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THE STATE OF KNOWLEDGE ON FOOD SAFETY AND FOOD WASTE AMONG YOUNG CONSUMERS

S u m m a r y

Background. Consumer behavior and food waste are crucial factors that contribute to global food insecurity. This study aimed to evaluate the knowledge of food safety and food waste young consumers in Poland have. The survey was conducted among young people aged 15 ÷ 29. The impact of education, place of residence and household residence on the knowledge of food safety and food waste was examined. The cross-sectional survey was carried out between September and December 2022, using the CAWI technique for data collection. The anonymity and confidentiality of data were ensured.

Results and conclusion. The respondent group comprised 640 people. Significant differences were observed in the definition of food safety among groups with different levels of education. The vast majority of respondents were not familiar with or did not even hear of the WHO's "5 Keys to Safe Food" (68.1 %), the 2030 Agenda for Sustainable Development (86.3 %) or the concept of sustainable food (59.1 %). On the other hand, when it came to issues of food loss and waste, 86.5 % of respondents were familiar with these concepts. As many as 67.3 % of respondents admitted to throwing food away. The groups differed significantly both in terms of education and place of residence. Based on logistic regression, it was estimated that those living alone, those living in the city and those with secondary and higher education were more likely to pay attention to food waste. Based on the survey, it can be concluded that large-scale educational action is needed.

Key words: food safety, young people, food waste, nutritional knowledge

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Introduction

Access to food is a fundamental human need that plays a crucial role in the development and maintaining good health [57]. Currently, global food production surpasses the requirements of the world's population. However, despite this abundance, the World Food Programme (WFP), a division of the United Nations, estimates that approximately 850 million people worldwide still suffer from hunger or severe malnutrition [15]. According to the Food and Agriculture Organization (FAO), nearly three billion individuals lack access to a well-balanced and nutritious diet [15, 30]. Pandemics and military conflicts around the world are likely to worsen disparities in food and water access. Hence, it becomes imperative to ensure food security at the individual, national, regional and global level, particularly in light of these challenges [7, 21, 33, 57].

Consumer behavior and food waste are crucial factors that contribute to global food insecurity. The Rome Declaration on World Food Security, included in the World Food Summit Roadmap, emphasizes the importance of taking action to eliminate poverty and social inequality arising from food access. It also highlights the need for a peaceful, stable and supportive political, social and economic environment as the foundation to prioritize global food safety [44]. In the context of food insecurity worldwide, significant attention is given to the scale of food loss and waste, which poses a global problem in ethical, social, environmental and economic terms [55, 64]. It is estimated that one-third of all food produced globally is wasted due to inadequate management [61]. The issue of food waste is a complex effect of several factors, including consumer behavior, which affects all aspects of the food chain [2]. In the United Nations' 2030 Agenda, food waste is primarily addressed in Goal 12 on sustainable consumption and production, and indirectly in Goal 2, which aims to eliminate hunger, promote food safety and improved nutrition, as well as to encourage sustainable agriculture [55, 57].

Food safety is a crucial issue that affects individuals of all ages. Insufficient knowledge about proper food handling and preparation could result in severe health consequences, such as hospitalization and even death. Therefore, awareness of food safety guidelines is essential [3]. However, young consumers tend to waste more food than older individuals. One of the known reasons is the perception of “use by” and “best before” dates on food products. Some young people tend to discard all food past the date indicated on the packaging, regardless of this description. This issue highlights a need for food safety education among young consumers [13, 35, 62].

Based on a study conducted by the Food Standards Agency in the UK, young individuals aged between 16 and 24 years are more inclined to engage in precarious food-related behavior, such as failing to wash their hands before preparing or consuming food, using the same cutting board for raw meat and vegetables, and consuming expired food products. These behaviors can lead to the spread of harmful bacteria such

as *Salmonella* and *Escherichia coli*. To address this issue, several organizations have launched campaigns aimed at increasing food safety awareness among young people. For instance, the Centre for Disease Control and Prevention (CDC) has developed the Safe Food Schools program, which provides teachers with resources and materials to educate their students on safe food handling practices [40].

Similarly, the Food and Drug Administration (FDA) has launched a 'Food Safety for Mums-to-Be' campaign to educate pregnant women and young mothers about the importance of safe food handling during pregnancy [8]. The presence of higher levels of food safety knowledge is associated with more positive attitudes toward safe hygiene behavior, highlighting the need for educational interventions [3]. Studies conducted on adults indicate that food safety knowledge improves with age and experience. Women tend to score higher than men, and younger individuals have the greatest need for additional food safety education [46]. The burden of foodborne diseases is a global issue that necessitates worldwide efforts in terms of cooperation, funding, awareness and involvement from various governments and policy-makers, especially in developing countries [53]. The Rapid Alert System for Food and Feed (RASFF), which is in place in all Member States in the EU, is an example of the efforts being made in this regard. It allows for the monitoring of food safety risks and taking immediate, preventive action [32].

The process of development of the food market is also accompanied by the phenomenon related to the lack of rational food management and the growing phenomenon of food waste [39]. Catering establishments have become not only places related to feeding people of different ages but also institutions responsible for the potential education of young consumers, especially in terms of care for sustainable development and the environment [43]. Food waste has a significant impact on food security both globally and locally [4]. Generation Z consumers (Gen Z), taking into account the age of birth from the mid-1990s to the beginning of 2010, are characterized by great potential in terms of shaping food consumption patterns [25]. The complexity of the research problem related to sustainable consumption has been observed in numerous publications [20, 28, 54]. A kind of research gap, however, consists of issues related to the habits of young consumers regarding food waste.

This study aimed to evaluate the knowledge of food safety, sustainable food and food waste young consumers in Poland have. The survey was conducted among young people aged 15-29. Based on the stated objectives, the following research hypotheses were formulated:

1. Those people with higher education are characterized by greater knowledge of food safety.
2. Those aged $20 \div 29$ are characterized by greater knowledge of food safety than those aged $15 \div 19$.

3. People living in cities are characterized by greater knowledge of food safety.
4. People with higher education pay more attention to food waste.
5. People living in cities pay more attention to food waste.

Material and methods

The cross-sectional survey was carried out between September and December 2022, using the CAWI (Computer-Assisted Web Interview) technique for data collection. The anonymity and confidentiality of data were ensured.

The research sample was recruited from among young people in Poland through social media advertisements. Interested individuals were directed to a questionnaire, which they were asked to complete if they met the inclusion criteria. Inclusion criteria included those aged 15 ÷ 29 who gave informed consent to participate in the study. For those under 18, consent was requested from a parent or legal guardian. Out of 664 collected questionnaires, 24 were rejected due to serious errors.

The study used an author's questionnaire based on the works of Tomaszewska et al. [57]; Zborowski and Mikulec [64]; Bilska et al. [2]; Zborowski and Mikulec [63]; and Mikulec et al. [31].

The survey questionnaire consisted of closed-ended questions, covering various aspects. Respondents were required to provide information such as their gender, age, education level, place of residence and household size.

The exploratory section of the questionnaire included inquiries about the respondents' knowledge of food safety and factors influencing it, the awareness of sustainable food issues and familiarity with the WHO's "Five Keys to Safer Food." Additionally, the survey incorporated questions regarding food waste, including its causes. Most questions were answered with a simple "yes" or "no" response.

The collected data was analyzed using Statistica 13.3 (Stat Soft Polska **Sp. z o.o.,** Poland). The study results were presented using percentage distribution (%), indicating the proportion of each score (% of indications). By age, the respondents were divided into two age groups 15 ÷ 19 (the age at which young people attend high school) and 20 ÷ 29 (the age at which young adults potentially start their independent lives). To assess differences between groups categorized by education, age and place of residence, the Chi-square test of independence with Yates correction was employed. A multivariate logistic regression model was prepared to verify if an education level, age and place of residence has an impact on whether a person pays attention to food waste. The independent binary variable in the model included categories: "no paying attention to food waste" (class 0) and "paying attention to food waste" (class 1). During the model preparation process, the dataset was split into a training set and a testing set in a proportion of 80:20 observations. Additionally, the oversampling method was applied to the minority class to achieve a balanced target variable in the training set. The selec-

tion of variables in logistic regression considered a multicollinearity problem. Due to the strong positive correlation observed between the variables connected with education and age, only the education variable was included in order to avoid multicollinearity. Taking all these factors into account, the following variables were selected: living alone or with family, place of residence and education. A statistical significance level of $\alpha = 0.05$ was considered for all analyses.

Results and discussion

A total of 463 women and 177 men participated in the survey, with a total sample size of 640 respondents. Almost two-thirds of the respondents lived in the countryside, while more than one-third came from urban areas. The size of the groups by age was similar to each other. Respondents aged 15-19 accounted for 43.0 % and those aged 20 ÷ 29 for 57.0 % of the total group. In the examined group, individuals with secondary school education predominated (49.1 %). More than 90 % of the respondents lived with their families in households of 3 ÷ 4 people (43.3 %) (Table 1).

Table 1. Characteristics of the study sample
Tabela 1. Charakterystyka badanej grupy

Parameters /Parametr	Number of Respondents [n] / Liczba Respondentów [n]	Percentage [%] / Odsetek [%]
Gender / Płeć		
Female / Kobiety	463	72.3
Male / Mężczyźni	177	27.7
Age [years] / Wiek [lata]		
15 ÷ 19	275	43.0
20 ÷ 29	365	57.0
Place of residence / Miejsce zamieszkania		
Countryside / Wieś	393	61.4
City / Miasto	247	38.6
Education / Wykształcenie		
Primary school / Podstawowoe	198	30.9
Secondary school / Średnie	314	49.1
Higher education / Wyższe	128	20.0
Current residence / Sytuacja rodzinno-mieszkaniowa		
I live alone / Mieszkam sam	57	8.9
I live with a family / Mieszkam z rodziną	583	91.1
Number of persons living in the household / Liczba osób zamieszkujących gospodarstwo domowe		
1 to 2 / 1 do 2	74	11.6
3 to 4 / 3 do 4	277	43.3
5 to 6/ 5 do 6	226	35.3
More than 6 / Powyżej 6	63	9.8

Knowledge of the definition of food safety

In the question "what is your understanding of food safety", the respondents were asked to indicate "yes" or "no" for each answer option. The majority of respondents selected the correct answer, which referred to the set of conditions that must be met concerning the actions to be taken at all stages of food production or trade to ensure human health and life. Significant differences in the frequency of selecting this answer were observed among different educational and age groups. Individuals with secondary education (30.5 %), aged 20 ÷ 29 (38.8 %) and those residing in rural areas (33.4 %) most frequently chose the answer "D". It was also noteworthy that the answer options "B" and "A", which pertained to contaminants in food and the use of food additives, were indicated as definitions of safe food with similar frequencies, although significant differences ($p = 0.04$) in the frequency of answering "A" were observed only for the 20-29 age group. (Table 2).

Table 2. Food safety definition by education level, age and place of residence
Tabela 2. Definicja bezpieczeństwa żywności według wykształcenia, wieku i miejsca zamieszkania

Responses / Odpowiedzi	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15-19	20-29	*p*	Countryside / Wieś	City / Miasto	*p*
A	12.1	20.2	6.9	0.46	18.8	20.2	0.04	23.3	15.6	0.52
B	15.5	24.1	10.2	0.97	21.1	28.4	0.91	30.3	19.5	0.67
C	9.2	4.5	2.1	< 0.01	10.8	5.0	<0.01	11.3	4.5	0.02
D	13.3	30.5	13.6	< 0.01	18.6	38.8	<0.01	33.4	23.9	0.06

Explanatory notes:
A – a set of conditions that must be met concerning the use of food additives; B – a set of conditions that must be met concerning the levels of contaminants and residues of plant protection products and fertilizers; C – a set of conditions that must be met concerning the organoleptic characteristics of food; D – a set of conditions that must be met concerning the actions that need to be taken at all stages of food production or trade to ensure human health and life.
Objaśnienia:
A – ogół warunków, które muszą być spełnione, dotyczący stosowanych substancji dodatkowych do żywności; B – ogół warunków, substancji zanieczyszczających, pozostałości środków ochrony i nawożenia roślin, warunków napromieniania żywności; C – ogół warunków, które muszą być spełnione, dotyczący cech organoleptycznych żywności; D – ogół warunków, które muszą być spełnione dotyczący działań, które muszą być podejmowane na wszystkich etapach produkcji lub obrotu żywnością – w celu zapewnienia zdrowia i życia człowieka.

The research results indicate a proper understanding of the concept of food safety. A review of the literature shows that knowledge about food safety varies among young people in different countries [5, 37]. Compared to our Polish youth, the youth from Jordan or Greece gave, on average, fewer correct answers to questions about food safety (only 46 %) [5]. In turn, young people living in Turkey and Saudi Arabia had a similar level of knowledge as Poles, respectively 57 % and 75 % of correct answers on food safety [47, 51]. Studies conducted among adults have shown that knowledge about food safety increases with age and practice: women score higher than men, and younger respondents show the greatest need for additional food safety education [46].

Factors influencing food safety

There were significant differences between respondents of different educational level and age in the perception of important factors that influenced food safety. These factors were: industrialization and intensification of food production (from 10.2 % of respondents with higher education to 18.4 % with a secondary school background), application of pesticides and plant protection and fertilization agents (from 14.1 % of respondents with higher education to 29.2 % with a secondary school background and 20.9 % of respondents aged 15 ÷ 19 and 37.3 % of those aged 20 ÷ 29), changes in animal breeding (e.g., the use of intensive animal farming practices) (from 10.8 % of respondents with higher education to 20.3 % with a secondary school background and 15.8 % of respondents aged 15 ÷ 19 and 27.3 % of those aged 20 ÷ 29), the emergence of new foodborne pathogens (from 7.8 % of respondents with higher education to 21.7 % with a secondary school background and 15.5 % of respondents aged 15 ÷ 19 and 24.1 % of those aged 20 ÷ 29), and aging populations (from 1.4 % of respondents with higher education to 6.1 % with a primary school background and 6.9 % of respondents aged 15 ÷ 19 and 5.3 % of those aged 20 ÷ 29) and the utilization of genetically modified organisms (GMOs) in food production (12.8 % of respondents aged 15 ÷ 19 and 21.9 % of those aged 20 ÷ 29) (Table 3). These results show, among other things, that young people are less afraid of genetically modified food and the possibility of pathogens in food (Table 3).

When considering the respondents' place of residence, significant differences were found in indicating changes in animal breeding (19.4 % of respondents living in rural areas and 23.8 % living in cities) and the utilization of genetically modified organisms (GMOs) in food production (19.5 % of respondents living in rural areas and 15.2 % living in cities) as factors influencing food safety. These factors were also most frequently indicated as posing threats to food safety (Table 3).

Food safety is one of the basic human needs, which, when simplified through Maslow's hierarchy of needs, is nothing more but the need for constant access to food.

Thus, it refers to the elimination of hunger and the internal sense of security in society [29].

Table 3. Factors influencing food safety by education level, age and place of residence
Tabela 3. Czynniki wpływające na bezpieczeństwo żywności według wykształcenia, wieku i miejsca zamieszkania

Factors / Czynniki	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15÷19	20÷29	*p*	Countryside / Wieś	City / Miasto	*p*
industrialization and intensification of food production / industrializacja i intensyfikacja produkcji żywności	10.9	18.4	10.2	0.02	15.5	23.9	0.15	23.4	15.9	0.43
application of pesticides and plant protection and fertilization agents / stosowanie pestycydów i innych środków ochrony i nawożenia roślin	15.1	29.2	14.1	<0.01	20.9	37.3	<0.01	34.2	24.6	0.09
changes in animal breeding / zmiany w żywieniu zwierząt	12.2	20.3	10.8	0.02	15.8	27.3	0.01	19.4	23.8	<0.01
emerging foodborne pathogens / pojawienie się czynników chorobotwór-czych przenoszonych przez żywność	10.1	21.7	7.8	0.03	15.5	24.1	0.13	23.9	15.6	0.69
mass production of food / masowa produkcja żywności	8.9	11.2	5.5	0.49	11.3	15.0	0.95	14.8	11.4	0.13
changes in lifestyle and consumption patterns / zmiany stylu życia i wzorców konsumpcji	5.3	7.5	2.8	0.73	7.8	7.8	0.15	9.5	6.1	0.93
aging populations / starzenie się społeczeństw	6.1	4.7	1.4	<0.01	6.9	5.3	0.01	7.9	4.2	0.44

food poisoning and infections / liczba zatruć i zakażeń pokarmowych	10.1	17.2	6.7	0.85	13.0	20.8	0.12	20.6	13.1	0.92
utilization of GMOs in food production / wykorzystywanie GMO do produkcji żywności	8.8	18.3	7.7	0.07	12.8	21.9	0.03	19.5	15.2	0.05

The scope of the conducted research also included the question of the respondents regarding factors determining food safety. Respondents indicating the main factors affecting food safety pointed to the industrialization and intensification of food production, the use of pesticides and plant protection and fertilization agents, changes in animal husbandry, the emergence of new food-borne pathogens and the aging of population. Changing socio-economic conditions make it difficult for food producers to provide adequate nutrition to an ever-growing global population. It is estimated that by 2050 the world population will reach 10 billion, which is a huge challenge for all sectors involved in food production [45]. Alternatives to existing food products, such as edible insects, can partly address this problem by diversifying food sources, as well as providing high-quality dietary protein [22, 23, 24, 59].

Plant protection products are used in many fields of agriculture to improve yields and product quality [52]. The most characteristic contribution of the use of pesticides is the reduction of food losses caused by pests and diseases of crops, especially in developing countries [6, 48, 49, 50]. Similar concerns about the use of pesticides have been observed in the Greek society. Greek consumers were found to be concerned about how pesticide residues in food could affect their health and that of their loved ones [52].

The factors influencing food safety indicated by young respondents are the emergence of new food-borne pathogens. Growing concerns about food safety in this area may be related to globalization, urbanization, increasing social affluence and changing eating patterns around the world. In low- and middle-income places, it is estimated that most foodborne illnesses still result from food mismanagement, which creates potential danger. Current literature suggests that food safety concerns are related to risks throughout the supply chain [26]. Therefore, further efforts to improve food safety should be continued, also through the education of young consumers.

Undoubtedly, nutrition is crucial for physical development and maintaining human health. Well-nourished children learn better and adults are more productive [12]. In recent years, the COVID-19 pandemic has possibly caused legitimate consumer concerns. As pointed out in the literature, there is currently no confirmed evidence of SARS-CoV-2 transmission through consumption of contaminated food or water [16].

Knowledge of concepts

The respondents were asked about their knowledge of issues including familiarity with the WHO's 5 steps to safe food, sustainable food and issues related to food loss and waste. The great majority of respondents neither knew nor had even heard of the WHO's "Five Keys to Safer Food" (68.1 %), the 2030 Agenda for Sustainable Development (86.3 %) or the concept of sustainable food (59.1 %). On the other hand, when it came to issues relating to food loss and waste, 86.5 % of the respondents were familiar with them, and 92.9 % paid attention to food waste. As many as 67.3 % of the respondents admitted to wasting food. These respondents differed significantly by both education and place of residence. The highest percentages of people who threw food away were those with higher education, aged 20 ÷ 29, and those living in rural areas (32.5; 41.2 and 38.6 %, respectively) (Table 4).

Table 4. Knowledge of selected topics related to food by education level, age and place of residence
Tabela 4. Znajomość podstawowych pojęć związanych z żywnością według wykształcenia, wieku i miejsca zamieszkania

Questions Pytania	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15 ÷ 19	20 ÷ 29	*p*	Countryside / Wieś	City / Miasto	*p*
Do you know or have you heard of the "Five Keys to Safer Food" developed by the World Health Organization (WHO)? / Czy znasz lub słyszałeś o opracowanych przez Światową Organizację Zdrowia (WHO) „Pięć kroków do bezpieczniejszej żywności”?										
Yes / Tak	13.2	14.2	4.5	< 0.01	16.9	15.0	< 0.01	21.6	10.3	0.03
No / Nie	17.8	34.8	15.5		26.1	42.0		39.8	28.3	
Do you know or have you heard of the 2030 Agenda for Sustainable Development? / Czy znasz lub słyszałaś/eś o Agendzie na rzecz Zrównoważonego Rozwoju 2030?										
Yes / Tak	4.1	4.8	4.8	< 0.01	5.5	8.3	0.59	8.1	5.6	0.63
No /Nie	26.9	44.2	15.2		37.5	48.8		53.4	32.9	

Do you know or have you heard of the term sustainable food? / Czy znasz lub słyszałaś/eś o pojęciu zrównoważona żywność?										
Yes / Tak	11.7	20.6	8.6	0.56	16.7	24.2	0.41	23.8	17.1	0.14
No / Nie	19.2	28.4	11.5		26.3	32.8		37.6	21.5	
Are you familiar with the concept of food loss and waste? / Czy znasz pojęcie strat i marnotrawstwa żywności?										
Yes / Tak	26.4	43.4	16.7	0.32	36.9	49.7	0.72	52.2	34.3	0.08
No / Nie	4.6	5.6	3.3		6.1	7.3		9.3	4.2	
Do you pay attention to food waste? / Czy zwracasz uwagę na marnowanie żywności?										
Yes / Tak	27.2	46.8	18.9	0.01	38.1	54.8	< 0.01	56.2	36.7	0.08
No / Nie	3.8	2.2	1.1		4.8	2.3		5.2	1.9	
Do you ever waste food? / Czy zdarza ci się marnować jedzenie?										
Yes / Tak	19.5	15.3	32.5	0.03	26.1	41.2	< 0.01	38.6	28.7	< 0.01
No / Nie	11.4	16.6	4.7		16.9	15.8		22.8	9.9	

The 2030 Agenda for Sustainable Development [58] sets out an action plan for the coming years on many levels. Sustainable Consumption and Production, a goal of the 12 Sustainable Development Goals (SDGs), advocates a 50 % reduction in global food waste. Renzi et al. [42] indicate that young consumers seem to pay special attention to global issues. They show a more favorable attitude towards sustainable behavior than older consumers. Unfortunately, as showed by the survey, most respondents do not know or have not even heard of the 2030 Agenda for Sustainable Development.

When it comes to issues related to food losses and waste, 86.5 % of the respondents know these terms, whereas 92.9 % pay attention to food waste. And as many as 67.3 % of them admit to throwing food away. Food waste occurs at all stages of the food chain, however, estimated studies indicate that households in developed countries have the largest share in food waste [1]. The Internet and the school environment were most often indicated as the source of knowledge on food waste. Studies show that interventions and the implementation of educational programs aimed at increasing social awareness of the scale of the problem lead to a reduction in the scale of food waste [9, 18]. Educational institutions around the world are working to implement an educational framework that integrates One Health and transdisciplinary competencies to improve sustainable food production and environmental management. The survey respondents

identify the concept of sustainable food with care for the natural environment. The educational trend focused on this area is "One Health". One Health is a concept according to which the health of humans, animals and the environment are inextricably linked [11].

Table 5. Specifying sustainable food by education level, age and place of residence
Tabela 5. Definiowanie zrównoważonej żywności według wykształcenia, wieku i miejsca zamieszkania

Responses Odpowiedzi	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15÷19	20÷29	*p*	Countryside / Wieś	City / Miasto	*p*
It is a product of sustainable agriculture, characterized by concern for the environment and the finances of the farmer, and accepted by the society / To produkt rolnictwa zrównoważonego, charakteryzującego się troską o środowisko, finanse rolnika i akceptowany przez społeczeństwo										
Yes / Tak	15.6	22.5	8.3	0.26	22.0	24.4	0.04	28.6	17.8	0.92
No / Nie	15.3	26.6	11.7		20.9	32.7		32.8	20.8	
It is food produced in an environmentally friendly way / To żywność produkowana w sposób przyjazny dla środowiska										
Yes / Tak	16.0	30.0	15.0	< 0.01	23.2	37.7	< 0.01	36.3	24.7	0.22
No / Nie	14.5	19.2	5.4		19.7	19.4		25.0	14.0	
It is food produced in accordance with the principles of profitable agricultural production and its social acceptance / To żywność wyprodukowana zgodnie z zasadami opłacalności produkcji rolniczej i jej akceptacji społecznej										
Yes / Tak	10.0	13.1	4.3	< 0.01	12.4	15.0	0.55	16.7	10.7	0.93
No / Nie	20.9	35.9	15.8		30.6	42.0		44.7	27.9	

In response to the question of where the respondents encountered the concept of sustainable development or sustainable food, the majority pointed at the Internet (32.3 %), school (23.6 %) and articles in scientific journals (13.5 %). The respondents perceived sustainable food as produced in an environmentally friendly manner (61 %). In response to this question, differences were found both in terms of the age of the respondents and their level of education. Those with a secondary education and those aged 20 ÷ 29 represented the largest percentage of those giving this answer (30.0 and

37.7 %, respectively). Rural residents also frequently answered in the same way (36.3 %), although they did not differ significantly ($p = 0.22$) from urban residents. On the other hand, the definition of products of sustainable agriculture, characterized by concern for the environment, the farmer's finances, and accepted by the society, was selected by 46.4 % of the respondents. Only respondents in the groups where age was the dividing criterion differed significantly ($p = 0.04$) (Table 5).

Food losses and waste

The respondents were asked to indicate how they understood food loss and waste. Most comprehended these concepts as food produced for consumption that has not been consumed by humans (60.9 %) and as a reflection of consumer behavior, often combined with conscious decisions to throw edible food products away (62.2 %) (Table 6). In the case of loss and waste perceived as the conscious throwing away of products, significant differences were observed between groups by level of education ($p < 0.01$) (31.5 % of those with a secondary school background), age ($p < 0.01$) (44.0 % of those aged 20 ÷ 29) and by place of residence ($p = 0.01$) (36.6 % of those living in rural areas). The groups also differed significantly from each other as regards their answers related to food waste and waste products being rejected outside the agri-food chain for economic and aesthetic reasons (Table 6).

Table 6. Understanding of food loss and waste by education level, age and place of residence
Tabela 6. Rozumienie strat i marnotrawstwa żywności według wykształcenia, wieku i miejsca zamieszkania

Responses Odpowiedzi	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15÷19	20÷29	*p*	Countryside / Wieś	City / Miasto	*p*
Food produced for consumption that has not been consumed by humans / Żywność wytworzona dla celów konsumpcyjnych, która nie została spożyta przez człowieka										
Yes / Tak	17.4	31.5	12.0	0.17	25.6	35.3	0.61	36.7	24.2	0.45
No / Nie	13.6	17.6	7.9		17.4	21.7		24.7	14.4	
Food products rejected outside the agri-food chain for economic and aesthetic reasons / Produkty żywnościowe odrzucone poza łańcuch rolno-żywnościowy ze względów gospodarczych, estetycznych										

Yes / Tak	10.3	20.5	10.1	0.01	14.2	26.7	< 0.01	22.3	18.6	< 0.01
No / Nie	20.6	28.6	9.9		28.8	30.3		39.1	20.0	
It is a representation of consumer behavior, often combined with conscious decisions to throw food products suitable for consumption away / To odzwierciedlenie zachowań konsumentów, często łączonych ze świadomymi decyzjami związanymi z wyrzucaniem produktów żywnościowych nadających się do spożycia										
Yes / Tak	15.8	31.5	14.9	< 0.01	22.2	40.0	< 0.01	36.6	25.6	0.01
No / Nie	15.2	17.4	5.2		20.8	17.0		24.9	12.9	
It is when food products are past their best-before date / To przekroczenie daty przydatności do spożycia przez artykuły spożywcze										
Yes / Tak	9.1	15.6	6.1	0.82	13.6	17.2	0.75	17.7	13.1	0.16
No / Nie	21.9	33.4	13.9		29.4	39.8		43.7	25.5	

Table 7. Factors determining safe food by education level, age and place of residence
Tabela 7. Czynniki decydujące o bezpieczeństwie żywności według wykształcenia, wieku i miejsca zamieszkania

Responses / Odpowiedzi	Education [%] / Wykształcenie [%]				Age in years [%] / Wiek w latach [%]			Place of residence [%] / Miejsce zamieszkania [%]		
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	*p*	15÷19	19÷29	*p*	Countryside / Wieś	City / Miasto	*p*
contamination-free food / żywność wolna od zanieczyszczeń										
Yes / Tak	17.9	35.2	15.1	< 0.01	25.9	42.3	< 0.01	39.5	28.7	0.01
No / Nie	12.9	13.7	5.2		17.1	14.7		21.9	9.9	
food that has not gone off/ żywność nieprzeterminowana										
Yes / Tak	11.7	16.3	8.1	< 0.01	15.5	20.6	0.97	21.3	14.8	0.32
No / Nie	19.2	32.8	11.9		27.5	36.4		40.2	23.7	
ecologically produced food / żywność produkowana metodami ekologicznymi										
Yes / Tak	13.1	13.8	6.9	< 0.01	16.7	17.2	0.03	22.8	11.1	0.04
No / Nie	17.7	35.4	13.1		26.3	39.8		38.6	27.5	

food with quality mark/certification / żywność mająca znak jakości/certyfikat										
Yes / Tak	13.3	21.3	7.5	0.51	20.2	21.8	0.04	26.3	15.6	0.53
No / Nie	17.7	27.7	12.5		22.8	35.2		35.2	22.9	
food that does not cause negative health effects to the body / żywność nie powodująca negatywnych skutków zdrowotnych dla organizmu										
Yes / Tak	14.2	35.2	14.7	< 0.01	22.1	42.0	< 0.01	37.2	26.9	0.02
No / Nie	16.7	13.9	5.3		20.9	15.0		24.2	11.7	
self-made food / żywność wyprodukowana samodzielnie										
Yes / Tak	6.6	8.6	2.8	< 0.01	9.1	8.9	0.09	11.9	6.1	0.30
No / Nie	24.4	40.4	17.2		33.9	48.10		49.5	32.5	

When indicating the factors for safe food, the respondents most often differed based on their level of education and age. Most understood it as free of contaminants and not causing negative health effects to the body (68.1 % and 64.1 %, respectively) (Table 7).

The respondents were asked to mark yes or no next to selected food products that were thrown away at home. Among the products most often indicated, were bakery products (33.2 %), dairy products (31.2 %), fruit (28.4 %), vegetables (25.4 %) and cold cuts (20.0 %). There were significant differences between the groups by education in discarding vegetables ($p = 0.01$); pasta and spices ($p < 0.01$) and groats ($p = 0.02$). Respondents with higher education were most likely to report discarding vegetables (13.9 %), while pasta, spices and groats were most likely to be thrown away by those with primary education. There were significant differences between groups by age observed in the throwing away of bread ($p = 0.02$); meat ($p = 0.01$); vegetables ($p = 0.01$); pasta, groats and spices ($p < 0.01$). Respondents aged 20 ÷ 29 were significantly more likely to report the throwing away of bread (21.1 %) and vegetables (16.7 %), while pasta, spices and groats were most often thrown away by those aged 15 ÷ 19. However, by place of residence, urban and rural residents differed significantly between each other in throwing away bakery products ($p < 0.01$), fruit ($p < 0.01$) and vegetables ($p < 0.01$). City residents were significantly more likely to report the throwing away of bread, fruit and vegetables compared to rural residents.

The obtained results are consistent with those obtained as part of the GOSPOSTRATEG program implemented in Poland in 2018 ÷ 2021, a research project devoted to the study of food losses and waste. Program called “Developing a system for monitoring wasted food and an effective program to rationalize losses and reduce food waste” (acronym PROM). Its purpose was also to examine how much food was wasted in Poland along the entire production chain - the so-called "from field to table". As a result, Bilska et al. [1] observed that bread was the most frequently wasted prod-

uct by Polish respondents (23.8 %). Almost 13 % of respondents "often and sometimes" threw away smoked meat, vegetables except for root vegetables, milk drinks and fresh fruit. Bread was wasted more often by people aged 18 ÷ 24, in our own research also people aged over 20 (20 ÷ 29) significantly more often declared that they threw bread away.

Table 8. Reasons for throwing food away by education level and place of residence
Tabela 8. Powody wyrzucania żywności według wykształcenia i miejsca zamieszkania

Responses / Odpowiedzi	Education [%] / Wykształcenie [%] $p = 0.03$			Age in years [%] / Wiek w latach [%] $p = 0.03$		Place of residence [%] / Miejsce zamieszkania [%] $p = 0.57$	
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	15÷19	20÷29	Countryside / Wieś	City / Miasto
obvious signs of spoilage / wyraźne oznaki zepsucia	9.7	26.2	13	15.1	33.9	28.1	20.9
expiration of shelf life / upływ terminu przydatności do spożycia	8.4	10.7	3.9	10.2	12.8	12.8	10.2
loss of organoleptic qualities (e.g. change in taste, smell, color, etc.) / utrata walorów organoleptycznych (np. zmiana smaku, zapachu, barwy itp.)	5.1	5.1	2.8	5.8	7.2	7.2	5.8
inability to use food purchased / nieumiejętność wykorzystania zakupionych produktów	2.8	2.8	0.9	3.5	3.0	4.6	1.9
buying excessive amounts of food products / kupowanie nadmiernych ilości produktów spożywczych	2.3	3.2	1.6	3.3	3.9	3.7	3.5

The respondents were asked to mark the reasons for throwing food away. The main reasons in the group by education, age and place of residence (98.5; 98.7 and 98.7 %, respectively) were obvious signs of spoilage, expiration date, change in organoleptic qualities, inability to use the products they had or purchase of excess food (Table 8). Only by education and age, the respondents differed significantly in the frequency of reasons for throwing food away. Individuals also pointed to reasons such as

preparing too large portions of food at home and the lack of smaller portions/packages of selected food products in markets.

When asked about noting the expiration date, the respondents with different levels of education and age differed significantly ($p = 0.03$). Respondents with secondary education and aged 20 ÷ 29 were most likely to notice this aspect of food by answering always (23.4 and 30.5 % respectively) and often (20.9 and 22.3 % respectively) (Table 9).

Table 9. Taking note of the expiration date of food products
Tabela 9. Zwracanie uwagi na datę ważności produktów spożywczych

Responses / Odpowiedzi	Education [%] / Wykształcenie [%] $p = 0.01$			Age in years [%] / Wiek w latach [%] $p < 0.01$		Place of residence [%] / Miejsce zamieszkania [%] $p = 0.34$	
	Primary school / Podstawowe	Secondary school / Średnie	Higher education / Wyższe	15÷19	20÷29	Countryside / Wieś	City / Miasto
always / zawsze	14.2	23.4	12.0	19.2	30.5	29.1	20.6
often / często	11.7	20.9	6.6	16.9	22.3	24.6	14.5
rarely / rzadko	4.4	3.3	1.3	5.3	3.6	6.3	2.7
never / nigdy	0.6	1.4	0.2	1.6	0.6	1.4	0.8

According to a report by the Food and Agriculture Organization of the United Nations [14], one-third of all food produced for human consumption was wasted each year in the 2000s. This represented approximately 1.3 billion tons of global food production per year. Given the scale of the problem, our research aimed to determine which groups of food products are wasted the most often . Among the food thrown away, the respondents most often mentioned bread, dairy products, fruit, vegetables and cold cuts. Similar observations were made by other researchers in the world [17, 19]. The main reasons for throwing food away are visible signs of spoilage, which can pose a serious threat to the health of consumers both in households and in public catering [27].

Another factor exacerbating the scale of the problem is the expiration of the best-before date. According to the Regulation of the European Union [41], the "date of minimum durability of food" means the date until which the food retains its specific properties, provided that it is properly stored. Observance of proper labeling is particularly

important in the case of food products that promote the growth of microorganisms and thus may pose a direct threat to human health. Different dates on food labels, including best-before dates, and misinterpretation of these dates directly lead to an increase in food waste [60, 65]. It is observed that the terms "use by" and "best before" mean the same thing to respondents. Differences in the scope and methods of date marking can contribute to confusion between the industry and consumers and ultimately lead to significant, unnecessary food loss and waste [34].

It should be emphasized that there is a problem with direct measurement of food loss and waste levels mainly due to the different ways in which data is obtained. Niedek et al. [36] indicate that there are no universal methods of obtaining data, and their selection depends on the specificity of a particular stage or link in the agri-food chain in which the measurement is to be made and on the purpose of this measurement. The European Union has been undertaking a number of initiatives in this area for years, which are reflected in legal acts, such as Regulation (EC) No. 2150/2002 of November 25, 2002 on waste statistics or Directive 2008/98/EC of the European Parliament and of the Council of November 19, 2008 on waste. In 2019, the Act of 19 July 2019 on counteracting food waste was introduced in Poland.

As part of its “From Field to Table” strategy, the European Commission is working on revisions to Regulation 1169/2011 on the provision of food information to consumers. It envisages various scenarios for what can be done to further combat food waste. One of the proposals is to extend the list of products exempted from the obligation to indicate the minimum durability date. A second proposal is to abandon the term 'best before' in order to keep only one name for the 'use by' date. The third proposal is to use new wording for the use-by date: "best before, often good after" or "end of expiry date, best before" or changes in format, layout, color such as imposing a mandatory graphical/visual presentation (e.g. red color for use-by dates and green for minimum durability dates or different symbols such as the STOP sign to indicate dates) [10].

Research conducted by Bilska et al. [1] showed that a greater percentage of men than women declared that they usually did not check the stock levels in the household before going shopping, which may be associated with an increase in food waste. The author also emphasized that information about food products stored at home before going shopping is the key to avoiding unnecessary food purchases. This practice would lead to less waste due to expired food. In addition, if consumers used a proper food storage system and useful principles such as meal planning by inventory and FIFO, they could reduce the amount of waste caused by forgotten food. The results of the conducted research show how diverse the causes and sources of food waste are and how all these factors are interrelated. The 2030 Agenda for Sustainable Development [58] sets out an action plan for the coming years on many levels. Sustainable Consumption and Production, a goal of the 12 Sustainable Development Goals (SDGs),

advocates a 50 % reduction in global food waste. Several actions should be taken to prevent food waste. These activities start at home by planning a shopping list. When making food products, you should choose only those ingredients that you will be able to reliably use. When dining out, order smaller portions or take leftovers home. At home, use the cooling and freezing of food, which is the best way to preserve it [56]. Adolescence is a special development period for young consumers in terms of nutritional education. There is a positive impact of education through the work of teachers on the awareness of young people on making food choices and reducing losses related to food waste [38].

Logistic regression

The results obtained using logistic regression was shown in Table 10.

Table 10. Parameters of logistic regression model
Tabela 10. Parametry modelu regresji logistycznej

	Coefficint	Stdandard error	$p > \|z\|$
Living alone or with family / Mieszkam sam lub z rodziną	-0.6139	0.101	< 0.010
Place of residence / Miejsce zamieszkania	0.4925	0.157	< 0.012
Secondary education / Wykształcenie średnie	0.9108	0.144	< 0.010
Higher education / Wykształcenie wyższe	0.4468	0.200	0.026

The model achieved an accuracy level of 0.69, a low result that can be explained by the difficulty associated with predicting social phenomena. The F1-score, which takes into account precision and recall, was 0.74. With a significance level of 0.05, all variables were statistically significant.

The interpretations of the estimations for each variable were as follows:

a) People living with their families had about 46 % lower chances of paying attention to food waste compared to people living alone, ceteris paribus.
b) People living in cities had about 64 % higher chances of paying attention to food waste compared to people living in rural areas, ceteris paribus.
c) People with secondary education had approximately 2.5 times higher chances of paying attention to food waste compared to people with primary education, ceteris paribus.
d) People with higher education had about 56 % higher chances of paying attention to food waste compared to people with primary education, ceteris paribus.

Limitations of the Study

Despite the considerable sample size of 640 young individuals, obtained through voluntary sampling, there may be concerns about its representativeness. Although the survey was conducted only in Poland and focused solely on young people, the research aimed to investigate the level of knowledge about food safety and food waste among this demographic group, as they often do not yet manage their own households. Conversely, restricting the survey to young people in Poland offers an opportunity to compare the findings with those from other countries. Moreover, it would be beneficial to enhance the survey methodology by integrating a food diary to quantify the amount of wasted food.

Conclusion

1. Based on the study, the research hypotheses were verified. Chi2 test and logistic regression confirmed most of the research hypotheses, so it should be concluded:
   a) Those aged 20 ÷ 29 are characterized by greater knowledge about food safety, compared to those aged 15 ÷ 19.
   b) People living in cities do not differ in their level of food safety knowledge compared to those living in the countryside.
   c) People with higher education pay more attention to food waste.
   d) People living in cities, despite throwing away more bread, fruit and vegetables, pay more attention to food waste than rural residents.
   e) The hypothesis that people with higher education are characterized by greater knowledge of food safety was not confirmed. Those with secondary education are characterized by a higher level of food safety knowledge, compared to the other groups.
2. Additionally, based on the survey, it should be concluded that the state of knowledge about food safety among young consumers in Poland requires a series of educational activities.
3. Educational efforts also need to be taken in the area of sustainability and sustainable food issues. Only 13.7 % of the respondents have heard of the 2030 Agenda for Sustainable Development, and less than half (40.9 %) are familiar with the term sustainable food. The main source of knowledge about the subject is the Internet (for 32.3 % of the respondents) and school (for 23.6 % of the respondents), so it is worth using these sources to promote topics on the subject more widely.
4. Although the state of knowledge of Polish young consumers does not differ from that of young people living in other countries (e.g. Turkey and Saudi Arabia), it is slightly better than that of young Greeks or Jordanians.

5. It should be emphasized that realizing the importance of the issues of food safety, food waste, sustainability and production is more relevant than ever, if only because the consequences of industrial explosive growth are becoming increasingly felt.
6. It is necessary to undertake educational activities on a large scale because education about this subject is extremely important both for the sake of our health, but also for the condition of the planet on which we live.

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STAN WIEDZY NA TEMAT BEZPIECZEŃSTWA I MARNOWANIA ŻYWNOŚCI WŚRÓD MŁODYCH KONSUMENTÓW

S t r e s z c z e n i e

Wprowadzenie. Zachowania konsumentów i marnowanie żywności są kluczowymi czynnikami, które przyczyniają się do globalnego braku bezpieczeństwa żywnościowego. Niniejsze badanie miało na celu ocenę wiedzy młodych konsumentów w Polsce na temat bezpieczeństwa żywności i jej marnowania. Badanie przeprowadzono wśród młodych ludzi w wieku $15 \div 29$ lat. Zbadano wpływ wykształcenia, miejsca zamieszkania i miejsca zamieszkania gospodarstwa domowego na wiedzę na temat bezpieczeń-

stwa żywności i marnowania żywności. Badanie przekrojowe przeprowadzono w okresie od września do grudnia 2022 r., wykorzystując do zbierania danych technikę CAWI. Zapewniono anonimowość i poufność danych.

Wyniki i wnioski. Grupa respondentów liczyła 640 osób. Zaobserwowano istotne różnice w definiowaniu bezpieczeństwa żywności w grupach o różnym poziomie wykształcenia. Zdecydowana większość respondentów nie znała lub nawet nie słyszała o "5 kluczach do bezpiecznej żywności" WHO (68,1 %), Agendzie na rzecz zrównoważonego rozwoju 2030 (86.3 %) czy koncepcji zrównoważonej żywności (59.1 %). Natomiast, jeśli chodzi o kwestie strat i marnowania żywności, 86.5 % respondentów było zaznajomionych z tymi pojęciami. Aż 67.3 % respondentów przyznało się do wyrzucania żywności. Grupy różniły się istotnie zarówno pod względem wykształcenia, jak i miejsca zamieszkania. Na podstawie regresji logistycznej oszacowano, że osoby mieszkające samotnie, mieszkające w mieście oraz osoby z wykształceniem średnim i wyższym częściej zwracały uwagę na marnowanie żywności.

Słowa kluczowe:bezpieczeństwo żywności, młodzież, marnowanie żywności, wiedza żywieniowa