FAMILY HEALTH DISEASE

edited by
Filip Gołkowski and
Małgorzata Kalemba-Drożdż

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Family – Health – Disease. Preface

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The family is the basic social cell and a person's closest environment; it plays the dominant non-medical role in shaping health as it is the primary source of knowledge about nutrition, life-style and disease prevention. The family may determine both healthy habits and anti-health behaviors; it influences the entire duration of a person's life. It is important to emphasize the extremely significant role of the family in providing care, supporting treatment processes, and giving company to an ill family member.

However, transferring most of the responsibility for the health of sick person from medical care professionals to the family means that disease not only affects the sick person but may also lead to an increased burden for caregiving family members. As a consequence, the burnout of caregivers prevents effective treatment of the patient or even makes it impossible; moreover, the quality of the caregiver's life decreases.

Chapter One, by Agnieszka Fusińska-Korpik, provides scientific reflection on the consequences of caring for caregiving relatives of patients with schizophrenia and ways of holistically supporting patients and their families.

Issues concerning the carer's burden are also addressed in Chapter Two, by Agnieszka Skorupska-Król, Paulina Kurleto and Grażyna Dębska, who describe selected types of support and their importance for the quality of life of caregivers of people after ischemic stroke.

In Chapter Three, Leszek Pawłowski and Jakub Bil discuss the extremely important social topic of the currently emerging possibilities of effective prevention of suicide. The authors not only emphasize the determinants of this phenomenon (motives for suicide and individual and environmental risk factors) but also indicate the remedies included in specific programs which open new possibilities for saving human lives.

In Chapter Four, Renata Bajcarczyk, Renta Florek and Dorota Kozieł describe teenagers' and their mothers' knowledge about cervical cancer prevention and HPV vaccines. As the mother-daughter relationship is one of the closest, it seems to play a key role in the maintenance and development of the female reproductive health of daughters. As the primary prevention of cervical cancer is based on education and vaccination of young girls, this issue should be also addressed to their mothers.

In Chapter Five, Joanna Witkoś describes the opinions of final-year medical students concerning the stages of life and age of women that are predisposed to stress urinary incontinence. The advanced aging of societies is an emerging problem which challenges healthcare professionals as well as family members. Urinary incontinence is currently one of the most widespread medical problems and has a real influence on the daily lives of millions of women.

In Chapter Six, Małgorzata Kalemba-Drożdż with Agata Grzywacz Kisielewska and Joanna Kin-Dąbrowska consider if vegetarian, vegan or non-meat-excluding diets may affect the content of heavy metals, dioxins and polychlorinated biphenyls in human milk. Natural feeding represents a newborn baby's first relationship and is an opportunity to form healthy eating habits for both mother and child. The results of the research suggest that high food diversity can protect against the accumulation of anthropogenic toxins.

We hope that the book will be a source of knowledge for students of medicine disciplines, health care professionals, researchers dealing with health and disease issues in the context of the family, as well as decision-makers responsible for health policy.

Chapter 1

Caregiver burden in relatives of patients with schizophrenia – reality and methods of support

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Abstract

Schizophrenia is a chronic disease that affects about 1% of the population. Scientific interest in the families of sick people has been rooted in the search for systemic factors affecting the onset, course and prognosis of the illness. Today, more and more attention is being paid to the role of the family as a source of support in the treatment process, and family cohesion is considered a positive prognostic factor. A person with schizophrenia often needs accompanying in the recovery process, therefore the patient's relatives can be a source of instrumental and socio-emotional support, often providing motivation for treatment and rehabilitation. Still, in the public health system the opportunities to support the patient's family are relatively small and limited to single initiatives. At the same time, research results and clinical experiences suggest that caregivers often feel overwhelmed by daily duties, feel a lack of reliable knowledge, and it is difficult for them to adjust themselves to their new role. This chapter provides scientific reflection on the consequences of caring for a person with schizophrenia. The state of the study and the possibilities of holistic support for the patient and his family system are analyzed.

Key words: schizophrenia, caregivers, burden

Introduction

The family is an essential part of the treatment of mentally ill persons. It is estimated that mental illness has a significant impact on patients themselves and up to 10 people in their surroundings [1]. The illness of a relative always makes it necessary to reorganize roles, responsibilities and habits. Just as sick people learn to adapt to the new situation, family members look for new forms of communication and try to find a balance between concern and demands, care and freedom. The appearance of mental illness in a family is a challenge and requires internal reorganization. Although the original characteristics of the family (pre-crisis history, consistency, coherence, individual characteristics of all family members) are of undoubted importance, families often do not receive appropriate support from medical staff and therefore search independently not only for information about the disease and treatment, but also for support with their own problems. Research supports the thesis that interventions targeting the patient's family can have a significant impact on treatment outcomes, including the length and quality of remission [2].

Caregiver burden

In most cases, a person who takes care of a mentally ill patient belongs to their immediate family [1]. Studies among families of people with schizophrenia shows that caregivers are mostly women, most of whom live with the sick person and perform professional duties in parallel. In almost half of cases, the patient's caregivers were parents, followed by husband/spouse. A caregiver often feels (and usually is) responsible for taking care of the patient's household duties and needs, monitoring his mental state, detecting early relapse signals, and verifying the regularity of medication and medical checks. Caring for a relative with mental illness also requires real financial costs [3]. In the case of a heavy load, the caregiver often feels a kind of burnout in this role that is manifested by a feeling of fatigue, helplessness, and often anger towards the sick person.

Although the concept of caregiver burnout originally applied to those in a professional role [4], contemporary research clearly shows that family members of people with disabilities suffer from burnout symptoms that are comparable to those experienced by professional caregivers [5]. The sense of emotional exhaustion not only negatively affects the quality of life of the caregiver and is a risk factor in their own mental problems, but it also triggers negative defense mechanisms and can negatively affect their involvement in care.

The impact of a relative's disease on the functioning of the family (e.g. reduction of economic status, limitation of leisure opportunities) is referred to as "caregiver/family burden" in the literature [6–10]. These consequences are generally divided into two basic categories:

- Objective burden – directly related to the severity of symptoms, the duration of the disease, and sociodemographic variables (age, gender, level of education, degree of kinship). These relate to real changes in the functioning of the family (increased duties, change in professional activity, deterioration of the caregiver's health)
- Subjective burden – the mental functioning of the caregiver, including a sense of tension, despondency, loss of something important in life and even anger.

Based on interviews with caregivers of people with schizophrenia, Gater et al. [11] categorized the basic areas affected by the experience of care. In the caregivers' narratives, they found the following threads:

1) Emotional Impact – the issue of emotions experienced due to the burden of care was discussed in interviews most often. The subjects described feelings of overload, sadness, helplessness, frustration, embarrassment, anger or stress, but they also reported severe and disturbing mood swings.
2) Caregivers' Concerns – mostly related to the course of illness and its impact on the patient's functioning. Caregivers often wonder how their role will look as the disease progresses.
3) Impact on Daily Activities – for many of those surveyed, caring for a person with schizophrenia had become a central part of their life

that marginalizes opportunities and needs related to leisure and social relations. It is worth noting that primary caregivers feel alone in the performance of their role. In such cases, the disease may influence other relationships within the family.

4) Physical Impact – caregivers often observed a concrete impact of the burden on their own health. They not only felt worn out and tired but also reported an increase of chronic physical symptoms. This may be related to stress level, chronic anxiety and real physical demands.
5) Financial Impact/Impact on Employment – in most of the studied families, a person with schizophrenia was more or less financially dependent on others. As a result, caregivers reported decreased financial status, less productivity due to the burden and, in some cases, the need to give up work.
6) Impact on Relationships with Others – caregivers saw the disease as disrupting their relationships with loved ones and the wider social environment. They declared they had only a small amount of time that they could devote to other family members; they also reported social isolation that was compounded by the stigma phenomenon. Many studies still indicate that caregivers of mentally ill people experience stigmatization in the area of social contacts [12–14]. In the studied families, most relatives felt isolated and responsible for the patient's illness. They reported getting negative feedback not only from the widely defined social environment but also from medical staff. Such experiences are a source of shared stigma. The persistent sense of guilt and shame about the disease that is shared by relatives makes the family procrastinate with the search for help and shut out the external environment, which often has a negative impact on the patient's health and recovery process.
7) Impact on the Relationship with the Person with Schizophrenia – taking into account the negative aspects of the relationship between a caregiver and a person with schizophrenia, families often mentioned aspects related to denial of the problem and the need for continuous monitoring of treatment. Relatives often described this experience as

a kind of struggle that drained their strength and permanently violated mutual trust.

Factors leading to caregiver burden

Polish studies of families of patients receiving stationary psychiatric treatment are consistent with previously described results. They show that the care burden affected most subjects, most of whom declared frequent concerns about the patient's health, safety and future, as well as the burden of constant efforts to motivate him to be active. As many as 67% of the surveyed caregivers experienced a real deterioration in their health [10]. Caregivers of mentally ill people, due to high stress levels, are at risk of developing depressive and anxiety symptoms.

Although studies do not allow the creation of a uniform matrix of the factors that affect the burden of caregivers of people with schizophrenia, on the basis of qualitative studies many authors are attempting to classify the most important ones [15–17].

It seems that the burden of care should be related to the course of the disease itself. Although some studies confirm this relationship, it is unclear whether this applies to positive and negative symptoms or to the general level of functioning [16]. It is possible that both of these factors have equal meaning. The severity of symptoms can directly affect the difficulty of providing care as a result of disrupted communication and behavioral disturbances (e.g. aggression). Families report the weeks before hospitalization as the most overwhelming period in the care cycle of the sick person [17]. Inefficiency and isolation can make it necessary to assist a sick person in fulfilling even basic life needs. It was also revealed that high levels of stress and burnout among caregivers were related to patients' poor response to treatment [15].

Researchers have attempted to analyze the type of relationship between the patient and the caregiver as a determinant of the care burden. The results in this area are inconsistent but indicate that the highest burden falls on patients' parents and spouses [18–20].

Caregivers who feel overwhelmed by their everyday struggles often present inefficient ways of dealing with the crisis. Among them, avoidance, denial, coercion and negative distraction dominate [21–24]. Scientists pay special attention to relatives' appraisals and their role in caregivers' burnout and patients' recovery processes. It was revealed that caregivers who appraise the illness more negatively tend to report a greater burden and stress level [25]. Negative cognitive appraisals may result not only from depressive symptoms, but also from lack of knowledge and experience. They may be especially visible when the symptoms of schizophrenia first occur [26]. It seems to be especially important to support families from the beginning of the care process in order to help them find a sense of their role in the patient's recovery and inform them about possible positive outcomes and prognoses. Surprisingly, single studies suggest that active and problem-focused coping strategies may be related to greater burnout among caregivers [27], thus increasing helplessness when there is insufficient support.

Positive outcomes

In the psychiatric literature, the concept of 'burden' is increasingly being replaced by more neutral terms such as 'consequences of care' or 'care experience'. This is done to highlight the multifaceted experience of the crisis of a family member's mental illness and its impact on the whole family system. In various studies, positive outcomes of care have been mentioned by caregivers [9]. They reported that such an experience can lead to greater sense of living, love and a deeper relationship. It must be noted that with appropriate support, caregivers may experience post-traumatic growth which leads them to evaluate their experiences positively [28]. It is not surprising then that positive outcomes from the patient–caregiver relationship are correlated with social support, optimistic and problem-focused coping mechanisms, and personality traits such as openness to experience, extraversion, conscientiousness, and agreeableness [29]. These results support the role of various intervention programs developed for schizophrenia caregivers in order to help them manage the crisis of mental illness and the burden of care.

Methods of support

The problem of family experiences when caring for schizophrenic patients is a universal challenge in all countries. One of the main and most widely available forms of support for caregivers of mentally ill people is psychoeducation [30], which should focus primarily on equipping relatives with the most important information on mental health and its dysfunctions. Most often this takes place in thematic sessions and involves a discussion of various types of disease, their symptoms, as well as prevention and diagnosis of relapse signals, treatment options and costs, including the effects of pharmacotherapy. This knowledge allows caregivers to feel safer and more competent in their roles, and also, among other things, it realistically supports the treatment process by more effectively recognizing the signs of deterioration of the mental health of a close person [31]. Furthermore, it is useful to equip families with skills related to coping with stress and methods of reducing it (e.g. relaxation techniques) [32].

Caregivers of persons with mental disturbances often struggle with a sense of misunderstanding and alienation that makes it difficult for them to seek support and meet their social needs. The literature draws attention to the important role played by support groups for families of people with schizophrenia [6]. Both reports from scientific literature and practical experiences of working with relatives of mentally ill people suggest that the experience of participating in a support group builds a sense of belonging, understanding and acceptance. In addition, caregivers of mentally ill people learn ways of communicating and finding a balance between providing support and allowing the patient to be autonomous and make mature decisions. Sharing their own experiences reduces tension and is a source of hope. This form of support facilitates the process of adaptation in the face of the diagnosis of the mental illness of a family member. It is also helpful for sustaining remission and dealing with everyday difficulties, as well as meeting the social needs of people who deal with mental illness in their family.

Research shows that family support is a factor that positively affects the treatment process of psychiatric patients [33–35]. Relatives may play an important role in supporting the patient's self-esteem and building their hope in a positive response to treatment and a return to everyday life. At the same time, they are a source of security that provides support during crisis periods and offers a safe space for rebuilding self-reliance and preventing the creation of a stigma-based self-image.

Lack of or inadequate support from relatives can hinder the treatment process, including shortening remission periods, non-compliance with medical recommendations, or lack of motivation to build self-reliance. In psychiatric treatment, the best results are achieved when the patient, doctor and family work together towards a successful recovery. Due to these benefits, attention should be increasingly paid to efforts aimed at implementing multifaceted family support in psychiatric care.

Measurement of caregiver burden is a process that is usually not included in the formal diagnosis of a patient's situation, for example on psychiatric wards. However, due to the fact that family well-being is an essential factor in a patient's recovery, standardized measures of caregiver burnout should be one of the main parts of the diagnostic process as they help to get a broad picture of the current situation and its future potential for rehabilitation purposes.

Conclusions

Schizophrenia, due to its course, is a disease that is considered a serious crisis for the family. Various studies reporting caregiving experiences may result in advantages for the development of the treatment of mentally ill people. This need is consistent with actual trends in psychiatry which encourage taking care of patients in their own environments and reducing the risk of acute states and hospitalizations. Although the caregiver’s burden is a fairly universal aspect of family relationships and seems to be observed worldwide, there are cultural differences that relate to the social perception of mental illnesses and methods of help. Further research in Poland is needed to explore family–patient relationships and the effects of a family member’s mental illness on treatment results and quality of life.

Chapter 2

Assessment of selected types of support and their importance for the quality of life of carers of people after ischemic stroke

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Abstract
Introduction: Informal carers of people who have had an ischemic stroke constitute one of the pillars of the state's welfare system. Individual social support can help solve carers' health problems and improve their quality of life. The aim of the presented research was to assess selected social services and indicate the importance of this support for self-assessment of their quality of life.

Material and methods: Research material included the results a diagnostic survey obtained from 39 informal caregivers of people who had suffered an ischemic stroke. The Berlin Social Support Scales and the WHOQOL-Bref quality of life questionnaire were used. The statistical analysis was carried out with the use of SPSS Statistics 24.0 software.

Results: When better support is perceived by the guardian, this correlates with higher quality of life in the social ($r = 0.31$) and environmental ($r = 0.32$) spheres. Better currently received support correlates with higher quality of life in the psychological ($r = 0.32$) and environmental ($r = 0.36$) spheres.

Conclusions: 1. Social support is important for carers' perceived satisfaction with their quality of life; 2. Satisfaction with personal functioning facilitates essential activities for providing competent care.

Key words: informal care, stroke, social support, quality of life

Introduction

Family carers are the main pillar of the state's welfare system [37]. The advantages of the care they provide pertain to the close relationship between them and their patients, which is normally characterized by mutual trust and a high level of involvement in the procedures and day-to-day life of the patients. What is also important is the closeness of caregivers, their availability, and the on-going possibility to identify needs or evaluate actions undertaken for their patients. On the other hand, this type of care is a difficult physical and emotional experience for the caregiver. The lack of interdisciplinary support staff that would enable more effective caregiving at home may be the cause of negative psychophysical experiences among this group of people. Caregiver Stress Syndrome (CSS) has been known for a long time; its symptomatology is varied and relates to the emotional and mental situation (Figure 1).

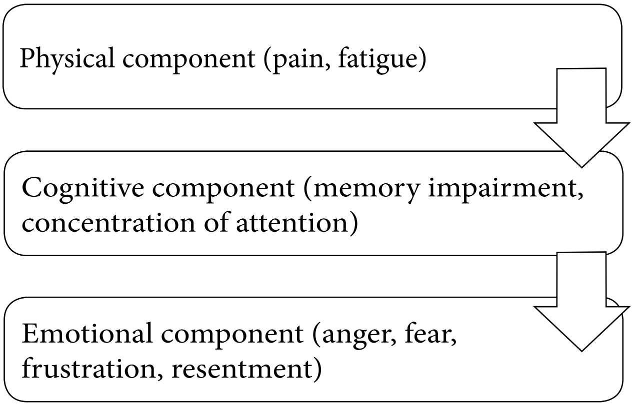

Figure 1. Components of a Caregiver's Stress Team [38]

English-language literature defines family caregivers as *"forgotten patients"* due to the fact that the health status and quality of life of the caregiver negatively changes in response to their duties [39]. So, how do you counteract the difficulties that arise in the life of the caregiver of a chronically ill person? How to reduce the risk of health problems and poor quality of life? It seems that one answer to these questions may be social support. This is defined as a kind of social interaction undertaken by one or many participants in a problematic, difficult or critical situation. Emotions, information, instruments of action and material goods are transferred or exchanged in the course of this interaction. Support itself does not have a positive meaning if it is not adapted to the needs and expectations of the people who should benefit from it. There is evidence that constant support can shape an attitude of dependence and learned helplessness which limits the carer's adaptability and can even make them feel unwell [40].

Aim

The aim of the presented research was to assess selected aspects of social support received by carers of people after an ischemic stroke, and to indicate the importance of this support for self-assessment of their quality of life.

Materials and Methods

The study group consisted of 39 people who directly looked after ischemic stroke patients. The study was cross-sectional and self-descriptive. The diagnostic survey method and the estimation method were used. The main research tools were standardized, including the WHO QOL-Bref Questionnaire and the Berlin Social Support Scales (BSSS).

The World Health Organization Questionnaire – The World Health Organization Quality of Life-BREFF (WHOQOL-BREFF) is a universal tool for assessing the quality of life of healthy and sick people for cognitive and clinical purposes. It contains 26 questions which analyze four areas of life: physical, psychological, social, and environmental. The questionnaire also includes two questions that are analyzed separately: a question about the carer's general perception of their quality of life, and a question about their perception of their own health. Question scoring is in the range from 1 to 5 and has a positive direction: the higher the number of points, the better the quality of life [41]. The Polish version of the Berlin Social Support Scale (BSS Berlin Social Support Scale) consists of 8 items, to which the respondent responds on a 4-point Likert scale. The higher the score, the higher the level of social support [42]. For the purposes of the research objective, the results obtained in the following BSSS subscales were statistically analyzed:

1. perceived available support (assessment of the availability of assistance from other people),
2. demand for support (the need to use support in a difficult situation),
3. seeking support (frequency or extent of seeking help from others),
4. currently received support (perceived assistance provided by others for persons receiving support).

In addition, the survey used its own questionnaire regarding subjective opinions on support; a socio-demographic data sheet was also used.

Statistical analysis

Statistical analysis of the results was carried out using SPSS Statistics 24.0. The following descriptive statistics were calculated for the examined variables: average (M), standard deviation (SD), minimum value (Min.) and maximum value (Max.). Normal distribution of results was confirmed by the Shapiro-Wilk test. The correlation between the variables was evaluated using Pearson correlation(r) and Kendall's tau-b. The significance of the results was assumed at the level of $\alpha = 0.05$.

Results

Characteristics of the studied group

The respondents were aged 22–78 (M = 52.31; SD = 15.11): women (71.8%), married persons (84.4%), higher education (41%), resident of a large city (74.4%) in the Lesser Poland voivodship (76.9%) and working full time (53.8%).

Table 1. Socio-demographic characteristics of the study group

Feature	Answer	*n*	%
Sex	Female	28	71.8%
	Male	11	28.2%
Marital status	Married	33	84.6%
	Single	3	7.7%
	Widowed	1	2.6%
	Informal relations	2	5.1%
	Divorced	0	0.0%
Education	Primary	1	2.6%
	Vocational	8	20.5%
	Secondary education	14	35.9%
	Higher	16	41.0%
Inhabitancy	Small city (up to 100,000 citizens)	6	15.4%
	Large city (over 100,000 citizens)	29	74.4%
	Rural area	4	10.2%
Voivodship	Lesser Poland	30	76.9%
	No data	9	23.1%
Profession	Full time	21	53.8%
	Part time	3	7.7%
	Contract	1	2.6%
	Pension	1	2.6%
	Retired	12	30.8%
	Others	1	2.6%

Experiences related to caring for a sick person

Guardians most often looked after a spouse (33.3%) or a parent (25.6%); care was less often provided for a child (17.9%) or another family member (17.9%), i.e. siblings, mother-in-law, niece, grandson. The vast majority of the carers (92.3%) had no previous experience in caring for a person after a stroke. Caregivers, due to the current health condition of a loved one, most often felt slight (48.7%) or strong fear (30.8%) of suffering from a stroke (Table 2).

Table 2. Structure of experiences related to caring for a sick person

Experience	Answer	*n*	%
Relationship with the sick person	Husband/wife	13	33.3%
	Child	7	17.9%
	Sibling	2	5.1%
	Parent	10	25.6%
	Partner	1	2.6%
	Niece	1	2.6%
	Mother-in-law	2	5.1%
	Grandson	3	7.7%
Is it the first person in a family after a stroke to be taken care of?	Yes	36	92.3%
	No	3	7.7%
Do you feel a fear of a stroke associated with the illness of a loved one ?	Yes, to a large extent	12	30.8%
	Yes, to a small extent	19	48.7%
	No fear	8	20.5%

Sense of support of caregivers

According to the respondents, they received most support from their spouse (66.7%): this was mostly emotional support (53.8%), but what was most needed was actually informational support (69.2%). In their opinion, the support they provide is sufficient (71.8%) for those under their care (Table 3).

To interpret the results obtained in the study using the BSSS scale, descriptive statistics were calculated for each of them. Their analysis indicates that each of the specified types of support was rated highly, although the highest M value (median) was recorded in the currently received support subscale (M = 3.72) (Table 4).

Although self-assessment of the quality of life was not a fundamental goal in the presented material, descriptive statistics that measure this variable are presented in Table 5 for the analysis of the relationship between the quality of life and social support. The obtained values indicate that caregivers rate the social aspects of their quality of life the highest (M = 75.33).

Table 3. Structure of the sense of support of caregivers

Issue	Answer	*n*	%
Care received from	Husband/wife	26	66.7%
	Children	14	35.9%
	Sister/brother	7	17.9%
	Parents	3	7.7%
	Other relatives	3	7.7%
	Nurses	5	12.8%
	Doctors	4	10.3%
	Partner	0	0.0%
	Friends	1	2.6%
Type of support received	Emotional support	21	53.8%
	Informational support	19	48.7%
	Instrumental support	9	23.1%
	Material support	1	2.6%
	Spiritual support	8	20.5%
Support expected	Emotional support	17	43.6%
	Informational support	27	69.2%
	Instrumental support	13	33.3%
	Material support	5	12.8%
	Spiritual support	6	15.4%
Sufficiency of the support	Yes, and my loved one feels the same	28	71.8%
	Yes, although my loved one does not recognize it often	7	17.9%
	Yes, although I think I should get more	3	7.7%
	No, because whatever I do is not sufficient	1	2.6%

Table 4. Descriptive statistics of self-assessment of selected aspects of the sense of support

	Min	*Max*	*M*	*SD*
Perceived available support	1.00	4.00	3.21	0.61
Demand for support	2.00	4.00	3.21	0.56
Currently received support	2.38	4.00	3.72	0.39
Support sought	2.00	4.00	3.48	0.57

Min / Max – minimum / maximum; M – mean, SD – standard deviation

Table 5. Descriptive statistics of self-assessment of the quality of life of carers of sick people

	Min	*Max*	*M*	*SD*
Somatic domain	44	100	66.74	12.20
Psychological domain	31	94	65.15	15.53
Social domain	44	100	75.33	15.40
Environmental domain	44	94	70.31	11.65

Min / Max – minimum / maximum; M – mean, SD – standard deviation

The relationship between the sense of support and the standard of life of caregivers of ischemic stroke patients showed that a guardian's better perception of the support they receive correlates significantly with higher quality of life in the social (r = 0.31) and environmental (r = 0.32) domains. When better support is currently received, this correlates moderately but significantly with a higher standard of living in the psychological (r = 0.32) and environmental (r=0.36) domains (Table 6).

Table 6. Values of Pearson's correlation between the sense of support and quality of life of carers of ischemic stroke patients

	Examined aspects of quality of life			
Examined aspects of support	Somatic domain	Psychological domain	Social domain	Environmental domain
Perceived available support	0.12	0.25	0.31*	0.32*
Demand for support	-0.09	0.17	-0.07	0.07
Currently received support	0.17	0.32*	0.26	0.36*
Support sought	-0.21	-0.13	0.14	-0.01

$*p< 0.05$

Discussion

Quality of life is a so-called soft assessment indicator and is analyzed with increasing frequency among both the sick and the healthy. For the purposes of this work, quality of life is understood as subjectively felt satisfaction in the context of a person's needs and capabilities [43]. Many factors determine the degree of this satisfaction: some of them are beyond our control (e.g., age, treatment, place of residence, etc.) or their impact is negligible, while others are can be influenced, for example with social support. Support for the quality of life of carers of ischemic stroke patients plays a protective role. Moreover, it can be identified as one of the important predictors of high quality of life [44]. According to many reports on the quality of life of caregivers of ischemic stroke patients, their quality of life worsens due to the fact that they are fulfilling this role [45]. The aim of the study was to assess the support provided for caregivers of people after ischemic stroke and to analyze the importance of this support for their perceived quality of life. The obtained results indicate that in the self-assessment of caregivers, support is important for their quality of life. A higher assessment of perceived support is significantly associated with better quality of life in the environmental (r = 0.31) and social (r = 0.32) dimensions. Therefore, the presence of people who can be counted on in difficult situations is important in order to satisfy interpersonal relationships, offer a sense of security, develop and implement life passions, and finally provide satisfaction with personal life. The results of a Polish national survey entitled Caregivers of Oncologically and Neurologically Ill Patients (2018) indicate that caregivers often have to consider giving up their life plans and passions (66% of respondents), and even activities such as work or studying (11.9%).

Better currently received support in the form of the presence of a loving person who shows acceptance and care and raises caregivers' self-esteem is crucial for experiencing less negative emotions, higher self-acceptance, and a feeling of meaning in their lives. Undoubtedly, this highly rated psychological aspect motivates further actions, creates new ways of solving problems, counteracts the process of caregiver burnout, and co-determines their emotional condition, which often is subjected to anxiety, sadness, low mood and even sometimes anger towards themselves or their mentees. In a multicenter study, Zysnarska et al. (2010) observed anxiety disorders of varying severity in more than 58% of respondents (caregivers of chronically ill people); depressive mood disorders were observed in nearly 40% of respondents [46]. Moreover, the results of Cumming et al.'s (2008) study show that an increase in social support is associated with a lower level of anxiety, depression and internal irritability among carers of ischemic stroke patients [47]. There is evidence that a support group is an important tool when coping with home care. The participants of Cumming et al.'s study were diverse in terms of age, gender, social role, and the type and scope of care experience, which is why they become the optimal source of informational and emotional support for each other. Informational support is an exchange of information that aids a better understanding of the situation, the general life situation, and the problem itself. Emotional support is not only about providing positive emotions, it is also about experiencing community and belonging [40].

Condonet et al.'s (2019) study provides interesting information on key areas of interventions that are important for the well-being of the informal caregivers of stroke patients [48]. According to this study, some key interventions that can improve well-being are training to deal with difficult emotions, strategies for taking care of one's own health, or problem-solving skills. The other studied group (the caregivers) also indicates the importance of interventions which focus on their emotional condition, or identifying potential areas in which they need help to cope with the patient's care. Jaracz et al. (2012) adds that professional activities directed to dyads (ischemic stroke patients and their caregivers) should be two-way and aim to increase the patient's independence, while providing caregivers with strategies for coping with stress [49]. The results obtained in the aforementioned 2018 national survey indicate that – apart from informal support received from self-help groups – specialist support from medical staff such as doctors and nurses (47.9% respondents) and psychological support (33% respondents) are also important. [37]. This confirms that nurses are perceived by caregivers as being competent in providing support. The declared need for informational support that is so important in the field of patient care can and should be met by nursing staff because pre- and post-graduate education provides the necessary knowledge and skills. Therefore, using these skills in nursing practice is a way to meet the reported needs and is a factor that builds nurses' authority and strengthens their position in an interdisciplinary team [50].

Conclusions

1. Adequate Social support for carers of ischemic stroke patients is important for their satisfaction with their quality of life.
2. Satisfaction experienced in the field of personal functioning makes it easier for carers to take actions that are relevant to competent care for the sick.

Chapter 3

Currently emerging possibilities of effective suicide prevention

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Abstract
Although more than 120 years have passed since the first scientific work on suicide, humanity is still struggling to effectively reduce the number of suicides and counteract self-destructive behavior. WHO reports from 2010 [51] and 2014 [52] on the prevention of suicide indicate the directions and areas of preventive actions, but they also stipulate that – with a few exceptions – they are unable to indicate clearly proven prevention methods. This work, which is based on analysis of the latest literature (mainly from 2015–2019) shows the upcoming changes in the way we look at the possibilities of such prevention. Literature data suggest that the problem of suicide prevention cannot be effectively solved without changing the paradigm and focusing on new technologies. The current paradigm, which is based on so-called causal modeling, does not work when diagnosing the threat of suicide because the problem of suicide is too complex. Hence, it is proposed that machine learning based on large amounts of data (largely from biological material) should be used to create appropriate diagnostic algorithms. In the future, appropriate smartphone applications could be used to guide patients at risk of suicide. The Zero Suicide model described in the literature draws attention to the organizational needs of preventive therapy and the appropriate motivation of people participating in this therapy. The summary of the work contains the idea that – unfortunately, as in many other health issues, but also in the area of suicide prevention – success will depend not so much on the efforts of researchers and clinicians (because they are usually motivated enough), but on the good will and common sense of political decision-makers.

Key words: suicide, suicide theories, suicide prevention, new technologies, effectivenes

Introduction

Suicidal behavior, including committed suicides, is a global phenomenon and is considered to be one of the most important problems facing health care systems [51–53]. A particular burden on society is this type of behavior in adolescents [54,55] and women in the postpartum period [56,57]. It is believed that suicidal behavior can be effectively prevented [51,52], but in practice the proven preventive measures turned out to only hinder access to suicide-facilitating tools, firearms and readily available poisons [51]. Various other preventive measures are used, but their effectiveness generally lacks sufficient evidence [58], mainly because the observed groups are too small and the results of different work must be compiled and developed in the form of meta-analyses, or because the effects of a given intervention may be also attributed to other factors.

Poland has one of the highest suicide rates, especially suicides committed by young people [52, 59]. Hence, Poland should particularly approve the World Health Organization (WHO) directives on counteracting suicidal behavior, and these documents recommended to the member countries of the United Nations to reduce their annual suicide rate by 10% in 2013–2020 [52, 60]. Unfortunately, the annual suicide rates in Poland remain roughly the same. The WHO data available on the internet shows that this indicator for Poland in 2020 is 16.2 per 100,000 inhabitants and is one of the highest in the European Union.

Considering the topicality of the issue of suicide prevention, this work tries first to reflect contemporary views on the essence and mechanisms of suicidal behavior, and secondly to indicate, on the basis of available literature, current and anticipated possibilities of preventing such behavior.

The phenomenon of suicide and other self-destructive behaviors and their definition

Suicide and self-destructive behavior that does not lead to death are multidimensional phenomena that usually have many reasons [51–53, 61].

Hołyst [53, p. 128] describes the propensity to commit suicide as a function of at least five variables: *energy* (treated by this author as an individual property and, as one might guess, related to broadly understood neurobiology and individual experiences); *superstition* ("culturally inherited social pressure"); *religion* ("spiritual strength of belief shaped by the community"); *philosophy* ("forced by logic, rigor of philosophical arguments inherent in the consciousness of the individual"); and *science* ("perception of own findings of natural sciences"). Of course, the decisive factor here is the stress caused by a specific variable for each individual [cf. 53, p. 123], a configuration of adverse external factors or a disease, including, first of all, mental disorders. In the concepts of self-destructive behaviors presented by Kubacka-Jasiecka [61], "energy" can sometimes dominate the individual (typically a young person), thus leading to acting-out reactions, as evidenced by the quotations that the author collected from such people when they explained how they came to attempt suicide [61, pp. 179–181]. In psychiatric terms, such a reaction (suicide attempt, or in less fortunate cases, suicide) could be diagnosed as a special case of acute stress response (F 43.0 according to ICD-10).

The issue of the role of "energy" in the mechanism of undertaking suicidal actions is even more pronounced when dealing with such action in a person suffering from a serious mental disorder, because in him suicidal thoughts, which by definition should precede the act of suicide [62–66], may be drastically unusual. For example, in schizophrenia, these may be "bothersome auditory hallucinations, partially silenced by the patient, delusions or religious voices that induce lethal actions", etc. [67, p. 23, tab. 3.4]. It is worth emphasizing here that in connection with the definition rigor, which will be discussed below, not every death inflicted by "one's own hand" should be classified as suicide.

One of the authors (L.P.) is familiar with the case of a patient who was brought to a Hospital Emergency Department with a serious self-inflicted stabbing that required immediate specialist treatment. As a would-be "suicide", the patient, after a stay in the thoracic surgery ward, was transferred to a psychiatric ward. There, it turned out that inflicting a blow to the chest near the heart with a knife (if not for fortunate immediate help from the family, the wound would have to be fatal) the patient was convinced that... he saves his life. As he explained, a "demonic being" wanted to rip his heart out, so he – wanting to save himself – decided to damage his heart so that it would have no value for the "demonic being".

The first scientific definition of suicide was formulated by Durkheim in 1897 [53, 68]. The French-English translation is: "all cases of death resulting directly or indirectly from a positive or negative act of the victim himself, which he knows will produce this result" [68]. Since then, at least 14 other definitions of suicide have been created [68], which shows how extremely difficult it is to clearly define this phenomenon [68,69]. Similarly, it is with other self-destructive behaviors [68, 69], which, in the opinion of eminent world experts in the field of suicidology, is extremely detrimental to the development of this field [68, 69].

The main problem that tries to solve various new – in relation to the first, "classical" – definitions is the problem of "the victim's knowledge of the result of the act". It is very different with this, especially in psychiatric patients (see the case described above) and in children who still have an immature central nervous system [70] and probably therefore – incomplete awareness of the irrevocability of death [53, p. 1262]. In people who are under the influence of alcohol or other intoxicating substances (and they very often attempt suicide), their awareness of the effects of their behavior may also be questionable.

In view of the persistent conceptual chaos associated with the non-uniformity of the terminology used in specialist literature [68, 69], WHO provides its own "working" definitions of self-destructive behavior. According to these definitions, ***suicide*** is the act of deliberately killing oneself; ***attempted suicide*** means any non-fatal suicide bombing (*suicide attempt is used to mean any non-fatal suicidal behavior and refers to intentional self-inflicted poisoning, injury or self-harm which may or may not have a fatal intent or outcome*); ***suicidal behavior*** refers to a series of activities (behaviors) related to the idea of suicide, such as thinking about suicide (imagining suicide), planning suicide, attempting suicide and committing suicide (*suicidal behavior refers to a range of behaviors that include thinking about suicide (or ideation), planning suicide, attempting suicide and suicide itself*) [52].

Although thoughts about suicide have "always" accompanied man, their descriptions were of a philosophical or legal nature [53]. The first theoretical description of this phenomenon is attributed to Durkheim, who approached the issue from the perspective of a sociologist [53]. Later, psychoanalysts and psychiatrists started working on the problem of suicidality and self-destructive behavior [53, 61, 71]. The first experimental works from psychiatric clinics, using so-called psychological autopsy, showed that people who commit suicide suffer from serious mental disorders, mainly bipolar disorder and alcoholism [71]. The percentage of people in whom no diseases could be demonstrated in this work was not more than 2% [71]. Supported by an official WHO document from 1968, a conviction arose that in its essence suicide is closely related to mental illness, mainly depression [53, p. 507]. Therefore, to prevent suicide, you need to fight the symptoms of depression. It was only the results of the Mann group [72] and Philips et al. [73] from the turn of the 21st century that strongly undermined this conviction. The Mann Group showed that there is no correlation between the severity of suicidal behavior and the severity of other symptoms of depression (and generally other symptoms characteristic of a given psychiatric disorder), when it also has such (i.e. suicidal) behavior. Philips et al. stated, however, that in China, where the attitude towards suicide is more "liberal" than in the so-called West, as much as 37% of all cases of suicide assessed by psychological autopsy (511 randomly selected cases from various provinces of China were assessed) did not show any symptoms of mental illness prior to suicide. The results of these last two works and the results of neurochemical and neuroimaging studies allowed Maria Oquendo and her colleagues to formulate a neurobiological theory of suicide [74], and even propose a separate psychiatric diagnostic unit focused on suicidal behavior [75,76]. This proposal, at least in part, was reflected in the latest edition of the American DSM classification [77].

Although research on the neurobiological basis of self-destructive behavior is attracting more and more attention from researchers and their sponsors due to the urgent need to find markers of threatening suicide and to synthesize appropriate drugs [78], the current theories of suicide are three psychological theories proposed in 2005–2015 and currently subject to verification [62–66]. Their novelty, compared to the previous theories, is their strict adherence to the "from idea to action" paradigm, therefore these are "processual" theories.

The most important concepts of Thomas Joiner's theory [62,63] are *thwarted belongingness* and *perceived burdensomeness*. If these feelings occur together, suicidal thoughts arise, i.e. a process begins that can lead to suicide. In order for a suicide to happen, a third condition must be met: the ability to overcome the pain and fear associated with such an attack (*acquired capability*). According to this theory, this ability an individual may have innate, but more often acquires it in connection with previous aversion experiences (getting used to pain), such as difficult childhood, self-mutilation, experience of violence, military service, etc.

The focal point of O'Connor's concept [64,65], which is more elaborate than Joiner's theory, is the feeling of "being trapped" (*entrapment*). His suicidal behavior model has three parts. The first depicts the "ground" that characterizes the individual (genetic, environmental and bio-related conditions). The feeling of "entrapment", which is placed in the middle of the second part of the model, occurs due to a previous sense of "defeat and humiliation" if the latter is strengthened by appropriate moderating factors. These moderating factors may, for example, be difficulties in solving social problems, memory distortions, psychological ruminations, etc. If a sense of "being trapped" does exist, it may encounter ***motivational moderators***, such as a sense of loneliness and of being a burden taken into account in Joiner's theory, and others. These moderators (of course, in the presence of a sense of "being trapped") lead to suicidal thoughts and plans, especially in the absence of some important protective factors (natural resilience, social support, etc.). Liberating the implementation of these plans is associated with ***volitional motivators***, which may have a psychological, social, physiological or environmental nature and be associated with the availability of appropriate means, lack of fear of death, increased sensitivity to pain, impulsiveness, previous suicidal behavior, etc. By the act of suicide bombing itself (no matter if it ends in death or not) they are presented by O'Connor graphically in the third part of the model.

The last of the modern theories of suicide, formulated in 2015 in the same paradigm as the previous two, was proposed by Klonsky and May [66]. According to these authors, suicidal ideation appears when a person ***simultaneously*** feels distress (pain) and has a sense of hopelessness. The condition for the emergence of strong suicidal ideation in such a situation is a feeling of a lack of *connectedness*; this is not only about connectedness with other people, but also with some idea, activity, etc. In turn, the condition for the implementation of such ideas, if they appear, there is the ability to attempt suicide, which in this theory is understood quite broadly, more broadly than in Joiner's, because it is both about pain resistance and the availability of funds, skills in using them, etc.

As can be seen from the above, all the theories described here are quite similar, but at the same time they provide somewhat differently stressed hints as to the possible prevention of suicide. The importance of one of them (preventing the acquisition of resistance to pain) seemed to be noted by the Prime Minister of Great Britain, Theresa May, when in January 2017 she talked about the implementation of the new national strategy for suicide prevention. She emphasized at the time that great efforts would be made to treat self-harming young people [79]. It has been known for a long time that self-harm is one of the strongest predictors of suicide [80]. To what extent the theories presented prove to be useful for preventive actions, and which of them will prove to be the most inspiring in practice in this respect, will only be shown by the results of the research.

Social costs of suicidal behavior

Suicidal behavior, which is rarely mentioned, has considerable social costs. Unlike natural death, suicide requires thorough forensic investigation, which involves many people and sometimes requires expensive specialist research. It is necessary here to rule out murder and accidents; if we exclude these two, it then becomes necessary to exclude or confirm the indirect participation of others (inciting suicide is punishable by law). The costs of forensic investigations, of course, include the costs of funerals and therapeutic interventions in relation to people from the deceased's surroundings (for example, in the case of a student, such activities sometimes have to cover the entire school in addition to the immediate family). Other, i.e. not ending, self-destructive behaviors often require sick leave and long-term treatment; they may also result in long-term disabilities that are difficult to compensate. Even suicidal thoughts, which according to the WHO definition [52] are also considered suicidal behavior, if persistent, result in a decrease in productivity at work and a decrease in the creativity of the individual experiencing them. If the person who has committed suicide or permanent, serious self-harm is young, then the costs listed above are increased due to the fact that this person might be permanently employed, and these costs can be counted, and are the highest.

A paper from Australia [81] calculated the average cost of a young person's suicide (average age at death – 20 years, 4 months and 24 days) in 2014. It amounted to 2,884,426 Australian dollars: $9,721 direct costs, $86,460 related to caring for people in mourning, and $2,788,245 related to loss of productivity. As reported in this work, in Australia, the total cost of suicides of young people is about $511 million a year. Similarly, the total cost of all suicides and non-fatal self-destructive behaviors in Australia in 2014 was $6.73 billion [82]. The authors of this last work also calculated that the average profit of every dollar invested in the prevention of suicide and non-suicidal self-destructive behavior should return about one and a half dollars (1.11–3.07 dollars). It is worth noting here that although these costs are huge, they might theoretically be underestimated. In the given works, there is no reflection on the possibility of losing, as a result of suicide, extremely gifted people, even geniuses. This is likely because the propensity to commit suicide is a typical feature of bipolar disorder [83], and in turn people with extraordinary creativity often develop it [84].

Summary of research results to date on suicide prevention

As indicated in the Introduction, suicide can be prevented [51,52]. Unfortunately, recent meta-analyses of previously published results differ in their conclusions as to the type of the most effective interventions. While some authors show the effectiveness of proper education of doctors and removing access to dangerous tools (firearms, strong poisons) or places [85], others suggest that to this difficult access, whose effectiveness is confirmed, some pharmacological interventions (clozapine, lithium salts) and relevant school programs [86], and yet others only confirm the effectiveness of one of the psychological and sociological interactions [58]. These differences may result from the fact that these summaries concerned papers published in a slightly different period, and furthermore the methodological details of the studies differed. For example, Mann et al. [85] analyzed the results of articles published in 1966–2005, Zalsman et al. [86] analyzed articles published in 2005–2014, and Riblet et al. [58] analyzed all articles available in EMBASE, Medline, CINAHL, PsycINFO and Cochrane Library from the beginning of these databases to the end of 2015. From the methodological details given here, it seems that the most authoritative study should be the meta-analysis conducted by Riblet et al. [58], and they gave only one intervention (WHO BIC), which the results of meta-analytical calculations indicate as certain. This means that the effectiveness of the preventive methods used so far is poor.

Initially, states attempted to prevent suicidal behavior by criminalizing it and treating suicide bombings as a crime, and survivors were punished [53, 87]. Because this did not bring many results but only falsified statistics, and because suicides were carefully hidden, in the mid-twentieth century most countries abandoned the penalization of suicides, punishing only those who encouraged it [87]. In about thirty countries where suicide is still illegal (mainly Muslim countries), the current situation does not allow conclusions to be drawn about the preventive effectiveness of such a method; in about half of these countries, the suicide rate is much lower than the world average, but in the other half it is much higher [87]. In countries that refrained from criminalizing suicide after a corresponding amendment to legislation, the suicide rate clearly decreased [87].

After withdrawing from the criminalization of suicidal behavior, some countries replaced it with national strategies for preventing suicide [52, 88], which are modernized from time to time [52, 79]. According to WHO 2014 data [52], 28 countries have introduced such strategies, but, unfortunately, Poland is not one of them. The adopted strategies are usually based on two very similar models, described exactly by Hołyst [53]: PST (from the angelic – Primary, Secondary, Tertiary) and USI (from the English words: Universal, Selective, Indicated). It seems that the latter model, proposed in 1994 by the Institute of Medicine in Washington [53], is now more widespread [cf. 51, 52]. "Universal" prevention within the meaning of this model refers to the general population of a given country (e.g. limiting access to firearms, poisons, adequate protection of bridges, high-rise buildings and metro networks, and adequate information for the public). "Selective" prevention focuses on subpopulations which, for one reason or another, may be at particular risk of suicide (e.g. persons with mental disorders, persons performing certain specific professions, persons subject to violence, etc.). On the other hand, "Indicative" prevention applies to individuals and not to entire groups. A model example of this last intervention is people who have attempted suicide and who subsequently enter psychiatric care facilities.

A comparison of four countries that have introduced national suicide prevention strategies against four other countries that are very similar in all respects but differ only in terms of the absence of such a strategy leads to the conclusion that the adoption of this type of national strategy significantly reduces the suicide rate, albeit mostly among men [88]. Nevertheless, the overall result of this comparison is still significant because usually (a significant exception is China [52]) there are 3–5 suicides among men for each woman's suicide [51,52,88]. The results of the work cited here [88] suggest that men in the age groups 25–44 years and 45–64 years benefit most from the suicide strategy. The fact that suicide prevention strategies to have their intended effect undoubtedly has to be enjoyed, but unfortunately another fact has to worry: despite the implementation of an appropriate strategy, recently an increase in suicide has been observed in young (10–24 years) women [89] as well as in children.

One of the most frequently cited publications is the joint work [90] of authors from three excellent American universities, most of them from Harvard University. In accordance with the current methodology of conducting meta-analyses, these authors have thoroughly analyzed all prospective works on suicides that have appeared in the last 50 years, mainly in terms of determining significant predictors of suicidal behavior. Their study shows that at present we do not have such predictors, and therefore the effects of all previous preventive actions are quite mediocre [90]. The work cited here draws attention to the erroneous assumptions that unfortunately many researchers in the field of suicidology make. This applies primarily to misunderstanding the term "risk factor". The authors of the study claim that most suicidologists upgrade ordinary correlates to "risk factors"; however, for a "correlate" (obtained in a transverse study) to be promoted to a "risk factor", it must be checked in a prospective study with a control group (if it "proves" its impact, it will be promoted). And only when in a prospective study with an appropriate control group we prove that manipulation of the "risk factor" changes the statistically observed comparison result, we can "promote the risk factor" to a "predictor" [90]. The discussed work draws attention to a fact that has been highlighted as a result of the analyses that at present none of the correlates of suicidal behavior, either individually or in a team, can be considered as a reliable predictor of such behavior [90]. They propose an innovative solution to the problem of the exact predictability of suicide: abandoning the search for predictors and replacing it with the search for appropriate algorithms [90].

Emerging opportunities to prevent suicide more effectively

Specialists involved in suicide are rather optimistic about the possibility of far more effective prevention of self-destructive behavior than is currently the case [91]. “Swallows heralding spring” are: 1) the effectiveness of the “Zero Suicide” program [92]; 2) the discovery of an extremely fast antidepressant, and above all the anti-suicidal action of ketamine [93,94]; 3) the experimentally confirmed anti-suicidal effectiveness of some forms of psychotherapy [58, 95, 96]; 4) the experimentally confirmed effectiveness of some interventions carried out in the school environment [97]; 5) the constantly growing pool of potential biological markers of self-destructive behavior, where markers that are already recognized and described [74,98] are constantly new, e.g. genetic variations not described previously that may affect the function of oxytocin [99,100], changes in the mutual proportion and levels of biometals, such as molybdenum, nickel, ruthenium, selenium, strontium and zinc [101], changes in the field of non-coding RNA fragments circulating in the blood, so-called microRNAs [102], and changes related to so-called gamma oscillations in EEG [103]; 6) the emergence of new technologies that on one hand can help to recognize a patient at risk of suicide who requires immediate assistance, and on the other hand, carriers of therapeutic content and at the same time tools to monitor patients’ current state [104].

Let’s start at the end of this list. The groundbreaking work of Franklin et al. [90] showed that the basic difficulty in preventing suicide bombings is the unpredictability of such an event in the sense of its exact location on the timeline. Based on the accumulation of so-called risk factors, we diagnose that “the patient is seriously threatened with suicide”, but we do not know when this suicide will occur, whether in three days or, for example, five years, and yet what we should do depends on this decision [90]. New technologies (machine learning) will most likely soon allow us to solve this problem [105–108]. By entering a huge amount of all possible data about people who have committed suicide into a computer, we will be able to obtain algorithms that in the future, based on data about a specific person, will be able to indicate whether this person is at risk of suicide or not, and, if yes, when exactly this suicide (unless we intervene) will occur. This “machine diagnosis” will allow doctors of the future to make rational therapeutic decisions such as forcing involuntary hospital treatment, leaving outpatient treatment, and maybe even choosing the right “personalized” therapy. The role of these new technologies does not end with diagnosis. Smartphone applications allow continuous monitoring of a patient’s emotional state [109] and remote delivery of therapeutic content [109, 110]. Experts believe that such a “smartphone” approach may in the future be even better than traditional methods due to the extraordinary acceptance observed in modern youth of everything that is related to such technology [55, p. 87].

Therefore, what was said earlier about machine learning and the “substantive” basis for creating appropriate algorithms (i.e. the need to have as much different data as possible), the fifth point of the enumeration basically requires no comment. The neurobiological theory of suicide [74] reminded us that much depends on neurobiological parameters, and that such parameters that are associated with self-destructive behavior should be intensively sought. Of course, it is best when these parameters are readily available from electrophysiological methods such as EEG [103], neuroimaging methods, or methods that can determine the genetic, epigenetic, hormonal and biochemical condition of the body using body fluid samples, mainly blood. Such methods are already becoming widely available [111], and bioinformatics techniques are being developed to improve them [112].

Suicidologists have long been interested in the possibility of using interventions targeted at specific social groups to prevent self-destructive behavior, because on the one hand it is technically easier to reach a selected group (e.g. schoolchildren) than all of society; on the other hand, such intervention can be profiled depending on the type of recipient by examining in advance which occupational or employee groups are most at risk. Hence, the identification of professional groups most at risk of suicide is one of the most important points of modern preventative solutions [113].

Schoolchildren have recently become the object of special concern for suicidologists, because even in countries where the overall suicide rate is decreasing, for this age group and "professional" is increasing [52,54,55], which of course must be worrying. Therefore, there is a growing interest in programs that could stop this negative tendency.

The European Union has recently funded a huge research program called SEYLE (Saving and Empowering Young Lives in Europe [SEYLE] study), in which 10 EU countries took part (Austria, Estonia, France, Germany, Hungary, Ireland, Italy, Romania, Slovenia and Spain), Israel and Sweden as a coordination center [97]. As a result of the implementation of this program, implemented, which is very important, on the basis of RTC (randomized controlled trial), and in which 168 schools and approx. 12 thousand students aged 14–16 years took part, it was found that at least one of the assessed interventions, called YAM (Youth Aware Mental Health), proved to be effective, clearly reducing the number of suicide attempts in the teenagers covered [97]. In addition to the many other interesting results that this study provided, one more finding deserves attention: reading books and watching movies acts as a protective factor against suicidal thoughts and plans [114].

One of the most important ways of preventing suicidal behavior is therapy for people directly at risk of suicide. This applies to people with mental disorders, including addicts or self-mutilators, but above all it applies to people who have already attempted suicide as well as people currently in crisis caused by the loss of some goods, the death of a loved one, etc. The methods used so far have shown moderate and even dubious effectiveness [58]. The antidepressants that are very often used in such situations [115] do not take effect for some time (usually 2–3 weeks) and do not show special specificity [51,94,115]. Also, as demonstrated in healthy volunteers [116], they are able to intensify aggressive and auto-aggressive behaviors themselves, which is most likely related to their ability to evoke akathisia [117]. Such akathisia may occur in people who exhibit genetically conditioned (by polymorphism) characteristics of the P450 cytochrome system that differ from the average [117]. Other drugs, such as mood-stabilizing lithium salts or neuroleptic clozapine are effective in patients with suicidal tendencies affected by bipolar disorder or schizophrenia, respectively, [93,94], but they do not take effect immediately, only after prolonged period of use [93]. Therefore, the great discovery made in 2000 and later confirmed by the results of control studies was the discovery of the immediate anti-suicidal effect of ketamine [93,94]. Unfortunately, ketamine, which is called a dissociative anesthetic and has been used in anesthesiology for quite some time, is known to cause hallucinations and has some addictive potential [94]. Currently, there is a search for a drug that acts on suicidal behavior like ketamine but without its side effects. The prophylactic effect of ketamine on suicidal behavior is so spectacular that one of its stereoisomers, esketamine, which is still more effective than ketamine [93,94], is currently being introduced to treatment (under the trade name Spravato). It is worth adding here that the intensive search for biomarkers of depression and the risk of suicide, which was mentioned earlier, can not only contribute to more accurate diagnoses of people potentially at risk of suicide, but also to the creation of new drugs that are more beneficial than ketamine. This is indicated by the conclusions drawn from a review of research results on this topic which was conducted in 2019 by Kalkman [118].

In addition to a promising new drug (esketamine), the results of recent meta-analyses indicate that at least two psychotherapeutic approaches are also effective in those at risk of suicide. These are the short intervention and contact of BIC recommended by WHO [58], and cognitive-behavioral therapy (CBT) [86,95,96]. Zalsman et al. [86] and Jobes et al. [95,96] list several other promising therapies, primarily dialectic-behavioral therapy (DBT).

Although, as it results from the above, we are not completely deprived of the methods and means needed to counteract suicidal behavior; however, the use of those already available unfortunately does not translate, as so far, into a significant decrease in the suicide rate and the self-harm rate. It seems that the reason for this is, above all, the imperfect organization of suicide prevention [119], for which managers and politicians are primarily responsible. Unfortunately, politicians are not interested in activities that may significantly increase social welfare but are not necessarily popular; moreover, they are difficult to implement and have little political value [120]. Jobes and Chalker [96] are convinced that with well-organized care for people at risk of suicide, much better results can be obtained than those observed so far; they suggest that the most important factor is a diverse but individualized approach to such people. In the work cited here [96], they present an original, stepped model of care for such at-risk people, A Stepped Care Model for Suicide Care, which is the "embodiment" of such an approach and whose concept was born in connection with their involvement in the "Zero Suicide" program. This program led to the development of model management of patients at risk of suicide and implementation of this model into the therapeutic management of a large number of American psychiatric units.

The principles of the Zero Suicide model were described by Brodsky and colleagues [92]. The model is based primarily on proven methods of diagnosis and intervention, a friendly and individualized approach to the patient and the iron consequence of the actions taken, obliging medical staff regarding the order and conscientiousness of performing specific procedures. Briefly speaking, the model is based on two slogans: *Identify*, *Engage*, *Treat* and keep in touch after discharge (*Transition*), which concerns the method of providing care; *Lead*, *Train*, *Improve*, which relates to the attitudes of staff who take care of such patients, not only doctors but also nurses. Diagnosis of suicide risk is based on tools such as The Columbia Suicide Severity Rating Scale (C-SSRS) and The Suicide Assessment Five-step Evaluation and Triage (SAFE-T). CBT, DBT and CAMS (Collaborative Assessment and Management Suicidality) interventions are used as methods of working with the patient, as well as SPI (Safety Plan Intervention) and Crisis response planning. After discharge from the ward, the patient is monitored for about two years and is kept in contact (phone, letters, postcards, e-mails, text messages). If needed, he can count on the support of social workers. The whole procedure has 10 stages. Three levels relate to the diagnosis process (assessment of the patient's risk of suicide); three relate to the intervention process (creation of an individual safety plan based on cooperation, training in dealing with difficult situations, integrated therapy specific for people at risk of suicide); and four relate to the process of post-discharge monitoring (determining the manner of contact, monitoring contacts in times of increased risk, involvement of the family or appropriate social factors, calling the patient for clinical evaluation). As can be seen from the above description, the Zero Suicide program does not use any extraordinary methods, but rather distinguishes itself from other "therapies as usual" due to the caring attitude of the treatment staff and the appropriately planned and implemented treatment process.

Summary

The hopes presented here for the future approach to the therapy of self-destructive behavior bring hope that in the near future people at risk of suicide will be precisely diagnosed and effectively treated. Unfortunately, only where decision-makers will care about it, because in addition to changing the way of thinking and traditionally understood causal modeling [cf. 53, p. 71], innovative diagnosis and treatment will have to also involve considerable costs and organizational skills. Hence, as expected, such an innovative approach (this is mainly about precise diagnosis based on large amounts of data and machine learning) will first be introduced in the US Army, which is already beginning to apply machine learning and diagnostic algorithms [107]. It should be hoped, however, that when the US military develops appropriate, highly effective methods, over time they will become broadly available in medicinal civilian units, not only in the United States, but also in other countries, including Poland. It also seems that universal and selective strategies regarding suicide prevention might still have some value. Diagnosis through current epidemiological studies [113] of particular, more at risk than other social groups (e.g. students [55,97], construction workers [121], etc.), and then addressing them to properly prepared and checked programs, such as the YAM program [97] will also translate into a decrease in suicide rates for these groups and, consequently, for the overall population. It is worth recalling here that in those countries that have implemented a national strategy on suicide prevention and therefore carry out various activities of this type, suicide rates tend to be decreasing [88]. Poland, which has no such strategy, is therefore exposed to an increase in this indicator. This country seems to be "negatively modeled" in other respects as well. There are at least two reasons here that make it possible to predict not only the lack of a decline, but even an increase in the suicide rate in a group which should be of special concern, namely young people. The recent education reforms have caused frustration among teachers because, according to scientific evidence [122], should move to students, resulting in additional stress and epigenetic modification, making them more susceptible to suicide not only now but even in future generations [122]. The second premise is the so-called "LGBT free zones" in Poland. When adopting resolutions to include their administrative unit in such a zone, which is a phenomenon on a global scale [123], local authorities are most likely not aware of the fact that in all probability they will contribute to an increase in the number of suicides among young people who have sexual orientation or gender identification issues, because such people, being particularly sensitive to rejection, commit suicide much more often [55,124]. These last two examples show that one cannot think about effective implementation of suicide prevention without politicians' effective and intelligent involvement.

Chapter 4

The knowledge of teenagers and their mothers about cervical cancer prevention and HPV vaccines

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Abstract

Introduction: Infection with highly oncogenic types of HPV is associated with the development of cervical cancer in 70–80% of cases. Primary prevention of cervical cancer is based on education and vaccination of girls aged 11–12 before sexual initiation (PTG recommendations). HPV vaccination is not obligatory. The aim of the study is to examine the knowledge of women and their daughters about the prevention of cervical cancer in terms of cytological tests, HPV infection, and vaccines against HPV.

Material and methods: The research group consisted of female students of two secondary schools in Tarnobrzeg and their mothers. The research method employed was a questionnaire created by the author.

Results: There were 105 correctly fullfilled questionnaries from daughters and 46 from mothers. 50% of mothers have knowledge that cytological examination should be done every year, 54% know the proper time for examination. Mothers and daughters have the knowledge about cytological examinations, know the relation between HPV infection and cervical cancer. Both groups are in favour of vaccinations (mothers 60.8% daughters 80%). Only 8.6% of mothers have vaccinated their daughters, however 59.04% of daughters would like to have HPV vaccination.

Conclusions: In the study group, both mothers and daughters have knowledge about cytological examination and the relationship between HPV infection and the development of cervical cancer; the mothers know how HPV infection occurs. However, the mothers' knowledge about HPV vaccination is insufficient as they do not know about the vaccines, they do not know when to vaccinate their daughters, and they are afraid of the side effects of vaccination.

Key words: HPV infection, vaccine, prophylactics, cervical cancer

Abbreviations used in the text

HPV – Human Papilloma Virus
WHO – World Health Organization
IARC – International Agency for Research on Cancer

Introduction

In 2008, Professor Harald zu Hausen received the Nobel Prize for the discovery of the human papillomavirus [125]. Currently, about 200 types of this virus are known and a further dozen or so are in the process of being identified. According to American data, over 50% of sexually active people (both women and men) may be temporarily infected with HPV during their lives [126]. The virus types that are low-oncogenic, i.e. type 6, 11, 42, 43, 44 and 53, are responsible for benign neoplasia and papillary epithelial hyperplasia in type of condylomata acuminate and condylomata plana [127]. The highly oncogenic types, i.e. 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, and 68, coexist with malignant neoplasia and cervical squamous cell carcinoma [128]. HPV infection is also associated with throat, rectal and penile cancer. Research conducted by IARC in 11 countries showed the presence of HPV 16 DNA and HPV 18 DNA in 70% of squamous cell carcinomas and 80% of cervical glandular carcinomas [126]. IARC reports that in 2018, 570,000 cervical cancers were detected worldwide and 310,000 women died of this disease [126].

Vaccinations are undoubtedly one of medicine's greatest achievements and have safely reduced the number of diseases that once decimated populations. Experts estimate that around 122 million people owe their lives to vaccines. However, since the creation of the first smallpox vaccine by

Edward Jenner, there have been voices that have undermined the safety and effectiveness of vaccination [128]. Anti-vaccination movements have been somewhat successful, as evidenced by the increase in the number of unvaccinated children [128]. In Poland, apart from compulsory vaccinations, there are also recommended vaccinations which are not financed by the state. Local governments often contribute to the financing of the latter by funding vaccinations for citizens. Most often, flu vaccinations are funded. Recommended vaccinations include vaccines against the HPV virus. The first vaccine against the HPV virus was introduced to the market in the USA in 2006 under the name Gardasil, whereas in Poland it is known as Silgard. This (quadrivalent) vaccine protects against infection with four types of virus: 16, 18, 6 and 11. Since 2007, the Cervarix vaccine has also been available, which protects against two types of virus: 16 and 18 [129]. In 2014, Gardasil 9 vaccine was launched on the market; it protects against 9 types of virus: 6, 11, 16, 18, 31, 33, 45, 52 and 58; seven of these types are highly oncogenic viruses [130]. The risk of adverse reactions to HPV vaccines is low, with about 25,000 side effects of human papillomavirus vaccines reported in the US between 2006 and 2014, 90% of which are classified as mild (subfebrile condition, itching at the site of injection, moderate fever) [131]. The WHO recommends the introduction of HPV vaccines for 9–14-year-old girls and boys [132]. In 2012, a common standpoint of the Polish Gynecological Society and the Polish Pediatric Society was published which recommended routine vaccinations for girls aged 11–12 years and for girls aged 13–18 years who had not been vaccinated previously [133]. Vaccinated women should undergo cytological screening because the vaccine does not protect against all types of this virus. Due to the protection it offers against some types of penile, head, cervical and anal cancer (and to break the HPV transfer chain), in some countries boys are also vaccinated (e.g. Australia, Switzerland, Israel) [132]. WHO experts predict that if we do not start vaccination, the number of cervical cancer deaths will increase by 50% within 20 years [134]. In 2020, the 73rd World Health Assembly will discuss the global strategy for 2020–2030 to accelerate the elimination of cervical cancer [134].

The aim of study

The aim of the study was to examine the knowledge of women and their daughters concerning the prevention of cervical cancer, including cytological tests, HPV infection, and vaccines against HPV.

Material and methods

The research group consisted of students from two secondary schools in Tarnobrzeg (Mikołaj Kopernik Secondary School and Hetman Jan Tarnowski First Social Secondary School) as well as the students' mothers. The research was conducted in April and May 2019. Interested students and their mothers were invited to participate in the study. Due to the low number of questionnaires returned by mothers, the results were not developed in relation to the mother–daughter pairs but were counted separately. The research method was a diagnostic survey, for which the author's questionnaire was used. The questionnaire for girls included questions concerning cytology and the time of the first cytological examination, the HPV infection method, the connection between HPV and cervical cancer, the general attitude to vaccination and HPV vaccines, and willingness to be vaccinated. The mother's questionnaire was extended to include questions about the frequency of cytology tests, whether women want to vaccinate their daughters, the reasons for not vaccinating, what vaccine they would choose, and whether they consider education on cervical cancer prevention sufficient.

Results

Pupils were encouraged to participate in the study: 105 correctly completed questionnaires were received, while the number of questionnaires returned by mothers was much lower (46 correctly completed questionnaires). Pupils participating in the study were aged 16 years (9.52%), 17 years (36.19%) and 18 years (54.28%). The age of the mothers was 37 to 54 years; the average age was 45.7 years. In the studied group of women, 47.82% had secondary education, 41.3% had higher education, and only10.86% had vocational education. The vast majority of women (76%) live in Tarnobrzeg, while 23.9% live in rural areas. As far as the family situation is concerned, 76.08% are married, 17.39% are divorced and 6.52% are single. When asked about their financial situation, 63.04% of women described it as good, 21.73% as average, 15.21% as very good, and none declared a bad financial situation.

The question about cytological examination was addressed to all the subjects: mothers and daughters. The frequency of answers is gathered in Table 7.

Table 7. Knowledge of mothers and daughters about cytological examination

Cytology is tested by:		Mothers	Daughters
collecting swabs from the cervix	N	38	88
	%	82.6	83.8
female genital imaging methods	N	4	13
	%	8.7	12.4
assessing vaginal cleanliness	N	4	3
	%	8.7	2.9
assessing the level of female sex hormones	N	-	1
	%	-	0.9

The vast majority of the respondents (over 80% in both groups, both women and their daughters) replied that cytology is a test that consists in taking swabs from the cervix. In the group of mothers, 8.7% of women believe that cytology refers to female genital imaging and vaginal cleanliness testing. In the group of daughters, 12.4% believe that cytology is a method of female genital imaging; 2.9% of girls think that cytology is a test of vaginal cleanliness, and only 0.9% think that it is a test of the level of female sex hormones.

Mothers were asked how often they perform a cytological examination and in which phase of the cycle they should request the examination.

In the group of mothers, 50% declared that they know that they should have a cytological examination every year, 34.7% once every 3 years, and 15.2% once every 5 years (Figure 2).

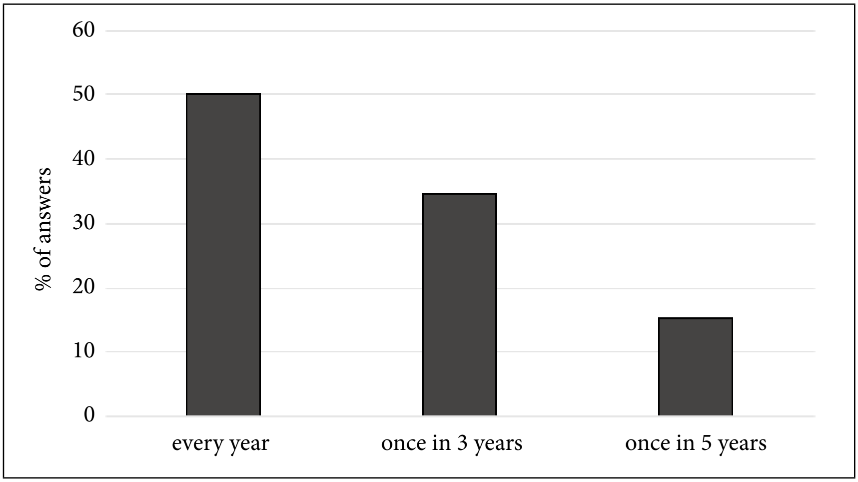


Figure 2. How often should cytological examination be done? Answers in the group of mothers

Table 8 shows the women's knowledge about when cytological examination should be done.

Table 8. How often should cytological examination be done? Answers of women by education, place of residence and material situation

Cytological examination	Education				Place of residence		Financial status		
	Higher		Secondary	Vocational	City	Village	Very good	Good	Average
Once a year	n	12	10	1	17	6	2	18	3
	%	52.2	43.5	4.3	73.9	26.1	8.7	78.3	13
Every 3 years	n	10	6	-	13	3	3	9	4
	%	62.5	37.5		81.3	18.7	18.7	56.3	25
Every 5 years	n	6	-	1	5	2	2	2	3
	%	85.7		14.3	71.4	28.6	28.6	28.6	42.8

54.3% of the respondents stated that a cytological examination has to be performed between the 10th and 20th day of the cycle, 17.3% a few days before menstruation, 15.2% think that it does not matter, while 13.2% of women admit that they do not know when they should have a cytological swab (Figure 3).

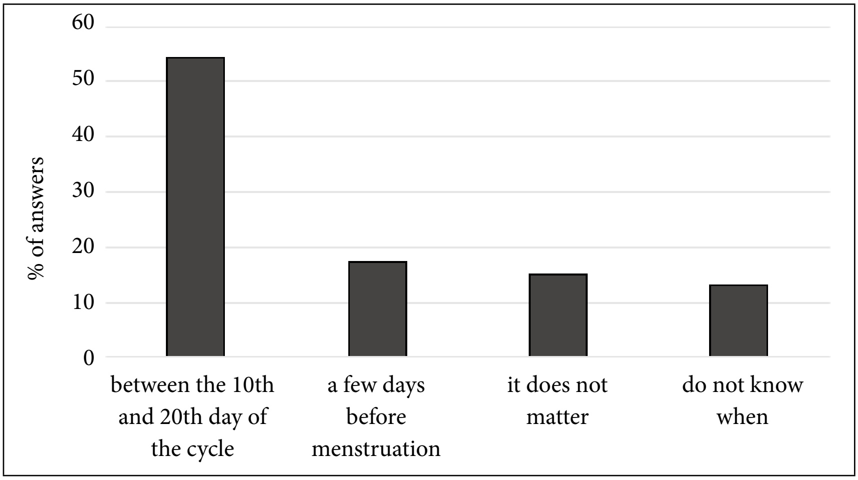


Figure 3. When should women come for a cytological examination?

The group of girls was asked when the first cytological examination should be performed: 68.57% claimed that it should be after the onset of sexual intercourse, 12.38% stated before 25 years of age, 2.85% before 30 years of age, 10.47% claimed that no later than 3 years after sexual initiation; 5.71% did not know when the first cytology should be performed.

Girls were asked if condoms protect against HPV infection: 88.6% responded that it reduces the risk of infection, 6.67% that it offers complete protection, while 4.7% stated that condoms do not protect against HPV infection.

The relationship between cervical cancer and HPV infection is known by 86.9% of mothers and 74.3% of daughters; 4.4% of mothers and 20.9% of daughters associate frequent intimate infections with cervical cancer;

8.7% of mothers and 3.9% of daughters indicate HIV infection as the cause of cervical cancer; only 0.9% of daughters indicated other causes of the disease, e.g. genetic as shown in Figure 4.

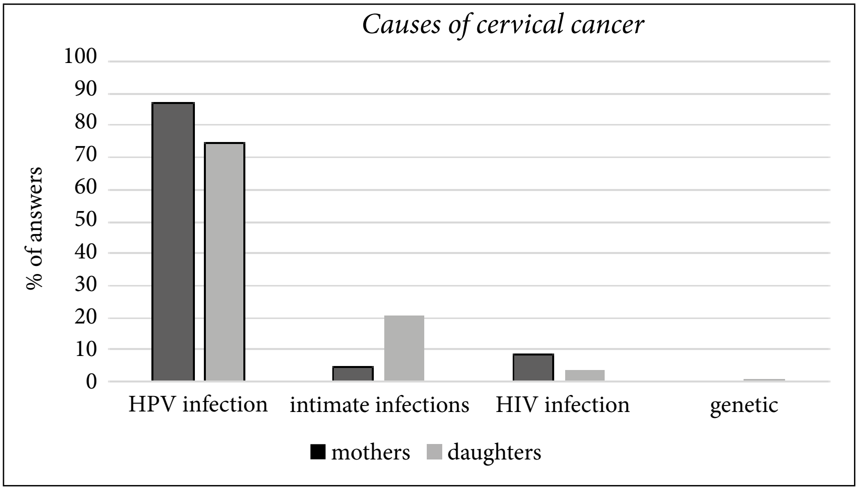


Figure 4. The surveyed women's opinions on the causes of cervical cancer

The most common supporters of vaccination were women with higher education (67.85%), married women (89.28%), in good financial situation (71.42%), city residents (67.85%).

Opponents of vaccination are women with higher and secondary education (50%), married women (50%), in good financial situation (75%) and city residents (75%). In the group of women who have no opinion on vaccination, women with higher education predominate (50%), followed by married women (57.14%), in a good financial situation (42.85%) and rural women (71.42%). The results are gathered in Table 9.

Table 9. Approach to vaccination: women surveyed by education, marital status, place of residence and financial situation

Approach to vaccination		Education			Marital status			Financial situation			Place of residence	
		Higher	Secondary	Vocational	Married	Divorced	Single	Very good	Good	Average	City	Village
Supporters	%	67.85	28.57	3.57	89.28	7.14	3.57	14.28	71.42	14.28	67.85	32.14
28	N	19	8	1	25	2	1	4	20	4	19	9
Opponents	%	50	50		50	25	25		75	25	75	25
4	N	2	2	–	2	1	1	--	3	1	3	1
No opinion	%	50	42.85	7.14	57.14	35.71	7.14	21.42	42.85	35.71	28.57	71.42
	N	7	6	1	8	5	1	3	6	5	4	10

The surveyed women and their daughters were asked how HPV infection occurs. The frequency of answers is shown in Figure 5: 89.2% of mothers and 86.6% of daughters indicated sexual intercourse; 4.3% of mothers and 7.6% of daughters claimed that it occurs due to poor hygiene such as unclean underwear; 2.1% of mothers and 1.9% of daughters indicated the droplet route of infection; 4.4% of mothers and 3.9% of daughters admitted that they did not know the route of infection.

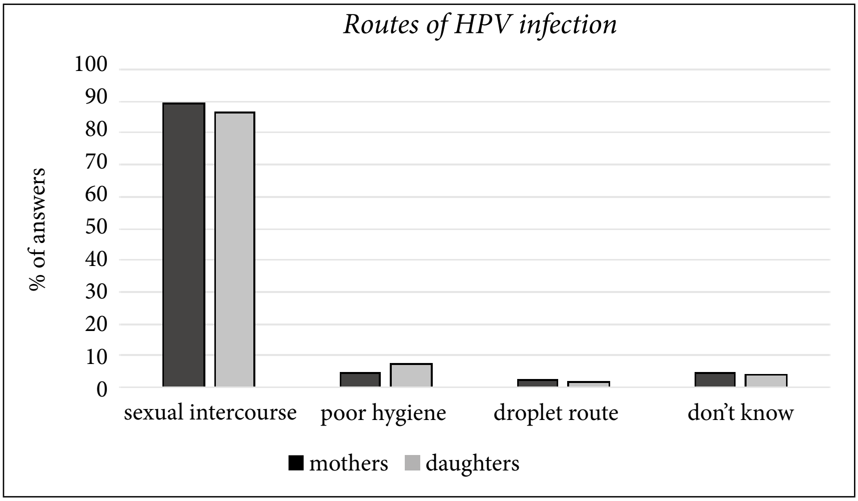


Figure 5. Methods of HPV infection in the opinion of the surveyed women

Mothers and daughters were asked about their general attitude to vaccination and their opinions on HPV vaccines. 60.8% of mothers and 80% of daughters declare themselves to be in favor of vaccination; 8.7% of mothers and 6.6% of daughters are against vaccination, which is worrying for a rather large group; 30.5% of mothers and 13.4% of daughters have no opinion (Figure 6).

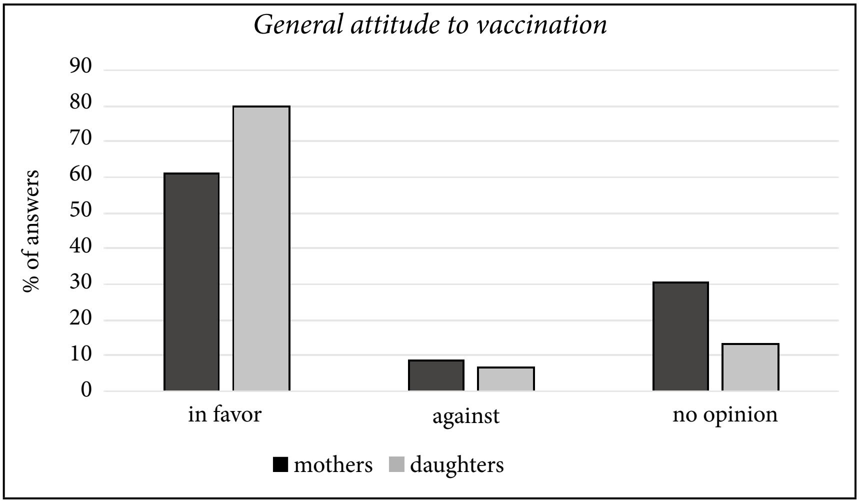
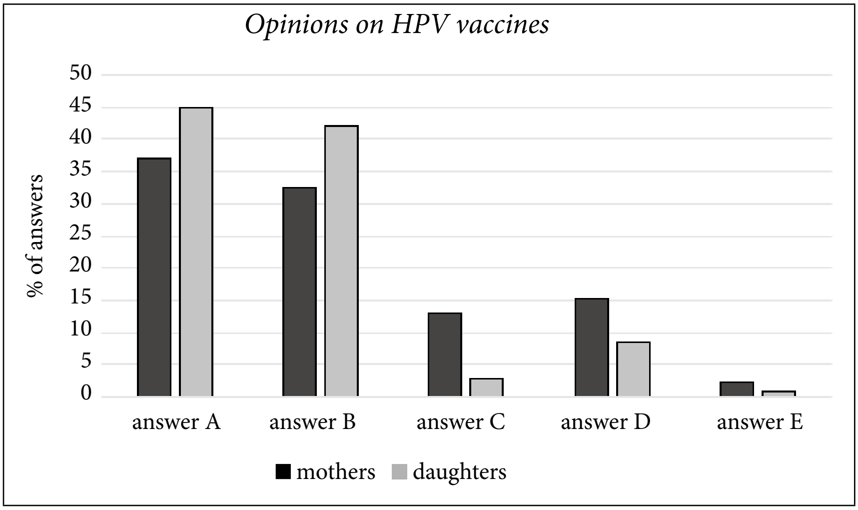


Figure 6. Approach to vaccination in the group of tested women

Comparable results were obtained for responses A and B as shown in Figure 7: 36.9% of mothers and 45.6% of daughters believe that vaccination is necessary; 32.6% of mothers and 42% of daughters think that vaccination is not necessary but worthwhile. Answer C (the vaccine only profits pharmaceutical companies) was selected by 13.04% of mothers and only 2.9% of daughters. 15.3% of mothers and 8.6% of daughters had no opinion. Vaccine is a trend created by the media is the view of 2.16% of mothers and 0.9% of daughters.

The group of mothers was asked whether cytological tests can be abandoned after HPV vaccination: 84.8% of the women replied no, 4.3% answered affirmatively, and 10.9% did not know.



A/ Vaccination is necessary because too many women die of cervical cancer. B/ Vaccination is not necessary but being vaccinated is worthwhile. C/ The vaccine only profits pharmaceutical companies that want to make as much money as possible. D/ I have no opinion. E/ It is a trend created by the media.

Figure 7. Opinions of the women surveyed on HPV vaccines

Women were asked if they had vaccinated their daughters: only 8.7% answered affirmatively and 91.3% declared that they had not. The question about the reason for not vaccinating was open-ended and the women gave the following reasons: high cost of vaccination (8 answers), too little information about vaccines (7 answers), information about the negative effects of vaccination (4 answers), daughter is too young (2 answers) or has not yet started sexual relations (2 answers). The answers do not sum up correctly because not all women answered this question.

Mothers who had vaccinated their daughters were between 51 and 54 years old: 75% were city residents with higher and secondary education, and all declared good financial status. The vaccinated teenagers are students of the Nicolaus Copernicus High School, which is a state school.

However, the daughters were asked whether they would like to be vaccinated against the HPV virus: 59.04% answered yes, 5.76% did not want to be vaccinated, 31.4% did not yet know, and 3.8% had already been vaccinated.

The interviewed women were asked if they would vaccinate their daughters if the local government or the National Health Fund financed it: 54.3% said yes, 28.3% said no, and 17.4% said they did not know what to do. When asked what vaccine they would choose, 43.4% answered that they did not know, 23.9% would choose a 2-valent vaccine, 17.4% a 4-valent vaccine, and 15.3% a 9-valent vaccine as shown in Figure 8.

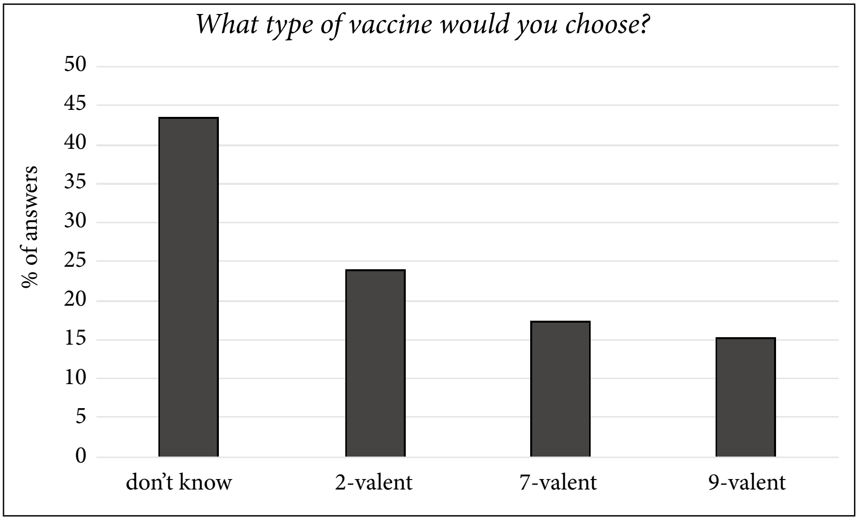


Figure 8. Choice of HPV vaccine in the group of women

The surveyed women were asked if education on cervical cancer prevention is sufficient: 21.7% answered affirmatively, and 78.3% thought that there is insufficient education on cervical cancer prevention.

Discussion

Prevention, especially primary prevention, is the most effective way to reduce the risk of cancer of all kinds, including cervical cancer. Primary prevention includes sexual education and vaccination. The available vaccines against the HPV virus only protect against the highly oncogenic types. These vaccines are not obligatory in Poland, and the decision to vaccinate is taken only by parents. Research by Falenczyk K. et al.

has shown that only 52.9% of parents see the need to vaccinate their child with recommended vaccinations [128]. The Polish Gynecological Society recommends vaccination of girls before sexual initiation and the recommended age is 11–12 years. Due to the high cost of vaccination (1 dose costs around 500 PLN; the whole cycle costs about 1500 PLN) it is a considerable expense in the family budget. Parents' awareness and education must be sufficiently high for them to see the necessity of vaccinating their daughters. Research on cervical cancer prevention is dominated by early detection of disease symptoms, cytological screening, and assessment of health behaviors, including sexual behaviors of women. Studies carried out in the UK have shown that eight years of vaccination of girls (2008–2016) reduced the prevalence of HPV in the population from 8% to 6.9% [135].

Słopiecka A. and Wiraszka G. examined the behavior of women after the occurrence of disease symptoms: about 20% of the respondents waited as long as 10 months after the occurrence of symptoms before they visited a doctor, which shows a low awareness of health issues among the respondents. The women who consulted a doctor immediately after observing the symptoms (14.5%) were young women up to 35 years of age; no statistical differences were found in terms of education and place of residence [136]. In a study by Machaj A. et al., 13.2% of the respondents admitted to risky sexual behaviors (intercourse with a random partner without the use of a condom), while sexual contact under the influence of alcohol, drugs and other psychoactive substances most frequently (29.5%) occurs among non-religious persons [137]. PTGiP recommends a cytological screening test once every 3 years; a test every 12 months is recommended for women at risk (HIV-infected, HPV-infected, treated for intraepithelial neoplasia) [138]. Our own research shows that 50% of women have a cytological examination every year; 34.7% state that they have a cytological examination once every 3 years. This group includes women with higher education, city residents, and those with good financial status. In the study of Leszczyńska K. et al., 24% of women under 30 and 28% over 30 believe that cytological examination should be performed every 3 years [139].

In our own research, 74.2% of girls and 86.9% of their mothers know that cervical cancer is associated with HPV infection. In a study by Nowicki A. et al., more than half of the surveyed women in the group associated with health care considered HPV infection to be the main cause of cervical cancer; in the group not associated with health care, only 13% indicated the link between HPV infection and cancer [140]. In these studies, in both groups more than half of the women would have been vaccinated against HPV if it had been possible [140].

In the studies conducted by Stefanek A. and Durka P., there were no statistical differences in terms of knowledge about the existence of the HPV vaccine among women of different age groups and education levels. The differences were only due to the place of residence: fewer women in rural areas and small towns knew about the HPV vaccine [141]. In the studies of Lewandowska A. et al., women up to the age of 45 displayed more knowledge than older women [142]. In our research, 80% of girls and 60.8% of mothers declared themselves in favor of vaccination. When asked about the HPV vaccine, in both groups most respondents (36.9% of mothers and 45.5% of daughters) stated that vaccination is necessary because too many women die of cervical cancer. The next largest group of respondents (mothers 32.6% and daughters 41.9%) stated that vaccination is not necessary but is worthwhile. Thus, the women tested were in favor of HPV vaccination, but only 8.6% of the respondents answered positively when asked if they had vaccinated their daughters. In the group of daughters, 59.04% expressed a desire to be vaccinated, 5.7% did not want to be vaccinated, and 31.4% did not know.

HPV vaccination is not mandatory and is not reimbursable; mothers cite the financial cost as one of the main causes for this. If the cost of the vaccine were covered by the local government or the National Health Fund, 54.3% of women would vaccinate their daughters, 28.2% would not want to vaccinate their daughters, and 17.3% did not know. In a study by Szafransko-Baranska A. that was conducted on 134 girls who qualified for free vaccination as part of a local primary prevention program for cervical cancer, 93.7% of them participated in the vaccination [143]. Parents had the opportunity to attend an educational meeting before making the decision: 60% of parents reported that the knowledge gained from the meeting had influenced their decision to vaccinate; 40% of parents made their decisions based on knowledge gained from the media [143]. In EU countries, 23 countries recommend routine vaccination of girls against HPV; only Austria also recommends vaccination of boys [144]. In Denmark, after the introduction of the vaccine, 90% of teenagers were vaccinated; however, as a result of information about negative effects of vaccination, this number dropped to 40%. Subsequently, an information campaign was undertaken which slowly restored confidence in the vaccine [145]. In California, surveys involving teenagers' parents, physicians and support staff at a primary health care facility were carried out: the interviews showed that parents were in favor of vaccination but still postponed the vaccination [146]. The level of HPV vaccination is influenced by reports of the negative effects of the vaccine, the way vaccination is financed, scientific evidence on its efficacy, and the ethical attitudes of parents [147–149].

Our own research shows that women do not have sufficient knowledge about vaccines, and 43.4% of them answered that they did not know what vaccine they would choose; 73.2% of respondents stated that the education on cervical cancer prevention is insufficient.

Conclusions

1. The group of examined women and their daughters have knowledge about the cytological examination, the relationship between HPV infection and the development of cervical cancer; the mothers know how HPV infection occurs.
2. Mothers' knowledge of HPV vaccines is insufficient and they do not know which vaccine to choose.
3. Mothers declare themselves to be in favor of vaccination; however, the non-vaccination of daughters is explained by economic reasons and lack of knowledge about vaccines.

4. It is necessary to educate women in cervical cancer prevention, with particular emphasis on primary prevention, i.e. vaccination.
5. Parents should be directed to information about the safety of vaccines, the type of vaccines, and the age at which girls should be vaccinated.
6. The attention of local authorities and the National Health Fund should be drawn to financing at least some of the costs of vaccination or including HPV vaccination in the schedule of obligatory vaccinations.

Chapter 5

Final-Year Medical Students' Opinions Concerning the Stages of Life and Age of Women that are Predisposed to Stress Urinary Incontinence

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Abstract

Urinary incontinence is an embarrassing problem and is probably one of the last taboos in contemporary medicine. It is currently one of the most common chronic female diseases and constitutes a serious health problem in modern society. Stress urinary incontinence occurs when an increase in intra-abdominal pressure associated with coughing, sneezing, laughing, running, a rapid change in body position, or hard physical work is accompanied by involuntary urinary leakage. This is a widespread medical problem that has a real influence on the daily lives of millions of women around the world. It isolates them from society and prevents normal functioning, adversely affecting work, relaxation, relationships, and self-confidence; it also affects the psyche, leading to lower self-esteem, neurosis, and depression. The aim of the study was to evaluate the knowledge of students graduating from medical faculties regarding the stages of life, the age, and the percentage of women in Poland predisposed to stress urinary incontinence. The research included 1,581 participants who were students in their final year of medical studies at several universities. Research was conducted by means of the author's questionnaire. In all groups, the highest percentage of 'age' indications, particularly the age at which women are predisposed to experiencing the symptoms of stress urinary incontinence, ranged from 41% to 50%. Among the indications for the 'life stage', the vast majority of respondents stated that the menopausal period increased the likelihood of urinary incontinence. 92.5% of the respondents were from a group of physicians, 91% from a group of nurses and midwives, 85.7% from a group of physiotherapists, and 79.3% were from other medical faculties. Conclusion. Students graduating from medical faculties possess good knowledge about the stages of life, the age, and the percentage of women in Poland predisposed to stress urinary incontinence. They know which group of women might be affected by this problem and they are aware that there is a substantial likelihood that they will be engaged in conversations with their patients regarding this embarrassing problem.

Key words: urinary incontinence, stages of life, women, students' knowledge

Introduction

Despite significant progress within the scope of diagnosis and treatment, urinary incontinence is still perceived by society as an embarrassing problem which is unwillingly reported to physicians. Stress urinary incontinence occurs when an increase in intra-abdominal pressure associated with coughing, sneezing, laughing, running, a rapid change in body position, or hard physical work is accompanied by involuntary urinary leakage [150]. It is the most common form of urinary incontinence and it can occur at any age. Patients unknowingly pass small amounts of urine without the sense of urinary urgency. It is characteristic for this type of urinary incontinence that the symptoms subside during night rest and the frequency of micturition during the day does not change [150]. There are numerous causes of stress urinary incontinence in women, including pelvic floor muscle weakness, lowered position of the organs of the minor pelvis, hard physical work, or hormone disorders (oestrogen deficiency) [151]. Urinary incontinence constitutes a symptom or a complication of numerous serious, often chronic, female diseases, including not only the organs of the minor pelvis and the urinary system [152–154]. This symptom may occur as a result of neurological conditions such as multiple sclerosis, or diseases of the respiratory system, including chronic obstructive pulmonary disease [155,156].

The results of the majority of epidemiological studies confirm that pregnancy and childbirth lower the pelvic floor; at the same time, they are an inseparable risk factor for urinary incontinence in the later period of a woman's life [157]. During pregnancy, the connective tissue (including the pelvic floor diaphragm) relaxes, which constitutes a physiological process that prepares a woman for childbirth. During delivery, when the child passes through the reproductive tract, the tissues and surrounding nerves (particularly the anal sphincter) are often damaged and stratification of the visceral pelvic fascia that is responsible for maintaining the proper position of the reproductive organs occurs [158].

The menopausal period significantly contributes to the occurrence of symptoms of urinary incontinence. Oestrogen plays a very important role in the functioning of the lower part of the urinary system. Oestrogen receptors are in the urinary bladder, urethra, and central nervous system, all of which are areas responsible for initiation and control of micturition. Furthermore, oestrogen-dependent regulation of blood flow through the sub-mucous venous plexus increases intra-urethral pressure, which supports the mechanism of the urethral sphincters [159]. Hypoestrogenism initiates atrophic lesions, which are visible in the decreased mass and size of the reproductive organs as well as in the thickness of their mucous membranes. Urogenital atrophy is also related to the fasciomuscular structures of the minor pelvic floor and the lower part of the urinary system. Womb prolapse and the occurrence of the symptoms of urinary incontinence may be a consequence of low oestrogen levels and atrophic lesions. In Poland, the prevalence of urinary incontinence in women at the menopausal age is estimated at the level of 33% [160–162].

Basic health care personnel (GPs, gynaecologists, midwifes, nurses, and physiotherapists) should talk with women about stress urinary incontinence, promote preventive measures against this condition at every stage of a woman's life, organize training and indicate predisposing factors, and provide educational materials such as brochures or leaflets. Students in their final year of medical studies will soon be basic healthcare personnel, therefore they need to have specialist knowledge of this problem. A basic step when dealing with a female patient suffering from urinary incontinence is gathering information about the symptoms. It is crucial to have knowledge about this condition as only expertise makes it possible to lead a substantive discussion and to provide further professional assistance.

In this time of ageing populations and the resulting increasing incidence of urinary incontinence, it is important to call the attention of medical communities to this problem, to raise their awareness of this subject, and to encourage them to spread knowledge that will make it possible to take appropriate action for the benefit of women suffering from this condition. The task of medical staff is not only to promote knowledge about urinary incontinence among women of all ages, but also to eliminate misconceptions and the taboo surrounding it. Without well-educated and professional medical personnel who recognize the need to act in support of a particular problem, it is difficult to undertake long-term preventive or therapeutic initiatives.

The aim of the study was to evaluate knowledge of students graduating from medical faculties about the age and stage of life of women who are particularly predisposed to the symptoms of stress urinary incontinence. In addition, the authors made an attempt to determine whether students know what percentage of women in Poland suffer from this condition.

Materials and methods

The research included 1,581 students in their final years of medical studies from several universities: 1,255 women and 326 men participated in the research. Four hundred and thirty-two students of the faculty of medicine (including 282 women and 150 men aged 24.9±0.95) constituted the L Group. Four hundred and two physiotherapy students (including 288 women and 114 men aged 25.4±3.8) formed the F Group. Two hundred and fifty-eight female students of nursing and midwifery (aged 30.1±7.59) constituted the P Group. Four hundred and eighty-nine students of medicine and dentistry, pharmacy, laboratory medicine, cosmetology, and public health studies (including 427 women and 62 men aged 24.8±4.1) constituted the IK Group (control group).

The author's own questionnaire was applied, having been verified by the CEM Market and Public Opinion Research Institute, Kraków. In the questions regarding the problem, respondents were instructed to enter the age or period of life (of a woman) which they regard as predisposing to the occurrence of stress urinary incontinence. In addition, respondents were asked to give their opinion on what percentage of women in Poland suffer from stress urinary incontinence. A possible 'I do not know' answer was included in the questionnaire.

Data analysis

Excel 2016 and Statistica 9.0 software were used for archiving and statistical analysis. The chi^2 test was used for analysis: $\alpha=0.05$ was considered statistically significant.

Results

The respondents' answers were divided into three categories: age, stage of life, and the period of pregnancy and childbirth. The 'age' category was additionally divided into seven ranges: up to 20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, and over 70 years. The 'life' category was divided into five stages: mature, reproductive, menopausal, older, and every stage. When the responses were analysed, the number of indications in a specific category was regarded as 100% in each group. The answer 'I do not know' was chosen by 11.6% of respondents in the P group, 15.5% of respondents in the L group, 17.2% of respondents in the F group, and 25.3% of respondents in the IK group.

Most respondents stated that age was a factor that contributes to the occurrence of the symptoms of stress urinary incontinence in women (Figure 9). This opinion was expressed by 50.3% of people from the L group, 48.3% of people from the IK (control) group, 43% of people from the P group, and 39.9% of people from the F group.

The majority of the respondents (31.3%) in the P group indicated 'stage of life' as an important period for the occurrence of ailments of stress urinary incontinence; in the other groups, this answer was given by 23% of students from the L group, 20.8% of students from the F group, and 18.1% of students from the IK group. The period of pregnancy and childbirth was indicated by approximately 22% of students from the F group, about 14% of students in the P group, and by 11% and 8% of students from the L and IK groups, respectively. Statistical analysis confirmed that the statistical differences between all groups were significant, taking into account the perceptions of the age or period of life of women predisposed to the occurrence of stress urinary incontinence ($p < 0.001$ or $p < 0.05$) (Figure 9).

In all groups, the highest percentage of indications ranged from 41 to 50 years as the age at which women are particularly predisposed to the occurrence of this condition (Figure 10). This answer was given by 57.3% of students from the L group, 45.1% of students from the P group, 40.2% of students from the IK group, and 33% of students from the F group. The following results were provided for the 31–40 age group: 30.3% in the F group, 24.6% in the P group, 22.4% in the IK group, and 19.7% in the L group. The results for the 21–30 age group were 17.6% in the F group, 11.8% in the IK group, 6.8% in the L group, and 3.3% in the P group. The 51–60 age range was considered predisposing to the occurrence of urinary incontinence in women by 18% of people in the P group, 17.1% of people in the IK group, 13.8% of people in the F group, and 11.5% of people from the L group. Only respondents in groups IK, L, and P reported that only women over the age of 70 are predisposed, but this percentage was low, ranging from 0.4% to 0.8%. Respondents rarely mentioned the age up to 20 (from 1.6% to 4.3%). The F group significantly differed statistically from all groups (L and P $p < 0.001$, IK $p < 0.05$). There were no statistically significant differences between the P group and the IK group or between the P group and the L group (Figure 10).

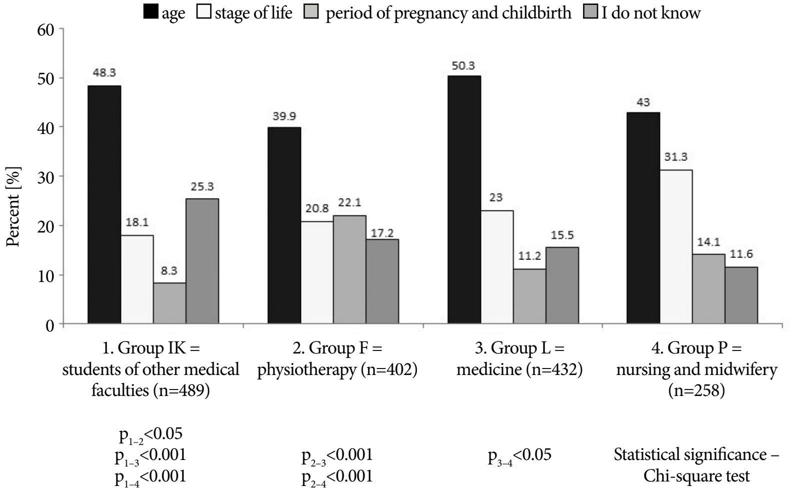


Figure 9. Percentage of respondents who considered various ages, periods, or stages of women's life as predisposing to the occurrence of stress urinary incontinence

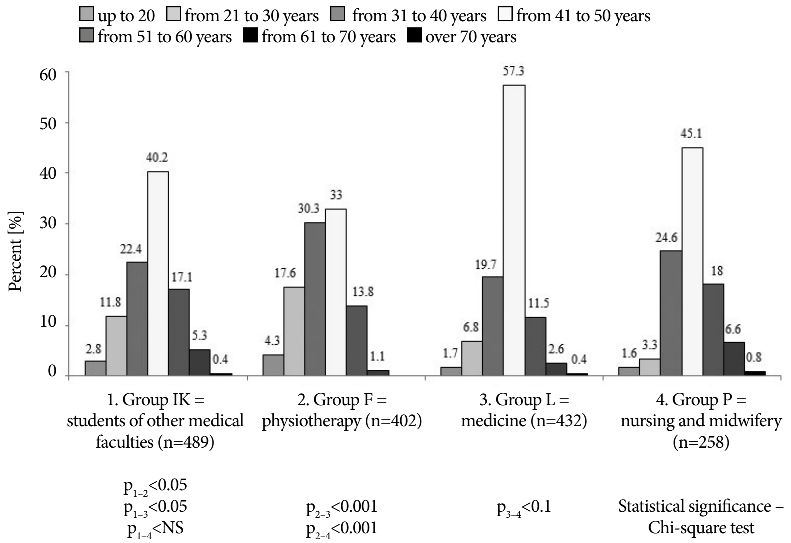
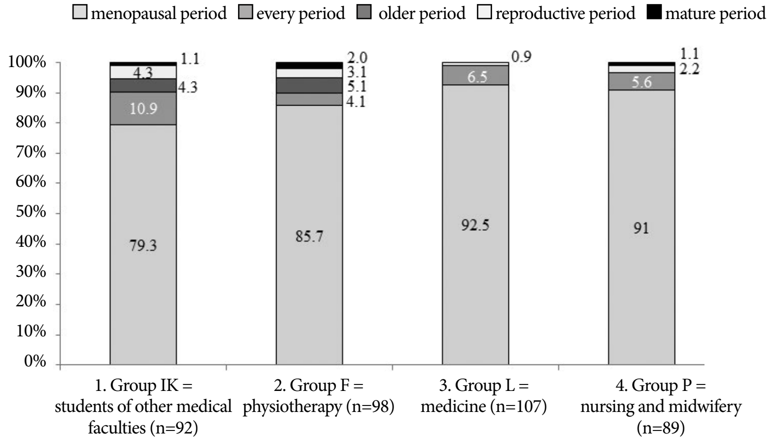


Figure 10. Percentage of indications for various decades of life as predisposing factors for the occurrence of stress urinary incontinence in women (n = number of indications in the group, NS = non-significant).

Among the indications for the 'stage of life', the vast majority of respondents stated the menopausal period contributed to the occurrence of symptoms of stress urinary incontinence (Figure 11). This answer was provided by 92.5% of respondents from the L group, 91% of respondents from the P group, 85.7% of respondents from the F group, and 79.3% of respondents from the IK group. Approximately 11% of people in the IK group found that symptoms of stress urinary incontinence in women might occur at 'every' age and period of life. The same answer was given by 6.5% of people from the L group, 5.6% from the P group, and 4.1% from the F group. Only the IK group (4.3%) and F group (5.1%) indicated 'older' age, whereas the F group (2%) as well as the P and IK groups regarded 'mature' age as predisposing to the occurrence of this condition. A small percentage of all respondents indicated the 'reproductive' age: 4.3% in the IK group, 3.1% in the F group, 2.2% in the P group, and 0.9% in the L group. The distribution of indications for various periods of life as predisposing factors for the occurrence of stress urinary incontinence in women was significantly statistically different between the IK group and F group (P <0.05) (Figure 11).



p_{1-2}<NS
p_{1-3}<0.05
p_{1-4}<NS

p_{2-3}<0.05
p_{2-4}<NS

p_{3-4}<NS

Statistical significance – Chi-square test

Figure 11. Percentage of indications for different stages of life as predisposing factors for the occurrence of stress urinary incontinence in women (n = number of indications in the group, NS = non-significant)

The respondents were also asked to give their opinion concerning the percentage of adult women in Poland suffering from stress urinary incontinence. The respondents' task was to enter a number between 1 and 99% which in their opinion illustrated the scale of this problem. If a respondent did not respond, it was assumed that they did not know or were not aware of the percentage of women in Poland suffering from urinary incontinence. Almost all respondents, more than 95% in each group, answered this question.

In a further analysis of the obtained results, the number of provided answers in each group was 100%. The highest percentage of respondents concluded that 21% to 40% of women in Poland suffer from stress urinary incontinence. This answer was provided by 45.3% of respondents from the P group, 41.9% from the IK group, 39.3% from the F group and 35.4% from the L group (Figure 12). In the IK group, 26.2% of students believed that 6% to 20% of women in Poland suffer from stress urinary incontinence. A similar opinion was held by 21.6% of respondents in the F group, 18.6% in the P group, and 42.8% in the L group. According to 25.6% of respondents in the P group, the percentage of women suffering from this condition ranges between 41% and 60%. 23.1% of students from the F group, 18.6% from the IK group, and only 9.3% from the L group had the same opinion. From 2.8% to 10.4% of respondents concluded that the percentage ranges from 61% to 80%, and 0.2% to 0.8% state that it ranges from 81% to 100%. Significant differences were demonstrated between the control group (IK) and the F group ($p < 0.01$), the L group ($p < 0.001$) and the P group ($p < 0.05$), and between the L group and the F and P groups ($p < 0.001$) (Figure 12).

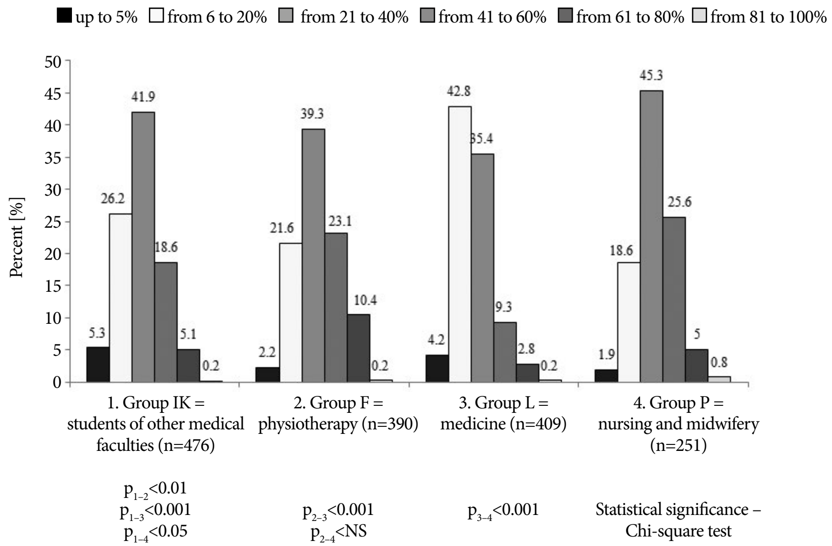


Figure 12. The percentage of respondents who stated what percentage of adult women in Poland suffer from stress urinary incontinence (NS – non-significant)

Discussion

Stress urinary incontinence affects women at all ages, both young, especially those after natural childbirth, as well as those at menopausal ages. It is also a common geriatric problem and the prevalence of urinary incontinence increases with age. The influence of pregnancy and childbirth on the occurrence of stress urinary incontinence has been confirmed in numerous studies [163–167], but many incidences of this disorder that occur after this period continue to remain hidden due to embarrassment. The reason for the occurrence of urinary incontinence in pregnant women is related to the period of general hormonal changes and topical changes in the pelvic floor and lower part of the urinary system. Urinary incontinence in women is closely related to the function of the reproductive organs. Women who have had more pregnancies definitely suffer more frequent incidents of urinary incontinence due to the greater extent of soft tissue injuries sustained during natural labour [163–167].

During pregnancy, numerous changes occur in a woman's body, including the functions of the urinary bladder. The most common symptom is increased frequency of micturition. This is related to compression of the pregnant uterus on the wall of the urinary bladder, resulting in its decreased capacity as well as increased urinary continence in the ureters. Higher susceptibility to urinary tract infections may constitute an additional factor that affects problems with urinary continence in the course of pregnancy [163–167].

Most scientific reports emphasize that the menopausal period predisposes women to the occurrence of symptoms of stress urinary incontinence [161,162,168,169]. A decline in the hormonal function of the ovaries and associated low oestrogen levels contribute to urinary incontinence [170]. The lack of sex hormones is responsible for decreased vaginal acidity and physiological disappearance of bacterial flora, which increases susceptibility to infections caused by bacteria migrating from the vulva. Inflammatory conditions in the vagina are often accompanied by chronic infections of the lower part of the urinary system, which can lead to difficulties in urinary continence. Therefore, during the menopausal period urinary incontinence affects 19% to 70% of women, depending on the examined population. Urinary incontinence symptoms are present in 33% of women at menopausal age, and this is the period of life in which they occur most frequently [168–170].

Urinary incontinence is also a common geriatric syndrome which leads to serious health consequences such as urinary tract infections, skin lesions, bedsores and (in the event of night diuresis) sleep disorders and an increased risk of falls and bone fractures [161,162,168,171–173]. The vast majority of women with urinary incontinence do not seek medical attention, believing that the condition is age-related and so is not responsive to treatment. In the United States, urinary incontinence occurs in half of women over the age of 60 and is becoming one of the main causes of early admission to nursing homes. The reasons for avoiding medical care include shame, embarrassment, lack of faith in obtaining effective assistance, and the difference in age between patients and young medical staff [171–175].

In the authors' own research, respondents used the age criterion most frequently (40–50%), most often giving the fourth and fifth decade of women's life. Among students who associated the occurrence of the disease with a stage of life (18–31%), about 80% to 93% of them regarded the menopausal period as being particularly predisposing to the occurrence of the condition. About 8% to 22% of respondents stated that the periods of pregnancy and childbirth were particularly predisposing. About 12% of nurses and midwives, about 15% of physicians and 17% of physiotherapists did not attempt to indicate the age or period of life in which urinary incontinence may occur. About 11% of respondents from the IK group believed that each stage of life can predispose women to the onset of this illness

Undoubtedly, the prevalence of urinary incontinence among women increases with age. Demographic analysis of women with urinary incontinence confirms that 4.4% of patients aged 20–29 suffer from urinary incontinence, whereas in women aged 30–39 there is an increase to 12% [176].

It was also found that in 36% of women the disease occurred during the reproductive period, and in the remaining percentage of women it occurred during the menopause. Urinary incontinence affects 8% to 30% of women aged 40–60, whereas only 25% of women report it as a common condition [176–179]. Other studies state that in the second decade of life the problem affects about 10% of women, in the fifth decade about 30%, and in the eighth decade of life up to 40% of women. Goforth et al. [180] point out that in the fifth decade of life, 27.6% of women suffer from urinary incontinence, followed by a decrease in morbidity, then an increase in the eighth decade of life up to 34%. In total, urinary incontinence occurs in about 30% of women in their forties and increases to 35% for women aged over sixty, whereas stress urinary incontinence is diagnosed in 63% of these patients.

The 2003 ICS report presented a survey of over 4,500 women in nine countries. It was confirmed that the percentage of women suffering from urinary incontinence depended on the age of the examined individuals. This problem affects 25% of women aged under 18, 37% of women aged 35–54, and 39% of women aged over 55. Considering the fact that urinary incontinence is present in 3 out of 10 women, 49% of women suffer from stress urinary incontinence, 22% suffer from urge incontinence, and 29% suffer from mixed urinary incontinence. For example, 42% of women in Canada, 41% in the UK, 36% in Australia, 35% in Sweden, 30% in the United States and Mexico, 29% in Germany, 27% in Italy, and 23% in France and Spain suffer from stress urinary incontinence. In comparison to urinary incontinence, 21% to 25% of women suffer from hypertension, 20% suffer from depression, and 8% to 9% suffer from diabetes. Urinary incontinence is regarded as a social disease [180,181] due to its presence in over 5% of the population, regardless of ethnic or cultural differences.

Epidemiological studies on the incidence of urinary incontinence within the population show a large data discrepancy which falls between 17% and 60% of the population [182–184]. Stress urinary incontinence in women is a widespread problem. However, women all over the world most often remain silent about this subject and not admit to this embarrassing condition for many years, so it is difficult to determine precisely what percentage of women suffer from it [182–184]. Respondents in this study are to a large extent aware of how many women in Poland suffer from this condition. The percentage of responses ranged from approximately 45% in the L group to approximately 60% in the F and IK groups. This percentage was slightly overstated only among respondents from the P group, in which it amounted to approximately 70%.

The majority of the examined students showed good knowledge about the age, the stage of life, and the percentage of women in Poland suffering from stress urinary incontinence. It might be concluded that they are familiar with the scale of the problem and know which groups of women are particularly affected by this embarrassing condition. This research suggests that respondents may talk about this disease with their patients in the future because they have expertise in it, but most importantly they know which particular groups of women they should talk to about this issue.

As such activities are included in their professional abilities, general practitioners, gynaecologists, urologists, midwives, nurses, and physiotherapists are required to offer effective measures to assist patients suffering from stress urinary incontinence. These people should talk to women about stress urinary incontinence and promote preventive measures against this condition at every stage of a woman's life. Health care workers can and should improve the life quality of women suffering from stress urinary incontinence if they are convinced that this is an important and worthwhile problem. In addition, creating a preventive program which aims to reduce the number of women suffering from this condition would prove to be an investment in the future health and comfort of women's lives.

Conclusions

Students graduating from medical studies display good knowledge about the stages of life, the age, and the percentage of women in Poland suffering from stress urinary incontinence. It is highly probable that young medical personnel will be able to break down the barrier of shame and raise this issue with their patients.

Chapter 6

The diet type: vegan or traditional European (non-excluding meat) affects the content of heavy metals, dioxins and polychlorinated biphenyls in human milk

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Abstract

Introduction: Environmental pollution with heavy metals, dioxins and PCBs is a serious ecological and health problem, as they enter our bodies with the food we consume. Metals and dioxins can bioaccumulate and biomagnify, thus theoretically lower levels of toxins in the body should characterize individuals using a vegan diet that excludes products of animal origin.

Methods: The contents of heavy metals: arsenic (As), barium (Ba), chromium (Cr), zinc (Zn), cadmium (Cd), cobalt (Co), copper (Cu), nickel (Ni), lead (Pb) and mercury (Hg) as well as dioxins and polychlorinated biphenyls (PCBs) was analyzed in the breast milk of 50 women in relation to the type of diet they ate (traditional Polish or excluding meat). The concentration of metals in breast milk was determined with mass spectrometry, whereas the concentration of dioxins and PCBs was determined using gas chromatography.

Results: It was found that in some breast milk samples the content of arsenic, barium, chromium, nickel, lead and mercury exceeded admissible concentrations. Higher concentrations of copper and barium were determined in samples from women using the traditional diet, while in breast milk from women on a vegetable diet there was a higher concentration of mercury and nickel. Higher levels of heavy metals were found in breast milk samples collected in spring than in autumn. The concentration of dioxins and polychlorinated biphenyls did not exceed admissible values.

Conclusions: The ambiguous influence of the diet type on toxin concentration in human milk was observed. It cannot be stated unequivocally that vegetarian diet is a preventive factor against the accumulation of heavy metals or dioxins and PCBs in human milk.

Key words: heavy metals; dioxins; breast milk; lactation; environmental pollutants; veganism

Abbreviations

dlPCB, dioxin-like polychlorinated biphenyls; ndl-PCB, nondioxin-like polychlorinated biphenyls; LOQ, Limit of Quantification; PCDD, polychlorinated dibenzo-para-dioxins; PCDFs, polychlorinated dibenzofurans; TEQ, Toxic Equivalent; WHO-TEF – World Health Organization-Toxic Equivalency Factor

Introduction

We live in the Anthropocene age in which the natural environment has been irreversibly changed by humans and unfortunately these changes mainly encompass the destruction and continually escalating pollution of waters, soil and air. Our very own organisms are poisoned by polycyclic hydrocarbons, dioxins, polychlorinated biphenyls, heavy metals that we introduce into the surrounding environment. Pollutants along with water are taken up from the soil by plants, which then are taken up by animals, undergo bio-accumulation and bio-magnification in the subsequent links of the food chains, at the top of which are humans. As a dietary hazard for humans special consideration should be given to animal products, especially fish (also freshwater) and shellfish, as well as farm animals fed fishmeal, due to the strong accumulation of heavy metals and dioxins in both aquatic organisms [185, 186] and offal (of animal origin) [187].

However, flavonoids and antioxidants present in plants have a protective effect against damage caused by heavy metals [188, 189]. But at the same time some plants also have the ability to accumulate metals [190] and in addition, pesticides used in agriculture constitute a serious source of heavy metals, dioxins and polychlorinated biphenyls in the environment [191–199].

Anthropogenic toxins – heavy metals

Arsenic (As) is released from ores during the production of copper, lead and zinc, during coal combustion and the production of pesticides. Inorganic arsenic compounds can enter the body by the inhalation of dust, drinking contaminated water and skin contact with contaminated water or soil. This metal is accumulated in rice and the flesh of fish. Arsenic blocks sulfur residues in enzyme and it has genotoxic and carcinogenic effects [200, 201]. It is excreted from the human body in urine, where it can be detected at levels of 0.013–0.25 mg/l [202].

Barium (Ba) is used in the pharmaceutical industry, cosmetics and medicine as a contrast agent in the examination of the digestive system. Insoluble barium salts, such as barium sulphate, are considered non-toxic. Soluble and at the same time toxic barium salts include: barium chloride, barium (V) nitrate, barium (V) chlorate, barium acetate and barium carbonate, and risk of exposure occurs in the metallurgical industry and with the use of pesticides [203]. Barium toxicity results mainly from the displacement of potassium ions and precipitation of sulphate anions [204].

Chromium (Cr) at a +3 oxidation state is considered to be an essential element for health and is part of the composition of chromodulin, a tetrapeptide participating in the binding of insulin to the insulin receptor. However, chromium at a +6 oxidation state has both toxic and carcinogenic properties, easily penetrates cell membranes and can reach the cell nucleus. Chromium is one of the most commonly occurring environmental pollutants, especially waters [205, 206].

Cobalt (Co) is a micronutrient found in the body in the form of vitamin B12 (cobalamin). Inorganic cobalt is commonly found in the soil, air and food and is used in the metallurgical, ceramic and medical industries for coating prostheses and endo-prostheses. The risk of cobalt poisoning is mainly due to inhalation exposure, however excess consumption of inorganic cobalt may lead to the development of cardiomyopathy [207].

Cadmium (Cd) is found in zinc ores, is used in industry for producing battery electrodes and as a pigment. It is absorbed by inhalation or through food, especially with seafood and offal, as well as with tobacco smoke [185,191]. It accumulates in the liver and complexed by metallothionines in the kidneys. Cadmium is eliminated very slowly, its half-life in the body is about 16 years [208]. It is highly toxic, disturbing the metabolism of iron, zinc, copper, calcium, magnesium and selenium. It increases the risk of breast, uterine and prostate cancer.

Copper (Cu) is an essential microelement. It is transported by albumin and stored by hepatic ceruloplasmin. It is used as a cofactor of numerous enzymes, among others: lysyl hydroxylase, cytochrome c oxidase, superoxide dismutase, tyrosinase. Excess copper is removed in the bile. However, disturbances of homeostasis between its absorption and excretion may cause hepatitis, kidney necrosis and neurodegeneration [209].

Nickel is absorbed primarily with water. This metal often causes type IV allergy and may be neurotoxic and carcinogenic [210].

Mercury is rapidly stored and accumulated for decades in internal organs, including kidneys and the brain. Exposure to mercury can damage the nervous, excretory and immune systems [211]. Mercury occurs in the form of metallic mercury, in inorganic as well as organic compounds. It can be present in foods, specially seafood, in high concentrations.

Lead is absorbed through the digestive tract and the respiratory system, to a lesser extent through the skin. It penetrates the placenta and can be found in milk in large quantities. In the digestive tract of adults, 10% of lead present in food is absorbed, and in children this can be as high as up to 50%. Absorption of lead in the gut is reduced in the presence of calcium and phosphorus in the diet, but is increased in the presence of vitamin C. Accumulation of lead leads to damage to the nervous tissue, immune system, bone marrow, kidneys, skin and has a mutagenic and teratogenic effect [186,189,211].

Dioxins and polychlorinated biphenyls

Dioxins is a name for polychlorinated dibenzo-para-dioxins (PCDD) and polychlorinated dibenzofurans (PCDFs) (Figure 13).

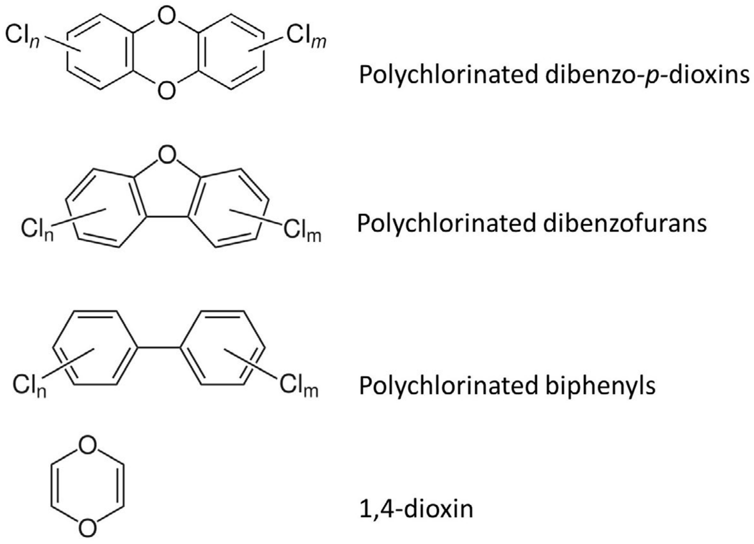

Figure 13. Dioxin structure

These compounds are formed during uncontrolled incineration of waste. Dioxins were also present in plant pesticides used in the 1980s. They are poorly water-soluble compounds, however dissolve well in fats. They have a very long half-life and bioaccumulate, especially in the adipose tissue of animals [192]. The presence of dioxins and PCBs in the body may lead to endocrine system disruption [193], delayed neurological development [194], impaired immune function, as well as mutations and carcinogenesis [195], mainly through interaction with aryl receptors. However it has also been shown that they can bind to thyroid, estrogen and androgen receptors, as well as inhibit serotonin synthesis and modify hormone levels [212,213]. Hepatic toxicity may be manifested as a result of changes in gene expression, enzyme activity, and probably as a result of damage caused by reactive oxygen species that are generated during the first phase of detoxification of these compounds on cytochrome P450 [214].

In conclusion, the negative impact of heavy metals and dioxins on the human body may include the induction of oxidative stress, intracellular transmission changes, endocrine disorders, internal organ damage, cardiovascular, respiratory, excretory, nervous and reproductive disorders, and carcinogenesis [189,191]. Toxins circulating in a woman's body during lactation can be found in human milk thereby they can also poison infant's organism.

Aim

The aim of the study was to determine whether the level of heavy metals, dioxins and polychlorinated biphenyls present in the human milk of lactating women depends on a vegan or traditional Polish diet (non-excluding meat). Due to the fact that heavy metals and dioxins may bioaccumulate and biomagnify, it was hypothesized that the lower level of tested toxins characterized people eating a vegan diet, i.e. excluding all products of animal origin, than those who consumed meat, fish, eggs and other zoonotic food products.

Methods

Tested group

The pilot study included 50 lactating women between the ages of 21 and 41. 25 women used a traditional diet including products of animal origin, while 25 women kept to a diet excluding meat, of which 9 women kept a vegetarian diet and aside from eating plant based foods included dairy products and occasional eggs and 16 women were on a purely vegetable (vegan) diet for at least three years preceding the study. The recruitment of the participants took place via an internet advertisement placed on a culinary website "Trochę Inna Cukiernia" [215] willingly followed by vegans. Participants were informed about the purpose of the study and expressed their agreement with written consent. The women participating in the study completed a survey on lifestyle, place of residence, reproductive and health history as well as a nutritional questionnaire. Breastfeeding women collected up to 3 samples of their milk between 1st and 18th week of lactation.

Nutritional questionnaire

The nutritional survey had a character of frequency questionnaire to be fulfilled by women for the four weeks before the sampling. The survey contained 176 food products with possibility to insert additional products by the participants. The number of total different food products consumed during a month before sampling. The frequency of their consumption was analyzed from very frequent: several times a day; once a day; several times a week; once a week; several times a month; once a month as very rare.

Heavy metals concentration in human milk

The 10–50 ml milk samples collected were stored at -80°C until assays analysis. The study of heavy metal content in the human milk was carried out at the Accredited Hydrogeochemical Laboratory at the AGH University of Science and Technology in Krakow using inductively coupled plasma mass spectrometry (ICP-MS) method on an ELAN 6100 spectrometer (Perkin Elmer). The content of arsenic, barium, chromium, zinc, cadmium, cobalt, copper, nickel, lead and mercury were analyzed in accordance with PN-EN ISO 17294-2: 2016-11.

Dioxins and polychlorinated biphenyls in human milk

The examination of the content of dioxins and polychlorinated biphenyls (PCBs) in human milk was carried out on 1 liter of collected samples, which was provided by four participants from Krakow and its surrounding settlements. The samples were stored at -20°C until analysis. Two of the women who provided samples for this study used a vegan diet for a minimum of three years, and two used a traditional diet containing dairy, eggs and meat. The analysis was carried out in the Accredited Trace Analysis Laboratory at the Krakow University of Technology using gas chromatography and tandem mass spectrometry GC-MS/MS according to EU regulation 709/2014 procedure P/01 issue 03 of 11/03/2010 (accreditation certificate AB 749). The average fat content of human milk was taken as 3%.

In the study the listed congeners of dioxins were analyzed: 2,3,7,8-TeCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TeCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, OCDF. The uncertainty of the determination of congener was estimated at 26%. Dioxin-like polychlorinated biphenyls (dlPCB) congeners were analyzed: PCB77, PCB126, PCB169, PCB81, PCB105, PCB114, PCB118, PCB123, PCB156, PCB157, PCB167 and PCB189. The uncertainty of the determination of congener was estimated at 22%. The content of PCB congeners with properties nondioxin-like polychlorinated biphenyls (ndl-PCB) were tested: PCB28, PCB52, PCB101, PCB 138, PCB153, PCB180 with The uncertainty of the determination of congeners estimated at 22%. The results were presented in accordance with the Commission Regulation (EU) No. 1259/2011 dated 02.12.2011 and as the upper limit, toxic equivalents (TEQ) were adopted as a unit.

Statistical data analysis

Statistical analysis of the collected data was carried out using the Statistica 10 softwear (StatSoft Polska). Analysis of variance was carried out using the ANOVA under the condition of positive homogeneity of variance in Levene's test and supported by post-hoc Tukey's analysis. The strength of the relationship between the variables was evaluated using the general *F* test and the Fisher procedure. To establish the existence of a correlation between the measured parameters, linear regression was used. The strength of the relationship between the variables was assessed by calculating Pearson's correlation coefficients. The results of tests where the probability of type I error was less than 0.05 were considered as statistically significant.

Results

After preliminary statistical analyses, where no significant differences between the vegan and vegetarian group were found, it was decided to combine the result pool for diets excluding meat: vegan and vegetarian. This allowed to equalize the number of analyzed groups.

Basic statistical results for the measurement of heavy metal concentrations in breast milk are presented in Table 10.

Table 10. Content of heavy metals in samples of human milk (n=124)

Metals in human milk	Mean	Minimum	Maximum	S.D.	R.A. in mammal milk	Number of samples exceeding R.A.	R.A. in water
As [mg/kg]	44.9	0.7	497.2	77.4	<100	9	<50
Ba [mg/kg]	69.1	1.7	525.3	95.3		20	<100
Cd [mg/kg]	0.6	0.1	2.7	0.7	<10	0	<5
Co [mg/kg]	14.3	1.6	70.9	14.0	0.5-7*	10	
Cr [mg/kg]	52.7	2.8	245.2	56.8		40	<50
Cu [mg/kg]	0.26	0.06	1.04	0.21	0.2-0.3*	15	
Hg [mg/kg]	4.9	0.0	74.6	9.3	<10	5	
Ni [mg/kg]	152.7	4.4	1713.7	298.3		58	<50
Pb [mg/kg]	20.8	0.1	212.9	40.6	<20	34	<10
Zn [mg/kg]	1.01	0.14	8.07	1.35	1.7-5*	5	

*S.D. – standard deviation. R.A. – recommended allowances, * typical concentration in mammal milk [201, 202]*

The concentrations of heavy metals in human milk were significantly positively correlated between each other ($p < 0.05$). There was a correlation between the concentrations of arsenic and the concentrations of cadmium, chromium and mercury; between barium concentration and concentrations of cadmium, chromium, mercury, nickel and lead. The concentration of cadmium also correlated with chromium, mercury, nickel and lead.

It was found that there was no statistically significant correlation between the concentration of metals in breast milk and the duration of lactation nor the age of a woman in the study group nor the number of children.

In human milk from women on a traditional diet, the concentration of barium ($p = 0.0134$) and copper ($p = 0.038$; Figure 14) was significantly higher than in breast milk from vegans and vegetarians.

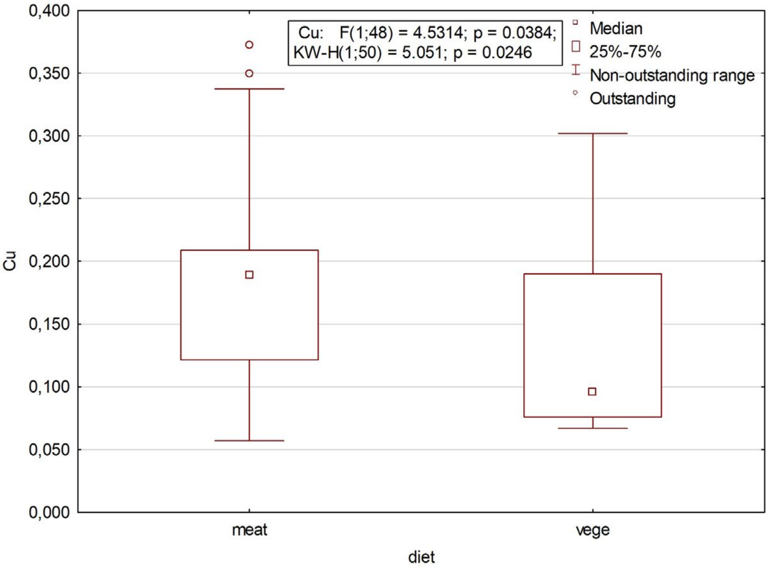

Figure 14. Relation of copper concentration in human milk samples (N=50) as measured by mass spectrometry to the women's diet: non-excluding meat (meat) or vegetarian and vegan (vege)

However, a higher concentration of mercury (p = 0.019), nickel (p = 0.035; Figure 15) and lead (p =0.036) were found in women excluding meat from their diet.

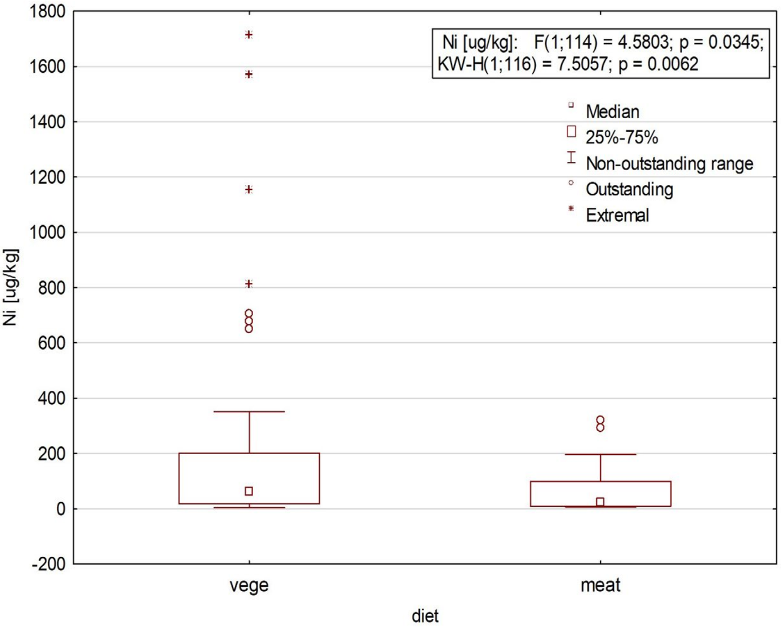

Figure 15. Correlation of nickel in human milk samples (N=50) as measured by mass spectrometry in relation to the women's diet: traditional (non-excluding meat) or vegetarian and vegan (vege)

The diet diversity distribution is shown in Figure 16. The mean number of consumed products was 85.28 (S.D. = 28.15) and median = 86.5; the minimum number of consumed food products was 35, while the maximum was 190.

The frequency of consumption of different food products was very diversified, however the high frequency of none of the analyzed products influenced the level of metals in human milk.

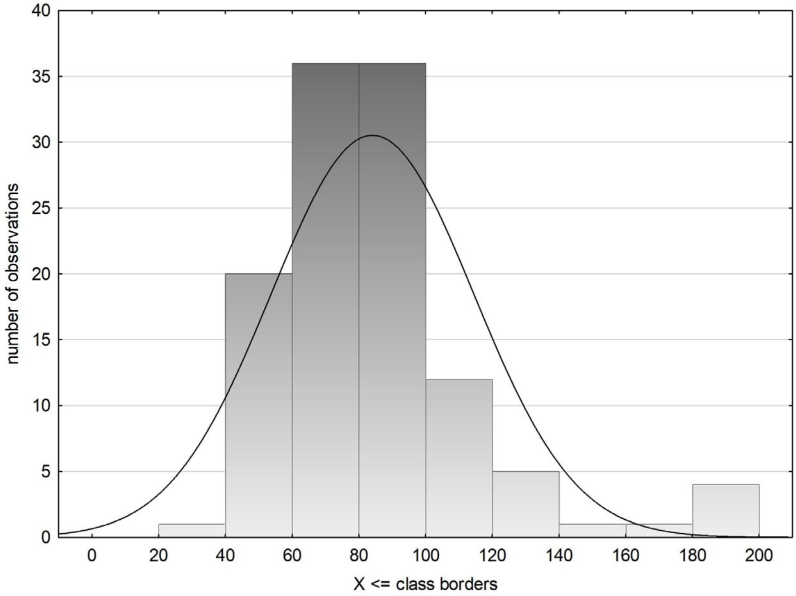

Figure 16. Food diversity among participant shown as a number of different food products consumed by the participants during one month before sampling the milk

The food diversity was independent from the diet type (vegetarian or non-excluding meat). Moreover the season of the year did not influence significantly the diversity of diet. However there was observed that the high diversity of consumed food products had an protective effect on concentration of metals in human milk: barium p = 0.035, copper p = 0.003, cobalt p = 0.032, mercury p = 0.003, nickel p = 0.017 and lead p = 0.009 (Figure 17), when the median was used as a border value for groups division in ANOVA test.

Significantly higher concentrations of heavy metals were observed in human milk samples taken between July and October than in samples collected between March to May: barium p = 0.000 (Figure 18); cadmium p = 0.007; cobalt p = 0.000; chromium p = 0.001; copper p = 0.001; mercury p = 0.017; nickel p = 0.001; lead p = 0.000.

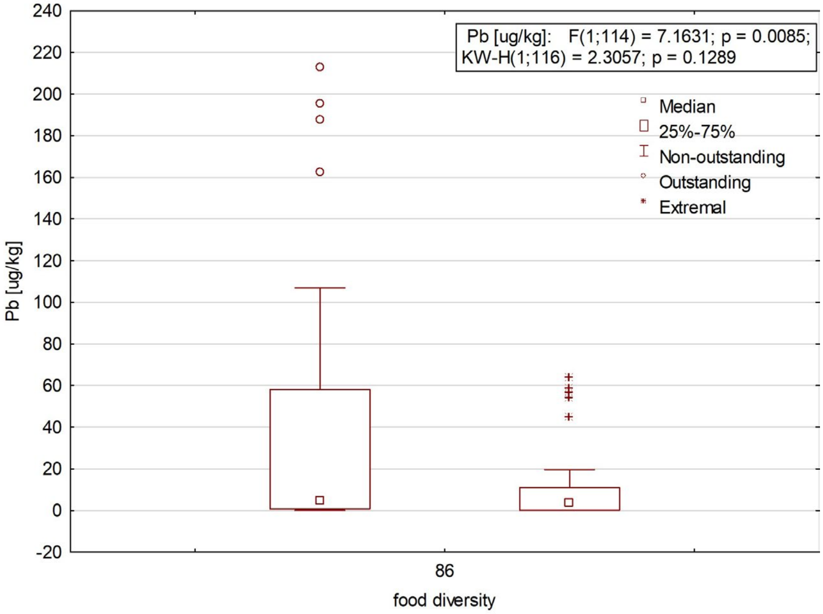

Figure 17. The concentration of lead in human milk in relation to number of food products consumed during a month before sampling. The border value for the group division was a median of number of eaten food products

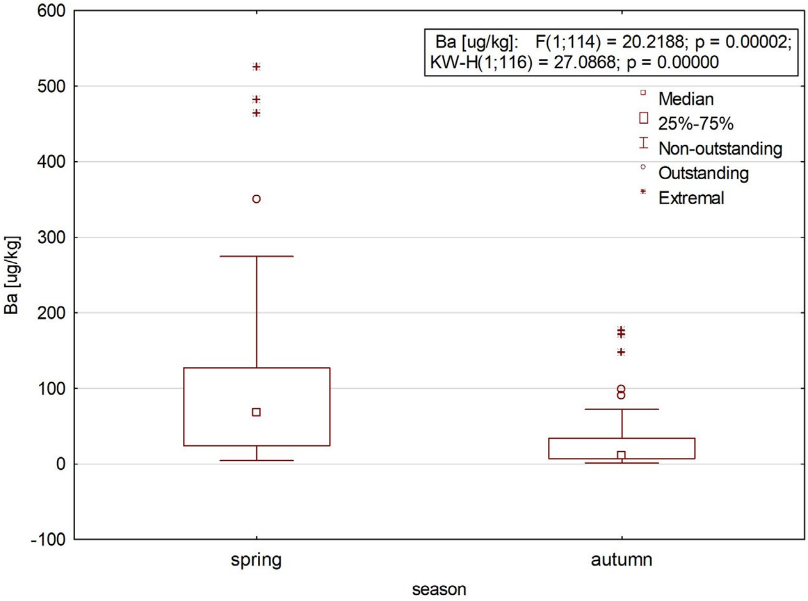

Figure 18. Correlation of barium in human milk samples (N=50) as (measured by mass spectrometry) in relation to the season when the sample was collected

The content of polychlorinated biphenyls and dioxins in human milk is shown in Table 11 and Table 12.

Table 11. Content of the sum of dioxins, dioxin-like polychlorinated biphenyls (dlPCB) and polychlorinated biphenyls with properties unlike dioxins (ndl-PCBs) in the human milk of four women from Małopolska region (Lesser Poland) expressed as TEQ equivalents [pg/g fat] ± standard deviation

Measurement	Milk 1 Traditional diet Big city	Milk 2 Traditional diet Small town	Milk 3 Vegan diet Big city	Milk 4 Vegan diet Small town
Dioxins total WHO-PCDD/F-TEQ [pg/g fat]	0.72 ± 0.19	7.0 ± 1.8	0.31 ± 0.08	0.91 ± 0.24
total dioxins and dlPCB WHO-PCDD/F-PCB-TEQ [pg/g fat]	1.30 ± 0.32	8.0 ± 2.0	0.35 ± 0.09	1.10 ± 0.27
ndl-PCB [ng/g fat]	1200 ± 2.7	35.0 ± 7.6	0.35 ± 0.08	3.10 ± 0.67

Table 12. Detailed results of dioxin and polychlorinated biphenyls content in breast milk samples from women from Małopolska expressed as TEQ equivalents [pg/g fat]

Milk sample 1, from woman on traditional diet, living in big city				
Congener	WHO-TEF	LOQ	Content	TEQ
		[pg/g fat]	[pg/g fat]	[pg/g fat]
Dioxins		0.231		0.72
2,3,7,8-TeCDD	1	0.045	n.o.	0.045
1,2,3,7,8-PeCDD	1	0.053	0.15	0.15
1,2,3,4,7,8-HxCDD	0.1	0.084	n.o.	0.0084
1,2,3,6,7,8-HxCDD	0.1	0.039	0.49	0.049
1,2,3,7,8,9-HxCDD	0.1	0.060	0.09	0.009
1,2,3,4,6,7,8-HpCDD	0.01	0.069	1	0.01
OCDD	0.0003	0.110	9.6	0.0029
2,3,7,8-TeCDF	0.1	0.069	0.45	0.045
1,2,3,7,8-PeCDF	0.03	0.094	0.5	0.015
2,3,4,7,8-PeCDF	0.3	0.110	0.83	0.25
1,2,3,4,7,8-HxCDF	0.1	0.230	0.48	0.048
1,2,3,6,7,8-HxCDF	0.1	0.150	0.39	0.039
1,2,3,7,8,9-HxCDF	0.1	0.140	n.o.	0.014
2,3,4,6,7,8-HxCDF	0.1	0.130	0.26	0.026
1,2,3,4,6,7,8-HpCDF	0.01	0.240	0.44	0.0044
1,2,3,4,7,8,9-HpCDF	0.01	0.520	0.88	0.0088
OCDF	0.0003	0.340	1.6	0.00048
dlPCB		**0.043**		**0.6**
3,3’,4,4’-TCB (PCB77)	0.0001	0.380	5.6	0.00056
3,3’,4,4’,5-PeCB (PCB126)	0.1	0.300	4.5	0.45
3,3’,4,4’,5,5’-HxCB (PCB169)	0.03	0.430	3.4	0.102
3,4,4’,5-TCB (PCB81)	0.0003	0.650	n.o.	0.0002
2,3,3’,4,4’-PeCB (PCB105)	0.00003	0.510	234	0.00702
2,3,4,4’,5-PeCB (PCB114)	0.00003	0.620	30	0.0009
2,3’,4,4’,5-PeCB (PCB118)	0.00003	0.360	1029	0.03087
2’,3,4,4’,5-PeCB (PCB123)	0.00003	0.700	13	0.00039
2,3,3’,4,4’,5-HxCB (PCB156)	0.00003	0.470	222	0.00666
2,3,3’,4,4’,5’-HxCB (PCB157)	0.00003	0.610	44	0.00132
2,3’,4,4’,5,5’-HxCB (PCB167)	0.00003	1.000	88	0.00264
2,3,3’,4,4’,5,5’-HpCB (PCB189)	0.00003	0.910	29	0.00087
		[ng/g fat]	[ng/g fat]	
ndl-PCB		**0.00523**	**12**	
PCB28		0.0024	1.9	
PCB52		0.0012	0.15	
PCB101		0.00046	0.31	
PCB138		0.00019	2.3	
PCB153		0.00058	4.4	
PCB180		0.00047	2.9	

Milk sample 2, from woman on traditional diet, living in small town				
Congener	WHO-TEF	LOQ	Content	TEQ
		[pg/g fat]	[pg/g fat]	[pg/g fat]
Dioxins		**0.772**		**7**
2,3,7,8-TeCDD	1	0.19	n.o.	0.19
1,2,3,7,8-PeCDD	1	0.18	3.7	3.7
1,2,3,4,7,8-HxCDD	0.1	0.26	n.o.	0.026
1,2,3,6,7,8-HxCDD	0.1	0.12	1.4	0.14
1,2,3,7,8,9-HxCDD	0.1	0.18	1.6	0.16
1,2,3,4,6,7,8-HpCDD	0.01	0.18	19	0.19
OCDD	0.0003	0.21	81	0.0243
2,3,7,8-TeCDF	0.1	0.34	0.63	0.063
1,2,3,7,8-PeCDF	0.03	0.28	0.4	0.012
2,3,4,7,8-PeCDF	0.3	0.39	3.9	1.17
1,2,3,4,7,8-HxCDF	0.1	0.59	9.2	0.92
1,2,3,6,7,8-HxCDF	0.1	0.34	1.8	0.18
1,2,3,7,8,9-HxCDF	0.1	0.36	n.o.	0.014
2,3,4,6,7,8-HxCDF	0.1	0.40	1.1	0.11
1,2,3,4,6,7,8-HpCDF	0.01	0.49	n.o.	0.0049
1,2,3,4,7,8,9-HpCDF	0.01	0.87	1.9	0.019
OCDF	0.0003	0.64	2.7	0.00081
dlPCB		**0.104**		**1**
3,3’,4,4’-TCB (PCB77)	0.0001	1.40	11	0.0011
3,3’,4,4’,5-PeCB (PCB126)	0.1	0.86	6.8	0.68
3,3’,4,4’,5,5’-HxCB (PCB169)	0.03	0.60	6.9	0.207
3,4,4’,5-TCB (PCB81)	0.0003	2.30	n.o.	0.00069
2,3,3’,4,4’-PeCB (PCB105)	0.00003	0.83	499	0.015
2,3,4,4’,5-PeCB (PCB114)	0.00003	0.81	74	0.0022
2,3’,4,4’,5-PeCB (PCB118)	0.00003	48.00	2403	0.072
2’,3,4,4’,5-PeCB (PCB123)	0.00003	1.10	15	0.00045
2,3,3’,4,4’,5-HxCB (PCB156)	0.00003	0.58	731	0.022
2,3,3’,4,4’,5’-HxCB (PCB157)	0.00003	0.75	142	0.004
2,3’,4,4’,5,5’-HxCB (PCB167)	0.00003	1.00	240	0.0072
2,3,3’,4,4’,5,5’-HpCB (PCB189)	0.00003	0.96	94	0.00282
		[ng/g fat]	[ng/g fat]	
ndl-PCB		**0.0133**	**35**	
PCB28		0.0096	1.2	
PCB52		0.0016	0.36	
PCB101		0.00067	0.98	
PCB138		0.00026	8	
PCB153		0.00068	14	
PCB180		0.00051	10	

Milk sample 3, from woman on vegan diet, living in big city				
Congener	WHO-TEF	LOQ	Content	TEQ
		[pg/g fat]	[pg/g fat]	[pg/g fat]
Dioxins		**0.274**		**0.31**
2,3,7,8-TeCDD	1	0.062	n.o.	0.062
1,2,3,7,8-PeCDD	1	0.059	n.o.	0.059
1,2,3,4,7,8-HxCDD	0.1	0.100	n.o.	0.01
1,2,3,6,7,8-HxCDD	0.1	0.040	n.o.	0.004
1,2,3,7,8,9-HxCDD	0.1	0.066	n.o.	0.0066
1,2,3,4,6,7,8-HpCDD	0.01	0.064	0.74	0.0074
OCDD	0.0003	0.079	6.7	0.0020
2,3,7,8-TeCDF	0.1	0.11	0.26	0.026
1,2,3,7,8-PeCDF	0.03	0.11	n.o.	0.0033
2,3,4,7,8-PeCDF	0.3	0.14	0.2	0.060
1,2,3,4,7,8-HxCDF	0.1	0.25	n.o.	0.025
1,2,3,6,7,8-HxCDF	0.1	0.16	n.o.	0.016
1,2,3,7,8,9-HxCDF	0.1	0.15	n.o.	0.015
2,3,4,6,7,8-HxCDF	0.1	0.14	n.o.	0.014
1,2,3,4,6,7,8-HpCDF	0.01	0.24	0.27	0.0027
1,2,3,4,7,8,9-HpCDF	0.01	0.47	0.54	0.0054
OCDF	0.0003	0.24	n.o.	0.000072
dlPCB		**0.039**		**0.04**
3,3’,4,4’-TCB (PCB77)	0.0001	0.59	4.6	0.00046
3,3’,4,4’,5-PeCB (PCB126)	0.1	0.32	n.o.	0.032
3,3’,4,4’,5,5’-HxCB (PCB169)	0.03	0.21	n.o.	0.0063
3,4,4’,5-TCB (PCB81)	0.0003	0.90	n.o.	0.00027
2,3,3’,4,4’-PeCB (PCB105)	0.00003	0.32	7.5	0.000225
2,3,4,4’,5-PeCB (PCB114)	0.00003	0.45	1.4	0.000042
2,3’,4,4’,5-PeCB (PCB118)	0.00003	0.23	19	0.00057
2’,3,4,4’,5-PeCB (PCB123)	0.00003	0.49	1.9	0.000057
2,3,3’,4,4’,5-HxCB (PCB156)	0.00003	0.24	3.4	0.000102
2,3,3’,4,4’,5’-HxCB (PCB157)	0.00003	0.29	0.76	0.0000228
2,3’,4,4’,5,5’-HxCB (PCB167)	0.00003	0.49	1.2	0.000036
2,3,3’,4,4’,5,5’-HpCB (PCB189)	0.00003	0.37	n.o.	0.000011
		[ng/g fat]	[ng/g fat]	
ndl-PCB		**0.0015**	**0.35**	
PCB28		0.00038	0.14	
PCB52		0.00033	0.43	
PCB101		0.00025	0.029	
PCB138		0.000086	0.034	
PCB153		0.00024	0.075	
PCB180		0.00021	0.025	

Milk sample 4, from woman on vegan diet, living in small town				
Congener	WHO-TEF	LOQ	Content	TEQ
		[pg/g fat]	[pg/g fat]	[pg/g fat]
Dioxins		**0.772**		**0.91**
2,3,7,8-TeCDD	1	0.10	n.o.	0.1
1,2,3,7,8-PeCDD	1	0.09	0.17	0.17
1,2,3,4,7,8-HxCDD	0.1	0.16	n.o.	0.016
1,2,3,6,7,8-HxCDD	0.1	0.08	0.67	0.067
1,2,3,7,8,9-HxCDD	0.1	0.12	n.o.	0.012
1,2,3,4,6,7,8-HpCDD	0.01	0.12	6.2	0.062
OCDD	0.0003	0.13	33	0.0099
2,3,7,8-TeCDF	0.1	0.14	1.4	0.14
1,2,3,7,8-PeCDF	0.03	0.16	0.3	0.009
2,3,4,7,8-PeCDF	0.3	0.22	0.26	0.078
1,2,3,4,7,8-HxCDF	0.1	0.58	1.1	0.11
1,2,3,6,7,8-HxCDF	0.1	0.36	0.56	0.056
1,2,3,7,8,9-HxCDF	0.1	0.24	n.o.	0.024
2,3,4,6,7,8-HxCDF	0.1	0.25	0.28	0.028
1,2,3,4,6,7,8-HpCDF	0.01	0.42	n.o.	0.0042
1,2,3,4,7,8,9-HpCDF	0.01	1.60	2.4	0.024
OCDF	0.0003	0.39	1.5	0.00045
dlPCB		**0.128**		**0.14**
3,3’,4,4’-TCB (PCB77)	0.0001	1.00	26	0.0026
3,3’,4,4’,5-PeCB (PCB126)	0.1	0.97	n.o.	0.1
3,3’,4,4’,5,5’-HxCB (PCB169)	0.03	1.00	n.o.	0.03
3,4,4’,5-TCB (PCB81)	0.0003	1.70	n.o.	0.0051
2,3,3’,4,4’-PeCB (PCB105)	0.00003	1.50	53	0.0016
2,3,4,4’,5-PeCB (PCB114)	0.00003	1.80	5.1	0.00015
2,3’,4,4’,5-PeCB (PCB118)	0.00003	1.10	201	0.006
2’,3,4,4’,5-PeCB (PCB123)	0.00003	2.70	7.3	0.000219
2,3,3’,4,4’,5-HxCB (PCB156)	0.00003	1.20	10	0.000
2,3,3’,4,4’,5’-HxCB (PCB157)	0.00003	1.40	1.7	0.000
2,3’,4,4’,5,5’-HxCB (PCB167)	0.00003	3.80	5.5	0.000165
2,3,3’,4,4’,5,5’-HpCB (PCB189)	0.00003	4.80	n.o.	0.00014
		[ng/g fat]	[ng/g fat]	
ndl-PCB		**0.0119**	**3.1**	
PCB28		0.0025	0.89	
PCB52		0.0035	0.54	
PCB101		0.0014	0.97	
PCB138		0.00031	0.2	
PCB153		0.0021	0.41	
PCB180		0.0021	0.056	

dlPCB, dioxin-like polychlorinated biphenyls; ndl-PCB, nondioxin-like polychlorinated biphenyls; Te – tetra; Pe – penta; Hx – heksa; Hp – hepta; LOQ, Limit of Quantification; TEQ, Toxic Equivalent; WHO-TEF – World Health Organization- Toxic Equivalency Factor

Discussion

Concentration of heavy metals in human milk

Due to the lack of established permissible standards for the concentration of heavy metals in human breast milk, the obtained results were compared to the accepted norms of metal content in milk of farmed mammals [187,216]. In the absence of developed standards for milk, it was decided to apply the accepted standards for the content of heavy metals in drinking water, as human milk constitutes the only nourishment for the first six months of an infant's life. Both these limit values are only a reference point for a safe concentration of heavy metals in breast milk. It should be taken into account that milk from farmed animals never constitutes the sole source of food for humans, which is why acceptable standards for the content of heavy metals in milk may appear to be too high when related to those for infants, and for this reason it is legitimate to use the more stringent standards for permissible concentrations of heavy metals in drinking water. It is worth mentioning that in the study group there was no high egg intake, both among vegetarians and women on a traditional diet, and what is also important to note, women using a traditional diet did not consume large amounts of fish, which both eggs and fish are often a significant source of toxins [186,196].

Unfortunately, in nine samples of human milk tested, the concentration of arsenic exceeded multiply the acceptable concentration in milk and water. The effect of diet type, place of residence or other factors on the concentration of this compound was not confirmed in comparison to pilot study [217].

It was also found that in some women's milk the content of barium exceeded the standards acceptable for those found in drinking water and it was related to diet type (higher in vegetarians) and negatively related to food diversity (lower if the diet was rich) and the season of the year (higher in spring).

It has been demonstrated that the concentration of cadmium in breast milk samples didn't exceed acceptable limits for this metal in either milk or water. The diet type used by the sample donor didn't influence the cadmium content however the higher concentrations were found in spring.

There are no set standards for cobalt in food products. It is worth mentioning that cobalt can occur not only as unfavorable inorganic compounds but also appears in the vitamin B12 as an ion coordinated in corrin ring. The analytical methods used in the study did not allow distinguishing the form in which cobalt is excreted in milk. It can only be concluded that in some samples the cobalt concentration strongly exceeded the amount of cobalt typically found in human milk as the vitamin B12 [218]. The higher concentrations of cobalt were observed in spring season.

The concentration of chromium in products for consumption should not exceed 0.05–0.1 mg/kg, unfortunately this value was exceeded in forty breastmilk samples. A statistically higher concentration of chromium was found in milk sampled in spring.

The higher concentration of copper was found in samples collected in spring than in autumn. The dangerous levels of copper (2–3 mg per day) were determined in fifteen of the analyzed milk samples. The samples collected in autumn and from women with diversified diet were characterized by lower levels of that metal.

It has been found that in more than 1/5 of all samples the concentration of lead exceeded the acceptable standards for milk and water. There was no relationship between the concentration of lead and the season of the year however higher concentrations of lead were found in milk of women using vegetarian diet and lower if the diet was rich.

Statistically higher concentrations of mercury was observed in women using a plant based diet, although theoretically a reverse dependence was expected due to the fact that its source is higher in animal products. However the diet diversity was a protective factor against high concentration of mercury in milk.

Unfortunately, in more than 1/3 of the analyzed milk samples, the nickel concentration exceeded the limits set for drinking water. The high food diversity protected against accumulation of nickel in milk. The high level of nickel in milk was found in spring season and it was related to the diet of the women as it was higher in samples from vegetarians.

The lower concentrations of barium, copper, cobalt, mercury, nickel and lead were observed in milk samples collected by women using very diversified diet who were eating more than 86 food products during a month before sampling. Then it is observed that the diet of high food diversity may protect against accumulation of toxins.

In addition, it was found that the concentrations of eight of the ten heavy metals analyzed in human milk were significantly higher in the samples collected in spring, than in the late summer and early autumn, before the start of the heating season. This is an indication that perhaps the key to increasing the level of heavy metals in the body and milk of nursing mothers is not diet but air pollution. Car fumes, heating homes with coal-fired boilers/stoves and the use of low-quality fuel cause air standards to be repeatedly exceeded in winter, this could be a probable reason for the high contamination of human milk with anthropogenic toxins as Poland is one of the most polluted countries in European Union [219].

The number of children, the duration of lactation didn't influence the heavy metals concentration in milk. However, it should be taken into account that this study did not analyze many factors that could possibly affect the concentration of heavy metals in milk, such as: the release of toxic accretions from the women's tissues, for example due to hormonal changes or changes in body weight.

Concentration of dioxin and polychlorinated biphenyls

Due to the analysis of the contents of dioxin and PCB was performed in a very small number of samples of the pilot study [217], the results of these tests cannot be subjected to statistical analysis and should be treated only as a report. The obtained values of dioxins could be related to values found in animal milk as well as in human milk from women in other populations.

According to the WHO recommendations, the maximum permissible daily allowance of PCDD dioxins is 1 pg-TEQ/kg body weight.

According to published data, female breast milk contains 25–40 pg-TEQ/g fat, while in animal milk this content is at the level of 0.1–6 pg-TEQ/g fat [196]. Therefore, assuming that an infant weighing approx. 5–8 kg, fed exclusively on human milk, consumes about 150 ml of milk with an average fat content of about 3%, it is probable that daily will receive up to 50 times the dose of dioxins than an adult with a standard diet. The results obtained in this study indicate a significantly lower content of dioxins and dioxin-like polychlorinated biphenyls (dlPCB) in the studied milk of women living in Poland than in previously published data [196]. The content of dioxins in human milk in the Netherlands [197] ranges between 4.3–32 pg-TEQ/g fat and 0.6–8.1 pg-TEQ/g fat for dioxin-like PCBs. In contrast, in Germany, the presence of dioxins in concentrations of 1.8–34.7 pg-TEQ/g fat and dlPCB 1.2–50.1 pg-TEQ/g fat [212] was found in breast milk. In China, concentrations of dioxins in human milk were found in concentrations of 7.4–23.6 pg-TEQ/g fat and dlPCB 0.9–7.9 pg-TEQ/g fat [198], while in Vietnam 1.5–14, 2 pg-TEQ/g fat [199]. Thus, the measured concentrations do not differ from the values reported in other studies and most importantly do not exceed the WHO recommended daily dose for an infant, which supports the thesis that human milk is the best solution for newborn nutrition [220], even though it sometimes has higher dioxin concentrations than in milk substitute preparations [196,221].

Conclusions

The ambiguous influence of the diet type on toxin concentration in human milk was observed. It cannot be stated unequivocally that vegetarian diet is a preventive or risk factor on the concentration of heavy metals or dioxins and PCBs in human milk. Data analysis in order to determine which environmental factors affect the content of dioxins in milk requires further testing on a larger number of samples. The issue worth of in-depth analysis seems to be the impact of the level of air pollution on the concentration of anthropogenic toxins in the milk of nursing mothers.

Women using a traditional European diet had higher concentrations of copper and barium in their milk, while samples from women excluding meat from their diet were characterized by a higher concentration of mercury, nickel and lead. However the diet diversity was found as a strong protective factor against accumulation of heavy metals in milk which is an important voice in underlining the meaning of food diversity [222–224]. Then it is to conclude that high food diversity may be more beneficial for health than exclusion of some food products.

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