The State of Nutrigenomic Education in Poland

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Abstract
Background: In Poland, 45 higher education institutions offer degrees in dietetics. However, only 20 of these offer nutrigenomics or nutrigenetics courses. Objectives: The purpose of this study was to assess the current state of nutrigenomic education in Poland and to evaluate the level of nutrigenomic knowledge held by dieticians. Methods: A cross-sectional survey was performed to examine the self-reported attitudes of 193 dietetics students and dietetics professionals who graduated from 33 Polish higher-level institutions. Results: The great majority of respondents were familiar with nutrigenomics and had a positive attitude to it, and this attitude was independent of whether they participated in nutrigenomics courses. Sixty-six percent of the respondents had received training in nutrigenomics, but nutrigenomic education did not meet the expectations of 57% of dieticians. Dieticians possess low levels of self-reported knowledge of nutrigenomics, and only about 15% of respondents know how to effectively communicate information on genetic risk to patients and understand the effect of nutrients on molecular mechanisms. Despite this lack of knowledge, 59% of respondents had a positive attitude to nutrigenomics, and 63% of them had a great interest in broadening their knowledge. Subjects who had participated in nutrigenomics courses exhibited a better understanding of several areas of nutrigenomics. They were especially interested in practical aspects of nutrigenomics, such as the essence of personalized diets and the practical application of nutrigenomics. Conclusions: In conclusion, Polish dieticians have a positive attitude to nutrigenomics but do not perceive themselves as well educated in this field, which is partly due to systemic problems. The study shows the need for improvements in nutrigenomic education in Poland.

Introduction

Nutrigenomics is a relatively new field of science that studies the relationship between nutrients and the genome on the cellular, tissue, and whole organism levels [1]. The term describes the complex effects of dietary compounds on the genome, transcriptome, metabolome, and proteome [2]. For practitioners, knowledge of nutrigenomics may help in understanding those interactions [3]. Consequently, the purpose of commercial applica-
tions of nutrigenomics may include better patient educa-
tion for optimal health and preventing diet-related dis-
eases, such as diabetes, cancer, obesity, metabolic syn-
drome, and cardiovascular diseases [4–9]. It has been
postulated that diet-related diseases could be prevented
or treated by genotype-based personalized nutrition,
whereby nutrient intake is optimized based on the indi-
vidual genetic makeup [10]. Nutrigenetics is, thus, a
branch of nutritional genomics [11] that investigates the
impact of interindividual differences on dietary response,
metabolism, and risk of diet-related diseases [12]. Preci-
sion nutrition should be based on clear evidence of valid-
ity [13], but to date there has been no official guidance on
personalized dietetic advice. Recently, the International
Society of Nutrigenetics and Nutrigenomics issued rec-
ommendations on caffeine intake and, more recently, its
position on precision nutrition in obesity [14].

Incorporation of personalized nutrition in practice re-
quires incorporating nutrigenetics into the education sys-
tem of dieticians at higher education institutions (HEIs).
As a member of the European Higher Education Area,
Poland has participated in the Bologna Process since
1999, according to which most tertiary education institu-
tions should provide 2-degree programs: a first cycle as a
bachelor’s degree (3 years; at least 180 ECTS credits) and
a second cycle as a master’s degree (2 years; at least 90
ECTS credits) [15]. Legally, HEIs are separate and auton-
omous educational units; in Poland, the Minister of Sci-
cence and Higher Education is responsible for the man-
agement of the tertiary education system as well as for
formulating and implementing educational policy and
supervising HEI activities [15]. In accordance with the
Law on Higher Education of July 27, 2005, the Minister
established particular degree program requirements (in-
cluding framework teaching content) for each field and
level of study [16]. In October 2011, the Minister imple-
mented the qualifications frameworks to fulfil Bologna
Process requirements [17]. On this basis, nutrigenomics
can be included in dietetics courses. Nevertheless, the
framework of educational legislation allows academic
teachers to develop individual program plans by auton-
omously undertaking activities; HEIs may also create indi-
vidual programs based on these schemes. Referring to the
teaching frameworks [17], nutrigenomics and nutrige-
netics are not mentioned in the legislation, and, thus, the
Teaching of these subjects highly depends on the inter-
pretation of each institution.

Although nutrigenomics is still not utilized in the ma-
Jority of health-care systems around the world, in the last
2 decades the awareness of the role of nutritional genom-
ics in health care and dietetics has increased [18]. It seems
reasonable that dieticians and dietetics students should be
well educated in nutrigenomics in order to communicate
and translate genetic information to their patients and to
encourage them to perform the genetic tests and apply
treatment, where necessary [19]. Even though nutrige-
nomics and nutrigenetics are still emerging new areas of
science, they are often ignored in the higher education
system. In Poland, dietetics is taught at 45 HEIs. Of these,
11 are medical universities, 16 are other public institu-
tions, including universities of life science, and 18 are pri-
vate higher-level institutions. However, only 20 of these
offer nutrigenomics or nutrigenetics courses.

Recent surveys have shown that US, Australian, and
UK dieticians have low levels of knowledge about and
confidence in nutritional genomics and genetics [19].
These results have created a need to review the current
status of nutrigenomic education in Poland and have si-
multaneously raised the question of the attitude of Polish
dieticians to nutrigenomics. To address these questions,
we have performed a cross-sectional survey focusing on
the subjective opinions of dietetics professionals and stu-
dents.

Methods

Participants

Overall, 193 survey respondents completed the questionnaire
between August 2017 and February 2018. The target groups were
dietetics students and dietetics professionals who had graduated
from Polish HEIs, including medical and life sciences universities
and private institutions. All participants provided informed writ-
ten consent.

Survey

Our brief cross-sectional questionnaire consisted of 13 ques-
tions in 3 parts and included several questions on (1) demograph-
cs; (2) nutrigenomic knowledge and participation in nutrigenomics
courses; (3) general attitude to areas of nutrigenomics, opinions on
nutrigenomic education, and an understanding of basic issues. This
anonymous questionnaire was distributed indirectly to respondents
by social media and directly to the heads of nutrition faculties and
academic teachers. The questionnaire was available on paper for
students at Poznań University of Life Sciences and in electronic
form for other participants. To examine the attitude, opinion, and
level of understanding of specific nutrigenomic issues, a 5-point
numeric Likert scale was used. The scale has scores ranging from 1
to 5 labelled as follows: strongly disagree, disagree, neutral, agree,
and strongly agree. We calculated the mean scores of the responses.

Questionnaire Development and Validation

The first step in questionnaire validation was to establish face
and content validity in collaboration with an expert panel, consist-
ing of an associate professor, assistant professors, and PhD stu-

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students in the nutrition and nutrigenomics fields, who validated the simplicity, clarity, and relevance of each item. The specific aims of the validation were to determine whether (1) the questionnaire was an appropriate tool to answer the research questions; (2) the questionnaire measures what it was supposed to measure; and (3) the sequence of questions is logical. Further, a pilot study was carried out to evaluate face validity and to test the questionnaires. The questionnaires were completed by 45 dietetics students at Poznań University of Life Sciences to ensure that the questions were clear, readable, and comprehensible.

Reliability was assessed using the test-retest procedure [20] among a group of 12 master’s degree students from Poznań University of Life Sciences. The questionnaires were completed twice by the same group of respondents at 2 different points in time to examine the stability of the questionnaire. The period of time between the first and the second survey was 1 week, which was enough to forget the answers but not long enough to allow for changes in opinions or attitudes. To avoid ambiguities and bias, participants did not participate in any nutrigenomics or genetics courses between the 2 surveys. The reliability of the questionnaire was calculated by estimating the correlation coefficient (Pearson’s correlation) [21] between the scores on the first and second tests. The values of the correlation coefficient ($r$) were high for all items ($r > 0.9$), which confirmed that the questionnaire’s results are reproducible. The internal consistency reliability after the first and second round of surveys using Cronbach’s alpha test revealed very good internal consistency (alpha coefficient = 0.89) [22].

### Statistical Analysis

All statistical analyses were performed using Statistica software with a $p$ value < 0.05 considered statistically significant. Differences between groups were examined using the Mann-Whitney test.

### Results

#### Sample Characteristic

In all, we received 193 questionnaires from 33 Polish HEIs; 178 were online and 15 in paper form. Only 24 out of these HEIs have offered nutrigenomics courses. Eighty-nine of the respondents were dietetics students at medical universities and 79 at other public universities, including universities of life sciences. Over 60% of the survey respondents were at the time of the survey: 39% ($n = 75$) in the first cycle and 25% ($n = 47$) in the second cycle of a dietetics program. About 21% ($n = 37$) of respondents had a bachelor’s degree, and 26% ($n = 50$) had a master’s degree in dietetics. Most respondents were full-time dietetics students (76%). The majority of respondents who completed the survey were female (over 90%).
General Attitudes to Nutrigenetics

Altogether, 95% (n = 183) of the dieticians surveyed had heard of nutrigenomics. Their general attitude to nutrigenomics was positive (59%) or neutral (39%). Only 2% of respondents had a negative attitude. Over half of the subjects (56%) were interested in nutrigenomics, which is in line with their positive attitude to nutrigenomics.

Figure 1 shows that most respondents stated that they were interested in broadening their knowledge in the area of nutrigenomics. Of the survey participants, 66% had received training in nutrigenomics. The classes were mainly organized at HEIs in the form of obligatory seminars, lectures, and laboratory sessions which lasted up to 30 h during the semester. However, the nutrigenomic education failed to meet the expectations of 57% of respondents, with only 19% being satisfied. Asked whether knowledge of nutrigenomics was important for dieticians, the majority of respondents (74%) answered positively. Specifically, 28% strongly agreed and 46% agreed with that statement (Table 1). However, when we asked whether nutrigenomics was important for the dietetics profession, we obtained different results: only 17% of respondents stated that it was very important, with 40% indicating that it was important for professionals.

What Should Be Taught in a Dietetics Program?

In the next part of the questionnaire, we posed questions eliciting what respondents thought should be taught in a dietetics program (Fig. 2; Table 1). The overwhelming majority of participants (over 90%) pointed to the main aspects of a personalized diet, the practical applications of nutrigenomics, and the communication of genetic risk information to patients.
The effects of cell function on cell function were the most desired subjects in dietetics programs. About 60% of respondents indicated issues such as the functions of genetic material, nutrigenomics research areas, and knowledge of the relationship between genes and traits as being important in dietetics programs.

Level of Knowledge

The final part of the survey concerned self-reported levels of understanding of nutrigenomic issues (Fig. 3; Table 1). Generally, dieticians perceived their level of understanding of nutrigenomics as low. Three-fifths of nutrigenomic issues were unintelligible for the respondents. The most difficult topics were: “the effective communication of genetic risk information to patients,” with only 15% of respondents stating that they truly understood this topic; “nutrigenomics research areas,” which was understood by 22% of respondents; and “the effect of nutrients on molecular mechanisms,” understood by only 15% of dieticians. The best-understood topics were “knowledge of the relationship between genes and traits” (39% of respondents stating that they understood this topic well), “functions of genetic material” (38%), “the main aspects of personalized diet” (37%), and “relationships between genes and the functioning of the body” (37%) (Fig. 3).

Effect on Responses of Participation in Nutrigenomics Classes

In order to determine how participation in nutrigenomics classes affected the responses, we further stratified and assigned responders to 2 subgroups: those subjects who had never participated in any nutrigenomics classes (group 1, \( n = 65 \)) and those who had participated in nutrigenomics classes prior to the survey (group 2, \( n = 128 \)). Statistically significant differences were observed for 7 items: attitude to nutrigenomics (\( p < 0.001 \)), expectations of nutrigenomic education at their institution (\( p < 0.001 \)), and level of understanding of the following topics: functions of genetic material (\( p < 0.05 \)), relationships between genes and the functioning of the body (\( p < 0.05 \)), practical applications of nutrigenomics (\( p < 0.05 \)), nutrigenomics research areas (\( p < 0.05 \), and relationship
between genes and traits ($p < 0.05$) (Table 2). All items were scored higher by individuals who participated in nutrigenomics classes.

**Discussion**

Our study shows that the majority of Polish dieticians and dietetics students are familiar with nutrigenomics and have a positive attitude to it. This attitude was independent of whether the subjects had taken nutrigenomics courses. We additionally demonstrated that, although dieticians were interested in nutrigenomics, they have low levels of self-reported nutrigenomic knowledge. They particularly had problems understanding the effects of nutrients on cell function and molecular mechanisms, with respectively only 29 and 18% of dieticians understanding these topics well. Consequently, the strong relationship between levels of nutrigenomic knowledge and the understanding of practical application of nutrigenomics research areas is not surprising. As we have shown, only 15% of respondents know how to effectively communicate about genetic risk to patients. In addition, the majority of dieticians did not comprehend the basics of genetics, such as the functions of genetic material or the relationship between genes and traits – only 38 and 37% stated that they understood these. This problem of a lack of knowledge is international. Similar results on low levels of genetic and nutrigenomic knowledge among dietetics professionals and students have been reported in other countries [19, 23, 24].

The responses suggest a few possible reasons for these findings. First, there are no complete, high-quality educational materials available in the Polish language; dieticians thus experience significant difficulties understanding material in a foreign language. Moreover, the low level of knowledge of genetic and nutrigenomic issues may be secondary to limited time available for nutrigenomic education in dietetic curricula. Lectures on these topics usually take up to 30 h of the entire program (data not

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**Fig. 3.** Level of understanding of different nutrigenomic topics. Bars represent the percentage of responses to the statement "I understand this topic well" on a 5-point numeric Likert scale (strongly disagree, disagree, neutral, agree, and strongly agree.)
shown), which may be too little to permit a full understanding of the topic. Furthermore, there are only a few departments specializing in nutrigenomics in Poland, so HEIs are faced with a shortage of qualified academic staff and overall low confidence in genomics among academic teachers. Nutrigenomic education did not meet the expectations of 57% of respondents, which may be associated with unattractive, poor presentation of the content and its incomprehensible message. On the other hand, students can see that it is not possible to learn the complexities of nutrigenomics in the short time available, leading to a lack of interest in the subject.

The other reason for such a low level of knowledge may be the lack of science institutions and companies (apart from HEIs) organizing nutrigenomics courses and summer schools. Our findings confirm this hypothesis, showing that over 30% of dieticians have never taken part in a nutrigenomics course. This group had significantly lower self-reported levels of knowledge than dieticians who had participated in nutrigenomics classes in the following topics: functions of genetic material, relationships between genes and the functioning of the body, practical applications of nutrigenomics, nutrigenomics research areas, and relationships between genes and traits.

### Table 2. Intergroup differences in the responses of Polish dieticians in the nutrigenomic education survey

| Item                                                                 | Median values of the responses with their interquartile ranges | p value |
|----------------------------------------------------------------------|---------------------------------------------------------------|---------|
|                                                                     | group 1 (n = 65)                                             | group 2 (n = 128) |
| **Self-reported attitudes**                                         |                                                               |         |
| Knowledge of nutrigenomics is important for dieticians              | 4.0±2.0                                                      | 4.0±2.0 ns  |
| I am interested in nutrigenomics                                    | 4.0±1.0                                                      | 4.0±1.0 ns  |
| Knowledge of nutrigenomics is important for dietetics profession    | 4.0±1.0                                                      | 4.0±1.0 ns  |
| The nutrigenomic education at my institution meets my expectations  | 2.0±2.0                                                      | 2.5±2.0 0.000 |
| I am interested in broadening my knowledge of nutrigenomics         | 4.0±2.0                                                      | 4.0±2.0 ns  |
| **The following topics should be taught in dietetics programs**     |                                                               |         |
| The effects of nutrients on cell function                           | 4.0±1.0                                                      | 5±1.0 ns  |
| The effect of nutrients on molecular mechanisms                     | 4.0±2.0                                                      | 4.0±2.0 ns  |
| The functions of genetic material                                   | 4.0±2.0                                                      | 4.0±1.0 ns  |
| Relationships between genes and the functioning of the body         | 4.0±1.0                                                      | 4.0±1.0 ns  |
| The practical applications of nutrigenomics                         | 5.0±1.0                                                      | 5.0±1.0 ns  |
| The effective communication of genetic risk information to patients | 4.0±2.0                                                      | 4.0±2.0 ns  |
| Nutrigenomics research areas                                        | 4.0±2.0                                                      | 4.0±2.0 ns  |
| The relationship between genes and traits                            | 4.0±2.0                                                      | 4.0±1.0 ns  |
| Understanding biochemical laboratory test results in the diagnosis of diet-related diseases | 5.0±1.0                                                      | 5.0±1.0 ns  |
| The main aspects of personalized diet                               | 5.0±1.0                                                      | 5.0±1.0 ns  |
| **I understand this topic well**                                    |                                                               |         |
| The effects of nutrients on cell function                           | 3.0±1.0                                                      | 3±1.5 ns  |
| The effect of nutrients on molecular mechanisms                     | 2.0±1.0                                                      | 3.0±1.0 0.049 |
| The functions of genetic material                                   | 3.0±1.0                                                      | 3.0±2.0 0.001 |
| Relationships between genes and the functioning of the body         | 3.0±1.0                                                      | 3.0±1.5 0.002 |
| The practical applications of nutrigenomics                         | 2.0±2.0                                                      | 3.0±2.0 0.026 |
| Effective communication of genetic risk information to patients      | 2.0±2.0                                                      | 2.0±2.0 ns  |
| Nutrigenomics research areas                                        | 2.0±2.0                                                      | 3.0±2.0 0.007 |
| The relationship between genes and traits                            | 3.0±3.0                                                      | 3.0±2.0 0.004 |
| Understanding biochemical laboratory test results in the diagnosis of diet-related diseases | 2.0±2.0                                                      | 3.0±2.0 ns  |
| The main aspects of personalized diet                               | 3.0±2.0                                                      | 3.0±2.0 ns  |

Results are presented as median values of the responses. Group 1, those subjects who had never participated in any nutrigenomics classes. Group 2, those who had participated in nutrigenomics classes prior to the survey. ns, not significant.
Finally, an equally important factor affecting the state of knowledge is the lack of a supportive environment. There are no Polish nutrigenomic or nutrigenetic societies that could gather dieticians and organize nutrigenomic events or lectures. Nevertheless, despite these factors, Polish dieticians have a generally positive attitude to nutritional genetics and are highly interested in broadening their knowledge, with about 70% expressing a desire to develop their knowledge in these topics.

However, looking closer at the results, it can be seen that students are more interested in the practical side of nutrigenomics, such as “the main aspects of personalized diet,” “understanding biochemical laboratory test results in the diagnosis of nutrition-related diseases,” and “the practical applications of nutrigenomics.” An understanding of these issues may be helpful in applying knowledge in real-life situations and may help critical thinking and evidence-based reasoning. These skills are very important, especially when faced with ubiquitous nutritional trends and pseudofacts. Focusing on the practical aspects of nutrigenomics during the education process thus seems a way of making such subjects more attractive to the students.

To provide better prospects for future dieticians and nutritionists, it is essential to promote the professional development in nutrigenomics and to allow them to become involved in that process. There is a need to improve awareness of the role of nutrigenomics in dietetic education. To improve the nutrigenomic education in Poland, well-qualified academic staff and access to better-quality learning materials must be provided. In addition, it is worth considering establishing a nutrigenomic organization or society which would bring dieticians together and prompt a discussion. However, improvements in nutrigenomic education will not achieve their goals without refinement of the educational frameworks and improvements in the Polish educational system.

Important strengths of the study include capturing a wide range of nutrition/dietetics professionals, most HEIs with dietetics programs in Poland, and validation of the survey instrument. However, there are also some limitations. Statistical tests were run without correction for multiple testing, and any potential confounding factors were also not included in the statistical analysis.

In conclusion, despite their positive attitude and strong desire to develop themselves, Polish dieticians possess low levels of nutrigenomic knowledge. To improve this situation, much more attention should be placed on nutrigenomic education in Poland. Nevertheless, these problems appear to be international, so a common solution may help improve the situation. A good example is the study of Fang et al. [25], who showed that providing additional nutrigenomics courses to dietetics students resulted in an increased interest in nutrigenomics and improvements in students’ knowledge. A potential solution has also been presented by Prasad et al. [26], who proposed a detailed plan for improving nutrigenetic and nutrigenomic education in dietetic curricula. However, the implementation of this program may be insufficient. Students develop the skills and acquire knowledge as part of a long-term process [27], so repeated exposure to nutrigenomics is needed. For that reason, recurring cycles of nutrigenomics classes at universities and additional courses after graduation are necessary to give a full understanding of the issues and, consequently, to apply the knowledge effectively. Such a complex program appears to be the most effective and promising strategy to improve the current state of nutrigenomic knowledge [28].

**Statement of Ethics**

All participants provided informed written consent.

**Disclosure Statement**

The authors declare that they have no conflicts of interest.

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**Author Contributions**

M.A.M.-C. collected the surveys, analyzed the data, and wrote the draft manuscript. A.C. designed the study, supervised the project, and revised the manuscript.

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