International Journal of Human Movement and Sports Sciences 11(6): 1305-1312, 2023 http://www.hrpub.org
DOI: 10.13189/saj.2023.110614

Exploring the Impact of Dietary Factors on Body Composition in Elite Saudi Soccer Players: A Focus on Added Sugars, Salt, and Oil Consumption

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Received June 6, 2023; Revised August 25, 2023; Accepted September 14, 2023

Cite This Paper in the Following Citation Styles

(a): *[1] Adam Amawi, Ghareeb Alshuwaier, Abdulrahman Alaqil, Walaa Jumah Alkasasbeh, Abdulmalek Bursais, Anwar Al-Nuaim, Jawaher Alhaji, Mohamed Alibrahim,Faisal Alosaimi, Lana Nemer, Yuba Gautam, Naif Al-Barha, Jumana Shehadeh , "Exploring the Impact of Dietary Factors on Body Composition in Elite Saudi Soccer Players: A Focus on Added Sugars, Salt, and Oil Consumption," International Journal of Human Movement and Sports Sciences, Vol. 11, No. 6, pp. 1305 - 1312, 2023. DOI: 10.13189/saj.2023.110614.*

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Abstract Soccer elite players' nutrition is crucial to optimizing their performance and improving body composition. Currently, less is known about the correlation between added sugars, salt, and oil intake and body composition. The aim of this current study was to evaluate the impact of increased consumption of sugars, salt, and oil on the body mass index (BMI) and fat percentage of elite soccer players hailing from Saudi Arabia. A cross-sectional, self-administered Saudi Food Frequency Questionnaire (FFQ) was collected from 81 young Saudi elite soccer athletes aged between 18 and 25 years, with a mean age of 19 years, to assess participants' food intake. Body fat percentage was determined through the measurement of skinfold thickness, while the BMI was computed for all participants, resulting in an average value of 22 kg/m ? Our results showed that the total score indexes of sugar, salt, and oil intake were [0-4], [0-10], and [0-63], respectively. An evident and statistically significant correlation (P = 0.003) was noted between the sugar index and the BMI of the athletes, exhibiting an R-squared coefficient of 0.106. Moreover, a positive and significant relationship (P = 0.033) was found between salt intake and fat mass, with an R-squared value of 0.056. Our results suggest that elite soccer athletes should avoid overconsumption of added sugar, salt, and oil in order to improve body composition and enhance performance.

Keywords Soccer, Elite, Body Composition, Fat Percentage, Sugars, Salt, Oil

1. Introduction

Soccer (or football in the UK) is a world-famous sport classified as involving intermittent and intense physical activity. It requires highly intensive training and a high energy demand [1]. Proper nutrition holds a pivotal role as a critical determinant in athletes' performance [2]. Nutrition has a vital impact on sports training [3]. Due to the high-intensity physical effort involved in soccer and the aim to enhance game quality, improving the dietary intake of soccer players is necessary for optimal performance [1], [4]. The crucial roles of dietary habits and nutrient intake are vital for maximizing athletic performance [5]. Moreover, understanding that nutrition significantly supports intensive training leads to another important point. The diets of elite soccer players differ from those of non-elite soccer players, and applying healthy eating strategies enhances the former's prospects of success in their sport [6].

In the context of a soccer match, the energy demanded for the high-intensity physical exertion is generated through both the anaerobic systems (involving phosphocreatine and glycogen) and the aerobic systems involving the oxidation of fats and carbohydrates [1]. Therefore, nutrition demands considerable attention to ensure desired performance and body development in these athletes and to protect their health in the short and long term [7]. At present, the body mass index (BMI) stands as the prevailing approach for diagnosing and categorizing obesity, primarily due to its convenience and simplicity in comparison to alternative techniques. BMI is derived from the measurements of an individual's height and weight. As per findings from the National Health Examination Survey, BMI is computed by dividing an individual's weight in kilograms by the square of their height in meters [3]. An elevated BMI typically suggests an increased accumulation of body fat mass [8], [9]. Consequently, cardiorespiratory function and performance are inversely affected by higher percentages of fat mass [10]. Given that excess fat mass does not contribute to energy production, the energy cost of exercising increases [10]. Moreover, managing body weight and adjusting body composition are highly associated with athletic performance [11][12]. As injury risk is a key concern in athletic performance and health, the higher the player's weight, the greater the risk of developing muscle, bone, and tendon injuries [10]. Importantly, being a member of a sports team also affects bone mass health [12]. Nonetheless, the exploration of the correlation between sugar intake and obesity was carried out through the analysis of information from the combination of the Sugar and Sweetener Outlook from the United States Department of Agriculture (USDA) and obesity prevalence data obtained from the Center for Disease Control and Prevention (CDCP) [13]. The results indicated that decreased sugar intake is linked to a deceleration in the yearly rise of obesity rates [14]. Moreover, diets high in added sugar promote obesity development [8]. Salt contains about 40% sodium and 60% chloride; significant sodium and water losses can occur during exercise, leading to excessive dietary intake and negatively affecting fluid balance [15]. Sugars added to food during processing and preparation are defined as added sugar, typically found in sports drinks [16]. Fat is important for health, depending on the amount and type chosen. Unfortunately, the most commonly overconsumed fats are unhealthy types, namely saturated and trans fatty acids [17]. The central aim of this present study was to evaluate the effects of consuming supplementary sugars, salt, and oil on the body mass index (BMI) and fat percentage among elite soccer players originating from Saudi Arabia.

2. Materials and Methods

2.1. Study Design

Employing a cross-sectional research approach, the researchers examined the impact of increased sugar, salt, and oil intake on the BMI and fat percentage of elite soccer players based in Riyadh, Saudi Arabia. The research followed the ethical guidelines set forth in the Declaration of Helsinki and received ethical clearance from the Ethics Committee at King Saud University (Approval code: E-21-5659). Written consent was acquired from all participants, and the authors took diligent measures to address ethical concerns, such as plagiarism, data falsification, and duplicate publication.

2.2. Participants

The study's sample comprised a cohort of youthful Saudi soccer players (N = 81; aged 18–25 years). Recruitment occurred during the Saudi Arabia league 2020–2021, with participants drawn from three football clubs located in Riyadh, Saudi Arabia. These clubs hold official registration as professional clubs in the Saudi Football Federation. The selection criteria included factors such as being injury-free, maintaining good health, and not experiencing any digestive disorders. Participants engaged in regular daily training sessions and took part in matches once or twice per week. The training regimen encompassed various components, including warm-up exercises, technical drills, tactical exercises (small-sided games), and cool-down routines.

2.3. Anthropometric Measurements

Prior to the commencement of the study, participants' body weights were assessed using a precise digital scale (Seca 813, Germany) with an accuracy level of 0.1 kg. For all participants, the Siri equation (495/body density – 450; Siri, 1961) was employed to convert body density into a percentage value of body fat [16]. Body fat percentage was assessed through skinfold thickness measurements taken at seven specific sites: subscapular, triceps, chest, midaxillary, suprailiac, abdomen, and thigh. A proficient expert in the Saudi Arabia league performed the measurements using a Holtain skinfold caliper (Holtain Ltd., Crymych, UK). The total of these skinfold measurements was then used to calculate the comprehensive body fat percentage. Subsequently, this value was used to derive body density using the provided equations [18], [19]: = 1.112 - (0.00043499 × sum of skinfolds) + (0.00000055 × square of the sum of skinfold sites) - (0.00028826 × age).

2.4. Food Frequency Questionnaire

The Food Frequency Questionnaire (FFQ) [20] was employed to evaluate participants' food intake. The questionnaire comprises 24 categories, including dairy products, fruits, vegetables, meat, fish, eggs, mixed dishes, sandwiches, snacks, bread, cereal, starches, beverages, juices, drinks, sweets, seeds, nuts, fast food, non-fast food, artificial sweeteners, vitamins, minerals, and fats, oils, and sugars. To achieve the aforementioned research objectives, only the results from the FFQ items related to sugars, salt, and oil were included in the analysis.

In their exploration of the impacts of increased sugar, salt, and oil intake on the BMI and fat percentage among elite soccer players from Saudi Arabia, the investigators employed a Food Frequency Questionnaire (FFQ) to evaluate the eating habits of the participants. Here’s an explanation of the rationale behind choosing the FFQ and its role in the study:

1) Comprehensive Dietary Assessment: The FFQ is a widely used tool in nutritional research, especially when researchers are interested in assessing the long-term dietary habits of participants. It is designed to capture the frequency and quantity of consumption of various foods and food groups over a specified period. In this study, the authors aimed to understand the potential effects of added sugars, salt, and oil consumption on BMI and fat percentage. The FFQ allows them to assess the habitual intake of these specific nutrients, providing insights into the players' overall dietary patterns.
2) Exploration of Specific Nutrients: The authors focused on added sugars, salt, and oil in their study. These nutrients are of particular interest due to their potential influence on health outcomes. The FFQ was tailored to include questions related to these specific nutrients, enabling the researchers to quantify the participants' intake accurately.
3) Longitudinal vs. Cross-Sectional Study Design: The research employed a cross-sectional methodology, where data was gathered at a singular time instance. Cross-sectional studies are well-suited for exploring associations between variables at a specific moment. The FFQ, in this context, allows the researchers to understand the dietary patterns of the participants at that particular time and examine potential relationships between nutrient consumption and health indicators within the constraints of the study design.

In summary, the Food Frequency Questionnaire was chosen as the dietary assessment tool in this study to offer a comprehensive comprehension of the participants' habitual consumption of added sugars, salt, and oil. The extensive list of food items covered in the FFQ enabled the researchers to investigate the potential associations between nutrient intake and health outcomes (BMI and fat percentage) within the context of a cross-sectional research design. The collected FFQ data were crucial for conducting the subsequent statistical analyses to explore these associations.

2.5. Statistical Analysis

The investigated variables were described using (i) central tendency measures such as frequency, percentages, means, and medians, and (ii) dispersion measures including standard deviation and ranges. A total score for each food group (sugars, salt, and oil) was calculated to determine the food index for each group. A Pearson’s correlation test was conducted to examine any correlations between the selected health indicators (years’ experience playing soccer, weight, BMI, and fat percentage) and each food group index (sugars, salt, and oil). Additionally, multiple linear regression was employed to assess how well the variables predicted BMI and fat percentage based on the three food group indexes (sugars, salt, and oil). T-tests, ANOVA, Additionally, regression tests were employed in this investigation, with a significance level established at $P < 0.05$.

3. Results

Data were collected from 81 elite Saudi soccer players aged 17–21 years old (mean age: 19 ± 1 years) who had 1–14 years of experience in playing soccer (mean experience: 6 ± 3 years). The athletes' BMI scores ranged from 17 to 31 kg/m^2 (mean: 22 ± 2 kg/m^2), and their fat percentage ranged from 4 to 17, with a mean of 9 (SD = 3) (Table 1).

Table 1. Characteristics of soccer players (n = 81)

Variables	Mean ± SD	Min	Max
Age (y)	19 ± 1	17	21
Experience (y)	6 ± 3	1	14
Weight (kg)	66 ± 8	52	85
BMI (kg/m^2)	22 ± 2	17	31
Fat percent %	9 ± 3	4	17

3.1. Salt Consumption among Athletes

The analysis revealed that only 6.7% (n = 5) of the participants reported not adding salt while cooking (see Table 3). In contrast, 41.3% (n = 31) always added salt while cooking. Moreover, 39.7% (n = 29) reported not adding salt while eating, whereas only 5.5% (n = 4) always added salt while eating. Furthermore, only 19.7% (n = 14) confirmed using "low salt" salt.

3.2. Sugar Use among Athletes

In this study, 88.2% (n = 67) of athletes (football players) reported adding sugar to their beverages (refer to Table 2). Among those who added sugar, 94.2% (n = 65) used white sugar. Table 2 provides information about sugar, salt, fat, and oil consumption among the participants.

3.3. Fat and Oil Consumption among Athletes

Regarding fat or oil consumption, 16 participants (21.6%) reported consuming fat or oil on bread, while 51 participants (78.4%) stated that they use fat or oil in cooking. The results, as shown in Table 3, display the frequency of using different types of oil or fat among the participants. The least consumed was ghee at 48.4% (n = 39), followed by olive oil at 49.4% (n = 40). The most highly consumed were butter and vegetable oil at 56.8% (n = 46).

3.4. Item Indexes

Cumulative scores were computed for each group of food items, where a greater average denoted a more healthful food index. The comprehensive score for the sugar index spanned Ranging between 0 and 4, the mean score was 1.96 (with a standard deviation of 0.60). The examination based on quartiles unveiled that 75% of the participants displayed an elevated sugar index. Moreover, the comprehensive score for the salt index spanned On a scale of 0 to 10, the mean score was 6.26, accompanied by a standard deviation of 2.62. The quartile analysis indicated that 75% of the sample exhibited a moderate to high salt index. Furthermore, the total score for the oil index Spanning a range of 0 to 50, the mean value was 22.12 (standard deviation = 19.31). The quartile analysis demonstrated that 50% of the participants showcased a moderate to high oil index, as detailed in Table 4.

Table 2. Sugar, Salt, Fat, or oil consumption among the participants

Variables		n (%)
Adding sugar	Yes	67 (88.2)
	No	9 (11.8)
Type of sugar	Brown	3 (4.3)
	White	65 (94.2)
	other	1 (1.4)
Adding salt while cooking	Sometimes	20 (26.7)
	Rarely	13 (17.3)
	No	5 (6.7)
	Always	31 (41.3)
	Usually	6 (8)
Adding salt while eating	Sometimes	17 (23.3)
	Rarely	23 (31.5)
	No	29 (39.7)
	Always	4 (5.5)
	Usually	0 (0)
Using “low salt” salt	Yes	14 (19.7)
	No	57 (80.3)
Using fat / oil on bread	yes	16 (21.6)
	no	58 (78.4)
Using fat / oil in cooking	yes	51 (78.4)
	no	23(21.5)

Table 3. Frequency of consuming different types of fat/oil

Items	<1/month	1-3/month	1/wk	2-4/wk	5-6/wk	1/day	2-3/day	4-5/day	>6/day
Butter	9 (19.6)	9 (19.6)	9 (19.6)	5 (10.9)	2 (4.3)	7 (15.2)	4 (8.7)	0 (0)	1 (2.2)
Margarine	27 (65.9)	4 (9.8)	5 (12.2)	1 (2.4)	0 (0)	2 (4.9)	1 (2.4)	1 (2.4)	0 (0)
Lard	29 (69)	6 (14.3)	2 (4.8)	0 (0)	1 (2.4)	3 (7.1)	1 (2.4)	0 (0)	0 (0)
Vegetable oil	18 (39.1)	7 (15.2)	6 (13)	3 (6.5)	2 (4.3)	9 (19.6)	0 (0)	0 (0)	1 (2.2)
Olive oil	13 (26)	7 (14)	9 (18)	6 (12)	1 (2)	9 (18)	2 (4)	3 (6)	0 (0)
Ghee	21 (53.8)	7 (17.9)	4 (10.3)	1 (2.6)	0 (0)	4 (10.3)	1 (2.6)	1 (2.6)	0 (0)
Mayonnaise	26 (59.1)	7 (15.9)	4 (9.1)	2 (4.5)	0 (0)	4 (9.1)	0 (0)	0(0)	1 (2.3)

Data are expressed as No. (%).

Table 4. Item Groups indexes/relationship between selected demographic and item groups indexes

Food groups	M ±SD	Expected range	MIN	MAX	Variables	Experience	Weight	BMI	FAT
Sugar	1.96 ±0.60	0 - 4	0	4.00	r	0.138	0.163	0.326**	0.124
					p	0.221	0.146	0.003	0.270
Salt	6.26 ±2.62	0 - 10	0	10.00	r	-0.149	0.170	0.300**	0.237*
					p	0.184	0.129	0.006	0.033
Oil	22.12 ±19.31	0 - 63	0	50.00	r	-.0046	0.168	0.206	0.081
					p	.682	0.134	0.065	0.470

**Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed)

3.5. Relationship between Selected Demographic Variables and Item Group Indexes

To examine the relationship between the item group indexes and the selected demographic variables (years' experience playing soccer, weight, BMI, and fat percentage), the Pearson correlation test was performed, with the alpha significance level set at < 0.05. The analysis revealed a noteworthy positive correlation between the sugar index and BMI (correlation coefficient, r = 0.326, p = 0.003). Likewise, a significant positive association was identified between the salt index and BMI (correlation coefficient, r = 0.300, p = 0.006). Furthermore, a meaningful positive correlation was noted between the salt index and fat percentage (correlation coefficient, r = 0.237, p = 0.033) (see Table 4).

3.6. Prediction of BMI Based on Sugar, Salt, and Oil Indexes

To determine the best predictors of BMI, A forward stepwise (two-step) linear regression analysis was executed, using a significance level of < 0.05. The three variables that could predict BMI among the sample population were the sugar index, salt index, and oil index (see Table 4). The results revealed that the best prediction model consisted of the sugar index alone. The analysis (see Table 4) indicated that the final one-factor model (regression equation) was statistically significant F(1, 79) = 9.397, p = 0.003), with an R-squared (R2) value of 0.106. Athletes' BMI was significantly predicted by their sugar index (beta = 0.326, p = 0.003). The overall fitness of the model was represented by an R-squared value of 0.106, indicating that this particular model could explain 10.6% of the variation in participants' BMI.The predicted BMI of the participants was calculated as 19.629 + 1.160 (sugar index) of the total scores.

3.7. Prediction of Fat Percentage Based on Sugar, Salt, and Oil Indexes

To determine the best predictors of participants' fat percentage, a forward stepwise (two-step) linear regression was performed with an alpha significance level of <0.05. The three variables that could predict fat percentage among the participants were the sugar index, salt index, and oil index (see Table 4). The results revealed that the best prediction model consisted of the salt index alone. Further analysis (see Table 4) indicated that the final one-factor model (regression equation) was statistically significant F(1, 79) = 4.683, p = 0.033), with an R-squared (R2) value of 0.056. Participants' fat percentage was significantly predicted by their salt index (beta = 0.351, p = 0.033). The overall model fit was R2 = 0.056, indicating that this model accounted for 5.6% of the variance in athletes' fat percentage. The predicted fat percentage was calculated as 8.522 + 0.424 (salt index) of the total scores.

4. Discussion

The objective of this study was to assess the consumption of added sugar, oil, and salt among elite Saudi soccer players and to examine their association with BMI and fat composition. Our results indicate that the total score indexes for sugar, salt, and oil ranged from 0 to 4, 0 to 10, and 0 to 63, respectively. In a similar Turkish study by Urhan and Yıldız, which included 93 adolescent soccer players, sodium was found to be one of the most consumed micronutrients [21]. Moreover, the energy ratios from the daily diet and saturated fat consumption among individuals in all groups exceeded the reference values. Additionally, a notable high consumption of salt was observed [22]. It is important to keep in mind that the recommended daily sodium intake is less than 1.2 g [22]. According to the research conducted by Godek and colleagues, the average American ingests around 3.4 grams of sodium daily, which is equivalent to 8.6 grams of sodium chloride (commonly known as table salt) or roughly 1.7 teaspoons (approximately 8.5 grams) of salt [23]. Additionally, it is anticipated that large soccer players consume more salt than the typical American, as the former consume salt in response to the latter's significant sodium losses. On the other hand, a study of the nutrient intake of Division I athletes from the National Collegiate Athletic Association found that male athletes consumed an average of 2.94 ±1.3 g of sodium each day [24]. In the survey, there were 185 male athletes, and 29% of them played football. In a study of 19 male soccer players competing in the Mato Grosso

Governor Cup, an annual tournament that serves as a qualifying platform for participants in the Brazil Cup, Raizel et al. found that excessive sodium intake was defined an average sodium intake of 3141.77 ± 939.76 mg/day, surpassing the Tolerable Upper Intake Level (UL) of 2300 mg/day [1]. The results of this study revealed that 74% of the athletes had a sodium intake above this level. It is important to emphasize that a higher salt consumption within an athletic population might not necessarily be a cause for concern even if it surpasses the recommended limit. The recommended level is intended for the general population; athletes often require higher salt intake due to significant sweat loss [22]. However, a significant positive relationship between the sugar index and athletes' BMI was observed (R2 = 0.106). The probability of an increase in sugar intake being associated with a rise in body BMI was statistically significant (P = 0.003). This is concerning because excessive consumption of added sugar is associated with numerous detrimental health effects, including an elevated risk of obesity, elevated blood pressure, diabetes mellitus, cardiovascular disorders, non-alcoholic fatty liver ailment, and malignancy [25]. Moreover, the findings indicated a statistically significant positive correlation between salt intake and fat mass (R-squared = 0.056), demonstrating a moderately strong relationship. The probability of increased salt intake being linked to a rise in fat percentage was found to be significant (P = 0.033), highlighting the adverse health consequences of excessive salt consumption. This can subsequently lead to elevated blood pressure, further contributing to cardiovascular morbidity and mortality [26]. Recently, athletes have been increasingly inclined to adhere to strict diets to enhance their performance, which renders them highly susceptible to developing eating disorders (EDs) [27]. An eating disorder, characterized by an unhealthy relationship between eating habits and weight [28], is notably prevalent. A recent study conducted by Ghazzawi et al. found that 34% of Jordanian athletes are classified as being 'at risk' of developing an eating disorder [29]. Considering the escalating rise in the prevalence of eating disorders [30] and the presence of inadequate eating habits among athletes [29], it has become imperative to focus on athletes' dietary patterns. Conversely, despite the detrimental impact of irregular weight cycles on athletic performance, Ghazzawi et al. [12] surprisingly postulated a positive association between exercise and bone health in their study. Our study makes a valuable contribution to the field of sports nutrition and athlete performance. By investigating the correlation between dietary components such as added salt, sugar, and oil/fat, and their impact on BMI and body fat composition in Saudi soccer players, we offer crucial insights for optimizing their diets to enhance performance and overall health. Our research identifies potential relationships between these dietary components and key physical metrics like BMI and body fat composition. This allows us to develop tailored dietary regimens that cater to the specific needs of elite-level soccer players, potentially leading to improved on-field performance and better overall well-being for the athletes. The emphasis on implementing stringent dietary regimens for elite-level players is paramount, given nutrition's critical role in performance, recovery, and injury prevention. Coaches, sports nutritionists, and players themselves can benefit from evidence-based dietary recommendations, empowering them to make more informed choices about their consumption.

5. Conclusions

The research findings underscore the significance of adopting a well-balanced nutritional approach among elite Saudi soccer players, with a particular focus on the consumption of added sugars, salt, and oils. This approach is crucial for maintaining both optimal performance levels and overall health. Acknowledging the necessity of additional salt and sugar intake to replenish what is expended during rigorous training sessions and matches, it is imperative to approach these elements with prudence. The potential repercussions on BMI and body fat composition stemming from excessive consumption of salt and sugar necessitate caution in their dietary incorporation. The correlations established within this study accentuate the demand for meticulously crafted nutritional strategies, rooted in empirical evidence and customized to cater to the distinct requirements of athletes. As such, it is advisable that elite soccer players exercise mindfulness regarding their intake of salt, sugar, and oil. This approach serves the dual purpose of effectively managing their body composition while concurrently elevating their athletic capabilities. A variety of dietary alternatives and strategies are recommended, empowering athletes to make informed nutritional decisions. The incorporation of whole foods replete with essential nutrients, optimization of hydration practices, and collaboration with registered dietitians or nutrition specialists specializing in sports nutrition. Integration of these recommendations into the athletes' daily dietary regimens holds the promise of not only enhancing their on-field performance but also safeguarding their enduring well-being. By thoughtfully embracing these guidelines, soccer players have the opportunity to elevate their game while ensuring the preservation of their long-term health.

6. Limitations of the Study

Our study is susceptible to specific constraints that might restrict the broad applicability of the findings. These limitations encompass a limited sample size and the concentration of the study in a solitary locale. As a result, it is advisable that forthcoming research endeavors involve more extensive and varied sample sizes to augment the strength of conclusions within similar contexts.

Acknowledgments

The researchers extend their thanks to the Deanship of Scientific Research and the College of Sports Sciences and Physical Activity at King Saud University for their valuable support in conducting this study. Heartfelt appreciation is conveyed to all the participants who willingly participated, generously devoting their time and collaboration to enrich the research. The researchers also express gratitude to the sports clubs and entities that facilitated data collection and provided essential assistance, enabling the successful execution of this study. Our heartfelt thanks go to the faculty members and researchers who provided guidance, insights, and critical feedback throughout the research process.

Conflicts of Interest

The authors affirm that they do not possess any conflicting interests.

Funding

None.

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