

# Impact of family-centered study: a theory-based intervention to promote preventative behaviors for iron deficiency anemia in primary students: A randomized controlled trial protocol

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## Abstract

**Background:** Iron deficiency is a prevalent nutritional issue worldwide, particularly affecting girls and contributing to anemia.

**Objectives:** This study aims to evaluate an educational intervention program utilizing the intervention mapping approach to enhance mothers' preventive behaviors against iron deficiency in primary students.

**Methods:** Participants will be assigned to either the intervention (n = 75) or control (n = 75) groups based on preset criteria in a matched-pair, two-arm parallel randomized controlled trial. An education program will be conducted through in-person communication and questionnaires with the mothers of selected students. The intervention comprises four sessions employing the integrated (intervention mapping approach) model, with data collection taking place at baseline and after six months.

**Conclusion:** As the first model-based education and attractive intervention study, this trial is novel and effective in boosting preventive behaviors against iron deficiency anemia in primary school students.

**Keywords:** Preventive medicine, Behaviors, Iron deficiency Anemia, Students.

## Introduction

Health is a crucial aspect that plays a vital role in the progress and survival of a society. Iron deficiency anemia is a major public health concern, particularly among school-age children. Fulfilling the physical requirements of individuals, such as nutrition, clothing, security, and healthcare, is a primary responsibility of families.<sup>1</sup> Moreover, it impacts children's lifestyles. The family environment acts as a foundation for learning and supporting health beliefs, values, and behaviors, as well as planning and implementing health promotion activities.

Creating a healthy home environment and adopting a healthy lifestyle are crucial to promoting health and preventing diseases. Families play a critical role in this aspect. The World Health Organization (WHO) has reported that by improving the level of knowledge and

information among parents and families, two-thirds of the fourteen million children who die each year due to various reasons can be saved.<sup>2</sup> Therefore, educating parents and promoting healthy behaviors in the family setting can have a significant impact on children's health and overall well-being.<sup>2</sup>

Health education programs that target children should give special attention to mothers, as they play a vital role in their children's health. The level of awareness and knowledge that mothers have can have a significant and undeniable impact on their children's well-being. Educating mothers about healthy lifestyles should include the importance of balanced nutrition as well as breaking bad habits that families may have become accustomed to over time without knowing whether they are beneficial or harmful. It is also worth noting that, when it comes to

children's health, the knowledge and practices of mothers may be even more critical than family income. Short health recommendations often fall short of addressing the underlying causes of many health problems, which are often linked to individual, group, and family lifestyles. Therefore, health educators and health teams must play an essential role in examining clients' behaviors in their context to identify areas where behavior change is needed and necessary. Raising awareness and actively involving the community, as well as providing access to iron supplements, are strategies that can be employed to achieve health promotion goals effectively.<sup>3</sup>

Iron deficiency anemia is a widespread global health issue,<sup>3</sup> particularly prevalent in developing countries.<sup>4</sup> School-age children are particularly vulnerable, with more than half of them affected by this type of anemia.<sup>5</sup> Iron deficiency anemia is a prevalent health issue worldwide, affecting two billion people, according to the World Health Organization.<sup>6</sup> Particularly common in childhood, studies in South Africa show that 4 to 36 percent of school-age children, aged 11 and under, suffer from anemia, and 5 to 32 percent have iron deficiency.<sup>7</sup>

According to recent studies, iron deficiency anemia is prevalent in school-age children globally, including 16.6% of children in Ecuador, with 75.5% of all anemias related to iron deficiency anemia.<sup>8</sup> In the United States, the prevalence of iron deficiency anemia ranges from 3 to 10 percent and affects up to 30 percent of the low-income population.<sup>9</sup> Health and nutrition experts emphasize that primary prevention is crucial to controlling this type of anemia. Nutritional education programs, particularly those geared towards mothers, can play a significant role in increasing awareness of a balanced diet, eliminating harmful eating habits, and ultimately improving children's health. To better address the issue of iron deficiency anemia, it is essential to promote a better understanding of nutrition and its role in overall health while encouraging healthy eating habits.

### **Theoretical basis**

When it comes to designing effective health education programs, a variety of theories and models are utilized to improve health behaviors. These educational frameworks provide guidance for predicting behavioral determinants

and promoting the effectiveness of health programs. In many ways, theories and models provide a foundation for understanding how individuals learn and behave and why they behave the way they do. By focusing on motivational training methods and correcting misconceptions, health education programs can play an essential role in achieving the goal of promoting healthy behaviors. Given the importance of health education, combining both science and art can facilitate the development of a successful learning process aimed at creating desirable behaviors and improving overall health outcomes.<sup>10</sup>

Intervention mapping is a theoretical framework that utilizes evidence-based planning to address health-related issues through an ecological approach. Using intervention mapping, changes can be made at multiple ecological levels, including the modification of environmental factors and the promotion of behavior change in individuals at risk. This approach prioritizes enhancing both health and quality of life through behavioral modifications, as depicted in Figures 1 and 2.<sup>11</sup>

Intervention mapping is a framework that consists of six steps with a varying number of tasks in each step, as shown in Figures 3 and 4. The completion of each step's tasks serves as a guide towards the next stage, guiding the development, implementation, and evaluation of a health plan. Both the completion and implementation of the steps are crucial for the proper execution of the program, as intervention mapping is developed as a sequence to ensure proper execution of the program.<sup>11</sup>

### **Hypotheses**

The first hypothesis is that moms will promote more iron deficiency anemia prevention practices in first-grade female students in Torbat-e Heydarieh in the experimental group than in the control group prior to and six months after the intervention. The second hypothesis is that demographic factors will have an impact on the rate of cognitive prevention of iron deficiency anemia by first-grade female students in Torbat-e Heydarieh, from the perspective of their mothers.

### **Objectives**

This study aims to determine the global incidence of non-fatal electrical injuries that result in amputations, which

can be challenging to estimate accurately.

## Methods

### Trial design

This study utilized a matched-pair, two-arm, parallel, randomized controlled trial design. The sample size for this study consisted of 150 participants, with 75 assigned to both the intervention and control groups based on inclusion and exclusion criteria. Data collection was carried out during the 2021–2022 school year. Within the intervention group, participants received educational materials delivered in-person and through communication with the mothers of selected students, while the control group did not. Required data are collected from all participants using a written questionnaire administered through interviews with the participants.

The intervention program consisted of four sessions utilizing the integrated intervention mapping approach. A qualified healthcare practitioner has overseen the program. Extensive research suggests that health education can play a significant role in preventing diseases and improving health. However, failures to change and correct unhealthy behaviors have been reported, resulting in ineffective messages being communicated to the public. In order to effectively change health behaviors, it is essential to combine innovative programs with the theory of health behavior. By utilizing this approach, the program aims to achieve the aforementioned goals.

Intervention mapping is an evidence-based planning framework that employs an ecological approach to evaluate and intervene in health-related issues. By focusing on changing the behavior of individuals at risk and modifying environmental factors, intervention mapping aims to make behavioral changes that translate to improved health and quality of life.

Intervention mapping consists of a six-step process, with each step comprising a number of tasks that provide guidance for subsequent steps. The completion and implementation of each step are integral to the development, implementation, and evaluation of a health plan. The structured nature of intervention mapping enables program developers to move between tasks and

steps, ensuring the proper implementation of the program.<sup>11</sup>

The study includes promoting awareness, motivation, and skill development, with specific components aimed at preventing iron-deficiency anemia. These include cooking high-iron foods at home, incorporating dairy products into daily diets, monitoring physical activity in first-year primary school girls, purchasing iron pills, and encouraging regular use of iron tablets. Data will be collected at baseline and after six months of follow-up.

### Participants

The study involved mothers of families who have first-grade daughters attending primary schools in Torbat-e Heydarieh. To be eligible for participation, mothers must have the agreement of the school principal, provide written consent for their child to participate, possess the ability to attend training sessions, and be familiar with studying requirements. Failure to meet these criteria or to express dissatisfaction with participation resulted in exclusion from the study as an incomplete completion of questionnaires.

### Intervention

The intervention consisted of four sessions, each lasting 60 minutes with a 1-week interval, spanning 6 weeks in total. A trained education instructor and a health educator implemented the program. The educational content was developed using previous studies. Furthermore, the mothers in the control group also received limited information on the prevention of iron deficiency anemia. The educational program encompassed three components, including awareness, motivation, and skill development, as detailed in Table 1.

### Outcomes and Measures

To gather data on the age, gender, grade, and instrumental type of participants, a brief demographic characteristics questionnaire was administered. The questionnaire follows a structure similar to the one devised using intervention mapping, concentrating mainly on the first and second steps.

Mothers conducted data collection through a questionnaire administered at the school association. The questionnaire consisted of two sections: behavioral

demographics and cognitive and behavioral determinants, with five cognitive determinants: attitude, perceived sensitivity, perceived severity, perceived self-efficacy, awareness of symptoms, and awareness of preventive behaviors. The questionnaire was designed based on the

results of program development, utilizing an intervention mapping approach with emphasis on the second and sixth steps. To ensure the questionnaire's validity in this study, three methods were deployed: face validity, content validity, and structure validity.

**Table 1.** Content, components, and methods of this study

Content	Components	Methods
<b>Session 1. (Promoting in awareness)</b>	Improvement of knowledge about importance Awareness of symptoms Awareness of preventive behaviors Persuasive communication The role of nutrition and food in the prevention of iron deficiency anemia in girls by mothers The role of supplements and regular testing of blood iron levels in the prevention of iron deficiency anemia in girls by mothers	- Lecture - Brainstorm, Q & A - Showing PowerPoint, - Uploading posters, pamphlets, text, ...
<b>Session 2. (Promoting in motivation)</b>	Creating a positive attitude Mothers express their belief in the importance of cooking foods high in iron. Mothers express their confidence in cooking foods high in iron. Mothers express their belief in the effectiveness of using dairy products in the daily diet of the family to prevent iron deficiency anemia. Mothers recognize that the use of dairy products in the daily diet of the family is a preventive behavior for iron deficiency anemia. Mothers recognize that encouraging regular iron supplementation is effective in preventing iron deficiency anemia.	- Group discussion - Role playing - Recording participants' thoughts and experiences about proper posture
<b>Session 3,4. (Development of skills)</b>	Improvement of participants' abilities to accomplish proper behavior Mothers say that monitoring regular physical activity in girls is effective in preventing iron deficiency anemia.	- Direct experience - Vicarious experience - Demonstration, re- demonstration - Verbal persuasion - Corrective feedback
<b>Perceived sensitivity Perceived severity Perceived self-efficacy</b>	Improvement of Perceived sensitivity, perceived severity and perceived self-efficacy about importance	- Recording participants' thoughts and experiences about proper posture

**Sample size**

To determine the required sample size for the present study, the following formula is employed: [formula not included]. The calculated number of samples is based on a 5% α, 95% confidence level (Z = 1.96), 30% P, 70% Q, and 3% accuracy (d = 3%). The sample is systematically clustered, accounting for a loss of 300 individuals. Given the large population size, the study employed a multi-stage

random sampling method.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N} \left( \frac{z^2 pq}{d^2} - 1 \right)}$$

The number of samples in this section is calculated using the following formula: Based on the preliminary results of

the study and the same formula, the sample size for the two intervention groups and one control group is calculated using the Pokac method, resulting in an estimated number of 75 individuals per group.

$$n = \{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times [p_1(1-p_1) + p_2(1-p_2)]\} / (p_1 - p_2)^2$$

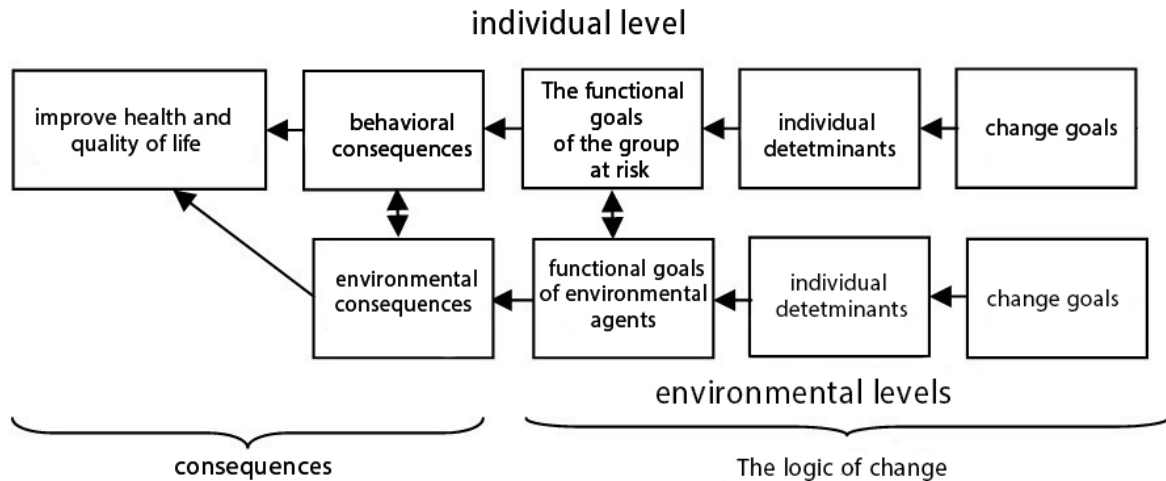
**Randomization**

In the descriptive part of the study, the subjects (mothers) were randomly selected, and the samples participated in the preliminary test. The results were analyzed and reported.

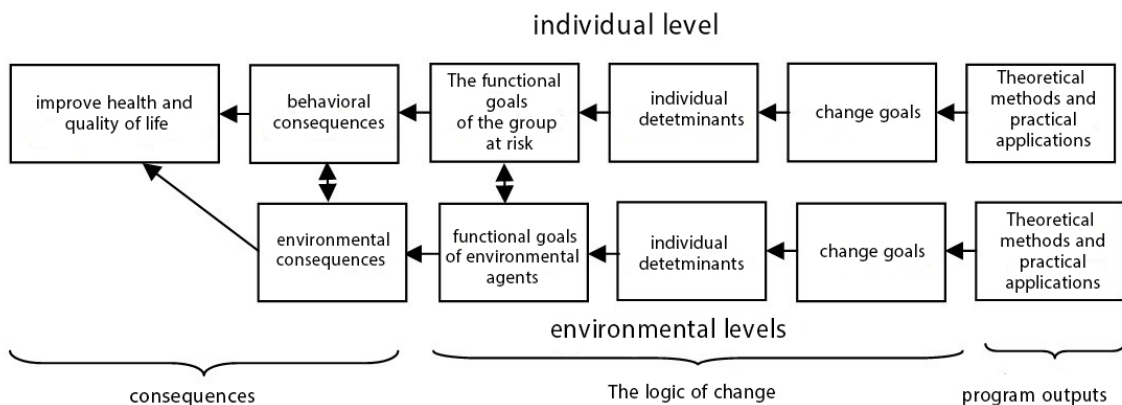
In the quasi-experimental study, the subjects were selected randomly again, and the groups participated in the preliminary test. In the experimental group, the

intervention took place, and both groups participated in the final test.

The intervention in this study was based on the intervention mapping framework. The subjects were divided randomly into two groups, which were the test and control groups. Based on the research objectives and hypotheses, the researcher intervened in the experimental group following the final test and analyzed the results. The first group was assigned to the interventional group, and the second group was designated as the control group through a random assignment done under the supervision of the principal researcher. The current RCT protocol was reported in compliance with the CONSORT guidelines. Figure 5 illustrates the study flowchart.



**Figure 1.** Logical model of intervention mapping approach



**Figure 2.** Logical model of intervention mapping approach

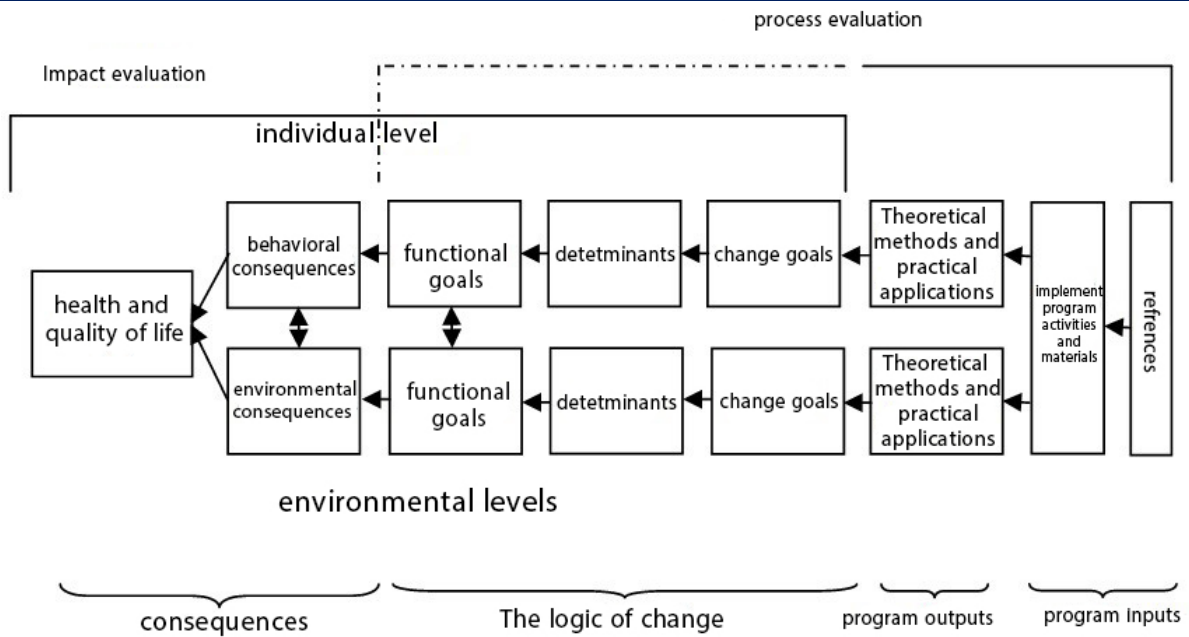


Figure 3. Logical model of intervention mapping approach

assessment	<b>Step one</b>	<ul style="list-style-type: none"> <li>• Creating a participatory planning group</li> <li>• Needs assessment guidance</li> <li>• Estimating community capacity</li> <li>• Adjust the health implications and quality of life of the program</li> </ul>
	<b>Needs assessment or Logical model of problem</b>	
	<b>Step two</b>	<ul style="list-style-type: none"> <li>• Express the consequences of changing behavior and environment</li> <li>• Expressing functional goals</li> <li>• Select important and changeable determinants</li> <li>• Build a matrix of change goals</li> </ul>
	<b>The matrix of change goals or the logical pattern of change</b>	
	<b>Step three</b>	<ul style="list-style-type: none"> <li>• Generate program ideas in the planning group</li> <li>• Identify theoretical methods</li> <li>• Selection of theoretical methods</li> <li>• Selection or design of practical application</li> <li>• Ensure that applications address change goals</li> </ul>
	<b>Theory based methods and practical application of intervention</b>	
Implementation	<b>Step four</b>	<ul style="list-style-type: none"> <li>• Consultation with participants and implementers</li> <li>• Create program themes ranges sequences and list materials</li> <li>• Prepare project documentation</li> <li>• Browse available program materials if available</li> <li>• Drafting program materials and protocols</li> <li>• Pre-test and trial test of program materials and protocols</li> <li>• Production of materials and protocols</li> </ul>
	<b>Intervention program planning</b>	
	<b>Step five</b>	<ul style="list-style-type: none"> <li>• Identify potential adopters and implementers</li> <li>• Reassessment of the planning team</li> <li>• Express the implications and functional goals of program use</li> <li>• Specify the determinants of adoption and implementation</li> <li>• Build a matrix change goals</li> <li>• Selection of theoretical methods and practical application</li> <li>• Design interventions for adoption and implementation</li> </ul>
	<b>Planning the adoption</b>	
	<b>Implementation and Sustainability of the program</b>	
	<b>Step six</b>	<ul style="list-style-type: none"> <li>• Review the logical pattern of the program</li> <li>• Write impact assessment questions</li> <li>• Write change assessment questions on determinants</li> <li>• Write process evaluation questions</li> <li>• Preparation of indicators and scales</li> <li>• Specify the evaluation plan</li> </ul>
	<b>Plan an evaluation Plan or rational evaluation model</b>	
	<b>Implementation</b>	

Figure 4. Six main steps in the intervention mapping process



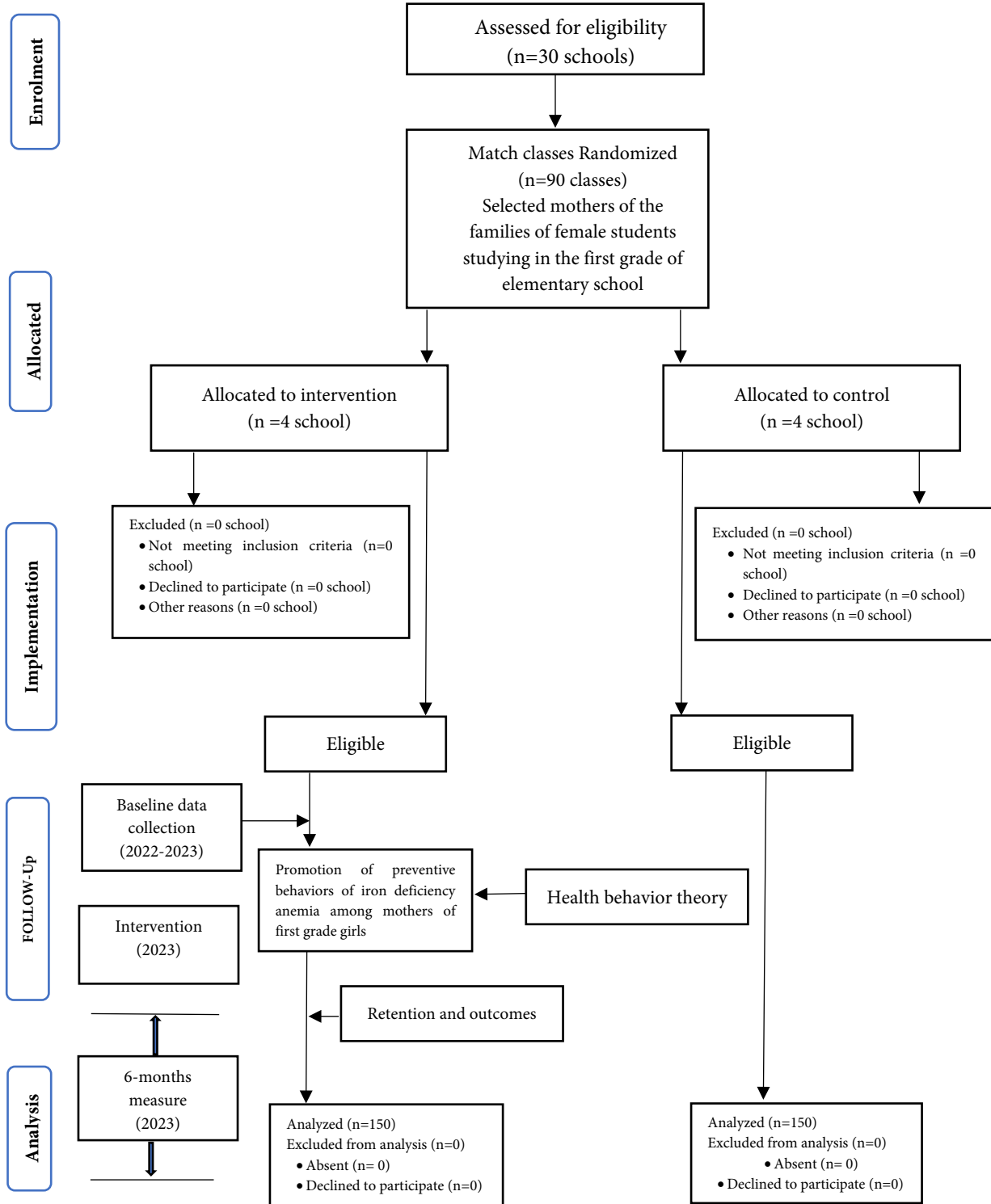
**Statistical analysis**

After entering the data into SPSS (version 21.0, SPSS Inc, Chicago, IL, USA) to describe the data from the descriptive tests of frequency, mean and standard deviation and to analyze the data from the tests; Independent t-test, paired t-test, Pearson correlation and linear regression by

Backward method will be used at a significance level of 0.95e.

**Ethical considerations**

The study will be conducted in accordance with the Declaration of Helsinki. Trial Registration Number (TRN): ISRCTN73824458 has been registered.



**Figure 5.** The study process flow diagram

## Discussion

Preventative programs for healthy mothers are necessary, as has been extensively recorded. Nevertheless, studies on the potential influence of preventive behaviors on iron deficiency anemia are limited. Because people's views and perceptions can be influenced by other beliefs, developing questionnaires that effectively measure certain regions is a difficult undertaking. In other words, mothers' attitudes towards iron deficiency anemia prevention behaviors may be intertwined with their other belief structures, as the present study aims to explore.

Our project aimed to explore the impact of family education on promoting preventive behaviors and cognitions of iron deficiency anemia among primary school female students. As mothers play a significant role in educating their children, the effect of this educational intervention was assessed through them.<sup>12</sup> However, in this study, no significant results were observed in all indicators related to the cognitive structures of mothers. This outcome is not surprising, as developing countries with low education levels and poor incomes face various challenges.<sup>13</sup> For instance, in African countries, including Afghanistan, anemia affects almost half of all primary school children. One possible reason for the lack of significant differences in the cognitive structures of the two groups before the intervention could be the observed low levels of literacy and education among the study participants.<sup>14</sup>

That is, the study groups consisted of a higher average number of illiterate individuals compared to literate individuals. Another significant factor that contributed to the insignificance of the results was the economic status of the study population. Improvements in education and economic growth could be linked to reducing the rate of anemia among primary school children. Nutritional education programs implemented in schools have successfully decreased the occurrence of iron deficiency and subsequent anemia in school-going children.

A clinical study was conducted to investigate the effects of nutrition education interventions on reducing iron deficiency anemia among 623 female primary school students in Venezuela. The prevalence of iron deficiency was observed to be 25%. The study found that nutrition

education interventions had a significant effect on reducing the prevalence of iron deficiency to 14%.<sup>5,6</sup>

## Conclusions

Preventative programs for iron deficiency anemia are crucial in promoting healthy behaviors among primary school students in Torbat-e Heydarieh. Implementation of long-term interventions targeting preventive behaviors can be highly effective. These interventions can serve as valuable healthcare promotion initiatives for the community.

## Acknowledgment

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## Competing interests

The authors declare that they have no competing interests.

## Abbreviations

World Health Organization: WHO.

## Authors' contributions

All authors accepted and participated in the design of the study. NK, FP and MHD is the main investigator and drafted the manuscript. MHD supervised the study and contributed to all aspects of the study. All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

## Funding

This study is based upon research funded by Torbat-e Heydarieh under project No. 98000026. The plan is a student plan and does not have a specific financial obligation, the university does not support a significant amount.

## Role of the funding source

None.



### Availability of data and materials

The data used in this study are available from the corresponding author on request.

### Ethics approval and consent to participate

This trial has been approved by the ethics committee of Torbat-e Heydarieh University under the code IR.THUMS.REC.1400.024. We will be invited all of the available students and mothers that approve for participation by their school's principal; inform them about research design, aim, objectives, as well as voluntariness, confidentiality, and their rights. They will be then agreed to participate in the study by completing and returning the questionnaire. Trial Registration Number (TRN): ISRCTN73824458 has been registered. The written consent will be obtained

### Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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