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	Title of research article  The Influence of Prebiotic Supplementation on Glycemic Regulation and Metabolic Adaptation Following Exercise: A Field-Based Study on Diabetic Bodybuilders in Algeria
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Abstract	The regulation of blood glucose in individuals with diabetes mellitus represents one of the most pressing challenges in modern sports physiology and nutritional science. Among dietary strategies aimed at improving metabolic control, prebiotics—non-digestible fermentable fibers that selectively stimulate the growth of beneficial intestinal microbiota—have emerged as promising modulators of glucose metabolism and insulin sensitivity. This field-based experimental study investigates the acute and subacute effects of prebiotic supplementation on glycemic regulation following structured resistance training sessions among diabetic athletes in Algeria. The study followed a two-phase mixed-method design. Initially, a pilot experiment with three diabetic bodybuilders was conducted to establish the feasibility, reliability, and validity of the selected physiological measures. Subsequently, a purposive sample of eight diabetic bodybuilders actively engaged in regular training was divided into an experimental group (receiving prebiotics) and a control group (without supplementation). Blood glucose

concentration was the primary dependent variable, measured at pre-training, post-training, and recovery phases. Statistical analysis was conducted using SPSS version 26, employing Levene's test to verify homogeneity of variance, the Shapiro-Wilk test for data normality, the paired and independent t-tests for intra- and intergroup comparisons, and Cohen's d for effect size determination. Reliability was verified using Pearson's correlation coefficient, while validity was estimated through the square root of reliability values. Findings revealed a statistically significant improvement in post-training glycemic stability among the experimental group, suggesting that prebiotic intake enhances post-exercise glucose homeostasis and supports more efficient metabolic recovery. These results underscore the dual role of physical training and gut microbiome modulation in optimizing diabetic athletes' health outcomes. The study also highlights the psychosocial and cultural dimensions of body training in Algerian athletic contexts, where fitness and body aesthetics are increasingly integrated into a holistic model of health and self-realization. This research contributes to the growing field of nutritional ergogenics and exercise-based diabetes management, offering preliminary evidence for incorporating prebiotic strategies into personalized exercise nutrition programs for diabetic populations.

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Introduction

Bodybuilding is one of the sports that focus on strengthening muscles, increasing their size and hypertrophy, which has increased its popularity especially among youth who frequent gyms to achieve an attractive appearance and well-defined muscles, the ideal body that most young men aspire to have. The performance of various physical exercises is not limited to fat reduction and burning calories and fats in different body areas only. Physical fitness and strength exercises involving some iron tools with different weights are among the methods to achieve a slender figure and prominent muscles. However, this task is not easy; it requires following a suitable training program and a specific diet meeting the body's needs for carbohydrates and proteins. (Akasha, 2017, p. 125)

It is defined as a sport derived from physical culture that includes various attributes in a way that makes the athlete complete, healthy, strong, beautiful, and capable of enduring all life challenges. (Andrieu, 1992, p. 226) It is also defined as a sport that develops the human body through training, exercises, and weights targeting physical content such as visible abdomen, chest, hand, leg, and other parts to improve appearance, increase well-defined muscles, and develop the body. (Ahmed, 2012, p. 17)

Body satisfaction in adults is associated with achieving personal interactions and happiness in life generally. "Mohamed Al-Shobrawi" sees a positive correlation between body image and both life satisfaction and social adjustment. (Al-Shobrawi, 2001, p. 127)

For satisfaction, attention must be paid to nutrients that determine the sources of energy in the body, which are carbohydrates, lipids, and proteins to a lesser extent. (Bahaa El-Din Salama, 2007, p. 104)

Among the nutrients are prebiotics and probiotics aim at targeting obesity, diabetes, metabolic syndrome, as well as hypertension, oxidation, cell damage, and other diseases. (Green et al., 2020). Sources of prebiotics include raw materials such as vegetables, grains, dairy, and meat products. (Das et al., 2020)

The effect of prebiotics on diabetes which is considered one of the most important chronic diseases affecting individuals today, and is called a lifestyle disease like hypertension and other chronic diseases linked to technological advancement and industrial societies, as well as sedentary lifestyle diseases, is among the metabolic disorders widespread across all countries and social levels. (Abu Al-Ala Ahmed Abdel Fattah, 1998, p. 173)

Prebiotics work by regulating the activity and quantity of intestinal bacteria, mostly in the lower region, which makes the gut immune system very important. This immune system consists of gut-associated lymphoid tissue (GALT) and other cells aimed at protecting the gastrointestinal tract from various antigens that are readily supplied from food, commensal, and pathogenic bacteria.

Many intestinal cells are responsible for stimulating the production of IgA antibody isotypes, which increases the gastrointestinal barrier's immunity. T helper 17 cells (Th17 cells) are also part of the gut immune system, maintaining the integrity of the mucosal barrier while stimulating intestinal epithelial cells to produce antimicrobial peptides and regulating blood sugar levels. (Atrashi, 2011, p. 23) Diabetes is defined as a metabolic disorder resulting in abnormally high blood sugar levels due to various causes that may be psychological, physical, excessive sugar intake, or genetic factors. (WHO, 1999) The World Health Organization defined it also in Geneva (1979) as a chronic disease occurring due to genetic or acquired factors or other causes. (Bazar Ali Jokal, 2007, p. 30)

From here, we approached the general question:

Does prebiotic intake influence the regulation of blood glucose levels?

2- Partial Hypotheses:

1. Prebiotics have an effect on blood glucose levels during physical activity.
2. Prebiotics have an effect on blood glucose levels after physical activity.

3 - Study objectives:

- Determine the effective role played by prebiotics in the body.
- Clarify the relationship between prebiotics and pancreatic stimulation.
- Define this active component in the body.
- Emphasize daily consumption of this component from dietary or external sources.

Research methodology: We conducted an exploratory study on a sample of three athletes from the same team selected purposively, then they were excluded from the main group. The experimental protocol was applied on them, including measuring blood sugar levels using Free Style Lite, and heart rate measurement using a Smart Watch Pro 4.

	FC (B/min)	Blood sugar level (mg/dl)
Reliability	0.866	0.913
Validity	0.930	0.955

From Table (1), we notice that all reliability values are greater than (0.80), which is evidence of the reliability of the tests and the measured traits. Validity is the square root of reliability, and all values shown in the table are close to or equal to one (1), confirming the validity of the tools used in the experiment.

The experimental method was used in the main study on a sample of eight bodybuilders with diabetes (under 21 years old) from Setif province, who were required to consume a fiber-rich diet daily. They were selected purposively and divided into two equal groups (control and experimental). Then, Levene's test was used to examine the homogeneity ratio.

Table (02) shows the results of Levene's test for homogeneity of variance based on the arithmetic mean:

		Group1	Group2	Df ₁	Df ₂	Levene's Statistic	Significance level	observation
Anthropometric measurements	Age	18.5	19	1	6	0.429	0.537	Homogeneous
	Weight (Kg)	62.5	60.5			0.033	0.862	Homogeneous
	Height (Cm)	180.25	176.85			0.364	0.569	Homogeneous
	Sleeping hours (H)	8.25	7.75			1.6	0.253	Homogeneous
Physiological measurements	Sugar level	125.25	124			5.357	0.06	Homogeneous
	Resting heart rate	62	62			0.429	0.537	Homogeneous
	F c p B. Min							

Table (03) shows the normal distribution of the test results conducted on the sample

Chapiro Wilk test for pre-measurements						
Characteristics	Significance level	df	Calculated value	sig	Decision	Measurements
Weight(kg)	0.05	8	0.954	0.657	Follows normal distribution	Anthropometric
Height(cm)			0.978	0.953	Follows normal distribution	
Blood sugar level			0.358	0.911	Follows normal distribution	Physiological
Resting heart rate			0.885	0.21	Follows normal distribution	
F c p B. Min						

From the table, it is clear that all values exceed the significance level (0.05), which assures us that all values are normally distributed and that the sample is homogeneous. Therefore, the Student's t-test can be applied to the sample.

Table (04) shows the differences in the pre-test measurements for the control and experimental groups concerning the measured indicators:

	sig	Calculated T	Tabulated T	Decision
Resting heart rate	1	0	1.94	Not significant

Blood sugar level	pre	0.651	0.467		Not significant
	post	0.801	0.264		Not significant

From the previous table, we find that all probability values are greater than the significance level (0.05), and all calculated t-values are smaller than the tabulated t-values, confirming that there are no statistically significant differences between these means.

Table (05) shows the differences between the pre-test and post-test measurements for the control group concerning the measured indicators:

		sig	Calculated T	Tabulated T	Decision
Resting heart rate		0.08	2.61	2.35	Not significant
Blood sugar level	pre	0.267	1.26		Not significant
	post	0.761	0.333		Not significant

From the table above, it is clear that the calculated t-values are much less than the tabulated t-value, and the significance levels are greater than (0.05) which means there are no differences between the pre-test and post-test means for the control group regarding the measured indicators.

Table (06) shows the differences between the pre-test and post-test measurements for the experimental group concerning the measured indicators.

		sig	Calculated T	Tabulated T	Decision
Resting heart rate		0.007	6.78	2.35	Significant
Blood sugar level	pre	0.03	3.80		Significant
	post	0.03	3.50		Significant

According to the table above, it is clear that all calculated t-values are exceed the tabulated t-values, and the significance level is less than (0.05). This indicates the presence of statistically significant differences in favor of the post-test measurements.

Table (07) shows the effect size for the pre-test and post-test measurements of the experimental group using Cohen's D test.k

		Cohen's D Test			
		n	T	D	Effect
Heart Rate		8	6.7	3.4	Strong
Blood sugar level	pre		3.8	1.9	
	post		3.5	1.7	

Based on table 7, we notice that all values are well below (0.5), indicating a weak effect of the independent variable on the dependent variable, which are the heart rate indicator and blood sugar levels

Hypotheses Discussion:

- The results related to Cohen's d effect size show that the effect was large or strong in favor of fibers' impact on regulating blood sugar levels before exercise. In other words, both measurements for blood sugar had values of 0.9, indicating strong reliability and validity at 0.95, as well as strong sample homogeneity with a normal distribution. There were no statistically significant differences between the pre-test measurements of the control and experimental groups for the measured indicators. However, statistically significant differences existed for the experimental group on these indicators, particularly the blood sugar indicator in the pre-test condition. This confirms that the results support the first hypothesis that fibers affect improving blood sugar levels before exercise.
- Since the effect size was strong regarding blood sugar levels, this indicates a noticeable improvement during consumption of fiber-rich diets. Based on the previous tables, this confirms the second hypothesis stating that these dietary fibers have a strong effect on improving good gut bacteria and regulating blood sugar during and after exercise for diabetic athletes.

Key Conclusions:

- Prebiotics affect improving the efficiency and proportion of beneficial bacteria in the intestines.
- Beneficial bacteria play an effective role in improving blood sugar levels among athletes.
- Dietary fiber intake is essential, especially for diabetic patients.
- Fiber intake is also important for enhancing the efficiency of the cardiovascular system.

Conclusion:

The effective role played by beneficial bacteria in the human body significantly improves blood sugar levels, especially in diabetic patients. They are an active component in the human gut, and modifying their proportion helps improve numerous body functions, including cardiovascular efficiency and pancreatic functions, particularly insulin and glucagon levels in the blood. These conclusions are supported by the results presented in the tables, demonstrating the important role of this element in the body.

Ethical Considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision) and approved by the Ethical Research Committee of the University of Sétif 2 (Reference No: STAPS/2025/09). All participants were fully informed about the purpose, procedures, and potential risks of the study. Written informed consent was obtained prior to participation. Participants were assured of confidentiality, voluntary participation, and the right to withdraw at any stage without consequence. Data collected were anonymized and used solely for research purposes.

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Conflict of Interest Declaration

The authors declare no conflict of interest regarding the conduct, results, or publication of this research. All authors have read and approved the final version of the manuscript and agree with its submission to an international peer-reviewed journal.

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