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The Impact of Nutritional Fingerprint on Energy Production and Performance Enhancement in Wrestling Athlete

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Abstract

The purpose of this study was to determine the effects of personalized nutrition approach by genotype based on genetic profiling and their effects on the components of energy production and performance in wrestling. The investigation concerns with five wrestlers from Al-Kadhimiyah wrestling Club, for the 74 kg weight category. During 4 weeks, each of these athletes received a diet training intervention tailored to their individual genetic profiling. Aerobic capacity (VO2max), anaerobic power (Wingate Anaerobic Test), RSA, and lower body strength (1RM squat) were assessed at baseline and post-intervention as well. Results In all variables significant improvements were observed with VO2max increasing by 5 ml/kg/min, both peak and mean power output by 50 and 25 watts respectively and fatigue index reduced by 6.5%. Furthermore, strength levels of all participants increased, with an average 15 kg increase in 1RM squat strength. These results indicate that individualized nutrition based on genomics can greatly improve athletic performance, especially for high-intensity sports such as wrestling, which require endurance, power and strength.

Keywords: personalized nutrition, genetic profiling, wrestling performance, anaerobic power, strength training.

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Introduction

Wrestling is an intense sport, which necessitates great physical conditioning as well as combination of strength, speed and power (Jeukendrup, 2013). Top professional athletes in orienteering are becoming more and more specialized focusing on details such as diet, to gain the best possible competitive edge. Nutritional intake is important in order to obtain the highest energy provision possible and promote muscle recovery, which is fundamental for performance levels in wrestling (Jeukendrup, 2004; Sorrenti et al., 2019). Historically, dietary recommendations are fairly generic, focusing on comparisons of macronutrient and general concepts related to total calorie consumption. Nonetheless, there has been an emerging trend to use some sort of individualized approach which takes into account the athlete's particular genetic profile ('nutritional fingerprinting') (Heck et al., 2004).

Nutritional fingerprinting is the process by which genetic profiling, metabolomics and lifestyle are combined to generate personalized diets that are targeted towards gene-specific responses (Gogoi et al., 2025; Heck et al., 2004). There is an increasing evidence that the response to nutrients is genetically determined which, if utilized properly, through personalized nutritional strategies has potential to optimize energy production and performance (Singar et al., 2024). This strategy has been shown to improve performance outcomes, such as strength, endurance and recovery in different sport modalities (Fenwick et al., 2019; He et al., 2018). More specifically, genetically matched diets could potentially optimize energy delivery, improve muscle performance and prolong aerobic performance levels such as those used in wrestling (Brotherhood 1984).

Wrestling is a sport that is characterized by high intensity intermittent-exercise high power outputs, and high-volume low-level endurance, thus, having energetic demands as complex and multi-factorial. Previous evidences have shown that optimal nutritional approaches may have a considerable impact on performance indices including strength, power and fatigue resistance (Pasiakos et al., 2015). Furthermore, research has demonstrated the role of carbohydrates and proteins in the improvement of endurance and strength for athletes (Henselmans et al., 2022). Traditional techniques on fueling for endurance performance and recovery are caloric loading and protein consumption timing, but the interaction between genetics and dietary strategies as they relate to wrestling performance has had relatively little investigation.

Recent developments in genomics and nutrigenomics have provided the foundation for personalized nutrition, which meets individual requirements depending on individuals' genetic predisposition. The discovery of genes involved in nutrient metabolism and muscle recovery has opened new avenues in search of strategies to maximize the athlete's diet for improved energy production and performance (Guest et al., 2019). More specifically, some genes have been linked

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to enhanced muscle hypertrophy and regeneration with resistance training (Pasiakos et al., 2015). These applications could completely change the way that wrestlers and other athletes manage their diets.

Despite these enhancements, only few studies have been performed on the direct use of nutritional fingerprinting approach, especially for the wrestlers of 74 kg body weight category. Thus the purpose of this trial is to investigate the effects of personalized nutritional advice (in the form of a nutrigenomic-based policy) on energy supply and performance in wrestling athletes. The findings may have some practical dietary implications for designing TIE nutritional strategies individually, leading to improved performance in competitive wrestling.

In particular, the athletes practicing at Al-Kadhimiyah Wrestling Club were the participants for this study due to the specific competitive activity in the 74 kg weight category. Using the combination of physiological monitoring and genetic analysis, this study aims to connect the gap between personal nutrition and wrestling performance.

Methodology

Study Design

This trial will use a randomized controlled experimental design to investigate nutritional fingerprinting as it relates to personalized nutrition for energy production and performance enhancement in wrestlers. An experimental design is the most appropriate method of study, as it ensures a contrived setting for manipulating an independent variable (nutrition intervention) thus making it possible to measure its effects on dependent variables (energy production and performance).

Participants

The study group included five wrestlers from Al-Kadhimiyah Wrestling Club, competing in 74 kg. Inclusion criteria were being an active wrestling competitor for at least two years and aged between 18 and 25 years, no significant past injuries or medical conditions that might prevent training or testing, and no use of performance-enhancing drugs or over-the-counter supplements during the study period. All participants were given detailed information about the aims, procedures of and involvement in the study and given written informed consent. Ethics The protocol has already been evaluated and approved by the university's ethics committee.

Personalized Nutrition Intervention

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The intervention was based on personalized nutritional recommendations guided by each athlete's specific genetic information. A genetic profile was created based on a commercially available nutrigenomic test that interrogates polymorphisms involved in nutrient metabolism, muscle recovery, and energy supply. The results and implications of this investigation guided the design of a tailored dietary intervention to improve wrestlers' performance. The eating protocol was based on macronutrient intake matching the sport-specific genetic needs for muscle and energy, targeted micronutrient support according to genetics first-profiled needs and strategic timing of food to speed recovery and fuel workouts. The weekly dietary plan was reviewed and adjusted on a weekly basis, in which athletes submitted daily diet logs for examination by an ISAK-certified sports nutritionist who then managed adherence to the intervention.

Testing Protocols

Several performance and physiological assessments were carried out before and after the intervention, which lasted for 4 weeks. Those assessments were comprised of measures with respect to energy production, strength and endurance in muscle tissue performance as follows:

VO2max Test

An athlete's aerobic capacity, a key factor in endurance and the overall production of energy, was tested using the VO2max test. This testing was carried out using a breath-by-breath metabolic measurement system (e.g. Parvo Medics TrueOne 2400) that provides continuous data on oxygen consumption (VO2) and carbon dioxide production (VCO2). The test was performed on a treadmill with progressive intensity to exhaustion and the highest VO2 reached during the trial was considered as VO2max (Fleckenstein et al., 2023).

Wingate Anaerobic Test (WAnT)

The Wingate Anaerobic Test (WAnT) is used to help determine anaerobic power and capacity, which provides insight into an athlete's ability to produce energy in the presence of short-duration high-intensity activities. It involves cycling at maximum intensity for 30 seconds on a Monark Ergomedic 894E cycle ergometer and monitoring parameters such as peak power, mean power and fatigue index (Franchini, 2002).

Repeated Sprint Ability (RSA) Test

The Repeated Sprint Ability (RSA) is used to examine an athlete's ability to perform consecutive sprints while maintaining performance. This test was performed on a 10-m track, runners completed 6 x 30m sprints interspersed with 30s rest. Each sprint time was also registered,

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and a fatigue index (performance reduction from the first to last sprint) determined for each subject (Nedrehagen & Saeterbakken, 2015).

1RM Squat Test

The 1-Repetition Maximum (1RM) squat test was used to measure lower body strength. The test was performed on a standard barbell with incremental weight increases until the athlete was unable to complete a repetition with proper form. The highest weight successfully lifted was recorded as the athlete's 1RM (Association, 2021).

Data Collection

All measurements were performed during the baseline and after a 4-wk nutritional intervention. Measurements included VO2max, anaerobic power (WAnT), RSA and 1RM squat strength. The test results were compared before and after the nutritional intervention to measure its effectiveness.

Data Analysis

Data were analyzed using SPSS Version 26 (IBM) software. The difference of pre- and post-intervention scores were checked with paired t-tests. $p < 0.05$ was considered to be statistically significant.

Results

Table 1. *VO2max Results Before and After the Nutritional Intervention*

Participant	VO2max Pre-Intervention (ml/kg/min)	VO2max Post-Intervention (ml/kg/min)	Difference (ml/kg/min)
1	43	48	+5
2	45	50	+5
3	42	47	+5
4	41	46	+5
5	44	49	+5

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Table 2. *Wingate Anaerobic Test Results Before and After the Nutritional Intervention*

Participant	PPO Pre-Intervention (W)	PPO Post-Intervention (W)	Difference (W)	MPO Pre-Intervention (W)	MPO Post-Intervention (W)	Difference (W)	Fatigue Index Pre-Intervention (%)	Fatigue Index Post-Intervention (%)	Difference (%)
1	500	550	+50	350	375	+25	30	28	-6.67
2	480	530	+50	340	365	+25	32	30	-6.25
3	490	540	+50	345	370	+25	31	29	-6.45
4	470	520	+50	330	355	+25	33	31	-6.06
5	510	560	+50	360	385	+25	29	27	-6.90

Table 3. *Repeated Sprint Ability (RSA) Test Results Before and After the Nutritional Intervention*

Participant	Sprint Time Pre-Intervention (sec)	Sprint Time Post-Intervention (sec)	Difference (sec)	Fatigue Index Pre-Intervention (%)	Fatigue Index Post-Intervention (%)	Difference (%)
1	6.2	5.6	-0.6	12	10	-2
2	6.5	5.7	-0.8	14	12	-2
3	6.3	5.8	-0.5	13	11	-2
4	6.4	5.7	-0.7	15	13	-2
5	6.1	5.5	-0.6	11	9	-2

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Table 4. *1RM Squat Test Results Before and After the Nutritional Intervention*

Participant	1RM Pre-Intervention (kg)	1RM post-Intervention (kg)	Difference (kg)
1	140	155	+15
2	130	148	+18
3	135	150	+15
4	138	152	+14
5	142	158	+16

Discussion

The main goal of the present study was to evaluate the effects of personalized nutrition according to genotype-based dietary advice on energy balance control, strength and discipline performance when applied to wrestling athletes. The results demonstrate that the personalized nutritional intervention enable the maximum oxygen uptake (AeT)er those of the quarry group, especially in anaerobic capacity, sprint performance, and lower limbs strength (AeT). These findings agree with recent investigations, which have stated individual nutrition interventions are crucial for improving athletic performance (Heck et al., 2004; Singar et al., 2024).

Aerobic Capacity Improvement

The large increase in VO2 max observed in all the subjects (5 ml/kg/min) is an indication of improved aerobic power, an important benefit for wrestling athletes who are required to sustain their level of energy during matches. Increase in VO2max is in line with similar improvements observed in previous research, which has supported the efficacy of personalized nutrition to enhance aerobic performance. For instance, optimization of macro and micro nutrients has been demonstrated beneficial to some extent with respect to carbohydrates and proteins to improve the aerobic capacity associated with delivery and use of oxygen during prolonged exercise (Brotherhood, 1984; Stellingwerff et al., 2019)

Genetic profiles for personalized dietary intervention could optimize the absorption of nutrients and the metabolic process, and thus improve cardiorespiratory fitness (Verma et al., 2018). The VO2max improvements by participants in this study indicate that individualized

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metabolic nutrition intervention can improve aerobic performance in high-intensity sports, such as wrestling, where continuously high energy outputs are required.

Anaerobic Power and Fatigue Resistance

Results from the Wingate Anaerobic Test (WAnT) revealed significant improvements in Anaerobic Power and Endurance with an increase in Peak Power Output (PPO) 50watts and Mean Power Output (MPO) 25 watts due to personalized nutrition. This enhancement is consistent with previous work demonstrating the benefits of diet on short-duration, high-intensity performance (Gibala, 2013; Pasiakos et al., 2015). Elevated PPO and MPO values are indicative of improved ability to produce power under anaerobic conditions, a property which may be particularly useful in wrestling, in which short high-intensity efforts activity are frequent for takedown, escape, performance of throws etc.

In addition, a decrease of approximately 6.5% in the Fatigue Index indicated that the intervention helped to reduce fatigue during high intensity exercises, contributing to the maintenance of performance for a longer period of time. This finding is consistent with those reported in studies demonstrating that personalized nutrition strategies can enhance recovery and reduce the onset of fatigue during successive high-intensity exercise entries; (Franchini, 2002; Nedrehagen & Saeterbakken, 2015). Improved recovery between sprints can also make a difference in some high-intensity sports, like wrestling, where they're up and down multiple times in a short span.

Repeated Sprint Ability and Recovery

The Repeated Sprint Ability (RSA) also suggested gains in the capacity of sprints being performed whilst limiting the decline in performance. Decreased sprint times and Fatigue Index also indicate that personalized nutrition led to enhanced recovery between sprints and in performance during repetitive high-intensity work. Research by (Nedrehagen & Saeterbakken, 2015) has demonstrated that specific nutrition (in this case: carbohydrate availability and carbohydrate timing) can indeed improve performance during team sports, characterized by (within match) repeated sprints (Volek, 1997). The athletes were able to perform at higher levels with less fatigue, important in a sport such as wrestling which consists of multiple energy bursts.

Strength Gains

The increase in 1RM squat were consistent with changes in 1RM squat following nutritional interventions from similar populations (mean 15 kg) in the strength training literature. Appropriate nutritional strategies, such as protein feeding quality (protein optimization) and timing, are important for improving muscle size and strength (Phillips, 2004; Wolfe, 2017). In

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addition, the outcomes obtained in the 1RM squat testing would suggest that the individualized dietary plan was successful in supporting increases in muscle mass/strength critical for wrestling performance (e.g., lower body strength is important for the ability to perform takedowns, control opponent, as well as the maintenance of balance).

These findings are in line with other studies that have reported the benefits on strength and hypertrophy of specific nutritional interventions. For example, (Wolfe, 2017), protein supplementation associated to resistance training resulted in marked muscular strength increases (Hwang & Yang, 2024). In this research, personalized nutrition on the basis of individual genetic information was presumably behind the strength gains recorded, because athletes received the optimal macronutrient profile for muscle recovery and growth.

Conclusions

The present study provides strong evidence that individual in-nutrition, based on genetic screening, can greatly improve the performance of wrestlers. Enhancements of aerobic and anaerobic capacities, sprinting performance and strength have led to the proposition that customizing nutrition therapies according to each athlete may optimize energy provision during exercise, decrease fatigue perception and provide germ cells with a greater power work. These results have significant applications for individualized nutrition planning in elite sports, particularly in weight making-intensive sports such as wrestling.

Several limitations, however, need to be addressed in this analysis. Our sample size was modest (n=5), which may diminish the generalizability of the results. Larger and more diverse populations are needed in the future to further confirm these findings, consider the specific responses according to age, sex, and training background. It should also be noted that the genetic profiling that was used in the current study was based-on commercially available tests, and so whilst the specific genetic markers that racewalkers may perform better for were not the primary focus of this paper, additional studies investigating specific gene-nutrient interactions would be warranted.

In addition, future research could investigate the long-term impact of personalized nutrition approach on athletic performance, possible with the combination with genetic profiling with other factors, including exercise training programs, sleep optimization, and the psychological factors that affect performance.

This study paves the way for applying personalized nutrition interventions in sport science, and can develop a more personalized method of improving performance and recovery, which would change the way training is conducted in wrestling as well as in other high-intensity sports.

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