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Original

EVALUACIÓN COMPARATIVA DE LAS RECOMENDACIONES DIETÉTICAS Y KINESIOLÓGICAS CON Y SIN EXTRACCIÓN DE DATOS DE PERFILES GENÉTICOS

COMPARATIVE ASSESSMENT OF THE DIETARY AND KINESIOLOGICAL RECOMMENDATIONS WITH AND WITHOUT GENETIC PROFILING DATA MINING

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RESUMEN

Objetivos: Nuestro trabajo tuvo como objetivo comparar dos enfoques estratégicos para definir planes personales eficientes de dieta y actividad física basados en los datos disponibles. **Material y métodos:** El desequilibrio energético entre las calorías consumidas y las calorías gastadas es la causa elemental de la obesidad y el sobrepeso y puede abordarse con directrices y recomendaciones basadas en la población para metodologías de planes personalizados de dieta y actividad física. Dos profesionales independientes en nutrición y preparación física realizaron un conjunto paralelo de planes personales para 15 participantes que voluntariamente solicitaron su plan dietético y de actividad física. Un profesional utilizó mediciones físicas y datos autoinformados, mientras que el segundo utilizó además datos de perfiles genéticos. Las principales diferencias se observaron en planes más específicos de restricciones dietéticas en el tipo de ingesta de calorías y el tipo de entrenamiento de resistencia que era factible sólo cuando se tenían en cuenta los datos genéticos. **Resultados:** De 15 participantes, 9 de ellos se encontraban en la categoría de obesidad o sobrepeso. El 46.7 % de ellos no tenía ningún régimen dietético específico, el 73.33 % tenía un trabajo sedentario mientras que el 53.3 % realizaba actividades físicas regulares 2 o 3 veces por semana. **Discusión:** En comparación con el parámetro "frecuencia de ejercicio" (utilizando la prueba de concordancia kappa entre evaluadores), se obtuvo el valor del parámetro kappa de -0,15, lo que indica una coincidencia negativa entre los dos métodos probados. **Conclusiones:** Nuestro estudio implica que el uso informado y guiado de perfiles genéticos ampliamente accesibles y su uso estandarizado podrían contribuir significativamente a la especificidad de los planes personalizados de dieta y actividad física.

Palabras clave: obesidad, perfil genético, ingesta calórica, entrenamiento personalizado.

COMPARATIVE ASSESSMENT OF THE DIETARY AND KINESIOLOGICAL RECOMMENDATIONS WITH AND WITHOUT GENETIC PROFILING DATA MINING

ABSTRACT

Objectives: Our work aimed to compare two strategic approaches in defining efficient personal dietary and physical activity plans based on available data. **Methods:** Energy imbalance between calories consumed and calories expended is the elementary cause of obesity and overweight and can be addressed with population-based guidelines and recommendations for personalized dietary and physical activity plan methodologies. Two independent professionals in nutrition and physical coaching made a parallel set of personal plans for 15 participants who voluntarily asked for their dietary and physical activity plans. One professional used physical measurement and self-reported data while the second used genetic profiling data in addition. Main differences were observed in more specific plans for dietary restrictions in calorie type intake and type of endurance training that was feasible only when genetic data were taken in account. **Results:** Out of 15 participants, 9 of them were into the category of obese or overweight. 46.7 % of them did not have any specific dietary regime, 73.33 % hade sedentary jobs while 53.3 % of them had regular physical activities 2 or 3 times per week. **Discussion:** Compared to the parameter "frequency of exercise" (using the *Interrater kappa agreement* test), the value of the kappa parameter of -0.15 was obtained, which indicates a negative match between the two tested methods. **Conclusions:** Our study implies that informed and guided use of widely accessible genetic profiling and its standardized use could significantly contribute to the specificity of personalized dietary and physical activity plans.

Keywords: obesity, genetic profiling, calorie intake, personalized training.

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INTRODUCTION

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. According to the World Health Organization (WHO), in 2016, more than 1.9 billion adults were overweight and 650 million of them were obese. Recent WHO data suggests that each year almost 2.8 million people die as a consequence of being overweight or obese (WHO, 2024). Energy imbalance between calories consumed and calories expended is the elementary cause of obesity and overweight. Changes in physical activity and dietary habits are in many cases the result of environmental and societal changes associated with lack of supportive policies in different sectors (e.g. health, environment, agriculture, transport, urban planning, food processing, distribution, marketing, and education) (Hill et al., 2013; Romiet et al., 2017). Overweight and obesity, and their related noncommunicable diseases, can be very often prevented. Supportive communities and the environment have a crucial role in shaping people's choices, by making the choice of healthier foods and regular physical activity the choice that is the most accessible, available and affordable or simply – the easiest choice, and therefore preventing overweight and obesity (Clarke et al., 2016; Esdaile et al., 2022).

WHO reports that cardiovascular diseases (CVDs) are the leading cause of death globally (WHO, 2021). Most CVDs and other common non-communicable diseases can be prevented by evidence-based lifestyle modifications, addressing the behavioral risk factors such as tobacco use, unhealthy diet and obesity, and physical inactivity (Stewart et al., 2017). Considering that mentioned diseases are largely preventable, more attention should be given to supportive environment and communities to promote healthy lifestyle and motivation. For that purpose, introducing the concept of evidence based and personalized nutrition with physical activity plans could be of great help.

Genomic analysis enabled targeted genetic profiling that are functionally associated with individual predisposition for metabolism or resistance/sensitivity to certain types of foods, diet, or physical activity, etc. Those analyses have shown that specific genotype (i.e. *FADS1* or *MTHFR*) correlates with distinct individual needs for a daily intake of supplements. This goes in favour to the fact that modern nutrition plans for the treatment of certain health disorders, as well as in their prevention, should consider individual and population make-up in order to ensure their effectiveness (AlSaleh et al., 2014). Targeted genetic profiling is emerging as an evidence base for personalized diet and physical activity plans with increased efficiency (Gkouskou et al., 2024; Singar et al., 2024). On the other hand, classical ways of creating a personalized diet and exercise plan based on morphometric and nutritional profiles of individuals, if carefully prepared and scientifically exact, can result in successful outcomes of physical conditioning, optimization of individual body weight and lifestyle (habits). The aim of this research was to examine whether there are significant differences in personalized plans based on the classical approach (analysis of the physical constitution and individual habits) compared to plans based on a person's genetic profile.

METHODS

Fifteen volunteers who participated in this study signed informed consent to provide the following data: gender, age, height, weight, chest circumference, waist circumference, circumference of the left and right upper arm, right thigh circumference and right calf circumference. Anthropometric measurements were obtained as described in Dzehverovic et al. (2017). The ethical aspects of the aim and methodology employed in this research were approved by the Institutional Ethics Board of the UNSA-Institute for Genetic Engineering and Biotechnology.

BMI was calculated using an online calculator. Participants provided buccal swabs for the genetic profiling using the method described elsewhere (Dzehverovic et al., 2017). Two professionals in nutrition and physical coaching prescribed personal dietary and physical activity plans for all participants, independently. One of them applied constitutional and self-reported data only, while the second used constitutional, subject self-reported data and genetic profiling data to produce personal plans.

Each participant got two separate dietary and physical activity recommendation plans that were further compared. *Interrater kappa agreement test* (MedCalc 19.0.4) was used to evaluate differences

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between the two approaches to the generation of nutrition and kinesiology guidelines. Using this method (Fleiss, 1971; Fleiss et al., 2003), we compared the results (recommendations) for the same parameters given by the two experts who used different assessment methodologies – one based on targeted genetic profile and life habits and the other based on body measurements and life habits.

Comparison results were shown as K (kappa) statistical parameters. When K=0, there is no concordance between the two results series (two compared methods), when K=1 there is an absolute concordance between two result series (two compared methods) and when K<0 - concordance is higher than the one by chance.

RESULTS

Out of 15 participants, 7 were male and 8 were female, with ages ranging from 23 to 52 years. Based on BMI, 6 participants were in a category with normal weight (18.5-24.9 kg/m2), 7 were in the overweight category (25.0-29.9 kg/m2) and 2 were in (30.0-39.9 kg/m2) the obese category. Three participants had a chronic disease (depression, Hashimoto's disease anemia, and hypothyreosis) and the rest were reported as healthy. Besides data and measurements described in materials and methods, participants gave information about their dietary habits, daily physical and current sports activities. Most of them did not have any dietary regime (46.7 %), while 73.33 % reported a sedentary job. 53.3 % of participants had regular physical activities 2 or 3 times per week (Graph 1).

Dietary (Table 1) and physical activity (Table 2) recommendations were given to each study participant with and without genetic profiling data mining.

Graph 1. Percentage representation of the respondent's dietary habits – A; job type – B and physical activity – C

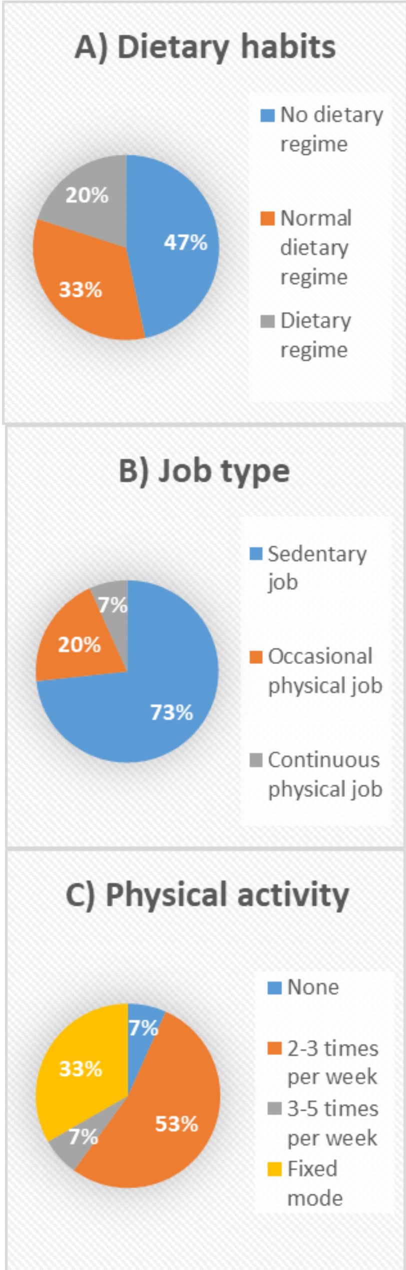

Table 1. Dietary recommendations based on constitutional and self-reported data with and without genetic profiling data mining

Calorie intake	Carbohydrates intake	Lipids intake	Protein intake
3	3	3	3
2	2	2	2
1	1	1	1
2	2	2	2
1	1	1	1
1	1	1	1
2	2	2	2
2	2	2	2
2	2	2	2
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
3	3	3	3
2	2	2	2
1	1	1	2
2	2	2	2
1	1	1	1
1	1	1	2
1	1	1	2
2	2	2	2
2	2	2	2
2	2	2	2
1	1	1	2
1	1	1	1
1	1	1	2
1	1	1	2
1	1	1	2

Legend: 1 – Reduced; 2 – Maintaining; 3 – Increased;

● dietary recommendations without genetic profiling data;

● dietary recommendations with genetic profiling data.

When comparin the parameter "frequency of exercise" (using the Interrater kappa agreement test), the value of the kappa parameter of -0.15 was obtained, which indicates a negative match between the two tested methods. Comparison of the “type of activity” parameter showed a kappa value of 0.05, a positive but low concordance between the two methods. The classic approach has shown greater diversification between recommendations, while the personalized one is based on only one type of activity. Recommendations for the “intensity of training” parameter partially matched in about 20% of cases (kappa value 0.18). When it comes to recommendations for the type of endurance training, the match between the two methods was about 40% or K = 0.39. The analysis of the differences in the recommendations for the “type of strength training” revealed a kappa value of approximately 0, which is a complete disconcordance. Analysis of two parallel series of results for nutrition recommendations showed complete concordance (Kappa is 1) for total calorie intake, and carbohydrate and fat intake. However, a difference was observed in the protein intake recommendations where the kappa value was 0.33 with an agreement of about 33%.

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Table 2. Physical activity recommendations based on constitutional and self-reported data with and without genetic profiling data mining

Without genetic profiling data					**With genetic profiling data**				
Frequency of exercise	Type of activity	Intensity of training	Type of endurance training	Type of strength training	Frequency of exercise	Type of activity	Intensity of training	Type of endurance training	Type of strength training
3	1	4	3	1	3	1	4	2	5
2	3	2	3	1	3	3	4	2	1
4	3	2	1	1	3	3	2	1	1
3	3	2	3	1	3	1	4	2	4
3	3	2	1	1	4	2	2	1	1
4	3	2	1	1	4	1	3	1	1
4	3	2	1	1	3	1	3	1	4
2	3	2	3	1	3	3	3	1	4
2	3	4	3	1	4	1	4	2	5
2	3	2	3	1	3	1	4	2	4
4	3	2	1	1	3	1	3	1	4
3	3	2	1	1	4	2	2	1	1
4	3	2	1	1	3	1	3	1	4
4	3	2	1	1	3	1	3	1	2
4	3	2	1	1	3	1	4	2	1

1 - once a week	1 - strength	1 - low	1 –cardio	1 - functional	1 – once a week	1 - strength	1 - low	1 -cardio	1 - functional
2 – twice a week	2 - endurance	2 - medium	2 - muscular	2 - structural	2 – twice a week	2 - endurance	2 - medium	2 - muscular	2 - structural
3 – three times a week	3 - mixed	3 - high	3 - combined	3 - isometric	3 – three times a week	3 - mixed	3 - high	3 - combined	3 - isometric
4 – four or more times a week	4 – light	4 - submaximal 5 – maximal	4 - repetitive	4 - repetitive 5 – maximal	4 – four and more times a week	4 – light trainings	4 - submaximal 5 – maximal	4 - repetitive	4 - repetitive 5 – maximal

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DISCUSSION

Our work aimed to compare two strategic approaches in defining efficient personal dietary and physical activity plans based on the available type of data. Therefore, two independent professionals in nutrition and physical coaching made a parallel set of personal plans for 15 participants who voluntarily asked for their dietary and physical activity plans. One professional used physical measurement (height, weight, BMI, etc.) and self-reported data (dietary habits) and the second used genetic profiling data in addition. Notably, 9 out of 15 respondents (60%) fell into the category of obese or overweight, which is expected given the fact that this was not a random sample of the general population, but a sample of people who wanted to change their dietary and physical activity habits.

In the case of personalized dietary recommendations, no differences in the recommendations for caloric intake of carbohydrates and fats were observed in our study, but there was a significant difference in the recommendations for the protein intake regimen. The differences arise from the fact that the classical dietary recommendation is based on moderate specific intake (of proteins), and (nutri)genetic on the reduced total intake. While a personalized dietary plan on the basis of genetic markers relies on a balanced dietary intake for all equally, except in the case of metabolic polymorphisms that carry the risk of intake of certain foods (caffeine, gluten, sugar, fat, etc.), the classic approach of making a personalized diet and exercise plan is guided by a specific ratio of protein intake that is related to physical activity.

Two genes and their variants, *ACE* (encodes angiotensin converting enzyme) and *ACTN3* (encodes actinin 3), are directly related to physical endurance traits (*ACE* I /I) and strength-based skills (*ACTN3* R / R), but neither of these markers can be considered predictive. These two genes, along with additional metabolic genes, play a role primarily in identifying athletic propensity (predisposition to strength, endurance, susceptibility to injury, etc.) but are not the only factor in athletic success (Guth & Roth, 2013). The application of these and genetic markers related to metabolism and susceptibility to certain foods and their utilization represents an important potential given the commercial availability of genetic technologies. Genetic profiling gives us insight into certain individual characteristics - cardiovascular and other personal physiological risks and limitations, risks for allergies and metabolic disorders, which cannot be observed by classical methods of analysis of physical constitution before the implementation of a personalized diet and exercise plan. For possible, future applications of genetic profiling in the development of personalized guidelines, it is necessary to have initial information on allelic and genotypic frequencies for a certain geographical area (e.g. BiH or region) because population genetic make-up significantly affects the individual response to food and drugs (Kaput et al., 2015).

Global and regional growing trends in obesity require a systemic and informed societal response. In the US, the incidence of obesity in the adult population is over 68% (Wright and Aronne, 2012), while in Europe the prevalence of obesity is between 42 and 70% depending on the region. Interestingly, the incidence of obesity is higher among women in Western European countries than in East-European and Middle Eastern countries (Seidell, 1995).

Prospective research on the epidemiology of obesity and geographically specific eating habits in Bosnia and Herzegovina as a South-East European country is rather scarce. In the study of Abazović et al. (2016) where 33,200 primary school students from the continental part of the country were included, 50 percent of children in primary schools deviated from normal body weight, of which about 10% were malnourished, and 40% were overweight. In a similar study of the school population of the Mediterranean part of Bosnia and Herzegovina Čolakhodžić et al. (2017) concluded that 37% of the examined children were overweight, which consequently led to postural problems and spinal deformities.

The recommended type of physical activity is another essential component of a prospective, personalized diet and exercise plan. Methodologically harmonized and representative research on total physical activity in the general population is rare. The studies are mainly carried out in urban areas, without considering demographic specifics and socio-economic parameters. However, numerous clinical and other studies suggest its importance. Lee et al. (2012) found that maintaining physical activity reduces the risk of incident hypertension by 26% - 28%, for metabolic syndrome by 42% - 52% and the risk of hypercholesterolemia by about 30%. Moreover, the study conducted on the student population showed a correlation between the diet and

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the physical performance, specifically, subjects moderately adhering to the Mediterranean diet (considered healthy) exhibited a greater volume of physical activity (Díaz-Quesada et al., 2024). Results of our study show differences in personalized physical activity plans based on the classical approach and plans based on a person's genetic profile.

There are certain differences in recommendations for frequency of exercise. A personalized approach dictates information about the frequency of training sessions. Namely, each person, depending on their own recreational habits, age, health status and other factors, has their own optimum when it comes to physical activities and recreation. Certainly, with the increase infitness abilities, regulation of morphological characteristics and health status, the frequency of exercise may be more frequent over time.

For the specific type of activity, there was a positive but low concordance between the two methods. The classic approach has shown greater diversification between recommendations, while the one according to genetic profile is based on only one type of activity. A mixed type of activity is the best choice in this case because through such a way of exercising the subjects will develop different motor skills such as strength and endurance. In this case, it is important to develop both motor aspects because the subjects are at the beginning of the training process and need to start with basic motor skills. Of course, there may be some differences between the subjects, so younger ones can do a little more strength training than endurance, while older ones can work more endurance than strength training. This will not essentially change their type of activity, it will definitely stay mixed.

According to classical recommendations, the intensity of exercise is medium for most of participants, and according to the genetic profile, three people should have a medium intensity of exercise, six people should have a high intensity of exercise, while the rest six people should have a submaximal intensity of exercise. The intensity of the exercise largely determines the goal of the training. Since the participants are at the beginning of the training process, most of them have certain health difficulties, and the intensity of the medium load would suit them best in this case.

Recommendations based on genetic profiling indicate that most respondents, ie. nine of them, should benefit from the cardio endurance training, while six subjects should do muscular endurance training. Classical recommendations say that also nine respondents should do cardio endurance training, although they are not the same person, while six respondents should do a combined type of endurance. The reason for this lies in the fact that classical recommendations took into account the fact that the respondents are novice exercisers and that at the beginning of the introduction of regular exercise they must strengthen both the ability of the heart muscle and muscle mass of the trunk and extremities.

Existing research on the types of physical activity and nutritional recommendations is mainly driven by specific motivation that differs significantly between the sexes (Molanorouzi et al., 2015), but also between age categories and type of physical activity. Furthermore, psychological well-being is stated as the primary reason for exercise, and the lesser motive is mastery of skill and mood. In a study of motivation to exercise in Norwegian fitness centers, it was observed that the motives for exercising by gender differ significantly where for men the motive is mainly atmosphere and mastery of the skill, while for women vitality is mainly the primary motive (Larsen et al., 2021). Therefore, the parameter of individual motivation should be included among the key ones in the development of a personalized diet and exercise plan, because self-motivation is one of the key factors in the success and sustainability of the exercise plan.

CONCLUSIONS

Here we present the results of the comparison of the dietary and kinesiological recommendations with and without the use of genetic profiling data, performed by two independent experts for the same group of study participants. The classical approach used physical measurements and self-evaluation data, while personalized mined targeted gene analysis data in addition. We observed notable differences in the classical approach and genetic data based personalized plans that should be addressed in systemic and populationbased approaches for addressing obesity and other life-time health risk factors.

Furthermore, the increased knowledge in global genetic variation and its correlation with functional parameters will enable higherresolution genetic profiling that could guarantee a better and faster impact of personalized dietary and physical activity plans.

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