Consumer awareness and sweetener consumption habits of dietetics students

Sylwia Jaruga-Sękowska Departmennt of Health Promotion Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND
https://orcid.org/0000-0003-0142-2013

Agata Wójcicka Departmennt of Health Promotion Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND, ORCID: nie dotyczy;

Wiktoria Staśkiewicz, Department of Food Technology and Quality Evaluation, Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND
https://orcid.org/0000-0003-2420-5935

Joanna Woźniak-Holecka Departmennt of Health Promotion Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND
https://orcid.org/0000-0002-4468-063X

Gabriela Wanat-Kańtoch Departmennt of Health Promotion Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND
https://orcid.org/0000-0002-4915-3011

Marek Kardas, Department of Food Technology and Quality Evaluation, Faculty of Health Sciences in Bytom, Medical University of Silesia in Katowice, POLAND
https://orcid.org/0000-0002-4810-1025

Correspondence:
sjaruga@sum.edu.pl

Abstract:

Introduction. The incidence of obesity has continued to rise over the years, a problem that is driving increased consumer interest in agents that can replace sucrose. Sweet taste is linked to feelings of pleasure and happiness. For this reason, among others, substances that are alternatives to sugar have received increasing attention over the past few years. The **aim** of the study was to assess consumer awareness and sweetener consumption habits of dietetics students. **Material and methods**. The study included 201 participants aged 18-27 years studying nutrition. Nutritional status was assessed using the Body Mass Index (BMI). A proprietary validated survey questionnaire was used to assess consumer awareness and assess eating habits **Results**. The subjects' nutritional status was examined by assessing their BMI. Most of the respondents had a BMI described as normal. Respondents mostly sometimes

focused attention on the amount of calories consumed during the day, with 64.68% (N=130) of respondents giving this answer. Respondents cited health benefits (28.36%; N=57), energy value (20.40%; N=41), and taste (17.91%; N=36) as the most influential factor in choosing a particular sweetener. The study group's nutritional knowledge of sweeteners was unsatisfactory. **Conclusions**. Dietetics students' knowledge of sweeteners is alarmingly low. Most of the respondents had a BMI described as normal. In view of the low level of knowledge of the respondents, additional measures should be introduced resulting in an increase in the awareness of students in the described field, for example, increasing the number of lectures covering the above topics.

Keywords*: nutrition knowledge, nutritional status, sweeteners, sucrose

Introduction

Obesity is one of the serious public health problems, and it affects both adults and children. Many studies indicate that obesity is a much more complex problem than previously thought (Carocho et al., 2017). The disease is a component of many factors, both internal and external. These include the consumption of energy-rich foods, the consumption of excessive portions, physical inactivity, adverse changes in the intestinal microbiota, and the consumption of products high in fat, sugar and intense sweeteners (Veldhuizen et al., 2017). The incidence of obesity has continued to rise over the years, a problem that is driving increased consumer interest in agents that can replace sucrose (Low et al., 2016).

Humans experience through five basic senses, through which they interpret signals from the environment. Sweet taste is linked to feelings of pleasure and happiness (Carocho et al., 2017). For this reason, among others, substances that are alternatives to sugar have received increasing attention over the past few years (Veldhuizen et al., 2017). There is a growing interest in alternative products and foods with lower calorie, sugar and other substances that would replace standard products in terms of sweetness while maintaining a reduced caloric value, while having no toxic or carcinogenic properties (Veldhuizen et al., 2017). Sucrose and sugar syrups have been replaced over time by sweeteners of natural as well as synthetic origin with low or zero energy value. The popularity of the use of alternative sweeteners is growing all the time due to the increasing nutritional awareness of consumers, nutritionists and food manufacturers (Veldhuizen et al. 2017, Gertik & Przysławski 2006).

We perceive the impression of sweetness in food mainly through sugars such as sucrose, glucose or fructose. Sweet taste is not only caused by saccharides. Many compounds, of natural as well as synthetic origin, that differ in structure can imitate it. These include low-molecular-weight simple compounds, peptides, glycosides, as well as more complex proteins (Jarosz et al., 2020, Low et al., 2016).

According to Regulation (EC) No. 133/2008 of the European Parliament and the Council of the European Community, sweeteners are substances used to impart a sweet taste to foods or used in sweeteners (Veldhuizen et al., 2017, Sikorski & Stroszczyk 2017). They can be used to replace sucrose during the production process of lower-energy foods, foods that do not cause tooth decay and sugar-free foods. They are also used as sugar substitutes when this allows for extended shelf life. Sweeteners are also used in the production of special dietary foods (Sikorski & Stroszczyk 2017, Regulation (EC) No. 1333/2008, Zdrojewicz et al., 2015].

Sweeteners have many functions in foodstuffs, they can be divided as follows:
- Natural sugars, mono- and disaccharides: fructose, glucose, sugar syrups, sucrose, lactose, maltose;
- Additional sweeteners:

o Artificial intense sweeteners, tens to hundreds of times sweeter than sucrose. The best known are: acesulfame K (E950), aspartame (E951), cyclamate (E952), saccharin (E954), sucralose (E955) and neotame (E961);
o Among the most popular natural sweeteners are steviol glycosides (E960), thaumatin (E957);

- Semi-synthetic sweeteners (fillers) with sweetness lower than sucrose. Among the most popular are: xylitol (E967), erythritol (E968), sorbitol (E420), mannitol (E421), maltitol (E965), lactitol (E966) and isomaltose (E953) (Carocho et al., 2017, Drzewiecka 2016].

The **aim** of the study was to assess consumer awareness and sweetener consumption habits of dietetics students.

Material & methods

Participants

The study group consisted of first- and second-level dietetics students of the Bytom Faculty of Health Sciences at the Silesian Medical University in Katowice. The study included 201 participants, 188 women, and 13 men. Inclusion criteria for the study consisted of agreeing to participate in the study, having the status of a student of the Silesian Medical University majoring in dietetics, and participating in all elements of the study.

Procedure/Test protocol/Skill test trial/Measure/Instruments

The survey was conducted in the months of October-December 2021. The survey included an assessment of nutritional status and an analysis of consumer awareness and eating habits, as well as an assessment of nutritional knowledge regarding the use of sweeteners.

Nutritional status was assessed using the Body Mass Index (BMI). Height was measured using a SECA 213 stadiometer, while body mass was obtained by measuring with a SECA 769 balance. The results provided a basis for the assessment of height-weight ratios in relation to standards for the European population and WHO recommendations (WHO "Body Mass Index – BMI") (World Health Organization -BMI).

BMI was calculated using the formula (WHO "Body Mass Index – BMI"):

$$BMI = \frac{body\ mass\ [kg]}{(height\ [m])^2}$$

According to the WHO (World Health Organization), the following ranges of values for BMI were adopted:

- <18.49 – Underweight,
- 18.5-24.99 - Normal weight,
- 25.0-29.99 – Overweight,
- >30.0 – Obese (World Health Organization -BMI).

A proprietary validated survey questionnaire was used to assess **consumer awareness and assess eating habits**. The survey was divided into sections. The first part of the survey contained questions on general information, such as gender, age, body mass and height, place of residence, and year of study. The second part of the survey contained 33 questions on consumer awareness and sweetener consumption habits. The survey included open-ended and closed-ended questions with a choice of one or more answers.

The level of knowledge was assessed using the author's test, the answers obtained were evaluated by points. The maximum a respondent could get was 14.5 points (100%). Interpretation of the results was based on the following scale:

- 13-14.5 pts. - state of knowledge was assessed as very good,
- 11-12.75 pts. - state of knowledge was assessed as good,
- 9.5-10.75 pts. - state of knowledge was rated as sufficient,

- 8-9.25 pts. - state of knowledge was rated as acceptable,
- 0-7.75 pts. - state of knowledge was rated as insufficient.

Data collection and analysis / Statistical analysis.

Statistical analyses were performed using Statistica v.13.3 programs (Stat Soft Polska) and R v. 4.0.0 package (2020) under GNU GPL license (The R Foundation for Statistical Computing).

In order to present quantitative data, mean values and standard deviations - X±S - were calculated. For qualitative data, percentage notation was used. Compliance with normal distribution was checked using the Shapiro-Wilk test). The χ^2 test with variations depending on the sample size or U Mann-Whitney and Pearson test was used to assess correlations. A value of $p<0.05$ was used as a criterion for statistical significance.

Results

The survey was conducted on a group of 201 people: 188 women and 13 men. The majority of the survey group were first degree students (64.18%), while the rest were second degree students (35.82%). The vast majority of respondents (77.11%) declared a city as their place of residence, while 22.89% of the respondents indicated a village. The characteristics of the study group are shown in Table 1.

Table 1. Characteristics of the study group

Variable	Mean	SD	Min-max
Age [years]	23	2,95	18-27
Body mass [kg]	60,51	10,69	42-120
Body Height [cm]	166,86	7,43	150-213

The subjects' nutritional status was examined by assessing their BMI. Most of the respondents had a BMI described as normal. The exact distribution of BMI in the study group is shown in Figure 1.
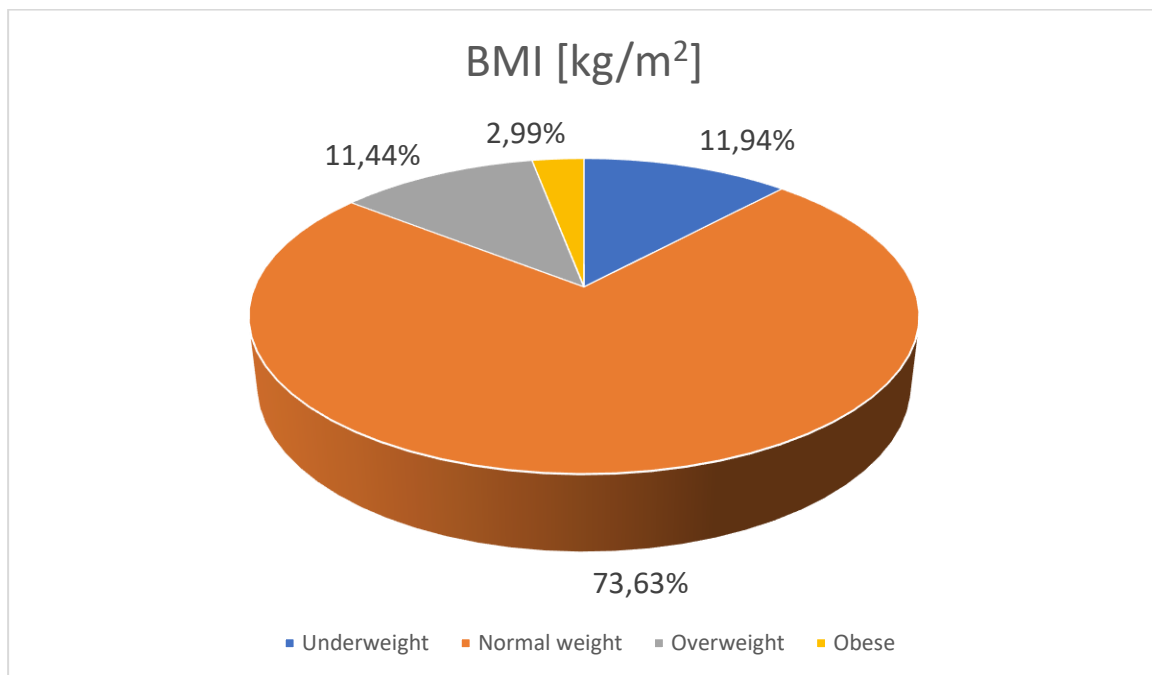

Figure 1. Body mass index (BMI) of respondents (N=201).

Respondents mostly sometimes focused attention on the amount of calories consumed during the day, with 64.68% (N=130) of respondents giving this answer. A smaller number of respondents said they always take note, 28.88% (N=48), while the fewest respondents answered that they never mind the amount of calories consumed (11.44%; N=23). The vast majority of respondents (74.13%; N=149) limit their consumption of sucrose, only 8.46% (N=17) of people completely exclude sugar, while 17.41% (N=35) continue to use it. Figure 2 shows the reasons why respondents exclude sugar from their diet.
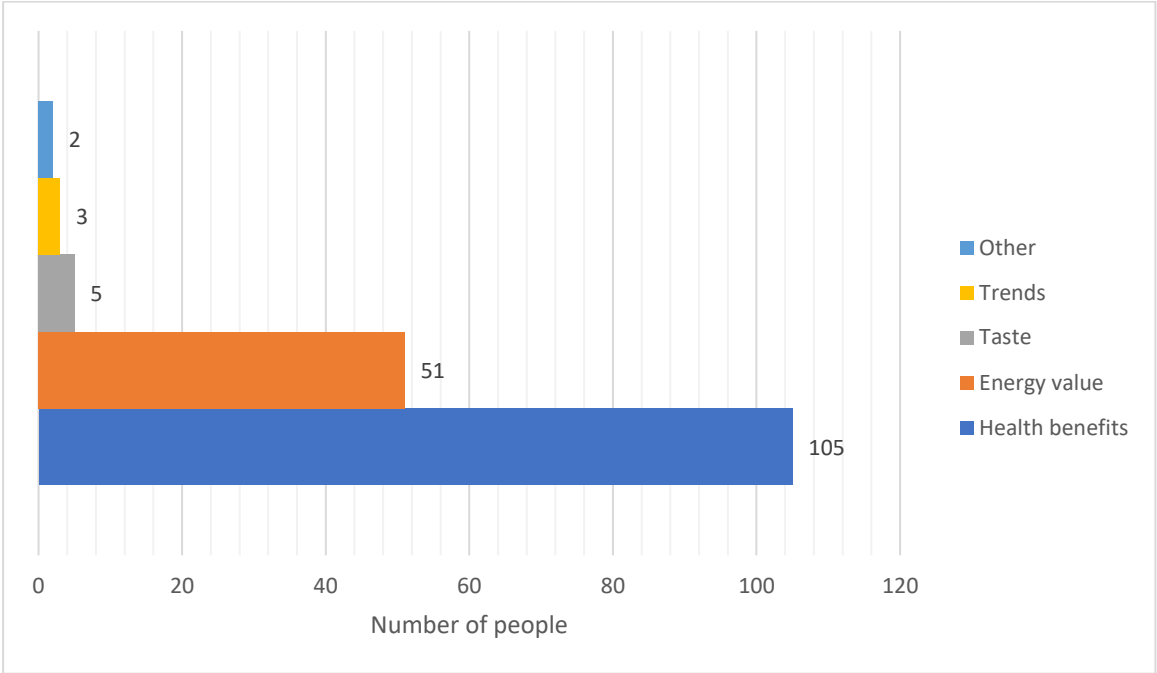
Figure 2. Reason for excluding or restricting sucrose (N=201).

More than half of respondents (53.23%; N=107) are considering eliminating sucrose with the intention of replacing it with other sweeteners, 11.44% (N=23) of respondents are considering eliminating sucrose altogether, as well as other sweeteners, while 10.95% (N=22) of respondents do not know whether they intend to eliminate sucrose. More than half of respondents (53.23%; N=107) are considering replacing sucrose with polyols, the next choice of respondents was intense sweeteners (19.91%; N=36). In contrast, 30 respondents do not know what they would replace sucrose with. The vast majority (79.10%; N=159) of respondents consume sweeteners, while the remainder (20.90%; N=42) did not declare consumption of any sugar substitutes. Figure 3 shows the sweeteners declared by respondents.

Figure 3. Declared sweeteners consumed (N=201).

Respondents cited health benefits (28.36%; N=57), energy value (20.40%; N=41), and taste (17.91%; N=36) as the most influential factor in choosing a particular sweetener. The price of the sweetener was 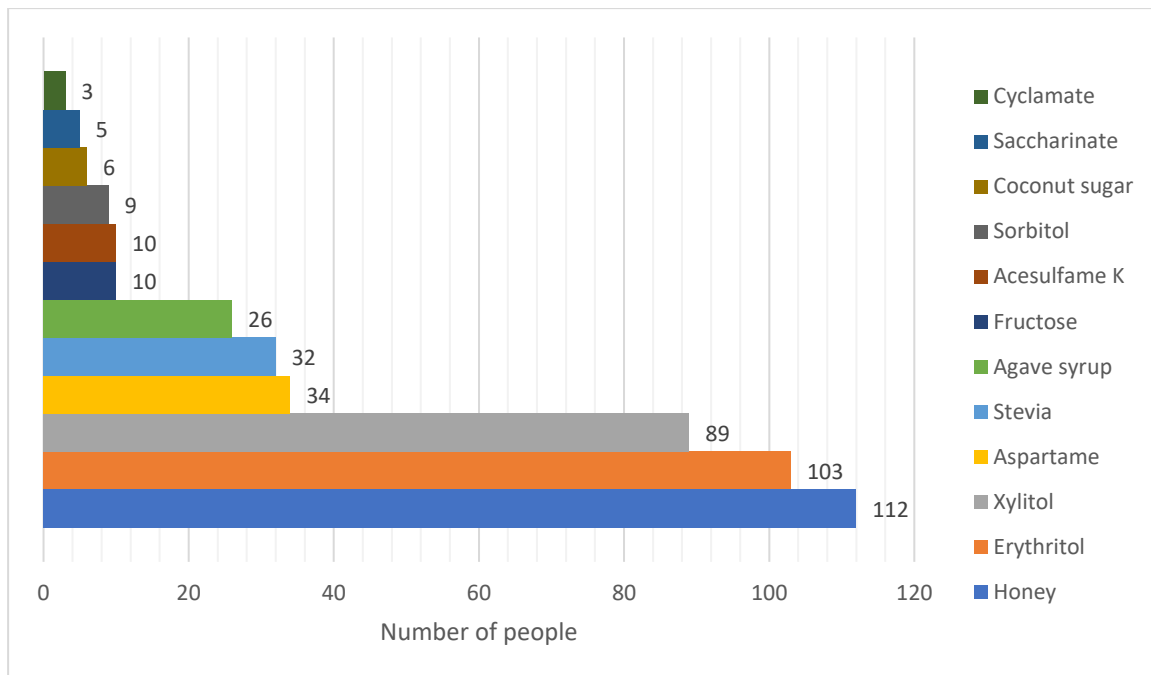an important selection criterion for 7.46% (N=15) of respondents, and 1% of respondents indicated other factors. The majority of respondents (53.73%; N=108) said they consumed zero/light beverages, while the remaining 46.27% (N=93) of respondents denied consuming such beverages. The majority (60.70%; N=122) of respondents pay attention to what replaces sucrose in food products, 20.90% (N=42) of respondents do not pay attention to this, and 18.40% (N=37) of respondents do not care about the question.

The largest percentage of respondents (87.06%; N=175)) indicated a lower energy supply as a perceived benefit of sweeteners, a slightly smaller percentage (64.18%; N=129) of respondents indicated that the use of sweeteners is beneficial for diabetics, 58.21% (N=117) of respondents perceived their positive effect on oral health, and 40.30% (N=81) of respondents perceived their glycemic index. Other characteristics of sweeteners were indicated by a small percentage of respondents, 2.99% (N=6) of respondents do not perceive the benefits of their use, while 1.99% (N=4) said they had no knowledge.

The largest percentage (51.74%; N=104)) of respondents indicated price as a negative aspect of sweetener use, a slightly smaller number of respondents (48.76%; N=98)) indicated adverse laxative effects, 46.77% (N=94) of respondents perceived habituation to excessive sweetness, and 45.77% (N=92) indicated health effects, as well as a slightly smaller number of respondents (45.27%; N=91)) indicated taste/taste. In descending order, respondents indicated negatively about carcinogenic effects (16.42%; N=33), effects on the microbiome (7.46%; N=15). A small percentage (5.47%; N=11) of respondents indicated that they did not perceive a negative effect of sweeteners, and 2.99% (N=6) said they had no knowledge on the subject.

Table 2 shows the results regarding the surveyed group's nutritional knowledge of sweeteners.

Table 2. Nutritional knowledge of sweeteners of the study group (N=201)

Level of knowledge	N (%)
Very good	0
Good	0
Acceptable	1(0,5%)
Admissible	46(22,89%)
Unsatisfactory	154(76,61%)

The majority of respondents (76.62%; N=154) indicated the Internet as the main source of knowledge about sweeteners, with slightly fewer (67.16%; N=135) respondents pointing to classes held at the university and EBM (Evidence Based Medicine) articles (45.77%; N=92). Books were indicated as a source of knowledge by 37.31% (N=75) of respondents, popular science articles by 27.86% (N=56) and training by 22.39% (N=45), with only 1% of respondents indicating sources of knowledge other than those listed.

There was statistically significant variation in the nutrition knowledge of respondents by degree (p=0.02). Grade 2 students showed a higher level of nutritional knowledge than grade 1 students. In contrast, there were no statistically significant differences between the level of nutritional knowledge and the respondents' BMI (p=0.73) (Figure 4).
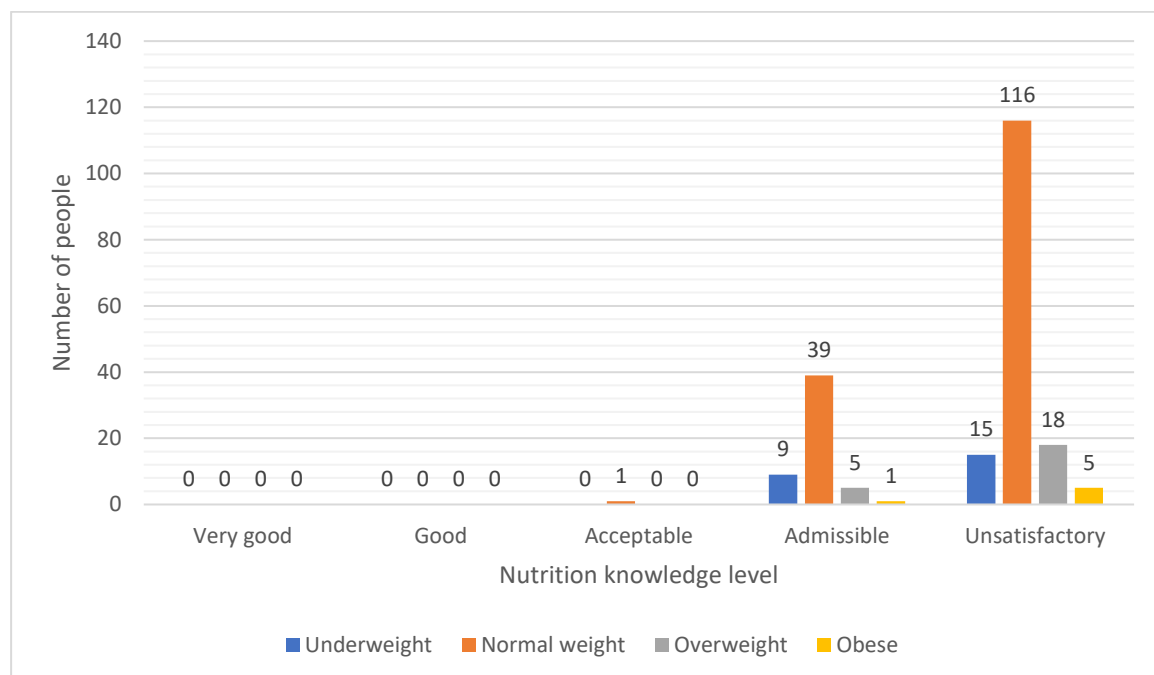
Figure 4. Nutrition knowledge of respondents vs. BMI (N=201)

There was no statistically significant relationship between paying attention to the amount of energy consumed per day and BMI (p=0.32).

Discussion

Obesity is one of the serious public health problems, and it affects both adults and children [14]. The incidence of obesity continues to increase over the years, this problem is the reason why there is increasing consumer interest in agents that can replace sucrose (Egg et al., 2020, Lonher et al., 2017).

Over the past few years, consumption of sweeteners has been steadily increasing, especially among young people. The entry into the student period by young people significantly affects their lifestyle changes, including eating habits. The period of study, usually placed

between the ages of 19 and 25, is a time when a young person's eating habits are formed. Students tend to choose unhealthy processed foods that affect the risk of obesity and other chronic non-communicable diseases. Students choose to consume foods and beverages with intense sweeteners to compensate for the consumption of excess energy (Egg et al., 2020).

Knowledge of sweeteners is important, especially for a dietitian who uses them in his work and should be an authority in his field. Patients consulting a dietitian need to get as complete information as possible about the safety, choice, taste and healthfulness of their chosen sweeteners in order to make the best choice for themselves. The dietitian, as a nutrition counselor, should recommend or advise against certain substances according to the current state of knowledge. The author's study shows that the level of knowledge of dietetics students about sweeteners was low. The assumed hypothesis of a high level of knowledge of dietetics students about sweeteners was not confirmed. In the vast majority (76.61%) of the respondents, the state of knowledge was determined as insufficient, in the case of 22.89% of the respondents, the state of knowledge was determined as acceptable, and only one person showed knowledge at a sufficient level. In a study by Koszowska et al. on the knowledge and opinions of dietetics and pharmacy students regarding sugar substitutes, it was shown that the level of knowledge of students in one and the other field is at a similar level (Koszowska & Zubelewicz-Szkodzińska 2012).

The author's study also tested the correlation of knowledge level about sweeteners with body mass index BMI. The correlation of the knowledge test with body mass index was not confirmed. The most numerous group of respondents with normal body weight (73.63%) received a failing grade (76.61%) and an acceptable grade (22.89%). In a study of the assessment of nutritional behavior of medical and non-medical students from the Świętokrzyskie Province, Misiarz et al. showed a small and inverse relationship between the knowledge test score and the value of body mass index BMI, both medical and non-medical students (Misiarz et al., 2013).

Our study showed a statistically significant relationship between the degree of study and the level of knowledge of the respondents. Second-degree students had more knowledge about sweeteners than first-degree students. Wilson et al. in their study of knowledge of non-nutritive sweeteners among university students also showed a correlation between the level of knowledge of first-year students compared to that of students in their second or further years (Wilson et al., 2019). In the study presented here, the respondents' level of knowledge was found to be lower than expected. The results of the study proved to be surprising due to the fact that the group of respondents was students in science-related fields and those related to medical care (Wilson et al., 2019). Egg et al. in a study of the relationship between nutritional knowledge, education, and other determinants of food intake and lifestyle habits among adolescents from urban and rural high schools in the Tyrol in western Austria proved the relationship between the amount of hours spent on nutrition education and students' knowledge (Egg et al., 2020). Taking into account our own study and the above-cited studies conducted in other countries, the conclusion is that the number of hours devoted to nutrition education influences the knowledge test score, which consequently leads to healthy eating habits, as well as to increased competence of the future nutritionist.

Excessive consumption of energy-dense foods high in easily digestible carbohydrates (sucrose) contributes to an increase in type 2 diabetes, cardiovascular disease, and obesity. The use of sucrose-replacing sweeteners in food products aims to reduce the incidence of overweight and obesity caused by carbohydrate disorders. Our own study analyzed the possibility of excluding sucrose from the diet. More than half of the respondents (53.23%) consider eliminating sucrose with the intention of replacing it with other sweeteners, while 11.44% of respondents consider eliminating sucrose from the diet altogether. The incidence of a relationship between reducing sucrose intake and body mass index (BMI) levels was also

studied. No significant relationship was found. The normal-weight group of respondents was the most numerous, the vast majority of which, 53.23%, considered partial elimination of sucrose from the diet. No studies were found verifying the correlation of reducing sucrose intake with body mass index (BMI). In our study, respondents were asked about their main source of obtaining knowledge about sweeteners. The majority (76.62%) of them pointed to the Internet as the most common place to seek information, slightly me, 67.16% pointed to university classes, and 45.77% to EBM articles. In the study by Koszowska et al. subject literature and mass media were marked as the most common sources of obtaining knowledge. Available information was identified as insufficient (Koszowska & Zubelewicz-Szkodzińska 2012).

In recent times, there has been an increase in concerns about health and quality of life caused by a highly processed diet high in fat, salt, and sugar. With the increase in consumer interest in reducing the aforementioned ingredients, the food industry has made every effort to offer consumers an alternative. The choice of sweeteners as a substitute for table sugar is wide. In a self-reported survey, respondents were asked whether and which sweeteners they use. The vast majority (79%) of respondents reported consuming sweeteners. Among the most frequently consumed were honey (55.72%), erythritol (51.24%), and xylitol (44.28%). The least common was saccharin (1.49%), sucralose (2.49%), and coconut sugar (2.98%). Factors influencing respondents' choice varied, with the most frequently stated being health benefits (28.36%), energy value (20.40%), and taste (17.91%). More than half (51.74%) of respondents described the available knowledge as partially sufficient. Price (51.74%), laxative effects (48.76%), and habituation to excessive sweetness (46.77%) were most frequently cited as negative aspects of sweetener use. In a study by Webb et al. of non-nutritive sweetener consumption patterns among university students in the Caribbean, the majority of respondents did not use sweeteners or foods or beverages with them. Among respondents consuming sweeteners, the ability to experience a sweet taste that is not an energy carrier was the main factor influencing their choice (Webb et al., 2019). In a study by Wilson et al. students declared that price, taste preference, and health effects were the biggest influences on their choice of substances (Wilson et al., 2019).

Conclusions

Based on the results, it was concluded that dietetics students' knowledge of sweeteners is alarmingly low. In addition, there is a statistically significant relationship between the degree of study and the knowledge of the respondents. Second-degree students showed higher knowledge of sweeteners than first-degree students. There was no significant relationship between dietary knowledge of sweeteners and the BMI body mass index level. In view of the low level of knowledge of the respondents, additional measures should be introduced resulting in an increase in the awareness of students in the described field, for example, increasing the number of lectures covering the above topics.

Conflicts of interest - The authors declare no conflict of interest.

References:

Carocho M, Morales P, Ferreira I. Sweeteners as food additives in the XXI century: A review of what is known and what is to come. Food Chem Tox. 2017; 107: 302-317.

Drzewiecka A. Sztuczne i naturalne środki słodzące. Kosmetologia Estetyczna. 2016; 4 (5): 365-369.

Egg S, Wakolbinger M, Reisser A, et al. Relationship between nutrition knowledge, education and other determinants of food intake and life style habits among adolescents from

Urban and rural secondary schools in Tyrol, western Austria. Pub Health Nutr. 2020; 23:17.

Gertig H, Przysławski J. Bromatologia zarys nauki o żywności i żywieniu. Warszawa: PZWL; 2006.

Jarosz M, Rychlik E, Stoś K, Charzewska J. Normy żywienia 2020. Warszawa: PZH; 2020.

Koszowska A, Zubelewicz-Szkodzińska B. Wiedza i opinie studentów dietetyki i farmacji w zakresie substytutów cukru. J Ecol Health. 2012; 104(2):198-204.

Low J, McBride R, Lacy K, Keast R. Psychophisical evaluation of sweetness functions cross multiple sweeteners. Chem Sens. 2016; 42(2):111-120.

Lohner S, Toews I, Meerpohl J. Health outcomes of non-nutritive sweeteners: analysis of the research landscape. Nutr J. 2017; 16:55.

Misiarz M, Malczyk E, Złoteńka-Synowiec M, et al. Ocena zachowań żywieniowych studentów kierunków medycznych i niemedycznych z województwa świętokrzyskiego. Piel Zdr Publ. 2013; 3(3):265-272.

Pearlman M, Obert J, Casey L. The association between artificial sweeteners and obesity. Curr Gastroenter Rep. 2017; 19:64.

Regulation (EC) No. 1333/2008 of the European Parliament and of the Council of December 16, 2008 on food additives (OJ 2008 No. 354 item 16)

Sikorski Z, Stroszczyk H. Chemia żywności główne składniki żywności. Warszawa: PWN; 2017.

Webb MC, Chong D, Bawa S. Consumption patterns of nonnutritive sweeteners among university students at a Caribbean institution. J Am Coll Health. 2019; (3):1-6.

Wilson T, Murray B, Price T et al. Non-nutritive (artificial) sweetener knowledge among university students. Nutrients 2019; 11(9):2201.

World Health Organization. Regional Office for Europe. "Body mass index – BMI" - [cited 2022 Jan 28]. Available from: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

Veldhuizen MG, Babbs RK, Patel B, et al. Integration of Sweet Taste and Metabolism Determines Carbohydrate Reward. Curr Biol. 2017; 27(16):2476-2485.

Zdrojewicz Z, Kocjan O, Idzior A. Substancje intensywnie słodzące – alternatywa dla cukru w czasach otyłości i cukrzycy. Med. Rodz 2015; 2(18):89-93.