tablets widely available in Sweden had higher prevalence of excessive caffeine consumption and mortality[25]. Recent recommendations are to limit caffeine consumption to moderate amount not exceeding 400.0 mg/day or 5.7 mg/kg for healthy adults[22].

In Thailand, based on the 1979 Food Act, the Food and Drug Administration (FDA) requires caffeinated products, particularly beverages, comply with the general food code. The 1981 and 2000 Notifications of the Ministry of Public Health mandated by the FDA also require caffeine to be not exceeding 50.0 mg/serving in sealed container products[27] and to be not exceeding 100.0 mg/100 ml in a liquid form of "ready-to-drink coffee"[28], respectively. Based on the empirical study in 1994[29] and the report of the Ministry of Public Health in 2000[30], 38.6% of the respondents aged 12 years and over from all regions of Thailand consumed caffeine (n = 4,809). This was especially common among working age respondents, the respondents residing in Northeast region, and those who were agriculturalists, transportation, and logistics as well as waged workers. Their major caffeine sources were coffee and tea, energy drinks, and carbonated soft drinks. Several studies indicated potential caffeine consumption risk practices among Thai population such as having excessive consumption[5,29,31], having mixed caffeinated drinks with other beverages such as alcoholic beverage and coffee[23]. A 2001 survey of caffeine consumption in Bangkok indicated that the working-age residents consumed on average 200.0 to 250.0 mg/day of caffeine, and high-risk caffeine users were laborers (23.3%) and officers (14.1%)[4]. A 2004 case control study in central Thailand indicated that energy drink was a major source of caffeine consumed by the study construction workers (n = 372). Their caffeine consumption was significantly increased among those who worked overtime, ever used drug addicting substance, were married, received motivation, and had positive attitude towards energy drinks, at $p<0.05$. Construction workers reported they mixed Kratom leaf, an illegal psychoactive plant in Thailand, in their caffeinated drinks to better boost energy for endurable work[5].

The increased consumption of caffeine among people of all ages and the expansion of beverage industries have been witnessed in Thailand. Consequently, it is important to characterize the caffeine consumption patterns that accompany such social changes. The present study aimed to examine caffeine consumption behaviors (CCB) and factors contributing to consumption pattern among the working-age population residing in rural communities in northeastern Thailand.

Material and Method

Study design, research setting, and participants

This analytical cross-sectional research study analyzed data from the working-age population aged 15 to 59 years. Subjects were drawn by using multi-stage sampling based on population size unknown formula[32] suggested by Cochran[44] as follow:

$n = Z^2_{\alpha/2} P (1-P) / e^2 = (1.96)^2 x 0.35 x 0.65 / (0.05)^2 = 349.6$

$n_{cluster} = n_{SR} \times D.E. = 349.6 x 3.7 = 1,293.6$

$n_{opt} = n_{SR} \times D.E. / Response\ rate = 349.6 x 3.7 / 0.98 = 1,320$

Where n = sample size $\alpha = 0.05$

Z = confidence coefficient (1-α), which is 1.96

P = proportion of caffeine consumption among working-age group based on previous study is 35.0% or 0.35

e = error of estimation, which is 0.05

$n_{cluster}$ = number of sample drawn by using cluster sampling

n_{SR} = sample size drawn by simple random sampling

D.E. = design effect, which, in the present study, is 3.7

Response rate = in the present study uses the response rate of 98% or 0.98

n_{opt} = expected sample size

The participants were firstly drawn from one out of four regional health, which was Health Region 9, located in the Northeast region of Thailand covering four out of 20 provinces. Secondly, we then sampled one out of four provinces of the Health Region 9, which was Nakhon Ratchasima province (NR). Thirdly, we sampled one out of 32 districts in NR, which was Pak Thong Chai district (PTC). A fourth-stage sample was a cluster sample involving one out of 22 sub districts located in PTC, which was "Busamor" sub district. Busamor comprised of 11 rural communities with 3,332 working-age individuals. We then conducted household survey asking each working-age individual if he/she consumed caffeine at least one time during the past month. All of the respondents who so indicated and were able to read and write Thai were invited to participate in the study based on their willingness (n = 1,321). The study was conducted between 2012 and 2013.

The research tools included caffeine consumption survey interview guide and seven-day-caffeine consumption diary. First, the caffeine consumption survey interview guide comprised four parts: personal characteristics, health related information, perceptions about caffeine consumption, and CCB. Personal characteristics of the participants included information about age, sex, marital status, education, occupation, personal incomes (Baht/month), family type, number of household members, and status in a household. Health related information comprised of having current illness(es) such as diabetes, hypertension, cardiovascular diseases, gastro-intestinal diseases, musculoskeletal related problems, cancers, and other reported psychological related conditions. A score of this part was 1 to 3, where 1 = no illness, 2 = having at least one illness, and 3 = having two illnesses or more.

Ten items measured perceptions about caffeine consumption regarding health related effects based on dose of consumption (Q1-Q4), frequency of consumption (Q5), consumption method (Q6), and others (Q7-Q10), including retention of caffeine in the body, suitability of caffeine consumption among individuals with gastric tract problem(s), caffeine tolerance symptoms, and time duration of unpleasant symptoms of caffeine consumption cessation. Total perceptions about caffeine consumption scores were calculated by summing correct perceptions to generate a total maximum score of ten points. These scores were divided into low (less than 4 points), moderate (5 to 6 points), and high (7 to 10 points) levels of appropriate perceptions.

Four items measured CCB generating a maximum possible score of 17 points. The overall CCB scores were divided into three levels: not at risk or minimal risk level (less than 6 points); at risk level comprising low (7 to 9 points), moderate (10 to 12 points) to high (13 to 17 points). First, dose of caffeine consumption depicting by daily amount of consumption ranged from not at risk or minimal risk (1 to 3 points: less than 100.0, 100.0 to 199.9, and 200.0 to 299.9 mg/day) to at risk in a moderate level (4 to 5 points: 300.0 to 399.9, 400.0 to 499.9 mg/day) and at risk in high level (6 to 10 points: 500.0 to 599.9, 600.0 to 699.9, 700 to 799.9 mg/day). Second, frequency of caffeine consumption, it comprised two categories of not at risk or minimal risk level, in which 1 point = consumption of caffeine less than once a day and 2 points = consumption of caffeine every day. Third, caffeine consumption method, it included not at risk or minimal risk level (1 point = no modification of both formula and form of caffeine) and at risk level (2 points = modification of either caffeine formula or form of in taking or both, and 3 points = mixing some substance(s) potentially affecting health. Fourth, consuming caffeine while having illness(es), it comprised not at risk or minimal risk level (1 point =

no illness) and at risk level (2 points = having at least one illness).

Second, the seven-day-caffeine consumption diary was constructed by the researchers based on the reviewed literature and several group meetings with community leaders and working-age representatives (n = 30). Through these discussions, we shaped a list of questions about caffeine consumption and potential risk practices of the working-age group. Consequently, we used such a diary for calculation of daily amount of caffeine consumption reported by the participants. The researchers and three trained interviewers used measurement aids such as measuring cups, spoons, rulers, and illustrated pictures and example products of locally available caffeinated beverages or packages to assist participants in estimating accurate consumed caffeine quantities. The amount of daily caffeine consumption was calculated from a participant's complete reported seven-day-caffeine consumption diary. A mean total amount of caffeine consumed from all sources for each participant was then calculated and reported as milligrams per day (mg/day).

The nutrition specialists and physicians confirmed the validity of the survey interview guide and the seven-day-caffeine consumption diary.

Caffeine database development

A list of the 27 items of caffeine beverages participants reported in the seven-day-caffeine consumption diary was generated by the researchers to construct a caffeine database (Table 1). Such items were then grouped into five main categories, 1) coffee, 2) tea, 3) energy drinks, 4) carbonated soft drinks, and 5) others. Caffeine values were obtained from various reliable sources[33-35,38].

Data analysis

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics was consisted of frequency, percentage, mean, and standard deviation. Binary logistic regression analysis was used to determine factors contributing to the participants' at risk practices of CCB, including age, sex, education, marital status, number of household members, family type, status in a household, personal

Table 1. Summary of the caffeine database of content by beverage category

Beverage category/type/description	Caffeine content	
	(mg/ml)	(mg/fluid ounce)
Coffee		
Caffeinated		
- Instant coffee, instant coffee mix, prepared from flavored mix	110-150/150	6.0
- Ready-to-drink: bottled or canned, brand specify	74-212/180	4.1-20.0
Decaffeinated coffee		
- Decaffeinated, instant coffee, brand specify	2-5/150	0.4-1.0
Tea		
Black		
- All types brewed, caffeinated, brand/no brand specified	23-110/150	5.9
- Instant tea, dried tea leaf (e.g., Chinese Oolong tea)	8-55/150	1.6-11.0
- Bottled ready-to-drink	21-51/250	2.5-6.2
Green		
- Instant tea, dried tea leaf (e.g., Jasmine tea), brand/no brand specified	8-55/150	1.6-11.0
- Ready-to-drink: bottled, canned or packed, brand specified	21-51/250	2.5-6.2
Energy drinks		
Generic, regular, brand not specified	50/100-150	10.0
Brand specified, regular, bottled or canned, brand specified[39]	40-78/150	3.4-20.5
Carbonated soft drinks (CSDs)		
All types, caffeinated, regular or diet, added flavors, brand specified	29-65/325	3.0
Others		
Chocolate		
- Chocolate milk, chocolate drinks, prepared from mix, brand specify	9-12/180	0.2-2.0
- Ready-to-drink: bottled or packed, brand specified		
Cocoa		
- Cocoa drinks, bottled or packed ready-to-drink or prepared from mix	5-30/180	0.8-5.0
- Instant cocoa or instant cocoa mix, brand specified	28.0/150	5.6

income, occupation, and perceptions about caffeine consumption. Odd ratio and 95% confidence interval (95% CI) were also used to compare the factors potentially affecting "at risk" practices of CCB among the study participants. The Statistical Package for Social Science (SPSS version 17.0) was used for all statistical analyses.

A mean total amount of caffeine consumption in the present study was categorized in line with the current recommendation of a moderate daily caffeine intake for adults to be approximately 280 to 399 mg/day or 4.0 to 5.7 mg/kg by the authorized committees[22] and organizations[35,36]. Consequently, in the present study, we chose to use 300 mg/day or approximately 4.2 to 4.6 mg/kg, given the average body weights of Thai population were 65.0 and 70.0 kg for women and men, respectively[37].

The study was approved by the Ethics Committee of Mahasarakham University (Ref. No. 0026/2011). In addition, the participants aged less than 18 years were included in the present study based on their own willingness and the permission of their parents or guardians.

Results

Personal characteristics

The working-age participants comprised both men (50.6%) and women (49.4%), 75.2% were married, and 37.9% attained secondary education. Their age range (mean ± SD) was 18 to 59 (40.2±8.4) years. Nearly half of them were waged workers, the rest were agriculturalists, government and state enterprise officers, housewives, and merchants, respectively from high to low. Their monthly personal income range (mean ± SD) was 1,000 to 40,000 (9,566.9±8,984.9) Baht. The working-age participants majorly resided in a nuclear family (77.6%). Their family sizes ranged from three to six members (mean ± SD = 4.5±0.96). There were more household members (63.5%) than household heads included in the present study (Table 2).

Health related information

Approximately 29.1% of the working-age participants indicated that they consumed caffeine while having at least one illness. Their reported illnesses ranged from one to three illnesses, which included both physical and psychological related problems. Their physical health problems included circulatory system (39.0%), e.g., hypertension, cardiovascular diseases, vertigo, and migraine, gastrointestinal related problems (25.5%), e.g., gastritis and constipation, musculoskeletal related problems (24.2%), e.g., muscle strain, osteoporosis, arthralgia, rheumatoid arthritis, and gout. Their endocrine related problem included type II diabetes (6.8%). Their psychological health related problems (4.5%) included sleeplessness and stress (Table 3).

Perceptions about caffeine consumption

The majority of this working-age group had low (83.0%) to moderate (17.0%) level of appropriate perceptions about caffeine consumption. Seventy-one point nine percent of them appropriately perceived about mixing caffeine with other substances could lead to harmful effect on health. Over half of them (56.5%)

Table 2. Personal characteristics of the working-age participants (n = 1,321)

Personal characteristics	Number (%)
Sex	
Men	668 (50.6)
Women	653 (49.4)
Age (years)	
<30	201 (15.2)
30-39	323 (24.5)
40-49	674 (51.0)
50-59	123 (9.3)
Marital status	
Single	105 (7.9)
Married	994 (75.2)
Ever married (divorced or separated)	222 (16.8)
Education (years)	
Primary (4-7)	353 (26.7)
Secondary (9-12)	500 (37.9)
Vocational or some college (12-14)	333 (25.2)
College/University (≥16)	135 (10.2)
Occupation	
Waged workers	588 (44.4)
- Factory workers	319 (54.3)
- Laborers	102 (17.3)
- Office workers	75 (12.8)
- Security guards	54 (9.1)
- Drivers	38 (6.5)
Agriculturists	393 (29.8)
Government and state enterprise officers	158 (12.0)
Housewives	143 (10.8)
Merchants	39 (3.0)
Personal income (Baht/month), mean ± SD	9,566.9±8,984.9
Range	1,000-40,000
<5,000	195 (14.8)
5,000- 9,999	920 (69.6)
10,000-14,999	41 (3.1)
15,000-19,999	36 (2.7)
20,000 and over	129 (9.8)

perceived correctly that overdose caffeine consumption could lead to tachycardia and arrhythmia. However, 28.1 to 30.2% of them correctly perceived about caffeine tolerance symptoms and precaution of caffeine consumption among the individuals with gastrointestinal tract problems. Less than one-fourth of them correctly perceived health related issues (18.2 to 24.5%), particularly caffeine cessation symptoms, e.g., headache, nausea, and vomiting did not decrease in two to three days and individuals aged 15 years and over could not consume caffeine in a comparable amount of the adults. The same amount could not correctly perceive dose related information (16.8 to 23.9%), e.g., they did not agree that caffeine consumption of 200 mg/day and over could negatively affect health, consuming a large quantity of caffeine could lead to durable and productive work, and caffeine could not remain in the body for an average of three to four hours. Only 13.6% of them perceived correctly about frequency of caffeine consumption, specifically frequent caffeine consumers manifested caffeine tolerance higher than less frequent ones (Table 4).

Table 3. Health status of the working-age participants (n = 1,321)

Health status	Number (%)
Having illness	385 (29.1)
Circulatory system	150 (39.0)
- Hypertension	104 (69.3)
- Others (i.e., irregular heart rhythms, vertigo, migraine)	46 (30.7)
Gastrointestinal and excretory system	98 (25.5)
- Gastritis	81 (82.7)
- Others (i.e., constipation, diarrhea, nausea and vomiting)	17 (17.3)
Skeletal and muscular system	93 (24.2)
- Muscle strain, myalgia	78 (83.9)
- Osteoporosis	9 (9.7)
- Others (i.e., arthralgia, rheumatoid, gout)	6 (6.4)
Endocrine related system (diabetes type II)	26 (6.8)
Others (i.e., sleeplessness, stress)	18 (4.5)

Caffeine consumption behaviors

The working-age participants consumed caffeine largely from coffee (74.7%). Their other caffeinated types of beverage included energy drinks (66.4%), chocolate and cocoa drinks (52.6%), and carbonated soft drinks (48.6%). The majority of them consumed two (36.3%) to three (35.5%) combinations of caffeinated types of beverages, while 12.4% consumed from single type of caffeinated beverage and mostly from coffee. The most popular combinations of two types of caffeinated beverage were coffee and energy drinks, and of three combinations were coffee, energy drinks and cocoa drinks. It was notable that 14.6% of these participants consumed four types of caffeinated beverage.

The working-age participants in the present study largely had "at risk" practices of CCB in a low (61.5%) to moderate (26.5%) level, while only 12.0% of them had "not at risk or minimal risk" of these

Table 4. Number and percentage of working-age participants by appropriate perceptions about caffeine consumption (n = 1,321)

Perceptions about caffeine consumption	n (%)
1. Consumption of caffeine 200 mg/day or more can negatively affect health. (F)	316 (23.9)
2. Consuming a larger amount of daily caffeine lead to better perform durable and productive work. (F)	229 (17.3)
3. Caffeine can remain in a body for an average of 3 to 4 hours. (F)	222 (16.8)
4. Overdose of caffeine consumption can lead to tachycardia and arrhythmia. (T)	747 (56.5)
5. Every day caffeine users manifest higher caffeine tolerance than less frequent ones. (T)	179 (13.6)
6. Mixing caffeine with other substances, e.g., energy drinks, alcoholic beverages, are not harmful. (F)	950 (71.9)
7. Caffeine is not suitable for individuals with gastrointestinal tract problem such as gastritis. (T)	371 (28.1)
8. Individuals aged 15 years and over could consume caffeine in a comparable amount to adults. (F)	241 (18.2)
9. Caffeine tolerance symptoms are not including unpleasant mood, restlessness, and nervousness. (F)	399 (30.2)
10. Headache, nausea, and vomiting during caffeine cessation decrease in 2-3 days. (F)	323 (24.5)
Level of appropriate perceptions about caffeine consumption	
Low level (1-4 points)	1,097 (83.0)
Moderate level (5-6 points)	224 (17.0)
High level (7 points and over)	-

T = true; F = false

practices. There were four identified "at risk" practices of CCB patterning in this population group, including excessive caffeine consumption, frequent consumption of caffeine, having at risk method of consumption, particularly consuming a modified form or formula of caffeine, and consuming caffeine while having chronic illness(es) (Table 5).

Excessive consumption of caffeine, greater than 300 mg/day, was found among 44.7% of the working-age participants (Table 5). Supportive data indicated the wide range of their daily caffeine consumption (mean ± SD), 6.6 to 962.0 (302.5±176.7) mg/day. The average amount of daily caffeine intake (mean ± SD) was also higher among the working-age participants who were having salary 10,000 to 14,900 Baht/month (373.1±136.7 mg/day), government and state enterprise officers (338.6±201.4 mg/day), aged less than 30 years (321.5±189.5 mg/day), single and ever married (313.1±196.4 and 314.0±194.9 mg/day), college graduates (308.4±181.3 mg/day), and women (307.6±179.7 mg/day).

Frequent consumption of caffeine, consumption of caffeine every day was found among 67.4% of this working-age group, with women constituted slightly higher proportion (68.9%) than men (65.9%). There were higher proportions of the participants who frequently consumed caffeine, particularly those who were aged less than 30 years (71.6%) comparative to other age groups (63.4 to 69.3%), merchants (76.9%), and housewives (73.4%), living in extended family (70.4%), having moderate level of appropriate perceptions about caffeine consumption (70.3%), receiving secondary education (69.4%), and college education (69.0%), household members (68.8%), and married (68.5%).

Table 5. Caffeine consumption behavior (CCB) of the working-age participants (n = 1,321)

CCB	n (%)
Daily amount of caffeine consumption (mg/day)	
Mean ± SD	302.5±176.7
Min-max	6.6-962.0
<100.0	169 (12.8)
100.0-199.9	261 (19.8)
200-299.9	300 (22.7)
300-399.9	215 (16.3)
400-499.9	187 (14.2)
500-599.9	110 (8.3)
600-699.9	46 (3.5)
≥700	33 (2.5)
Frequency of caffeine consumption	
Less than once a day	431 (32.6)
Every day	890 (67.4)
Method of caffeine consumption	
No modification	734 (55.6)
Modification by mixing in substances	494 (37.4)
Modification of formula and/or form	93 (7.0)
Consumption of caffeine while having illness	
No illness	936 (70.9)
Have at least one illness	385 (29.1)
Overall CCB (points)	
Not at risk/minimal risk level (1-6)	159 (12.0)
Low risk level (7-10)	812 (61.5)
Moderate risk level (11-14)	350 (26.5)
High risk level (15-17)	-

For method of caffeine consumption, the study found that consuming a modified form and/or formula of caffeine as well as mixing caffeine with other substances were found among 44.4% of this working-age group. Mixing caffeine beverage with other substances that might potentially be hazardous to health was found among 37.4% of this working-age group. Of which, their added substances included: mixed coffee and instant coffee (45.0%), analgesic medication, specifically Paracetamol, and Aspirin (30.7%), energy drinks (15.8%), and alcoholic beverages, including white spirit (8.5%). Reported modifications of the caffeine form or formula were found among 7.0% of this population group. Their modification of formula included consumption of caffeine in higher concentration from the product instruction, while their modification of form included directly consuming instant coffee powder (in a solid grounded form) either mixed or not mixed with cream and sugar. Caffeine consumption by mixing in other substances and modifying form and formula of caffeine were considered as "at risk" practices of CCB, and were found higher among those who were merchants (51.3%), government and state enterprise officers (51.9%), and laborers (50.0%). Data also showed higher proportion of such "at risk" practices among those who were ever married (47.7%), having appropriate perceptions about caffeine consumption in a low level (46.3%), receiving vocational or some college education (45.9%) and college or university (45.4%) education, as well as aged 40 to 49 years (45.4%).

Caffeine consumption while having at least one illness was found among 29.1% of the working-age participants. Since their chronic illnesses were ranging from physical related diseases, such as hypertension and cardiovascular diseases, gastritis and other gastrointestinal tract related problems, osteoporosis, muscle strain, rheumatoid arthritis, and other musculoskeletal related problems, and endocrine

related problems, to mental related conditions such as stress, anxiety, and sleeplessness. Therefore, they were subjects to be cautioned about caffeine consumption. In addition, caffeine consumption while having illness was found to be higher among working-age participants who were men (30.7%) than women (27.7%), aged 30 to 39 years (32.5%) than other age groups (24.9 to 29.3%), married (30.4%) than single and ever married (25.5%), residing in extended families (29.5%) than nuclear families (29.0%), household members (46.1%) than household heads (45.4%), receiving secondary education (33.0%) than those receiving other education levels (24.1-29.2%), drivers (34.2%) than those in other occupations (21.3-33.3%), or having salary greater than 10,000 Baht/month (31.1%) than those with less salary (28.9%). However, the working-age participants who had appropriate perceptions about caffeine consumption in a moderate level (29.5%) had consumed caffeine while having illness(es) similar likely to those having such perceptions in a low level (29.0%).

Factors affecting CCB

Logistic regression analysis indicated that neither sex, age, marital status, education, type of family, nor perceptions about caffeine consumption of the working-age participants was a significant factor catering to "at risk" practices of CCB, data was not significant at $p<0.05$. Higher income participants (greater than 10,000 Baht/month) were 1.4 times more likely to exhibit "at risk" practices of CCB than the lower income peers (95% CI = 1.1-1.8, $p<0.05$). For the status in a household, the present study found that those who were household members exhibited 1.3 times more likely to perform "at risk" practices of CCB than those who were household heads (95% CI = 1.1-1.6, $p<0.05$). The working-age participants differed in their "at risk" practices of CCB across occupations. Relative to the security guards, the working-age participants who were more likely to exhibit "at risk" practices of CCB (OR: 95% CI) including government and state enterprise officers (1.9 times: 1.2-3.3) and housewives (1.9 times: 1.1-3.1), data was significant at $p<0.01$-0.05 (Table 6).

Discussion

The present study used ample sample size to give more explicit estimations of caffeine consumption for working-age residents in rural setting of Thailand. We initially examined caffeine consumption among working-age residents in the study communities, followed by construction of a caffeine database based on our survey interview guide, a seven-day-caffeine consumption diary, and baseline data form reliable sources[2,31,38].

Despite that the study participants reported their caffeine consumption largely on brand-specified caffeine products, consumption of non-brand caffeine products, such as special coffees available widely in local food and drink shops were also reported. Their mean daily caffeine consumption from all beverage sources was 302.5±176.7 mg/day (women 307.6±179.9 mg/day, men 297.4±174.0 mg/day), which was an increase from the reported 100 mg/day of the respondents in the 1994 nationwide survey on caffeine consumption behavior in Thailand[29], and 200 to 250 mg/day reported for urban residents in Bangkok in 2001[4]. It was also higher than reported in the 2010 and 2011 survey of caffeinated beverage consumers of 122 to 225 mg/day of the adults aged 18 to 64 years in the U.S.[36]. Findings from this current study also indicated some of the Thai working-age population in rural settings had excessive consumption of caffeine. The results showed that 14.3% of them consumed between 500 and 699 mg/day of caffeine, and 6.0% consumed over 700 mg/day of caffeine. These situations serve as alarming signs for local health personnel, policy makers and related authorities to find solutions suitable for this population group based on local problems and needs.

Table 6. Significant factors influencing CCB of the working-age participants (n = 1,321)

Factors	CCB		
	Odds ratio (95% CI)	Beta estimate ± SE	*p*-value
Personal income (≥10,000 Baht/month): no vs. yes	2.050 (1.159-3.625)	0.718±0.291	0.014
Status in a household (A household member): no vs. yes	1.291 (1.028-1.621)	0.255±0.116	0.028
Occupation			
Security guards (baseline)			
Housewives	1.860 (1.108-3.124)	0.621±0.265	0.019
Government and state enterprise officers	1.981 (1.190-3.298)	0.684±0.260	0.009

Five major caffeine sources of this working-age group were coffee (74.7%), energy drinks (66.2%), chocolate milk or drinks and cocoa drinks (51.6 to 55.8%), cola carbonated soft drinks (48.4%), and tea (28.8%). Women consumed caffeine from all sources in a comparable pattern to men. Additionally, 37.4% of the total working-age participants consumed caffeine by mixing it with other substances. Based on the 1994 nationwide survey respondents aged 12 years and over in Thailand[30], covering 4,809 residents of Bangkok and some selected provinces from 12 health regions, further indicated that 16.9% of the respondents consumed caffeine by mixing it with other substances. Of which, their added substances were liquor or beer (90.5%), addictive substance, particularly mate amphetamine (2.5%), and analgesic medication (1.6%), particularly Thamjai and Boadhai brands. The same study further indicated that consumption of caffeine mixing with other substance was highest among respondents residing in the Northeast region both men and women[29]. In the 2004 case control study involving with construction labors in the Central region of Thailand also reported about caffeine consumption by mixing caffeinated beverages, particularly energy drink, with addictive substance, such as Kratom leaf[5]. Kratom leaf, leaf of a plant *Mitragyna speciosa*, which was native to Southeast Asia region[40], was considered as illegal psychoactive substance in Thailand. In contrary to such findings, aside from alcoholic drinking beverage, no other addictive substance was reported to be added in caffeinated drinking beverage among the working-age participants in this current study. Comparative to the previous study[29], this current study also indicated higher proportion (current study vs. previous study) of individuals consuming caffeine mixing with other substances (37.4% vs. 16.9%) and increased caffeine consumption among women (59.4% vs. 32.7%). The increased proportion of the frequent consumers and daily caffeine users, four to seven times/week, was also evidenced among working-age participants both genders in this current study and in the previous study[30] (men and women in this current study vs. men and women in the previous study), particularly government and state enterprise officers (86.4% and 93.5% vs. 11.9% and 1.5%), waged workers, with an exception of drivers and transportation workers (81.1% and 77.1% vs. 48.1% and 13.2%), and agriculturalists (70.8% and 85.7% vs. 29.7% and 5.6%). However, caffeine consumption among drivers and transportation workers in this current study (70.8% and 85.7%), who used to be reported as the top ranking caffeine user group in the previous study (69.2% and 50.0%)[29], was also on the rise but to the lesser degree. Moreover, there were more varieties of caffeine sources reported by the working-age participants in this current study compared to what had been reported in the past[4,5,29], particularly chocolate milk, cocoa drink, and bottled ready-to-drink green tea.

The majority of the working-age participants in this current study had "at risk" practices of CCB in a low (61.5%) to moderate (26.5%) levels, 44.7% of them consumed excessive caffeine (>300 mg/day) and approximately 29.1% of them consumed caffeine while having illness(es). Moreover, 37.4% of them consumed caffeine by mixing it with other substances that were potentially harmful to health. These included other caffeinated products (45.0%), analgesic medication (30.7%), energy drink (15.8%), and alcoholic drinking beverages (8.5%). Mixing of caffeine with other caffeinated drinking beverages led to increased consumption of excessive amount of caffeine to the body, consequently, it increased likelihood of the individuals to have insomnia and sleep latency[3]. It was potentially increased dependency if taking caffeine in an excessive amount in an extensive period[9,18], and potentially caused menstrual disturbances among women who were habitual caffeine users[11]. Consuming of caffeine mixing with analgesic medication such as Paracetamol and Aspirin were found to have some impacts on health. A combination of caffeine and Paracetamol were found to be useful in that caffeine increased absorption of the analgesic thereby enhancing and prolonging analgesic activity that were desirable for the individuals suffering from acute to severe pain, particularly those with low back pain[7]. However, some adverse effects of Paracetamol on hepatic function had also been reported. Taking of Aspirin in certain dose for three consecutive weeks can lead to mild-to-moderate dyspepsia in sensitive individuals[42]. This coupled with some of the working-age participants in this current study has gastrointestinal tract related problems, particularly gastritis, therefore, caffeine consumption among over one-tenth of these working-age population in rural setting is problematic. Moreover, those who consumed caffeine mixing with Aspirin are prone to have more disturbances related to gastric irritation. Energy drink was the third most added substance reported among the working-age caffeine users in this current study. Adding energy drinks may be problematic for sensitive individuals, children, adolescents, and pregnant women because of its high caffeine content (40.0 to 78.0 mg/100 to 150 ml)[38].

The practice of mixing energy drinks with alcohol could also lead to excessive consumption of alcohol and its consequent impacts such as sexual assault and traffic accident caused by an influence of alcohol[41]. In addition, a number of ingredients in energy drinks, such as taurine and niacin, also posed a risk of toxicity[43]. Despite the World Anti-Doping Agency does not categorize caffeine as a prohibited substance[43], however, many researchers indicated the needs for further research on potential for toxicity of caffeine products available in our today-markets. For example, caffeine-based weight loss products also present toxicity risks[43] and is important issue to be further focused among the working-age population and other age groups in both rural and urban settings in Thailand and elsewhere.

Conclusion

Nearly two-fifths of the working-age participants residing in the rural northeastern communities in the present study consumed caffeine beverages, particularly coffee, energy drinks, chocolate milk, and cocoa drinks, as well as carbonated cola soft drink and tea. Their overall CCB was considered as "at risk" practices in a low to moderate level (80.0%). Their "at risk" practices of CCB included having excessive consumption of caffeine, greater than 300 mg/day (54.8%) with an average of caffeine 302.5 mg/day (SD ±176.7), frequent consumption of caffeine (67.4%), modification of caffeine prior to consumption (44.4%), specifically mixing caffeine with other substances such as other caffeinated beverages, alcoholic beverages, and anti-fever or pain medicine (e.g., Paracetamol and Aspirin), as well as consumption of caffeine while having current chronic illness(es) (29.1%), particularly hypertension, gastritis, osteoporosis, muscle strain, rheumatoid arthritis, type II diabetes, and mental related illnesses (e.g., stress, anxiety, and sleeplessness). Factors such as income, household status, and occupation were important determinants of caffeine consumption behaviors among this working-age group. Higher income participants (>10,000 Baht/month) were 1.4 times more likely to exhibit "at risk" practice of CCB than the lower income peers ($p<0.05$) and household members were 1.3 times more likely to exhibit "at risk" practice of CCB than their peers who were household heads ($p<0.05$).

Additionally, those who were government and state enterprise officers, as well as housewives were nearly twice more likely to have "at risk" practices of CCB than their peers who were security guards ($p<0.01$ and $p<0.05$, respectively). A large number of these working-age participants had low to moderate level of appropriate perceptions about caffeine consumption, particularly on the issues related to amount of daily caffeine consumption and related health impacts of mixing caffeine beverages with other substances. Those who were government and state enterprise officers as well as housewives had "at risk" practices of CCB more than their peers in other occupation groups. Given the low to moderate level of the appropriate perceptions about caffeine consumption and the prevalence of caffeine consumption while having illness among this group of population, thereby, increasing the need for health personnel and local administrators, as well as national policy makers to provide and/or plan for solutions suitable for local problems and needs in current day situation in rural Thailand. Importantly, the study on CCB and potential risk practices of mixing caffeine with other substances and the use of caffeine-based weight loss products and toxicity are to be focused in future research studies.

What is already known on this topic?

The research studies on caffeine consumption have been extensively conducted to explain caffeine consumption practices of general population and some groups of population, such as construction labors, industrial workers, university students, high school students. A large body of literature in Thailand focuses on consumption of particular sources, such as energy drink, coffee, carbonated drinks.

What this study adds?

This current research study serves as the first large-scale research study to quantify daily caffeine consumption across different caffeinated beverage types or sources in a rural working-age population in northeastern Thailand. The construction of a database of caffeine values in the present study is also beneficial for determining caffeine dosage across different caffeinated beverage sources. Findings on caffeine consumption and their "at risk" behaviors will be useful for shaping health solutions suitable for local problems and needs in changing social and environmental context, which coffee culture is on the rise.

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Potential conflicts of interest

None.

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พฤติกรรมการบริโภคคาเฟอีนของประชากรวัยทำงานในชุมชนชนบท ภาคตะวันออกเฉียงเหนือของประเทศไทย

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ภูมิหลัง: *ประชากรวัยทำงานในประเทศไทยมีการบริโภคคาเฟอีนเพิ่มมากขึ้น องค์ความรู้และการศึกษาเกี่ยวกับพฤติกรรมการบริโภคคาเฟอีนและความเสี่ยงจากการบริโภคกาแฟในประชากรวัยทำงานในชุมชนชนบทของประเทศไทยยังมีน้อย*

วัตถุประสงค์: *เพื่อศึกษาพฤติกรรมการบริโภคคาเฟอีน (caffeine consumption behavior) และปัจจัยที่มีอิทธิพลต่อพฤติกรรมการบริโภคคาเฟอีนที่เสี่ยงในประชากรวัยทำงาน*

วัสดุและวิธีการ: *การศึกษาเชิงวิเคราะห์แบบภาคตัดขวาง ณ จุดเวลาใดเวลาหนึ่ง ครั้งนี้ใช้วิธีการสุ่มตัวอย่างแบบหลายขั้นตอนได้จำนวนผู้เข้าร่วมโครงการซึ่งเป็นประชากรวัยทำงาน 1,321 คน ที่บริโภคกาแฟ จากจำนวน 3,332 คน ที่อาศัยอยู่ในชุมชนชนบทในภาคตะวันออกเฉียงเหนือของประเทศไทย เก็บรวบรวมข้อมูลโดยใช้แบบสัมภาษณ์พฤติกรรมการบริโภคคาเฟอีน และแบบบันทึกการบริโภคคาเฟอีนในรอบ 7 วัน วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนาและสถิติเชิงอนุมาน ได้แก่ ความถี่ ร้อยละ ค่าเฉลี่ย และส่วนเบี่ยงเบนมาตรฐาน รวมทั้ง binary logistic regression, odds ratio และ 95% confident interval (95% CI)*

ผลการศึกษา: *ร้อยละ 39.6 ของประชากรวัยทำงานในพื้นที่ศึกษาบริโภคคาเฟอีน ประชากรวัยทำงานที่ศึกษา (มีอายุระหว่าง 18-59 ปี, มีอายุเฉลี่ย (± SD) 40.2±8.4 ปี, เป็นเพศหญิงร้อยละ 49.4) บริโภคคาเฟอีนเฉลี่ย 302.5±176.9 มก./วัน โดยร้อยละ 67.4 มีการบริโภคคาเฟอีนทุกวัน สารคาเฟอีนที่บริโภคได้มาจากการดื่มกาแฟ เครื่องดื่มชูกำลัง นมช็อกโกแลตและเครื่องดื่มผสมโกโก้ น้ำอัดลม และน้ำชา พฤติกรรมการบริโภคคาเฟอีนที่เสี่ยง ได้แก่ การบิโภคคาเฟอีนในปริมาณมากกว่า 300 มก./วัน (ร้อยละ 44.7) การบริโภคคาเฟอีนเป็นประจำทุกวัน (ร้อยละ 67.4) การบริโภคคาเฟอีนโดยดัดแปลงสูตรหรือส่วนผสมของเครื่องดื่มรวมทั้งการผสมกับสารหรือเครื่องดื่มอื่น ๆ (ร้อยละ 44.4) และการบริโภคคาเฟอีนในขณะที่มีปัญหาสุขภาพ (ร้อยละ 29.1) ทั้งนี้พบว่ารายได้ สถานะในครอบครัว และอาชีพเป็นปัจจัยที่มีอิทธิพลต่อพฤติกรรมการบริโภคคาเฟอีนที่เสี่ยงของประชากรวัยทำงานกลุ่มนี้อย่างมีนัยสำคัญทางสถิติ ($p<0.01$-0.05)*

สรุป: *ประชากรวัยทำงานที่อาศัยอยู่ในชุมชนชนบทในภาคตะวันออกเฉียงเหนือของประเทศไทย โดยเฉพาะผู้ที่มีรายได้สูง และเป็นสมาชิกในครัวเรือน ที่ประกอบอาชีพบางอาชีพมีความเสี่ยงต่อการได้รับผลเสียต่อสุขภาพที่เกิดจากพฤติกรรมการบริโภคคาเฟอีน และควรเป็นกลุ่มเป้าหมายที่ต้องได้รับคำแนะนำเพื่อการปรับเปลี่ยนพฤติกรรมการบริโภคคาเฟอีนที่เหมาะสมต่อไป*