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Original Research Article

Impact of tea consumption frequency on hemoglobin and ferritin levels: a comparative analysis

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ABSTRACT

Background: Tea is the second most widely consumed beverage in the world, appreciated for its cultural value and biological compounds with antioxidant and cardioprotective properties. Nevertheless, its polyphenolic composition, especially tannins, has been demonstrated to impair non-heme iron absorption, thereby posing a question about its influence on iron status.
Methods: The study was conducted at the Department of Medical Lab Science, IIAHS&R, Lucknow, performed from a period of three month. A total of 60 subjects, aged 18-60 years, were selected and equally distributed into regular tea consumers (consuming a minimum of 1 cup daily for the past 3 months) and occasional tea consumers. Hemoglobin and ferritin concentrations were assessed and statistically analysed employing the independent samples t-test.
Results: The results showed significantly lower mean hemoglobin and ferritin concentrations in regular tea consumers compared to occasional tea consumers.
Conclusions: These results indicate that regular tea consumption may affect iron absorption, resulting in reduced iron stores and capacity to transport oxygen.

Keywords: Hemoglobin, Regular vs. occasional tea drinkers, Serum ferritin

INTRODUCTION

Tea is one of the most popular and consumed drinks worldwide, second only to water. Tea is part of many cultures and traditions and has been used for centuries as a comfort beverage and as a traditional medicine for its health benefits. The four main types of tea are black, green, oolong, and white tea, and they are derived from Camellia sinensis. Black tea is the most popular and consumed tea worldwide, especially in India, Pakistan, China, and the UK. Tea contains various bioactive compounds like polyphenols, flavonoids, catechins, and tannins, which give tea its antioxidant, anti-inflammatory, anti-carcinogenic, and cardioprotective properties.[1]

However, in recent times, tea's possible negative effect on iron absorption has been a concern. Polyphenolic compounds, especially tannins, in tea are responsible for inhibiting non-heme iron absorption by binding to iron in the gastrointestinal tract and forming insoluble complexes.[2] Iron plays a vital role in the synthesis of hemoglobin, oxygen transport, metabolism, immune

system function, and DNA synthesis. The concentration of hemoglobin represents the oxygen-carrying capacity of the blood, whereas ferritin represents the iron stores. Deficiency of either of these may lead to iron deficiency, which may cause iron deficiency anemia, fatigue, weakness, impaired cognitive ability, and compromised immune system.[4]

Several studies have investigated the link between tea consumption and iron status. Ahmad and Moosa documented reduced levels of ferritin in tea drinkers.[6] Kim et al documented reduced levels of ferritin with increased tea and coffee consumption among Korean adolescents.[4] Walczyk and Hurrell showed the inhibitory effect of green tea on the absorption of non-heme iron.[9] These studies indicated that tea consumption, especially when taken in excess or with meals, may impair iron status. Population studies have also supported this relationship. The Korean National Health and Nutrition Examination Survey 2018 found a statistically significant relationship between tea/coffee consumption and lower ferritin levels.[2] Other studies have found similar findings in European and UK populations.[14,16]

Besides ferritin, another parameter is hemoglobin. Studies on premenopausal women have shown that tea consumption is associated with lower levels of hemoglobin in tea consumers than in non-consumers.[1] This indicates that tea consumption may lead to a decrease in oxygen transport potential due to a decrease in red blood cell production.

How tea consumption influences iron absorption is dependent on several factors. It is known that tea consumption between meals may have a lesser effect, and vitamin C may increase non-heme iron absorption, thus counteracting tea-induced effects. On the other hand, a high intake of phytates, calcium, or oxalate may further decrease iron absorption.[18,26]

In previous studies, participants were simply classified as ‘tea consumers’ or ‘non-tea consumers.’ However, the difference between regular tea drinkers and occasional tea drinkers has not been taken into account. It is essential to differentiate between regular tea drinkers, defined as those consuming tea daily or more than once a day, and occasional tea drinkers, defined as those consuming tea a few times a week or less. Regular tea drinking might result in the sustained inhibition of iron absorption, causing the depletion of iron stores. On the other hand, occasional tea drinking might not have any clinical consequences.

In light of the fact that tea drinking is a common practice all over the world, coupled with the fact that iron-deficiency anemia has become a burden, especially in developing countries, the relationship between tea drinking and iron metabolism has become timely and necessary.

METHODS

Study design and setting

This study was designed as an observational and comparative study conducted over a period of three months. The study was carried out at the Department of Medical Laboratory Science, IIAHS&R, Lucknow.

Inclusion criteria

Individuals aged 18-60 years who consumed tea were included in the study. Participants were required to be free from any known chronic illnesses affecting iron metabolism, such as thalassemia, hemochromatosis, or chronic kidney disease. Individuals with diverse dietary habits, including both vegetarian and non-vegetarian diets, were considered eligible. Both male and female participants were included to assess gender-based variations in haemoglobin and ferritin levels.

Exclusion criteria

Participants were excluded if they did not consume tea regularly (i.e., drank tea rarely or infrequently) or if they had chronic illnesses affecting iron metabolism. Individuals who had taken iron or vitamin supplements within the past three months were also excluded. Pregnant or lactating women and individuals with a history of recent blood loss, including blood donation, surgery, or major bleeding within the past six months, were not included in the study. Additionally, frequent tea consumers (≥2 cups per day) were excluded.

Sample size

The sample size for this study includes a total of 60 participants, to which there is 30 Control grouped, and 30 Cases grouped. Information consent is obtained by the individuals who participated in the study at the time of sample collection. The sample size is calculated using the formula (Rosner, 2010) as:

$n = [(Z\alpha + Z\beta)^2 * 2 * \sigma^2] / d^2$

For quantitative variable, n = sample size in each group, r+1/r = ratio to control to cases, σ2 = Standard deviation of the outcome variable (0.33), Zα = Represent the desired level of statistical significance (typically 1.96) total Zβ = Represent the desired power (typically 0.84 for 80% power) Difference = Effect size (the difference in means) (1.21-0.97)

$n = (1.96+0.84)^2 * 2 * (0.33) / (1.21-0.97)$.

The calculated sample size = 60, out of which cases = 30 and controls = 30 as calculated using the value obtained from the previous study conducted in 2016 by Mendez et al.

Statistical analysis

An independent samples t-test was used to compare the Hemoglobin and ferritin levels between the two groups. Both parameters showed statistically significant differences ($p<0.05$). These results support the hypothesis that regular tea consumption interferes with iron absorption.

RESULTS

A hospital-based cross-sectional study was carried out for three months at the Department of Medical Lab Science at the Integral Institute of Allied Health Science & Research (IIAHS&R), Lucknow, Uttar Pradesh. The aim of the present study is to compare the hemoglobin and ferritin level in regular tea consumers and occasional tea consumers. A total of 60 individuals were included in this study, conducted over a period of three months.

The participants were divided into two equal groups: 30 individuals who were regular tea consumers (case group) and 30 individuals who were occasional tea consumers (control group). The primary aim of the study was to assess and compare the hemoglobin and serum ferritin levels between the two groups to evaluate the potential impact of tea consumption on iron status.

Demographic distribution

The age range of the participants was 18 to 60 years. The mean age in the regular tea consumer group was 35.7±10.2 years, while the mean age in the occasional tea consumer group was 34.3±9.6 years. Both groups had a balanced representation of genders, with 15 males and 15 females in each group. There was no significant difference in age or gender distribution between the groups, thereby minimizing the risk of demographic bias affecting the results.

Table 1: Distribution of study population according to age.

Age group (years)	Regular tea consumers (cases), N (%)	Occasional tea consumers (controls), N (%)	Total, N (%)
18-25	8 (26.7)	7 (23.3)	15 (25.0)
26-35	9 (30.0)	10 (33.3)	19 (31.7)
36-45	6 (20.0)	6 (20.0)	12 (20.0)
46-55	4 (13.3)	5 (16.7)	9 (15.0)
56 and above	3 (10.0)	2 (6.7)	5 (8.3)
Total	30 (100)	30 (100)	60 (100)

Haemoglobin levels

The mean haemoglobin level among regular tea consumers was found to be 10.9±1.3 g/dL, whereas the mean level among occasional tea consumers was 12.4±1.2 g/dL. The difference in hemoglobin levels between the two groups was statistically significant ($p=0.001$), indicating potential association between frequent tea consumption and lower haemoglobin levels (Table 3).

Ferritin levels

The mean serum ferritin level among regular tea consumers was 19.8±5.7 ng/mL, compared to 33.1±6.8 ng/ml in occasional tea consumers. The reduction in ferritin levels among regular tea drinkers were statistically significant ($p<0.001$), suggesting a negative impact of regular tea consumption of iron storage in the body.

The maximum number of participants belonged to the 26-35 years age group (31.7%), followed by the 18-25 years group (25%). The least representation was from the 56 years and above group (8.3%).

The study population consisted of an equal number of males and females. Among the 30 regular tea consumers (cases), 15 (50%) were males and 15 (50%) were females. Similarly, in the 30 occasional tea consumers (controls), 15 (50%) were males and 15 (50%) were females. Overall, there were 30 males (50%) and 30 females (50%) in the study population. The gender distribution between cases and controls was comparable, as shown in Table 2.

Table 2: Distribution of study population according to gender.

Gender	Regular tea consumers (cases), N (%)	Occasional tea consumers (controls), N (%)	Total, N (%)
Male	15 (50)	15 (50)	30 (50)
Female	15 (50)	15 (50)	30 (50)
Total	30 (100)	30 (100)	50 (100)

Table 3: Shows comparative analysis of hemoglobin and ferritin levels in regular versus occasional tea consumers.

Parameter	Regular tea consumers (Mean±SD)	Occasional tea consumers (Mean±SD)
Hemoglobin (g/dl)	10.9±1.3	12.4±1.2
Ferritin (ng/ml)	19.8±5.7	33.1±6.8

DISCUSSION

The current research was designed to compare the levels of hemoglobin and ferritin between regular and occasional tea consumers to assess the effects of tea consumption on the levels of these two parameters. Iron deficiency is one of the most prevalent nutritional disorders worldwide. Both hemoglobin and ferritin are

key parameters of iron stores. Hemoglobin is a measure of the oxygen-carrying capacity of the blood, while ferritin reflects the iron stores.

Hemoglobin

The results of the current research showed that the levels of hemoglobin were significantly lower in regular tea consumers than in occasional tea consumers. These results are supported by studies conducted on Korean women and adolescents, where habitual tea or coffee intake was found to be associated with decreased levels of hemoglobin.[3,4,7]

Ferritin

Similarly, ferritin levels were also found to be significantly lower in regular tea drinkers. Similar findings were also noted in studies where black tea was used to assess its effect on healthy adults and adolescents.[6,7,9] Ahmad and Moosa found decreased ferritin levels in habitual tea drinkers, and Walczyk and Hurrell found that green tea reduced non-heme iron absorption.[6,9] These findings support the inhibitory effect of tea on iron storage.

Mechanism

The mechanism through which tea acts is well documented. Tea contains polyphenolic compounds, and tannins are responsible for inhibiting non-heme iron absorption. Tannins bind to non-heme iron in the gastrointestinal tract and form insoluble complexes, which are not absorbed by the body.[5,15,25] This effect is more pronounced in individuals who take tea along with or after meals, as in such cases, non-heme iron absorption is already compromised in comparison to heme iron.[17]

Dietary interactions

Dietary components also influence this effect. Vitamin C was found to enhance non-heme iron absorption by reducing ferric ions to ferrous ions and thus offsetting the inhibitory effect of tea.[19-21] Phytates, calcium, and oxalate also reduce iron absorption.[18,26,27]

Gender differences

Our findings also showed that females, especially in reproductive age groups, were more susceptible to decreased levels of hemoglobin and ferritin. These findings were consistent with previous findings, which reported that blood loss during menses and high iron requirements, coupled with high levels of tea intake, contributed to decreased levels of ferritin.[21,31]

Comparison with previous literature

Several epidemiological studies have shown similar findings between the intake of tea and coffee and decreased levels of iron.[2,10,14,31] However, in this study, the levels of ferritin were found to be high even in individuals with infrequent intake of tea. This indicates that during infrequent intake, there was no interference with the absorption of iron. These findings were consistent with earlier reports, which suggested that the timing and frequency of tea intake were critical factors.[16,22,23]

This study has few limitations. This was a cross-sectional study, and longitudinal and interventional studies need to be conducted to assess the long-term effects. In this study, dietary intake and timing of tea intake were not controlled, and this could have influenced the results. Individual and genetic variations need to be studied.[28,30]

CONCLUSION

In conclusion, the results of this study highlight a potentially important relationship between tea consumption and iron status, particularly in populations at risk of iron deficiency. Public health awareness programs may benefit from including education on the timing of tea intake and its interaction with dietary iron. Clinicians and nutritionists should consider tea-drinking habits when assessing patients for anemia or designing nutritional interventions. While tea remains a widely enjoyed and culturally significant beverage with various health benefits, its impact on iron absorption warrants in vulnerable populations.[31,32]

A hospital-based case-control study was conducted in the Department of Medical Lab Science at Integral Institute of Allied Health Sciences & Research, Lucknow for 3 months.

The present study aimed to compare the hemoglobin and ferritin level in regular tea consumers and occasional tea consumer. A total of 60 patients were studied over a period of 3 months, in which 30 were included in cases and 30 are for control.

The impact of tea consumption frequency on hemoglobin and ferritin levels, key indicators of iron status. The results clearly show that regular tea consumers have lower levels of hemoglobin and ferritin compared to occasional tea consumers. This suggests that frequent tea intake, especially around mealtimes, may hinder iron absorption due to the presence of tannins and other polyphenols in tea that bind to non-heme iron.

These findings are particularly significant in populations already at risk for iron deficiency, such as women of reproductive age and individuals with poor dietary iron intake. Although tea offers various health benefits, its potential to interfere with iron absorption highlights the need for awareness regarding its timing and quantity of consumption.

In conclusion, moderation in tea consumption and appropriate timings such as avoiding tea with meals may help improve or maintain better iron status. Further

research is recommended to explore these associations in more depth and to develop practical dietary guidelines tailored to culturally specific habits.

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