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Correlation Between Breast Density Classification with Sugar Levels for Iraqi Women

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ABSTRACT

Breast density, a critical parameter in mammographic imaging, refers to the proportion of fibroglandular tissue to fatty tissue within the breast. It is a significant factor in breast cancer risk assessment, as higher breast density is associated with an increased risk of breast cancer and can obscure lesions on mammograms, complicating early detection. The American College of Radiology classifies breast density into four categories: A (almost entirely fatty), B (scattered areas of fibroglandular density), C (heterogeneously dense), and D (extremely dense).This study aims to investigate the relationship between breast density classification and blood sugar levels among Iraqi women. The methods 100 women in this study. Mammography was utilized to determine the breast density. The results statistically significant between breast density classification , age and suger levels tests while not significant with body mass index for both breast. conclusion: our results indicate that the Iraqi women with breast density classification showed a decrease in age (for both breasts).other results breast density an increase with increase of suger levels of patients.

Keywords: *Mammography, fibro glandular, Breast density.*

1. INTRODUCTION

Mammography is widely recognized as the most accurate and reliable method for detecting small, otherwise undetectable breast cancers. However, it carries a slight but notable risk of radiation-induced harm[1][9]. Concerns have been raised regarding the potential carcinogenic effects of the radiation absorbed by breast tissue, as breast cancer often originates in the glandular tissues of the breast. The mean absorbed radiation dose, which reflects the radiation risk associated with mammography, is a critical parameter in evaluating the safety of this diagnostic procedure. Calculating the mean glandular dose is a fundamental aspect of quality control in mammographic imaging systems[2]. Studies have shown a 10% annual increase in breast cancer incidence, with a notable rise among individuals under 40 years of age, attributed to routine screenings and early detection. Despite the benefits of early diagnosis, the increased radiation exposure associated with mammography remains a significant concern due to its potential link to breast cancer development[3][4].

Radiological examinations often model the breast as a homogeneous mixture of fibroglandular and adipose tissues. Fibroglandular tissue[5], in particular, is more susceptible to carcinogenesis, making the assessment of radiation doses to this tissue essential for evaluating the risks of mammographic examinations. The International Commission on Radiation Units and Measurements (ICRU) Report 44 outlines the structural composition of fibroglandular and adipose tissues, providing a basis for understanding their radiological characteristics and sensitivity[6][7].

Diabetes mellitus is a multifactorial metabolic disorder characterized by chronic hyperglycemia, along with disturbances in lipid and protein metabolism caused by impaired insulin secretion, action, or both. Patients with diabetes may experience various symptoms, including excessive thirst, frequent urination, blurred vision, and weight loss[10][8] .

Diabetes can progress to severe conditions involving elevated sugar keto acids, which may lead to complications and disorders in large blood vessels, contributing to diseases such as stroke and other related conditions . Understanding the classical insulin signaling pathway is essential for comprehending the pathophysiology of type 2 diabetes. Insulin is the primary hormone responsible for regulating blood sugar levels, and in most cases, a proper balance between insulin secretion and action is necessary to maintain normal glucose levels[18] .

Breast cancer is the most common type of cancer globally and a leading cause of cancer-related deaths. As a complex disease, the exact mechanisms underlying its initiation remain unclear. However, its pathogenesis involves a multifaceted interplay of genetic, environmental, and lifestyle factors[11] .

Insulin, an endocrine peptide hormone, consists of 51 amino acids and is secreted by pancreatic beta cells. It is composed of two disulfide bridges connecting the α and β chains as a dimer, along with a third intrachain disulfide bridge within the α chain. Insulin plays a critical role in maintaining [7]healthy glucose and lipid levels. Additionally, it supports various cellular functions, including glycogen production, lipid metabolism[12], DNA synthesis, gene transcription, amino acid transport, and protein synthesis and degradation [18].

Insulin-like growth factor-1 (IGF-1) is a peptide composed of 70 amino acid residues, divided into four domains (A-D). While the A-C domains are present in proinsulin, only the A and B domains are found in mature insulin. The liver is the primary source of circulating IGF-1 under the regulation of growth hormone, though other organs can express IGF-1 through autocrine or paracrine mechanisms [18].

Insulin-like growth factors play diverse roles, including regulating cell differentiation and transformation, promoting cell motility, inhibiting apoptosis, and stimulating cell proliferation. Numerous studies have demonstrated[13] that elevated IGF-1 levels are associated with various cancers, such as prostate, pre- and postmenopausal breast, lung, thyroid, and colorectal cancers[18] .

2. PATIENTS AND METHODS

The Iraqi patients were referred to Alawiya Educational hospital major facilities between November 2024 to December 2024. One hundred , ages ranging from (30 to 60) years .All patients agreed to be involved in this study.

All participants were exposed to suger levels test in medical laboratory of hospital.

Participant Selection Inclusion Criteria

a. Women aged between 40 and 60 years .

b. Healthy women have no known medical conditions affecting breast density.

Exclusion Criteria

The women with mastectomy or any breast surgery or breast implant done and will women who do not take to Hormone Replacement Therapy (HRT), pregnant women and lactating women.

Measurements of BI-RAD

All subjects involved in this study were exposed to mammography examination

Determine their BI-RAD, mainly in both breasts for Iraqi women.

Statistical analysis

We conducted statistical analyses using version 19 of the statistical package for social sciences (SPSS). Data were presented in simple measures of frequency, percentage, mean, standard deviation, and range (minimum-maximum values).The significance of difference of different means (quantitative data) were tested using Students-t-test for difference between two independent means or Paired-t-test for difference of paired observations (or two dependent means), or ANOVA test for difference among more than two independent means. The significance of difference of different percentages (qualitative data) were tested using Pearson Chi-square test (χ^2-test) with application of Yate's correction or Fisher Exact test whenever applicable. Statistical significance was considered whenever the P value was equal or less than 0.05

3. RESULTS

Participants in the study were distributed across three main age groups: 40-49 years (20%), 50-59 years (41%) and 60-69 years (39%). The mean of age was 46.8 years and a standard deviation of 7.7 years. The body mass index (BMI) distribution of patients was follow: 32% were overweight (BMI 25-29.9), 46% were obese (BMI 30-34.9), 15% were in the obese II category (BMI ≥35) and 7% were in the normal BMI. The range of BMI was (20.08 to 44.14) and mean was (31.25 Kg/m²). show these results at, (table 1). During this study,100 patients in which 64 (64%) of participants had the same breast density in both breasts, while 36 (36%) had different densities.Show at (figure 1).

Table (1): Typical values for Anthropometric measurements of patients

Anthropometric measurement’s		No.	%
Age (years)	40---49	20	20.0
	50---59	41	41.0

	60---69years	39	39.0
	Mean±SD (Range)	46.8±7.7	(35-59)
BMI (Kg/m²)	Normal (18.5-24.9)	7	7.0
	Overweight (25-29.9)	32	32.0
	Obese (30-34.9)	46	46.0
	Obese II (=>35)	15	15.0
	BMI (Kg/m²)	31.25±4.83	(20.08 - 44.14)
Same breast density	Same	64	64.0
	Different	36	36.0

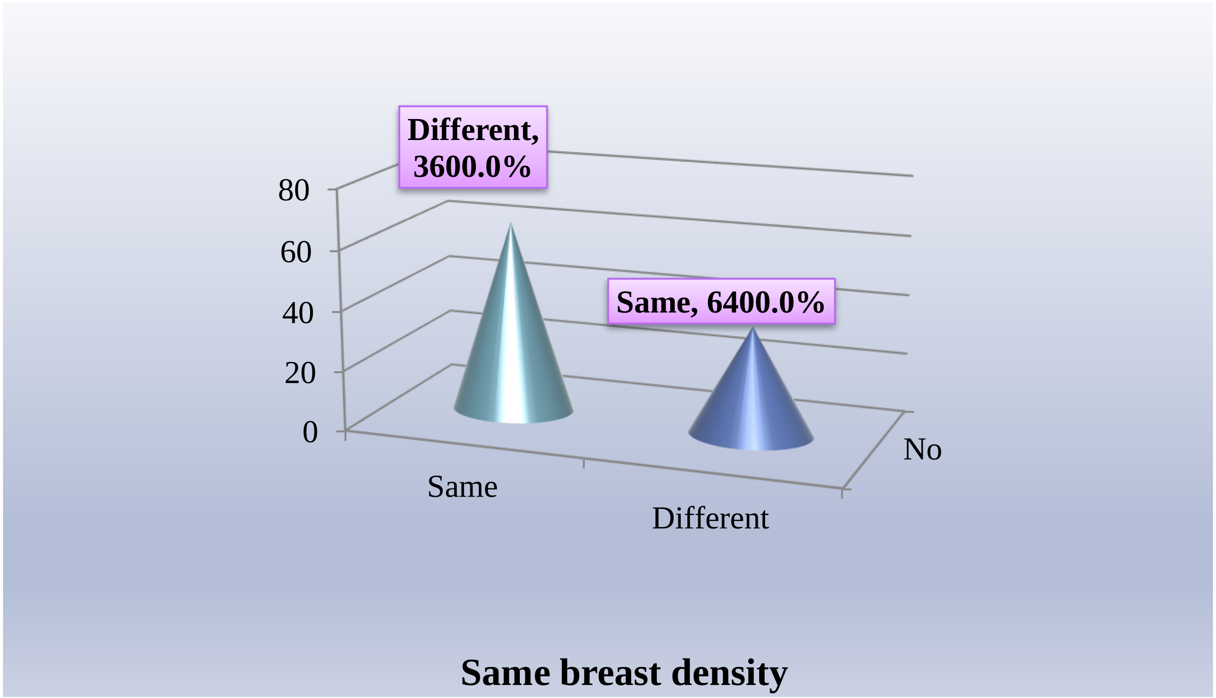

Figure (1): Total number of patients according to breast density classification.

figure (2) provides a nuanced examination of breast density classification utilizing the BI-RADS scoring system for both the right and left breasts. Majority of the patients have breasts density of class fatty (A) for right (68 patients or 68.0%) and left breasts (70 patients or 70.0%),followed by scattered fibro glandular density (B) with 17 patients (17.0%) for right breasts but 24 patients with 24.0% for left breasts . Heterogeneously dense (C) is observed in right breasts (11 patients or 11.0%) and 4 patients (4.0 %) for left breasts .finally the extremely dense (D) for right breasts was (4 patients or 4.0%) but the Left breast was 2 patients (2.0%) .

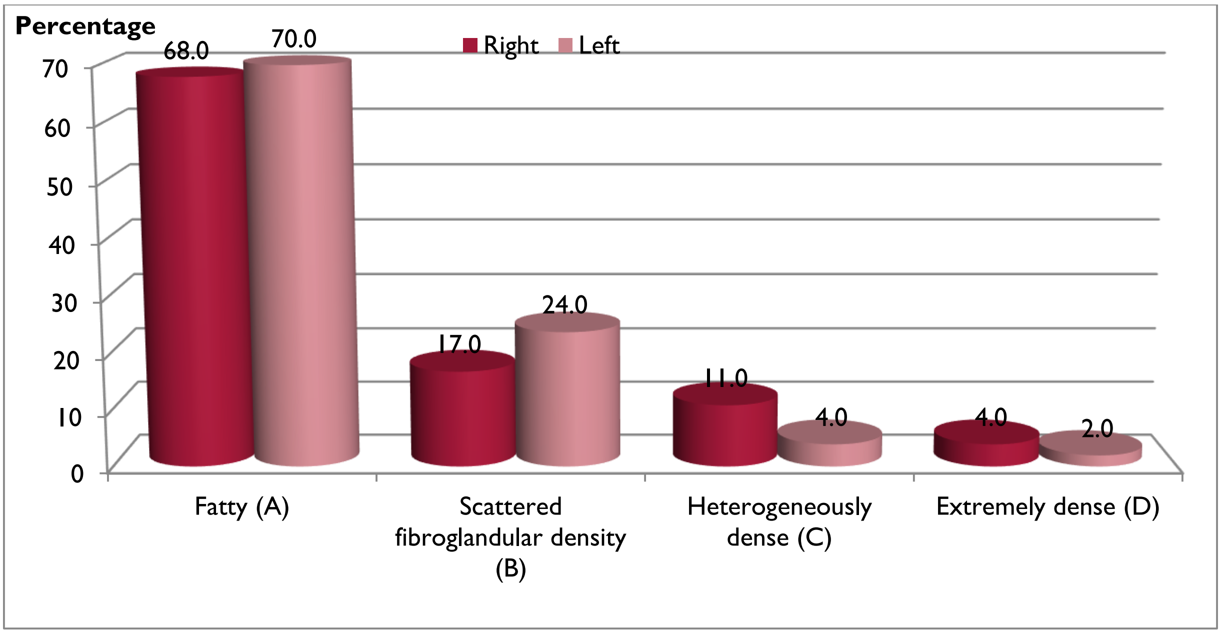

Figure (2):Breast density classification for both breasts.

Based on the table (2) provided regarding right breast density classification according to BI-RADS categories .Age and Breast Density Classification in the age group of 40-49 years, there was a significant difference (p-value = 0.001) in the distribution of breast density classifications:8.8% had fatty breast tissue (A).29.4% had scattered fibro glandular density (B).54.5% had heterogeneously dense breast tissue (C).75.0% had extremely dense breast tissue (D).In the age group of 50-59 years:45.6% had fatty breast tissue (A).29.4% had scattered fibro glandular density (B).36.4% had heterogeneously dense breast tissue (C).25.0% had extremely dense breast tissue (D). In the age group of 60-69 years:45.6% had fatty breast tissue (A).41.2% had scattered fibroglandular density (B).9.1% had heterogeneously dense breast tissue (C).None had extremely dense breast tissue (D).BMI and Breast Density Classification:In terms of BMI categories, there was no significant difference (p-value = 0.468) in the distribution of breast density classifications:Among participants with normal BMI, the distribution was relatively balanced across the four categories, with the highest percentage (25.0%) in the extremely dense category (D).Overweight participants had the highest percentage in the fatty breast tissue category (45.6%).Obese participants had higher percentages in both fatty and scattered fibroglandular density categories (45.6% and 52.9%, respectively).Those in the obese II category had higher percentages in fatty breast tissue (13.2%) and scattered fibroglandular density (29.4%). Overall, the data suggests that age has a significant impact on the distribution of breast density classifications, with younger participants (40-49 years) showing a higher prevalence of heterogeneously and extremely dense breast tissue compared to older participants.

Table(2): The correlation between right breast density with age and body mass index

Anthropometric measurements		Right breast Density classification (BI-RADS)								P value
		Fatty (A)		Scattered fibroglandular density (B)		Heterogeneously dense (C)		Extremely dense (D)		
		No	%	No	%	No	%	No	%	
Age (years)	40---49	6	8.8	5	29.4	6	54.5	3	75.0	0.001*
	50---59	31	45.6	5	29.4	4	36.4	1	25.0	
	60---69years	31	45.6	7	41.2	1	9.1	-	-	
BMI (Kg/m²)	Normal (18.5-24.9)	5	7.4	-	-	1	9.1	1	25.0	0.468
	Overweight (25-29.9)	23	33.8	3	17.6	4	36.4	2	50.0	

	Obese (30-34.9)	31	45.6	9	52.9	5	45.5	1	25.0	
	Obese II (=>35)	9	13.2	5	29.4	1	9.1	-	-	
*Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.										

Table (3) display the relationship between age and left breast density classification: In the age group of 40-49 years, there was a significant difference (p-value = 0.002) in the distribution of breast density classifications:11.4% had fatty breast tissue (A).45.8% had scattered fibroglandular density (B).25.0% had heterogeneously dense breast tissue (C).No participants had extremely dense breast tissue (D).In the age group of 50-59 years:38.6% had fatty breast tissue (A).41.7% had scattered fibroglandular density (B).75.0% had heterogeneously dense breast tissue (C).50.0% had extremely dense breast tissue (D). In the age group of 60-69 years:38.6% had fatty breast tissue (A).41.7% had scattered fibroglandular density (B).75.0% had heterogeneously dense breast tissue (C).50.0% had extremely dense breast tissue (D).In the age group of 50-59 years:50.0% had fatty breast tissue (A).12.5% had scattered fibroglandular density (B).None had heterogeneously dense breast tissue (C).50.0% had extremely dense breast tissue (D).BMI and Breast Density Classification there was no significant difference (p-value = 0.456) in the distribution of breast density classifications across different BMI categories :Among participants with normal BMI, the distribution was relatively balanced across the four categories, with none having heterogeneously dense or extremely dense breast tissue .Overweight participants had the highest percentage in the fatty breast tissue category (35.7%).Obese participants had higher percentages in fatty breast tissue (44.3%) and scattered fibroglandular density (50.0%), with some also having heterogeneously dense and extremely dense breast tissue.Participants in the obese II category showed a mix of densities, with no clear trends.

Table(4): The relationship between left breast density with age and body mass index.

Anthropometric measurements		Left breast Density classification (BI-RADS)								P value
		Fatty (A)		Scattered fibroglandular density (B)		Heterogeneously dense (C)		Extremely dense (D)		
		No	%	No	%	No	%	No	%	
Age (years)	40---49	8	11.4	11	45.8	1	25.0	-	-	0.002*
	50---59	27	38.6	10	41.7	3	75.0	1	50.0	
	60---69years	35	50.0	3	12.5	-	-	1	50.0	
BMI (Kg/m²)	Normal (18.5-24.9)	6	8.6	1	4.2	-	-	-	-	0.456
	Overweight (25-29.9)	25	35.7	6	25.0	1	25.0	-	-	
	Obese (30-34.9)	31	44.3	12	50.0	1	25.0	2	100	
	Obese II (=>35)	8	11.4	5	20.8	2	50.0	-	-	
*Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.										

This table(5, presents the analysis of blood sugar levels among participants, categorized into four groups based on their blood sugar readings: Very Low, Low, Moderate, and High. The table provides the number of participants (No.), the mean blood sugar level along with the standard deviation (Mean ± SD), the minimum (Min) and maximum (Max) readings, and the percentage (%) of participants in each category.

- **VeryLow(<70):**
  No participants were recorded in this category, indicating that no one had blood sugar levels below 70. The percentage of participants in this group was 0.0%.
- **Low(70–140):**
  This category included the majority of participants (61 individuals, 61.0%). The average blood sugar level in this group was 91.93 mg/dL with a standard deviation of ±18.90, indicating moderate variability within the group. The blood sugar levels ranged from 73.00 mg/dL to 134.86 mg/dL.

- **Moderate(141–200):**
  Seventeen participants (17.0%) were classified in this category. The mean blood sugar level was 175.21 mg/dL with a standard deviation of ±17.10, suggesting less variability compared to the low category. The readings in this group ranged from 150.16 mg/dL to 200.00 mg/dL.
- **High(>200):**
  This group included 22 participants (22.0%), with the highest blood sugar levels recorded. The average blood sugar level was 340.65 mg/dL, with a large standard deviation of ±87.98, indicating high variability within this category. Blood sugar levels ranged from 209.00 mg/dL to 463.00 mg/dL.

Table (5): The mean and range of blood sugar test .

Category	No.	Mean ±SD	Min	Max	%
Very low <70	_	_	_	_	0.0
Low (70-140)	17	91.93±18.90	73.00	134.86	17.0%
Moderate (141-200)	21	175.21±17.10	150.16	200.00	21%
High > 200	61	340.65±87.98	209.00	463.00	61%

This table(6) analyzes the correlation between breast density classification, as defined by BI-RADS, and blood sugar levels among a group of Iraqi women. The data categorize women into three blood sugar level groups: Low (70–140), Moderate (141–200), and High (>200), based on their respective breast density classifications: Fatty (A), Scattered (B), Heterogeneously Dense (C), and Extremely Dense (D).The results show that women classified with Fatty (A) breast density all fell into the low blood sugar group, with only four cases reported. No cases were observed in the moderate or high blood sugar categories for this group. For women with Scattered (B) breast density, all 20 cases were found in the moderate blood sugar group, with no representation in the low or high groups. Women with Heterogeneously Dense (C) breast density were entirely in the high blood sugar category, with seven cases reported. Similarly, women with Extremely Dense (D) breast density were also exclusively in the high blood sugar group, with a significantly larger number of cases (69).The mean and standard deviation (SD) for each blood sugar level group were as follows:

Low: 91.93 ± 18.90

Moderate: 175.21 ± 17.10

High: 340.65 ± 87.98

When analyzing the statistical correlation between breast density and blood sugar levels, a positive moderate correlation was observed with a correlation coefficient (R) of 0.290. However, the p-value of 0.058* indicates that this correlation is not statistically significant at the 0.05 level.

Table (4.10): Correlation between breast density classification and blood sugar test for Iraqi woman.

Breast density classification	Low (70-140)		Moderate (141-200)		High >200	
	No.		No.		No.	
Fatty(A)	_		_	_	_	-
Scattered(B)	_		-	_	_	-
Heterogeneously dense (C)	7	41.17	9	42.85	15	24.59
Extremely dense (D)	10	58.82	12	57.14	46	75.40
P-value	0.058*					

*Correlation is significant at the 0.05 level.

4. DISCUSSION

It is well known that breast cancer is one of most common disorders affecting the life of women. The findings of this study, which show a significant inverse relationship between age and breast density classification, are consistent with existing literature[18]. It is well-established that younger women tend to have denser breast tissue, which can make mammogram interpretation more challenging and may increase the risk of breast cancer. As women age, breast tissue typically undergoes involution and becomes less dense, which makes mammogram interpretation easier. These results align with the study by F T H Bodewes., et al., which reported a significant inverse relationship between breast density and age. Their study also found that the percentage of lesions with calcifications was higher in women with denser breasts and in younger women. Notably, all the cases in their pilot study showed positive mammographic findings when increasing age was associated with decreasing breast density ($r = -0.521$, $p < 0.01$)[6].

Regarding the lack of a significant association between BMI and breast density classification, it is not necessary for there to be an inverse relationship between body mass index (BMI) and breast tissue density in menopausal women, although a general trend may exist. Women with higher BMI typically have lower breast density because increased fatty tissue appears less dense on mammograms. In contrast, women with lower BMI often have a higher proportion of glandular and connective tissue, leading to higher breast density. However, this relationship is not absolute, and exceptions exist. Several factors can influence this association[15]:

1. Hormone Levels: Hormonal variations, such as hormone replacement therapy (HRT), can maintain or even increase breast density, even in women with higher BMI.

2. Genetics: Genetics play a significant role in breast density, and some women may naturally have denser breasts regardless of their BMI[21].

3. Regarding race as a factor influencing breast density, there are noticeable differences in breast density among individuals of different ethnic backgrounds. Studies have shown that racial factors can impact the composition of breast tissue, thereby affecting breast density. For example, it has been found that women of Asian or African descent tend to have denser breast tissue compared to women of European or American descent. Women of Asian descent,[14] for instance, often have more glandular tissue in their breasts, which can make mammogram interpretation more challenging. In contrast, women of European descent generally have less dense tissue, making mammograms easier to interpret, but this can also reduce the ability to detect tumors in early stages [12].

4. Age and Menopause: As women age and go through menopause, breast density generally decreases, though the degree of change can vary widely among individuals[16].

The findings of this study suggest a possible association between breast density and blood sugar levels, particularly with higher glucose levels observed in women with denser breast categories (C and D). Although the statistical analysis did not reach conventional significance ($p = 0.058$*), the trends observed are noteworthy and warrant further exploration.

Women with heterogeneously dense (C) and extremely dense (D) breasts displayed a distinct clustering in the high blood sugar category, with mean glucose levels reaching 340.65±87.98 mg/dL in the extremely dense group. This observation could be explained by several physiological and hormonal mechanisms. Dense breast tissue is known to be more hormonally active due to [17] its higher proportion of glandular tissue, which is highly responsive to estrogen and other hormonal fluctuations. Estrogen, while playing a protective role in some metabolic processes, can also contribute to insulin resistance in certain contexts, leading to impaired glucose metabolism and higher blood sugar levels[19].

Furthermore, dense breast tissue has been linked to increased systemic inflammation, a known risk factor for metabolic syndrome and type 2 diabetes. Chronic low-grade inflammation [9] can interfere with insulin signaling pathways, exacerbating hyperglycemia[20].

5. CONCLUSION

The study that age and breast density classification are inversely correlation while not relationship between body mass index and breast density classification for both breast and found high positive correlation between BI-RADS with suger levels of Iraqi women in Baghdad.

Conflict of interest

The authors state that they have no conflicts of interest.

Ethical clearance

Informed consent was acquired from all the patients included in this study.

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