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Study of some nutritional status indicators (BF%, TBW%) and their relationship with vertical jump ability

- The case of elite athletes in some specialized sports with jumping -

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Abstract:

The aim of this research is to study the potential relationship between some nutritional status indicators, represented by body fat percentage (BF%) and total body water percentage (TBW%), and their relationship with vertical jump ability through the tests of squat jump (SJ) and countermovement jump (CMJ) among elite male senior athletes in the disciplines of volleyball (N=53, Age=25.31±4.51), basketball (N=44, Age=26.58±5.41), long and triple jump (N=23, Age=22.53±3.4), and high jump (N=14, Age=21.94±3.93).

It was found that there is a statistically significant negative relationship with the indicator (BF%), while a statistically significant positive relationship was recorded with the indicator (TBW%).

Keywords: Relationship, nutritional status indicators, vertical jump, elite athletes.

1-Introduction and Problem Statement:

Evaluating body composition is one of the fundamental measurements for assessing nutritional status, determining health status, and assessing the physical fitness level of individuals in general and athletes in particular.

Body composition refers to the body's composition in terms of fat mass, muscle mass, bone mass, fluids, etc.

This division, known as the anatomical model, is the most common method for evaluating athletes, in addition to the binary model that divides body components into fat mass and lean mass, which is a more general model.

In our study, we relied on body fat percentage (BF%) and total body water percentage (TBW%) as two main indicators of body composition andnutritional status .

Evaluating body composition is important for improving physical performance,and also nutritional status.

Many sports disciplines require a high level of specific body characteristics, such as fat mass and non-fat mass, which affect performance to varying degrees in various sports and performance elements, including vertical jump(Al-Hazzaa, 2009; Al-Janadi, 2015)

Vertical jump is considered one of the most important factors in sports achievements in volleyball, basketball, and track and field events. It is a physical attribute that refers to the ability to lift the body's center of gravity to the highest vertical height through muscular contraction.

It requires a high level of muscular coordination and optimal muscular strength, especially in the lower limbs.

In our study, we mean the level of achievement for athletes as the focus of the study through vertical jump tests according to Bosco **(1993, cited by Cometti, 2006)**, which include squat jump (Sj), counter movement jump (CMJ), and the extent of their ability to jump to the maximum height in each of these tests.

A basketball or volleyball player cannot excel in the specialized skills of their sport blocking in volleyball, shooting while) jumping in basketball, spiking and powerful serving in volleyball) or achieve acceptable numbers that enable them to compete at national and international levels in individual sports such as track and field events, without possessing the appropriate morphological characteristics, in addition to a high level of explosive strength and the ability to jump high, known as the vertical jump **(Toubal & Ben Lkahla, 2015; Satri, 2011; Al-Hazzaa, Al-Janadi, 2015; Asli et al., 2017 ;2009)**

(Toubal & Ben Lkahla, 2015, p. 125), (Satri, 2011, p. 66), (Al-Hazzaa, 2009), (Al-Janadi, 2015), (Asli et al., 2017, p. 359).

Vertical jump is considered a very important and decisive indicator and factor in sports that require skill performance.

Excelling in the ability to jump high, as is the case in basketball, is directly related to the level of achievement and effectiveness of performance in skills such as dunking, blocking, shooting while jumping, excelling, and winning rebound balls from the basket, both defensively and offensively. Studies indicate that a basketball player performs an average of (46±12 jumps) per game.

Volleyball players also need a high level of vertical jumping ability in order to respond effectively to the challenges posed by this sport. They achieve an average of

32.16 jumps per set, which amounts to 96.48 jumps in a 3-set match and 160.8 jumps in a

set match. This is demonstrated through -5 actions such as blocking at the net, spiking from the back and front zones, powerful serving, setting with jumps for the setter, and establishing a solid blocking wall for the middle player (comitti, 2002c). In track and field, the importance of jumping ability is evident as it is considered a sporting achievement in itself.

Therefore, in this study, we will investigate the relationship between body composition indicators as measures of nutritional status and the vertical jumping ability of elite Algerian athletes in the disciplines of volleyball, basketball, and jumping in track and field. We start with the following general question:

Is there a statistically significant relationship between body composition indicators and vertical jumping ability among elite male athletes in the disciplines of volleyball, basketball, and jumping in track and field?

Followed by the specific questions: Is there a statistically significant relationship between body fat percentage (BF%) and total body water percentage (T.B.W%) on one hand, and vertical jumping ability among volleyball players?

We propose the existence of a statistically significant relationship between body composition indicators and the level of vertical jumping ability among elite male athletes in volleyball, basketball, and jumping in track and field as a general hypothesis/

Followed by the following specific hypotheses:

1-There is a statistically significant relationship between body fat percentage (BF%) and vertical jumping ability among volleyball players.

2-There is a statistically significant relationship between total body water percentage (TBW%) and vertical jumping .ability among volleyball players.

This research aims to study the body composition, in addition to studying the vertical jump property with its various indicators among elite male players in volleyball, basketball, and jumping in track and field. It also attempts to investigate the mutual relationship between body composition indicators as indicators of nutritional status evaluation and the vertical jump property. Furthermore, it aims to identify the positive and negative effects resulting from these potential relationships to contribute to enhancing the level of athletic achievement by optimizing the use of scientific data and results.

2-Materials and Methods

2.1-Study Methodology: The methodology refers to the procedures, rules, and regulations that are established in order to reach and discover the facts. It is a specific program for various ways to answer the questions and inquiries raised by the subject (Ikhlas, Bahi, (p. 317 ,2002.

In this study, we have adopted the descriptive correlational methodology as it is suitable for the nature of the subject. Correlational studies are used to determine the extent to which changes in one factor correspond to changes in another factor (Karmish, Ababsa, 2014, p. (118.

This is what we seek in our research, which is to uncover and determine the nature of the relationship between body composition indicators and the vertical jump property.

2.2-Study Population: Our study population consists of athletes from the first division (top division) in basketball and volleyball, as well as athletes participating in the national championships and the Algerian Cup in track and field disciplines of high jump, long jump, and triple jump.

2.3-Study Sample: In this study, our sample is characterized by a high level of training and conditioning resulting from years of systematic scientific work. They are capable of competing at the elite and high levels. Our research sample consists of 134 Algerian elite male athletes who were purposively selected, distributed among the disciplines as shown in the following table:

Table (01): the general characteristics of the study sample, according to the sports disciplines.

Variables		**Total Sample N=134**	**High Jump N=14**	**Long Jump and Triple Jump N=23**	**Basketball N=44**	**Volleyball N=53**
Height (cm)	**MOY**	188	179	181	189	191
	ET(±)	8.2	5.1	6	8.9	5.5
	Max	207	1.9	191	205.5	207
	Min	168	1.72	172	168	182

Weight (kg)	**MOY**	80.94	73.2	73.81	83.35	84.07
	ET(±)	10.57	7.08	6.03	11.7	9.56
	Max	112.1	83.1	84	112.1	104.2
	Min	60	61.1	63.6	60	62.5
Age (yrs)	**MOY**	24.90	21.94	22.53	26.58	25.31
	ET(±)	4.90	3.93	3.4	5.41	4.51
	Max	36.50	31	29	36.5	36
	Min	18.00	18	18	18.5	18

The sample was selected purposively as they are the best athletes in their specialties in Algeria.

2.4-Temporal Area: The study was conducted from March to May 2019**.**

2.5-Study tools: We relied on the following tools to collect data for our research

2.5.1-Anthropometric measurement tools :

-Anthropometer device for measuring length

-Harpenden Caliper device for measuring skinfold thickness.

-Anthropometric measuring tape for measuring body circumferences.

-Smart electronic medical scale of type Scale :700 It is characterized by the ability to measure body composition through bioimpedance analysis, with a measurement accuracy of 0.1Kg. We relied on it to measure body weight in addition to total body water content (TBW).

2.5.2-Measurement of vertical jump performance: We relied on the Ergo Jump device of type"Globus"to perform the following tests: Counter Movement Jump (CMJ), Squat Jump (SJ).

2.5.3-Observation cards and logistic tools :

2.5.4-Statistical methods and techniques, : including

- We performed statistical analysis of the data using SPSS 24 software, and used descriptive statistical such as mean, standard deviation.

- Body fat percentage was calculated using the Mateigka equation.

Mateigka equation (1921) for calculating - body fat in both men and women:

$$BF = 1.3 \times Sa \times D$$

BF:Body fat mass in kilograms

Sa: Body surface area according to the Izakson equation.

D: 1/2 (d1+d2+d3+d4+d5+d6) /12.

d1: Subscapular skinfold thickness.

d2: (Bicipital skinfold + Tricipital skinfold) 2 /.

d3: Forearm skinfold thickness.

d4: Abdominal skinfold thickness.

d5: Quadriceps skinfold thickness.

d6: Calf skinfold thickness.

To calculate the body fat percentage, which is the conversion of body fat mass into a percentage of body weight, we apply the equation/

$$BF\% = (BF / Body\ Mass) \times 100$$

(Ould Ahmed,2014,P78), (Mateigka,1921,P225).

-Calculating the relationship between body composition indicators as well as various vertical jumping indicators using the Pearson correlation coefficient, and representing the nature of the relationship through curves.

Validity and Reliability of study tools: In our study, we relied on laboratory and technological tools, and we conducted measurements and tests according to precise instructions specific to each measurement or test used in many previous and similar studies.

3- Presentation and analysis of the results

3.1-Presentation of the results of the athletes' body composition study:

3.1.1-Presenting the results of a study on body fat percentage among students:

Table (02): Illustrates the results of the Body Fat Percentage Index for volleyball players, basketball players, long jumpers, triple jumpers, and high jumpers.

Statistical variables	High Jump	Long jump and triple .jump	Basket-ball	Volley-ball
Average	13.37 %	12.65 %	15.85 %	14.69 %
Standard	±2.72%	±2.56%	±5.04%	±4.89%

deviation				
Max Value	17.78 %	17.85 %	36.22 %	32.94 %
minimum value	8.54 %	9.26 %	7.76 %	8.20 %

From the analysis of Table (02), we find that the highest percentage of body fat mass (%Masse Grasse) was recorded by basketball players at (15.85% ± 5.04), followed by volleyball players at (14.69% ± 5.89), and high jump athletes at (13.37% ± 2.72). Long and triple jump athletes came in fourth place at (12.65% ± 2.56).

3.1.2-Results of Total Body Water Percentage (TBW%):

Table (03) illustrates the results of the Total Body Water Percentage(TBW%)for volleyball players, basketball players, long and triple jump athletes, and high jump athletes.

Statistical variables	High jump	Long and triple jump	Basket-ball	Volley-ball
Mean	56.31%	56.81%	59.12%	58.90%
Standard deviation	±2.56%	±2.62%	±3.80%	±4.06%
Max Value	62.10%	62.30%	65.70%	66%
minimum value	51.80%	51.8%	50.20%	39%

From the analysis of Table (03), we find that the highest percentage of total body water (%Total Body Water) was recorded by basketball players at (59.12% ± 3.80), followed by volleyball players at (58.90% ± and long and triple jump athletes at ,(4.06 .(2.62 ± %56.81) High jump athletes came in fourth place at (56.31% ± 2.56).

3.2-Presentation of Vertical Jump Test Results:

We conducted a study and test on the vertical jump ability of athletes using the Ergo Jump device. We performed different tests, including CMJ (Countermovement Jump) and SJ (Squat Jump), with the following results:

3.2.1-Height of Jump (HJ) indicator in the (SJ) vertical jump test Results:

Table (04) shows the results of the research sample spor ts groups in terms of the Height of Jump (HJ) indicator in the SJ test.

Statistical variables In centimeters (cm)	High jump	Long jump and triple jump	Basket-ball	Volley-ball
Mean	40.33 cm	43.2 cm	38.02 cm	45.79 cm
Standard deviation	±4.31 cm	±6.32 cm	±6.49 cm	±5.15 cm
Maximum value	48.2 cm	52.4 cm	49.7 cm	55.6 cm
Minimum value	31.6 cm	30.6 cm	23.2 cm	35.2 cm

From the analysis of the results in Table ,(04) we find that the highest average for the Height of Jump indicator in the Vertical Jump (SJ) test was recorded by volleyball players at: (45.79 cm±5.15), followed by long and triple jump athletes at: (43.2 cm±6.32), then high jump athletes at: (40.32 cm±4.31) while basketball players came in fourth place at: cm±6.49 38.02)).

3.2.2-Height of Jump (HJ) indicator in the (CMJ) vertical jump test Results:

Table (05) shows the results of the research sample sports groups in terms of the Height of Jump (HJ) indicator in the CMJ test.

Statistical	High	Long	Basketball	Volleyball

variables In centimeters (cm)	jump	jump and triple jump		
Mean	**43.74 cm**	**45.53 cm**	**40.65 cm**	**47.1 cm**
Standard deviation	**±4.40 cm**	**±5.83 cm**	**±6.72 cm**	**±5.73 cm**
Maximum value	**50.7 cm**	**58.5 cm**	**57 cm**	**56 cm**
Minimum value	**36.1 cm**	**35.6 cm**	**24.6 cm**	**34.80 cm**

From the analysis of the results in Table we find that the highest average for the ,(05) vertical jump height indicator in the Vertical Jump Test (CMJ) was recorded by volleyball players at: (47.1 cm±5.73), followed by long and triple jump athletes at: (45.53 cm±5.83), then high jump athletes at: (43.74 cm±4.40), while basketball players came in fourth place at: (40.65 cm±6.72).

3.3-Presentation of the results of the Pearson Test to study the relationship between some body composition indicators and the jump height indicator:

3.3.1-Presentation of the results of the Pearson Test to study the relationship between some body composition indicators and the jump height indicator (HJ: Height of Jump) in the Squat Jump Test (SJ) for volleyball, basketball, long and triple jump, and high jump athletes:

We studied the relationship between the jump height indicator (HJ: Height of Jump) in the Squat Jump Test (SJ) and the body composition indicators (total body weight, body fat percentage, total body water percentage) using the Pearson correlation test for the total sample, including athletes from different studied specialties and according to each sports specialty. The results are shown in .Table (06)

Table (06:results of the Pearson Test to study the relationship between some body composition indicators and the jump height indicator (HJ: Height of Jump) in the Squat Jump Test (SJ) for volleyball, basketball, long and triple jump, and high jump athletes.

	Jump height indicator (HJ: Height of Jump) in the Squat Jump Test (SJ)				
Body composition La composition corporelle	**Correlation coefficients by sports specialty**				**Total sample correlation coefficients**
	High jump	**Long and triple jump**	**Basket-ball**	**Volley-ball**	
1- Body fat percentage	-0.341*	-0.349*	-0.373*	-0.223*	**- 0.304****
2- Total body water percentage	0.171	*0.375	0.165	0.186	**0.157**

***: Significance at 0.05 * * : Significance at 0.01**

- For the total sample, our analysis revealed negative correlation coefficients with body fat percentage (-0.304**), while we did not find any relationship with muscle mass percentage, bone mass percentage, and total body water percentage.

-Regarding the correlation coefficients for volleyball groupWe found a negative : relationship with body fat percentage (-0.223**), while we did not find significant values for the total body water percentage.

- For the basketball player group, we found a negative correlation with body fat percentage (-0.373*), and no significant relationship with total body water percentage was identified.

- In the context of long and triple jump specialists, there was a notable negative relationship with body fat percentage (-0.349*), while a positive correlation was found with total body water percentage (0.375*).

-Regarding the correlation coefficients for high jump specialization: We found a significant negative relationship with body fat percentage (-0.341*), while we did not find any relationship with the total body water percentage. This can be confirmed in Figure(1).

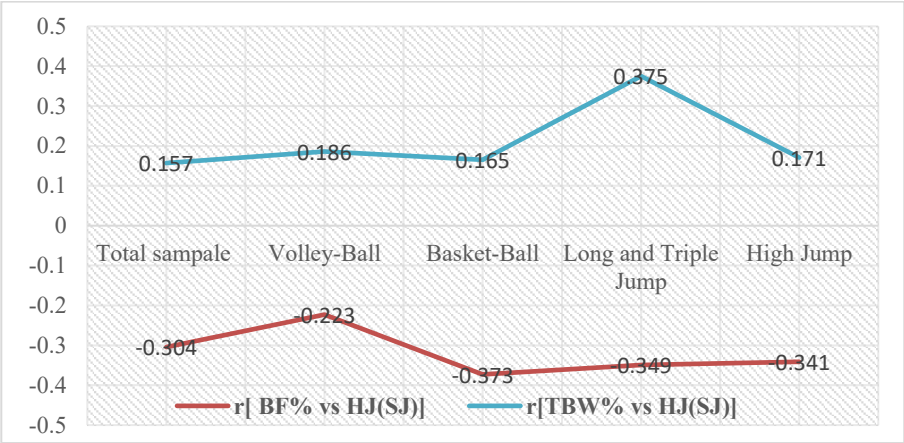

Figure (01) illustrates the changes in correlation coefficients between the characteristics and morphological indicators related to body composition and the high jump index (HJ) for the SJ test.

3.3.2-Presentation of Pearson Test results for the relationship between (BF%, TBW%) and the high jump index (HJ: Height of Jump) in the CMJ test:

We studied the relationship between the high jump index (HJ: Height of Jump) in the CMJ test and the body composition indicators related to nutritional status evaluation (body fat percentage, total body water percentage) using the Pearson correlation test for the total sample, including athletes from different studied specializations and according to each sports specialization. The results are shown in Table(07)

Table (07): Results of the "Person Test" to study the relationship between some characteristics related to body composition and the jump height indicator (HJ: Height of Jump) in the test (CMJ: Contre Mouvement Jump) for volleyball, basketball, and jump athletes (Long and triple), high jump:

	Jump height indicator (HJ: Height of Jump) in the test (CMJ: Contre Mouvement Jump)				
Body composition La composition corporelle	**Correlation coefficients by sports specialty**				**Total sample correlation coefficients**
	High jump	**Long and triple jump**	**Basket-ball**	**Volley-ball**	
1- Body fat	-	-0,277*	-	-0,406*	**-0,394****

percentage	0,340*		0,450**		
2- Total body water percentage	0,393*	0,376*	0,195*	0,315*	**0,218***
***: Significance at 0.05 * * : Significance at 0.01**					

-Regarding the correlation coefficients for the total sample we observed a negative significant relationship for body fat % (**0.394-) ,Also a positive significant relationship for the total body water% index (0.218*) was find.

- For volleyball players, the correlation coefficients revealed a significant negative relationship with body fat percentage (-0.406**), while a positive correlation was observed with the total body water percentage (0.315*).

-Regarding the correlation coefficients for basketball specialization: we observed a negative relationship with body fat percentage as well as a statistically ,(**0.450-) significant positive relationship with total body water %index (+0.195*) .

-The correlation analysis for long and triple jump group revealed a negative relationship with body fat percentage index (-0.277), suggesting that greater body fat correlates with lower performance. In contrast, a positive relationship with the total body water percentage index (0.376) was observed, implying that more total body water is related to better performance.

- The correlation coefficients for high jump athlete's demonstrated a negative correlation with body fat percentage (-0.340) and a positive correlation with total body water percentage (0.393).

The results of the correlation coefficients are presented in Figure (02).

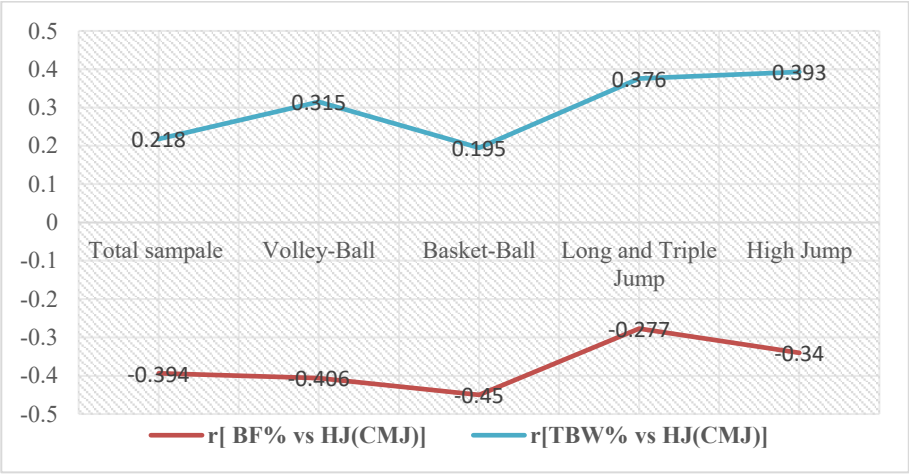

Figure (02) : changes in correlation coefficients between the characteristics and morphological indicators related to body composition and the high jump performance (HJ) for the Counter Movement Jump (CMJ) test.

4- Discussion of the results:

our Discussion of the results is related to Hypothesis

4.1-Hypothesis 01: The existence of a statistically significant relationship between body fat percentage (BF%) and vertical jump performance among the players in the study sample.

Through the statistical results of the relationship between body fat percentage (BF%) and vertical jump performance among athletes in the first section (top section) of basketball and volleyball, as well as athletes participating in the national championships and the Algerian Cup in track and field events such as high jump, long jump, and triple jump.

We arrived at the following results:

There is a statistically significant negative relationship between the variables (VJ-BF%), with the Pearson correlation coefficient ranging from [-0.406 to -0.277] for the vertical jump performance indicators, including the height of VJ in CMJ and SJ tests.

This is consistent with the study by (Al-Hazzaa, 2009), (Wilmore et al., 2008), (Beatriz .G et al., 2015), (Pantelis et al., (Hakan, Nebahat, 2019), which ,(2017 confirm the negative relationship between body fat percentage and athletic performance, especially in vertical jump performance.

Al-Hazzaa (2009) also states that "an increase in body fat percentage negatively affects athletic performance, especially in sports that require body weight-bearing, such as long-distance running, jumping, and

leaping" (Al-Hazzaa, 2009, p. 187). Therefore, the first hypothesis is supported.

4.2--Discussion of the results related to Hypothesis 02

Hypothesis 02: The existence of a statistically significant relationship between total body water percentage (TBW%) and vertical jump performance among the players in the study sampleM

Through the statistical study results of the relationship between the Body Water Mass (TBW%) indicator and the vertical jump, as shown in Table (7) and Figure (2), we have reached the following conclusions:

There is a positive linear relationship between the variables, with correlation coefficients ranging from [+0.195; +0.395] regarding the vertical jump height indicator for various tests (CMJ, SJ).

This is due to the fact that water is considered a fundamental component in the human body, constituting[50-70%] of body weight. Al-Hazaa (2007) indicates that:

"chemical reactions related to energy production in working muscles occur in the aqueous medium, and they will certainly be negatively affected by a decrease in body water content"(Al-Hazaa, 2007, p3).

Wilmore et al. (2008) also point out that : "the use of glycogen requires water, and thus a loss of 2%-4% of body fluids affects athletic performance" (Wilmore and al, 2008 ,p306).

However, studies that have demonstrated the impact of decreased Body Water Mass (TBW%) below normal rates and the effect of optimal hydration levels on performance have mostly been conducted in endurance sports, which, as we know, are characterized by an aerobic nature (such as long-distance running: 1500m, 5000m, 10000m, and marathons). Studies that have examined the effect of fluid loss in anaerobic efforts have shown weak effects(Wilmore et al, 2008, p323).

In contrast to the current study, which found a positive linear relationship between the variables.

This is according to the vertical jump test used, whether it is a test that emphasizes explosive power, such as SJ, or one that .requires muscle elasticity, such as CMJ

Therefore, the second hypothesis is confirmed.

5-Summary of results: Our study has reached the following results

1-There is an inverse relationship between the Body Fat Mass (BF%) indicator and the vertical jump property, meaning that an increase in body fat percentage negatively affects the performance level of the vertical jump, while a decrease leads to an increase in performance among the studied athletes.

2-There is a positive linear relationship between the Body Water Mass (TBW%) indicator and the vertical jump property (VJ) among the studied players, with a rate of %42.

6-Practical Applications:

-The necessity of coaches paying attention to the analysis of athlete's body composition (TBW%, BF%) and using them as indicators to evaluate the athletes' condition and enhance their performance**.**

-Raising athletes' awareness of the importance of fluid intake to compensate for the amounts lost due to physical exertion or climatic conditions, and informing them about the negative impact of fluid loss on sports results.

-Utilizing technological means in evaluating body composition for the real-time field information they provide to coaches, which can be employed to improve recovery processes and enhance physical fitness.

-Ensuring nutritional balance and consumption of healthy meals by athletes to maintain their body composition within the required standards for athletes, according to sports specialization.

-Researching dietary programs and regimes that contribute to maintaining athletes' body composition within the desired levels.

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