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A Study to Assess the Effectiveness of Mint Leaf Chutney Administration on Improving Iron Deficiency Anemia Among Adolescent Girls in Selected Pre-University Colleges at Kolar

Boya Chandrika*

Abstract

Iron deficiency anemia remains a prevalent nutritional disorder among adolescent girls, particularly in developing regions. This study aimed to assess the effectiveness of mint leaves chutney in improving iron deficiency anemia among adolescent girls in selected pre-university colleges at Kolar. A quasi-experimental research design was adopted, involving 60 adolescent girls aged 15–18 years who were screened and found to be anemic based on their hemoglobin levels. Participants were selected using purposive sampling and divided into experimental and control groups. The experimental group received 50 grams of freshly prepared mint leaves chutney daily for a period of 60 days, while the control group continued with their regular diet without supplementation. Hemoglobin levels were measured before and after the intervention using a standardized cyanmethemoglobin method. Data were analyzed using descriptive and inferential statistics. The results revealed a significant improvement in the mean hemoglobin levels of the experimental group compared to the control group ($p < 0.05$). The increase in hemoglobin concentration among participants in the experimental group suggests that mint leaves chutney, rich in iron and vitamin C, plays a beneficial role in enhancing iron absorption and correcting iron deficiency anemia. The findings support the incorporation of locally available, iron-rich dietary interventions such as mint chutney into adolescent nutrition programs. This study highlights the importance of promoting culturally acceptable and cost-effective dietary solutions to address nutritional anemia in resource-limited settings.

Keywords: Iron deficiency anemia, mint leaves chutney, adolescent girls, hemoglobin, nutritional intervention, Kolar.

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INTRODUCTION

"It is health that is real wealth and not pieces of gold and silver." -- *Mahathma Gandhi.*

Anemia is a medical condition that occurs when the blood does not contain a sufficient number of healthy red blood cells or adequate hemoglobin. Hemoglobin is an essential component of red blood cells responsible for carrying oxygen throughout the body. When red blood cells are reduced in number or are abnormal, or when hemoglobin levels are low or defective, the body's tissues do not receive enough

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oxygen. This oxygen deficiency leads to symptoms such as fatigue, as the organs are unable to function efficiently.
Anemia is one of the most prevalent blood disorders in India, affecting a large proportion of the population, particularly adolescent girls, with estimates suggesting nearly 90% prevalence in this group. Adolescence is a critical stage of growth and development, during which nutritional requirements are high. Female adolescents are especially vulnerable due to rapid growth, increased iron requirements, and monthly blood loss during menstruation. In developing countries, this makes them highly susceptible to iron deficiency anemia, second only to pregnant women.
In general, anemia is characterized by a reduction in either the number of red blood cells or the concentration of hemoglobin in the blood, leading to decreased oxygen-carrying capacity. When anemia develops gradually, symptoms may be mild or non-specific, including tiredness, weakness, shortness of breath, and reduced physical endurance. In cases where anemia develops rapidly, symptoms may be more severe and can include dizziness, confusion, fainting sensations, and increased thirst. Noticeable paleness usually occurs only in more advanced stages. Additional symptoms may vary depending on the underlying cause.
Anemia can be classified into three major types: anemia due to blood loss, anemia due to decreased red blood cell production, and anemia due to increased destruction of red blood cells. Blood loss may result from trauma or gastrointestinal bleeding. Reduced red blood cell production may be caused by iron deficiency, vitamin B12 deficiency, thalassemia, or bone marrow disorders. Increased destruction of red blood cells may occur due to genetic conditions such as sickle cell anemia, infections like malaria, or autoimmune diseases. Based on red blood cell size and hemoglobin content, anemia is further categorized as microcytic, macrocytic, or normocytic.
Globally, anemia is one of the most common blood disorders, affecting approximately one-quarter of the population. Iron deficiency anemia alone affects nearly one billion people worldwide. In 2013, iron deficiency-related anemia was responsible for about 183,000 deaths, a decrease from 213,000 deaths in 1990. It is more commonly observed among females, children, pregnant women, and the elderly. Anemia also contributes to increased healthcare costs and reduced productivity due to decreased work capacity.
The causes of anemia are broadly classified into impaired red blood cell production, increased red blood cell destruction (hemolysis), blood loss, and plasma volume expansion (hypervolemia). Often, multiple factors may contribute simultaneously. Blood loss is the most common cause of anemia; however, it usually leads to significant symptoms only when combined with impaired red blood cell production, most commonly due to iron deficiency.
Iron deficiency anemia is a common form of anemia caused by insufficient dietary iron intake, poor absorption of iron, or chronic blood loss from sources such as the gastrointestinal, uterine, or urinary tract. Iron deficiency is responsible for nearly half of all anemia cases worldwide and is more frequently observed in women than in men. Although global estimates vary, it is believed that over one billion people are affected by iron deficiency, making it a major public health concern.

- The body may fail to produce an adequate number of red blood cells.
- Blood loss due to bleeding can cause red blood cells to be lost faster than they are replaced.

Iron deficiency anemia (IDA) is a major global health problem, affecting nearly 1.5 billion people worldwide. In India, its prevalence varies widely from 38% to 72%, depending on age and gender, with a higher burden observed among women and children. After the age of six years, the incidence is notably higher in girls. This increased vulnerability may be attributed to factors such as menstruation, unequal distribution of food within households due to gender bias, and early marriage that often leads to early pregnancy.

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Research indicates that approximately 25–50% of girls become anemic by the time they attain menarche. In such cases, pregnancy further worsens pre-existing anemia. Various studies in India have also identified infections and worm infestations as important contributors to anemia. Additionally, cultural practices such as early marriage and adolescent pregnancy significantly increase the risk. Iron deficiency has been linked to menstrual irregularities and impaired physical growth. It also reduces physical work capacity and affects cognitive development, thereby negatively influencing academic performance. The prevalence of iron deficiency anemia is considerably higher in developing countries (30–48%) compared to developed nations (4.3–20%).

Iron deficiency anemia is widespread globally mainly because of poor absorption of non-heme iron, which constitutes the majority of dietary iron intake. The absorption of this form of iron is often inhibited by certain dietary components that reduce its bioavailability. However, vitamin C (ascorbic acid) enhances iron absorption by counteracting these inhibitors and is considered one of the most effective promoters of non-heme iron uptake. A study conducted in India reported a high prevalence of iron deficiency anemia among females aged 15–25 years. It was also observed that iron or folic acid supplementation, with or without vitamin C, significantly improved hemoglobin levels. The improvement was more pronounced in individuals who had lower baseline hemoglobin levels, although the average increase was consistent across different age groups. Dietary intake of vitamin C along with iron-rich foods significantly enhances iron absorption and improves hemoglobin status.

Mentha (mint) belongs to the Lamiaceae family and is a widely distributed genus of aromatic plants. The name is derived from the Greek word *míntha*. The genus includes approximately 13 to 18 species, though the exact number is uncertain due to natural hybridization among species. Numerous hybrids and cultivated varieties also exist. Mint plants are found across various regions, including Europe, Africa, Asia, Australia, and North America, giving them a subcosmopolitan distribution.

Mints are mostly perennial, aromatic herbs, though a few are annuals. They spread through underground and above-ground runners (stolons) and have upright, square-shaped, branched stems. The leaves grow in opposite pairs and vary in shape from oblong to lance-shaped, often with a serrated edge. Leaf coloration ranges from deep green and gray-green to shades of purple, blue, and occasionally pale yellow when dry. The flowers are typically white to purple and grow in false whorls known as verticillasters. The corolla is two-lipped with four nearly equal lobes, with the upper lobe usually being the largest. The fruit is a small nutlet containing one to four seeds.

NEED FOR THE STUDY

Iron is an essential component of hemoglobin, a protein present in erythrocytes (red blood cells) that is responsible for transporting oxygen from the lungs to various tissues of the body. It is also a key component of myoglobin, which supplies oxygen to muscle tissues and supports metabolic activities. In addition, iron plays a vital role in growth and development, normal cellular functioning, and the synthesis of certain hormones and connective tissues.

Dietary iron exists in two primary forms: heme iron and non-heme iron. Non-heme iron is found in plant-based foods and iron-fortified products, while heme iron is present in animal

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sources such as meat, poultry, and seafood. Animal foods typically contain both forms of iron. Heme iron is produced when iron is bound to protoporphyrin IX and contributes approximately 10–15% of total iron intake in Western diets.

Several indicators are used to assess iron status, and these vary depending on the stage of iron deficiency. Serum ferritin levels are commonly used to detect early iron depletion. As iron deficiency progresses, the body's ability to deliver stored and absorbed iron to tissues becomes impaired, leading to reduced serum iron levels, decreased transferrin saturation, lower reticulocyte hemoglobin content, and increased total iron-binding capacity. Other markers such as elevated red cell zinc protoporphyrin and serum transferrin receptor levels also indicate worsening deficiency.

The final stage of iron deficiency is iron deficiency anemia (IDA), which occurs when hemoglobin concentration, hematocrit, mean corpuscular volume, and mean corpuscular hemoglobin fall below normal levels. Although hemoglobin and hematocrit tests are commonly used for screening iron deficiency, they are not highly sensitive or specific for early detection.

Hemoglobin values below 13 g/dL in males and below 11 g/dL in females are generally considered indicative of iron deficiency anemia.

Age groups	No Anaemia	Mild	Moderate	Severe
Children 6–59 months of age	≥11	10–10.9	7–9.9	<7
Children 5–11 years of age	≥11.5	11–11.4	8–10.9	<8
Children 12–14 years of age	≥12	11–11.9	8–10.9	<8
Non-pregnant women (15 years of age and above)	≥12	11–11.9	8–10.9	<8
Pregnant women	≥11	10–10.9	7–9.9	<7
Men	≥13	11–12.9	8–10.9	<8

For female adolescents with iron deficiency anemia, an additional dietary iron intake of approximately 60 g per week is recommended along with the prescribed Recommended Dietary Allowance (RDA) in order to help correct the deficiency.

Adolescence is a period of rapid physical growth, second only to infancy, and is associated with a significantly increased requirement for energy and nutrients. Nutritional demands are higher during this stage than at any other time in the life cycle. Proper nutrition is closely linked with physical growth, and adequate intake is essential for achieving optimal growth and development. Inadequate dietary intake during this critical period may lead to delayed sexual maturation and impaired or stunted linear growth.

Before puberty, the nutritional requirements of boys and girls are almost similar; however, during puberty, biological and body composition changes lead to sex-specific nutritional needs. Both males and females experience a sharp increase in nutrient requirements during

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adolescence, with the highest demand occurring during the peak growth spurt. At this stage, nutritional needs may be nearly double compared to other adolescent periods. Dietary Reference Intakes (DRIs), developed by the Food and Nutrition Board of the United States, provide guidelines for assessing and planning nutrient intake in healthy individuals. The recommended dietary allowance for iron in adolescent females is approximately 18 mg per day under normal hemoglobin conditions.

Inadequate dietary intake, particularly of iron and vitamin B12, is a major cause of anemia. Conditions such as pregnancy, diarrhea, intestinal disorders, and malabsorption syndromes further increase the requirement for iron, vitamin B12, and folate—nutrients essential for preventing anemia. According to the Indian Council of Medical Research (ICMR), the recommended dietary intake of iron is 28 mg per day for adult males and 30 mg per day for females, which increases to about 38 mg per day during pregnancy.

Studies show that India has a large vegetarian population, which results in higher consumption of non-heme iron, which is less efficiently absorbed by the body compared to heme iron from animal sources. The absorption rate of iron from animal-based foods is two to three times higher than that from plant-based foods. Good dietary sources of iron include lean meats such as beef, mutton, turkey, chicken, pork, and fish. Plant-based sources, although less bioavailable, remain important and include green leafy vegetables such as mint leaves, legumes like beans, lentils, soybeans, fortified cereals, and whole grains. The absorption of plant-based iron can be significantly enhanced when consumed along with vitamin C-rich foods.

Iron deficiency anemia is more prevalent in developing countries (30–48%) compared to developed countries (4.3–20%). Additionally, adolescent girls in developing countries are more commonly affected than boys. A World Health Organization (WHO) situational analysis in South-East Asia reported a prevalence of iron deficiency anemia ranging from 56% to 90%. Similarly, the National Nutrition Monitoring Bureau (NNMB) reported that 72–80% of younger adolescents (12–14 years) and 73–84% of older adolescents (15–17 years) were affected by iron deficiency anemia. Further, a large-scale study conducted by the Indian Statistical Institute in 2009 found that 89.7% of adolescent girls across India were anemic.

In response to this public health concern, the Government of India has implemented iron and folic acid supplementation programs along with dietary recommendations. However, compliance with iron supplementation remains low due to side effects such as gastrointestinal discomfort.

Mint leaves are widely available green leafy vegetables in India throughout the year. Two common varieties are spearmint and peppermint. Two tablespoons of fresh peppermint provide approximately 2 calories, 0.12 g protein, 0.48 g carbohydrates, 0.03 g fat, and 0.30 g fiber. Mint also contains small amounts of potassium. A serving of peppermint provides about 1 g of carbohydrates, including 0.5 g of fiber, while spearmint provides about 2 g of carbohydrates, including 1.6 g of fiber. The fiber content in mint helps in reducing cholesterol levels and may lower the risk of obesity.

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Spearmint, in particular, is a good source of minerals, especially iron, providing about 2.7 mg per serving. It contributes approximately 15% of the daily iron requirement for women and 34% for men, as reported by the Institute of Medicine.

Based on personal observation and considering the dietary habits and lifestyle of the Indian population, the researcher felt the need to explore an alternative or complementary approach to iron supplementation. Therefore, the investigator is interested in evaluating the effectiveness of mint leaves chutney on improving hemoglobin levels among female adolescents with iron deficiency anemia.

OBJECTIVES OF THE STUDY

1. To assess the baseline hemoglobin levels among adolescent girls in the experimental group.
2. To assess the baseline hemoglobin levels among adolescent girls in the control group.
3. To compare the post-test hemoglobin levels of adolescent girls between the experimental and control groups after administering mint leaves chutney only to the experimental group.
4. To determine the association between post-test hemoglobin levels and selected demographic variables in the experimental group.
5. To determine the association between post-test hemoglobin levels and selected demographic variables in the control group.

HYPOTHESIS

H1: There will be a significant difference in post-test hemoglobin levels between the experimental group and the control group.

ASSUMPTIONS

- Adolescent girls are likely to have low hemoglobin levels due to iron deficiency.
- Administration of mint leaves chutney may help improve hemoglobin levels in adolescent girls.
- Mint leaves may support or enhance iron absorption in the body.

OPERATIONAL DEFINITIONS

i. **Assess:** Refers to measuring hemoglobin levels as an outcome of mint leaves chutney administration.

ii. **Effectiveness:** Refers to the extent of improvement in hemoglobin levels among adolescent girls after the intervention.

iii. **Mint leaves chutney:** A tasty, spicy food preparation made using fresh mint leaves, considered rich in iron and potentially helpful in improving iron deficiency anemia. The preparation includes 100 g of mint leaves, 20 g of horse gram, and one green chilli.

iv. **Iron deficiency anemia:** A common type of anemia characterized by hemoglobin levels below 10 g/dL, resulting from insufficient dietary iron intake or poor iron absorption.

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v. **Adolescent girls:** Female students aged between 15 and 19 years studying in pre-university colleges.

LIMITATIONS OF THE STUDY

1. The study is confined to a selected setting only.
2. The sample size is limited to 60 participants.
3. The duration of the study is restricted to 4–6 weeks.

DELIMITATIONS OF THE STUDY

- Participants who are willing to take part in the study only.
- Participants who are available during the data collection period only.

SIGNIFICANCE OF THE STUDY

Iron deficiency anemia is a common health problem among adolescent girls. It mainly occurs due to insufficient dietary iron intake and poor absorption of iron. Various iron-rich foods are available in both vegetarian and non-vegetarian diets in India; however, vegetarian sources are more commonly consumed due to their availability and affordability.

This study highlights the potential use of mint leaves as a natural, cost-effective dietary source to improve hemoglobin levels. It also aims to explore the effectiveness of mint leaves chutney in reducing iron deficiency anemia among adolescent girls. Since limited scientific evidence is available regarding the direct impact of mint leaves on hemoglobin levels, this study is undertaken to evaluate its effectiveness.

CONCEPTUAL FRAMEWORK

An important aspect of research design is selecting an appropriate conceptual framework or theoretical foundation. Concepts are mental representations or ideas formed through observation of real-world objects, events, or experiences. A conceptual framework explains the relationship between variables, outlines assumptions, and provides a structured diagrammatic representation of the study.

In this study, the investigator has adopted **Ludwig's Open System Theory Model**, which explains how individuals adapt to their environment. The model is based on four main components: Input, Throughput, Output, and Feedback.

1. Input

The input includes adolescent girls studying in selected PU colleges in Kolar, Karnataka. It also includes demographic variables such as age, religion, family income, type of family, academic level, dietary pattern, and awareness about anemia. Baseline hemoglobin levels in both experimental and control groups are assessed using the Sahli's method.

2. Throughput

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The throughput refers to the intervention provided in the study, which is mint leaves chutney prepared and administered by the researcher to the experimental group students.

3. Output

The output is measured through post-test hemoglobin levels in both experimental and control groups. Positive output is indicated by an increase in hemoglobin levels, while no significant change indicates a negative outcome.

4. Feedback

Feedback refers to the evaluation of results. A negative outcome suggests the need for further intervention. However, this component is not included in the present study design.

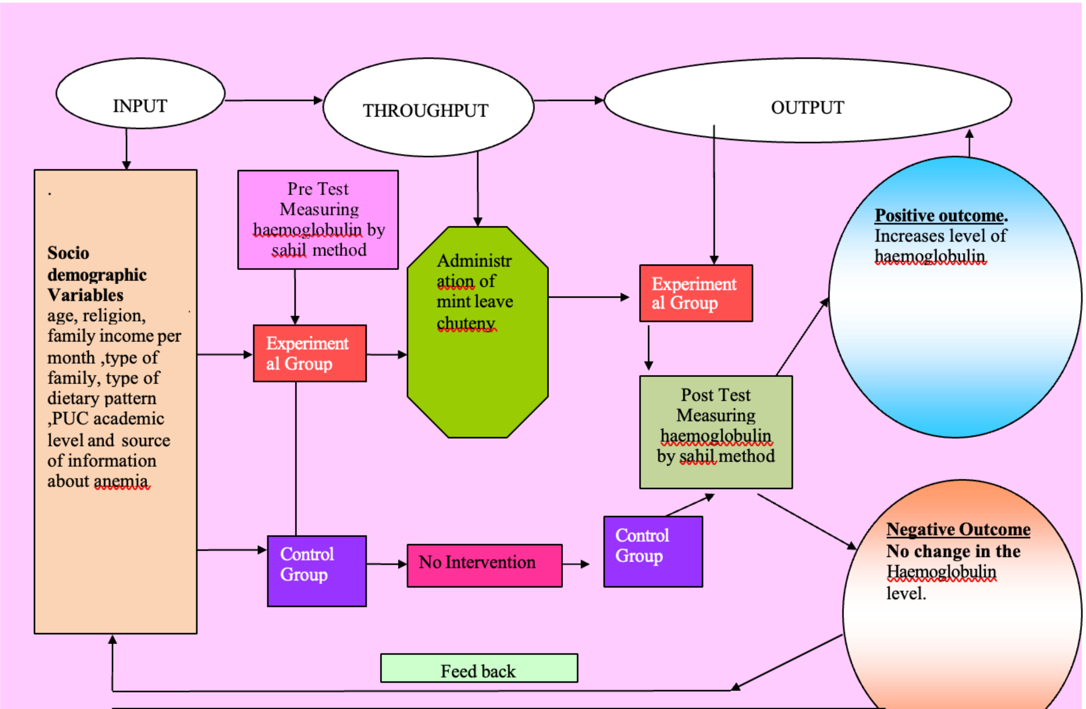

Figure 1 Conceptual Framework Ludwig open system model Theory

REVIEW OF LITERATURE

Review of literature is an essential step in the research process. It refers to a summary of existing knowledge related to a specific research problem and includes both what is already known and what remains unknown. An extensive review is usually carried out at the beginning of the study, while a limited review is done during the preparation of the research report to include recent findings and updated studies.

In this study, an extensive review of literature was undertaken by the investigator to gain a deeper understanding of the selected problem. The literature is organized and presented under the following headings:

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1. Studies related to iron deficiency anemia
2. Studies related to iron deficiency anemia and female adolescents
3. Studies related to dietary sources and iron deficiency anemia

1. Studies related to iron deficiency anemia

A study assessed the incidence and determinants of iron deficiency anemia (IDA) across four European countries using national primary care databases from Italy, Belgium, Germany, and Spain. The findings showed that the annual incidence of IDA ranged from 7.2 to 13.96 per 1,000 person-years, with higher rates in Spain and Germany. Females, both younger and older age groups, individuals with gastrointestinal disorders, pregnant women, those with menometrorrhagia, and users of aspirin or antacids were found to be at higher risk.

A population-based cross-sectional study conducted in Portugal reported an anemia prevalence of 19.9%, with 84% of cases previously undiagnosed. Higher prevalence was observed among women, young adults (18–34 years), older adults, and pregnant women. Iron deficiency was also highly prevalent, and most anemia cases were associated with low iron stores. The study concluded that both anemia and iron deficiency are widespread and often remain undetected.

A systematic review and meta-analysis in low- and middle-income countries found that 42.7% of pregnant women suffered from anemia. Maternal anemia was significantly associated with increased risks of low birth weight, preterm birth, perinatal mortality, and neonatal mortality. The study highlighted that a substantial proportion of adverse pregnancy outcomes in these countries is attributable to anemia, particularly in South Asia and low-income regions.

A study conducted in Kenitra among schoolchildren aged 6–15 years found an anemia prevalence of 16.2%. Iron deficiency was identified as a major contributing factor. The study also found a significant association between maternal education and anemia in children, while family income showed no significant effect. It recommended improving maternal education, economic conditions, and nutritional awareness to reduce anemia.

Globally, anemia affects nearly one-third of the population, with iron deficiency accounting for about half of all cases. It significantly impacts maternal and child health, physical performance, and productivity. High-risk groups include young children, women of reproductive age, and pregnant women.

A nationally representative survey in Kuwait reported anemia prevalence of 3% in adult males and 17% in females. Iron deficiency was more common among females and younger age groups, particularly adolescents. The study concluded that iron deficiency significantly contributes to anemia in the population.

A study on young women showed that better iron status was associated with improved attention, inhibitory control, and planning abilities. However, some findings suggested complex relationships between iron levels and working memory performance, indicating that iron status may influence cognitive function.

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Another study found a positive relationship between body iron levels and executive function in college women, particularly in planning ability, suggesting that adequate iron status supports cognitive performance even in the absence of anemia.

2. Studies related to iron deficiency anemia and female adolescents

The Global Burden of Disease study reported that iron deficiency anemia was the leading cause of years lived with disability among children and adolescents worldwide, affecting approximately 619 million individuals in 2013.

A study among pregnant adolescents found a high anemia prevalence of 41.27%. Untreated anemia was associated with adverse outcomes such as preterm birth, low gestational age, stillbirth, and higher risk of infections.

A national study among reproductive-age women found that iron deficiency anemia prevalence was 2.4% in younger women (12–21 years) and 5.5% in older women (22–49 years). Menstrual history and race were identified as significant factors influencing anemia risk.

A study in Ethiopia reported a 15.2% prevalence of anemia among school adolescents. Female gender, large household size, parental illiteracy, parasitic infections, and low body mass index were identified as significant risk factors.

A study in Kerala among schoolchildren found a 31.4% anemia prevalence. Poor dietary habits, irregular intake of iron-folic acid tablets, and consumption of tea/coffee with meals were associated with anemia.

A study in China reported a 17.2% anemia prevalence among infants aged 6–12 months. Lower intake of iron, vitamins, and other nutrients was associated with anemia, highlighting the importance of dietary quality.

Another study in China found an overall anemia prevalence of 13.4%, with higher rates among females and older adults. Household income was inversely associated with anemia prevalence.

A review among athletes indicated that serum ferritin and hemoglobin levels are important indicators of iron status. Iron supplementation and dietary counseling are recommended for managing iron deficiency in young individuals.

A hospital-based study among adolescents found that deficiencies in folate and vitamin B12 were more common than iron deficiency. Dietary intake and menstrual status were significant factors influencing anemia severity.

A study in Bangladesh reported anemia prevalence of 24.8% among adolescent girls. Iron and iodine deficiencies were common, and anemia was associated with increased risk of infections. The study recommended nutritional interventions.

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A clinical intervention study in young women found that iron supplementation improved attention and cognitive performance, especially in participants with improved ferritin levels.

A cross-sectional study among adolescent schoolgirls found 5.8% anemia prevalence and 8.5% iron deficiency. Parasitic infestation and low BMI were significant risk factors for anemia.

Studies related to dietary sources and iron deficiency anemia

A study compared iron absorption from meals with and without ascorbic acid in normal-weight, overweight, and obese women. The findings revealed that iron absorption in overweight and obese women was approximately two-thirds lower than in normal-weight women. Additionally, the enhancing effect of ascorbic acid on iron absorption was about half in overweight and obese individuals compared to those with normal weight. The study concluded that increasing vitamin C intake in obese individuals may have limited effectiveness in improving iron status.

Another study evaluated the impact of consuming cooked recipes made from sun-dried amaranth and cowpea leaves on beta-carotene, retinol, and hemoglobin levels in preschool children in Kenya. The vegetables were obtained from local markets and some were sun-dried in shade conditions. Laboratory analysis showed that fresh cowpea and amaranth leaves contained high levels of all-trans beta-carotene, and more than 60% of this content was retained after drying and cooking. Consumption of these vegetables significantly improved serum beta-carotene and retinol levels, while hemoglobin levels increased by 4.6%. The study concluded that locally available sun-dried leafy vegetables can enhance micronutrient status and improve hemoglobin levels in children.

An intervention study conducted in rural India assessed the effect of dietary modification on anemia prevention. After one year, the mean hemoglobin level increased significantly from 10.94 g/dL to 11.59 g/dL, accompanied by a reduction in anemia prevalence from 82% to 55.4% and iron-deficiency anemia from 30.3% to 10.8%. Improvement in hemoglobin levels was greater among women with higher participation in the intervention, including regular consumption of green leafy vegetables and seasonal fruits. The study concluded that dietary behavior change significantly reduces anemia risk.

A study conducted among schoolchildren aged 9–12 years assessed the effect of carotene-rich green and yellow vegetables on anemia and iron status. Children were provided standardized meals containing provitamin A-rich vegetables for nine weeks. Results showed a significant improvement in hemoglobin levels, while zinc protoporphyrin levels increased. The study concluded that such diets improve vitamin A status and hemoglobin concentration and reduce anemia prevalence; however, they did not significantly reduce iron deficiency or iron-deficiency anemia rates.

A study examining dietary patterns and anemia among Chinese adults identified that food habits significantly influence anemia risk. The study categorized diets into different patterns such as traditional (rice, vegetables, wheat flour), sweet tooth (sugary drinks and cakes), healthy (fruits, whole grains, vegetables), and macho (meat and alcohol). The results showed that traditional and sweet tooth dietary patterns were positively associated with higher anemia

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risk, while the healthy dietary pattern was associated with a lower risk. No significant association was found with the meat-based pattern. Women, particularly in northern regions, showed a higher risk of anemia. The study concluded that dietary patterns play a significant role in the prevalence of anemia.

METHODOLOGY

Research methodology refers to a systematic and controlled process of collecting, organizing, and analyzing data. It focuses on the development, validation, and evaluation of research instruments and techniques.

Research methods include the procedures, steps, and strategies used for gathering and analyzing data in a research study.

This chapter describes the methodological approach adopted for the present study. The main purpose of the study is to evaluate the effectiveness of mint leaves chutney on hemoglobin levels among adolescent students in selected PU colleges at Kolar.

The methodology includes the description of the research approach, research design, study setting, sampling technique, development and validation of the tool, reliability of the tool, data collection procedure, pilot study, and plan for data analysis.

RESEARCH APPROACH

The research approach refers to the overall procedure used to conduct the study. It guides the researcher in determining what to study, who will be studied, and how the results will be analyzed and interpreted.

Considering the nature of the problem and the objectives of the study, an experimental research approach was found to be most appropriate. The experimental approach helps in determining the effect of an independent variable on a dependent variable through manipulation, control, and randomization.

RESEARCH DESIGN

Research design refers to the overall plan used by the researcher to obtain answers to research questions and to test hypotheses. It provides a structured framework for collecting accurate, objective, and interpretable data.

It serves as a blueprint for conducting the study in a systematic manner.

In this study, a **two-group pre-test and post-test experimental design** was adopted to assess the effectiveness of mint leaves chutney on hemoglobin levels among adolescent students in selected PU colleges at Kolar.

The study consists of two groups:

- Experimental group

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- Control group

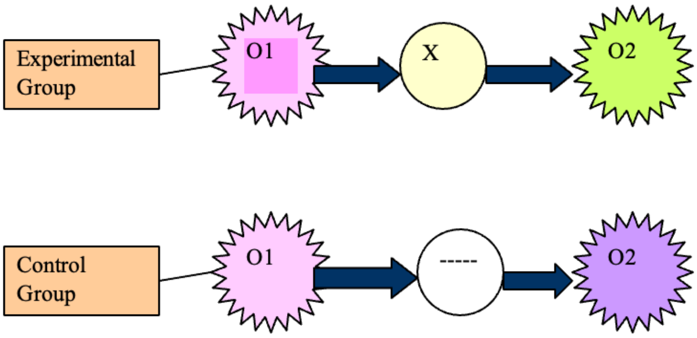

Figure 2 Schematic Representation of the Research Design

Key:-

O1-Pre test level of haemoglobulin

X = Administration of intervention (Mint leaves chutney)

O2- Post test level of haemoglobulin

VARIABLES

Variables are defined as characteristics, qualities, or attributes of individuals, objects, or situations that can change or vary. The main variables in this study include independent and dependent variables. The dependent variable represents the outcome influenced by the independent variable.

Independent Variable

An independent variable is one that is not influenced by other variables and is manipulated by the researcher. In this study, the independent variable is **mint leaves chutney**.

Dependent Variable

The dependent variable is the outcome variable that the researcher aims to observe, explain, or measure. In this study, the dependent variable is the **hemoglobin level**.

SETTING OF THE STUDY

The setting refers to the physical location and conditions where data collection is carried out. The present study was conducted in selected PU colleges in Kolar. The setting was chosen due to its accessibility and the availability of adequate samples under one institution or nearby locations.

TARGET POPULATION

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The target population refers to the entire group of individuals or elements that meet the specific criteria for inclusion in the study.

In this study, the target population consists of adolescent students studying in selected PU colleges of Kolar.

SAMPLE AND SAMPLING TECHNIQUE

Sample

A sample is a subset of the population selected to participate in a study. It represents the characteristics of the entire population.

In this study, the sample consisted of **60 adolescent students**.

Sample Size

The total sample size was 60 adolescents studying in selected PU colleges of Kolar. Out of these, 30 adolescents were assigned to the experimental group and 30 to the control group.

Sampling Technique

Sampling is the process of selecting a group of individuals or elements from a population to conduct a study.

In this study, a **probability sampling technique (simple random sampling method)** was used to select the participants. The selection was done using a coin-flip method, ensuring that each subject had an equal chance of being included in the study. A total of 60 adolescents were selected from the chosen PU colleges in Kolar, with 30 assigned to the experimental group and 30 to the control group.

CRITERIA FOR SAMPLE SELECTION

Inclusion Criteria

1. Adolescents aged between 16–18 years.
2. Adolescents studying in selected PU colleges.
3. Female adolescents included in the study.
4. Female adolescents who have attained menarche.

Exclusion Criteria

1. Adolescents who were not available during the study period.
2. Adolescents with poor health conditions at the time of the study.
3. Adolescents suffering from gastroesophageal reflux disease (GERD).

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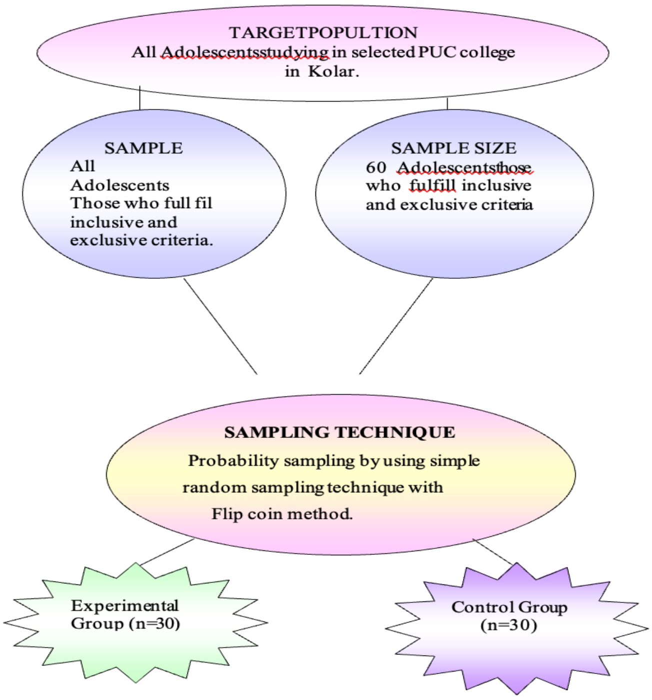

Figure:3 - Schematic presentation of sampling design.

DEVELOPMENT OF THE TOOLS

The selection of an appropriate tool in research is essential to collect valid and reliable data that supports meaningful conclusions relevant to the study objectives.

A hemoglobinometer using Sahli's method was selected as an appropriate instrument for measuring hemoglobin levels in this study.

Tool Development

The tool was developed by the investigator based on the objectives of the study. It was considered suitable for measuring hemoglobin levels and evaluating the effectiveness of the intervention.

DESCRIPTION OF THE TOOLS

The tool was divided into three parts:

Part I: Socio-Demographic Variables

This section included 7 items to collect background information such as:

- Name of the student
- Age
- Religion

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- Monthly family income
- Type of family
- Dietary pattern
- PUC academic level
- Source of information about anemia

Part II: Measurement of Hemoglobin Level (Sahli's Method)

Hemoglobin was estimated using Sahli's method with a hemoglobinometer.

- Apparatus Required

- Sahli's hemoglobinometer (haemometer)
- Distilled water
- Rectified spirit
- Cotton
- Lancet
- 0.1 N Hydrochloric acid (HCl)

- Components of Sahli's Hemoglobinometer

1. **Comparator box:** Contains colour standards on both sides with a central space for the diluting tube. The standard colour represents acid haematin equivalent to 14.5 g/dL hemoglobin diluted 100 times.
2. **Dilution tube:** Graduated in g/dL and percentage scale.
3. **Haemoglobin pipette:** Capillary pipette marked at 20 mm^3.
4. **Glass stirrer**
5. **0.1 N Hydrochloric acid bottle**

- Principle

Hemoglobin in blood is converted into acid haematin by adding 0.1 N HCl. The colour developed is matched against a standard colour to determine hemoglobin concentration.

- Procedure

- Fill the dilution tube with 0.1 N HCl up to the lowest mark.
- Place the tube in the comparator box.
- Clean fingertip with rectified spirit and prick to obtain blood.
- Draw blood into the pipette up to 20 mm^3 without air bubbles.
- Transfer blood into the acid solution immediately.
- Rinse pipette with acid 2–3 times and transfer into the tube.
- Mix and allow to stand for 10 minutes for conversion to acid haematin.
- Add distilled water dropwise until colour matches the standard.
- Record the hemoglobin level from the scale.

- Precautions

- Ensure no air bubbles or clots in the pipette.
- Avoid interference of graduations during colour matching.

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- Lift glass rod before matching colour.
- Wipe excess blood from pipette properly.
- Transfer blood immediately after collection.
- Take reading promptly to avoid colour change.

Part III: Observation Checklist

An observation checklist was prepared by the investigator to assess symptoms of anemia. It included 10 items.

- Scoring Procedure

A 5-point Likert scale was used:

- Never = 1
- Occasionally = 2
- Sometimes = 3
- Often = 4
- Always = 5

Minimum score: 10
Maximum score: 50

DEVELOPMENT OF THE INTERVENTION
Intervention Description

Mint chutney was prepared using:

- 100 g mint leaves
- 20 g horse gram
- 2 g green chilli

Mint leaves are a good source of iron and folate. A half-cup serving of spearmint provides approximately 5.41 mg of iron, meeting about 30% of daily iron requirements for women and 68% for men, along with folate content that supports hematological health.

ETHICAL CONSIDERATIONS

1. Permission was obtained from concerned authorities.
2. Written informed consent was taken from all participants after explaining the purpose and details of the study. Confidentiality was assured.
3. Participation was voluntary, and participants had the right to withdraw from the study at any time.

PILOT STUDY

A pilot study is a small-scale trial conducted before the main study to assess feasibility and improve the research design.

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The pilot study was conducted among 6 adolescents in selected nursing colleges in Kolar. After explaining the purpose, socio-demographic data were collected, and pre-test hemoglobin levels were measured. The intervention was administered only to the experimental group, followed by a post-test. The control group received only pre-test and post-test without intervention.

Data were coded, tabulated, and analyzed using statistical methods. The pilot study helped estimate the time required and overall feasibility of the main study.

Findings of Pilot Study

The pilot study indicated a significant difference in hemoglobin levels between the experimental and control groups.

DATA COLLECTION PROCEDURE

Prior permission was obtained from the principals of selected PU colleges in Kolar. The investigator explained the study purpose and obtained institutional approval.

After selection of participants, rapport was established and written informed consent was obtained. Socio-demographic data and pre-test measurements were collected from both groups. Blood samples were collected for hemoglobin estimation.

The mint chutney intervention was administered daily with lunch to the experimental group for 10 days. Post-test was conducted on the 11th day. The control group did not receive any intervention, and only pre-test and post-test were conducted.

Confidentiality and participant safety were strictly maintained throughout the study.

PLAN FOR DATA ANALYSIS

The collected data from 60 adolescents were organized and tabulated systematically. Data analysis was carried out using both descriptive and inferential statistics.

Descriptive statistics included:

- Mean
- Percentage
- Standard deviation

Inferential statistics included:

- Student's t-test
- Independent t-test
- Chi-square test

These methods were used to analyze and interpret the effectiveness of mint leaves chutney on hemoglobin levels among adolescent girls.

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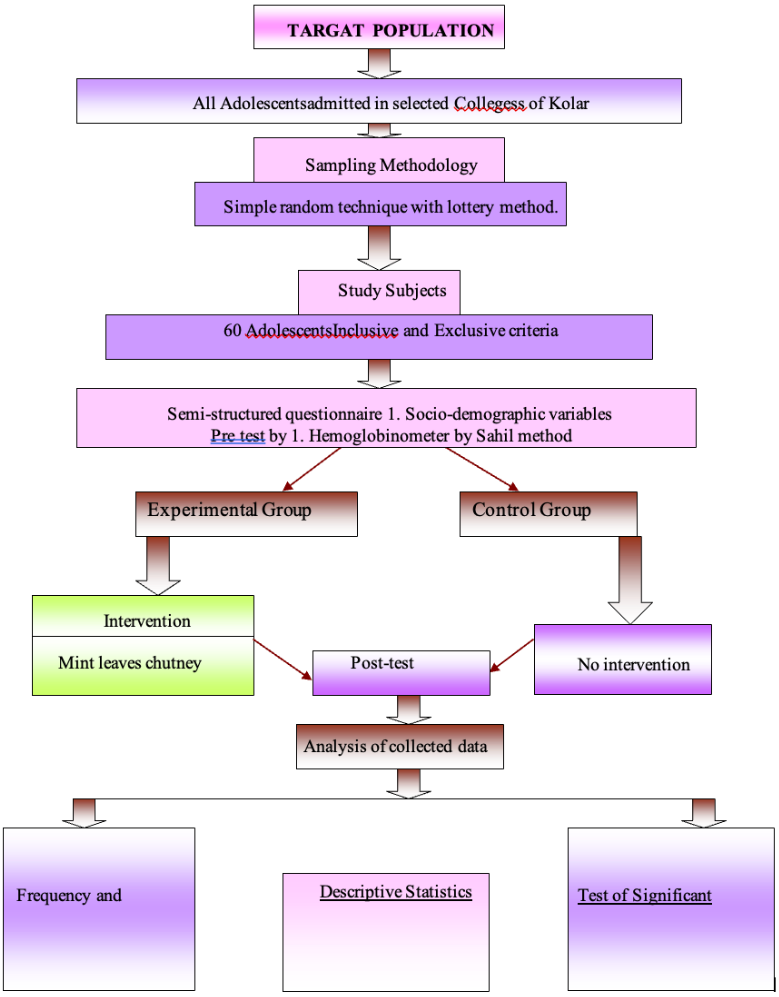

RESULTS – ANALYSIS AND INTERPRETATION

Data analysis refers to the process of organizing, categorizing, arranging, manipulating, and summarizing data in order to obtain meaningful answers to the research questions. The main purpose of analysis is to reduce the collected data into an understandable and interpretable form so that relationships related to the research problem can be examined and tested.

This chapter presents a systematic description of the analyzed data followed by its interpretation. The collected data were organized, tabulated, analyzed, and interpreted using both descriptive and inferential statistical methods. The findings are presented in the form of tables and figures for better clarity and understanding.

Presentation of Data: The analyzed data are presented under the following sections:

Section 1: Description of socio-demographic variables of students in both experimental and control groups.

Section 2: Analysis and interpretation of the effectiveness of mint leaves chutney on hemoglobin levels.

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Section 3: Association between post-test hemoglobin levels and selected socio-demographic variables.

Table- (1) Distribution of students according to socio demographic variables by frequency and percentage in experimental and control group .

Socio demographic variable	Experimental		Control	
	Frequency	Percentage	Frequency	Percentage
1. Age:				
a) 16 - 17years	18	60	14	46.7
b) 18 - 19 years	12	40	16	53.3
2. Religion:				
a) Hindu,	16	53.3	13	43.3
b) Muslim,	6	20	8	26.7
c) Christian	8	26.7	9	30
3. Family Income per month				
a) >Rs. 5000	18	60	13	43.3
b) Rs.5000- Rs.10000	12	40	16	53.3
c) Rs.10000<				
4. Type of Family				
a) Nuclear family	20	66.7	19	63.3
b) Joint family	10	33.3	11	36.7
5. PUC academic level				
a) More than 70%	10	33.3	9	30
b) 50%-70%	17	56.7	16	53.3
c) Below 50%	3	10	5	16.7
6.Source of information about anemia				
a) Friends	13	43.3	9	30
b) Relatives	7	23.3	5	16.7
c) School teachers	2	6.7	2	6.7
d) Health professional	8	26.7	14	46.7
e) Mass media	0	0	0	0
f) others	0	0	0	0
7.Area of residence				
a) Rural	11	36.7	10	33.3

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b) Urban	19	63.3	20	66.7

TABLE 1 SHOWS THAT DISTRIBUTION OF SOCIO DEMOGRAPHIC VARIABLES BET WEEN THE EXPERIMENTAL AND CONTROL GROUP.

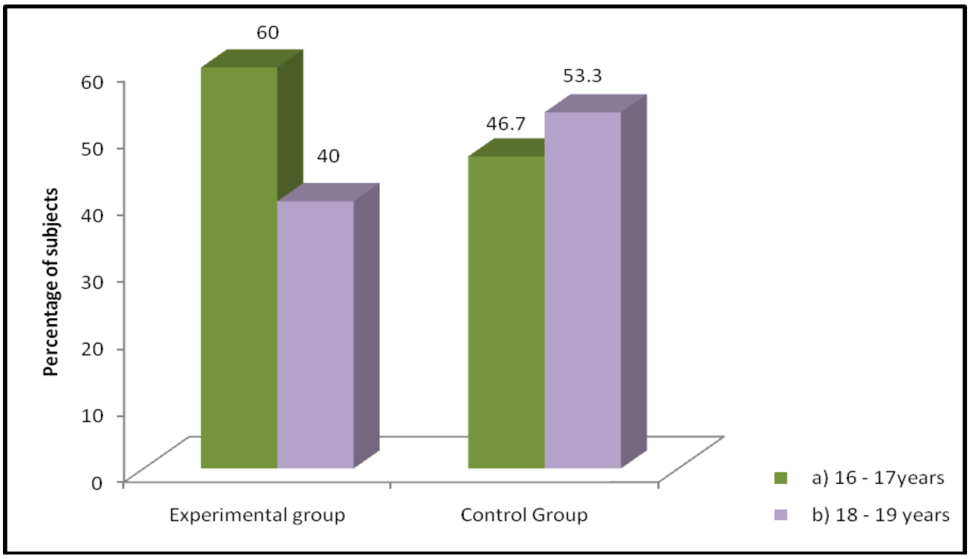

Figure 5 illustrates the age distribution of participants in both the experimental and control groups.

In the experimental group, 60% of the participants were in the age group of 16–17 years, while the remaining 40% were in the age group of 18–19 years.

In the control group, 46.7% of the participants were in the age group of 16–17 years, whereas 53.3% were in the age group of 18–19 years.

This shows that the majority of participants in the experimental group were younger (16–17 years), while in the control group, a slightly higher proportion belonged to the older age group (18–19 years).

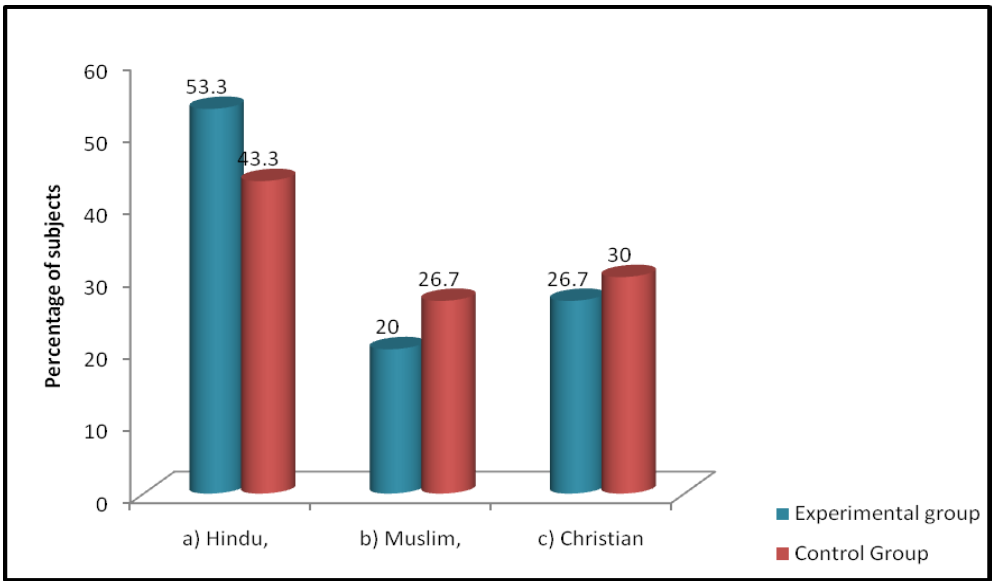

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Figure 6 presents a cylindrical diagram illustrating the distribution of religion among participants in the experimental and control groups. In the experimental group, 53.3% of participants were Hindu, 20% were Muslim, and 26.7% were Christian. In the control group, 43.3% were Hindu, 26.7% were Muslim, and 30% were Christian.

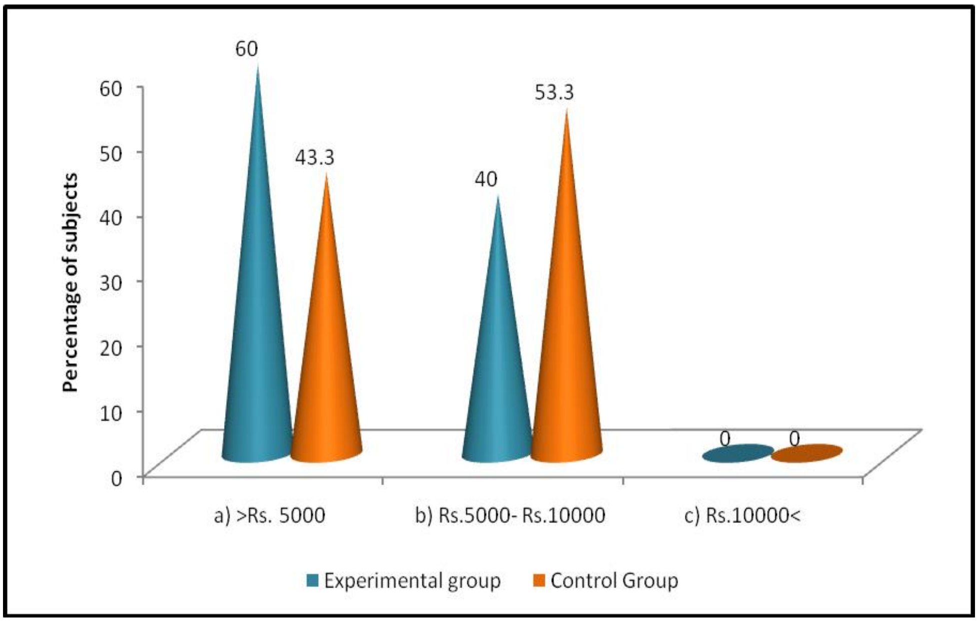


Figure 7 presents a cylindrical diagram illustrating the distribution of monthly family income among participants in the experimental and control groups. In the experimental group, 60% of participants had a monthly family income of more than ₹5,000, while 40% had an income between ₹5,000 and ₹10,000. In the control group, 36.7% of participants had a monthly income of more than ₹5,000, 33.3% had an income between ₹5,000 and ₹10,000, and 30% had an income of less than ₹10,000.

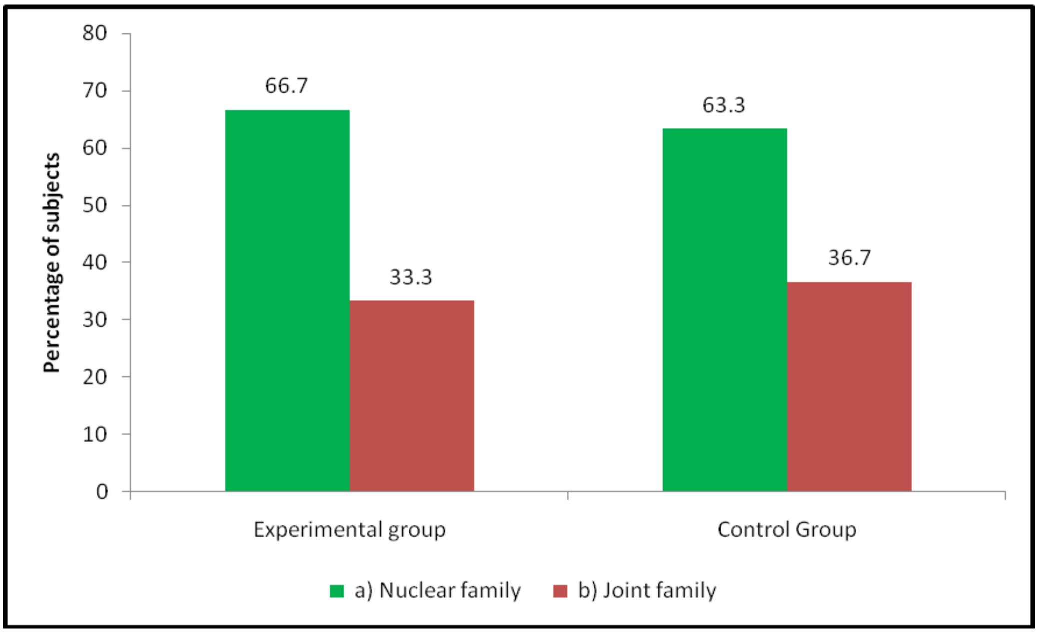


Figure 8 presents a bar diagram illustrating the distribution of the type of family among participants in the experimental and control groups. In the experimental group, 66.7% of participants belonged to nuclear families, while 33.3% belonged to joint families. In the control group, 63.3% of participants belonged to nuclear families, whereas 36.7% belonged to joint families.

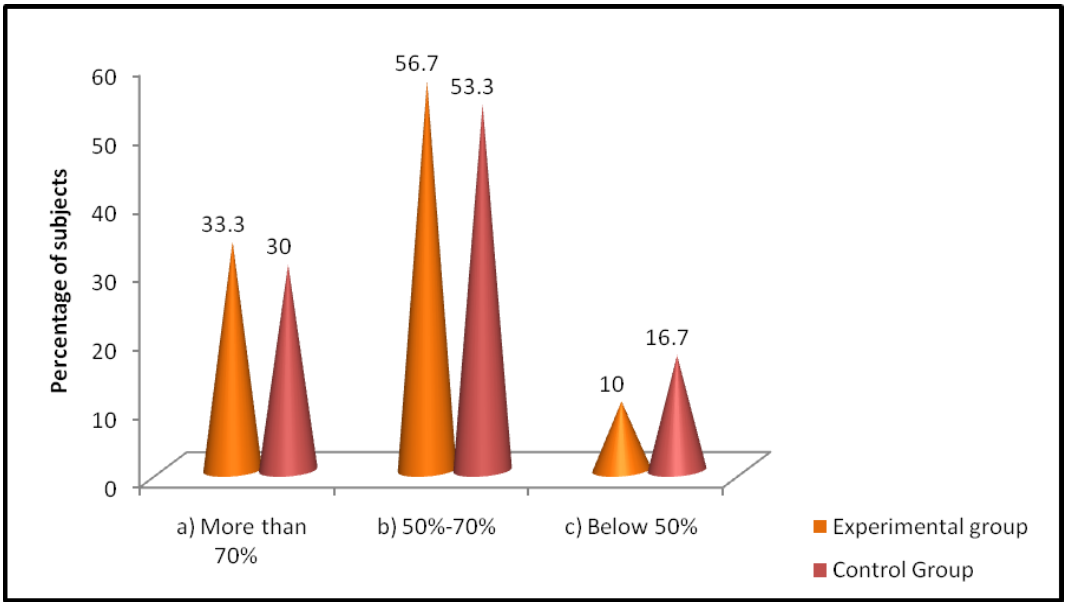
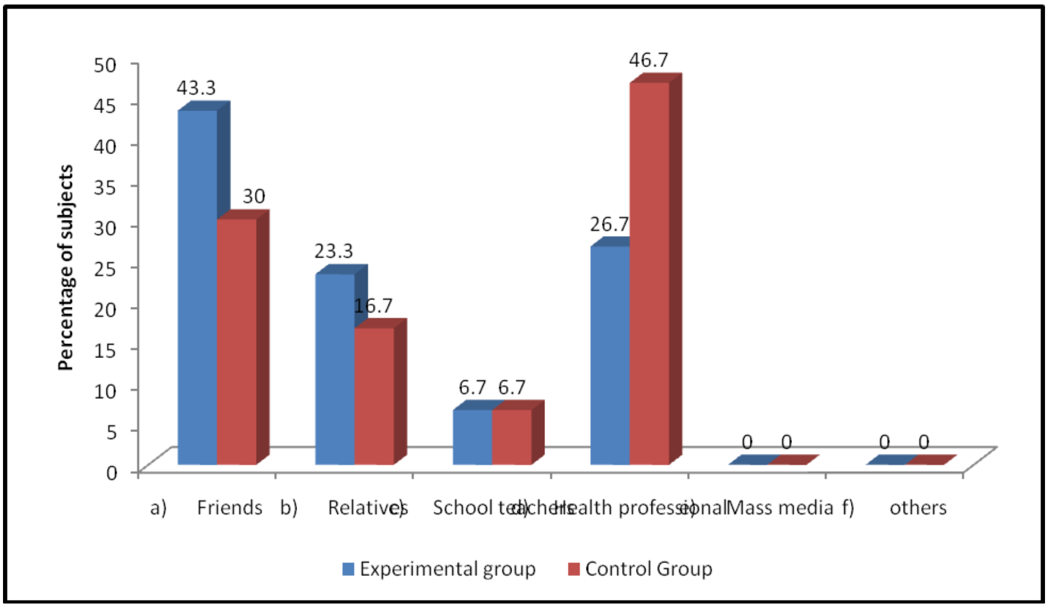


Figure 9 presents a bar diagram illustrating the distribution of PUC academic levels among participants in both the experimental and control groups. In the experimental group, 33.3% of participants scored more than 70%, 56.7% scored between 50% and 70%, and 10% scored below 50%. In the control group, 30% of participants scored more than 70%, 53.3% scored between 50% and 70%, and 16.7% scored below 50%.



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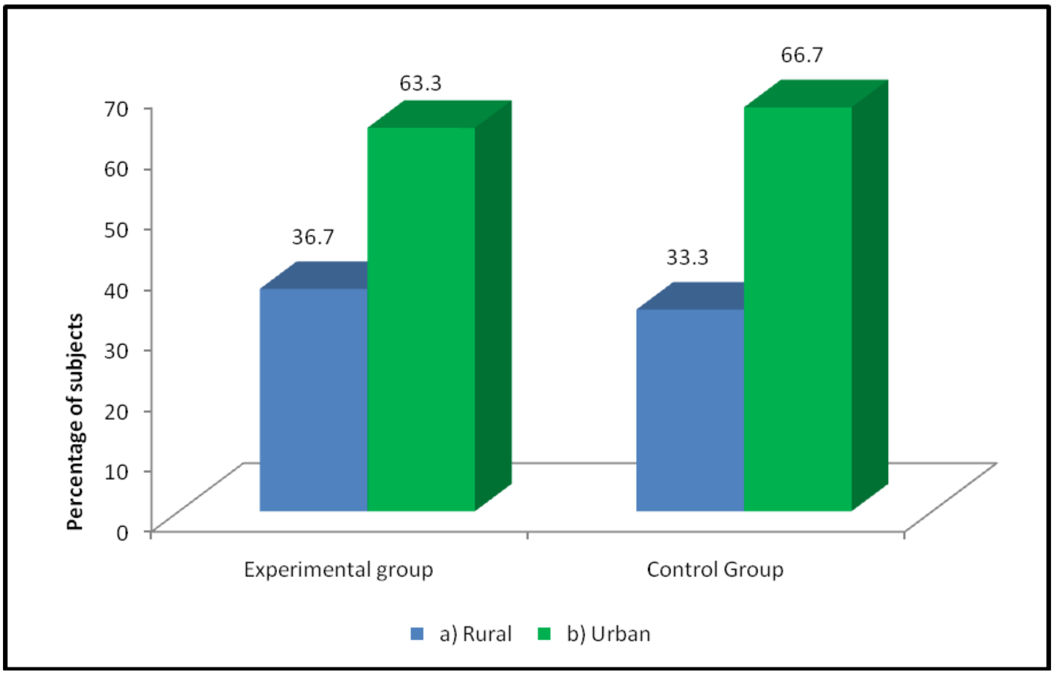
Figure(10)bar diagram showing the distribution source of information in both experimental and control group.

Regarding the source of information in the experimental group 43.3% were received from friends, 23.3% were got information by relatives ,6.7% were got by school teachers and 26.7% were got information by health professionals. In the control group 30 % were received from friends, 16.7% were got information by relatives ,6.7% were got by school teachers and 46.7% were got information by health professionals



Figure(11)bar diagram showing the distribution of residence in both experimental and control group. Regarding the residence in experimental group 36.7% were from rural area and 63.3% were from urban area In control group,33.3% were from rural area and 66.7% were from urban area.

Table(2) Independent 't 'test analysis of pre-test level of hemoglobin experimental and control groups .

	N	Mean	SD	Mean Difference	t value
Experimental	30	9.816	0.57	0.045	0.31
Control	30	9.771	0.57		p=0.76,NS

NS – No Significance P > 0.05

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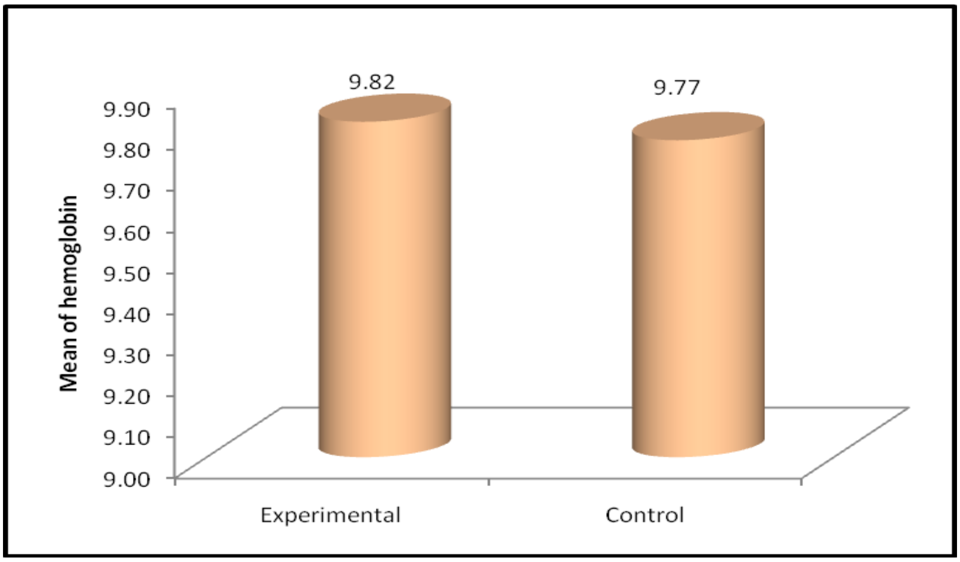
Table (2) shows that the pre-test level of hemoglobin experimental and control group. The Independent 't' test used to find out the significance between the experimental and control group.In experimental group pre test level hemoglobin 9.81 SD of 0.57 .In control group pre test level of hemoglobin was 9.77 SD of 0.57.Independant t test value was 0.31 ($p>0.01$) represent that there is no significant difference in the pre test level of hemoglobin.

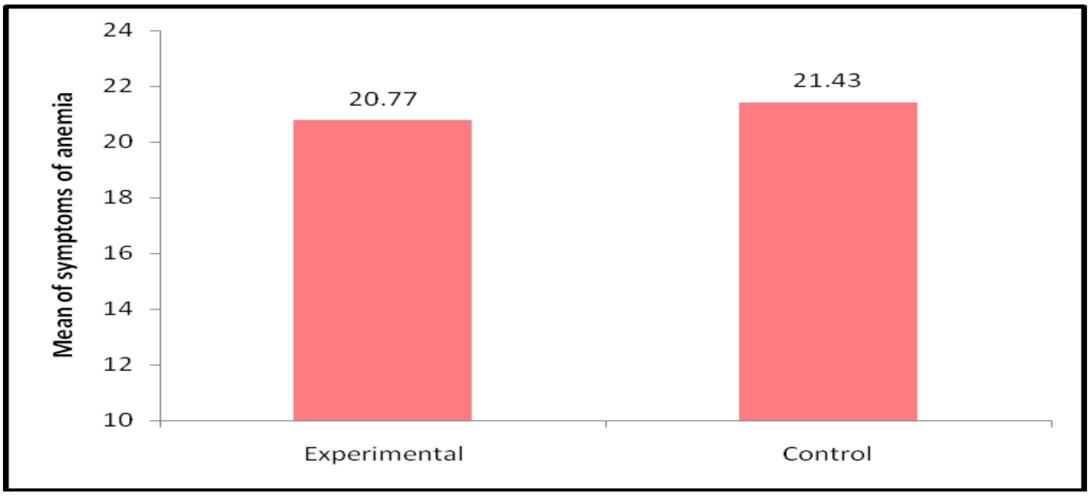


Figure(12) bar diagram pre test level of mean hemoglobin in both experimental and control group.

Table 3 shows that the symptoms of anemia in both experimental and control group.

	Range	Minimum	Maximum	Mean	SE	SD
Experimental		15	28	20.77	0.60	3.31
Control	1-50	17	27	21.43	0.51	2.81

Table 3 shows that in pre test mean of symptoms of anemia was 28 with SD of 20.7 in experimental group. In control group mean of symptoms of anemia was 21.43 with SD of 0.51.



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Figure(12)bar diagram showing mean of symptoms of anemia in both experimental and control group

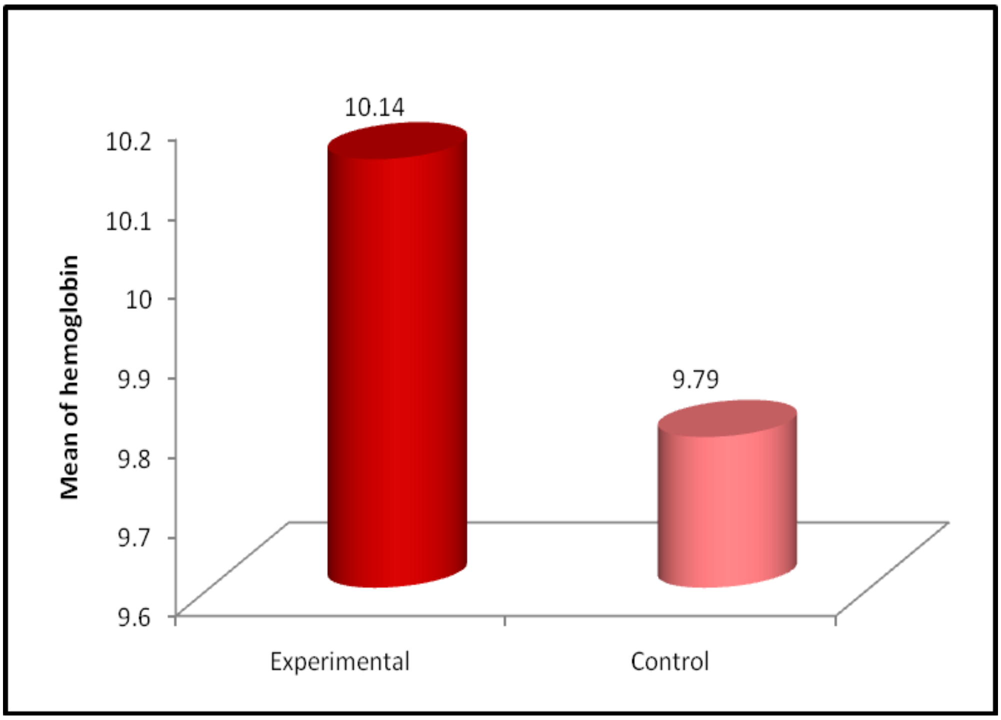
Table 4 shows that the post test level of hemoglobin between the experimental and control group.

	N	Mean	SD	Mean Difference	t value
Experimental	30	10.14	0.50	0.35	2,57
Control	30	9.79	0.55		p=0.01,NS

S** significant P<0.01

Table 5 shows that in the experimental group after the administration of mint leaves chutney , the post test level of hemoglobin was 10.14 with SD 0.5.In the control group was 9.79 with SD of 0.5 .Mean difference was 0.35 g/dl .

Obtained t value shows that there is an significant increase in the post test level of hemoglobin in experimental group than control group .Intervention was very effective to increase the hemoglobin .Net effectiveness of mint leave chutney was 0.35gm/dl. Research hypothesis was accepted



Figure(13)bar diagram showing post hemoglobin level in both experimental and control group.

Table 5 Frequency and percentage distribution of different levels of anemia in experimental group.

	Pre test n=30			Post test n=30	
	Range	Frequency	Percentage	Frequency	Percentage
Mild Anemia	10- 11g/dl	15	50	19	63.3
Moderate Anemia	8-10g/dl	15	50	11	36.7
Severe Anemia	<8g/dl	0	0	0	0

Table 5 depicts that the distribution of hemoglobin in experimental group.Fiffteen (50%) of them were distributed in mild anemia (10-11g/dl) and 15(50%) of them had moderate anemia(8-10mg/dl) in the pretest.After the administration of mint leaves chutney 19 (63.3%) were reported mild anemia and 36.7% were reported moderate anemia.

Table 6 Frequency and percentage distribution of different levels of anemia in control group.

		Pre test n=30		Post test n=30	
	Range	Frequency	Percentage	Frequency	Percentage
Mild Anemia	10- 11g/dl	15	50	15	50
Moderate Anemia	8-10g/dl	15	50	15	50
Severe Anemia	<8g/dl	0	0	0	0

Table 6 depicts that the distribution of hemoglobin in control group.Fiffteen (50%) of them were distributed in mild anemia (10-11g/dl) and 15(50%) of them had moderate anemia(8-10mg/dl) in the pretest. In the post test participants hemoglobin distributed as same without any change.

Table(7) Chi-square the post test level of hemoglobin and socio demographic variables in the experimental group. Median=10.33

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Sociodemographic Variables	Below Median	Above median	Chi Square Value
1. Age:			0.5
a) 16 - 17years	10	8	p=0.4
b) 18 - 19 years	5	7	NS
2. Religion:			
a) Hindu,	10	6	3
b) Muslim,	3	3	p=0.2
c) Christian	2	6	NS
3. Family Income per month			
a) >Rs. 5000	10	8	0.5
b) Rs.5000- Rs.10000	5	7	p=0.4,NS
c) Rs.10000<			
4. Type of Family			
a) Nuclear family	11	9	0.6
b) Joint family	4	6	p=0.4,NS
5. PUC academic level			
a) More than 70%	5	5	0.39
b) 50%-70%	8	9	p=0.8
c) Below 50%	2	1	NS
6.Source of information about anemia			
a) Friends	5	8	1.97
b) Relatives	5	2	p=0.5
c) School teachers	1	1	NS
d) Health professional	4	4	
e) Mass media	0	0	
f) others	0	0	
7.Area of residence			
a) Rural	5	6	0.14
b) Urban	10	9	p=0.7,NS

S* -Significance P < 0.01 NS – No Significance P > 0.05

Table(7) shows that the association between the pre test level of hemoglobin and socio demographic variable in the experimental group. Based on the fourth objectives used to Chi-square test used to associate the level of hemoglobin and selected socio- demographic variables age,reliogion,income /

month, type of family,PUC academic level source of information and area of residence in experimental group. The Chi-square value shows that there is no significance association between the pre test knowledge and socio demographic variables. (P>0.05) in the experimental group.

Table(8) Chi-square association between the post test hemoglobin and socio demographic variables in the control group .Median= 9.99

Sociodemographic variables	Below Median	Above median	Chi square Value
1. Age:			
a) 16 - 17years	7	7	0
b) 18 - 19 years	8	8	p=1,NS
2. Religion:			
a) Hindu,	7	6	0.18
b) Muslim,	4	4	p=0.9,NS
c) Christian	4	5	
3. Family Income per month			
a) >Rs. 5000	5	8	1.94
b) Rs.5000- Rs.10000	9	7	p=0.3,NS
c) Rs.10000<	1	0	
4. Type of Family			
a) Nuclear family	8	11	1.29
b) Joint family	7	4	p=0.2,NS
5. PUC academic level			
a) More than 70%	1	8	7.8
b) 50%-70%	11	5	p=0.02
c) Below 50%	3	2	s**
6.Source of information about anemia			
a) Friends	5	4	2.5
b) Relatives	2	3	p=0.4,NS
c) School teachers	2	0	
d) Health professional	6	8	
e) Mass media	0	0	
f) others	0	0	
7.Area of residence			

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a) Rural	4	6	0.6
b) Urban	11	9	p=0.4,NS

S* -Significance P < 0.01 NS – No Significance P > 0.05

Table(8) shows that the association between the post test level of hemoglobin and socio demographic variable mainly age,reliogion,income / month, type of family,PUC academic level source of information and area of residence in the control group. Based on the fifth objectives used to Chi-square test used to associate the level of hemoglobin and selected socio-demographic variables control group. The Chi-square value shows that there is no significance association between the post test hemoglobin and socio demographic variables. (P>0.05) in the control group except academic performance in PUC level.

DISCUSSION

The findings of the present study were discussed in relation to the objectives and hypotheses stated in Chapter II, along with supporting evidence from relevant studies. The discussion is organized based on the study objectives.

The tool used in the study consisted of three sections:

- Section I: Demographic data
- Section II: Effectiveness of mint leaves chutney on hemoglobin level
- Section III: Association between hemoglobin level and selected demographic variables

The present study was designed to assess the effectiveness of live mint leaves chutney on hemoglobin levels among female adolescents studying in PU colleges in Kolar.

Sample Characteristics

In the experimental group, most adolescents (60%) were in the age group of 16–17 years, while in the control group, 53.3% were in the age group of 18–19 years. Regarding religion, 53.3% of participants in the experimental group and 43.3% in the control group were Hindus.

With respect to monthly family income, 60% of participants in the experimental group and 36.7% in the control group had an income of more than Rs. 5000. Regarding type of family, 66.7% of the experimental group and 63.3% of the control group belonged to nuclear families.

In terms of PUC academic performance, 56.7% in the experimental group and 53.3% in the control group scored between 50–70%. Regarding source of information, 43.3% of the experimental group received information from friends, whereas 46.7% of the control group obtained information from health professionals. In both groups, most participants were from urban areas (63.3% in experimental group and 66.7% in control group).

Pre-test Level of Hemoglobin In the experimental group, the pre-test mean hemoglobin level was 9.81 g/dl with a standard deviation (SD) of 0.57. In the control group, the pre-test mean hemoglobin level was 9.77 g/dl with an SD of 0.57. The independent t-test value was 0.31 (p > 0.01), indicating

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that there was no significant difference between the two groups at baseline. This shows that hemoglobin levels were similar in both experimental and control groups before intervention.

The pre-test mean score of anemia symptoms was 28 with an SD of 20.7 in the experimental group, while in the control group it was 21.43 with an SD of 0.51.

These findings are supported by a study conducted in Bangladesh, which reported that anemia prevalence was 24.8% among adolescent girls. The study emphasized the need for interventional measures to reduce anemia among adolescents and pregnant women.

Another supporting study conducted among 363 adolescent school girls reported a prevalence of anemia of 5.8% and iron deficiency of 8.5%. The study found significant associations between hemoglobin levels and factors such as MCV, TIBC, age, and BMI.

Effectiveness of Mint Leaves Chutney

After administration of mint leaves chutney, the post-test mean hemoglobin level in the experimental group increased to 10.14 g/dl with an SD of 0.5. In the control group, the post-test mean was 9.79 g/dl with an SD of 0.5. The mean difference between the groups was 0.35 g/dl.

The independent t-test indicated a statistically significant improvement in hemoglobin levels in the experimental group compared to the control group. This confirms that the intervention was effective in increasing hemoglobin levels. The net effectiveness of mint leaves chutney was 0.35 g/dl, and thus the research hypothesis was accepted.

In the experimental group, before intervention, 50% of participants had mild anemia (10–11 g/dl) and 50% had moderate anemia (8–10 g/dl). After intervention, 63.3% had mild anemia and 36.7% had moderate anemia. In the control group, no significant change was observed between pre-test and post-test results.

Similar findings were reported in a study where schoolchildren consuming carotene-rich green and yellow leafy vegetables showed significant improvement in hemoglobin levels after 9 weeks of dietary intervention. The study concluded that such dietary intake improves iron status and overall nutritional health.

Association Between Hemoglobin Level and Demographic Variables

The chi-square test was used to determine the association between hemoglobin levels and selected socio-demographic variables such as age, religion, income, type of family, academic performance, source of information, and area of residence.

In the experimental group, no significant association was found between pre-test hemoglobin levels and socio-demographic variables ($p > 0.05$). Similarly, in the control group, no significant association was observed between post-test hemoglobin levels and most socio-demographic variables ($p > 0.05$), except for academic performance in the PU level, which showed a significant association.

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A supporting study conducted among school children in Kenitra reported a prevalence of anemia of 16.2%. The study found a significant relationship between maternal education and anemia ($p = 0.004$), but no significant association with family income. The study concluded that improving socioeconomic status, women's education, and nutritional awareness are important strategies to reduce anemia.

CONCLUSION

Management of iron deficiency anemia among adolescents involves ensuring adequate dietary intake to improve hemoglobin levels. Nurses play an important role in collaboration with nutritionists to promote cost-effective, easily available, and locally cultivable dietary sources, including those that can be grown in kitchen gardens, to prevent and manage iron deficiency anemia.

Emphasis should be placed not only on iron tablet supplementation but also on dietary sources rich in iron, such as mint leaves. These combined practices help create awareness regarding the importance of dietary iron intake, thereby improving prevention and prognosis of iron deficiency anemia and promoting better health outcomes.

Conclusions of the Study

Based on the findings of the study, the following conclusions were drawn:

- The pre-test mean hemoglobin level in the experimental group was 9.81 g/dl with a standard deviation (SD) of 0.57. In the control group, the pre-test mean hemoglobin level was 9.77 g/dl with an SD of 0.57.
- The pre-test mean score of anemia symptoms was 28 with an SD of 20.7 in the experimental group, whereas in the control group it was 21.43 with an SD of 0.51.
- The post-test mean hemoglobin level in the experimental group was 10.14 g/dl with an SD of 0.5, while in the control group it was 9.79 g/dl with an SD of 0.5.
- The net effectiveness of mint leaves chutney on hemoglobin was 0.35 g/dl.
- The distribution of hemoglobin levels showed that, in both groups during the pre-test, half of the participants had mild anemia and half had moderate anemia. After the intervention, some participants in the experimental group improved from moderate to mild anemia. However, no significant change was observed in the control group.
- There was no significant association between hemoglobin levels and demographic variables, except for PUC academic performance. Participants with higher academic scores (above 70%) showed comparatively higher hemoglobin levels in the control group.
- The independent t-test showed a statistically significant difference after the administration of mint leaves chutney ($p < 0.01$). Hence, the research hypothesis was accepted. This indicates that hemoglobin levels were significantly higher in the experimental group compared to the control group.
- Overall, the study concludes that mint leaves chutney was effective in improving hemoglobin levels among adolescents.

Implications of the Study

The findings of the study have implications in nursing education, nursing practice, nursing administration, and nursing research.

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Nursing Education

Basic nursing education is essential for developing competent student nurses. The study highlights the need to strengthen practical teaching related to dietary sources of iron. This will help students understand and apply nutritional interventions in clinical and community settings. Community health nursing education should include practical knowledge of dietary iron sources along with iron supplementation in the management of iron deficiency anemia.

Nursing Practice

There is a need for in-service education and periodic training programs on the management of iron deficiency anemia. Clinical practice guidelines should be strengthened to prevent and manage anemia effectively. Healthcare personnel, including staff nurses and village health nurses, should be adequately trained to assess and manage iron deficiency anemia, thereby reducing its incidence and prevalence.

Nursing Administration

Training programs for nursing administrators and public health nurses can enhance organizational efficiency and team functioning. Strengthening anemia management strategies improves quality assurance in healthcare services. Educating healthcare administrators about early detection and management of iron deficiency anemia helps reduce complications such as delayed growth, poor cognitive development, and increased mortality.

Nursing Research

Research on dietary sources of iron is essential for advancing nursing knowledge and practice. It promotes evidence-based practice and enhances critical and creative thinking among nurses. Continuous research encourages the integration of modern nutritional strategies into nursing care.

Suggestions

1. In-service education programs should be promoted to enhance competency in the assessment and management of iron deficiency anemia in both urban and rural healthcare settings.
2. Regular training programs should be conducted for school teachers regarding the prevention and management of iron deficiency anemia.
3. Education programs for student nurses, teachers, and village health nurses should be strengthened to create awareness about prevention and management strategies for iron deficiency anemia.

Recommendations

1. The study may be replicated on a larger sample to improve generalizability.
2. A longitudinal study with follow-up assessment may be conducted.
3. Comparative studies can be carried out using different dietary iron sources.
4. Studies can be conducted comparing adolescents and unmarried women.
5. Research may be extended to rural healthcare settings.
6. Studies may be conducted among school teachers.

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7. Interventions may be evaluated along with iron tablet supplementation.

Limitations of the Study

- The study was limited to late adolescents studying in selected settings.
- Generalization of findings is limited to the selected study setting.
- A larger sample size and longer duration would have provided a more comprehensive evaluation of the intervention's effectiveness.

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