Caffeine: a cup of care? An exploration of the relation between caffeine consumption and behavioral symptoms in persons with dementia

Kromhout-Wegewijs, M.A.

1

RELATION BETWEEN CAFFEINE AND BEHAVIORAL SYMPTOMS IN ELDERLY PATIENTS WITH DEMENTIA: AN OBSERVATIONAL STUDY

Published as Kromhout MA, Jongerling J, Achterberg WP. Relation between caffeine and behavioral symptoms in elderly patients with dementia: an observational study. The journal of nutrition, health & aging. 2014;18(4):407-10

ABSTRACT

Objectives:

Caffeine is known to improve concentration and reduce fatigue in healthy adults, but high doses may induce anxiety and agitation. Because the effects of caffeine in elderly people with dementia are unknown, this study explores the relation between caffeine and behavioral symptoms in a group of elderly patients with dementia.

Design:

An observational pilot study.

Setting:

A dementia special care unit of a Dutch nursing home.

Participants:

A total of 29 elderly patients with dementia.

Measurements:

Behavioral symptoms were measured with the NPI-NH, and sleep and caffeine consumption were measured using questionnaires.

Results:

A significant relation was found between the total amount of caffeine consumed during the day and apathy [Kendall's tau (KT) -0.287 p=0.03], and the number of times that participants got up at night (KT 0.462; p <0.01). The amount of caffeine consumed after 6 p.m. was also significantly related to the number of times participants got up at night (KT 0.436; p <0.01). Multilevel analysis showed caffeine to be negatively correlated with aberrant motor behavior [b=-0.47 (0.22), Wald (461)=-2.12, p=0.03] and apathy [b=-0.88 (0.45), Wald (461)= -1.96, p=0.05], and showed a significant relation between caffeine consumption after 6 p.m. and the number of times participants got up at night [b=0.48 (0.22), Wald (461)= 2.20, p=0.03].

Conclusion:

This study established an association between caffeine consumption and behavioral symptoms in elderly patients with moderately severe dementia. Therefore, adjusting caffeine consumption could be part of an interdisciplinary approach to behavioral symptoms, particularly when aberrant motor behavior, apathy or sleeping difficulties are involved. These results indicate that further research on the effects of caffeine on behavioral symptoms in dementia is warranted.

INTRODUCTION

Caffeine is a known stimulant and can interfere with several neurotransmissions including acetylcholine, epinephrine, norepinephrine, serotonin, dopamine and glutamate.(1) Animal and clinical studies suggest that caffeine can reduce cognitive decline in Alzheimer's disease.(2, 3) Based on caffeine's interference with neurotransmissions, an effect on behavior can be expected.

The effect of caffeine on the behavior of healthy adults is well studied, but with inconsistent results. One extensive review concluded that caffeine increases concentration and reduces fatigue in healthy adults even with normal use, but used in very large amounts or by sensitive individuals can also lead to increased anxiety and impaired sleep.(4) Anxiety or sleeping difficulties in people with dementia are referred to as behavioral and psychological symptoms of dementia, which also include agitation, depression, aggression, etc.

Behavioral symptoms are common in dementia. Over 80% of patients suffering from dementia exhibit at least one clinically relevant symptom during the course of the disease, especially agitation and apathy.(5) Medication, although frequently used, has only a moderate effect in patients with behavioral symptoms.(6) The use of psychosocial or person-centered interventions are known to positively affect behavior.(7) However, the effect of caffeine on behavioral symptoms is unknown in elderly patients with dementia. Based on the research on the behavioral effects of caffeine in healthy adults, two hypotheses can be formulated on the effect of caffeine on behavioral symptoms in dementia: 1) caffeine might increase behavioral symptoms in dementia; behavioral symptoms such as agitation, aggression and sleeping problems might be a direct result of caffeine consumption due to its stimulating effects on the central nervous system, and 2) caffeine might decrease behavioral symptoms in dementia, i.e. sensory overstimulation, fatigue and decreased alertness can result in agitation or other behavioral symptoms in dementia. Thus, due to its stimulating effects, caffeine might reduce fatigue and increase alertness resulting in a decrease in behavioral symptoms.

Therefore, this study explores the relation between caffeine and behavioral symptoms in elderly patients with dementia, with a focus on sleep, aggression, depression, anxiety, apathy, irritability and aberrant motor behavior (AMB).

METHODS

Procedure

The caffeine consumption and behavior of 29 residents living in the psychogeriatric unit of a nursing home were registered over a 96-h period by nursing staff, using several questionnaires. Baseline characteristics and the Reisberg Global Deterioration Scale (GDS) (8) were provided by the elderly-care physician and the medical records.

Participants

All 31 residents living in the psychogeriatric unit were eligible for the study with the exception of those with active psychiatric (co)morbidity (n=0), or an expected impending death (n=1), or when informed proxy consent was not obtained (n=1); this left 29 available participants for the present study.

Consumption of caffeine

A questionnaire was used to record the number of cups of coffee, tea and cola eight times a day (breakfast, 10 a.m., lunch time, 2 p.m., 4 p.m., dinner time, 7 p.m. and 21 p.m.). In accordance with conventional practice in the Netherlands, participants were free to choose their beverages. The consumption of these beverages was not limited, stimulated or otherwise regulated by the nursing staff. During the study all coffee was drip (filter) brewed in a standardized way and served in a standardized cup of 150 ml, with a caffeine content of approximately 85 mg per cup.(9)

Behavioral problems

Behavioral symptoms were scored using an adaptation of the Neuro Psychiatric Inventory-Nursing Home edition (NPI-NH).(10, 11) The NPI-NH is a reliable and valid observation scale which registers the presence, severity and frequency of behavioral symptoms, and the burden for caregivers.(12) Because the present study focused on specific types of behavior the items addressing delusions, hallucinations, euphoria, disinhibition and appetite were excluded, and only the items agitation/aggression, depression/dysphoria, anxiety, apathy/indifference, irritability/lability and AMB were scored at the end of every 8-h nursing shift, by the on-duty nurse.

Sleep problems were defined as night-time behaviors such as wandering around, but also as the inability to sleep, i.e. lying awake in bed. Instead of the NPI item 'nighttime behaviors' we used a specially developed night-time questionnaire which recorded whether a participant got up at night (including frequency and reason) and whether the participant lay awake in bed or was asleep. The participants were closely observed during 4 consecutive nights. All nursing and nutrition staff were trained in the use of the questionnaires administered in this study.

Statistical analysis

Initially, associations between the total caffeine consumption (during 96 h) and the presence/absence of a specific behavioral symptom (during 96 h) were calculated (SPSS 15.0) using non-parametric Kendall's tau correlation coefficient (KT), due to the small sample size, longitudinal dependency and not normally distributed data.

Because of the nested structure of the data, with (repeated) observations nested within individuals, the data were also analyzed using multilevel analysis. In this analysis data was were perceived as made up of two levels. The first level consisted of the repeated measurements of caffeine consumption (the independent variable), AMB, aggression, depression, anxiety, apathy and irritability (dependent variables). On this level each individual´s scores on a dependent

variable were related to their scores on the independent variable using linear regression equations. The second level consisted of the individuals participating in the study. On this level inter-individual differences in the model parameters of the first level (i.e., the regression coefficients) were modeled. In the current study no predictors for inter-individual differences were included; this means that the parameter values were modeled as normally distributed across individuals. For every dependent variable a separate multilevel analysis was done, and for every dependent variable two models were constructed. The first model analyzed the relation between caffeine and behavioral symptoms during the same time frame, i.e. caffeine consumed in the morning and any behavioral symptoms observed during the morning. However, because the effect of caffeine can last several hours, the relation between caffeine consumption and behavioral symptoms in the subsequent time frame was analyzed in the second model. All variables were entered into the multilevel analysis. Effects that were not significant in this analysis were step-wise removed to arrive at the final models.

RESULTS

Participants

The participants had a mean age of 84 (SD 6.6) years and suffered from moderate to severe dementia (Table 1). Over 50% was diagnosed with Alzheimer's disease. Although 12 of the participants used psychotropic drugs on the study days, none of the dosages was adjusted in the 4 weeks prior to or during the study.

Coffee consumption

During 96 h the participants consumed on average 15 (SD 5.6) units of caffeine. On the first morning the participants consumed a mean of 1.4 (SD 0.9) units of caffeine, followed by 1.8 (0.9), 1.6 (1.5) and 1.4 (1.0) units of caffeine on the subsequent mornings. In the evenings an average of 1.8 (0.8), 1.1 (0.7), 0.8 (0.5) and 1.6 (0.9) units of caffeine were consumed, respectively.

Behavioral problems

Of the 29 participants, 6 showed no behavioral problems of any kind during the entire observation period. The majority (n=18) showed a behavioral symptom to a maximum of once a day, whereas 5 had behavioral symptoms at least once a day. Irritability was the most frequent (n=20), followed by AMB (n=12). Aggression was observed in 9 participants, 5 of whom displayed aggression more than once during the observation period.

There was a significant negative correlation between the total amount of caffeine consumed and apathy (KT -0.287; p=0.03). Other forms of behavioral symptoms had no significant correlation with daily caffeine consumption (Table 2).

Table 1: Baseline characteristics of the study population (n=29).

Sex (n)	
Female	21
Male	8
Age in years: mean (range)	84 (69-96)
Dementia (n)	
Alzheimer's disease	16
Vascular dementia (VD)	4
Alzheimer' disease/VD	1
Korsakoff's syndrome	1
Not otherwise specified	7
Reisberg Global Deterioration Scale (n)	
5 = Moderate	8
6 = Moderately severe	14
7 = Severe	7
Renal function: mean ml/min (range)	59 (26-90)
Caffeine consumption: mean units/day (range)	3.8 (0.8-6.3)
Medical history (n)	
Depression	8
Anxiety disorder	1
Delirium	2
Psychotropic medication ATC (n)	
Antidepressant	5
Antipsychotics	3
Benzodiazepine	4

Table 2: Relation between behavior and total caffeine consumption per day (Kendall's tau correlation coefficient).

	Total caffeine consumption per day
Apathy	-0.287 p=0.03*
Depression	0.187 p=0.11
Anxiety	-0.135 p=0.39
Aggression	-0.179 p=0.11
Irritability	0.000 p=0.50
Aberrant motor behavior	0.850 p=0.29
Sleep: waking up at night	0.043 p=0.38
Sleep: getting up at night	0.462 p<0.01*

* statistically significant

In the first multilevel analysis, the relation between caffeine consumption and behavior was analyzed in the same time frame. A significant negative correlation was found between total daily caffeine consumption and AMB [b=-0.47(0.22), Wald (461)= -2.12, p=0.03] and apathy [b=-0.88 (0.45), Wald (461)= -1.96, p=0.05].

The second multilevel analysis showed no significant correlation between apathy, AMB, aggression, depression, anxiety or irritability and caffeine consumed in the previous time frame. (Table 3).

Table 3: Multilevel analysis of the relation between behavioral symptoms and caffeine consumption

	Model 1 (same time frame)	Model 2 (subsequent time frame)
Apathy	b=-0.88 (0.45), Wald (461)= -1.96, p=0.05*	b=-0.49 (0.69), Wald (432)= -0.72, p=0.47
Depression	b=-0.31 (0.29), Wald (461)= 1.01, p=0.28	b=0.34 (0.36), Wald (432)= 0.94, p=0.35
Anxiety	b=0.48 (0.48), Wald (461)= 1.00, p=0.32	b=1.53 (0.91), Wald (432)= 1.68, p=0.09
Aggression	b=0.22 (0.27), Wald (461)= 0.84, p=0.40	b=-0.15 (0.24), Wald (432)= -0.60, p=0.55
Irritability	b=-0.22 (0.15), Wald (461)= -1.40, p=0.16	b=0.19 (0.18), Wald (432)= 1.07, p=0.29
Aberrant motor behavior	b=-0.47 (0.22), Wald (461)= -2.12, p=0.03*	b=0.49 (0.32), Wald (432)= 1.54, p=0.12

* statistically significant

Quality and quantity of sleep

The nurses walked three rounds each of the 4 nights, totaling 12 observations per participant with a total of 348 observations. Only 3 participants slept continuously during all 4 nights. Of the remaining participants, 3 slept during the nurses' rounds but got up between the rounds, and 23 often lay awake in bed and/or walked around. Of the study participants, 14 (48%) did not get up during the night; the remaining 15 were seen a total of 108 times out of bed by the nurses during the observation period. The most common reason for getting out of bed was to use the bathroom (97 of 108) and, occasionally, just to stretch the legs (3 of 108) and/or due to a general feeling of restlessness (8 of 108). No behavioral symptoms, such as aggression or agitation, were observed during the night.

There was a significant correlation between caffeine consumption during the day and the number of times that participants got up at night (KT 0.462; $p < 0.01$) (Table 2). The amount of caffeine consumed in the evening was also significantly correlated with the number of times participants got up at night (KT 0.436; $p < 0.01$).

In the multilevel analysis, the total amount of caffeine consumed each day showed no significant relation with any form of sleeping problems. However, the amount of caffeine consumed in the evening (after 6 p.m.) was significantly related to the number of times that participants got out of bed [b=0.48 (0.22), Wald (461)= 2.20, p=0.03] (Table 3).

DISCUSSION

In this sample of elderly patients with dementia living in a special care unit a negative correlation between caffeine consumption and apathy and AMB was found. Caffeine consumption after

6 p.m. was correlated with getting out of bed at night. No significant correlations were found between caffeine and aggression, depression, irritability or anxiety.

This pragmatic, observational study is the first study to explore the effects of caffeine on sleep and behavior in patients with dementia but has some limitations which need to be discussed. First, caffeine was ingested orally and consumption was recorded, but serum caffeine levels were not measured. Also, individual differences in caffeine metabolism are likely and could have influenced the results. Second, the observational period was short (96 h). However, because the effect of caffeine usually lasts only a few hours it is likely that any effect of caffeine on behavior would be observed during the 96-h observation period. Third, the sample size was small. Despite these limitations, correlations were found between caffeine consumption and behavioral symptoms, representing a medium to large effect size which can, therefore, be considered relevant.

In the present study, caffeine consumption was negatively correlated with AMB and apathy. AMB encompasses a wide range of repetitive, often purposeless behaviors like wandering, pacing or plucking and is frequently used interchangeably with agitation.(13) Apathy is almost the opposite, a loss of motivation leading to diminished activity and attention. Apathy is a frequently occurring neuropsychiatric symptom of dementia, with a reported prevalence of around 30%.(5) The negative correlation between apathy and caffeine might be a result of apathy itself, with the participants being too apathetic to consume coffee, but might also imply that caffeine consumption can be used as a therapeutic measure. A possible mechanism for this inverse correlation between caffeine and both apathy and AMB is through the acetylcholinesterase pathway. The acetylcholinesterase inhibitor rivastigmine is known to reduce both apathy and AMB in nursing home residents with moderate to severe Alzheimer's disease.(14) Caffeine is also a non-competitive inhibitor of acetylcholinesterase.(1) Using caffeine as a therapeutic measure in both apathy and AMB might, therefore, be an interesting therapeutic option.

Changes in sleep behavior are common in dementia(15) and sleep disorders tend to be more severe in patients with dementia compared to those found in the elderly without dementia.(16, 17) Sleeping abnormalities are associated with an increase in cognitive decline, caregiver burden and behavioral symptoms in patients with dementia.(16) Therefore, it is important to identify and adequately treat all factors contributing to sleeping difficulties. In the present study, no relation between caffeine use and lying awake in bed was found, which is consistent with a previous study.(18) However, caffeine use after 6 p.m. was significantly correlated with the number of times participants got out of bed at night, mostly to use the bathroom. The sleeping difficulties observed in this study cannot be explained by the stimulating effects of caffeine (increased alertness and decrease fatigue), but could simply be due to the diuretic effects of caffeine. Therefore, reducing caffeine consumption after 6 p.m. in patients who get out of bed frequently during the night, especially combined with frequent noctural micturation, could be a simple intervention to improve sleep in elderly patients with dementia.

In conclusion, in these residents, caffeine consumption is negatively correlated with apathy and AMB and positively correlated with getting out of bed at night. Regulation of caffeine consump-

tion might be an easy, inexpensive and effective way to influence behavioral symptoms in elderly with dementia, especially when AMB, apathy or sleeping difficulties are involved; further study seems to be warranted.

REFERENCES

1. Pohanka M, Dobes P. Caffeine inhibits acetylcholinesterase, but not butyrylcholinesterase. Int J Mol Sci. 2013;14(5):9873-82.
2. Espinosa J, Rocha A, Nunes F, Costa MS, Schein V, Kazlauckas V, et al. Caffeine consumption prevents memory impairment, neuronal damage, and adenosine A2A receptors upregulation in the hippocampus of a rat model of sporadic dementia. Journal of Alzheimer's disease : JAD. 2013;34(2):509-18.
3. Canas PM, Porciuncula LO, Cunha GM, Silva CG, Machado NJ, Oliveira JM, et al. Adenosine A2A receptor blockade prevents synaptotoxicity and memory dysfunction caused by beta-amyloid peptides via p38 mitogen-activated protein kinase pathway. J Neurosci. 2009;29(47):14741-51.
4. Smith A. Effects of caffeine on human behavior. Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association. 2002;40(9):1243-55.
5. Zuidema SU, Derksen E, Verhey FR, Koopmans RT. Prevalence of neuropsychiatric symptoms in a large sample of Dutch nursing home patients with dementia. International journal of geriatric psychiatry. 2007;22(7):632-8.
6. Tariot PN. Medical management of advanced dementia. J Am Geriatr Soc. 2003;51(5 Suppl Dementia):S305-13.
7. Vernooij-Dassen M, Vasse E, Zuidema S, Cohen-Mansfield J, Moyle W. Psychosocial interventions for dementia patients in long-term care. Int Psychogeriatr. 2010;22(7):1121-8.
8. Reisberg B, Ferris SH, de Leon MJ, Crook T. The Global Deterioration Scale for assessment of primary degenerative dementia. Am J Psychiatry. 1982;139(9):1136-9.
9. Stephenson PE. Physiologic and psychotropic effects of caffeine on man. A review. J Am Diet Assoc. 1977;71(3):240-7.
10. Cummings JL, Mega M, Gray K, Rosenberg-Thompson S, Carusi DA, Gornbein J. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. Neurology. 1994;44(12):2308-14.
11. Cummings JL. The Neuropsychiatric Inventory: assessing psychopathology in dementia patients. Neurology. 1997;48(5 Suppl 6):S10-6.
12. Zuidema SU, Buursema AL, Gerritsen MG, Oosterwal KC, Smits MM, Koopmans RT, et al. Assessing neuropsychiatric symptoms in nursing home patients with dementia: reliability and Reliable Change Index of the Neuropsychiatric Inventory and the Cohen-Mansfield Agitation Inventory. International journal of geriatric psychiatry. 2011;26(2):127-34.
13. Cerejeira J, Lagarto L, Mukaetova-Ladinska EB. Behavioral and psychological symptoms of dementia. Front Neurol. 2012;3:73.
14. Cummings JL, Koumaras B, Chen M, Mirski D, Rivastigmine Nursing Home Study T. Effects of rivastigmine treatment on the neuropsychiatric and behavioral disturbances of nursing home residents with moderate to severe probable Alzheimer's disease: a 26-week, multicenter, open-label study. Am J Geriatr Pharmacother. 2005;3(3):137-48.
15. Morley JE. Behavioral management in the person with dementia. The journal of nutrition, health & aging. 2013;17(1):35-8.
16. Vecchierini MF. [Sleep disturbances in Alzheimer's disease and other dementias]. Psychol Neuropsychiatr Vieil. 2010;8(1):15-23.
17. Bombois S, Derambure P, Pasquier F, Monaca C. Sleep disorders in aging and dementia. The journal of nutrition, health & aging. 2010;14(3):212-7.
18. Ginsburg R, Weintraub M. Caffeine in the "sundown syndrome." Report of negative results. Journal of gerontology. 1976;31(4):419-20.