Cite as: Kaleta-Pilarska AP: Predictors of acceptance of disease – the role of Type D personality.
Psychiatr Psychol Klin 2024; 24 (4)

Received: 29.10.2024
Accepted: 03.02.2025
Published online: 15.04.2025

Angelina Patrycja Kaleta-Pilarska

Predictors of acceptance of disease – the role of Type D personality

Predyktory akceptacji choroby – rola osobowości typu D

Department of Epidemiology, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Katowice, Poland
Correspondence: Angelina Patrycja Kaleta-Pilarska, Department of Epidemiology, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Medyków 18, 40-752 Katowice, Poland, e-mail: akaleta@sum.edu.pl

Katedra i Zakład Epidemiologii, Wydział Nauk Medycznych w Katowicach, Śląski Uniwersytet Medyczny w Katowicach, Katowice, Polska
Adres do korespondencji: Angelina Patrycja Kaleta-Pilarska, Katedra i Zakład Epidemiologii, Wydział Nauk Medycznych w Katowicach, Śląski Uniwersytet Medyczny w Katowicach, ul. Medyków 18, 40-752 Katowice, e-mail: akaleta@sum.edu.pl

https://doi.org/10.15557/PiPK.2024.0037

ORCID iD
Angelina Patrycja Kaleta-Pilarska https://orcid.org/0000-0003-4525-9553

Abstract

Introduction and objective: Cancer is a significant health and social issue. The diagnosis of cancer and the treatment process require changes in lifestyle and priorities. Both the patient and their family must adapt to new living conditions. The level of acceptance of the disease has a significant impact on the patient's quality of life and plays an important role in the healing process. In connection with the above, a study was conducted to assess the importance of Type D personality in disease acceptance among patients with colorectal cancer. **Materials and methods:** A cross-sectional study was conducted among 200 patients with colorectal cancer. The study used the an original personality questionnaire, the Acceptance of Illness Scale, and the Type D Personality Scale. Statistical analysis included descriptive and analytical methods. The results of univariable analyses were verified using logistic regression. **Results:** The vast majority (75.5%) of participants with Type D personality did not accept their disease. **Conclusions:** The presence of Type D personality in patients with colorectal cancer in the period immediately preceding surgical intervention is associated with a lack of acceptance of the neoplastic disease. The significance of Type D personality is evident when considering the presence of colorectal cancer in the patient's family in the context of acceptance of the disease.

Keywords: colorectal cancer, Type D personality, disease acceptance

Streszczenie

Wprowadzenie i cel: Choroby nowotworowe stanowią istotny problem zdrowotny i społeczny. Rozpoznanie takiej choroby i proces jej leczenia wiążą się z koniecznością zmiany dotychczasowego stylu życia lub dotychczasowych priorytetów, a zarówno pacjent, jak i jego rodzina muszą dostosować się do nowych warunków życia. Poziom akceptacji choroby istotnie wpływa na jakość życia pacjenta i odgrywa ważną rolę w procesie zdrowienia. W literaturze opisano niewiele badań podejmujących tematykę znaczenia osobowości typu D dla akceptacji choroby, jaką jest rak jelita grubego. W związku z tym zaplanowano badanie, którego celem była ocena znaczenia osobowości typu D dla akceptacji przez chorych z rakiem jelita grubego. **Materiał i metody:** W badaniu wzięło udział 200 chorych z rozpoznanym rakiem jelita grubego. Zakwalifikowani do badania pacjenci przebywali w Zagłębiowskim Centrum Onkologii – Szpitalu Specjalistycznym im. Szymona Starkiewicza w Dąbrowie Górniczej. W trakcie badania wykorzystano autorski kwestionariusz osobowy, Skalę Akceptacji Choroby i Skalę do Pomiaru Typu D. Analiza statystyczna danych objęła metody statystyki opisowej i analitycznej. Wyniki analiz prostych zweryfikowano, stosując analizę regresji logistycznej. **Wyniki:** Zdecydowana większość (75,5%) badanych z osobowością typu D nie akceptuje swojej choroby. **Wnioski:** Występowanie osobowości typu D wśród badanych z rakiem jelita grubego w okresie bezpośrednio poprzedzającym interwencję chirurgiczną wiąże się z brakiem akceptacji choroby nowotworowej. Znaczenie osobowości typu D jest widoczne po uwzględnieniu występowania raka jelita grubego w rodzinie pacjenta w przypadku akceptacji choroby.

Słowa kluczowe: rak jelita grubego, osobowość typu D, akceptacja choroby

INTRODUCTION

The International Agency for Research on Cancer (IARC) classifies carcinogenic factors into four categories. Since 1971, over 1,000 factors have been evaluated, with more than 400 classified as carcinogenic, probably carcinogenic, or possibly carcinogenic (International Agency for Research on Cancer, 2024).

Currently, studies focus on both risk factors and prognostic factors. Of particular interest is the interaction between Type D personality and survival rates in cancer patients (Hislop et al., 1987; Jokela et al., 2014; Kozak, 2016; Ogińska-Bulik and Juczyński, 2008). However, there is limited research addressing the role of Type D personality in disease acceptance, especially in the context of colorectal cancer.

Cancer remains a significant health and social challenge. The diagnosis of cancer and the treatment process require changes in lifestyle or personal priorities. Both the patient and their family must adjust to new living conditions. Stress, fear, and negative emotions often make it difficult to adapt to the situation. One contributing factor may be a lack of disease acceptance (Lewandowska-Abucewicz et al., 2016; Sowa et al., 2018).

Acceptance of cancer is a complex process that may depend on the patient's self-esteem, personality, support from loved ones, and quality of medical care (Rolka et al., 2009; Ryś et al., 2009; Sowa et al., 2018; Uchmanowicz, 2015). The level of disease acceptance significantly impacts the patient's quality of life and plays an important role in the healing process (Juczyński, 2012). Acceptance of the disease facilitates better adaptation to the new reality and, at the same time, a reduced sense of psychological discomfort (Smoleń et al., 2018).

In light of these research needs, a study was undertaken to assess the significance of Type D personality in the acceptance of the disease among patients with colorectal cancer.

MATERIALS AND METHODS

A cross-sectional study was conducted among 200 patients diagnosed with colorectal cancer at departments of surgery and oncology, as well as the department of oncological surgery at the Zagłębie Centre of Oncology in Dąbrowa Górnicza. All patients signed informed consent forms. Participation in the study was voluntary. The analysis included 200 patients (89 females and 111 males) with a diagnosis of colorectal cancer. The age of participants was 65 ± 11.3 years (range: 24–85). The mean age at cancer diagnosis was 64.6 ± 11.4 years.

Detailed characteristics of the study participants can be found in a previously published article based on the same study (Kaleta-Pilarska and Barański, 2023).

The study protocol was approved by the Bioethical Commission of the Medical University of Silesia in Katowice (decision No. KNW/0022/KB59/18). The inclusion criteria for the study were as follows:

- diagnosed colorectal cancer;
- hospitalisation at one of the medical centres selected for the study and planned surgery for cancer removal;
- signed informed consent to participate in the study.

The questionnaire was administered via direct interviews conducted at the site of hospitalisation. The patients answered the questions in a separate room during a face-to-face meeting with the researcher. The final dataset was anonymised. The interviews were conducted prior to surgical intervention.

During the interview, the author's original questionnaire was used, as well as Polish versions of two questionnaires: the Acceptance of Illness Scale (AIS) and the Type D Personality Scale (DS-14).

The author's questionnaire consisted of 26 questions covering anthropometric, social, and economic variables. It also included questions related to the suspicion and diagnosis of colorectal cancer.

The questionnaire used to assess the Acceptance of Illness (AIS) in the adaptation proposed by Juczyński (2009) consists of 8 statements rated on a 5-point response scale, where 1 indicates complete agreement with the statement, and 5 means complete disagreement. The total score ranges from 8 to 40 points. A low score (<20 points) means a lack of acceptance of the disease. A high score (≥20 points) indicates disease acceptance by the examined person.

A practical tool for measuring Type D personality is the DS-14 questionnaire developed in the Polish version in 2005 by Ogińska-Bulik and Juczyński. The questionnaire, based on the earlier DS-16 scale developed by Denollet, is used in research across various countries. Hence, after the translation was accepted by the World Health Organization (WHO), it was adapted for Polish conditions. The statements included in the questionnaire were considered understandable and unambiguous. As a result, the DS-14 questionnaire is suitable for use with adult populations, both healthy and ill (Denollet, 2005; Pedersen and Denollet, 2004).

The DS-14 questionnaire consists of 14 statements (Denollet et al., 2000). Each statement is rated on a 5-point response scale (0 – false, 1 – rather false, 2 – hard to say, 3 – rather true, 4 – true).

Type D personality consists of two dimensions: Negative Emotionality (NE) and Social Inhibition (HS) (Ogińska-Bulik, 2010). Of the 14 statements of the questionnaire, 7 are related to the Negative Emotionality dimension, while the other 7 pertain to the Social Inhibition dimension. The sum of the obtained results for the Negative Emotionality and Social Inhibition dimensions is calculated separately. A score of at least 10 points in either dimension is the basis for qualifying the examined person to a given category. Obtaining at least 10 points in both dimensions justifies the diagnosis of Type D personality (Ogińska-Bulik and Juczyński, 2004, 2008).

The statistical analysis included descriptive and analytical methods. In the case of quantitative variables, the mean, standard deviation, median, and range were used for

 DOI: 10.15557/PiPK.2024.0037

description. The normality of quantitative variables was assessed with the Shapiro–Wilk test. Numbers and percentages were used to describe qualitative variables. The Chi² test was performed to assess the relationships between variables. The results of univariable analyses were verified using logistic regression. Regression coefficients and *p*-values were calculated from the full model (fully adjusted). Additionally, the stepwise procedure was employed. In this analysis, predictors of the dependent variable were identified using a statistical significance threshold of $p < 0.1$. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

When assessing the significance of Type D personality in relation to the acceptance of cancer, it was found that the vast majority of respondents with Type D personality did not accept their disease (75.5%). This relationship is highly statistically significant ($p < 0.001$) (Tab. 1).

Tabs. 2 and 3 present the results concerning the significance of the two Type D personality dimensions – Negative Emotionality and Social Inhibition – for the acceptance of cancer. The majority of the respondents who were classified within the Negative Emotionality dimension (Tab. 2) did not accept their illness (62.0%). The vast majority of the respondents who were not classified within this dimension reported acceptance (90.5%). Similarly, in the Social Inhibition dimension (Tab. 3), the majority of the respondents (73.9%) with this trait did not accept their illness. Both relationships were found to be highly statistically significant ($p < 0.001$).

The results of the simple analyses were verified using multivariate analysis in a logistic regression model. Tab. 4 presents the results of the complete logistic regression model.

Statistical significance in the complete logistic regression model for the role of Type D personality in cancer acceptance was demonstrated for the Type D personality variable ($p < 0.001$).

A stepwise procedure was performed to identify the final predictors of the dependent variable, which included Type D personality (no vs. yes) – OR = 5.6 (95% CI: 3.0–10.6) and the occurrence of colorectal cancer in the family (yes vs. no) – OR = 1.9 (95% CI: 0.9–4.1). Each of these factors independently increased the likelihood of non-acceptance of the disease. However, their co-occurrence did not increase this likelihood (no interaction – $p = 0.4$).

	Type D personality (*n* = 110)	**Non-Type D personality (*n* = 90)**	***p* value (Chi² test)**
Acceptance of the disease (*n* = 87)	27 (24.5%)	60 (66.7%)	<0.001
Lack of acceptance of the disease (*n* = 113)	83 (75.5%)	30 (33.3%)	

Tab. 1. The importance of Type D personality for the acceptance of cancer

	Qualification for the Negative Emotionality dimension (*n* = 179)	**No qualification for the Negative Emotionality dimension (*n* = 21)**	***p* value (Chi² test)**
Acceptance of the disease (*n* = 87)	68 (38.0%)	19 (90.5%)	<0.001 (result of Fisher's exact test)
Lack of acceptance of the disease (*n* = 113)	111 (62.0%)	2 (9.5%)	

Tab. 2. The importance of Negative Emotionality for the acceptance of cancer

DISCUSSION

The aim of the study was to assess the significance of Type D personality for disease acceptance among patients with colorectal cancer.

There is limited research in the literature addressing this topic. The results obtained in the study indicate that the vast majority of respondents with Type D personality traits do not accept their cancer diagnosis (75.5%). It was shown that, in the analysed group, patients with a family history of colorectal cancer accepted the disease almost twice as often (IS = 1.9). Among individuals with non-Type D personality, the odds of accepting the disease were more than five times higher (IS = 5.6).

In the study by Basińska and Andruszkiewicz (2016), conducted among 204 patients with chronic diseases (including cancer), it was observed that individuals with non-Type D personality accepted their illness much more often than patients with Type D personality. This observation was also confirmed in the present study. Individuals with Type D

	Qualification for the Social Inhibition dimension (*n* = 115)	**No qualification for the Social Inhibition dimension (*n* = 85)**	***p* value (Chi² test)**
Acceptance of the disease (*n* = 87)	30 (26.1%)	57 (67.1%)	<0.001
Lack of acceptance of the disease (*n* = 113)	85 (73.9%)	28 (32.9%)	

Tab. 3. The importance of Social Inhibition for the acceptance of cancer

Variable	Regression coefficient	*p* value
Type D Personality (no vs. yes)	0.8	<0.001
Sex (female vs. male)	–0.2	0.41
Place of residence (urban vs. rural)	0.02	0.92
Education level (lower than secondary vs. secondary and higher)	0.01	0.93
Marital status (in a relationship vs. single)	–0.3	0.52
Employment (employed vs. unemployed person)	–0.3	0.11
Religious belief (believer vs. non-believer)	0.04	0.91
Housing situation (living alone vs. with a family member)	–0.3	0.54
Support from family (no vs. yes)	–0.5	0.22
Financial status (satisfactory vs. non-satisfactory)	–0.3	0.44
Circumstances of cancer diagnosis (by a patient vs. by a doctor)	–0.1	0.70
Family history of colorectal cancer (yes vs. no)	0.3	0.13
Satisfaction with medical care (yes vs. no)	0.2	0.64
Occurrence of chronic disease – without mental disease (yes vs. no)	–0.2	0.22
Occurrence of other cancers (yes vs. no)	–0.7	0.11
Fitness status (unchanged vs. worse)	–0.05	0.80
Nutritional status (unchanged vs. worse)	–0.01	0.92
Smoking status prior to cancer diagnosis (no vs. yes)	0.1	0.54
Alcohol consumption prior to cancer diagnosis (no vs. yes)	0.2	0.44

Tab. 4. Results of the analysis of the complete logistic regression model for the significance of Type D personality for the acceptance of cancer

personality have greater difficulty adapting to the disease, which may hinder the acceptance process. This may be related to their more frequent experiences of negative emotions, avoidance of social contacts, increased experience of stress and anxiety in comparison to individuals presenting features of non-Type D personality, which negatively affects the process of accepting the disease (Basińska and Andruszkiewicz, 2016; Sher, 2005).

Acceptance of the disease in the group of patients with a family history of colon cancer may be due to greater awareness of the condition and better education on this subject (Dahl, 2010; Gao et al., 2025).

Similar to the study by Franke and Kupcewicz (2014), conducted among 76 patients with cancer, the present study did not confirm the significance of marital status, employment status, or family support for the acceptance of the disease.

	Acceptance of the disease
Type D Personality	↓
Family history of colorectal cancer	↑
↑ – a factor that increases the chance of a given feature occurring; ↓ – a factor that decreases the chance of a given feature occurring.	

Tab. 5. Final predictors of the importance of Type D personality for disease acceptance

In that study, however, the significance of non-deteriorated physical fitness for the acceptance of cancer was noted. This relationship was not confirmed in the present study. The results obtained by Czerw et al. (2016) concerning the significance of patients' financial situation for disease acceptance were not confirmed in the present study either.

Tab. 5 shows the final predictors of the significance of Type D personality for illness acceptance, as discussed above. The predictors were identified after performing backward selection of the complete multivariate analysis model. The criterion of statistical significance was set at $p < 0.1$.

As with other questionnaire-based studies, this study is not without weaknesses. One of them is the limited representativeness of the group of patients with colorectal cancer. This is due to the fact that recruitment was conducted at a single hospital. Only patients who were waiting for surgical removal of the tumour and consented to participate in the study were included. Therefore, for organisational reasons, patients treated in other medical facilities were not represented in the study.

A strength of the study was the full returnability of the questionnaires, resulting from direct contact between the respondents and the interviewer at the hospital. When answering the questions included in the questionnaires, the patients were in a room with the interviewer only. This approach eliminated any potential interference with the results caused by the presence of third parties, as well as the possibility of the patient not understanding a given issue,

 DOI: 10.15557/PiPK.2024.0037

due to the possibility of its expansion by the interviewer. The study was based on validated questionnaires commonly used for research in Poland. In this context, a questionnaire-based study is the only method that can be used in this type of research.

The study included a similar number of women and men (89 and 111, respectively), who did not differ statistically significantly in terms of age. Additionally, it is important that the study relied on multivariate analysis using an automatic backward selection procedure, which allows for the control of confounding factors when assessing individual models. This procedure is often omitted in studies by other authors. Publications by other authors on the presence of Type D personality among patients with colorectal cancer are based on studies of small groups, and therefore may yield distorted results.

Taking into account both the limitations and strengths of the present study, it seems that it fills the gaps in the state of knowledge about the frequency of Type D personality among patients with colorectal cancer, as well as its significance for illness acceptance. The results of the study have a substantial cognitive significance from the point of view of public health, particularly regarding the prevalence of Type D personality among patients with colon cancer, and can thus be the basis for planning preventive measures and psychological recommendations in the medical treatment of colon cancer patients, which complement the therapeutic approach.

The actual strength of the relationship between Type D personality and illness acceptance warrants further discussion. The study demonstrated the importance of this relationship, aligning with the study's objective. However, the actual importance of the relationship would be best discussed based on the concept of cause-effect dependency. Verification of this relationship in such terms would be possible based on the results of prospective studies. For many reasons, such studies are unrealistic, as they would require knowledge of personality before the onset of the cancer process. Therefore, it remains clear that this type of relationship is visible in the results of the cross-sectional analysis, which may reflect the importance of personality among the circumstances shaping the risk of cancer, as well as the effect of advanced cancer on the expression of Type D personality traits. From this perspective, the conducted study offers significant, measurable insights and provides a good basis for planning further, more methodically accurate analyses of this relationship. While prospective studies remain unrealistic, a desired research step in the analysed case would be to repeat the personality study in the same patients, in the period after the procedure, in a stable phase of their health. The basic expectation of such a protocol would be to determine whether Type D personality (and its diagnostic components) are a stable attribute in the analysed situation. This type of study, as an independent follow-up to this dissertation, is justified in the light of our own findings and existing literature.

CONCLUSIONS

The presence of Type D personality among the examined patients with colorectal cancer in the period immediately preceding surgical intervention is associated with a lack of acceptance of the neoplastic disease. The significance of Type D personality is visible after taking into account the presence of colorectal cancer in the patient's family in relation to the acceptance of the disease.

Conflict of interest

The author does not report any financial or personal connections with other persons or organisations which might negatively affect the content of this publication and/or claim authorship rights to this publication.

Author contribution

Original concept of study; collection, recording and/or compilation of data; analysis and interpretation of data; writing of manuscript; critical review of manuscript; final approval of manuscript: APKP.

References

Basińska MA, Andruszkiewicz A: Cechy osobowości typu D a funkcjonowanie w chorobie pacjentów ze schorzeniami przewlekłymi. Pol Forum Psychol 2016; 21: 221–237.

Czerw AI, Religioni U, Deptała et al.: Assessment of pain, acceptance of illness, adjustment to life with cancer, and coping strategies in colorectal cancer patients. Prz Gastroenterol 2016; 11: 96–103.

Dahl AA: Link between personality and cancer. Future Oncol 2010; 6: 691–707.

Denollet J: DS14: standard assessment of negative affectivity, social inhibition, and Type D personality. Psychosom Med 2005; 67: 89–97.

Denollet J, Vaes J, Brutsaert DL: Inadequate response to treatment in coronary heart disease: adverse effects of type D personality and younger age on 5-year prognosis and quality of life. Circulation 2000; 102: 630–635.

Franke E, Kupcewicz E: Akceptacja i przystosowanie psychiczne do choroby nowotworowej. In: Majchrzak-Kłokocka E, Woźniak (eds.): Organizacja i zarządzanie wyzwaniem dla pielęgniarek i położnych w nowoczesnej Europie. Część I. Wydawnictwo SAN, Łódź–Olsztyn 2014: 373–387.

Gao K, Jin H, Yang Y et al.: Family history of colorectal cancer and the risk of colorectal neoplasia: a systematic review and meta-analysis. Am J Gastroenterol 2025; 120: 531–539.

Hislop TG, Waxler NE, Coldman AJ et al.: The prognostic significance of psychosocial factors in women with breast cancer. J Chronic Dis 1987; 40: 729–735.

International Agency for Research on Cancer: IARC Monographs – General Information [Internet]. 2024. Available from: https://monographs.iarc.who.int/home/iarc-monographs-general-information/.

Jokela M, Batty GD, Hintsa T et al.: Is personality associated with cancer incidence and mortality? An individual-participant meta-analysis of 2156 incident cancer cases among 42,843 men and women. Br J Cancer 2014; 110: 1820–1824.

Juczyński Z: Narzędzia pomiaru w promocji i psychologii zdrowia. Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego, Warszawa 2012.

Juczyński Z: Zmaganie się z chorobą. In: Juczyński Z (ed.): Narzędzia pomiaru w promocji i psychologii zdrowia. Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego, Warszawa 2009: 162–166.

Kaleta-Pilarska AP, Barański K: Mental adjustment to cancer in patients with colorectal cancer. Nowotwory J Oncol 2023; 73: 213–219.
Kozak G: Osobowość stresowa (typ D), a strategie zmagania się z chorobą nowotworową. Pol J Health Fitness 2016; 1: 1–11.
Lewandowska-Abucewicz T, Kęcka K, Brodowski J: Akceptacja choroby nowotworowej u kobiet po mastektomii w województwie zachodniopomorskim – badania wstępne. Fam Med Prim Care Rev 2016; 18: 143–148.
Ogińska-Bulik N: Osobowość typu D a ryzyko uzależnienia od czynności. Psychiatria 2010; 7: 11–24.
Ogińska-Bulik N, Juczyński Z: Osobowość stresowa (typ D) a ryzyko występowania chorób układu krążenia. In: Kosińska-Dec K, Szewczyk L (eds.): Rozwój, zdrowie, choroba. Aktualne problemy psychosomatyki. BEL Studio, Warszawa 2004: 5–17.
Ogińska-Bulik N, Juczyński Z: Właściwości osobowości sprzyjające chorobom somatycznym – rola typu D. Psychoonkologia 2008; 12: 7–13.
Pedersen SS, Denollet J: Validity of the Type D personality construct in Danish post – MI patients and healthy controls. J Psychosom Res 2004; 57: 265–272.
Rolka H, Krajewska-Kułak E, Kułak W et al.: Akceptacja choroby i strategie radzenia sobie z bólem jako istotne komponenty oceny jakości życia zależnej od stanu zdrowia u chorych z migreną – doniesienie wstępne. Probl Pielęg 2009; 17: 178–183.
Ryś J, Wysocki WM, Chmielnik E et al.: Rodzaje operacji wykonywanych u chorych na raka piersi i zasady zabezpieczania materiału tkankowego do badania histologicznego. Pol J Pathol 2009; 3 (Suppl 1): 20–25.
Sher L: Type D personality: the heart, stress, and cortisol. QJM 2005; 98: 323–329.
Smoleń E, Jarema M, Hombek K et al.: Akceptacja i przystosowanie do choroby u pacjentów leczonych onkologicznie. Probl Pielęg 2018; 26: 37–43.
Sowa M, Głowacka-Mrotek I, Nowikiewicz T et al.: Ocena czynników wpływających na stopień akceptacji zachorowania na raka piersi u kobiet poddanych leczeniu oszczędzającemu gruczoł piersiowy: analiza odległa po upływie 5 lat od zabiegu – badanie wstępne. Pielęg Pol 2018; 67: 58–64.
Uchmanowicz I: Wpływ zespołu kruchości na ocenę akceptacji choroby u chorych w wieku podeszłym na niewydolność serca. Gerontol Pol 2015; 1: 3–10.

 DOI: 10.15557/PiPK.2024.0037