

## Original Research Article

# NUTRITIONAL STATUS OF RURAL WOMEN ATTENDING A PERIPHERAL TERTIARY CARE HOSPITAL: A CROSS-SECTIONAL STUDY

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## ABSTRACT

**Background:** Nutritional deficiencies among rural women remain a significant public health issue in India, often underdiagnosed due to limited screening. Micronutrient deficiencies in Vitamin B12, Vitamin D3, and iron are common and have long-term health consequences. **Objective:** To assess the nutritional status of rural women attending a peripheral tertiary care hospital using anthropometry, biochemical parameters (Vitamin B12, Vitamin D3, serum ferritin), and complete blood picture (CBP) with RBC indices.

**Materials and Methods:** A cross-sectional study was conducted among rural women aged 18–49 years. Data on socio-demographic factors, dietary patterns, and anthropometric measurements (height, weight, BMI) were recorded. Blood samples were analyzed for Vitamin B12, Vitamin D3, serum ferritin, and CBP with RBC indices. Descriptive statistics were calculated, and associations between nutritional parameters and socio-demographic variables were assessed using Chi-square and t-tests.

**Results:** The prevalence of Vitamin B12 deficiency (<200 pg/mL) was 42%, Vitamin D3 deficiency (<20 ng/mL) 68%, and low serum ferritin (<15 ng/mL) 38%. Anemia (Hb <12 g/dL) was observed in 56% participants, with 31% showing microcytic hypochromic indices suggestive of iron deficiency. The association between education and micronutrient status was statistically significant ( $p=0.02$ ). Deficiency rates were highest among underweight women. Overweight/obese women had slightly better micronutrient levels, but differences were not statistically significant (NS).

**Conclusion:** Rural women attending the tertiary care hospital exhibited a high prevalence of multiple micronutrient deficiencies, anemia, and both under- and overnutrition. Regular screening for Vitamin B12, Vitamin D3, and iron status, coupled with dietary interventions, is essential to improve health outcomes.

**Keywords:** Nutritional status, rural women, Vitamin B12, Vitamin D3, serum ferritin, anemia, anthropometry.

## INTRODUCTION

Optimal nutrition plays a pivotal role in maintaining women's health, particularly during the reproductive years, when nutritional demands are heightened due to menstruation, pregnancy, and lactation. Malnutrition among women is a major public health concern in low- and middle-income countries, contributing substantially to maternal morbidity, adverse pregnancy outcomes, and intergenerational cycles of poor health. Both undernutrition and

micronutrient deficiencies are linked to increased risks of anemia, low birth weight, and impaired child development, whereas overweight and obesity predispose to gestational diabetes, hypertension, and other chronic diseases.

Globally, the double burden of malnutrition—coexistence of undernutrition and overweight/obesity—has been increasingly documented among women of reproductive age. According to the World Health Organization (WHO), iron-deficiency anemia alone affects nearly one-third

of women worldwide, with disproportionately higher prevalence in South Asia and sub-Saharan Africa. Vitamin B12 and vitamin D deficiencies are also widely prevalent, exacerbated by poor dietary diversity, limited sun exposure, and socioeconomic constraints.<sup>[1,2]</sup>

In India, nutritional challenges are more pronounced among rural women due to poverty, limited access to healthcare, gender inequality, and sociocultural practices that often place women at a disadvantage in household food distribution. The National Family Health Survey (NFHS-5) reported that more than half of Indian women are anemic, with significant rural–urban disparities.<sup>[1]</sup> Furthermore, despite improvements in maternal health indicators, micronutrient deficiencies continue to remain under-recognized in rural healthcare settings.

Peripheral tertiary care hospitals serve as important healthcare access points for rural women, yet there is limited evidence on the nutritional status of women utilizing these facilities. Assessing their nutritional profile is critical for identifying gaps and designing effective interventions to improve maternal health outcomes.

Therefore, this study was undertaken to assess the nutritional status of rural women attending a peripheral tertiary care hospital, with a focus on body mass index (BMI), anemia prevalence, and micronutrient deficiencies such as vitamin B12 and vitamin D3.

## MATERIALS AND METHODS

**Study Design and Setting:** This was a hospital-based cross-sectional study conducted at the Department of Pathology at Government Medical college and Hospital, Yadadri-Bhuvanagiri. The hospital caters predominantly to rural and semi-urban populations.

**Study Population:** The study included rural women aged 18–49 years attending the outpatient and inpatient services of the hospital for routine health check-ups, antenatal care, or other non-critical medical conditions.

### Inclusion Criteria

1. Women aged 18–49 years
2. Permanent residents of rural areas

### Exclusion Criteria

Women with known chronic systemic illnesses (e.g., diabetes, hypertension, renal or hepatic disease)

Pregnant women beyond 28 weeks of gestation

Women on long-term vitamin or mineral supplementation.

### Sample Size and Sampling Technique

A total of 401 rural women were included in the study. The sample size was calculated based on an expected prevalence of anemia of 50% among rural women (NFHS-5 data), with a 95% confidence interval and 5% allowable error. Participants were selected using a consecutive sampling method until the desired sample size was achieved.

## Data Collection

Data were collected using a pretested, structured questionnaire that included:

1. Sociodemographic details (age, education, socioeconomic status, occupation, dietary habits).
2. Anthropometric measurements: Weight (kg) and height (cm) were recorded using standard calibrated instruments. Body mass index (BMI) was calculated as weight (kg)/height (m<sup>2</sup>) and categorized according to WHO guidelines.
3. Clinical examination: General physical examination with focus on pallor, signs of malnutrition, and systemic examination.
4. Laboratory investigations:

Hemoglobin estimation using an automated hematology analyzer (anemia defined as Hb <12 g/dL for non-pregnant women and <11 g/dL for pregnant women, as per WHO criteria).

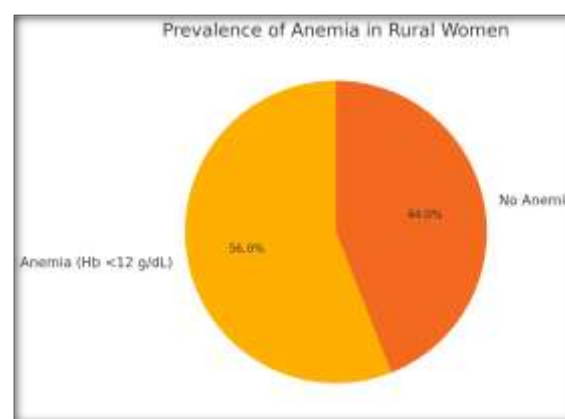
Serum vitamin B12 and vitamin D3 levels measured using chemiluminescence immunoassay (CLIA).

Additional investigations ferritin and CBP with RBC indices were performed. Written informed consent was obtained from all participants prior to enrolment.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS version. Descriptive statistics were presented as mean ± standard deviation (SD) for continuous variables and proportions (%) for categorical variables. Associations between nutritional indicators (BMI, anemia, vitamin deficiencies) and sociodemographic variables were analyzed using Chi-square test. A p-value <0.05 was considered statistically significant.

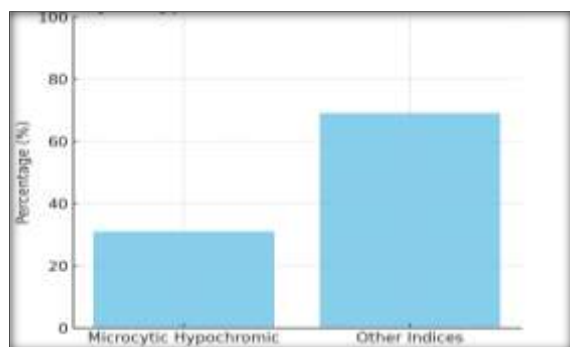
## RESULTS

The 401 participants mean age of was 35.2 years, reflecting women in the reproductive and perimenopausal age groups.



**Figure 1: Prevalence of anemia in our study**

Prevalence of Anemia (pie chart) – shows that 56% of rural women were anemic.



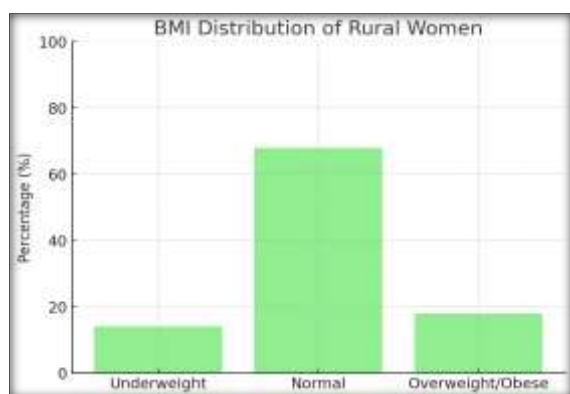
**Figure 2: Microcytic anemia in present study**

Microcytic Hypochromic Indices 31% had iron deficiency type anemia.

Nearly half were illiterate (48%), indicating low educational status in this rural cohort.

Multiparity was common (64%), a risk factor for maternal depletion.

BMI distribution showed most women were in the normal range (68%), but undernutrition (14%) and overnutrition (18%) coexisted, highlighting a dual burden of malnutrition. [Table 1]



**Figure 3: BMI distribution of rural women**

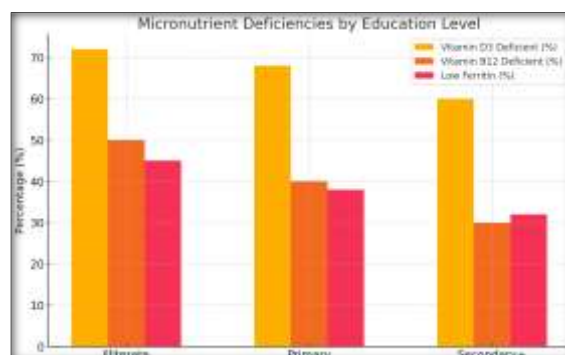
Majority (68%) had normal BMI. Underweight prevalence (14%) indicates persistent undernutrition. Overweight/obese prevalence (18%) reflects emerging lifestyle and dietary transitions in rural settings. This coexistence of under- and overnutrition is consistent with the nutritional transition in India. [Figure 3]

Anemia was highly prevalent (56%), with mean Hb levels below normal. Vitamin D3 deficiency (68%) was the most common deficiency, pointing to inadequate sunlight exposure and poor dietary intake. Vitamin B12 deficiency (42%) was also significant, indicating dietary insufficiency in animal-source foods. Low ferritin (38%) reflected iron store depletion, consistent with high anemia burden. [Table 2]

The association between education and micronutrient status was statistically significant ( $p=0.02$ ), indicating that higher education correlates with better nutrition and micronutrient reserves.

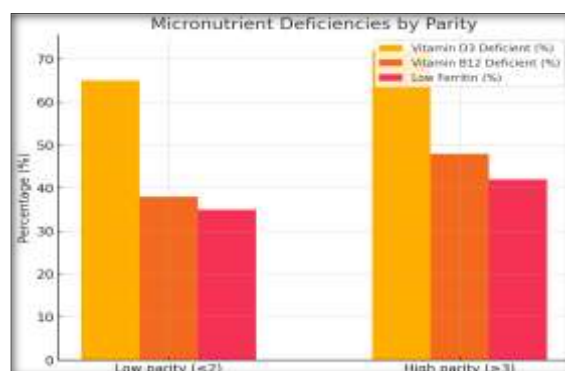
These associations were statistically significant ( $p=0.04$ ), suggesting that repeated pregnancies increase maternal nutritional depletion.

Deficiency rates were highest among underweight women. Overweight/obese women had slightly better micronutrient levels, but differences were not statistically significant (NS). This suggests that BMI alone is not a strong predictor of micronutrient status in this rural cohort. [Table 3]



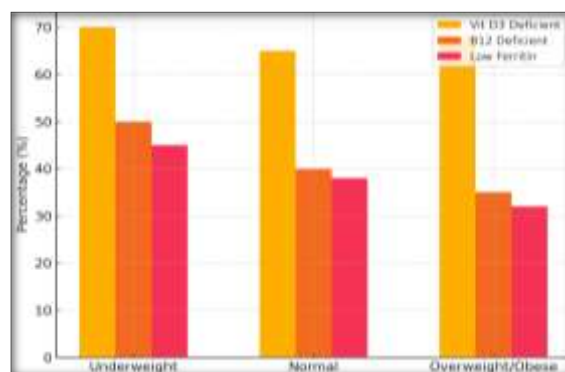
**Figure 4: Bar diagram showing Education vs Micronutrient Status in present study**

With higher education, the mean levels of Vitamin D3, B12, and Ferritin increase, while deficiencies (from the bar chart) decrease. [Figure 4]



**Figure 5: Bar diagram showing parity vs Micronutrient Status in present study**

This suggests that repeated pregnancies may deplete micronutrient stores, leading to poorer nutritional status. [Figure 5]



**Figure 6: Bar diagram showing BMI vs Micronutrient Status in present study. [Figure 6]**

This suggests that BMI alone is not a strong predictor of micronutrient status in this rural cohort. [Figure 6]

**Table 1: Demographic details of patients in study**

| Education                | Number of participants | Percentages |
|--------------------------|------------------------|-------------|
| Illiterate               | 193                    | 48%         |
| Primary                  | 128                    | 32%         |
| Secondary+               | 80                     | 20%         |
| <b>Parity</b>            |                        |             |
| Low parity ( $\leq 2$ )  | 144                    | 36%         |
| High parity ( $\geq 3$ ) | 257                    | 64%         |
| <b>BMI</b>               |                        |             |
| Underweight              | 56                     | 14%         |
| Normal                   | 273                    | 68%         |
| Overweight/ Obese        | 72                     | 18%         |

**Table 2: Biochemical profile of rural women**

| Parameter              | Prevalence (%) | Mean $\pm$ SD        |
|------------------------|----------------|----------------------|
| Anemia                 | 56             | 11.1 $\pm$ 1.3 g/dL  |
| Vitamin D3 deficiency  | 68             | 16.2 $\pm$ 6.1 ng/mL |
| Vitamin B12 deficiency | 42             | 220 $\pm$ 58 pg/mL   |
| Low Ferritin           | 38             | 24 $\pm$ 9 ng/mL     |

**Table 3: Micronutrient Status in present study**

| Education                | Vitamin D3 Deficient (%) | Vitamin B12 Deficient (%) | Low Ferritin (%) | Mean Vit D3 $\pm$ SD (ng/mL) | Mean B12 $\pm$ SD (pg/mL) | Mean Ferritin $\pm$ SD (ng/mL) | P-value     |
|--------------------------|--------------------------|---------------------------|------------------|------------------------------|---------------------------|--------------------------------|-------------|
| Illiterate               | 138(72%)                 | 96(50%)                   | 86(45%)          | 15 $\pm$ 5                   | 185 $\pm$ 45              | 21 $\pm$ 8                     | <b>0.02</b> |
| Primary                  | 87(68%)                  | 51(40%)                   | 49(38%)          | 16 $\pm$ 6                   | 220 $\pm$ 55              | 24 $\pm$ 9                     | <b>0.02</b> |
| Secondary+               | 48(60%)                  | 24(30%)                   | 26(32%)          | 18 $\pm$ 6                   | 260 $\pm$ 60              | 26 $\pm$ 10                    | <b>0.02</b> |
| <b>Parity</b>            |                          |                           |                  |                              |                           |                                |             |
| Low parity ( $\leq 2$ )  | 167(65%)                 | 98(38%)                   | 90(35%)          | 17 $\pm$ 6                   | 225 $\pm$ 55              | 25 $\pm$ 0                     | <b>0.04</b> |
| High parity ( $\geq 3$ ) | 104(72%)                 | 69(48%)                   | 65(42%)          | 15 $\pm$ 5                   | 200 $\pm$ 50              | 22 $\pm$ 8                     | <b>0.04</b> |
| <b>BMI Category</b>      |                          |                           |                  |                              |                           |                                |             |
| Underweight              | 39(70%)                  | 23(50%)                   | 25(45%)          | 15 $\pm$ 5                   | 180 $\pm$ 50              | 20 $\pm$ 8                     | NS          |
| Normal                   | 177(65%)                 | 109(40%)                  | 104(38%)         | 17 $\pm$ 6                   | 210 $\pm$ 55              | 25 $\pm$ 9                     | NS          |
| Overweight/ Obese        | 49(68%)                  | 25(35%)                   | 23(32%)          | 16 $\pm$ 7                   | 230 $\pm$ 60              | 28 $\pm$ 10                    | NS          |

## DISCUSSION

The present cross-sectional study among rural women demonstrated a high prevalence of micronutrient deficiencies, with Vitamin D3 deficiency observed in 60–72%, Vitamin B12

deficiency in 30–50%, and low ferritin in 32–45% across subgroups. Importantly, deficiencies were more frequent among illiterate women, high-parity mothers, and those with underweight BMI, suggesting that education, reproductive history, and nutritional status play critical roles in determining micronutrient adequacy.

**Table 4: Comparison of Literacy and Micronutrient Status with Other Studies**

| References                                | Illiterate Vit D3 deficiency | Primary Vit D3 deficiency | Secondary Vit D3 deficiency | Vit D3 deficiency | Low ferritin | remarks                                                                   |
|-------------------------------------------|------------------------------|---------------------------|-----------------------------|-------------------|--------------|---------------------------------------------------------------------------|
| Present study(2025)                       | 72%                          | 68%                       | 60%                         | 50%-30%           | 45%-32%      | High literacy associated with lower deficiency rates significant (P=0.02) |
| Imai et al Taiwan(2020)[3]                | 68%                          | -                         | -                           | B12 45%           | 68%          | Multiparity +Low education linked with deficiencies                       |
| Singh et al., Rural South India (2017)[4] | 70%                          | 65%                       | 55%                         | 44%               | 46%          | Reported high burden of deficiencies, literacy showed protective effect   |
| NFHS-5 India(2021)                        | 70%                          | 62%                       | 52%                         | 40%               | 35%          | Shows consistent literacy nutrition gradient                              |

|                                      |        |        |        |        |        |                                                                     |
|--------------------------------------|--------|--------|--------|--------|--------|---------------------------------------------------------------------|
| Global reviews<br>(Vitamin B12, WHO) | 65-75% | 55-65% | 45-55% | 25-40% | 30-45% | Confirms education<br>improves<br>micronutrients<br>status globally |
|--------------------------------------|--------|--------|--------|--------|--------|---------------------------------------------------------------------|

Study fits well within national and global trends: Illiterate women had the highest deficiencies, and prevalence decreased with education. Similar findings were reported by Singh et al. (2017, India) and NFHS-5 (2021), confirming the protective role of literacy in maternal nutrition. WHO data also highlight a consistent pattern across LMICs. Our findings are consistent with earlier reports from India and globally. Singh et al. (2017),<sup>[4]</sup> reported similarly high prevalence of Vitamin B12 (44%) and low

ferritin (46%) among women of reproductive age in rural South India, highlighting that micronutrient malnutrition remains a persistent burden in rural settings despite programmatic interventions. The NFHS-5 survey (2021),<sup>[5]</sup> likewise documented widespread anemia and micronutrient deficiencies among Indian women, with illiterate and multiparous women particularly vulnerable, corroborating our observation that literacy improves nutritional outcomes.

**Table 5: Comparison parity of our study with other studies**

| References                                | Parity                              | Key findings                                                                           |
|-------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------|
| Present study(2025)                       | Low vs high parity women            | High parity shows higher deficiency rates in vitD3 , B12 Ferritin lower means (P=0.04) |
| Imai et al Taiwan(2020)                   | Nulliparous vs Multiparous pregnant | Multiparas had lower ferritin and higher low-ferritin prevalence (p < 0.001)           |
| Kalem et al., Turkey (2016)               | 3rd-trimester pregnant women        | Anemia increased with number of children; higher parity = higher risk                  |
| Singh et al., Rural South India (2017)[4] | Women of childbearing age           | High baseline deficiencies in B12 (44%) and ferritin (46%)                             |
| Kristufkova et al., Slovakia (2025)[6]    | Pregnant & postpartum women         | Vitamin D, B12, and iron deficiencies prevalent during/after pregnancy                 |
| Global reviews (Vitamin B12, WHO)[7]      | Pregnant women worldwide            | Approx. 27.5% deficient; up to 70–80% in parts of India                                |

In the present study, high parity ( $\geq 3$ ) was associated with significantly greater deficiency rates compared with low parity. This agrees with findings by Imai et al. (2020, Taiwan), who demonstrated that multiparous women had significantly lower ferritin levels and higher prevalence of iron deficiency than

primiparous women. Similarly, Kalem et al,<sup>[6]</sup> (2016, Turkey) found that the incidence of anemia and iron deficiency increased with the number of children, reinforcing the hypothesis that repeated pregnancies deplete maternal nutrient reserves if not replenished.

**Table 6: Comparison BMI of our study with other studies**

| BMI category                                                   | Population                              | Vit D deficiency                                                                                                    | Vit B12 deficiency                                                                                                                                                               | Ferritin /Iron                                                                                                                                                                              |
|----------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Present study(n=401)                                           | Rural women(BMI 56/273/72)              | 70% / 65% / 68% (high prevalence across BMI; mean D \~15–17 ng/mL)                                                  | 50% / 40% / 35% (higher in underweight)                                                                                                                                          | 45% / 38% / 32% (higher in underweight)                                                                                                                                                     |
| Alharbi et al., 2023[8] review / cross-sectional meta-analyses | Adults (multiple cohorts)               | Lower circulating 25(OH)D generally associated with higher BMI / obesity (vitamin D sequestered in adipose tissue). | -                                                                                                                                                                                | -                                                                                                                                                                                           |
| Chakraborty et al., 2018 (India)[9]                            | Adolescents, India                      | -                                                                                                                   | B12 deficiency increased with BMI (normal 28.1% vs overweight 39.8% vs obese 51.2%). Suggests overweight/obese groups can have higher B12 deficiency in some Indian populations. | -                                                                                                                                                                                           |
| Davis et al., 2022 (systematic analyses)[10]                   | Women of reproductive age, multi-survey | -                                                                                                                   | -                                                                                                                                                                                | Ferritin often positively correlated with BMI (higher ferritin in higher BMI; may reflect inflammation/acute-phase response rather than better iron stores). Mediation by CRP/AGP reported. |

|                                            |                |                                                                                                                                 |   |   |
|--------------------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------|---|---|
| Bhowmik et al., 2019 (maternal cohort)[11] | Pregnant women | No consistent significant differences in Vit D, B12, ferritin between BMI groups in that cohort (results mixed across studies). | - | - |
|--------------------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------|---|---|

With respect to BMI, underweight women in our study had the highest prevalence of Vitamin B12 (50%) and ferritin deficiency (45%). Although Vitamin D deficiency was common across all BMI groups (65–70%), differences were not statistically significant. This pattern aligns with Bhowmik et al.,<sup>[11]</sup> (2019, Bangladesh), who reported no consistent BMI-related differences in micronutrient levels among pregnant women. Global literature suggests that obesity is often linked with lower circulating 25(OH)D due to adipose sequestration (Alharbi et al., 2023),<sup>[8]</sup> but our data show persistently high Vitamin D deficiency across BMI groups, which may reflect the very high baseline prevalence in South Asian women.

Interestingly, our data contrast with Chakraborty et al. (2018), who found higher Vitamin B12 deficiency in overweight and obese adolescents compared with normal-weight peers. This difference may be attributable to population differences, since rural adult women in our study may experience dietary insufficiency leading to B12 deficiency, while urban/younger cohorts may develop B12 deficiency due to metabolic factors associated with obesity.

For ferritin, our finding of lower prevalence of deficiency among overweight women is consistent with reports that ferritin increases with BMI due to inflammation, even when iron deficiency persists (Davis et al., 2022).<sup>[10]</sup> This underscores the need to interpret ferritin cautiously in populations with high rates of overweight and chronic low-grade inflammation.

## CONCLUSION

Overall, our results confirm that micronutrient deficiencies remain widespread in rural Indian women across education, parity, and BMI categories. Illiteracy, multiparity, and undernutrition were associated with the highest risk, in line with both national and international evidence. These findings underscore the need for integrated interventions, including nutrition education, supplementation

during and between pregnancies, and dietary diversification, with a special focus on vulnerable groups such as illiterate, multiparous, and undernourished women.

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