# The Effect of Iron Supplementation on Work Fatigue Level in Female Nurses

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**Abstract.** Iron fulfillment refers to an attempt to achieve the ideal conditions of every human body's metabolism stability, so it is crucial, especially for women considering the monthly cycle that reduces it. Dual role existence as an additional burden for working women also makes female workers vulnerable to work stress and job burnout. The nursing sector at Sultan Agung Islamic Hospital Semarang, which is dominated by women with an increasingly workload due to being one of the referral centers for health facilities on the north coast and locations that often experience flooding, is very close to excessive job fatigue. This study aims to analyze iron tablet supplementation's effect on female nurses' fatigue levels in an inpatient unit. This research is quantitative with a quasi-experimental method and one group pre-test and post-test design. This study populations were female nurses in the inpatient unit at Sultan Agung Islamic Hospital Semarang, with 40 people as a sample using the purposive sampling method. The dependent variable in this study was work fatigue level measured using reaction time application to determine reaction speed, while the independent variable was iron tablet supplementation for 4 weeks with 2 consumptions each week. The results showed that there was an increase in the reaction speed of respondents with an average of 44.8 milliseconds. The statistical test used was a Paired T-test test with measurement results showing a p-value of 0.0001 ($p<0.05$), so it is known that there is a difference before and after supplementation. It can be concluded that iron tablet supplementation has an effect in increasing the reaction speed of respondents which means a decrease in work fatigue level.

## 1 Background

The data from the Central Statistics Agency showed that period from 2021 to 2023 the number of workers in Indonesia increased by 7.56 million people or around 5.39 percent [1]. Therefore, work procedures and designs applied to the work environment should no longer only focus on men because as the number of open jobs increases, so do employment

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opportunities for women. However, the differences that exist between women and men, especially in terms of physical, social, and psychological aspects, of course, cannot be avoided, so based on this vulnerability, a fair and appropriate distribution must be made. A study conducted before found that women have a higher risk of mental disorders, as well as a greater risk of iron deficiency due to the menstrual cycle compared to men [2]. The signs and symptoms of iron deficiency anemia include extreme fatigue and weakness. The fatigue would affect academic and work performance impairments [3]. Research on nurses also found that 57 out of 67 participants experienced low to moderate chronic fatigue; 36 of those exhibited low to moderate acute fatigue levels; and 46 reported encountered low to moderate inter-shift fatigue [4].

As a party that seeks to provide benefits for the community, the government should respond to the difference because the establishment of ideals for increasing the participation of women workers has always been accompanied by consequences that must be considered. Through the Ministry of Health of the Republic of Indonesia, the Healthy and Productive Women Workers Movement (GP2SP) program is regulated through the Joint Agreement of the Ministry of Health Number HK.03.01/MENKES/31/2017, and is applied to all sectors with the main target being women as a continuation of the Law of the Republic of Indonesia Number 13 of 2003 concerning employment. [5] One of the main aspects covered in the program is the fulfillment of iron as a countermeasure for iron deficiency anemia in female workers. The urgency has received a lot of support because it supports productivity and performance levels at work. The effort is carried out by providing iron tablets accompanied by several supporting substances to female workers who are indicated and vulnerable to iron deficiency anemia such as women who are menstruating, pregnant, and other conditions as a consideration for the establishment of this GP2SP program [6].

Biologically, the fulfillment of iron refers to an attempt to achieve the ideal condition of every human being, namely the stability of the body's metabolism, especially in protein and oxygen synthesis [7]. This is indeed crucial for all women in the world because the monthly cycle reduces quite a lot of these substances from the body. As for women workers, in addition to the cycle, other burdens are more than women in general due to additional factors from the work environment. Therefore, the fulfillment of adequate nutrition must also be further improved, including the fulfillment of iron in anticipation of more severe negative impacts in the future. The occurrence of job burnout and job stress in all female workers is often associated with the multiple roles borne by these workers as stated in the previous journal. Job burnout has several factors, one of which is in line with this statement. Some of the factors of job burnout include excessive workload, non-ideal working hours, work stress, lack of social support, and so on, especially with the absence of good safety and health monitoring [8]

Women who work as nurses are also vulnerable to occupational fatigue because nurses are health workers with very high responsiveness along with the development of access to health fulfillment, so the community's need for health services that are closely related to nurses is increasing. The number of female nurses based on data from the World Health Organization (WHO) in 2021 is known to be 70% of the total nurses worldwide [9]. As one of the secondary level health facilities in Semarang, Sultan Agung Islamic Hospital (RSISA) becomes a place for health workers including nurses to carry out their duties to provide care for people experiencing health problems. As a hospital located on the north coastal route (pantura) of Semarang City and closely bordering Demak Regency, RSISA is the closest referral for residents around the pantura area when experiencing acute or chronic health problems, given the cooperation in the RSISA administration process with BPJS health. However, the heavy traffic and frequent flooding in the pantura area have caused various impacts on patients and workers at the hospital, including the preparedness that must be

owned when flooding occurs and extra vigilant travel when going to and after work by workers.

Supporting data obtained by the researchers shows that the hospital has not provided blood supplement tablets or iron tablets to its employees, especially female nurses. The number of female nurses at the hospital reached 616 out of a total of 829 nurses, or around 74% of the total number, and served in several units. The distribution is quite diverse, namely 185 medical support units, 38 outpatient units, 148 special units, and 245 inpatient units. A comprehensive health examination is carried out on all nurses within a period of 5-10 years without any other supervision which is carried out at least once a year in line with applicable regulations. Therefore, the researchers decided to conduct further research to observe the health coverage of female nurses, especially regarding iron deficiency, which is crucial to get attention as a worker's health issue.

## 2 Methods

A quasi-experimental method was used in this research with one group pre-test and post-test design. The population in this study were female nurses in the inpatient unit at the RSISA Semarang, consisting of 40 people taken by purposive sampling method, used certain considerations on individual factors of nurses that affect the level of work fatigue such as age and sleep duration in addition to nutritional fulfillment factors as the basis for iron tablet supplementation. Some of the inclusion criteria in this study were the age of around 20-40 years, sleep duration every day of around 7-8 hours, having no tea and coffee consumption habits (containing caffeine and tannin), having no health problems or allergies to iron or folic acid history and having willingness to be experimental respondents. [10, 11, 12] In this study, the dietary Fe intake of each respondent was ignored because it was difficult to control this factor.

The dependent variable in this study was the level of work fatigue measured using the reaction time application that has been previously calibrated to determine the reaction speed as a method of measuring the level of work fatigue [13], while the independent variable was the iron tablet supplementation for 4 weeks with 2 consumptions each week, which coincides with one full month of March 2024. The treatment, iron tablet supplementation was carried out by the researchers for less than 3 months as recommended by WHO because there was actually no significant difference in terms of results as reviewed in several previous iron tablet supplementation journals [10,11].

The Paired T-test was used in this research with a degree of confidence of 95% with an $\alpha$ value of 0.05. The research has received ethical clearance from the Health Research Ethics Commission (Komisi Etik Penelitian Kesehatan/KEPK) team of the Sultan Agung Islamic Hospital Semarang No. 26/KEPK-RSISA/II/2024.

## 3 Results and Discussions

### 3.1 General Description of Sultan Agung Islamic Hospital Semarang

The RSISA of Semarang is one of the institutions engaged in health services since it was established on August 17, 1971, in the North Semarang area, precisely on the north coastline/pantura [14]. Under the auspices of the Sultan Agung Waqf Board Foundation, this hospital has the motto "Loving Allah, Loving Others" and several types of health services namely general polyclinics, maternal and child health polyclinics, and family planning.

**Table 1.** Descriptive analysis of respondent's age

| Detail | Age (years) |
|---|---|
| Minimum | 25 |
| Maximum | 47 |
| Mean | 32.20 |
| Median | 32.50 |

Table 1 showed that the youngest respondent was 25 years old and the oldest was 47 years old. The mean age was around 32 years old and also for the median was around the same age.

### 3.2 Measurement Data of Work Fatigue Level

Fatigue is a feeling of weariness, tiredness, or lack of energy [15]. The occurrence of fatigue is not only physical but can also attack a person's psychological condition so that the reaction can also experience interference. Routine measurements such as psychomotor tests or reaction speed, blink loss tests, and subjective fatigue tests using questionnaires can be carried out to ensure that workers are always in top condition both in terms of physical ability and focus levels that go hand in hand with the psychological and mental conditions of the workers [16, 17, 18].

Measuring work fatigue was increasingly easy to do by using an application that adopts the work system of the reaction time test tool to measure the speed of a person's reaction to determine the level of focus which is also related to the level of work fatigue. The more focused a person is, the shorter the time needed and the lighter the level of fatigue experienced. On the other hand, when the reaction time required is longer, the level of focus decreases and the level of fatigue becomes heavier [13]. In this experimental-based research before and after the intervention, the test was applied using a pre-calibrated application with a reaction timer measuring instrument that has also been officially calibrated by an authorized institution.

**Table 2**. Frequency Distribution of Work Fatigue Level

| Work Fatigue Level | Before | | After | |
|---|---|---|---|---|
| | n | % | n | % |
| Normal (150.1 to 240.0 ms) | 0 | 0 | 10 | 25 |
| Mild Level Fatigue (240.1 to 410.0 ms) | 40 | 100 | 30 | 75 |
| Total | 40 | 100 | 40 | 100 |

Table 2 presents data on the level of job fatigue in female nurses in the inpatient unit of RSISA of Semarang obtained before and after iron tablet supplementation for a period of 4 weeks. The results show that there are differences before and after supplementation, namely before or pre-supplementation, 40 respondents experienced mild levels of job fatigue, or 100% of the total respondents. As for after supplementation, there were 10 respondents, or 25% who experienced a decrease in the level of fatigue to a normal level or did not experience fatigue, while the remaining 30 respondents, or 75% were still at a mild level of fatigue.

**Table 3.** Data Measurement of Work Fatigue

| **Respondents** | **Before (milliseconds)** | **After (milliseconds)** | **Before-After (milliseconds)** |
|---|---|---|---|
| Nurse 1 | 278 | 264 | 14 |
| Nurse 2 | 313 | 263 | 50 |
| Nurse 3 | 348 | 272 | 76 |
| Nurse 4 | **309** | **236** | **73** |
| Nurse 5 | 311 | 268 | 43 |
| Nurse 6 | 291 | 250 | 41 |
| Nurse 7 | 283 | 254 | 29 |
| Nurse 8 | 317 | 259 | 59 |
| Nurse 9 | *268* | *300* | *-32* |
| Nurse 10 | 292 | 246 | 46 |
| Nurse 11 | 289 | 253 | 36 |
| Nurse 12 | 321 | 261 | 60 |
| Nurse 13 | *258* | *263* | *-5* |
| Nurse 14 | 293 | 257 | 36 |
| Nurse 15 | 313 | 291 | 23 |
| Nurse 16 | 327 | 255 | 72 |
| Nurse 17 | *243* | *248* | *-5* |
| Nurse 18 | *285* | *295* | *-11* |
| Nurse 19 | **304** | **215** | **90** |
| Nurse 20 | 315 | 262 | 53 |
| Nurse 21 | 304 | 296 | 8 |
| Nurse 22 | **257** | **210** | **47** |
| Nurse 23 | 295 | 274 | 22 |
| Nurse 24 | **241** | **226** | **15** |
| Nurse 25 | 294 | 244 | 50 |
| Nurse 26 | *284* | *287* | *-3* |
| Nurse 27 | 297 | 242 | 55 |
| Nurse 28 | 323 | 274 | 49 |
| Nurse 29 | **321** | **239** | **82** |
| Nurse 30 | **256** | **230** | **26** |
| Nurse 31 | 284 | 244 | 40 |
| Nurse 32 | **331** | **237** | **94** |
| Nurse 33 | 379 | 269 | 109 |
| Nurse 34 | 331 | 261 | 70 |
| Nurse 35 | 314 | 260 | 54 |
| Nurse 36 | **312** | **238** | **74** |
| Nurse 37 | 294 | 247 | 47 |
| Nurse 38 | **321** | **240** | **81** |
| Nurse 39 | 314 | 272 | 42 |
| Nurse 40 | **279** | **195** | **84** |
| **Average** | **299.7** | **254.9** | **44.8** |

Table 3 shows the data obtained from the process of measuring the level of work fatigue in 40 respondents using a device-based "reaction timer" as a representation of the level of work fatigue using one of the applicable measurement methods. The measurement process is carried out before and after the treatment to determine changes in measurement values. There was a good change after the treatment, marked by 10 respondents who got measurement results below the 240.1-millisecond mark as a normal level or no fatigue (bolded). However, 5 respondents actually experienced unfavorable changes in time, given the negative difference between before and after measurement (italicized and underlined).

As a result, there was a difference in the pre-treatment and post-treatment measurements. Before the treatment, all 40 female nurses experienced mild levels of occupational fatigue with a range of measurement values of 240.1 to 410.0 milliseconds, without any of them falling into the normal category or not experiencing occupational fatigue. In contrast to this, the measurement results after treatment show better data, considering that 10 respondents fall into the normal category with a range of values of 150.1 to 240.0 milliseconds. The other 30 respondents remained in the mild fatigue category, but there was a significant decrease in the reaction time required in the reaction speed test.

Through these positive changes, it can be said that the iron tablet supplementation for 4 weeks had a fairly good impact marked by the faster reactions of the respondents, which certainly indicates an improved level of focus in the respondents. Although the overall statistics of the measurement results showed an improving trend, 5 respondents experienced an increase in reaction time or were slower in giving reactions at the time of measurement. This changing trend is certainly a negative finding in this study, although several other factors such as food intake patterns, sleep duration, and workload similarities have been attempted to be controlled by the researcher through the inclusion criteria questionnaire given to female nurses in the inpatient unit as the research population before the study was carried out so that there are no significant differences in each respondent later.

### 3.3 Pre-Post Supplementation Result

**Table 4. Bivariate Statistical Tests Result**

| *Paired T-Test* | | | |
|---|---|---|---|
| **Variable** | **Mean ± SD** | ***Sig. (2-tailed)*** | **Notes** |
| Work Fatigue | 44,8 ± 31,6 | 0,0001 | Any difference |

Table 4 shows the results of bivariate statistical tests using the Paired T-test method conducted on the results of work fatigue measurements before and after iron tablet supplementation. These results state that there was a significant difference marked by a difference in the average value, which is higher before supplementation by 44.8 milliseconds compared to after supplementation.

In addition, the difference in the two measurement results as stated in the table above, was also obtained through the process of comparing the significance value with the p-value which used a value of 0.05. As in the table above, a significance value of 0.0001 is obtained, which is <0.05, so it can be concluded that there is a difference between the two data.

There was some information related to factors obtained by researchers through reviewing the results of the inclusion criteria questionnaire responses. The criteria listed on the questionnaire have certainly been adjusted with consideration of the factors that cause work fatigue as added to the theoretical framework of this study such as individual factors in the

form of age, gender, nutritional status, marital status, health status, and psychological conditions, as well as work factors in the form of workload, types of work, tenure, work environment, and work posture [19,20]. The inclusion criteria were carried out by the researchers to control certain factors such as gender, health status, type of work, and additionally in the form of sleep duration and food intake habits of respondents. Some of the factors that were found and caused negative findings in these 5 respondents based on the theory of job fatigue were the factors of psychological conditions, marital status, and workload.

In retrospect, the reason why the respondents' psychological condition was the cause of this finding was the surrounding pressure that required respondents to do more, especially in terms of taking care of their families. This condition was closely related to the fact that the findings did occur among respondents who already have families so the moment of Ramadan gives extra obligations for them to always be ready to prepare meals for their families. In addition, the sudden change in leave time for certain nurses has resulted in a relief system being applied to nurses, which includes respondents with this negative trend, given the increasing number of patients and care actions that must be provided consistently to patients. Not only that, the uncertain weather conditions were also another reason for this finding. When this treatment period took place, there was a natural disaster of flooding that paralyzed mobilization around the hospital area. Moreover, the distance of the respondents' residences was quite far and took at least 1 hour to travel, so some chose to stay at the hospital for two days until the water had receded sufficiently.

As for other studies with similar treatment, positive results were obtained in the same period for 4 weeks with different respondents who came from athletes. In this study, it was concluded that iron tablet supplementation for 4 weeks did not have a significant impact on the hemoglobin status of the respondents. However, in other aspects related to the level of physical and psychological fatigue of the respondents, there were significant positive changes, especially when they were in the recovery phase after certain sports activities [21]. In addition, the consumption of vitamins and other substances that support the absorption of iron such as vitamin C and folic acid together, in fact, also increases the effectiveness of supplementation on changes in fatigue levels in a fairly short period [22]. This may also be another reason for the unfavorable trend among some respondents in the study of female nurses, despite the researchers' attempt to control the intake of substances that inhibit iron absorption such as tannins and caffeine.

It is also important to consider the relationship between the intake of other substances and the effectiveness of the supplementation treatment in providing improvements in fatigue levels. As explained in the previous paragraph, concurrent intake of vitamin C and folic acid can promote proper iron absorption by the body. Contrary to these two substances, tannin and caffeine in foods and beverages can inhibit iron absorption in the digestive tract by up to 80%, so that it will be missed from the digestive organs and wasted [23]. Both substances are commonly found in processed tea and coffee, which are generally consumed as an effort to warm the body or relieve nausea in certain conditions, especially in some pregnant women [24].

Consumption of tea and coffee has a good effect on the body with one of its properties, namely polyphenols, which will bind substances in the body to be excreted, so that when there is content that is not good for the body, it will be absorbed and excreted through the sewer in the digestive organs [24]. However, when tea and coffee consumption coincides with the content of substances that are good for the body such as iron, for example, the absorption and binding by tannins and caffeine will harm the body because it is unable to fulfill the body's need for these good substances. Based on research conducted on several pregnant women, it was found that consumption of tannins and caffeine, which are generally found in processed tea and coffee, had an unfavorable relationship with the incidence of iron

deficiency anemia [23, 24]. Thus, iron tablet supplementation is not recommended to be consumed together with processed tea and coffee because it will interfere with the absorption process by the body.

Iron tablet supplementation is one of the efforts that can be done by anyone to prevent iron deficiency anemia, especially for heavy activity. Anaemia as a health disorder has many further problems related to the body's immunity, even being one of the main factors causing fatigue. The government through the Ministry of Health of the Republic of Indonesia has also issued a decision on the implementation of GP2SP, one aspect of which is to carry out tablet supplementation as an effort to prevent iron deficiency anemia [6].

The current implementation of GP2SP is still relatively small, as data by the Directorate of Occupational Health and Sports of the Ministry of Health of the Republic of Indonesia in 2021, stated that only 750 companies or agencies have implemented the program [25]. Efforts to update the Joint Decree (SKB) between ministries are also carried out regularly, to be precise on March 18, 2021, online, as well as the increasingly massive Mitra Bhakti Husada award to 66 selected companies that have comprehensively implemented GP2SP, as an effort to spark other companies to also implement GP2SP in their respective companies [6]. In addition, motivation and socialization are also still being pursued to increase company awareness of the importance of implementing the program, especially for women workers.

Meeting the nutritional needs emphasized in the GP2SP program was not only carried out for female workers but also for male workers. However, the vulnerability of women who are more at risk than men, especially among workers, sparked the government to emphasize this regulation, with the hope of creating the next generation that was fulfilled nutritionally from the mother's womb. The program of providing additional nutrition in the form of food or drink intake has been carried out by RSISA of Semarang for all nurses without exception, by adjusting the number of night *shifts* that each nurse gets. Such efforts were already good enough in seeking additional nutrition for workers, especially nurses who always take turns caring for patients.

However, the provision of food and beverage rations in the form of biscuits and ready-to-drink milk at the beginning of the month at the same time causes a lot of bias as stated directly by several nurses that researchers met at the work site. The bias that occurred was due to the high possibility of mistargeting because the food and drinks provided would be consumed by those concerned at times other than those planned, namely during the night *shift*. Not only that, the possibility of the additional food being consumed by those who are not concerned is also another bias that should be considered by the hospital in this well-meaning effort.

The urgency of closely linking iron tablet supplementation, as one of the efforts to fulfill micronutrients, with work fatigue has already existed in several previous studies, which are then discussed again in this experimental-based research. Although macronutrient supplementation has been applied to nurses, the adequacy of micronutrients is still very minimal, one of which is the fulfillment of iron. The provision of iron was only given by the hospital routinely to female nurses who were in the pregnancy and breastfeeding phases. The recommendations conveyed by WHO and the Indonesian Ministry of Health also began to be emphasized to all women or women when they were already in the fertile age phase, namely at the age of 15-49 years, especially at the peak of the fertile phase, namely in the range of 20-45 years [6,10].

The results of this experimental-based research state that there was a significant difference as a result of paired bivariate statistical tests before and after treatment, corroborated by the mean difference and positive correlation. The statistical test used was the *Paired T-test,* considering the type of research is experimental and the data is parametric with normal distribution. As briefly explained in the research results, there is a significant difference in mean values between before and after treatment of 44.8 milliseconds. This can be known statistically through the table of data processing results or manually, considering

that the difference between the two averages does have such a value, namely with an average of 299.7 milliseconds before treatment and 254.9 milliseconds after treatment. The change that is interpreted as a decrease in the number between before and after treatment is positive in this study because the smaller the number obtained in the measurement of reaction speed, the higher the level of focus and reaction speed accompanied by the better level of fatigue that occurs in respondents.

Based on several previous studies, iron supplementation was one of the most important alternatives in overcoming and anticipating the occurrence of iron deficiency anemia, especially in female workers because it was quite cost-efficient to fulfill. The effect of iron on workers' work performance was also very significant, as explained in a journal based on a review of 12 previous journals which stated that the incidence of anemia greatly interferes with the optimal performance of workers and the most effective and easy alternative is iron tablet supplementation within a certain period [25]. Although 3 journals state that there is no significance in the effect of iron tablet supplementation on worker performance and 2 other journals have weak significance, there was reinforcement by 7 other studies that also consider the factors of work duration, sleep duration, and other nutritional intake patterns, as well as controlling factors in this study [25].

The type of effect felt through iron tablet supplementation as described in previous studies was to increase oxygen levels because it can bind oxygen with a large scope so that brain and muscle performance receive optimal support [25]. Not only that, but the real sustainable impact concluded in previous studies also states that cognitive abilities slowly declined, given the performance of the brain that is difficult to reach its optimal level [25]. In another study, the effect was also found to be related to the increased endurance of adolescent women, accompanied by activities that were not reduced due to easy fatigue, so that heart and lung health was always maintained from other health problems. However, iron tablet supplementation can reach its optimal value in influencing the level of fatigue of a worker if carried out over a long and continuous period [21].

Based on the recommendations set by WHO internationally, the optimal and ideal period of supplementation in increasing a person's Haemoglobin (Hb) level was for 3 months or 12 weeks [10]. This is also corroborated by several other journals which state that the longer the duration used for routine supplementation, the more comprehensive and significant the effect will be. However, in a journal review that collected various research results related to other iron tablet supplementation, it was said that a period of less than 3 months or 12 weeks was also carried out several times in previous journals and produced a significance that was not much different and also tended to be positive or better [11]. It was concluded in the journal that the effect provided by iron tablet supplementation is not greatly affected by the duration of supplementation, as long as the content of the supplement is in line with the body's needs recommended by WHO and is carried out at least once a week, accompanied by controlling other inhibiting factors such as consumption of substances that inhibit iron absorption such as caffeine and tannin, to the lack of sleep duration daily [11].

However, the analysis of the effect of iron tablet supplementation on the level of work fatigue in this study as a whole also tends to experience positive changes, given the faster reaction of the respondents in stimulating a color change in the reaction time measuring application called *"reaction time"*. As for this, it has no relationship with the respondents' recognition of the measurement mechanism because basically, the researchers have to explain the mechanism of the measurement and the measurement is carried out at a similar time, namely at the beginning of the respondents' work shift. Not only that, the change in the category of fatigue level as in the previous discussion also strengthens the significance of the effect of iron tablet supplementation in this study. A more comprehensive and sustainable iron tablet supplementation certainly showed a positive trend, considering that even with a

fairly short period, some respondents experienced increased focus and decreased levels of fatigue.

## 4 Conclusions

It can be concluded that after iron tablet supplementation, there was a change in the level of fatigue in the form of improvement in the measurement results. As many as 25% of nurses switched to the normal category or no longer experienced fatigue, while the other 30% nurses still experienced mild fatigue with an overall average of 254.9 milliseconds. Thus, there was an effect of iron tablet supplementation on the level of fatigue as in the bivariate statistical test with normal distribution using the *Paired T-test* method, it was stated that there was a significant difference, both in terms of significance value (0.0001), mean difference value (44.8), and weak positive correlation value (r=0.240).

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