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ARTICLE

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Coffee consumption in hemodialysis patients: how many?

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Abstract

Background and aims Coffee is one of the most widely consumed beverages worldwide. However, fluid intake restriction is an important and difficult challenge for hemodialysis (HD) patients. The aim of this study was to analyze the effect of coffee intake on hydration and nutritional parameters of HD patients.

Methods This was an observational, cross-sectional, multicenter study where 373 HD patients from 8 dialysis centers in Portugal were enrolled. A face-to-face questionnaire was applied and patient's clinical and body composition parameters were analyzed. The sample was divided into 3 groups depending on coffee intake: group 1—don't drink coffee, group 2—drink 1–2 coffees/day and group 3—drink 3 or more coffees/day. Laboratory and body composition parameters were registered in the month prior to the questionnaire application. Body composition was assessed with the Body Composition Monitor (BCM; Fresenius Medical Care Deutschland GmbH, Germany).

Results Patient's mean age was 67.2 ± 14.4 years and the mean HD vintage was 61.3 ± 56.2 months. Patients who reported drinking 3 or more coffees daily were younger, presented higher levels of potassium, phosphorus, diastolic BP, albumin and interdialytic weight gain (IDWG) and lower dialysis adequacy (Kt/V). Regarding body composition, patients in the group 3 showed higher body cell mass index (BCMI) and lean tissue index (LTI). On the other hand, the group 1 were the oldest, had a higher Kt/V, a lower diastolic blood pressure (BP) and potassium levels, whereas G2 presented a lower LTI, BCMI and IDWG.

Conclusions Drinking 3 or more coffees daily increases the risk of a higher diastolic BP, potassium and IDWG in HD patients.

Introduction

Overhydration is one of the main clinical features in chronic kidney disease because maintenance hemodialysis (HD) patients are exposed to extreme volume fluctuations and changes of hemodynamic conditions [1, 2]. It is a major contributor to hypertension, dialysis-associated hypotension, pulmonary and peripheral edema, heart failure, left ventricular hypertrophy and other adverse cardiovascular implications. [2] Fluid intake restriction is, therefore, one of the most important and difficult challenges on HD patients [3, 4].

Coffee is a complex mixture of chemicals that provide high amounts of chrologenic acid and caffeine (1,3,7-trimethylxanthine) [5–7]. The amount of caffeine in an espresso coffee (≈50 mL per coffee) in Portugal ranges from 62–88 mg [8]. Several micronutrients are found in an espresso coffee, including potassium (133 mg), phosphorus (5.5 mg), magnesium (5 mg) and niacin (0.35 mg). [9] The stimulant effect of caffeine on physiological and mental states is the main reason for coffee being one of the most habitual consumed beverages worldwide. Coffee is also often related to tobacco and alcohol consumption. In a recent review conducted by Grosso G et al., the authors point out that healthy populations who consume large amounts of coffee will tend to smoke more and to consume more alcohol [10]. Therefore, they strengthened that, until now, the research from observational studies (controlling the possible confounding factor of tobacco use) on the beneficial effects of coffee on cancer, cardiovascular diseases, metabolic and neurological disorders is promising [10]. Beyond its caffeine content and controversial effects on blood pressure control, coffee as a beverage can influence fluid control in the body, as a contributor to the total amount of daily liquids intake.

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In patients in maintenance HD, interdialytic weight gain (IDWG) is directly correlated with fluid intake and, therefore, is a good indicator of compliance to fluid intake recommendations in these patients [7, 11]. For this reason, IDWG consists in a parameter which is frequently monitored and should be maintained below 4–4.5% of patients dry weight or 2.5 Kg [11].

Patients' perception of the benefits of an adequate fluid intake control and their timeliness to change to the recommended behavior is a major contributor for fluid intake compliance [12]. Regardless of their psychological pattern, motivations and/or perceptions we aimed to investigate the impact of coffee consumption on hydration parameters and nutritional status of maintenance HD patients.

Methods

This was an observational, cross-sectional, multicenter study where 373 HD patients from 8 dialysis centers in Portugal were enrolled. A face-to-face questionnaire about fluid intake habits, including frequency of daily coffee consumption (Question: "How many coffees do you drink per day?"), was applied and patient's clinical and body composition parameters were recorded. The sample was divided into 3 groups depending on their daily frequency of coffee intake (≈50 mL per coffee, simple coffee with no added milk or cream):

- Group 1—don't drink coffee
- Group 2—drink 1–2 coffees/day
- Group 3—drink 3 or more coffees/day

We enrolled all the patients from the dialysis centers considering the pre-established inclusion criteria: age ≥ 18 years, 3 times weekly in-center HD for ≥3 months (with an online hemodiafiltration technique) and patients who accept to answer the questionnaire while the exclusion criteria consisted of patients with <18 years, those who presented verbal communications problems and/or patients that were on HD for <3 months. All patients were dialyzed with high-flux (Helixone®; Fresenius Medical Care) membranes and ultrapure water in accordance with the criteria of International Organization for Standardization regulation 13959:2009—Water for hemodialysis and related therapies.

Variables of interest

Age, gender, HD vintage, dry weight, dialysis adequacy, presence of diabetes, body mass index (BMI), IDWG, phosphorus, potassium, serum albumin, C reactive protein (CRP), normalized protein catabolic rate (nPCR), diastolic and systolic blood pressure (BP), fat tissue index (FTI), lean tissue index (LTI), body cell mass index (BCMI) and relative overhydration (overhydration/extracellular water [OH/ECW]) were recorded in the month prior to the questionnaire application.

High IDWG was reported as an IDWG > 4–4.5% of dry weight [11] and severe overhydration as OH/ECW ≥ 15%. Hypertension was defined as systolic BP ≥ 140 mm Hg and diastolic BP ≥ 90 mm Hg. The FTI and LTI reference ranges given by the Body Composition Monitor are based on gender and age.

Body composition measurements

In all patients, body composition was assessed through bioimpedance spectroscopy with the body composition monitor (BCM®; Fresenius Medical Care, Deutschland GmbH, Germany). The BCM takes measurements at 50 frequencies in a range of 5–1000 kHz. The measurement was performed approximately 30 min before the midweek HD session, with 4 conventional electrodes being placed on the patient, who was lying in supine position: 2 on the hand and 2 on the foot contralateral to the vascular access. Regarding the quality of measurements, all exceeded 95% which is the reference for an acceptable measurement quality.

The parameters obtained with the BCM were FTI, LTI, BCMI and OH/ECW.

Statistical methods

Patient characteristics were summarized using standard descriptive statistics. The Kolmogorov-Smirnov test was applied to assess normality.

Patients were categorized according to their group: group 1 (don't drink coffee), group 2 (drink 1–2 coffees/day) and group 3 (drink 3 or more coffees/day). Categorical variables are presented as percentages and continuous variables as mean ± standard deviation or as median and interquartile range, as appropriate. Comparison between the 3 groups was carried out through one-way analysis of variance and the post hoc analysis was performed by *Bonferroni* (Table 1).

Regression models were applied for laboratory and body composition parameters (dependent variables) on coffee consumption (independent variable) after adjustment for potential confounders (Table 2).

All statistical tests were performed using the Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS, Inc., Chicago, IL, USA). Statistical significance was defined as $p < 0.05$.

Table 1 Laboratory parameters and body composition: comparison between groups

Coffee consumption				
	G1 none $n = 123$	G2 ≥ 50–100 mL/day $n = 205$	G3 ≥150mL/day $n = 45$	p
Age (years)[a]	73 (61–80)	71 (63–78)	56 (47.5–66.5)	**<0.001***
Diabetics [n(%)][b]	56 (45.5)	72 (35.1)	12 (26.7)	0.047
HD vintage[a]	35 (16–68)	45 (20–94.5)	52 (20.5–102)	0.064
BMI (kg/m^2)[a]	25.9 (22.4–28.4)	25.5 (22.6–30.1)	26.5 (23.2–30.6)	0.169
Kt/V eq[c]	1.8 ± 0.3	1.7 ± 0.4	1.5 ± 0.2	**0.001**†
DWG (%)[a]	3.1 (2.3–3.6)	3.0 (2.2–3.8)	3.8 (2.3–4.9)	**0.013**‡
Phosphorus (mg/dL)[c]	4.2 ± 1.3	4.2 ± 1.2	4.9 ± 1.3	**0.004**§
Potassium (mEq/L)[c]	5.1 ± 0.8	5.2 ± 0.7	5.5 ± 0.8	**0.020**‖
nPCR (g/kg/day)[c]	1.16 ± 0.28	1.09 ± 0.24	1.15 ± 0.27	0.064
Albumin (g/dL)[a]	3.9 (3.6–4.2)	3.9 (3.7–4.2)	4.1 (3.9–4.3)	**0.007**¶
CRP (mg/dL)[a]	3.6 (1.7–9.3)	6.8 (2.7–13.7)	5.6 (2.3–12.9)	0.196
Diastolic BP (mmHg)[a]	59 (53–71)	62 (53–72)	75 (64–83)	**<0.001***
Diastolic BP ≥ 80 mmHg [n(%)][b]	3 (2.8)	8 (4.5)	8 (20.5)	<0.001
Systolic BP (mmHg)[c]	138.9 ± 24.1	136.5 ± 23.7	143.7 ± 24.8	0.224
Systolic BP ≥ 140 mmHg [n(%)][b]	54 (49.5)	85 (47.8)	23 (59)	0.446
BCMI (Kg/m^2)[a]	6.1 (4.9–7.4)	6.0 (4.8–7.4)	7.9 (6.4–9.7)	**<0.001***
LTI (Kg/m^2)[a]	11.5 (9.9–13.4)	11.4 (9.8–13.5)	14.1 (12.1–16.6)	**<0.001***
FTI (Kg/m^2)[c]	13.0 ± 5.4	13.8 ± 5.6	12.2 ± 5.5	0.194
% OH/ECW[c]	8.4 ± 7.7	7.9 ± 7.9	6.9 ± 7.5	0.616
OH/ECW > 15% [n(%)][b]	20 (18.3)	29 (16.5)	3 (7.7)	0.290

HD hemodialysis, *BMI* body mass index, *Kt/V* dialysis adequacy, *IDWG* interdialytic weight gain, *nPCR* normalized protein catabolic rate, *CRP* C-reactive protein, *BP* blood pressure, *BCMI* body cell mass index, *LTI* lean tissue index, *FTI* fat tissue index, *OH/ECW* overhydration

[a]Results are expressed as median (interquartile range)

[b]Results are expressed as frequencies [(n(%)]

[c]Results are expressed as mean ± SD

*$p < 0.001$ for the difference between G3 and G1 and with G3 and G2, $p = 1.00$ for the difference between G1 and G2 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

†$p < 0.01$ for the difference between G3 and G1, $p = 0.036$ for the difference between G1 and G2, $p = 0.105$ for the difference between G2 and G3 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

‡$p = 0.01$ for the difference between G2 and G3, $p = 1.00$ for the difference between G1 and G2, $p = 0.05$ for the difference between G3 and G1 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

§$p = 0.004$ for the difference between G2 and G3, $p = 0.006$ for the difference between G3 and G1, $p = 1.00$ for the difference G1 and G2 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

‖$p = 0.019$ for the difference between G3 and G1, $p = 1.00$ for the difference between G1 and G2, $p = 0.069$ for the difference between G2 and G3 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

¶$p = 0.005$ for the difference between G3 and G1, $p = 0.036$ for the difference between G2 and G3, $p = 0.695$ for the difference between G1 and G2 by one way ANOVA with post hoc Bonferroni correction for multiple comparisons

Bold denotes significant p-values

Results

This study included 373 maintenance HD patients. The mean age and the mean HD vintage were, respectively, 67.2 ± 14.4 years and 61.3 ± 56.2 months; 54.7% were male and 32.5% diabetics.

Most of the participants (67%) reported an intake of ≥1 cup of coffee/day. Among all the participants, 33.0% ($n = 123$) don't drink coffee (G1), 55.0% ($n = 205$) drink 1–2 coffees/day (G2) and 12.0% ($n = 45$) drink 3 or more coffees/day (G3).

Laboratory and body composition parameters were compared between the 3 groups of daily coffee intake (Table 1).

Patients who reported drinking 3 or more coffees daily were younger [56 (47.5–66.5) years], presented higher

Table 2 Logistic regression analysis for the highest levels of coffee intake

	Univariate analysis OR (95% CI)	*p*	Multivariate analysis[a] OR (95% CI)	*p*
LTI (High: above mean)				
G2	0.868 (0.54–1.41)	0.564	0.660 (0.38–1.14)	0.135
G3	4.082 (1.77–9.41)	**0.001**	1.950 (0.77–4.92)	0.157
FTI (High: above mean)				
G2	1.228 (0.76–1.99)	0.402	1.601 (0.95–2.69)	0.075
G3	0.857 (0.41–1.79)	0.681	1.515 (0.67–3.42)	0.318
IDWG (High: >4.5%)				
G2	1.081 (0.54–2.17)	0.826	1.298 (0.61–2.77)	0.500
G3	3.893 (1.69–8.95)	**0.001**	2.910 (1.17–7.23)	**0.021**
OH/ECW (High: >15%)				
G2	0.878 (0.47–1.64)	0.684	0.784 (0.4–1.52)	0.472
G3	0.371 (0.10–1.33)	0.127	0.329 (0.09–1.26)	0.104
Systolic BP (High: ≥140 mmHg)				
G2	0.931 (0.58–1.50)	0.769	1.051 (0.63–1.75)	0.849
G3	1.464 (0.70–3.07)	0.313	1.344 (0.60–3.02)	0.474
Diastolic BP (High: ≥90 mmHg)				
G2	1.663 (0.43–6.41)	0.460	2.764 (0.58–13.19)	0.202
G3	9.118 (2.28–36.46)	**0.002**	6.754 (1.38–33.16)	**0.019**
Potassium (High: >5.5 mEq/L)				
G2	1.404 (0.85–2.30)	0.184	1.343 (0.80–2.24)	0.259
G3	2.973 (1.46–6.05)	**0.003**	2.602 (1.23–5.50)	**0.012**
Phosphorus (High: >5.5 mg/dL)				
G2	0.923 (0.49–1.75)	0.805	1.016 (0.52–1.98)	0.962
G3	2.121 (0.93–4.86)	0.075	1.749 (0.72–4.23)	0.214

LTI lean tissue index, *FTI* fat tissue index, *IDWG* interdialytic weight gain, *OH/ECW* overhydration, *BP* blood pressure

[a]Multivariate analysis: adjusted for age, gender, diabetes and HD vintage

Bold denotes significant p-values

levels of potassium (5.5 ± 0.8 mEq/L), phosphorus (4.9 ± 1.3 mg/dL), diastolic BP [75 (64–83) mm Hg], albumin [4.1 (3.9–4.3) g/dL] and IDWG [3.8 (2.3–4.9)%] and lower dialysis adequacy (Kt/V) (1.5 ± 0.2). Regarding body composition, patients in the G3 showed higher BCMI [7.9 (6.4–9.7) Kg/m^2] and LTI [14.1 (12.1–16.6) Kg/m^2].

On the other hand, the G1 were the oldest [73 (61–80) years], had a higher Kt/V (1.8 ± 0.3), lower diastolic BP [59 (53–71) mmHg] and potassium levels (5.1 ± 0.8 mEq/L), whereas G2 presented a lower LTI [11.4 (9.8–13.5) Kg/m^2], BCMI [6.0 (4.8–7.4) Kg/m^2] and IDWG [3.0 (2.2–3.8)%].

No statistically significant differences were found between groups in regard to HD vintage, BMI, nPCR, CRP and systolic BP, FTI and overhydration.

Drinking 3 or more coffees/day was shown to be a strong predictor of a higher diastolic BP, high IDWG and high potassium levels, even after adjustment to age, HD vintage, presence of diabetes and gender (Table 2).

Discussion

The effect of coffee consumption on clinical and nutritional parameters was investigated in 373 HD patients from 8 dialysis centers in Portugal, taking into account some potential confounding factors. Daily coffee consumption increases the risk of higher diastolic BP, IDWG and potassium levels.

Patients who reported a daily intake of 3 or more coffees were younger than those with lower intakes (G1 and G2). In the study conducted by Grosso et al., which included the participants of the Health, Alcohol and Psychological factors In Eastern Europe (HAPIEE) project, coffee drinkers were characterized by a younger age [13]. Possibly, these patients consume a higher amount of coffee, because they are more active and some of them maintain their professional activity [13]. The ability of caffeine to promote vigilance, reduce sleepiness and enhance performance [14] may be the reasons for the reported intake by younger people. It has been described that HD patients frequently present cognitive impairment with marked executive dysfunction and reduced attention [7]. The habitual coffee consumption has benefits on cognitive performance by enhancement of attention, concentration and vigilance [7].

Concerning Kt/V, G3 patients presented lower values of dialysis adequacy. Patients in the G3 were younger and presented a higher BMI, therefore, we can speculate that this group of patients has a higher urea volume distribution which influences the Kt/V final result. However, we observed that, despite being lower in the G3, Kt/V is above the recommended value in the three groups of patients.

The G3 showed higher levels of potassium when compared with G1 and G2. A possible explanation for this fact is that, while 1–2 coffees/day have 135–270 mg of potassium, 3 or more coffees can reach 400 mg of potassium per day, which is very significant once the recommended daily intake of potassium in HD patients is between 1950–2730 mg/day [11]. Apart from coffee, there are other factors that can also affect the increase in potassium levels such as metabolic acidosis, constipation and consumption of foods/drinks rich in this mineral. However in our study we did not evaluate the influence of those issues. After adjustment for confounding variables, the influence of coffee consumption in potassium levels was confirmed.

With regard to BP, the group of HD patients that drink 3 or more coffees per day presented higher systolic BP ($p = 0.224$) and diastolic BP ($p < 0.001$). After adjustment for confounding variables, the daily intake of 3 or more coffees revealed a significant influence only in diastolic BP. The

systematic review conducted by Mesas A. et al. [15] concluded that, in hypertensive subjects, caffeine raises blood pressure for ≥3 h after ingestion. There is no evidence about usual coffee drinking and its relationship with the risk of high BP or which is the exact connection between them [16]. It was shown, through a meta-analysis, that higher coffee intake is associated with a modest decline in the risk of hypertension. Authors reinforce the possible influence of smoking and sodium ingestion in that association [17]. Data published by Grosso et al. [18] (considering healthy population) showed that coffee intake seemed to be inversely associated only with systolic BP and coffee drinking above 4 cups per day (600 ml) did not raise the risk of hypertension in a significant way [18]. They also pointed out that, even though the acute consumption of caffeine increases BP, when ingested through coffee, the hypertensive effect may be in some way reduced [18].

Microvasculature regulates tissue blood blow and systemic BP. Systolic BP is generated by conductance vessels, whereas the diastolic consists of peripheral resistance. As a result, an increase in systemic resistance leads to a rise in diastolic BP [19, 20]. Perhaps, it seems possible that our results are due to the effect of caffeine in increasing vascular resistance which can cause an increase in the diastolic BP [19].

Although overhydration, measured by BCM, was not influenced by the daily number of coffees consumed, dialysis adequacy was worst in the G3. Moreover, it was confirmed, after adjustment, that drinking 3 or more coffees per day influenced IDWG. Drinking this amount of coffee results in, at least, ≈150 ml of liquid. Considering an HD patient, without residual diuresis and whose daily recommendation for fluid intake is around 500 ml per day, that amount of coffee is significant, taking into account that other liquids will be ingested, such as water. Moreover, it is important to highlight that an accurate estimate of dry weight is important for a correct interpretation of the adequate percentage of IDWG.

In addition to increasing IDWG, as mentioned before our results showed that the consumption of 3 or more coffees per day also increased diastolic BP, independently of patients´ age, gender, HD vintage and presence of diabetes. In a study conducted by Song et al., with 5369 HD patients, it was shown that a greater IDWG and noncompliance with the dialysis regimen are independent risk factors for higher systolic and diastolic BP [21].

Regarding body composition parameters, the G3 presented better body composition parameters, with higher LTI ($p < 0.001$), higher BCMI ($p < 0.001$) and lower FTI ($p = 0.194$). In line to our results, except for FTI, which did not present significant differences between our groups, the study conducted by Grzegorzewska A et al. [22] with 30 dialysis patients (26 patients on HD and 4 patients on peritoneal dialysis), showed that the group of coffee drinkers (which drink at least 1 cup of coffee daily) presented lower fat mass and higher lean body mass. Authors emphasized the role of coffee consumption as one of the factors affecting bone mineral density in dialysis patients. Grzegorzewska et al. [22] exclude protein undernutrition as a reason for bone loss in coffee drinkers because, together with the findings related with FTI and LTI, their patients presented higher serum albumin concentrations. In our sample it was also found that the group with a higher coffee intake presented higher albumin levels ($p = 0.007$). In other study conducted by Grzegorzewska et al. [23] with an evaluation of serum lipid profile, the authors confirmed once more that coffee drinkers had a favorable body composition (lower body fat mass and higher lean body mass) as well as a higher serum albumin [23]. Although in our study the serum lipid profile was not analyzed, our results regarding the other parameters were in line with these findings, as mentioned above.

When comparing to patients who reported no coffee intake and after adjustment to possible confounding variables such as age, HD vintage, presence of diabetes and gender, higher levels of coffee intake almost triples the odds of having an IDWG above the recommended values (OR 2.91, 95% CI: 1.17, 7.23). What is more, in these patients, the probability of presenting diastolic BP > 90 mmHg is 6.7 times higher (OR 6.75, 95%CI: 1.38, 33.2) and more than doubles the probability of having potassium levels > 5.5 mEq/L (OR 2.60, 95% CI: 1.23, 5.50).

Some limitations should be considered when interpreting the results of this study. Our study design was cross-sectional, so hypothesis for causal relations cannot be drawn. We did not evaluate patient's smoking status and how this was related with coffee consumption and how can compromise IDWG in our population. A study conducted by Petrušić N et al., concluded that long-term smoking affects the function of the salivary glands which reflected in the reduced secretion of saliva [24], one of the major causes of xerostomia in HD patients [25]. Coffee drinking was assessed by self-reports through a questionnaire. Thus, the information about coffee consumption could be over- or underestimated. It is possible too, that patients with hypertension could have been advised to decrease coffee consumption in the past, which might have limited their coffee consumption after the diagnosis. Additionally, we do not have analyzed data about other food/drinks intake to compare the influence of that consumption in the nutritional parameters studied.

A strong point of this study was the large number of our sample included from different dialysis centers around the country. To our knowledge, this is the first study associating coffee intake with IDWG and overhydration in hemodialysis patients.

Conclusion

In one hand, this cross-sectional study indicates that drinking 3 or more coffees daily (≈50 ml per coffee) increases the risk of a higher diastolic BP, potassium and IDWG in HD patients. On the other hand, it seems that drinking 1–2 coffees daily can be considered as a safe amount because it has no significant effect in these patients nutritional status, neither on IDWG nor on their diastolic BP.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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