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Iron and calcium nutrition interventions among Vietnamese women

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ABSTRACT

Iron and calcium deficiencies remain a concern amongst working-age women in low to middle-income countries. This study aimed to evaluate the effect of nutritional intervention on the improvement of the iron status and calcium intake of this population. Non-pregnant workers at a company were divided into two groups. The intervention group (n=118) received nutritional intervention including nutritional education and an 8-week course of oral nutritional supplements (ONS). The control group (n=106) did not receive any intervention. Nutritional assessment, level of Hb concentration, serum iron, and ferritin were taken at baseline and after eight weeks. The results showed iron and calcium intake increased significantly in the intervention group. The effective intervention of serum iron was 33.3%. In conclusion, nutritional intervention such as nutritional education and ONS consumption is effective for improving iron status and calcium intake in working-age women.

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1. INTRODUCTION

Micronutrient deficiencies are a concerning problem, especially in working-age women in low and middle-income countries [1]–[4]. Iron and calcium deficiencies have been common issues among such women in Vietnam for many years [5], [6]. Iron deficiency is among the leading causes of years lived with disability in low-income and middle-income countries [7], [8]. Iron deficiency and iron deficiency anemia affect the productivity and reproduction of working women. Productively, it negatively affects the quality of work through conditions such as tiredness and weakness [9], [10]. Reproductively, if left untreated, malnourished women will enter pregnancy with a higher risk of maternal death, pregnancy loss, birth defects, and poor outcomes for the offspring [11]. In fact, 25.5% of Vietnamese working-age women have anemia. Among these women, iron deficiency is a very common cause with a prevalence of 54.3% and 37.7% in pregnant and non-pregnant women, respectively [12]. Controlling anemia is a global health priority: World Health Organization (WHO) is aiming for a 50% reduction in anemia prevalence in women by 2025 [13].

Besides iron, calcium also plays an important role. It helps in the growth and maintenance of healthy bones [14]. Calcium intake in adults has not met the requirement recommendation of the Vietnamese National Institute of Nutrition (800 mg/d) and decreased from 524 mg/capita/d to 506 mg/capita/d between 2000 to 2010 [15], [16]. In general, Vietnamese adults do not have the habit of drinking cow's milk or eating dairy products to supply calcium; this may lead to a low intake of calcium [17], [18]. It is necessary to establish a habit of consuming calcium-rich foods for the Vietnamese population.

Poor-quality diets resulting in low intakes of micronutrients are one major cause of micronutrient deficiencies. Nutrition improvement strategies in Vietnam that have been applied for the prevention and control of micronutrient deficiency include short-term supplementation, medium-term food fortification, and long-term dietary diversity. However, the number of strategies has been limited and they have not been effective long-term [5], [6], [18]. It is necessary to implement more strategies to improve iron and calcium deficiency with a focus on improving dietary patterns through food selection [6].

Nutrition intervention to change behavior needs to start from the knowledge and move to attitude and practice. In Vietnam, there have been very few studies about the effects of nutrition intervention. In this study, we wanted to implement a nutrition intervention including nutritional education and the use of an oral nutritional supplement (ONS) consisting of a milk product powder. Nutritional education included detailed guidance on food selection and a balanced diet. When the current researchers devised menus for nutrition education, we realized that iron intake could reach the recommended dietary allowances (RDA), which means that, in theory, iron intake could increase through nutritional education alone. However, calcium still would not meet the RDA. Predicting this situation, researchers chose to add Meiji's Mama Milk – a type of ONS – to the diet. The intervention group received one 200 ml cup of this product per day. We considered energy and nutrients in the ONS and gave nutrition education for subjects to reduce other food consumption in order to maintain energy and balance macronutrients during the intervention period. Hence, the primary goal of this study was to assess the effects of nutritional intervention on the improvement of iron status and calcium intake in working-age women at a company.

2. METHOD

2.1. Study setting and subjects

This interventional study was quasi-experimental research and was conducted at the Trang An Company, located in northern Vietnam, with intervention and control groups for pre and post-intervention assessment. Participants had to meet the following criteria: i) were aged from 18 to 55 years old, ii) were not pregnant, iii) did not use iron or vitamin supplementation, iv) agreed to participate in the research. Of 252 initial participants selected for nutritional assessment and divided equally into an intervention and a control group, 224 data met the criteria. In both groups, participants were matched together according to the following criteria: age group, calcium, and iron deficiency status. The intervention group (n=118) received the nutritional intervention, including nutritional education and 8-week use of ONS. The control group (n=106) did not receive any intervention.

2.2. Research progress

In the intervention group, there were three steps, including baseline assessment, nutritional intervention, and reassessment after eight weeks. In the baseline assessment and reassessment steps, nutrition assessment by the 24-hour dietary recall on three non-consecutive days and biochemical tests including Hb concentration, serum iron, and ferritin were conducted. In the nutrition intervention step, researchers developed and revised nutritional education materials including 8 sample nutrient-balanced menus with local foods and a 200 ml cup of Meiji's Mama Milk per day, which contains 218 kcal, 12 g protein, 5 g lipid, 30 g carbohydrate, 320 mg of calcium, 3.6 μg of vitamin D, 6.1 mg of iron, and 36 mg of vitamin C. The intervention group was divided into 3 subgroups of 40 and each attended a 120 minute nutritional education class, given by dietitians from Hanoi Medical University. The nutritional education focused on local food-based strategies promoting the consumption of iron-rich, vitamin C-rich, and calcium-rich foods and sunbathing to absorb Vitamin D. It also included detailed guidance on food preparation, recommended dietary intake, and balanced diets. Researchers followed up on participants' knowledge and adherence in the 3rd and 6th weeks via telephone. In the control group, only baseline assessment and reassessment after 8 weeks were implemented.

2.3. Data analysis

Input data were entered into Epidata 3.1 software and STATA ver 14.0 was used to analyze figures. With the quantitative variables, student's t-test (data is in a normal distribution) and Mann–Whitney U test (data is in non-normal distribution) were applied to compare the differences between the two groups. The Wilcoxon sign-rank test was used to compare the difference in each continuous and not normally distributed variable between baseline and final in each group. The p-value of 0.05 was applied as the level of statistical significance.

The DiD design is usually used when randomized controlled trials (RCTs) are not feasible or would be unethical. It is effective in minimizing selection bias to control for confounding variables and to rule out chance [19], [20]. There are also some previous studies that assessed the impact of nutrition interventions using this method [21], [22]. Since the sampling was not random, the difference in differences method (DiD) [20] was used to evaluate the effectiveness of the intervention for nutritional indicators in both groups. This method calculated the difference between before and after intervention in each group. Then, the average gain in the control group was deducted from the average increase in the intervention group to measure the effectiveness of the intervention.

2.4. Ethics approval

This research received ethical approval from the Institutional Review Board for Ethics in Biomedical Research – Hanoi Medical University (number 33/HMUIRB) on September 9, 2018. All participants were informed about the aims and procedures of the study before the data collection period.

3. RESULTS

In the beginning, the total number of participants in the study was 252 female workers of the Trang An Company. There were 28 subjects who dropped out of the study. At final, there were 224 subjects, 106 in the control group and 118 in the intervention group. Figure 1 shows a flow diagram of study participants.

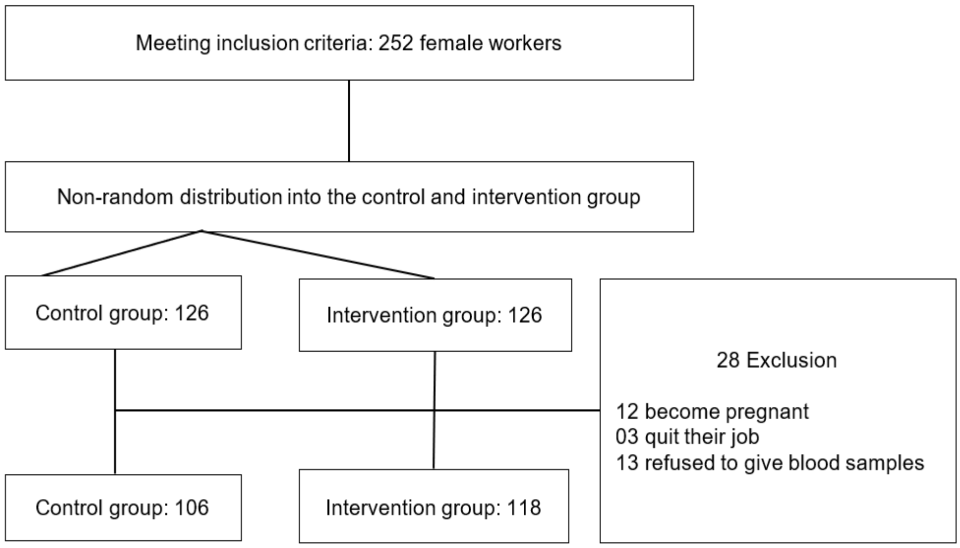

Figure 1. A flow diagram of study participants

Table 1 shows the baseline characteristics of participants. The mean age and body mass index (BMI) of the workers were 36.7 years old and 21.1 kg/m^2, respectively. There were no differences between the two groups in age and BMI.

Table 1. Baseline characteristics of participants

Characteristics	Total (n=224)	Control group (n=106)	Intervention group (n=118)	p-value
Age, years (mean±SD)	36.7±8.0	35.7±8.1	37.6±7.9	0.08
BMI (kg/m^2) (mean±SD)	21.1±2.3	21.1±2.4	21.1±2.2	0.90

Student's *t*-test

Table 2 indicates nutrient intake per day by the control and intervention groups at the baseline and final. The energy at baseline was 1,653±194 kcal; comprised of protein (67±12 g), lipid (46±12 g), and carbohydrate (242±43 g). Vitamin C before intervention in both groups was 70±38 mg, while the iron and calcium contents in the diet were 14±4 mg and 468±188 mg. There was no difference in energy, protein, lipid, and carbohydrate between the control and intervention groups at baseline and final. In the intervention group, vitamin C, iron and calcium intake increased at the 8-week final evaluation with $p<0.05$. These differences were not found in the control group.

Table 2. Nutrient intake per day of control and intervention group at the baseline and final

Nutrient	Time	Total (n=224) (mean±SD)	Control group (n=106) (mean±SD)	Intervention group (n=118) (mean±SD)	p-value ^{CI}	p-value ^{CBF}	p-value ^{IBF}
Energy (kcal)	Baseline	1653±194	1662±172	1644±212	0.23†	0.60‡	0.08‡
	Final	1658 ±208	1653±187	1662±226	0.74‡		
Protein (g)	Baseline	67±12	68±11	67±12	0.69†	0.14‡	0.29‡
	Final	69±12	69±13	68±11	0.47‡		
Lipid (g)	Baseline	46±12	47±13	46±12	0.58†	0.11#	0.52‡
	Final	46±12	45±12	47±12	0.16‡		
Carbohydrate (g)	Baseline	242±43	242±40	241±46	0.80‡	0.72#	0.59#
	Final	244±44	247±43	241±44	0.34‡		
Vitamin C (mg)	Baseline	70±38	67±40	72±36	0.33‡	0.37‡	<0.05‡
	Final	82±38	70±34	93±39	<0.05‡		
Iron (mg)	Baseline	14±4	14±4	14±4	0.41†	0.97‡	<0.05#
	Final	15±4	14± 4	16±4	<0.05‡		
Calcium (mg)	Baseline	468±188	446±199	489±177	<0.05†	0.69#	<0.05‡
	Final	534±186	449±152	611±181	<0.05‡		

#Wilcoxon signed-rank test, †Mann-Whitney test, ‡Student's t-test; CI: statistic tests were done between control and intervention group; CBF: statistic tests were done in control group at baseline and final; IBF: statistic tests were done in intervention group at baseline and final

Table 3 shows blood tests in the control and intervention groups at the baseline and final. There were improvements in hemoglobin concentration and serum iron at the final compared with baseline in the intervention group with p<0.05. We did not find any difference in the control group at baseline and final.

Table 3. Blood test in control and intervention group at the baseline and final

Blood tests	Time	Total (n=224) (mean±SD)	Control group (n=106) (mean±SD)	Intervention group (n=118) (mean±SD)	p-value^{CI}	p-value^{CBF}	p-value^{IBF}
Hemoglobin[1](g/L)	Baseline	130.8±10.8	130.7±11.2	130.9±10.4	0.91†	0.14#	<0.05‡
	Final	133.8±10.9	132.9±11.0	134.6±10.8	0.30†		
Serum iron[2] (μmol/L)	Baseline	14.4±6.5	14.5±6.7	14.4±6.2	0.96‡	0.13#	<0.05‡
	Final	15.3±6.2	15.0±6.9	15.6±5.6	0.37†		
Serum ferritin[3] (ng/mL)	Baseline	85.1±86.0	88.3±91.0	82.3±81.7	0.89†	0.14#	<0.05#
	Final	89.9±94.6	87.5±92.4	92.1±96.9	0.49†		

#Wilcoxon signed-rank test, †Mann-Whitney test, ‡Student's *t*-test
[1]Reference range in female is 121 to 151 g/L; [2]Reference range in female is 11 to 29 μmol/L; [3]Reference range in female is 20 to 250 ng/Ml; CI: statistic tests were done between control and intervention group; CBF: statistic tests were done in control group at baseline and final; IBF: statistic tests were done in intervention group at baseline and final

Table 4 shows the effectiveness of the intervention. For serum iron, there was not much difference between before and after the intervention in either group. Ferritin increased in both groups; this difference is statistically significant with p<0.05.

Table 4. The effectiveness of intervention

Indicators	Control group (n=106) n (%)			Intervention group (n=118) n (%)			EI (%)
	Before	After	p	Before	After	p	
Serum iron	3 (2.8)	4 (3.8)	1.000	6 (5.1)	2 (1.7)	0.13	33.3%
	103 (97.2)	102 (96.2)		112 (94.9)	116 (98.3)		
Ferritin	24 (22.6)	16 (15.1)	<0.05	26 (22.0)	16 (13.6)	<0.05	5.1%
	82 (77.4)	90 (84.9)		92 (73.0)	102 (86.4)		

EI: effectiveness index

4. DISCUSSION

This study evaluated the effect of nutritional intervention on Hb concentration, serum iron, and ferritin as indicators of iron and calcium homeostasis in working-age women at the Trang An Company, using the difference in difference (DiD) method. At the factory, workers have lunch in the cafeteria. They can choose their dishes and the amount of food by themselves. In addition, there is no dietitian to give nutrition education and balanced menus for workers in this factory. Therefore, without nutrition knowledge, the diet of workers at the factory and at home may not be balanced.

Before the intervention, an assessment of the factory's meals and 24-hour recall revealed that 93.3% and 92.9% of participants did not consume enough calcium and iron based on the Vietnamese RDA by about 489 mg and 14 mg, respectively. After the intervention, calcium and iron intake increased by about 122 mg and 2 mg, respectively. This may be attributed to the improved diet based on nutritional education and ONS. Through nutritional education, participants could learn more about iron, vitamin C, and calcium-rich foods and how to incorporate them into a well-balanced and local-friendly diet.

The data further show that Hb concentration, serum iron, and ferritin significantly increased in the intervention group. An American study showed that among consumers of supplements that contain iron, the median intake of iron was about 17 mg/d among nonpregnant women. The use of supplements that contain iron was associated with a significantly reduced prevalence of iron deficiency among women 19 to 50 years [23]. Another study indicated that iron-fortified milk can increase depleted iron stores in reproductive-age women [24]. A similar study in India also supports the benefits of nutritional education for dietary iron intake, Hb concentration, and ferritin level [25]. Interestingly, this study even assessed changes at the 16^{th} week although intervention stopped at the 8^{th} week. The change in hemoglobin at the 16^{th} week was 1.9, –1.9, 0, and –9.3% for the nutrition education, supplementation, nutrition education with supplementation, and control group respectively with a significant mean effect of nutritional education ($p<0.05$) and supplementation ($p<0.05$). This shows a potential long-term benefit of nutritional education that needs more attention, while the limitations of long-term educational campaigns still have to be taken into account [26]. Based on another similar study in Venezuela, the prevalence of iron deficiency was 25% at the beginning and was significantly reduced to 14.3% after nutritional education and intervention [27]. Therefore, nutritional education and supplementation play an important role in improving iron deficiency in women [28].

A study showed milk is a suitable vehicle for calcium and vitamin D2 fortification. When used in combination, the bioavailability of calcium and vitamin D2 increased, which indicated a positive interaction between the two nutrients [29]. We observed an increase in calcium intake by subjects in this study. However, because of research resources data about the vitamin D status of subjects was not collected.

The limitation of this study is that this was quasi-experimental research. Although the study location was the same and we could not blind subjects by using a placebo, the intervention and control groups were chosen from different shifts and departments to avoid their communication. We hope that bias was reduced in part. In this study, although nutrient-fortified milk powder may be more expensive than normal milk, the reason that nutrient-fortified milk powder was chosen was that it is easy to store and give to subjects for the long term. In addition, the difference between baseline calcium intake (about 500 mg/d) and the recommendation (800 mg/d) was about 300 mg/d. Therefore, we thought that the milk product powder with 320 mg calcium/cup would be more suitable for the study than normal milk (250 mg calcium/cup). After the study, the women were still able to buy the products by themselves because it is not so expensive and is available in Vietnamese stores.

5. CONCLUSION

The nutritional intervention had positive effects on iron status and calcium intake by improving dietary patterns in working women. It is necessary to have nutritional strategies to maintain the effectiveness of the intervention. Additionally, it is important to consider the cultural and social factors that influence dietary habits in different populations, in order to tailor nutritional interventions to meet the unique needs of each group.

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