

Original Research Article

A cohort study on change in hemoglobin levels in Indian female tea and coffee drinkers currently on oral iron therapy for iron deficiency anemia

Urvashi Bharia*, Manisha Srivastav

Department of Community Medicine, Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, Maharashtra, India

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***Correspondence:**

Urvashi Bharia,

E-mail: drurvashibharia@gmail.com

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ABSTRACT

Background: Anemia affects 57% of all nonpregnant Indian women between 15-49 years, as per NFHS-5 (2021). Socioeconomic and gender-based dietary inequality contribute to the prevalence of iron-deficiency anemia (IDA). The inhibitory effects of tea and coffee on iron absorption are well documented. Both beverages are commonly consumed in India, as accompaniments or meal substitutes. NFHS-5 doesn't provide data on the prevalence of IDA in particular.

Methods: Hemoglobin levels were collected from patient records for six months, from the beginning of treatment till the end of the study duration. Beverage consumption habits and compliance with oral iron therapy (OIT) were studied. The primary objective was to establish a correlation between excessive beverage consumption and unsatisfactory hemoglobin outcomes at the end of OIT.

Results: Of 380 anemic women interviewed, 160 (136 tea; 24 coffee) presented with IDA. Tea consumption was significantly associated with poor improvement in hemoglobin levels ($p=0.003$). Mean therapy duration was 4.31 ± 1.64 months with hemoglobin improvement of 0.58 g/dL (95% CI: $0.49-0.67$, $p<0.0001$). Compliance with OIT was 79.41%. 38.23% reported adverse effects like constipation, black stool, and nausea with headache ($n=2$); however, this did not reflect negatively on therapy compliance. Coffee consumption is not prevalent among lower socioeconomic groups in urban Mumbai; hence, no conclusions can be drawn. However, a downward trend between increased coffee intake and improvement in hemoglobin levels was found.

Conclusions: Excessive tea consumption might be associated with decreased efficacy of OIT. 35.7% of anemic women interviewed presented with IDA, indicating a dominance of non-nutritional etiologies.

Keywords: Anemia, Nutrition, Iron deficiency, Tea, Coffee, Prevalence

INTRODUCTION

Anemia, defined as a hemoglobin level <12 gm/dl, affects up to 57% of all nonpregnant Indian women aged 15-49, as per the NFHS-5 Survey 2021.¹ Nutritional strategies to manage iron deficiency anemia (IDA) include enhancing iron absorption through vitamin A and C intake, and reducing the consumption of iron inhibitors such as tea, coffee, and dairy.² Though treatment guidelines

recommend against the consumption of these beverages at and around mealtimes, patient compliance in this regard remains questionable. Due to these social practices, this study is relevant in the context of Indian society. It can be theorized that poor consumption habits and adherence to treatment guidelines could undermine the success of oral iron therapy (OIT).

Around 80% of Indians consume an average of 3 cups of tea per day, or 786 grams per year, along with added milk.^{3,4} There is no significant variation based on socioeconomic group.⁵ Both milk and tea are inhibitors of iron absorption.² The inhibitory effect of tea has been well studied. Tea contains caffeine, tannins, and polyphenols that inhibit iron absorption. However, polyphenol consumption has a paradoxical effect on serum iron levels, i.e., they inhibit iron absorption but increase erythropoiesis.⁶⁻⁸ According to the Coffee Board of India, 44% of the Indian population drinks coffee regularly, with 75% of coffee drinkers reporting 1-2 cups/day.⁹ Studies have shown that coffee inhibits iron absorption in a concentration-dependent fashion. The main phenolic compound in coffee, chlorogenic acid, is a potent inhibitor of nonheme iron absorption.^{10,11}

We conducted a pilot study to find that, despite more than six months of continuous OIT, several women's complete blood count tests continued to report an unsatisfactory rise in hemoglobin levels, and they were still anemic post-treatment. Further, multiple women reported tea consumption more than twice a day, with some claiming tea as their primary meal.

Lee et al demonstrated a negative correlation between coffee consumption and ferritin levels in a study on premenopausal Korean women.¹² There was no significant correlation with the consumption of green tea. Nyakundi et al suggested that high tea consumption is positively associated with iron deficiency among women of childbearing age in Kenya.¹³ Overall, limited studies have been published on the correlation between tea/coffee consumption and hemoglobin levels, and none have been published so far on the effects of tea/coffee consumption while undergoing OIT.

Objectives

The primary objectives of this study were to check for change in tea and coffee levels in women with IDA who are currently undergoing OIT; to analyze the association of tea/ coffee consumption on this change in hemoglobin level; and to check the overall patient compliance with OIT and document the commonly-encountered side effects.

The secondary objective were to calculate the prevalence of specifically IDA in urban Mumbai, as NFHS only provides data on anemia prevalence, without providing the specific etiologies; and calculate the response rate of IDA following OIT.

METHODS

Study design and data sources

A retrospective as well as prospective observational cohort study took place in the Medicine and Hematology OPDs of a tertiary care hospital in urban Mumbai, India.

Sample size was calculated to be 380 based on the 57% prevalence, 95% confidence interval, and 5% margin of error. Female patients with anemia were selected on the basis of their hemoglobin levels. Patients who met the inclusion criteria were recruited. Their hemoglobin levels were collected from patient records at the start and end of treatment. Participants were provided with a questionnaire on their beverage consumption habits, compliance with OIT, and associated side effects.

This study adheres to the STROBE guidelines for cohort studies. All protocols have been approved by the Institutional Ethics Committee of Lokmanya Tilak Municipal Medical College & General Hospital, Mumbai, and comply with the Declaration of Helsinki (1975), as revised in 2013. Participants providing vague or uncertain data were excluded to maintain an accurate quality of data. Laboratory values were collected directly from verified patient records to avoid any errors.

Study population

380 female diagnosed anemics, currently prescribed OIT by their physician, were recruited for participation between February and August 2025. They met the following inclusion criteria: age 15-49 years; hemoglobin <12 g/dl; have attained menarche (i.e., menstruate regularly); and not pregnant at the time of recruitment. Patients on parenteral iron supplementation or diagnosed with anemia-causing pathologies were excluded from the study.

Statistical analysis

Frequency analysis was conducted to understand the general population characteristics. Bivariate regression analysis was performed on IBM SPSS v30. Tea or coffee consumption in grams and OIT duration in months were taken as dependent variables influencing the recorded change in hemoglobin levels. Mean change in hemoglobin was calculated using a single-tailed t test. Compliance with OIT and the prevalence of side effects were also calculated. The overall prevalence of IDA in the anemic COHORT was analyzed.

RESULTS

Participants

Out of the total sample size of 380, 160 women presented with IDA, yielding a 35.7% prevalence of IDA. 136 of these women reported regular tea consumption, and 24 reported coffees. None reported both tea and coffee. All participants consumed milk with their beverage. None consumed lemon or decaffeinated drinks. Owing to the small sample size of the coffee arm, regression analysis was not performed due to a lack of statistical significance. General characteristics of the participants are mentioned in Table 1.

Table 1: Baseline characteristics of the included female anemic tea-drinkers.

Baseline characteristics	Values
Age* (years)	31.61±9.7
Number of participants	136
Oral iron therapy duration* (months)	4.31±1.64
Hemoglobin levels at the beginning* (g/dl)	9.76±1.21
Hemoglobin levels at the end* (g/dl)	10.37±1.28
Daily tea consumption**	6.25 g (total, twice daily)
Daily coffee consumption**	5g (total, once daily)

*Mean±standard deviation; **Median.

Table 2: Hemoglobin characteristics of the female anemic population based on grams of tea consumed per day.

Daily tea consumption	<5 grams	5-10 grams	10-15 grams	15-20 grams	≥20 grams
Number of participants	30	42	35	15	14
Age (years)*	31.54±9.75	31.63±9.64	31.61±9.79	31.63±9.81	31.59±9.79
Cups drank per day**	1	2	2	3	4
Hemoglobin levels at beginning (g/dl)*	9.82±1.19	9.85±1.16	9.8±1.22	9.82±1.16	9.78±1.37
Hemoglobin levels at end (g/dl)*	10.4±1.26	10.42±1.24	10.37±1.29	10.39±1.25	10.33±1.48
Change in Hb (g/dl)*	0.58±0.54	0.57±0.54	0.57±0.54	0.56±0.53	0.55±0.53

*Mean±standard deviation; **Median.

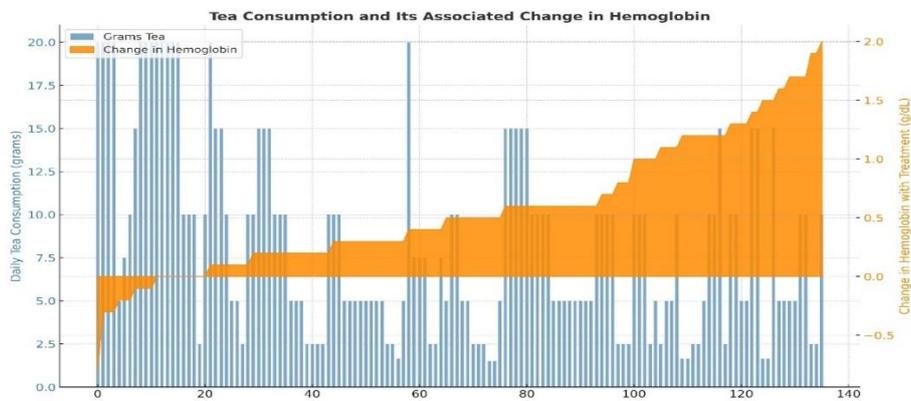


Figure 1: Individual participants' daily tea consumption (in grams) and change in hemoglobin after treatment.

^aNote that with a few exceptions, a negative or small change in hemoglobin is observed in frequent tea drinkers.

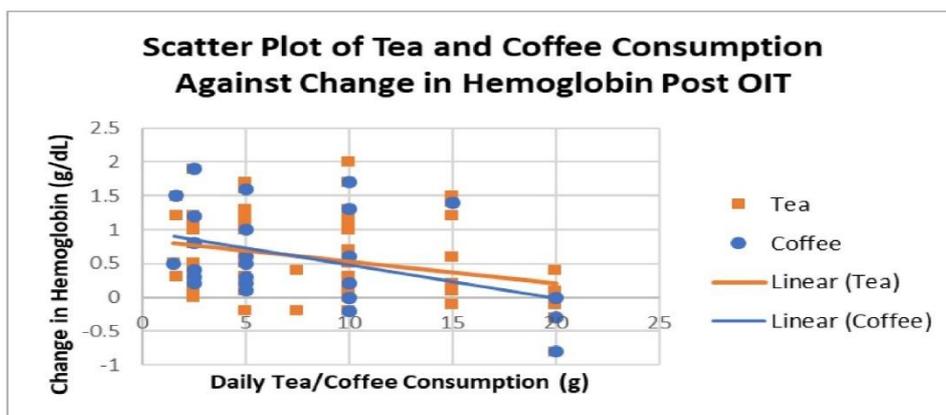


Figure 2: Scatter plot depicting a downward trend between improvement in hemoglobin levels and frequent tea or coffee consumption.

^aNote the correlation between poor improvement in hemoglobin levels and excessive tea consumption; ^bA stronger inverse relationship is observed among coffee drinkers; ^cStatistical test performed in univariate linear regression using Microsoft Excel 2024.

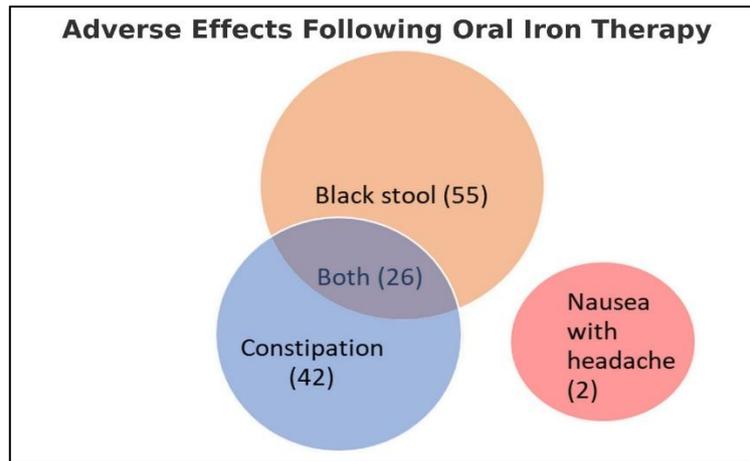


Figure 3: Adverse effects reported during oral iron therapy.

^a79.41% compliance is reported, with only 38.23% reporting adverse effects.

Table 2 presents the COHORT subdivisions on the basis of total daily tea consumption. Tea drinking behavior is expressed in terms of grams of tea leaves consumed per day, as cup size can show some variation that might skew results. As per standard measurements, 1 spoon of tea leaves is taken as 2.5 grams.

Figure 1 depicts a non-monotonic downwards trend in hemoglobin levels following OIT, in participants consuming up to 20 grams (4 cups) of tea per day. Except for some outliers, there is a steady increase in hemoglobin improvement rates in participants who drank less tea.

Primary outcomes

Bivariate regression analysis

Mean improvement in hemoglobin levels is 0.58 g/dl (95% CI: 0.49-0.67, $p < 0.0001$), calculated by a single-tailed t test. Both tea consumption in grams and OIT duration are significantly correlated with this change in hemoglobin. Standardized regression coefficient of tea consumption in grams is $\beta = -0.25$ ($p = 0.003$), indicating an inverse relationship. Increased OIT duration in months is directly correlated with improved hemoglobin ($\beta = 0.75$, $p = 0.008$). This indicated that tea consumption is a stronger, albeit negative, predictor of change in hemoglobin levels.

Regression analysis for the coffee cohort has not been performed. However, the scatter plot demonstrates a downward trend (Figure 2).

OIT compliance and prevalence of adverse effects

79.41% reported compliance with OIT regimens prescribed by their physician, with the majority consuming OIT with breakfast. 38.23% report adverse effects, namely constipation and black stool, with one participant reporting nausea and headache ($n = 2$). A Venn diagram of the same has been provided.

Secondary outcomes

While the mean hemoglobin level at the start of treatment is 9.76 ± 1.21 g/dl, most women are still anemic at the end of treatment (mean hemoglobin 10.37 ± 1.28 g/dl), though hemoglobin levels demonstrated a slight improvement (mean improvement 0.58 ± 0.54 g/dl). Only 18 of the 160 women (11.25%) achieved hemoglobin > 12 g/dl (classified as non-anemic) following treatment.

DISCUSSION

Key results and interpretation

India is a predominantly vegetarian society.¹⁴ This, as well as other factors such as socioeconomic and gender-based dietary inequality, contribute to severely limited iron bioavailability, which sets a precedent for IDA.^{1,15} India reports anemia across all genders and age groups. Worryingly, the prevalence of anemia appears to have risen since the previous NFHS-4 study conducted in 2015-16.¹⁶ Our results agree with Thankachan et al and Nyakundi et al that excessive tea consumption can contribute to IDA in women.^{13,17}

Sharma et al found 2 or more cups of tea per day to be a significant risk factor for anemia.¹⁸ The COHORT consumed a median of 2 cups (6.5 grams) of tea per day. Studies on pregnant women have strongly correlated excess tea consumption with anemia.¹⁹ Lee et al and Sung et al reported no significant correlation with green tea.^{12,20} The COHORT in this study exclusively consumed black tea, which might have a stronger negative effect on iron absorption than green.

A clinical trial by von Siebenthal et al recommended consuming OIT in the morning along with an ascorbic acid-rich drink like orange juice.²¹ Orange juice is notably unaffordable for Indian underserved populations; however, clinical trials comparing the efficacy of OIT consumption alongside an ascorbic acid-high, affordable

equivalent like lemon juice, or vitamin-C supplementation might yield successful results.

Owing to the statistically insignificant sample size of our coffee-drinking cohort, we decided against performing a regression analysis. The notable downward trend, however, has been observed in published literature across ethnic groups and has a physiological basis.^{11,12,19}

Our study reported a persistent anemic condition despite 6 or more months of OIT. Current guidelines under the Anemia Mukta Bharat Programme recommend prophylactic weekly 100mg elemental iron and 500 mcg folic acid supplementation throughout the reproductive period for women of childbearing age. Standardized treatments with specific dietary correlation for anemia have not been explored, leaving treatment plans open-ended.²² It is of note to mention that despite the iron and folic acid supplementation provided under this program, the prevalence of anemia did not significantly decrease.²³

This is reflected in the variations in patient records and prescriptions analyzed during this study. The overarching consensus, however, is that despite the treatment plan described by the physician, achieving a hemoglobin level above the anemic cutoff is unlikely. Ghosh et al explored the possibility of anemia overdiagnosis and proposed a lowered cutoff of 11 g/dl for anemia in Indian women.²⁴ Analyzing our same dataset with the new cutoff as 11 g/dl, we observe that 28 out of 135 (25 of the COHORT of 160 IDA patients reported hemoglobin above 11 g/dl at the start of treatment) women achieved the cutoff after dedicated OIT. This 20.7% response rate, albeit still lower than what is ideal, is greater than the current 11.25%. Moreover, a standard nationwide treatment regimen for anemia and specifically IDA is the need of the hour.

Iron deficiency is not the only factor contributing to anemia.²⁵ While NFHS surveys the overall prevalence of anemia, it fails to differentiate between IDA and non-IDA causes, artificially inflating the risk and potentially influencing treatment strategies. Our cohort reported a 35.7% prevalence of IDA, comparable to 34.5% found in Andhra Pradesh.²⁶ Rural populations report a significantly higher prevalence of IDA, possibly due to malnourishment, poverty, and lack of outreach programmes.²⁷ It is important to evaluate the prevalence of pure IDA due to nutritional deficiency. Ghosh et al found IDA to make up only one-third of the total anemia prevalence.²⁸ This is reflected in our study. In a country where any case of anemia is automatically assumed to be IDA, and guidelines suggest nutritional supplementation as the first line of treatment, screening for other possible causes of anemia may often be overlooked. This can severely affect treatment protocols, and the patient may not receive appropriate therapy until much later. This can negatively affect patient outcomes.

This COHORT study has some limitations. The questionnaire format can lead to potential recall bias. Moreover, the exact causal relationship between tea consumption and decreased efficacy of OIT has not been established. However, owing to the urban setting and even distribution of ages, Indian sub-ethnicities, and religions in our cohort, these results can be generalized to the Indian population. Another strength is the uniform age distribution across the tea-drinking cohort, indicating that the results are valid for the entire 15-49-year-old nonpregnant female demographic.

CONCLUSION

In conclusion, excessive tea consumption shows a significant negative correlation with improvement in hemoglobin levels in female IDA patients taking OIT. Therapy duration has a stronger positive correlation than tea consumption. OIT has a high compliance rate, and the side effects are manageable. The prevalence of IDA in urban populations might be lower than it currently appears on national databases. Future studies on the possible revision of hemoglobin cutoffs for anemia, and a nationwide standardized treatment and diet plan are recommended.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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