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Evaluation of the effectiveness of personalized genotype-based nutritional advice in healthy adults

Dissertation

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Sumary

The pattern of individual gene variants can determine the body's diverse responses to nutrition as well as modify the requirement for particular food components. It is assumed that individual responses to food may allow the division of the population into groups with specific nutritional requirements. Based on this approach the concept of personalised nutrition has developed which moves away from population-wide recommendations towards individualised recommendations. However, it has not been clearly established yet what is the effectiveness of personalised nutrition and whether the addition of genotype information as a form of personalised nutrition brings the expected results in terms of greater adherence to recommendations than in the case of the classic dietary approach. **The main objective of this study was therefore to determine the effect of a personalised nutritional intervention on the change in the consumption of selected dietary components and/or food products and selected health status indices.**

In order to meet the objective of the study two nutritional interventions (Project 1 and Project 2) were conducted, in which women and men aged 18-60 were enrolled. The recruitment for the projects was conducted using the internet and the university network of the University of Life Sciences in Poznań and Adam Mickiewicz University in Poznań, advertisements on the radio and television. Qualified persons were randomly assigned to a study or control group. The study groups received dietary recommendations tailored to their genotype, together with the information about their gene variant. The control groups received genotype-specific dietary recommendations but without the information about the carried gene variant. Those in the control group were only given the information about their genotype after the intervention had ended.

In Project 1 the recommendations were to reduce caffeine intake in people who carry the C allele in the *CYP1A2* gene (rs762551 polymorphism) responsible for its metabolism in the body. People with the C allele should consume no more than 100 mg/d of it. A higher intake may be associated with a higher risk of non-fatal myocardial infarction (based on International Society of Nutrigenetics & Nutrigenomics recommendations). In the case of Project 2 the modification of dietary recommendations concerned the consumption of vegetables and fruit. Differences in bitter taste perception associated with the rs713598, rs1726866 and rs10246939 polymorphisms of the *TAS2R38* gene result in individuals carrying the so-called PAV haplotype in the *TAS2R38* gene being sensitive to bitter taste, while those with the so-called AVI haplotype are insensitive to it. The subjects in the test group, carriers of the PAV allele, were

asked to increase their fruit and vegetable consumption to the recommended amount of 400 g/d from groups that are not identified as bitter, e.g. β-carotene-containing or root vegetables. The subjects in the two control groups (bitter-taste sensitive and non-bitter-taste sensitive) were asked to increase their intake according to the population-wide recommendations. Both interventions lasted 20 weeks. The Bioethics Committee at the K. Marcinkowski University of Medical Sciences in Poznan approved the study with study number 196/19. The study was registered in the ClinicalTrials.gov database under the numbers NCT04122053 'Personalised Nutrition Caffeine Intake in Healthy Adults' and NCT04145453 'Vegetables Intake and Polymorphism TAS2R38 Gene by Healthy Adults'.

Food Frequency Questionnaires (FFQs), including a purpose-built and validated questionnaire assessing caffeine intake, were used to analyse the consumption. In addition, a phone application was used to assess caffeine intake in real time.

In addition, anthropometric and biochemical parameters were analysed. Waist, hip, arm and thigh circumferences were measured using a non-stretch tape, height was measured using a height gauge (Radwag WPT), body weight and body composition were analysed using displaced air plethysmography on a BodPod device from (Cosmed), BMI (Body Mass Index) and body fat distribution indices were calculated from the conducted measurements. Body Mass Index (BMI) and body fat distribution indices, i.e. waist to hip ratio (WHR) and waist to height ratio (WHtR), were calculated from the conducted measurements.) As part of the biochemical parameters fasting glucose, total cholesterol and its HDL and LDL fractions, triacylglycerols, alanine aminotransferase (ALAT) and aspartate aminotransferase (ASPAT), gamma-glutamyl transpeptidase (GGTP) were determined using a Konelab 20i biochemical analyser (Thermofisher). *CYP1A2* (rs762551) and *TAS2R38* (rs713598, rs1726866 and rs10246939) genotypes were analysed using TaqMan probes (Thermo Scientific SNP Genotyping Assay). Using Statistica 13.3 (StatSoft Inc., Tulsa, OK, USA) differences in intake of the recommended dietary component before and after the intervention were assessed in each group as well as differences between the test and control groups. The significance level of $\alpha=0.05$ was adopted.

In Project 1 habitual caffeine intake was 380.69 ± 217.58 mg/d in the study group and 394.44 ± 256.29 mg/d in the control group. In both groups there was a reduction in caffeine intake recorded in the FFQ: in the study group it decreased on average by 39.6%.; $p = 0.000$ and in the control group by 43%; $p= 0.000$. In contrast, when data collected using the application is considered, average caffeine intake decreased in both groups: by 59.1%; $p= 0.001$ in the study group and by 54.5%; $p=0.045$ in the control group. Some anthropometric

parameters (waist circumference and fat distribution indices) improved in the study group. However, there were no differences between the groups.

The study analysed the relationship between the perception of bitter taste (*TAS2R38* haplotype) and fruit and vegetable consumption as determined by the FFQ. Two models of inheritance were considered (Model I and II). In Model I three groups of individuals were compared: sensitive (PAV/PAV homozygotes), moderately sensitive (PAV/AVI heterozygotes) and insensitive (AVI/AVI homozygotes) to bitter taste. In Model II sensitive vs. sensitive and medium-sensitive subjects were compared. In Model I there were no differences in total fruit and vegetable intake between bitter-taste sensitive individuals, with the exception of potatoes, which medium-sensitive individuals consumed by 0.45 p; p=0.010 more often than non-sensitive individuals, similarly, in Model II there were no differences between bitter-taste sensitive groups, with the exception of potatoes, which sensitive and medium-sensitive individuals consumed more often by 0.42 p=0.09.

In Project 2 changes in total fruit and vegetable intake were obtained only in the test group from 22.76 ± 5.61 to 24.59 ± 7.06; p=0.047. In all groups (test and control) the consumption of 'brassica' vegetables increased, with the highest percentage increase recorded in the test group (33.33%), in control group II it was 32.31%, and the lowest increase (21.92%) was observed in control group I. Most anthropometric indices (waist circumference, body fat content, lean body mass content, fat distribution indices) improved in the study group. However, there were no differences between the groups.

In summary, it can be concluded that adding genotype information to the dietary advice does not result in a greater change in consumption in the group having this information. Thus, dietary advice that includes genotype information is no more effective than advice without this information. In the study group the consumption of vegetables and bitter products did not depend on the TAS2R38 gene variant. The application for mobile devices can be used to a limited extent to assess caffeine intake due to the large percentage of participants not providing answers in the application.

Key words: personalized nutrition, nutrigenomic, precision nutrition, genetic, information, nutrigenetics, genetic testing

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