EUROPEAN JOURNAL OF HEALTH POLICY, HUMANIZATION OF CARE AND MEDICAL ETHICS

1(4)/2025

CARDINAL STEFAN WYSZYŃSKI UNIVERSITY IN WARSAW

Wydawnictwo Naukowe
Uniwersytetu Kardynała Stefana Wyszyńskiego

WARSAW 2025

Language Editing – Eric Hilton

Technical Editor – Joanna Dziurzyńska

Graphic Design and Typesetting – Renata Witkowska

Editorial Office Contact – ejhp@uksw.edu.pl

e-ISSN 2957-2002

Wydawnictwo Naukowe
Uniwersytetu Kardynała Stefana Wyszyńskiego w Warszawie
01-815 Warszawa, ul. Dewajtis 5,
tel. 22 561-89-23; e-mail: wydawnictwo@uksw.edu.pl

www.wydawnictwo.uksw.edu.pl

EJoHP 1(4)/2025

Contents

Zuzanna Grześczyk-Nojszewska, MD

Air pollution as an element of under- and postgraduate medical education: A narrative review of the curricula of Polish medical schools and specialty training programs 5

Agnieszka Mazurek, MD

Machine Learning Models for Patient Screening Using Routinely Collected Data in Primary Care 17

Iwona Wrześniewska-Wal, MD, Ph.D.

The role of the pharmacist in the integration of traditional and conventional medicine 29

Mateusz Jankowski, Prof. Ph.D. MD

Secondhand smoke exposure at home in a representative sample of adults in Poland in 2024: A cross-sectional survey 41

Radosław Sierpiński, Ph.D., Igor Kilanowski, Dr.

Descriptive analysis of the implementation of the program "Prevention 40 PLUS" in Poland, July 2021–December 2024 55

EJoHP 1(4)/2025

DOI: https://doi.org/10.21697/ejhp.0106.01
e-ISSN 2957-2002

2025, 4, 1: 5-16

Air pollution as an element of under- and postgraduate medical education: A narrative review of the curricula of Polish medical schools and specialty training programs

Zuzanna Grześczyk-Nojszewska, MD
Resident
School of Public Health
Center for Postgraduate Medical Education
ORCID: https://orcid.org/0009-0000-4520-9746

Received: 1 Jun 2025; Revised: 18 Jun 2025; Accepted: 27 Jun 2025

Abstract

The aim of this narrative review is to investigate whether the current curricula of under- and postgraduate programs training physicians in Poland cover air pollution and to what extent. For this purpose, the newest versions of the official curricula of selected postgraduate specialty programs and medical universities' curriculum criteria were analyzed. The investigation indicates that the topic of air pollution is in many cases included as an element of physicians' education, but to a very limited extent and without adequate information that is essential for effectively communicating its health risks to future patients.

Keywords: medical education, air pollution, postgraduate, university, specialty, residency

Introduction

Air pollution is a growing concern in many parts of the world, including Europe (Khomenko et al., 2023; Reis et al., 2022). It has been proven to increase the incidence and mortality of various non-communicable and communicable diseases, including cancers, upper respiratory tract diseases and infections, and cardiovascular, autoimmune, and neurological diseases (Sun et al., 2016; Weuve et al., 2021; Renzi et al., 2022; Karimi & Samadi, 2024). It therefore poses a major health threat, generating various types of additional healthcare-related costs (Manisalidis et al., 2020).

European Context

In the European Union, it has been estimated that as many as 300,000 additional deaths are attributed to air pollution each year (Council of the European Union, n.d.). It is important to note that the European Union's legislation for reducing air pollution plays a pivotal role in introducing and accelerating Poland's measures at the national level. This is, for the most part, because of the strict limits on each pollutant that countries are expected to meet before the year 2030 (European Parliament and Council of the European Union, 2024). In a broader perspective, this is a part of the EU's goal of "zero pollution by 2050," which was established on the assumption that the health and economic burden of air pollution in Europe is excessive. At the same time, new documents underscore the notion of clean air and the right to information about air quality as fundamental citizen rights.

The key new document mentioned above is the revised version of the Ambient Air Quality Directive (European Parliament and Council of the European Union, 2024), adopted in 2024. One of its goals is to reduce premature deaths due to air pollution by 55% and achieve €121 billion in savings in healthcare, education, and socioeconomic costs (European Environment Agency, 2024a). One of the most important elements of the new directive is the revision of annual and daily maximum concentration limits for each pollutant and setting threshold concentrations in 1 day or 1 hour which require reporting and alerting the public.

For fine inhalable particles with a diameter of 2.5 micrometers and smaller (PM2.5), the mean annual limit has been reduced from 25 $\mu g/m^3$ to 10 $\mu g/m^3$. The new daily maximum concentration is 25 $\mu g/m^3$ and 50 $\mu g/m^3$ is the alert threshold.

It is important to mention that even after these changes, the EU's proposed limits are still higher than those currently recommended by the World Health Organization (2021). However, the limits are ambitious, considering the fact that most parts of Poland notoriously exceed these thresholds (European Environment Agency, 2024b). The legislation is meant to be implemented into national law by the end of 2026.

Polish context

Among all the European Union member states, Poland has been known to face dangerously high levels of air pollution, especially in the cities. The most recent report on air pollution in European cities, published by the European Environment Agency in 2024 and based on data collected between 2022 and 2023, highlighted the fact that 6 of Europe's 20 most polluted cities are located in Poland (based on mean annual PM2.5 concentration) (European Environment Agency, 2024c). These results do show some minor improvement in the overall state of Poland's air quality when compared to a previous report presented in 2021, which indicated that 5 out of Europe's 10 most polluted cities were in Poland (Tilles, 2021). The city of Nowy Sącz, located in the south of Poland, had the worst air quality in Europe, with a mean annual PM2.5 concentration of 27.3 $\mu g/m^3$. In the recent report, this value dropped to 24 $\mu g/m^3$ and the city ranked second (European Environment Agency, 2024c). It is critical to note, however, that even with an improvement of mean annual levels, the frequent temporary exceedance of limits still poses a great health risk.

The sources of air pollution in Poland

Currently, the main pollutants exceeding the EU's limits in Poland include PM2.5, PM10, benzoapirene and N02 (World Bank, 2019). The highest concentrations are typically observed during the heating season in the late afternoons (starting from 6 pm).

PM2.5 particles, because of their small size, are considered to be the most harmful pollutants and are currently the biggest concern in Poland. PM2.5 emissions tend to peak in the winter months in large urban agglomerations and in the southern regions of Poland. The main source of PM2.5 is undeniably the combustion of solid fuels (and sometimes even domestic waste) in stoves and boilers in residential buildings for the purpose of heating. Traffic and industrial activity are also considered to be significant sources of this pollutant.

Benzo(a)pirene pollution is notably higher in comparison with other EU states, with some Polish agglomerations reaching five times the EU's threshold limit value of 1 ng/m^3. Again, exceedances are observed during the winter months, especially around larger cities. It comes mainly from burning wood and different solid fuels in residential areas, as well as motor vehicles and heavy industry (World Bank, 2019).

Health burden of air pollution in Poland

Multiple studies conducted in Poland have provided evidence of poor air quality having a significant impact on health (Nazar & Niedoszytko, 2022), resulting in additional hospitalizations, an increased number of cardiovascular episodes, and premature deaths – all of which could be avoided.

A recent study (Dąbrowiecki et al., 2025) examining the risk of hospitalization due to acute or chronic coronary syndrome in connection to air pollution proved that exposure to PM2.5, P10, and N02 was associated with a higher risk of admission due to ischemic heart disease. This was a large study, analyzing data from the three largest agglomerations in Poland over 5 years.

Higher morbidity due to cardiac episodes and air pollution in Poland was confirmed by Kuźma et al. (2024) in a report that analyzed the risk of STEMI and N-STEMI episodes in relation to PM2.5, NO2, and S02 levels. It was found that higher concentrations of these pollutants increased the risk of admission due to STEMI and N-STEMI.

A study by Holnicki et al. (2017) investigating the health burden of air pollution in the capital city of Poland, Warsaw, estimated that each year 2,800 deaths can be attributed to poor air quality (out of which 82% can be attributable to elevated PM2.5 levels and 16% to exceeding N0x normative thresholds). The study also showed that the effects of air pollution on cardiovascular risk in Poland are most significant for young people, women, and residents of rural areas, especially socioeconomically challenged ones.

Physicians' professional training in Poland

The process of training physicians in Poland involves two educational levels, undergraduate and postgraduate professional education. The first stage requires graduating from a medical university after a 6-year program to obtain the title of doctor of medicine (MD). In order to be able to receive a full medical license, each graduate is obliged to complete a 13-month internship in a clinical setting and to pass the state medical exam.

However, ending one's professional training at this stage is often insufficient to practice clinically in a medical specialization. The vast majority of medical doctors continue into specialization training programs (residency), allowing them to obtain the title of a specialist in a given field of medicine. The length of residency programs varies greatly, from 4 to 8 years, and some of the programs encompass two parts: foundational training in a broader area of medicine (e.g. internal or pediatric medicine) and specialist training (e.g. pulmonology or cardiology). Some programs (e.g. hypertensiology) are only intended for physicians who have already completed residency in a different specialization.

Methodology

In this narrative review, the official national law describing the teaching standards of medicine required in all Polish universities (Ministry of Education and Science, 2023) and 12 specialization training programs was reviewed to find any mentions of the topic of air pollution. As for the specialization programs, the 12 fields that were most appropriate for this type of content were selected and searched: public health, epidemiology, allergology (with internal medicine as a basic module), pulmonology, pediatric pulmonology (with pediatrics as a base module), hypertensiology, cardiology, pediatric cardiology, otolaryngology, pediatric otolaryngology, rheumatology, and clinical toxicology. Each curriculum came from the official public source, the Center for Postgraduate Medical Education (n.d.). This institution is in charge of creating the programs. As the curricula tend to change quite frequently, only the newest versions were considered (published in 2023, in some cases updated in 2024).

Results

University curriculum

In Poland, all universities approved to teach medicine are obliged to follow the rules disclosed in an ordinance of the Ministry of Science and Higher Education (2023). This act encompasses all of the elements of the curricula, the exact scope of knowledge, and the specific skills required to become a doctor of medicine. This document does not specifically mention the term “air pollution.” However, upon analysis, there is some content which may (but not necessarily) indirectly refer to this issue:

> The graduate has knowledge and understanding of: […] consequences of human exposure to chemical and physical agents and principles of prevention, […] pathogenesis of diseases, including genetic and environmental predisposing factors, […] epidemiological and environmental predisposing factors, causes, symptoms, principles of diagnosis and treatment in the most common diseases in children and their complications, including […] respiratory system diseases and allergies. […] Epidemiological and environmental predisposing factors, causes, symptoms, principles of diagnosis and treatment in the most common diseases in adults and their complications, including […] cardiovascular diseases, respiratory diseases, […] allergies [as well as …] principles of health-promoting behavior.

Whereas these paragraphs could be interpreted as referring at least partially to the health consequences of exposure to air pollution, in reality it is uncertain and leaves room for individual evaluation.

Curricula of the specialization programs

The specialization training programs analyzed for this review differed significantly in terms of the amount of information about the health consequences of air pollution and methods of preventing it. Below, they are all discussed in turn.

1. Public health

In the 4-year specialization training for the field of public health, the topic of air pollution is raised directly twice, as is – more importantly – the issue of indoor air quality, which is often omitted from the discourse: "the importance of environmental and behavioral factors for the health of the population and the development of diseases: factors of the physical and anthropogenic environment, atmospheric and indoor air."

Another mention in the curriculum comes from the course called Health Determinants: "environmental physical and anthropogenic determinants of health (atmospheric and indoor air, food, soil, water." It should also be assumed that the several mentions of environmental conditions or factors at least partially also refer to the issue of diseases caused and mediated by air pollution and counteracting its effects: "diseases caused by environmental conditions," "relationships between these diseases [non-communicable diseases, mainly cancers and circulatory system diseases] and risk factors, including environmental factors," or "assessment of the importance of individual environmental factors […] in shaping the health status, including the ability to identify and eliminate factors harmful to health."

During specialization training, learning about the institutions involved in monitoring air quality and studying its health and economic effects, such as the World Bank and the European Environment Agency (EEA), is also required. An integral part of training for the public health specialization is the specialist courses, i.e. blocks of classes devoted to specific, broad issues important for the field.

In addition to the aforementioned course, Health Determinants, a course called Prevention and Health Promotion is also required. Importantly, it is also part of the training for other specializations, including epidemiology and all fields with a specialist module in internal medicine. One of the topics covered is "applications of health prevention and promotion (including recommendations, actions, methods, tools, materials, etc.) for practical disease/health problem control, [including] current health recommendations in the context of disease risk factors or specific diseases/health problems (e.g. air pollution [or] climate change)."

2. Epidemiology

In the curriculum for epidemiology residency, apart from the aforementioned course, Prevention and Health Promotion, there are no direct references to the quality or pollution of atmospheric or indoor air. However, the requirements repeatedly address the topic of environmental pollution (municipal and occupational) and quite broad "environmental factors," e.g. "the importance of individual environmental and social factors in shaping the health status, including the ability to identify and eliminate factors harmful to health" or "health effects of exposure to harmful environmental factors, including sources and routes of exposure to harmful environmental factors." The program also refers several times to institutions and programs that are key to improving air quality as sources of knowledge about pollution: "sources of information on environmental epidemiology: a) World Health Organization programs, b) European Environment Agency programs."

Likewise, in the course on "Epidemiology of non-communicable diseases with elements of environmental epidemiology," the issue of "epidemiology of conditions and diseases related to communal and occupational environmental pollution" is discussed. However, it should be noted that this is one of several topics discussed during a 5-day course of a residency program which lasts a total of 3 years.

3. Allergology

During the basic module on internal medicine in the specialization training in allergology, "air pollution" appears directly only once, in the aforementioned course, Prevention and Health Promotion.

In the specialization module, during the course on "Prevention and treatment of allergic diseases," the list of required skills in the field of preventive measures includes "environmental interventions – methods of reducing exposure to allergens, reducing exposure to pollutants," which, it can be assumed, concern mainly air pollution in this context.

4. Pulmonology

As previously mentioned, the basic module of the training includes the course Prevention and Health Promotion. In the specialization module, there are no direct references to air pollution. The program only references "industrial dust and pneumoconiosis" (as part of the course on occupational respiratory diseases) and "prevention of obstructive lung diseases" in the course on obstructive diseases.

5. Pediatric pulmonology

The specialization program in pediatric lung diseases includes a basic module in pediatrics and a specialization module in pediatric lung diseases. This is one of the programs in which many direct references to air pollution can be found. The basic module curriculum mentions, although indirectly, "causes of upper and lower respiratory tract infections," "the influence of genetic and environmental factors on allergic diseases," and "primary and secondary prevention of allergies." The basic module also includes the course Prevention and Health Promotion, which has been mentioned before.

The most interesting part is certainly the scope of the specialization module program, in which direct mentions can be found about pollution: "the influence of air pollution on the condition of the respiratory system: the influence of particulate matter and volatile gases on the respiratory tract, diseases related to exposure to pollution." The ability to "recognize the influence of tobacco smoke and other air pollutants on children's health" is also required. The test also describes "environmental factors relevant to asthma and other respiratory disorders, [including] the impact of passive smoking and air pollution on the incidence of asthma."

This last issue is mentioned again in the same wording as a criterium for passing the asthma internship.

6. Pediatric cardiology

The specialization program in pediatric cardiology includes a basic module in pediatrics and a specialization module in pediatric cardiology. The content of the basic pediatrics module is the same as described above. The specialization module does not have any information on air pollution in its program.

7. Clinical toxicology

The clinical toxicology specialization program is based on the basic module in internal medicine, the content of which was discussed above. The specialization module, during the course on "the basics of industrial and environmental toxicology with consideration of neoplastic diseases" discusses "methods of diagnosing and preventing the most common health hazards related to exposure to toxic factors in the environment and workplace." However, this does not necessarily mean air pollution, but may rather concern topics closer to health and safety at work and occupational medicine, especially considering the wording of the following passages: "criteria, method of determining and interpreting the highest permissible concentrations in the air at workplaces" and "neoplastic diseases related to exposure to chemical compounds and specific technological processes."

8. Other specializations

The subject of air pollution was only directly addressed by the programs of the remaining five specializations during the 5-day course called Prevention and Health Promotion (as described above). The specialization module does not contain any direct or indirect references to the quality of outdoor or indoor air. This situation concerned the specializations in cardiology, hypertensiology, otolaryngology, pediatric otolaryngology, and rheumatology.

Discussion

The above analysis indicates that the topic of air pollution seems to be discussed rarely – if at all – in both university and postgraduate curricula. Certainly, this can be explained by the fact that the primary goal of teaching at this stage is to provide information and skills that are intended specifically to treat diseases. Due to the amount of information that needs to be covered, prevention – including the prevention of diseases caused by air pollution – remains a lower priority.

From a practical perspective, in a healthcare system that is characterized by a shortage of specialists – especially those working in the public system – long waiting times for specialist treatment, and the consequential short consultation times per patient, informing patients about the current level of air pollution or personal protection methods may not, again, seem to be the ideal way to use this time.

Furthermore, one may wonder to what extent the obligation in this area should rest with doctors and to what extent it could be taken over by other public institutions, which is already happening to some extent. Some municipalities ("Program czyste powietrze – oddech dla Opola," 2022) inform their residents when air pollution exceeds a certain level or make this information publicly available in smartphone applications, on websites, or near measuring devices in the vicinity of public utility buildings. Some alerts, along with information about recommended personal protection, are sent via text messages by the Government Security Center (Więckowska, 2021).

The topic of air pollution is present in Polish medical discourse, although it is the subject of very few studies to date. At the time of writing this review, the author has managed to find only two surveys checking Polish doctors' subjective knowledge on the topic of air pollution. Each of the studies assessed the doctors' knowledge of the subject as low (Zielonka, 2021, 2022). Pulmonologists declared sufficient knowledge of the issue in only 16% of cases; their knowledge was weaker than that of patients suffering from lung diseases and they declared checking the current level of pollution less often than patients (Zielonka, 2021). The second study, conducted among doctors of different specializations working in the same hospital, showed that only 5% of doctors knew the limit concentrations of air pollutants and only 3% raised this topic with patients (Zielonka, 2022). These findings indicate that it still remains a niche topic among doctors.

Increasing physicians' awareness of air pollution could potentially bring tangible benefits in improving the health of the Polish population. Although air pollution itself does not require pharmacological treatment in patients, the exacerbation of chronic diseases (cardiovascular or respiratory) it causes may result in an increased demand for drugs (Hassan et al., 2024). Reducing exposure could therefore reduce both the health effects and the need for medication.

In addition, there are already studies (Hadley et al., 2018) containing forms for assessing a patient's exposure to air pollution in the clinical environment, as well as proposals for individual interventions to reduce exposure.

Conclusion

The issue of air pollution does not appear directly in the requirements describing the medical curriculum at universities in Poland. The topic is mentioned during specialization training in selected fields of medicine, but remains scarce and probably of little importance to the overall training course. It should be considered whether, given the significant health burden resulting from exposure to air pollution in Poland, actions should be taken to make students and doctors more knowledgeable on this subject. This could reduce to some extent the negative impact of air pollution on the health of Polish residents.

References

Center of Postgraduate Medical Education (Centrum Medycznego Kształcenia Podyplomowego). (n.d.). [Curricula for postgraduate programs]. Retrieved May 18, 2025 from https://www.cmkp.edu.pl/ksztalcenie/podyplomowe/lekarze-i-lekarze-dentysci

Council of the European Union. (n.d.). *Air Pollution in the EU: Facts and Figures*. Retrieved May 18, 2025 from https://www.consilium.europa.eu/en/infographics/air-pollution-in-the-eu/

Dąbrowiecki, P., Konduracka, E., Kołtowski, Ł., Chciałowski, A., Dąbrowiecka, A., Kępa, P., Czechowski, P.O., Owczarek T., & Badyda A. (2025). Ambient Air Pollution and a Risk of Hospital Admission Due to Acute and Chronic Coronary Syndromes: A Time-Stratified Case-Crossover Study in the 3 Largest Urban Agglomerations in Poland. *Polish Archives of Internal Medicine*, *135*, 16925. https://doi.org/10.20452/pamw.16925

European Environment Agency. (2024a). *Premature Deaths Due to Exposure to Fine Particulate Matter in Europe*. Retrieved May 18, 2025 from https://www.eea.europa.eu/en/analysis/indicators/health--impacts-of-exposure-to

European Environment Agency. (2024b) *Poland: Air Pollution Country Fact Sheet 2024.* https://www.eea.europa.eu/en/topics/in-depth/air-pollution/air-pollution-country-fact-sheets-2024/poland--air-pollution-country-fact-sheet-2024

European Environment Agency. (2024c). *European City Air Quality Viewer.* Retrieved May 19, 2025 from https://www.eea.europa.eu/en/topics/in-depth/air-pollution/european-city-air-quality-viewer

European Parliament and Council of the European Union. (2024, October 23). Directive (EU) 2024/2881 on Ambient Air Quality and Cleaner Air for Europe. *Official Journal of the European Union*. Retrieved May 18, 2025 from https://eur-lex.europa.eu/eli/dir/2024/2881/oj

Hadley, M. B., Baumgartner, J., & Vedanthan, R. (2018). Developing a Clinical Approach to Air Pollution and Cardiovascular Health. *Circulation*, *137*(7), 725–742. https://doi.org/10.1161/CIRCULATIONAHA.117.030377

Hassan, N., March, C., Mohammadkhan, A., Zarandi, I., Wilson, S., & Slight, S. (2024). Using Medications to Prevent or Reduce the Impact of Poor Air Quality on Health: A Systematic Review. *International Journal of Pharmacy Practice*, *32*(Suppl. 2), ii20–ii21. https://doi.org/10.1093/ijpp/riae058.024

Holnicki, P., Tainio, M., Kałuszko, A., & Nahorski, Z. (2017). Burden of Mortality and Disease Attributable to Multiple Air Pollutants in Warsaw, Poland. *International Journal of Environmental Research and Public Health*, *14*(11), 1359. https://doi.org/10.3390/ijerph14111359

Karimi, B., & Samadi, S. (2024). Long-Term Exposure to Air Pollution on Cardio-Respiratory, and Lung Cancer Mortality: A Systematic Review and Meta-Analysis. *Journal of Environmental Health Science and Engineering*, *22*(1), 75–95. https://doi.org/10.1007/s40201-024-00900-6

Khomenko, S., Pisoni, E., Thunis, P., Bessagnet, B., Cirach, M., Iungman, T., Barboza, E. P., Khreis, H., Mueller, N., Tonne, C., de Hoogh, K., Hoek, G., Chowdhury, S., Lelieveld, J., & Nieuwenhuijsen, M. (2023). Spatial and Sector-Specific Contributions of Emissions to Ambient Air Pollution and Mortality in European Cities: A Health Impact Assessment. *The Lancet Public Health*, *8(*7), e546–e558. 10.1016/S2468-2667(23)00106-8 External Link

Kuźma, Ł., Dąbrowski, E. J., Kurasz, A., Święczkowski, M., Jemielita, P., Kowalewski, M., Wańha, W., Kralisz, P., Tomaszuk-Kazberuk, A., Bachórzewska-Gajewska, H., Dobrzycki, S., & Lip, G. Y. H. (2024). Effect of Air Pollution Exposure on Risk of Acute Coronary Syndromes in Poland: A Nationwide Population-Based Study (EP-PARTICLES study). *The Lancet Regional Health – Europe*, *41*, 100910. https://doi.org/10.1016/j.lanepe.2024.100910

Lederer, A. M., Fredriksen, P. M., Nkeh-Chungag, B. N., Everson, F., Strijdom, H., De Boever, P., & Goswami, N. (2021). Cardiovascular Effects of Air Pollution: Current Evidence From Animal and Human Studies. *American Journal of Physiology-Heart and Circulatory Physiology*, *320*(4), H1417–H1439. https://doi.org/10.1152/ajpheart.00706.2020

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in Public Health*, *8*, 14. https://doi.org/10.3389/fpubh.2020.00014

Ministry of Education and Science (Ministerstwo Edukacji i Nauki). (2023, September 29). Rozporządzenie Ministra Edukacji i Nauki z dnia 29 września 2023 r. zmieniające rozporządzenie w sprawie standardów kształcenia przygotowującego do wykonywania zawodu lekarza, lekarza dentysty, farmaceuty, pielęgniarki, położnej, diagnosty laboratoryjnego, fizjoterapeuty i ratownika medycznego [Regulation of the Minister of Education and Science of 29 September 2023 amending the regulation on education standards preparing for the professions of physician, dentist, pharmacist, nurse, midwife, laboratory diagnostician, physiotherapist, and paramedic]. *Dziennik Ustaw* [Journal of Laws], 2023, item 2152.

Nazar, W., & Niedoszytko, M. (2022). Air Pollution in Poland: A 2022 Narrative Review With Focus on Respiratory Diseases. *International Journal of Environmental Research and Public Health*, *19*(2), 895. https://doi.org/10.3390/ijerph19020895

"Program czyste powietrze – oddech dla Opola." (2022). niskaemisjaopole.pl. https://www.niskaemisjaopole.pl/dzialania-miasta-na-rzecz-czystego-powietrza/dzialania-miasta-opola-w-zakresie-ograniczenia-niskiej-emisji

Reis, L. A., Drouet, L., & Tavoni, M. (2022). Internalising Health-Economic Impacts of Air Pollution Into Climate Policy: A Global Modelling Study. *The Lancet Planetary Health, 6*(1), e40–e48. 10.1016/S2542-5196(21)00259-X

Renzi, M., Scortichini, M., Forastiere, F., De'Donato, F., Michelozzi, P., Davoli, M., Gariazzo, C., Viegi, G., Stafoggia, M., & BEEP Collaborative Group. (2022). A Nationwide Study of Air Pollution From Particulate Matter and Daily Hospitalizations for Respiratory Diseases in Italy. *Science of the Total Environment*, *807*(Part 3), 151034. https://doi.org/10.1016/j.scitotenv.2021.151034

Sun, G., Hazlewood, G., Bernatsky, S., Kaplan, G. G., Eksteen, B., & Barnabe, C. (2016). Association Between Air Pollution and the Development of Rheumatic Disease: A Systematic Review. *International Journal of Rheumatology*, *2016*, 5356307. https://doi.org/10.1155/2016/5356307

Tilles, D. (2021, June 17). *Polish City Has EU's Most Polluted Air as Poland Takes Half of Ten Worst Spots in Ranking*. Notes from Poland. https://notesfrompoland.com/2021/06/17/polish-city-has-eus-most-polluted-air-as-poland-takes-half-of-ten-worst-spots-in-ranking/

Weuve, J., Bennett, E. E., Ranker, L., Gianattasio, K. Z., Pedde, M., Adar, S. D., Yanosky, J. D., & Power, M. C. (2021). Exposure to Air Pollution in Relation to Risk of Dementia and Related Outcomes: An Updated Systematic Review of the Epidemiological Literature. *Environmental Health Perspectives*, *129*(9), 096001. https://doi.org/10.1289/EHP8716

Więckowska, M. (2021, November 2). *Przekroczenie norm jakości powietrza? RCB wyśle SMS-owy alert*. Teraz Środowisko. https://www.teraz-srodowisko.pl/aktualnosci/smog-PM10-alert-smsowy-RCB-11012.html

World Bank. (2019). *Poland – Air Quality Management – Final Report.* Retrieved May 18, 2025 from https://documents1.worldbank.org/curated/en/574171554178748054/pdf/Air-Quality-Management-in-Poland.pdf

World Health Organization. (2021). *WHO Global Air Quality Guidelines: Particulate Matter (PM2.5 and PM10), Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide.* World Health Organization. https://www.who.int/publications/i/item/9789240034228

Zielonka, T. M. (2021). The Awareness of Pulmonologists and Patients with Respiratory Diseases About the Impact of Air Pollution on Health in Poland. *Journal of Clinical Medicine*, *10*(12), 2606. https://doi.org/10.3390/jcm10122606

Zielonka, T. M. (2022). Awareness of Polish Physicians Regarding the Impact of Air Pollution on Health. *Archives of Environmental & Occupational Health*, *77*(6), 478–485. https://doi.org/10.1080/19338244.2021.1935677

EJoHP 1(4)/2025

DOI: https://doi.org/10.21697/ejhp.0106.02
e-ISSN 2957-2002

2025, 4, 1: 17-28

Machine Learning Models for Patient Screening Using Routinely Collected Data in Primary Care

Agnieszka Mazurek, MD
School of Public Health
Centre of Postgraduate Medical Education
ORCID: https://orcid.org/0009-0002-1176-4076
ul. Kleczewska 61/63, 01-826 Warszawa, Polska
Email: agnieszka.mazurek@cmkp.edu.pl
Phone: +48 22-5601-150

Refceived: 3 Jun 2025; Revised: 18 Jun 2025; Accepted: 27 Jun 2025

Abstract

Screening is crucial to preventing the health consequences associated with undiagnosed diseases. Electronic health records (EHRs) from primary care can be leveraged with machine learning (ML) techniques to create new tools for patient screening in general practice. The aim of this narrative review is to discuss the recent literature on the development and validation of predictive ML models designed for the early detection of health conditions using readily available patient data. The PubMed, Web of Science, Scopus, and IEEE Xplore databases were searched for studies published within the last five years. Twenty-one studies were found, covering a variety of health conditions. ML-based tools can function as independent screening tests or can enhance existing screening methods. Moreover, ML models can be employed to screen for conditions for which screening approaches have not yet been developed. However, primary care EHRs alone are not always a sufficient source of data for effective screening. Poor data quality can result in erroneous or biased predictions. Despite these limitations, the application of ML for screening has shown promising results, and further research in this area is warranted.

Keywords: machine learning, primary care, screening, electronic health records

INTRODUCTION

Screening is a fundamental public health intervention for secondary prevention of disease. The goal of screening is to identify a condition before symptoms develop so as to accelerate the initiation of treatment or supportive care to either cure the condition or slow its progression (WHO Regional Office for Europe, 2020). Screening can be universal (population-level and high-risk-independent), targeted (population-level and high-risk-dependent), or opportunistic (patient-level and high-risk-independent) (Eriksen et al., 2021).

Primary care provides an excellent setting for administering screening, as it is a regular point of contact with the healthcare system for the general population, irrespective of health status. It is estimated that the primary care enrollment rate in developed countries exceeds 70% (Lin et al., 2025), with some countries, such as the UK, having nearly 98% of the population registered in primary care (Nadarajah et al., 2023). Primary care encounters generate vast volumes of data that often reflect longitudinal medical history. This data, stored in electronic health records (EHRs), could be utilized to uncover subclinical indicators of numerous health conditions, which could then be used to develop new digital screening tools.

Currently, machine learning (ML) is one of the leading approaches to analyzing large amounts of data. Hence, the aim of this narrative review is to discuss recently published research in this field and identify emerging trends in the use of ML to develop screening tools for use in primary care.

METHODS

Search Strategy

This work is a narrative review of the recent literature describing patient screening in primary care using machine learning algorithms. PubMed, Web of Science, Scopus, and IEEE Xplore were searched for relevant articles published between January 1, 2020 and May 28, 2025. The following keywords were used in the search: machine learning, screening, and primary care. The inclusion criteria were the use of data readily available in primary care offices and the objective of screening, or aiding screening, for a health condition. Only studies written in English were considered.

Information Extraction

Each article was carefully reviewed to extract key information, including the authors, year of publication, data source, screening target, the algorithms evaluated, the best-performing algorithm and its performance metrics, the total number and types of features, the validation method, and any non-ML comparators used.

DISCUSSION

Summary of Search Results

A total of 21 studies fulfilled the inclusion criteria. They covered a range of conditions. Mental and behavioral disorders were the most frequently investigated (n=6), followed by diseases of the circulatory system (n=5), diseases of the digestive system (n=3), and endocrine, nutritional, and metabolic diseases (n=3).

Nine distinct algorithm classes were evaluated across all studies. The most prevalent model was logistic regression (LR), which was used in 15 studies. Random forest (RF) was the second model of choice, appearing in 14 studies. Five studies tested only one algorithm. Of the studies that tested more than one, four identified eXtreme Gradient Boosting (XGBoost) and three identified neural networks (NN) as the best-performing models. Other top performers were RF, LR, and Light Gradient Boosting Machine (LightGBM).

All studies employed internal validation to assess model performance, but only six carried out additional external validation to evaluate the generalizability. Furthermore, in five cases, ML performance was compared against standard screening tools.

A complete summary of the most important characteristics and findings of each study is presented in Table 1. The performance metrics reported in the table and throughout this work are the highest values achieved by the best-performing model on any validation set unless otherwise specified.

Table 1: Summary of Studies on Machine Learning Models for Screening in Primary Care

Authors, Year, Country	Target	Models	Validation		AUC	Sensitivity/ Recall	Specificity	PPV/ Precision	NPV	Accuracy	F1
Kimura et al., 2025, Japan	PET Aβ-positivity	**EN, LR, SVM**	I	LR	0.76 (0.01)	0.64 (0.03)	0.75 (0.03)	0.62 (0.03)	0.77 (0.01)	0.70 (0.02)	–
Eder et al., 2025, Germany	Depression	**XGB**, XGB+LR, SVM	I		–	0.878	0.886	–	–	0.882[a]	–
Wei et al., 2024, China	Carotid Artery Plaques	**LightGBM,** LR, NB, MLP, RF, SVM, XGB	I		0.854	0.595	0.892	0.729	0.817	0.795	0.655
Lu et al., 2024, Canada	Prediabetes	**DNN**, KNN, LR, NB, RF, SVM, XGB	I		0.76	0.60	–	0.69	–	0.72	0.64
Dabbah et al., 2024, Israel	Advanced Liver Fibrosis	LR, NN, RF, SVM, **XGB**	E		0.91 [0.88–0.97]	0.91 [0.84–0.96]	0.76 [0.72–0.80]	0.31 [0.26–0.34]	0.99 [0.98–1.00]	–	–
Szlejf et al., 2023, Brazil	Cognitive Impairment	CatBoost, LightGBM, LR, NN, **XGB**	I		0.873 [0.839–0.906]	0.316	0.969	0.298	0.972	–	0.307
Qin et al., 2023, China	MASLD	DT, RF, **SVM**, XGB	I		0.850 [0.840–0.850]	–	–	0.795 [0.781–0.795]	–	0.801 [0.789–0.801]	0.795 [0.781–0.795]
Nadarajah et al., 2023, UK	AF	LR, **RF**	I		0.824 [0.814–0.834]	0.781 [0.731–0.829]	0.731 [0.693–0.771]	0.025 [0.023–0.027]	0.998 [0.998–0.998]	–	–
Onishchenko et al., 2022, USA	IPF	PFSA + LightGBM	E	Men	0.88 (0.07)	0.68 (0.01)	0.95	0.50 (0.01)	0.98 (0.00)	–	–
				Women	0.94 (0.06)	0.83 (0.02)		0.38 (0.01)	0.99 (0.00)	–	–
Liu et al., 2022, China	Diabetes	CDKNN, KNN, **LGBM**, LR, NN, RF, SVM	I		0.697	–	–	–	–	–	–
Lin et al., 2022, China	Primary Aldosteronism	LR	E		0.839 [0.790–0.890]	0.582	0.892	0.716	0.820	0.793	–
Lee and Pak, 2022, South Korea	SI; SpoA	LR, RF, SVM, **XGB**	I	SI	0.861	0.853	0.869	0.819	0.895	0.863	–
				SPoA	0.880	0.861	0.900	0.861	0.900	0.884	–
Sekelj et al., 2021, UK	AF	CoxR, LR, **NN**, RF, SVM	E		0.87	0.500	0.926	0.169	0.984	–	–
Bennis et al., 2022, Netherlands	HF	**LR**, RF, XGB	I		0.772 [0.759–0.785]	0.761	0.653	–	–	0.655	–
Yu et al., 2021, China	Carotid Atherosclerosis	DT, **MLP**, RF, SVM, XGB	I		0.766 [0.754–0.769]	–	–	0.743	–	0.748	0.742
Souza Filho et al., 2021, Brazil	Depression	AB, CART, GB, KNN, LR, **RF**, SVM, XGB	I		0.87 (0.08)	0.90 (0.03)	–	0.88 (0.04)	–	0.89 (0.03)	0.89 (0.03)
Malhotra et al., 2021, UK	Pancreatic Cancer	**LR, RF**	I	15–60 y (20 mo)[b]	0.656	0.725	0.587	–	–	–	–
				61–99 y (17 mo)[c]	0.609	0.651	0.568	–	–	–	–
Amit et al., 2021, UK	Postpartum Depression	XGB	E		0.844 [0.830–0.857]	0.764 [0.735–0.791]	0.80	–	–	–	–
van Mens et al., 2020, Netherlands	Suicidality	RF	I		0.82 [0.78–0.86]	0.39 [0.32–0.47]	0.98 [0.97–0.98]	0.05 [0.04–0.06]	–	0.68[a]	–

Authors, Year, Country	Target	Models	Validation		AUC	Sensitivity/ Recall	Specificity	PPV/ Precision	NPV	Accuracy	F1
Rosenfeld et al., 2020, UK	Barret's Esophagus	DT, **LR**, NB, RF, SVM	E		0·81 [0·74–0·84]	0.90	0.58	0.77	0.77	0.769	0.77
Doyle et al., 2020, UK	NTM Lung Disease	XGB	I		0.94	0.135	–	0.091	–	–	–

Notes: Values in parentheses ( ) are standard deviations. Values in square brackets [ ] are 95% confidence intervals. If more than one model was tested, the best-performing model is shown in bold. If all are bolded, the performance was similar for all models and specific metrics are reported for only one model.

[a] Balanced accuracy; [b] Patients aged 15 to 60 years at 20 months before diagnosis; [c] Patients aged 61 to 99 years at 17 months before diagnosis.

Abbreviations: *AUC* – area under receiver operating characteristic curve; *PPV* – positive predictive value; *NPV* – negative predictive value; *PET* – positron emission tomography; *AB* – amyloid beta; *MASLD* – metabolic dysfunction-associated steatotic liver disease; AF – atrial fibrillation; *IPF* – idiopathic pulmonary fibrosis; *SI* – suicidal ideation; *SpoA* – suicide planning and attempt; *HF* – heart failure; *NTM Lung Disease* – nontuberculous mycobacterial lung disease; *EN* – elastic net; *LR* – logistic regression; *SVM* – support vector machine; *XGB* – eXtreme Gradient Boosting; *LightGBM* – Light Gradient Boosting Machine; *NB* – naïve Bayes; *RF* – random forest; *MLP* – multilayer perceptron; *DNN* – deep neural network; *KNN* – K-nearest neighbors; *NN* – neural networks; *DT* – decision tree; *PFSA* – probabilistic finite automata; *CDKNN* – centroid-displacement-based KNN; *CoxR* – Cox regression; *AB* – adaptive boosting; *CART* – classification and regression tree; *GB* – gradient boosting; *I* – internal; *E* – external.

Defining Machine Learning

Machine learning (ML) is a subfield of artificial intelligence (AI). Notably, the proliferation of natural language processing (NLP) and large language models (LLMs) has popularized the colloquial use of the term *AI* to refer to conversational chatbots. However, NLP and ML are distinct in their underlying computational methods and practical applications. ML refers to applying predictive algorithms to data to “learn” from existing patterns to solve classification or regression problems (Google Cloud, n.d.).

Standard Performance Metrics

Assessing the real-world utility of predictive ML models relies on being able to interpret their performance in a clinical context. The performance of classification models can be evaluated with familiar metrics, such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy.

In the field of ML, the four most commonly reported metrics are area under the receiver operating characteristic curve (AUC or AUROC), precision, recall, and F1 score (Google Developers, n.d.). AUC quantifies how well the model discriminates between positive and negative cases; it ranges from 0.5, indicating no discrimination, to 1, indicating perfect discrimination. The other three metrics assume values between 0 (worst score) and 1 (best score). Recall is equivalent to sensitivity and indicates the proportion of positive cases identified. Precision is equivalent to the PPV and indicates the proportion of correct positive predictions. The F1 score combines precision and recall, indicating the proportion of false positives and false negatives.

Unfortunately, there are no universal cut-offs for these metrics that could be used to definitively deem a model good or bad for screening, as performance expectations are highly use-case-dependent. Higher values are favored. For AUC, values above 0.6, 0.7, 0.8, and 0.9 correspond to acceptable, good, very good, and excellent performance, respectively (Hanna et al., 2023; White et al., 2023).

Model Validation

Generalizability is the ability of an ML model to make useful predictions on unseen data. Validation is crucial in this assessment and can be internal or external (Steyerberg et al., 2001). Internal validation involves randomly splitting the dataset into training and testing subsets. A simple test-train split, cross-validation, and bootstrapping are commonly used internal validation methods (Steyerberg and Harrell, 2016). Internal validation is straightforward and should be considered the bare minimum for evaluating model performance. External validation uses a separate, fully independent dataset to test the model. Strategies for external validation include geographical validation, in which the validation data is obtained from different locations (i.e., clinical sites or countries), and temporal validation, which uses data from different time periods (Steyerberg and Harrell, 2016).

All studies performed internal validation and six conducted external validation. Most models showed sustained performance. The model for advanced fibrosis in metabolic dysfunction-associated steatosis liver disease (MASLD) (Dabbah et al., 2024), which was trained using data from tertiary care, demonstrated comparable performance when tested on data from primary care. This finding highlights that models do not necessarily need to be trained on primary care data to be useful in those settings.

Novel Screening Tools

Perhaps the most promising application of ML for the development of screening tools is to target diseases for which no known screening methods exist. One such disease is idiopathic pulmonary fibrosis (IPF), which is characterized by an insidious onset and poor prognosis. A model, the zero-burden comorbidity risk score for IPF (ZCoR-IPF) (Onishchenko et al., 2022), was developed to predict the risk of IPF at 1 and 4 years prior to a formal clinical diagnosis. Comorbidity codes were used as the sole input. At 1 year, the model achieved an AUC of 0.88 (0.07), with moderate sensitivity at 95% specificity for men and 0.94 (0.06) for women with high sensitivity at 95% specificity. The NPV was 0.98 (0.00) for men and 0.99 (0.00) for women. These results indicate that ZCoR-IPF would be a valuable tool for screening IPF in general practice.

Enhanced Screening Tools

Another application of ML for screening is improving existing screening methods. ML models could supplement proven screening strategies with information derived from primary care records. The model to screen for depression (Eder et al., 2025) – using a combination of 15 deliberately chosen items from the World Health Organization Well-Being Index (WHO-5), the Patient Health Questionnaire-9 (PHQ-9), and the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) – achieved better results than the PHQ-9 alone. Another model to identify women at risk of postpartum depression (Amit et al., 2021) based on demographics, medical history, and labor complications performed slightly worse on its own than the Edinburgh Postnatal Depression Scale (EPDS). However, incorporating the EDPS score into the model improved performance over the individual components.

Fasting plasma glucose (FPG) is one of the recommended screening modalities for diabetes, but it can miss cases with incidentally normal results at the time of screening. To address this issue, a model for screening for diabetes (Liu et al., 2022) that incorporates demographic and anthropometric features along with an FPG measurement was developed. It performed better than the model without FPG, even if FPG was below the diagnostic threshold, showing an ability to improve standard screening strategies.

Alternative Screening Tools

In some cases, ML may be utilized to develop predictive models that could serve as an alternative to existing screening tools. This could be motivated by the need to deliver improved results, reduce reliance on specialized equipment or additional laboratory testing, and eliminate the need for invasive testing procedures.

In screening for advanced liver fibrosis in MASLD, the model of Dabbah et al. (2024) outperformed established tools such as the Fibrosis-4 Index (FIB-4) and the NAFLD Fibrosis Score (NFS), offering a markedly higher PPV while maintaining an NPV of 99% [98–100]. The Future Innovations in Novel Detection of Atrial Fibrillation model (FIND-AF) (Nadarajah et al., 2023) for identifying patients at risk of atrial fibrillation showed better performance than the C2HEST and CHA2DS2-VASc scores. The FIND-AF model also identified high-risk patients under 65 years old, whom these traditional approaches could otherwise overlook.

A model to screen for Alzheimer's disease (Kimura et al., 2025) by predicting the presence of intracerebral amyloid β plaques demonstrated moderate effectiveness at excluding individuals unlikely to show amyloid accumulation on positron emission tomography (PET), thereby limiting unnecessary scans. Two models for screening carotid atherosclerosis (Wei et al., 2024; Yu et al., 2021) showed that they could be used to assess atherosclerosis in asymptomatic adults using demographics, physical examination, and laboratory data. This is particularly important, given that carotid duplex sonography is neither economically feasible nor recommended for this population.

The prediabetes screening model of Lu et al. (2024) was built without incorporating any glycemia-related laboratory results, yet still managed good discriminatory performance. However, the recall was poor, suggesting limited potential to eliminate the need for additional blood tests.

Barrett's esophagus, a precursor to esophageal adenocarcinoma, is challenging to screen for due to its low incidence and the reliance on invasive endoscopy with biopsy. A model based solely on demographic and reflux-related symptoms (Rosenfeld et al., 2020) showed that it could be used as a low-burden alternative to identify at-risk patients who may require endoscopic evaluation.

Suboptimal Results

It should be acknowledged that primary care data may sometimes be insufficient to train ML models that could produce clinically actionable results. A model to identify patients at high risk of pancreatic cancer 17 to 20 months prior to diagnosis (Malhotra et al., 2021) was trained using data on demographics, comorbidities, symptoms, pharmacotherapy, and frequency of clinical encounters. Notably, no biomarkers or imaging results were included. The model achieved an AUC of 0.656 for patients aged 60 or younger at 20 months and 0.609 for patients older than 60 at 17 months before diagnosis. Specificity did not exceed 0.59 for either group. The authors proposed that the model would likely benefit from integrating biomarker assays to improve usability.

Model Limitations

One of the most frequently addressed limitations of the use of ML models in medicine is their explainability. This refers to the extent to which the features that most influenced the model's predictions agree with the medical knowledge explaining the pathophysiology of the target condition. Certain algorithms, such as RF, produce feature importance rankings that can be evaluated by healthcare professionals for clinical justifiability. For the algorithms that do not offer such solutions, the Shapley Additive exPlanations framework (SHAP) (Lundberg & Lee, 2017) can be used to attempt to explain the model's reasoning. Nearly all studies included in this review provided some analysis of feature importance, which should mitigate the risk of their models being dismissed by clinicians due to a lack of trust.

Poor-quality primary care EHRs could also affect the reliability of ML-based screening tools. The quality of the data found in EHRs is not uniform due to reporting inconsistencies between healthcare providers (van Mens et al., 2020). On the one hand, models trained on datasets affected by data missingness or inadequate or erroneous reporting would likely not achieve satisfactory clinical results. On the other hand, incomplete patient records, such as when patients underreport sensitive information regarding addiction, education, and income level (Malhotra et al., 2021), could negatively impact the accuracy of predictions made by even those models that were trained on high-quality data.

Ethical Considerations

Models trained on narrowly defined subpopulations do not represent the general population, which may limit their generalizability and affect the health outcomes of minority groups. For instance, the model used to screen for cognitive impairment (Szlejf et al., 2023) was trained on the medical records of Brazilian government workers, who are more likely than the general population to have higher education. Consequently, primary education, as opposed to higher education, was found to be one of the most important predictors of cognitive impairment. This could mean that the model was biased and could lead to inaccurate predictions and stigmatization of patients from different social classes if implemented in clinical practice.

Future Research Directions

A successful deployment of ML-based screening tools in primary care practice must be preceded by a thorough consideration and elimination of various implementation barriers. Clinical trials should be conducted not only for medical validation, but also to test the most appropriate approaches to seamlessly incorporate ML-based screening tools into the clinical workflow. Particular attention should be paid to designing solutions for the complete automation of the ML-based screening process to avoid placing an additional burden on physicians and other healthcare workers. Furthermore, surveys should be administered to physicians regarding their expectations of model explainability so that these expectations can be accounted for at the earliest stages of model development to ensure acceptability (Ahluwalia et al., 2025). Additionally, cost-effectiveness should be analyzed to justify the use of ML for screening to all stakeholders (Liu et al., 2022).

CONCLUSION

In conclusion, this review demonstrated that the use of ML to develop screening tools is a budding area of medical research. Primary care EHRs could be leveraged to enable screening for conditions that were previously considered medically and economically unfeasible to detect at scale. In addition, ML-based screening tools could replace or supplement existing screening strategies to improve patient outcomes and optimize resource utilization in primary care. The data used for model training should be carefully selected to prevent the incorporation of social bias into the predictions and to ensure equitable care for all patients. Future research should address potential implementation challenges at all stages of model development.

REFERENCES

Ahluwalia, V. S., Schapira, M. M., Weissman, G. E., & Parikh, R. B. (2025). Primary Care Provider Preferences Regarding Artificial Intelligence in Point-of-Care Cancer Screening. *MDM Policy & Practice*, *10*(1). https://doi.org/10.1177/23814683251329007

Amit, G., Girshovitz, I., Marcus, K., Zhang, Y., Pathak, J., Bar, V., & Akiva, P. (2021). Estimation of Postpartum Depression Risk From Electronic Health Records Using Machine Learning. *BMC Pregnancy and Childbirth*, *21*(1), 630. https://doi.org/10.1186/s12884-021-04087-8

Dabbah, S., Mishani, I., Davidov, Y., & Ben Ari, Z. (2024). Implementation of Machine Learning Algorithms to Screen for Advanced Liver Fibrosis in Metabolic Dysfunction-Associated Steatotic Liver Disease: An In-Depth Explanatory Analysis. *Digestion*, 189–202. https://doi.org/10.1159/000542241

Eder, J., Dong, M. S., Wöhler, M., Simon, M. S., Glocker, C., Pfeiffer, L., Gaus, R., Wolf, J., Mestan, K., Krcmar, H., Koutsouleris, N., Schneider, A., Gensichen, J., Musil, R., & Falkai, P. (2025). A Multimodal Approach to Depression Diagnosis: Insights From Machine Learning Algorithm Development in Primary Care. *European Archives of Psychiatry and Clinical Neuroscience* [Preprint]. https://doi.org/10.1007/s00406-025-01990-5

Eriksen, C. U., Rotar, O., Toft, U., & Jørgensen, T. (2021). *What Is the Effectiveness of Systematic Population-Level Screening Programmes for Reducing the Burden of Cardiovascular Diseases?* WHO Regional Office for Europe (WHO Health Evidence Network Synthesis Reports). Retrieved June 2, 2025 from http://www.ncbi.nlm.nih.gov/books/NBK567843

Google Cloud. (n.d.). AI Vs. Machine Learning: How Do They Differ?. Retrieved June 2, 2025 from https://cloud.google.com/learn/artificial-intelligence-vs-machine-learning

Google Developers. (n.d.). Classification: Accuracy, Recall, Precision, and Related Metrics. Retrieved June 2, 2025 from https://developers.google.com/machine-learning/crash-course/classification/accuracy-precision-recall

Hanna, M. G., Olson, N. H., Zarella, M., Dash, R. C., Herrmann, M. D., Furtado, L. V., Stram, M. N., Raciti, P. M., Hassell, L., Mays, A., Pantanowitz, L., Sirintrapun, J. S., Krishnamurthy, S., Parwani, A., Lujan, G., Evans, A., Glassy, E. F., Bui, M. M., Singh, R., Souers, R. J., de Baca, M. E., & Seheult, J. N. (2023). Recommendations for Performance Evaluation of Machine Learning in Pathology: A Concept Paper From the College of American Pathologists. *Archives of Pathology & Laboratory Medicine*, *148*(10), e335–e361. https://doi.org/10.5858/arpa.2023-0042-CP

Kimura, N., Sasaki, K., Masuda, T., Ataka, T., Matsumoto, M., Kitamura, M., Nakamura, Y., & Matsubara, E. (2025). Machine Learning Models for Dementia Screening to Classify Brain Amyloid Positivity on Positron Emission Tomography Using Blood Markers and Demographic Characteristics: A Retrospective Observational Study. *Alzheimer's Research & Therapy*, *17*(1), 25. https://doi.org/10.1186/s13195-024-01650-1

Lin, J., Bates, S., Allen, L. N., Wright, M., Mao, L., Chomik, R., Dietz, C., & Kidd, M. (2025). Uptake of Patient Enrolment in Primary Care and Associated Factors: A Systematic Review and Meta-Analysis. *BMC Primary Care*, *26*(1) 76. https://doi.org/10.1186/s12875-025-02779-0

Liu, X., Zhang, W., Zhang, Q., Chen, L., Zeng, T., Zhang, J., Min, J., Tian, S., Zhang, H., Huang, H., Wang, P., Hu, X., & Chen, L. (2022). Development and Validation of a Machine Learning-Augmented Algorithm for Diabetes Screening in Community and Primary Care Settings: A Population--Based Study. *Frontiers in Endocrinology*, 13. https://doi.org/10.3389/fendo.2022.1043919

Lu, K., Sheth, P., Zhou, Z. L., Kazari, K., Guergachi, A., Keshavjee, K., Noaeen, M., & Shakeri, Z. (2024). Identifying Prediabetes in Canadian Populations Using Machine Learning. In *2024 46th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. *2024 46th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, pp. 1–4. https://doi.org/10.1109/EMBC53108.2024.10782174

Lundberg, S., & Lee, S.-I. (2017). A Unified Approach to Interpreting Model Predictions. arXiv. https://doi.org/10.48550/arXiv.1705.07874

Malhotra, A., Rachet, B., Bonaventure, A., Pereira, S. P., & Woods, L. M. (2021). Can We Screen for Pancreatic Cancer? Identifying a Sub-Population of Patients at High Risk of Subsequent Diagnosis Using Machine Learning Techniques Applied to Primary Care Data. *PLOS ONE*, *16*(6). https://doi.org/10.1371/journal.pone.0251876

van Mens, K., Elzinga, E., Nielen, M., Lokkerbol, J., Poortvliet, R., Donker, G., Heins, M., Korevaar, J., Dückers, M., Aussems, C., Helbich, M., Tiemens, B., Gilissen, R., Beekman, A., & de Beurs, D. (2020). Applying Machine Learning on Health Record Data From General Practitioners to Predict Suicidality. *Internet Interventions*, 21, 100337. https://doi.org/10.1016/j.invent.2020.100337

Nadarajah, R., Wu, J., Hogg, D., Raveendra, K., Nakao, Y. M., Nakao, K., Arbel, R., Haim, M., Zahger, D., Parry, J., Bates, C., Cowan, C., & Gale, C. P. (2023). Prediction of Short-Term Atrial Fibrillation Risk Using Primary Care Electronic Health Records. *Heart*, *109*(14), 1072–1079. https://doi.org/10.1136/heartjnl-2022-322076

Onishchenko, D., Marlowe, R. J., Ngufor, C. G., Faust, L. J., Limper, A. H., Hunninghake, G. M., Martinez, F. J., & Chattopadhyay, I. (2022). Screening for Idiopathic Pulmonary Fibrosis Using Comorbidity Signatures in Electronic Health Records. *Nature Medicine*, *28*(10), 2107–2116. https://doi.org/10.1038/s41591-022-02010-y

Rosenfeld, A., Graham, D. G., Jevons, S., Ariza, J., Hagan, D., Wilson, A., Lovat, S. J., Sami, S. S., Ahmad, O. F., Novelli, M., Justo, M. R., Winstanley, A., Heifetz, E. M., Ben-Zecharia, M., Noiman, U., Fitzgerald, R. C., Sasieni, P., Lovat, L. B., Coker, K., Zhao, W., Brown, K., Haynes, B., Grant, T. N., Pietro, M. di, Dewhurst, E., Alias, B., Mills, L., Wilson, C., Bird-Lieberman, E., Bornschein, J., Lim, Y., Shariff, K., Lopez, R. C., Udarbe, M., Shaw, C., Rose, G., Sargeant, I., Al-Izzi, M., Schimmel, R., Green, E., Moorghen, M., Kanani, R., Baulf, M., Butcher, J., Butt, A., Bown, S., Lipman, G., Sweis, R., Sehgal, V., Banks, M., Haidry, R., Louis-Auguste, J., Kohoutova, D., Kerr, S., Eneh, V., Butter, N., Miah, H., Butawan, R., Adesina, G., Holohan, S., Idris, J., Hayes, N., Wahed, S., Houghton, N. K., Hopton, M., Eastick, A., Majumdar, D., Manuf, K., Fieldson, L., Bailey, H., Ortiz, J. F.-S., Patel, M., Henry, S., Warburton, S., White, J., Gadeke, L., Longhurst, B., Abeseabe, R., Basford, P., Bhattacharyya, R., Elliot, S., Bevan, R., Brown, C., Laverick, P., Clifford, G., Gibbons, A., Ingmire, J., Mawas, A., Harvey, J., & Cave, S. (2020). Development and Validation of a Risk Prediction Model to Diagnose Barrett's Oesophagus (MARK-BE): A Case-Control Machine Learning Approach. *The Lancet Digital Health*, *2*(1), e37–e48. https://doi.org/10.1016/S2589-7500(19)30216-X

Steyerberg, E. W. & Harrell, F. E. (2016). Prediction Models Need Appropriate Internal, Internal-External, and External Validation. *Journal of Clinical Epidemiology*, 69, 245–247. https://doi.org/10.1016/j.jclinepi.2015.04.005

Steyerberg, E. W., Harrell, F. E., Borsboom, G. J. J. M., Eijkemans, M. J. C., Vergouwe, Y., & Habbema, J. D. F. (2001). Internal Validation of Predictive Models: Efficiency of Some Procedures for Logistic Regression Analysis. *Journal of Clinical Epidemiology*, *54*(8), 774–781. https://doi.org/10.1016/S0895-4356(01)00341-9

Szlejf, C., Batista, A. F. M., Bertola, L., Lotufo, P. A., Benseãor, I. M., Chiavegatto Filho, A. D. P., & Suemoto, C. K. (2023). Data-Driven Decision Making for the Screening of Cognitive Impairment in Primary Care: A Machine Learning Approach Using Data From the ELSA-Brasil Study. *Brazilian Journal of Medical and Biological Research*, 56, e12475. https://doi.org/10.1590/1414-431X2023e12475

Wei, Y., Tao, J., Geng, Y., Ning, Y., Li, W., & Bi, B. (2024). Application of Machine Learning Algorithms in Predicting Carotid Artery Plaques Using Routine Health Assessments. *Frontiers in Cardiovascular Medicine*, 11. https://doi.org/10.3389/fcvm.2024.1454642

White, N., Parsons, R., Collins, G., & Barnett, A. (2023). Evidence of Questionable Research Practices in Clinical Prediction Models. *BMC Medicine*, *21*(1), 339. https://doi.org/10.1186/s12916-023-03048-6

WHO Regional Office for Europe. (2020). Screening Programmes: A Short Guide. Increase Effectiveness, Maximize Benefits and Minimize Harm. WHO Regional Office for Europe.

Yu, J., Zhou, Y., Yang, Q., Liu, X., Huang, L., Yu, P., & Chu, S. (2021). Machine Learning Models for Screening Carotid Atherosclerosis in Asymptomatic Adults. *Scientific Reports*, *11*(1), 22236. https://doi.org/10.1038/s41598-021-01456-3

EJoHP 1(4)/2025

DOI: https://doi.org/10.21697/ejhp.0106.03
e-ISSN 2957-2002

2025, 4, 1: 29-39

The role of the pharmacist in the integration of traditional and conventional medicine

Iwona Wrześniewska-Wal, MD, Ph.D.
ORCID: https://orcid.org/0000-0002-8892-5985
School of Public Health, Centre of Postgraduate Medical Education

Received: 5 Jun 2025; Revised: 26 Jun 2025; Accepted: 27 Jun 2025

Abstract

The integration of traditional, complementary, and integrative medicine (TCIM) into the healthcare system is becoming an increasingly important element of healthcare policy in European countries. In Europe, the lack of uniform legal regulations regarding TCIM results in significant differences in the availability, quality, and control of these services and products. Pharmacists can play a special role in the process of integrating traditional and conventional medicine. This professional group is easily accessible to patients and trained in both the safety of pharmacotherapy and advice on the use of herbal products. In Poland, under the Act on the Profession of Pharmacist and the implementing acts, pharmacists have obtained additional powers in performing diagnostic tests and taking preventive measures. This opens up new possibilities of also using pharmacists to integrate elements of traditional and natural medicine into academic practice.

Keywords: traditional medicine, pharmacist, diagnostic tests, prevention

Introduction

Regular consumption of herbs with documented health-promoting properties can effectively support public health strategy, especially considering the growing interest in medicine based on natural products (Ekor, 2014). It should be noted, however, that the effectiveness and safety of herbal medicine depend on the dose, standardization of preparations, and possible interaction with synthetic drugs. Therefore, the use of traditional medicines, including herbs, although well-established in practice, should also be supported by solid scientific evidence. In the case of some of these therapies, the evidence does not support their use – some even indicate the danger of such practices, which is why in traditional medicine one must be guided by only the science and safety of patients. The potential of herbs and the challenges related to the safety of their use is emphasized by the Global WHO Strategy Regarding Traditional Medicine for 2025–2034. This document of the World Health Organization (WHO) is a continuation of activities undertaken since 2002 to include TCIM in healthcare systems (WHO, 2019). The term TCIM is used by the WHO to refer to a wide range of healthcare practices which are not part of the dominant medical system of a given country. It includes both traditional medical systems (e.g., Chinese medicine) and supplementary and integration practices that are used in parallel with conventional (academic) medicine (von Schoen-Angerer et al., 2023).

The WHO indicates that over 100 countries recognized the importance of TCIM, but the scope of regulation, integration, and scientific research remains very diverse (Burki, 2025). The WHO document is a strategic framework for the Member States, enabling them to develop national policies and legal regulations regarding traditional medicine. The WHO recommends that Member States adopt or update domestic policies, strategies, and legal frameworks regarding traditional medicine; integrate TCIM with national healthcare systems; and support research, education, and staff development in this sector (WHO, 2019).

The World Health Assembly (WHA) drew attention to the possibility of using traditional medicine doctors and their assistants in primary care. In many countries, medical professionals can contribute to the safe, effective integration of traditional medicine into conventional medicine. In Poland, pharmacists are of particular importance in this process. Pharmacists, due to their education and professional role in the healthcare system, can actively support patients who use a combination of conventional and traditional medicine. In the past, the role of pharmacists in Poland was limited to distributing medicinal products and ensuring their proper storage. However, the development of the concept of pharmaceutical care has significantly expanded the scope of pharmacists' competences, which can now involve diagnostic and therapeutic activities (Bochniarz et al., 2022). The breakthrough moment was the adoption of the Act of the Profession of Pharmacist (Act of 10 December 2020), which defined pharmaceutical care and created a legal framework for services such as drug reviews, health education, and disease prevention. Thanks to their knowledge of pharmacology and their direct contact with patients, pharmacists can educate patients in the safe use of traditional products and can be part of therapeutic teams in integration care models (Wrześiewska-Wal, et al., 2023).

Objective

The purpose of the article is to analyze the applicable legal regulations regarding the extended professional competences of pharmacists and to assess their potential role in ensuring the safe support and education of patients using the parallel products of classical and traditional medicine. Particular emphasis was placed on identifying the legal instruments which enable pharmacists to join the patient care system.

Materials and methods

The World Health Organization documents issued between 2000 and 2024 were analyzed; these include recommendations, strategies, guidelines, standards, reports, and the health policies and health regulations of selected Member States. The Polish Act on the Profession of Pharmacist, the Pharmaceutical Act, and other executive acts were analyzed.

Integration of traditional and conventional medicine in selected European countries according to the WHO strategy

The Constitution of the World Health Organization provides that "the use of the highest achievable level of health is one of the basic rights of every person" (WHO, 1948). The right to health requires that services and health products be available, effective, available, acceptable, and good quality for everyone, without discrimination. The autonomy of patients in making health decisions also involves supporting their conscious choices. The current WHO strategy for 2025–2030 aims to support the Member States in developing politicians and implementing legal regulations that will strengthen the role of traditional medicine in maintaining the health of the population (WHO, 2025). The document emphasizes that decisions regarding the use of TCIM should be based on the best available safety evidence and effectiveness from research and practice. At the same time, scientific evidence must refer to knowledge that is unambiguous, systematic, and repetitive and can be assessed using methodological standards. It was based on previous work in the field of traditional medicine for the years 2002–2005 and an updated strategy for 2014–2023, which defined traditional medicine (WHO, n.d.a).

Pursuant to these documents, the term *traditional medicine* (TM) is "the sum of knowledge, skills and practices based on theories, beliefs and indigenous experiences for different cultures that can be explained or not, which are used to maintain health, as well as to prevent, diagnose, improve or treat physical and mental diseases" (ScienceDirect, 2025). A different term is *complementary medicine*. It refers to a wide set of healthcare practices which are not part of their own tradition or the conventional medicine of a given country and are not fully integrated into its dominant healthcare system (WHO, n.d.b). In some countries, these terms are used interchangeably with TM. In the literature on the subject, we also find other terms used to describe these healthcare practices: "natural medicine," "unconventional medicine," and "holistic medicine." It is important to remember that as the field evolves, the terms "complementary," "alternative," and "integrative" are constantly evolving. In everyday language, the words *alternative* and *complementary* are often used interchangeably, but the two terms refer to different concepts. When an alternative approach is used in conjunction with conventional medicine, it is considered complementary; when an alternative approach is used in place of conventional (academic) medicine, it is considered alternative (Trübner et al., 2025). Today, an integrated approach to health is predominant. Integrative health combines traditional, conventional, and complementary approaches in a coordinated manner (NCCIH, n.d.).

According to the WHO, 170 Member States reported using traditional medicine. The WHO (2019) also required these countries to provide "evidence and data to develop strategies, standards and regulations for its safe, profitable and fair use." A WHO report (2019) shows in detail which Member States have developed national policies on traditional medicine or have adopted provisions on herbal medicines. According to this report, Polish legislation on traditional medicine includes only herbal drugs. The National Office for the registration of medicinal products, as well as herbs and homeopathic medicine, is the Office of Registration of Medicinal Products, Medical Devices and Biocidal Products; the National Institute of Medicines in Warsaw is responsible for scientific research. The legal status of herbal medicines is specified in Art. 20(a–b) of the Pharmaceutical Law (Act of 6 September 2001). Herbal drugs are classified as prescription drugs, over-the-counter drugs, and herbal medicines. They are sold in pharmacies and other facilities. The WHO report indicates a lack of data from Poland on traditional medicine, education, and health insurance practices. Based on data from the report, the integration of traditional and conventional medicine in Poland is quite slow. The situation in other European countries is presented in Table 1.

Table 1: National policies and legal regulations regarding the integration of traditional and conventional medicine in selected European countries

Country	Policy TCIM	Legal regulations with commentary
Czechia	None	In 2024, the TCIM Institute was established at the Ministry of Health (Institute for TCIM/CAM, 2025). The TCIM Working Group develops educational and professional standards for practitioners in acupuncture and homeopathy.
Denmark	None	Dietary supplements with herbal ingredients are regulated by the Danish Medicines Agency and the Danish Veterinary and Food Agency (2025).
Germany	Yes	TCIM is integrated into the healthcare system. Selected therapies are reimbursed: naturopathy, chiropractic, homeopathy, physiotherapy, balneology, medical climatology, and acupuncture. Physicians can obtain additional CAM qualifications after theoretical and practical training (Joos, 2011).
Norway	Yes	A National Centre for TCIM research was established (NAFKAM, 2025). The Norwegian Alternative Treatment Act regulates what is and is not considered CAM treatment in Norway (Act on Alternative Treatment of Disease etc., 2004).
Poland	None	Regulations mainly concern herbal products (Act of 6 September 2001).
Portugal	None	In 2003, Act 45/2003 was approved, which regulates six professions of complementary therapy: acupuncture, homeopathy, osteopathy, chiropractic, naturopathy, and phytotherapy. The Technical Committee for TCIM has developed a structure for the accreditation, training, and certification of specialists in complementary therapy (dos Santos et al., 2020).
Switzerland	Yes	TCIM is included in the constitution. Traditional medicine is regulated at the federal and cantonal levels. In 2009, five TCIM practices were included in the national health plan: homeopathy, anthroposophic medicine, herbal medicine, acupuncture, and traditional Chinese medicine. Switzerland has established federal diplomas for naturopaths and ayurveda practitioners, which allows them to be legally registered and practiced even when these therapies are not reimbursed by basic insurance (Klein, 2015).
United Kingdom	Yes	The TCIM policy is integrated into the national health policy. There is regulation of OTC herbal medicines under the Traditional Herbal Medicines Regulation scheme, but there is limited regulation of herbal practitioners or the herbal remedies that they supply to patients following a one-to-one consultation (WHO, 2019).
Italy	Yes	TCIM is integrated in some regions, e.g., Tuscany. Tuscany was one of the first regions in Italy to implement systemic solutions for the integration of traditional medicine into public healthcare. This consisted in recognizing methods such as phytotherapy, homeopathy, and traditional Chinese medicine (acupuncture) as a complementary part – but not an alternative to – academic medicine (Belvedere, 2019). The legal basis is regional resolutions and implementing acts, including Regional Resolution of Tuscany No. 418/2005 – which recognizes acupuncture, homeopathy, and phytotherapy as part of health services within the regional health service – and Resolution No. 738/2007, which creates a network of reference CAM units, associated with the Regional Center for Integrative Medicine in Pitigliano.

Source: Based on the 2019 WHO report and the literature provided in the table.

The legal regulations concerning TCIM in the European countries presented above are significantly diverse, both in terms of the scope of formal legal acts and the level of integration of these practices with the public healthcare system. In many countries, there is no TCIM policy or uniform regulatory framework. In these countries, the regulations focus only on selected aspects, e.g., dietary supplements, herbal medicines (Denmark and Poland), or partial regulations regarding qualifications (Portugal). In Czechia, the TCIM Institute was established at the Ministry of Health in 2024, which may be a step toward systemic regulation of this field. Countries such as Germany, Switzerland, Norway, Great Britain, and Italy (selected regions) have extensive legal regulations that allow for the registration of practices and, in selected cases, reimbursement of TCIM services. One example is Tuscany, where regional resolutions have enabled the formal inclusion of selected TCIM practices in the health services offered within the regional healthcare system.

The role of a pharmacist in the healthcare system

Traditional medicine, understood as systems and practices based on indigenous and historical experiences and using natural substances and therapeutic techniques, plays an important role in preventive healthcare. Pharmacists in many countries take an active part in the prevention and promotion of health, using their position "as a link in the healthcare system and to increase the social prestige of the social profession" (Jahowicz et al., 2001). Pharmaceutical care is a key link for the healthcare system and patients. The concept of pharmaceutical care was created in the 1970s in the United States (McGivney et al., 2007). Initially, the purpose of these activities was to improve compliance with recommendations and detect adverse events and abuse of drugs. Currently, in many countries, pharmacists are increasingly involved in vaccination and management of chronic diseases. For example, in Portugal, pharmacists have been giving flu vaccination since 2008, and currently 17 different vaccines are available in 77% of pharmacies in the country (Kirkdale et al., 2017). Pharmacists in Australia and Great Britain conduct educational programs on controlling blood pressure, glucose, and lipids and quitting smoking, among other things (Drovandi et al., 2019; Silvaggi et al., 2017).

In Polish law, pharmaceutical care is a health service. The applicable regulations give two almost identical definitions of health service (Glanowski, 2019). The first, which defines health services as actions aimed at preventing, preserving, saving, restoring, or improving health and other medical activities resulting from the treatment process or separate provisions regulating the principles of their performance, is in Art. 5(40) of the Act on Healthcare Services Financed From Public Funds) (Act of 27 August 2004). The second, which does not state that these are actions for prevention, is in Article 2(1)(10) of the Act on Medical Activity (Act of 15 April 2011). And although pharmaceutical care in Poland is currently not funded from public funds, it is worth noting that it is defined in the Act on Healthcare Services Financed From Public Funds. Prevention is emphasized. In the case of pharmacists, preventive measures seem key.

From a legal perspective, extending pharmacists' competences to include diagnostic tests has enabled their active involvement in prevention. A pharmacist who wishes to provide pharmaceutical care to a patient using diagnostic tests is required to undergo additional training on qualification courses organized by the Center for Postgraduate Medical Education. Additional qualifications are required to perform antigenic tests for SARS-COV-2, blood glucose tests, lipid panels (total, high-density, and low-density cholesterol and triglycerides), fast fluid detection tests, C-reactive protein concentration, group A *Streptococcus* antigen test, and *Helicobacter pylori* tests; to measure basic vital signs such as blood pressure, heart rate, pulse and blood saturation, body weight, height, and waist circumference; and to calculate Body Mass Index and waist-to-hip ratio (Regulation of the Minister of Health of 21 January 2022). Pharmacists, after obtaining appropriate qualifications, may perform activities to detect risk and health education factors, including cardiovascular disease, type 2 diabetes, insulin resistance, and support for infection diagnostics.

Table 2: Role of pharmacists in diagnostic tests

Diagnostic examination	Pharmacists' preventive actions
Measurement of blood pressure, heart rate, and oxygen saturation	Early detection of hypertension, education, and referral to the doctor
Measurement of weight, height, and waist and hip circumference; calculation of BMI and waist-to-hip ratio	Risk assessment of metabolic syndrome, type 2 diabetes, and cardiovascular diseases
Blood glucose test (casual glycemia/fasting)	Early detection of abnormal glucose, education, and referral for further diagnostics
Lipid panel: total, high-density, and low-density cholesterol and triglycerides	Identification of dyslipidemia and education
C-reactive protein test	Assessment of the presence of inflammation and differentiation between viral and bacterial infections
Fast antigenic SARS-COV-2 test	Detection of infection
Antigenic test for the flu	Differentiation of throat infections and referral to a doctor if necessary
Streptococcus Pyogenes (group A) antigen test	Differentiation of throat infections and referral to a doctor if necessary
Serological test for *Helicobacter pylori*	Identification of peptic ulcer risk, education, and recommendation of further diagnostics

Source: Regulation of the Minister of Health of 21 January 2022

The regulation on the diagnostic tests that can be performed by a pharmacist is a significant step towards increasing the professional independence of this group. Enabling them to perform diagnostic tests directly in the pharmacy allows the pharmacist to provide the patient with comprehensive educational advice, including not only an interpretation of the results, but also recommendations on the use of herbal preparations. In practice, this means that a pharmacist, with the appropriate qualifications and pharmacy equipment (Regulation of the Minister of Health of 30 September 2002), can perform diagnostic assays such as blood pressure, glycemia, lipid profile, or anthropometric indicators (BMI or waist-to-hip ratio), which can identify risk factors for lifestyle diseases. On this basis, the pharmacist provides the patient with personalized advice on prevention and the safe use of herbal preparations. For example, in the case of a patient with high blood pressure, a pharmacist may advise the use of preparations containing extracts from plants such as hawthorn (*Crataegus* spp.) or garlic (*Allium sativum*), which have been shown in clinical trials to have antihypertensive properties, provided that possible interactions with any synthetic drugs taken by the patient are taken into account. In addition, the pharmacist monitors any potential adverse effects of all drugs. It should be remembered that, as with synthetic drugs, the use of herbal products is associated with the risk of adverse effects. Their occurrence may be related to various factors, such as incorrect identification of the plant species, adulteration of the herbal product with other substances, contamination with toxic or dangerous ingredients, incorrect dosage, incorrect use of herbal preparations, or interactions between herbal and synthetic drugs (Ekor, 2014). Pharmacists may report adverse effects related to herbal preparations to the Office for Registration of Medicinal Products (Act of 6 September 2001).

Table 3: Examples of activities within pharmaceutical care

Type of action	Description
Drug review	Assessment of drugs being taken, including herbs and supplements, and exclusion of drug and herb interactions
Health education	Consultations on lifestyle, diet, and supplementation of herbs with health-promoting properties
Individual care plan	Based on diagnostic tests and current scientific evidence, recommendation of appropriate herbal preparations as an element of prophylaxis or supportive therapy, adjusting the dosage and method of use to the individual conditions of the patient, and assessment of the safety and effectiveness of the therapy, taking into account potential interactions between synthetic drugs and herbal preparations

Source: Act of 10 December 2020

Conclusions

1. The WHO Strategy for 2025–2034 emphasizes the need to develop education, research, and the competences of medical staff, including pharmacists, in the field of traditional, complementary, and integrative medicine. The integration of TCIM into the healthcare system in Poland is slow and mainly concerns the regulation of herbal products.
2. New legal regulations concerning pharmacists, including the Act of 10 December 2020 on the Profession of Pharmacist and the Regulation on the List of Diagnostic Tests That May Be Performed by a Pharmacist, have expanded their role in the healthcare system, particularly in the integration of traditional and conventional medicine.

3. Pharmacists, as specialists in the field of pharmacotherapy, have the necessary qualifications to educate patients and plan individual care in the safe use of herbal preparations and potential interactions with synthetic drugs.

Recommendations

The WHO Strategy for 2025–2034 emphasizes the importance of developing education, research, and the competences of healthcare professionals, including pharmacists, in traditional, complementary, and integrative medicine (TCIM). In Poland, the integration of TCIM into the healthcare system is progressing slowly and remains largely limited to the regulation of herbal products. However, recent legal developments – such as the Act of 10 December 2020 on the Profession of Pharmacist and the Regulation on the List of Diagnostic Tests That May Be Performed by Pharmacists – have laid the groundwork for expanding their role within the healthcare system, including supporting the integration of traditional and conventional medicine. Pharmacists, as experts in pharmacotherapy, possess the qualifications necessary to educate patients and develop individualized care plans concerning the safe use of herbal preparations and the potential for interactions with synthetic drugs. They should be formally included in interdisciplinary therapeutic teams providing integrative care, with clearly defined responsibilities in patient counselling, preventive healthcare, and risk assessment. To effectively fulfill this role, the scope of specialist training and continuing education for pharmacists must be broadened to incorporate up-to-date knowledge in the field of TCIM, particularly with regard to standards of care and the latest scientific research. Following the example of countries such as Germany, Switzerland, Portugal, and Italy, Poland should consider developing certification and registration systems for TCIM services and products. In this context, pharmacists would play a crucial role in assessing potential interactions with conventional pharmacotherapy.

References

Act of 6 September 2001 – Pharmaceutical Law (consolidated text). (2001). *Journal of Laws of the Republic of Poland*, 2024, item 686.

Act of 10 December 2020 on the Profession of Pharmacist (consolidated text). (2020). *Journal of Laws of the Republic of Poland*, 2025, item 608.

Act of 15 April 2011 on Medical Activity (consolidated text). (2011). *Journal of Laws of the Republic of Poland*, 2025, item 450.

Act of 27 August 2004 on Healthcare Services Financed From Public Funds. (2004). *Journal of Laws of the Republic of Poland*, 2024, item 146.

Act on Alternative Treatment of Disease etc. (2004). Retrieved June 2, 2025 from https://lovdata.no/dokument/NL/lov/2003-06-27-64

Belvedere, K., Rossi, E., Di Stefano, M., & Baccetti, S. (2019). The Process of Integration of Complementary Medicines in Public Healthcare Service of Tuscany (Italy). *OBM Integrative and Complementary Medicine*, *4*(2), 22. DOI: 10.21926/obm.icm.1902022

Bochniarz, M., Inglot-Brzęk, E., Lewandowska, A., & Podgórska, J. (2022). Directions of Changes in the Profession of Hospital Pharmacist in Poland. *International Journal of Environmental Research and Public Health*, *19*(21), 14522. DOI: 10.3390/ijerph192114522

Burki, T. (2025). WHA Adopts New Strategy on Traditional Medicine. *The Lancet*, 405, 10493, 1897–1898. DOI: 10.1016/S0140-6736(25)01142-0

Danish Veterinary and Food Agency (DVFA). (n.d.). [Website]. Retrieved June 4, 2025 from https://www.foedevarestyrelsen.dk/

dos Santos, M. R. & Mendes, C. S. (2020). Traditional and Complementary Medicine Legislation in Portugal: Progress, Challenges and Flaws. *European Journal of Integrative Medicine*, 35, 101104. DOI: 10.1016/j.eujim.2020.101104

Drovandi, A., Teague, P. A., Glass, B., & Malau-Aduli, B. (2019). Australian Community Pharmacist Experiences With Smoking Cessation and Opinions of Health Warnings on Individual Cigarette Sticks. *International Journal of Pharmacy Practice*, *27*(2), 121–130. DOI: 10.1111/ijpp.12470

Ekor, M. (2014). The Growing Use of Herbal Medicines: Issues Relating to Adverse Reactions and Challenges in Monitoring Safety. *Frontiers in Pharmacology*, Jan 10, 4, 177. DOI: 10.3389/fphar.2013.00177

Glanowski, G. (2019). *Umowa o świadczenie zdrowotne* [Health service contract]. WoltersKluwer, 46.

Institute for TCIM/CAM. [Website]. (n.d.). Retrieved June 2, 2025 from https://www.itcim.org/about-us

Jachowicz, R., Brandys, J., Filipek, B., & Wolańczyk, M. (2001). Rola farmaceuty w profilaktyce i leczeniu cukrzycy [The Role of the Pharmacist in the Prevention and Treatment of Diabetes]. In *Farmacja w XXI wieku* [Pharmacy in the 21st Century]. XVIII Zjazd PTFarm.

Joos, S., Musselmann, B., & Szecsenyi, J. (2011). Integration of Complementary and Alternative Medicine Into Family Practices in Germany: Results of a National Survey. *Evidence-Based Complementary and Alternative Medicine*, Oct 19, 2011, 495813. DOI: 10.1093/ecam/nep019

Kirkdale, C. L., Nebout, G., Megerlin, F., & Thornley, T. (2017). Benefits of Pharmacist-Led Flu Vaccination Services in Community Pharmacy. *Annales Pharmaceutiques Françaises*, *75*(1), 3–8. DOI: 10.1016/j.pharma.2016.08.005

Klein, S. D., Torchetti, L., Frei-Erb, M., & Wolf, U. (2010). Usage of Complementary Medicine in Switzerland. *PLoS One*, *10*(10), e0141985. DOI: 10.1371/journal.pone.0141985

McGivney, M. S., Meyer, S. M., Duncan-Hewitt, W., Hall, D. L., Goode, J.-V. R., & Smith, R. B. (2007). Medication Therapy Management: Its Relationship to Patient Counseling. *Journal of the American Pharmacists Association*, *47*(5), 620–628. DOI: 10.1331/JAPhA.2007.06129

National Center for Complementary and Integrative Health (NCCIH). (n.d.). [Website]. Retrieved June 2, 2025 from https://www.nccih.nih.gov/

National Research Centre in Complementary and Alternative Medicine (NAFKAM). (n.d.). [Website]. Retrieved June 2, 2025 from https://nafkam.no/en/about-us

Regulation of the Minister of Health of 21 January 2022 on the List of Diagnostic Tests That May Be Performed by a Pharmacist. (2022). *Journal of Laws of the Republic of Poland*, 2022, item 153.

Regulation of the Minister of Health of 30 September 2002 on the Detailed Requirements to Be Met by the Premises of a Pharmacy (consolidated text). (2002). *Journal of Laws of the Republic of Poland*, 2024, item 595.

Silvaggi, A., Nabhani-Gebara, S., & Reeves, S. (2017). Expanding Pharmacy Roles and the Interprofessional Experience. *Journal of Interprofessional Care*, *31*(1), 110–111. DOI: 10.1080/13561820.2016.1249281

ScienceDirect. (n.d.). Topics: Traditional Medicine. Retrieved June 2, 2025 from https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/traditional-medicine

Trübner, M., Patzina, A., Lehmann, J., Brinkhaus, B., Kessler, C. S., & Hoffmann, R. (2025). Health Information-Seeking Behavior Among Users of TCIM. *BMC Complementary Medicine and Therapies*, *25*(1), 111. DOI: 10.1186/s12906-025-04843-9

von Schoen-Angerer, T., Manchanda, R. K., Lloyd, I., Wardle, J., Szöke, J., Benevides, I., Martinez, N. S. A., Tolo, F., Nicolai, T., Skaling-Klopstock, C., Parker, T., Suswardany, D. L., van Haselen, R., & Liu, J. (2023). Traditional, Complementary and Integrative Healthcare: Global Stakeholder Perspective. *BMJ Global Health*, *8*(12), e013150. DOI: 10.1136/bmjgh-2023-013150

World Health Organization. (n.d.a). *Global Strategies and Plans of Action That Are Scheduled to Expire Within One Year. WHO Traditional Medicine Strategy: 2014–2023*. Retrieved June 4, 2025 from https://apps.who.int/gb/ebwha/pdf_files/EB152/B152_37-en.pdf

World Health Organization. (n.d.b). *Traditional, Complementary and Integrative Medicine*. Retrieved June 4, 2025 from https://www.who.int/health-topics/traditional-complementary-and-integrative-medicine#tab=tab_1

World Health Organization. (1948). Constitution. *Journal of Laws of the Republic of Poland*, 1948, no. 61, item 450.

World Health Organization. (2019). *Global Report on Traditional and Complementary Medicine 2019*. Retrieved June 2, 2025 from https://www.who.int/publications/i/item/978924151536

World Health Organization. (2025). *Draft Global Traditional Medicine Strategy 2025–2034*. Retrieved 4 June, 2025 from https://www.who.int/publications/i/item/9789240088387

Wrześniewska-Wal, I., Pinkas, J., Ostrowski, J., & Jankowski, M. (2023). Pharmacists' Perceptions of Physician–Pharmacist Collaboration. *Healthcare*, *11*(17), 2444. DOI: 10.3390/healthcare11172444

EJoHP 1(4)/2025

DOI: https://doi.org/10.21697/ejhp.0106.04
e-ISSN 2957-2002

2025, 4, 1: 41-53

Secondhand smoke exposure at home in a representative sample of adults in Poland in 2024: A cross-sectional survey

Mateusz Jankowski, Prof. Ph.D. MD
Department of Population Health, School of Public Health,
Centre for Medical Postgraduate Education, Warsaw, Poland
ORCID: https://orcid.org/0000-0002-7142-5167
ul. Kleczewska 61/63, 01-826 Warszawa, Polska.
Email: mateusz.jankowski@cmkp.edu.pl
Phone: +48 22-5601-150

Received: 6 Jun 2025; Revised: 27 Jun 2025; Accepted: 27 Jun 2025

Abstract

Secondhand smoke (SHS) is the smoke produced when tobacco products – such as cigarettes – are burned; SHS is harmful to health. This study assesses secondhand smoke exposure at home in a representative sample of adults in Poland and identifies factors associated with secondhand smoke exposure at home. This study is based on data from a nationwide cross-sectional survey (February 2024). Self-reported exposure to SHS at home was assessed using a questionnaire. The study population was comprised of 1,080 adults aged 18 years and over, of which 36.2% smoked cigarettes or used e-cigarettes or heated tobacco in the past 30 days. Exposure to secondhand smoke at home was declared by 25.1% of all respondents, including 41.2% among smokers and 16.0% among non-smokers. Among all respondents, the factors significantly associated with higher odds of exposure to secondhand smoke at home were living in rural areas (OR: 1.84, 95%CI: 1.07–3.17, p=0.03), having three or more household members (OR: 2.63, 95%CI: 1.37–5.06, p=0.004), having bad economic status (OR: 1.68, 95%CI: 1.03–2.72, p=0.04), smoking cigarettes (OR: 2.26, 95%CI: 1.62–3.16, p<0.001), and using e-cigarettes or heated tobacco products (OR: 2.18, 95%CI: 1.49–3.20, p<0.001). Among non-smokers (n=689), the factors significantly associated with exposure to secondhand smoke at home were living in rural areas (OR: 2.35, 95%CI: 1.10–5.02, p=0.03) and having three or more household members (OR: 2.42, 95%CI: 1.01–5.81, p=0.04). This study revealed that SHS exposure at home remains a significant public health problem in Poland.

Keywords: secondhand smoke; exposure; tobacco smoke; smoke-free policy

Introduction

Secondhand smoke (SHS) is the smoke produced when tobacco products, such as cigarettes, are burned (Okoli & Kodet, 2015; Flor et al., 2024). SHS exposure happens when people inhale smoke expelled by smokers or from tobacco products (Okoli & Kodet, 2015; Lee et al., 2022; Flor et al., 2024). SHS is harmful to human health: it is estimated that 1 million deaths annually are caused by SHS exposure [2]. Non-smokers exposed to SHS are at higher risk of cardiovascular diseases, lung diseases, and cancers (Lee et al., 2022). Moreover, in children, SHS exposure can evoke asthma attacks and respiratory infections (Mbulo et al., 2016). There are no safe levels of secondhand smoke exposure, so only policies aimed at completely eliminating SHS from the environment can effectively protect the population.

In Poland, between 2009 and 2019, a significant decrease in SHS exposure in public places was observed, as a consequence of the smoke-free law adopted in 2010 (Jankowski, Rees, et al., 2020). The greatest progress in protecting against SHS exposure was observed in transport services, where the percentage of adults in Poland exposed to SHS decreased from 45.7% in 2009 to 11.7% in 2019 (Jankowski Rees, et al., 2020). A similar decrease was observed in bars/pubs: from 45% in 2009 to 7% in 2019 (Jankowski et al., 2020). In September 2019, SHS exposure at home (in the past 30 days) was reported by 6.1% of respondents, including 11.5% of smokers and 4.5% of non-smokers (Jankowski, Pinkas, et al., 2020). Between 2019 and 2022, the percentage of households in Poland that implemented fully smoke-free homes decreased from 66.1% to 60.6% (Ostrowska et al., 2023). The following sociodemographic groups were more likely to have a fully smoke-free home: males, non-smokers, those with higher education, and those who live alone (Ostrowska et al., 2023). In 2024, 44.1% of adults in Poland declared support for the new law to institute a smoking ban on private balconies (Grudziąż-Sękowska et al., 2024). Public health interventions based on legal regulations are one of the most effective forms of action that protect non-smokers from exposure to SHS.

SHS exposure at home remains a significant public health problem (Okoli & Kodet, 2015; Lee et al., 2022; Flor et al., 2024). A home is an indoor environment where people spend most of their time. It is particularly important to protect vulnerable populations (especially children) from SHS exposure in the home (Mbulo et al., 2016; Lee et al., 2022; Possenti et al., 2024). Analyzing current levels of SHS exposure at home and identifying factors associated with SHS exposure at home may inform policymakers about further needs for anti-tobacco interventions and other actions to protect non-smokers from exposure to SHS (Possenti et al., 2024).

This study assesses secondhand smoke exposure at home in a representative sample of adults in Poland and identifies factors associated with secondhand smoke exposure at home.

Material and methods

Study design and measures

This study is based on data from the nationwide cross-sectional survey on the attitudes of Poles towards smoking and the use of novel nicotine-containing products. Data were collected in February 2024 by a dedicated public opinion company – Nationwide Research Panel Ariadna (Jankowski et al., 2024) – using computer-assisted web interviews. The questionnaire was available online on the research platform managed by Nationwide Research Panel Ariadna and all participants received invitations via e-mail and text message. Respondents were selected (quota sampling method) from over 100,000 adult users of the company's services. The study sample was selected following the stratification model that included gender, age, and size of the place of residence in line with the Demographic Yearbook published annually by Statistics Poland.

Secondhand smoke exposure at home was assessed with the following question: "In the last 30 days, have you been exposed to secondhand smoke in the home where you live (someone smoked in your presence)?" (yes/no).

Questions on socioeconomic characteristics were also addressed (Jankowski et al., 2024).

Non-smokers were defined as those who did not use cigarettes, e-cigarettes, or heated tobacco products in the last 30 days at least (even once).

The study protocol was approved by the Ethical Review Board at the Center of Postgraduate Medical Education (No. 403/2023) as of 23 August 2023. All procedures were in line with the Declaration of Helsinki.

Data analysis

The data were analyzed using IBM SPSS Statistics version 29 and are presented with frequencies and proportions. The chi-squared test was used to analyze differences between qualitative variables. Multivariable logistic regression models were prepared to identify factors associated with secondhand smoke exposure at home in a general population, as well as among non-smokers (dependent variable). In bivariable analysis, all variables were analyzed separately. The variables which were found to be statistically significant in the bivariable analysis were included in the multivariable logistic regression model. Odds ratios (OR) and 95% confidence intervals (95%CI) were used to present the results of regression analysis. The threshold for statistical significance was set at $p<0.05$.

Results

The study population was comprised of 1,080 adults aged 18 years and over, of whom 30.4% were cigarette smokers (in the past 30 days), 15.2% had used e-cigarettes at least once in the past 30 days, and 10.9% had used heated tobacco products at least once in the past 30 days (Table 1). Exposure to secondhand smoke at home was declared by 25.1% of all respondents. Younger respondents (18–29 years) more often declared exposure to secondhand smoke at home (p=0.001). Moreover, the highest exposure was declared by those with elementary education (33.3%; p=0.04), those in informal relationships (36.1%; p=0.02), and those living in rural areas (29.1%; p=0.04). Higher percentages of respondents exposed to SHS at home were observed among those living with at least two other people (31.0%; p<0.001), those living with children at home (29.9%; p=0.01), and those with active occupational status (27.6%; p=0.02). Moreover, those who currently smoked or used e-cigarettes or heated tobacco products (p<0.001) more often declared exposure to secondhand smoke at home (Table 1).

Table 1: Characteristics of the study population by exposure to secondhand smoke at home in the past 30 days (n=1,080)

Variable	Secondhand smoke exposure at home in the past 30 days		
	Yes n (%)	No n (%)	p-value
Overall	271 (25.1)	809 (74.9)	
Gender			
female (n=572)	149 (26.0)	423 (74.0)	0.4
male (n=508)	122 (24.0)	386 (76.0)	
Age [years]			
18–29 (n=140)	50 (35.7)	90 (64.3)	**0.001**
30–39 (n=211)	51 (28.9)	150 (71.1)	
40–49 (n=201)	49 (24.4)	152 (75.6)	
50–59 (n=203)	52 (25.6)	151 (74.4)	
60 and over (n=325)	59 (18.2)	266 (81.8)	
Education			
primary (n=18)	6 (33.3)	12 (66.7)	**0.04**
vocational (n=132)	39 (29.5)	93 (70.5)	
secondary (n=461)	128 (27.8)	333 (72.2)	
higher (n=469)	98 (20.9)	371 (79.1)	
Marital status			
single (n=214)	52 (24.3)	162 (75.7)	**0.02**

Variable	Secondhand smoke exposure at home in the past 30 days		
	Yes n (%)	No n (%)	p-value
married (n=619)	142 (22.9)	477 (77.1)	
informal relationship (n=147)	53 (36.1)	94 (63.9)	
divorced (n=52)	15 (28.8)	37 (71.2)	
widowed (n=48)	9 (18.8)	39 (81.3)	
With children			
yes (n=732)	175 (23.9)	96 (27.6)	0.2
no (n=348)	557 (76.1)	252 (72.4)	
Place of residence			
rural (n=416)	121 (29.1)	295 (70.9)	**0.04**
city with fewer than 20,000 residents (n=137)	28 (20.4)	109 (79.6)	
city with 20,000–99,999 residents (n=211)	50 (23.7)	161 (76.3)	
city with 100,000–499,999 residents (n=187)	50 (26.7)	137 (73.3)	
city with more than 500,000 residents (n=129)	22 (17.1)	107 (82.9)	
Number of household members			
1 (living alone) (n=134)	18 (13.4)	116 (86.6)	**<0.001**
2 (n=414)	88 (21.3)	326 (78.7)	
3 or more (n=532)	165 (31.0)	367 (69.0)	
Children in the home			
yes (n=345)	103 (29.9)	242 (70.1)	**0.01**
no (n=735)	168 (22.9)	567 (77.1)	
Occupational activity			
employed/self-employed (n=656)	181 (27.6)	475 (72.4)	**0.02**
passive (unemployed or retired) (n=424)	90 (21.2)	334 (78.8)	
Self-declared economic status			
good (n=330)	77 (23.3)	253 (76.7)	0.08
moderate (n=606)	147 (24.3)	459 (75.7)	
bad (n=144)	47 (32.6)	97 (67.4)	
Cigarette smoking (past 30 days)			
yes (n=328)	133 (40.5)	195 (59.5)	**<0.001**
no (n=752)	138 (18.4)	614 (81.6)	
E-cigarette use (past 30 days)			
yes (n=164)	83 (50.6)	81 (49.4)	**<0.001**
no (n=916)	188 (20.5)	728 (79.5)	
Heated tobacco use (past 30 days)			
yes (n=118)	56 (47.5)	62 (52.5)	**<0.001**
no (n=962)	215 (22.3)	747 (77.7)	

Among smokers, 41.2% were exposed to secondhand smoke at home, compared to 16.0% of non-smokers (Table 2). Smokers exposed to secondhand smoke more often had primary or secondary education (p=0.007). Moreover, non-smokers who lived in rural areas (53.6%) were more often exposed to secondhand smoke at home than smokers who lived in rural areas (38.5%; p=0.004).

Table 2: Socioeconomic differences between smokers and non-smokers exposed to secondhand smoke at home

Variable	Secondhand smoke exposure at home in the past 30 days (yes)		
	Smokers, e-cigarette users and heated tobacco users n=391	**Non-smokers (any nicotine product) n=689**	**p-value**
	n (%)	n (%)	
Overall	161 (41.2)	110 (16.0)	
Gender			
female	89 (55.3)	60 (54.5)	0.9
male	72 (44.7)	50 (45.5)	
Age [years]			
18–29	36 (22.4)	14 (12.7)	0.2
30–39	31 (19.3)	30 (27.3)	
40–49	30 (18.6)	19 (17.3)	
50–59	31 (19.3)	21 (19.1)	
60 and over	33 (20.5)	26 (23.6)	
Education			
primary	5 (3.1)	1 (0.9)	**0.007**
vocational	32 (19.9)	7 (6.4)	
secondary	73 (45.3)	55 (50.0)	
higher	51 (31.7)	47 (42.7)	
Marital status			
single	32 (19.9)	20 (18.2)	0.2
married	77 (47.8)	65 (59.1)	
informal relationship	33 (20.5)	20 (18.2)	
divorced	12 (7.5)	3 (2.7)	
widowed	7 (4.3)	2 (1.8)	
With children			
yes	103 (64.0)	72 (65.5)	0.8
no	58 (36.0)	38 (34.5)	

Variable	Secondhand smoke exposure at home in the past 30 days (yes)		
	Smokers, e-cigarette users and heated tobacco users n=391	Non-smokers (any nicotine product) n=689	p-value
Place of residence			
rural	62 (38.5)	59 (53.6)	**0.004**
city with fewer than 20,000 residents	12 (7.5)	16 (14.5)	
city with 20,000–99,999 residents	36 (22.4)	14 (12.7)	
city with 100,000–499,999 residents	38 (23.6)	12 (10.9)	
city with more than 500,000 residents	13 (8.1)	9 (8.2)	
Number of household members			
1 (living alone)	10 (6.2)	8 (7.3)	0.7
2	50 (31.1)	38 (34.5)	
3 or more	101 (62.7)	64 (58.2)	
Children in the home			
yes	65 (40.4)	38 (34.5)	0.3
no	96 (59.6)	72 (65.5)	
Occupational activity			
employed/self-employed	112 (69.6)	69 (62.7)	0.2
passive (unemployed or retired)	49 (30.4)	41 (37.3)	
Self-declared economic status			
good	48 (29.8)	29 (26.4)	0.2
moderate	81 (50.3)	66 (60.0)	
bad	31 (19.9)	15 (13.6)	

The factors which were significantly associated with a higher probability of exposure to SHS at home were living in rural areas (OR: 1.84, 95%CI: 1.07–3.17, p=0.03), having three or more household members (OR: 2.63, 95%CI: 1.37–5.06, p=0.004), having bad economic status (OR: 1.68, 95%CI: 1.03–2.72, p=0.04), smoking cigarettes (OR: 2.26, 95%CI: 1.62–3.16, p<0.001) and using e-cigarettes or heated tobacco products (OR: 2.18, 95%CI: 1.49–3.20, p<0.001) (Table 3).

Table 3: Factors associated with SHS exposure at home in a representative sample of adults in Poland

	Bivariable Logistic Regression		**Multivariable Logistic Regression**	
Overall	OR (95%CI)	p-value	aOR	p-value
Gender				
female	1.11 (0.85–1.47)	0.4		
male	Reference			
Age [years]				
18–29	2.51 (1.60–3.91)	<0.001	1.55 (0.85–2.85)	0.2
30–39	1.83 (1.22–2.76)	0.004	1.24 (0.72–2.16)	0.4
40–49	1.45 (0.95–2.23)	0.09	0.97 (0.55–1.70)	0.9
50–59	1.55 (1.02–2.37)	0.04	1.07 (0.66–1.74)	0.8
60 and over	Reference		Reference	
Education				
higher	Reference		Reference	
less than higher	1.50 (1.13–1.99)	0.005	1.27 (0.93–1.74)	0.1
Marital status				
single	1.39 (0.63–2.06)	0.4	1.30 (0.53–3.18)	0.6
married	1.29 (0.61–2.73)	0.5	1.32 (0.56–3.09)	0.5
informal relationship	2.44 (1.10–5.43)	0.03	2.17 (0.88–5.36)	0.09
divorced	1.76 (0.69–4.50)		2.49 (0.87–7.10)	0.09
widowed	Reference		Reference	
With children				
yes	0.83 (0.62–1.10)	0.2		
no	Reference			
Place of residence				
rural	2.00 (1.20–3.31)	0.007	1.84 (1.07–3.17)	**0.03**
city with fewer than 20,000 residents	1.25 (0.67–2.32)	0.5	1.34 (0.69–2.59)	0.4
city with 20,000–99,999 residents	1.51 (0.87–2.64)	0.2	1.28 (0.70–2.32)	0.4
city with 100,000–499,999 residents	1.78 (1.01–3.11)	0.04	1.53 (0.84–2.80)	0.2
city with more than 500,000 residents	Reference		Reference	
Number of household members				
1 (living alone)	Reference		Reference	
2	1.74 (1.01–3.01)	0.04	1.74 (0.91–3.31)	0.09
3 or more	2.90 (1.71–4.92)	<0.001	2.63 (1.37–5.06)	**0.004**

	Bivariable Logistic Regression		Multivariable Logistic Regression	
Children in the home				
yes	1.44 (1.08–1.92)	0.01	0.82 (0.54–1.24)	0.3
no	Reference		Reference	
Occupational activity				
employed/self-employed	1.42 (1.06–1.89)	0.02	1.24 (0.86–1.79)	0.2
passive (unemployed or retired)	Reference		Reference	
Self-declared economic status				
good	Reference		Reference	
moderate	1.05 (0.77–1.44)	0.8	1.24 (0.88–1.75)	0.2
bad	1.05 (0.77–1.44)	0.04	1.68 (1.03–2.72)	**0.04**
Cigarette smoking (past 30 days)				
yes	3.04 (2.28–4.05)	<0.001	2.26 (1.62–3.16)	**<0.001**
no	Reference		Reference	
E-cigarette or heated tobacco use (past 30 days)				
yes	3.70 (2.68–5.12)	<0.001	2.18 (1.49–3.20)	**<0.001**
no	Reference		Reference	

Among non-smokers (n=689), living in rural areas (OR: 2.35, 95%CI: 1.10–5.02, p=0.03) and having three or more household members (OR: 2.42, 95%CI: 1.01–5.81, p=0.04) were significantly associated with exposure to secondhand smoke at home (Table 4).

Table 4: Factors associated with SHS exposure at home among non-smokers (n=689)

	Bivariable Logistic Regression		Multivariable Logistic Regression	
Overall	OR (95%CI)	p-value	aOR	p-value
Gender				
female	1.01 (0.69–1.52)	0.9		
male	Reference			
Age [years]				
18–29	1.65 (0.81–3.34)	0.2		
30–39	2.20 (1.24–3.91)	0.07		
40–49	1.42 (0.75–2.68)	0.3		
50–59	1.62 (0.87–3.01)	0.1		

	Bivariable Logistic Regression		Multivariable Logistic Regression	
60 and over	Reference			
Education				
higher	Reference			
less than higher	1.23 (0.85–1.93)			
Marital status				
single	2.14 (0.47–9.73)	0.3	1.92 (0.41–8.92)	0.4
married	2.33 (0.54–10.07)	0.3	1.82 (0.41–8.10)	0.4
informal relationship	4.10 (0.89–18.86)	0.1	3.49 (0.74–16.51)	0.1
divorced	1.39 (0.21–9.01)	0.7	1.69 (0.25–11.25)	0.6
widowed	Reference		Reference	
With children				
yes	0.90 (0.58–1.38)	0.6		
no	Reference			
Place of residence				
rural	2.36 (1.12–4.98)	0.03	2.35 (1.10–5.02)	**0.03**
city with fewer than 20,000 residents	1.61 (0.67–3.86)	0.3	1.68 (0.69–4.08)	0.3
city with 20,000–99,999 residents	1.11 (0.46–2.69)	0.8	1.23 (0.50–3.01)	0.7
city with 100,000–499,999 residents	1.08 (0.43–2.70)	0.9	1.08 (0.43–2.72)	0.9
city with more than 500,000 residents	Reference		Reference	
Number of household members				
1 (living alone)	Reference		Reference	
2	1.71 (0.77–3.81)	0.2	1.57 (0.82–3.94)	0.3
3 or more	2.71 (1.25–5.88)	0.01	2.42 (1.01–5.81)	**0.04**
Children in the home				
yes	1.35 (0.87–2.08)	0.2		
no	Reference			
Occupational activity				
employed/self-employed	1.22 (0.80–1.85)	0.4		
passive (unemployed or retired)	Reference			
Self-declared economic status				
good	0.67 (0.34–1.32)	0.2		
moderate	0.86 (0.46–1.59)	0.6		
bad	Reference			

Discussion

This nationwide study showed that exposure to secondhand smoke at home remains a significant public health problem in Poland. One quarter of adults, including 41.2% of smokers and 16.0% of non-smokers, declared being exposed to SHS at home. Socioeconomic differences in exposure to SHS at home were identified, of which place of residence and number of household members were the most important factors among non-smokers.

The findings from this study revealed that the percentage of adults in Poland exposed to SHS at home in 2024 was significantly higher than in 2019: 25.1% vs. 6.1% (in the past 30 days; Jankowski, Pinkas, et al., 2020). This observation may result from the fact that the 2019 study was carried out in September and the 2024 data were collected in February, as more people may have smoked at home due to the cold season. In 2024, a higher percentage of people declared being exposed to SHS at home, among both smokers (11.5% in 2019 vs. 41.2% in 2024) and non-smokers (4.5% in 2019 vs. 16% in 2024) (Jankowski, Pinkas, et al., 2020). This observation requires further investigation.

Among all respondents and in the subgroup of non-smokers, living in rural areas and having three or more household members were associated with a higher probability of exposure to SHS at home. Previously published data also suggest that rural populations are at higher risk of SHS exposure (Carreras et al., 2019; Vander Weg et al., 2021; Štěpánek et al., 2022). This observation may result from the fact that rural residents live in detached houses rather than apartment buildings and may feel more comfortable and confident smoking in their homes. Respondents in households with at least three residents reported higher SHS exposure, which may result from the fact that the risk of SHS exposure increases with the number of household members. In all respondents, bad economic status was also associated with a higher probability of SHS exposure at home. This is also in line with previously published data, as low economic status is considered an important factor associated with unhealthy behaviors and higher health risks related to environmental exposure (Milcarz et al., 2018; Vander Weg et al., 2021). As expected, smokers (users of cigarettes, e-cigarettes, or heated tobacco products) had a higher probability of SHS exposure at home. This results from the fact that these people may smoke with relatives or friends who live with or visit them. Further educational activities promoting smoke-free homes and protection against secondhand smoke should target rural populations and groups with low socioeconomic status.

This study has practical implications for health policy in Poland. Firstly, it showed that SHS exposure at home is a significant public health problem that should be addressed with public health interventions. The study also indicated priority populations for education on SHS exposure and its health effects. There is a need to increase the number of educational activities on the health effects of SHS exposure addressed to inhabitants of rural areas. Moreover, the study also revealed that smokers and users of novel nicotine-containing products should be educated about the effects of secondhand smoke on bystanders and others in the smoker's vicinity.

The major limitations of this study are that SHS exposure was self-reported, no measurements were taken in the home, and cotinine levels were not included. Because this study was carried out with the CAWI technique, respondents without internet access were excluded. Moreover, secondhand smoke exposure was assessed generally, without distinguishing between cigarettes, e-cigarettes, and heated tobacco products.

Conclusions

This study revealed that one quarter of Poles are exposed to secondhand smoke at home. Place of residence and number of household members were the most important factors associated with a higher probability of secondhand smoke exposure at home among non-smokers. Further public health interventions are needed to protect the population and to promote smoke-free homes.

References

Carreras, G., Lugo, A., Gallus, S., Cortini, B., Fernández, E., López, M. J., Soriano, J. B., López-Nicolás, A., Semple, S., Gorini, G., & TackSHS Project Investigators. (2019). Burden of Disease Attributable to Second-Hand Smoke Exposure: A Systematic Review. *Preventive Medicine*, 129, 105833.

Flor, L. S., Anderson, J. A., Ahmad, N., Aravkin, A., Carr, S., Dai, X., Gil, G. F., Hay, S. I., Malloy, M. J., McLaughlin, S. A., Mullany, E. C., Murray, C. J. L., O'Connell, E. M., Okereke, C., Sorensen, R. J. D., Whisnant, J., Zheng, P., & Gakidou, E. (2024). Health Effects Associated With Exposure to Secondhand Smoke: A Burden of Proof Study. *Nature Medicine*, *30*(1), 149–167.

Grudziąż-Sękowska, J., Sękowski, K. B., Grześczyk-Nojszewska, Z., Sierpiński, R., Ostrowski, J., Pinkas, J., & Jankowski, M. (2024). Public Support for New Tobacco Control Measures in Poland: A Cross-Sectional Survey 2024. *Tobacco Prevention & Cessation*, 10. doi: 10.18332/tpc/196135

Jankowski, M., Grudziąż-Sękowska, J., Kamińska, A., Sękowski, K., Wrześniewska-Wal, I., Moczeniat, G., Gujski, M., Kaleta, D., Ostrowski, J., & Pinkas, J. (2024). A 2024 Nationwide Cross-Sectional Survey to Assess the Prevalence of Cigarette Smoking, E-Cigarette Use and Heated Tobacco Use in Poland. *International Journal of Occupational Medicine and Environmental Health*, *37*(3), 271–286.

Jankowski, M., Pinkas, J., Zgliczyński, W. S., Kaleta, D., Wierzba, W., Gujski, M., & Rees, V. W. (2020). Voluntary Smoke-Free Home Rules and Exposure to Secondhand Smoke in Poland: A National Cross-Sectional Survey. *International Journal of Environmental Research and Public Health*, *17*(20), 7502.

Jankowski, M., Rees, V., Zgliczyński, W. S., Kaleta, D., Gujski, M., & Pinkas, J. (2020). Self-Reported Secondhand Smoke Exposure Following the Adoption of a National Smoke-Free Policy in Poland: Analysis of Serial, Cross-Sectional, Representative Surveys, 2009–2019. *BMJ Open*, *10*(9), e039918.

Lee, J. W., Yang, W., Kim, Y. S., Kim, Y., Yoo, H. S., & Kang, H. T. (2022). Exposure to Secondhand Smoke and a Tobacco-Specific Carcinogen in Non-Smokers. *Korean Journal of Family Medicine*, *43*(2), 117–124.

Mbulo, L., Palipudi, K. M., Andes, L., Morton, J., Bashir, R., Fouad, H., Ramanandraibe, N., Caixeta, R., Dias, R. C., Wijnhoven, T. M., Kashiwabara, M., Sinha, D. N., Tursan d'Espaignet, E., & GATS Collaborative Group. (2016). Secondhand Smoke Exposure at Gome Among One Billion Children in 21 Countries: Findings From the Global Adult Tobacco Survey (GATS). *Tobacco Control*, *25*(e2), e95–e100.

Milcarz, M., Polanska, K., Bak-Romaniszyn, L., & Kaleta, D. (2018). Tobacco Health Risk Awareness Among Socially Disadvantaged People: A Crucial Tool for Smoking Cessation. *International Journal of Environmental Research and Public Health*, *15*(10), 2244.

Okoli, C. T. & Kodet, J. (2015). A Systematic Review of Secondhand Tobacco Smoke Exposure and Smoking Behaviors: Smoking Status, Susceptibility, Initiation, Dependence, and Cessation. *Addictive Behaviors*, 47, 22–32.

Ostrowska, A., Pinkas, J., Giermaziak, W., Wierzba, W., Gujski, M., & Jankowski, M. (2023). Smoke-Free Homes in Poland During the COVID-19 Pandemic: A Nationwide Cross-Sectional Survey. *International Journal of Occupational Medicine and Environmental Health*, *36*(1), 84–95.

Possenti, I., Gallus, S., Lugo, A., López, A. M., Carreras, G., Fernández-Megina, R., González-Marrón, A., Gorini, G., Koprivnikar, H., Papachristou, E., Lambrou, A., Schoretsaniti, S., Pénzes, M., Carnicer--Pont, D., & Fernandez, E. (2024). Best Practices for Secondhand Smoke and Secondhand Aerosol Protection and Evidence Supporting the Expansion of Smoke- and Aerosol-Free Environments: Recommendations From the 2nd Joint Action on Tobacco Control. *Tobacco Prevention & Cessation*, 10. doi: 10.18332/tpc/193147

Štěpánek, L., Ševčíková, J., Horáková, D., Patel, M. S., & Durďáková, R. (2022). Public Health Burden of Secondhand Smoking: Case Reports of Lung Cancer and a Literature Review. *International Journal of Environmental Research and Public Health*, *19*(20), 13152.

Vander Weg, M. W., Cunningham, C. L., Howren, M. B., & Cai, X. (2021). Tobacco Use and Exposure in Rural Areas: Findings From the Behavioral Risk Factor Surveillance System. *Addictive Behaviors*, *36*(3), 231–236.

EJoHP 1(4)/2025

DOI: https://doi.org/10.21697/ejhp.0106.05
e-ISSN 2957-2002

2025, 4, 1: 55-64

Descriptive analysis of the implementation of the program "Prevention 40 PLUS" in Poland, July 2021–December 2024

Radosław Sierpiński, Ph.D.
ORCID: https://orcid.org/0000-0002-4731-1565

Igor Kilanowski, Dr.
ORCID: https://orcid.org/0000-0002-1309-2317
National Center for Health Policy and Research on Health Inequalities
Cardinal Stefan Wyszynski University in Warsaw
01-938 Warsaw, Poland
ul. Dewajtis 5, 01-815 Warszawa
Email: r.sierpinski@uksw.edu.pl
Phone: +48 22 561 88 00

Received: 9 Jun 2025; Revised: 18 Jun 2025; Accepted: 27 Jun 2025

Abstract

The prevention and early detection of diseases through screening are key public health actions. The program "Prevention 40 PLUS" was a population-based screening program for adults aged 40 and over, available from July 2021 and April 2025. This study provides a descriptive analysis of the implementation of the program in Poland between July 2021 and December 2024. Data for the study were obtained from the National Health Fund through a request for access to public information. Between July 2021 and December 2024, a total of 5,071,360 participants completed the questionnaire available within the program. Between 2023 and 2022, the annual number of participants increased by 302,292 participants, and between 2023 and 2024, an increase of 116,393 participants was noted. Among the participants, 58.6% were women. Over 60% of the participants signed up for the program via the hotline. Over one fifth (21%) of the participants were aged 40–44 years. In general, almost half of the participants (48.1%) were aged 40–54 years. The largest groups of participants of the program lived in Masovia (11.7%) and Greater Poland (10.9%). Less than 5% of the participants lived in the Lubusz or Opolskie voivodeship. Prevention

40 PLUS was well-accepted and over 5 million Poles declared a willingness to participate in this program over its 4-year span.

Keywords: prevention; screening; early detection; public health; Prevention 40 PLUS

Introduction

The prevention and early detection of diseases through screening are key public health actions (Martin-Moreno et al., 2016; Speechley et al., 2017). Population screening programs offer medical examinations for specific diseases to a population of apparently healthy, asymptomatic individuals (Williams, 2022). Most of the population-based screening programs are focused on early detection of various types of cancer (Sheridan et al., 2025). The European Council (2022) recommends European Union (EU) Member States to implement population screening for six cancers: breast, cervical, colorectal, gastric, lung, and prostate. Cervical and colorectal cancer screening programs enjoy the greatest success (Shieh et al., 2016). However, different population screening programs have been implemented worldwide to better address the health needs of local populations (Ebell et al., 2018). Moreover, national screening programs may also better address the sociocultural determinants of health and address the inequalities resulting from these determinants.

On July 1, 2021, a population-based preventive program was introduced in Poland, called Prevention 40 PLUS (Regulation of the Ministry of Health of 14 June 2021 on the pilot program "Prevention 40 PLUS", 2021). This program provided free preventive screening for all Polish men and women over the age of 40. The aim of the program was to increase the number of people undergoing preventive screening, increase early detection of diseases and disorders, and prevent the development of these diseases (Ministry of Health, 2025). This program was implemented in response to the COVID-19 pandemic and the decrease in the utilization of health services, including preventive services, observed in the first year of the COVID-19 pandemic (Mularczyk-Tomczewska et al., 2022).

Prevention 40 PLUS offered a group of diagnostic tests selected specifically for men and women (Regulation of the Ministry of Health of 14 June 2021 on the pilot program "Prevention 40 PLUS", 2021). All participants underwent the following assays: peripheral blood count with differential and platelet count; total cholesterol level or lipid profile; blood glucose level; alanine transaminase (AlAT), aspartate transaminase (AspAT), and gamma-glutamyltransferase (GGTP) levels; blood creatinine level; general urine test; blood uric acid level; fecal occult blood – immunochemical method (iFOBT); blood pressure measurement; and anthropometric measures, such as body mass, height, waist circumference, and body mass index (BMI). Moreover, in men, total prostate-specific antigen (PSA) levels were tested (Ministry of Health, 2025).

All insured individuals could participate in the program at publicly funded health service centers. Individuals interested in participating in this program were obligated to fill out the dedicated screening questionnaire, available online at the Patient's Online Account or via a hotline or authorized healthcare facility. In July 2023, it was announced that people over 40 years of age could use the program for a second time if at least 12 months had passed since the previous enrolment. The program ended on April 30, 2025 (Ministry of Health, 2025).

This aim of this study is to provide a descriptive analysis of the implementation of Prevention 40 PLUS in Poland between July 2021 and December 2024.

Material and Methods

This study is an analysis of data on the program Prevention 40 PLUS, a preventive screening program available within the Polish public healthcare system for all insured persons aged 40 and over (Regulation of the Ministry of Health of 14 June 2021 on the pilot program "Prevention 40 PLUS", 2021). Each participant of the program was required to complete a questionnaire, based on which the diagnostic tests to be offered as part of the program were selected. The questionnaire was available at the Patient's Online Account or via a designated hotline. Once the questionnaire was completed, a referral was generated for tests appropriate for the patient's health risks. This solution was innovative in nature, as it did not require a doctor's visit, facilitating access to basic diagnostics and health prevention in accordance with the list of benefits specified in the regulation (Ministry of Health, 2025).

Completing the questionnaire resulted in a referral for laboratory testing. For the purposes of this analysis, any person who completed the questionnaire and received a referral was considered a program participant. This study did not analyze the percentage of people who, despite completing the questionnaire and receiving a referral, did not undergo laboratory testing (Ministry of Health, 2025).

Data on the implementation of Prevention 40 PLUS were obtained from the National Health Fund through a request for access to public information. The National Health Fund, as a public payer, monitored and supervised the implementation of the publicly financed screening program.

The request for access to anonymized data regarding the implementation of the program encompassed the following data about the participants:

- gender
- age
- provincial branch of the National Health Fund assigned to the participant's place of residence
- changes in the number of participants over time.

In this study, data on questionnaires filled out between July 1, 2021 and December 31, 2024 were analyzed. The data were entered into an electronic database and analyzed using MS Excel.

Results

Between July 2021 and December 2024, a total of 5,071,360 participants completed the questionnaire connected with the program Prevention 40 PLUS (Figure 1). Between 2023 and 2022, the annual number of participants increased by 302,292 participants, and between 2023 and 2024, an increase of 116,393 participants was noted (Figure 1). Among the participants, 58.6% were women.

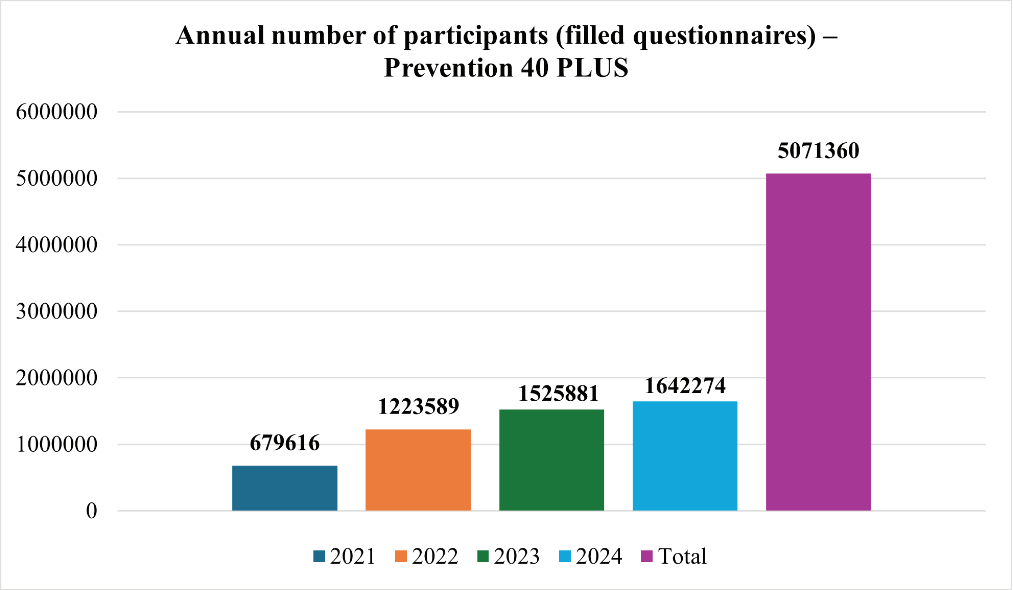

Figure 1. Annual number of participants (completed questionnaires) of Prevention 40 PLUS, July 2021–December 2024

The monthly number of participants of the program is presented in Table 1. Over 60% of the participants signed up for the program via the hotline. The highest number of monthly participants was observed in March 2023: a total of 176,378 (Table 1).

Table 1: Monthly number of participants of the Prevention 40 PLUS program

Month	Total number of questionnaires	Source of questionnaires	
		Patient's Online Account	Hotline
July 2021	134,393	123,785	10,608
August 2021	72,160	58,076	14,084
September 2021	94,411	71,435	22,976
October 2021	141,526	109,336	32,190
November 2021	130,614	94,985	35,629
December 2021	106,512	75,642	30,870
January 2022	66,936	42,039	24,897
February 2022	58,055	31,916	26,139
March 2022	60,185	25,587	34,598
April 2022	71,647	32,513	39,134
May 2022	93,869	34,449	59,420
June 2022	125,632	51,564	74,068
July 2022	87,711	25,998	61,713
August 2022	105,723	30,406	75,317
September 2022	123,670	34,508	89,162
October 2022	136,439	37,779	98,660
November 2022	166,059	44,950	121,109
December 2022	127,663	31,284	96,379
January 2023	121,080	29,657	91,423
February 2023	157,492	44,501	112,991
March 2023	176,378	57,709	118,669
April 2023	112,467	27,587	84,880
May 2023	124,622	26,235	98,387
June 2023	107,954	19,217	88,737
July 2023	116,132	26,260	89,872
August 2023	125,543	28,061	97,482
September 2023	122,087	23,495	98,592
October 2023	130,315	28,473	101,842
November 2023	141,777	31,487	110,290
December 2023	90,034	21,559	68,475
January 2024	132,208	31,471	100,737
February 2024	153,236	33,804	119,432
March 2024	144,359	31,422	112,937

Month	Total number of questionnaires	Source of questionnaires	
		Patient's Online Account	Hotline
April 2024	151,254	30,862	120,392
May 2024	146,920	38,697	108,223
June 2024	174,710	46,575	128,135
July 2024	100,690	21,875	78,815
August 2024	98,782	20,230	78,552
September 2024	104,965	19,449	85,516
October 2024	127,114	27,500	99,614
November 2024	150,199	42,939	107,260
December 2024	157,837	51,529	106,308
Total	**5,071,360**	**1,716,846**	**3,354,514**

Over one fifth (21%) of the participants were individuals aged 40–44 years. The highest interest in the program was among the youngest eligible for the program: almost half of the participants (48.1%) were aged 40–54 years (Table 2).

Table 2: Age group of the participants of Prevention 40 PLUS

Age group [years]	Percentage of all participants
40–44	21.0%
45–49	15.3%
50–54	11.8%
55–59	10.5%
60–64	11.4%
65–69	12.3%
70–74	9.2%
75–79	4.7%
80–84	2.2%
85–89	1.1%
90–94	0.4%
95 and over	0.1%

Most of the participants of Prevention 40 PLUS lived in Masovia (11.7%) and Greater Poland (10.9%) (Table 3). Less than 5% of them lived in Lubusz or Opolskie voivodeship.

Table 3: Participants of Prevention 40 PLUS by voivodeship

Voivodeship	Percentage of all participants
Masovia	11.7%
Greater Poland	10.9%
Silesia	9.7%
Lublin	9.5%
Subcarpathia	9.2%
Lesser Poland	7.9%
Lower Silesia	6.8%
Pomerania	5.6%
West Pomerania	4.6%
Świętokrzyskie	4.2%
Lodzkie	4.2%
Kuyavia-Pomerania	4.0%
Podlaskie	3.7%
Warmia-Masuria	3.5%
Lubusz	2.6%
Opole	2.0%
missing data	0.8%

Discussion

This study provides a descriptive analysis of the implementation of the program “Prevention 40 PLUS” in Poland, including data on the participants (July 2021–December 2024). The findings from the study revealed a year-by-year increase in the number of participants. Most of the participants were women and almost half of the participants were aged 40–54 years. The program was utilized most in Masovia, Greater Poland, and Silesia, which are the voivodeships with the highest numbers of residents.

Prevention 40 PLUS was a major population-based screening program implemented in Poland after the COVID-19 pandemic (Ministry of Health, 2025). It was widely promoted on TV and radio, in the press and digital media, and on social media. The program was led by the Ministry of Health and, following several extensions over 5 years, it ended on 30 April 2025.

The study showed that over 5 million Poles aged 40 and over filled out the screening questionnaire, which automatically generated referrals for laboratory tests. This number includes also those who filled out the questionnaire but did not show up for tests, as well as those who participated in the program twice with an interval of at least 12 months.

It is estimated that 12.8 million Poles are aged 40 years and over, so the number of people who participated in Prevention 40 PLUS is encouraging and points to a relatively high interest in screening after the COVID-19 pandemic. Every year, an increase in the number of participants was observed, which suggests growing interest in the program. Monthly differences in the number of participants were observed, which may suggest that in some months people are less likely to undergo preventive screening, such as during the summer or the last month of the year. The findings from this study also indicate the role of a well-organized hotline as a source of health information and enrollment for screening, especially for older adults. Over 60% of the participants signed up for the screening via the hotline. The role of hotlines as a source of information about available healthcare services and a place to register for health services, including preventive services, requires further investigation (Brody et al., 2020).

Most of the participants were women, but this observation is in line with previously published data that this population is more likely to perform screening tests (Mularczyk-Tomczewska et al., 2022). The highest group of participants (almost 50%) were aged 40–54 years, which suggests that the youngest eligible populations were most interested in the health screening. It can be hypothesized that putting the target group for the program (those 40 years and older) in the name of the program had an impact on the youngest eligible group, who felt at high risk and realized that they should perform a screening test (Agrawal et al., 2021). Moreover, this group could be in the best health due to their age and may be the most interested in staying healthy as long as possible, leading them to undergo screening (Chien et al., 2020).

Out of the 16 voivodeships, the percentage of participants in the Prevention 40 PLUS program living in Lublin and West Pomerania was relatively higher than the proportion of the population in these voivodeships to the general population of Poland. However, this observation and regional differences in the utilization of preventive services require further investigation.

The major limitation of this study is the fact that the dataset available for analysis does not allow for identification of those who filled out the questionnaire but did not show up for tests despite receiving a referral. Moreover, those who participated in the program twice could not be identified either. The results of the laboratory tests were not analyzed. This publication included data through December 31, 2024 so as to include a full calendar year. At the time of request for data, it was unknown when the program would end. The program ended on April 31, 2025 and was replaced by the program "My Health," which includes a similar scope of research but is aimed at people who are 20 years of age and older and is based on different organizational principles.

Conclusions

The program Prevention 40 PLUS was well-accepted; over 5 million Poles declared a willingness to participate in it over its 4-year span. The highest interest in participating in this population-based screening program was among the youngest eligible age group: 40–54-year-olds. Further analysis should assess the impact of Prevention 40 PLUS on health literacy levels and public attitudes toward preventive screening.

conceptualization: RS, IK; methodology RS; writing – original draft RS, IK; writing – review and editing RS, supervision RS

References

Agrawal, S., Makuch, S., Lachowicz, G., Dróżdż, M., Dudek, K., & Mazur, G. (2021). How Sociodemographic Factors Impact the Utilization of Recommended Clinical Preventive Screening Services in Poland: A Nationwide Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, *18*(24), 13225.

Brody, C., Star, A., & Tran, J. (2020). Chat-Based Hotlines for Health Promotion: A Systematic Review. *mHealth*, 6, 36.

Chien, S. Y., Chuang, M. C., & Chen, I. P. (2020). Why People Do Not Attend Health Screenings: Factors That Influence Willingness to Participate in Health Screenings for Chronic Diseases. *International Journal of Environmental Research and Public Health*, *17*(10), 3495.

Ebell, M. H., Thai, T. N., & Royalty, K. J. (2018). Cancer Screening Recommendations: An International Comparison of High Income Countries. *Public health reviews*, *39*, 7. https://doi.org/10.1186/s40985-018-0080-0

European Council. (2022). *Council Updates Its Recommendation to Screen for Cancer*. Retrieved from: https://www.consilium.europa.eu/en/press/press-releases/2022/12/09/council-updates-its--recommendation-to-screen-for-cancer/

Martin-Moreno, J. M., Harris, M., Jakubowski, E., & Kluge, H. (2016). Defining and Assessing Public Health Functions: A Global Analysis. *Annual Review of Public Health*, *37*, 335–355.

Ministry of Health. (2025). *Prevention 40 PLUS*. Retrieved from: https://www.gov.pl/web/zdrowie/profilaktyka-40-plus

Mularczyk-Tomczewska, P., Żarnowski, A., Gujski, M., Sytnik-Czetwertyński, J., Pańkowski, I., Smoliński, R., & Jankowski, M. (2022). Preventive Health Screening During the COVID-19 Pandemic: A Cross--Sectional Survey Among 102,928 Internet Users in Poland. *Journal of Clinical Medicine*, *11*(12), 3423.

Regulation of the Ministry of Health of 14 June 2021 on the Pilot Program "Prevention 40 PLUS" [Rozporządzenie Ministra Zdrowia z dnia 14 czerwca 2021 r. w sprawie programu pilotażowego „Profilaktyka 40 PLUS"]. (2021). Journal of Laws of 2021, item 1081. Retrieved from https://api.sejm.gov.pl/eli/acts/DU/2021/1081/text.pdf

Sheridan, B., Irzaldy, A., Heijnsdijk, E. A. M., Dimitrova, N., Senore, C., Basu, P., & de Koning, H. J. (2025). Prioritizing Performance and Outcome Indicators for Quality Assessment of Cancer Screening Programs in the EU. *Public Health*, *239*, 185–192.

Shieh, Y., Eklund, M., Sawaya, G. F., Black, W. C., Kramer, B. S., & Esserman, L. J. (2016). Population--Based Screening for Cancer: Hope and Hype. *Nature Reviews. Clinical Oncology*, *13*(9), 550–565. https://doi.org/10.1038/nrclinonc.2016.50

Speechley, M., Kunnilathu, A., Aluckal, E., Balakrishna, M. S., Mathew, B., & George, E. K. (2017). Screening in Public Health and Clinical Care: Similarities and Differences in Definitions, Types, and Aims – A Systematic Review. *Journal of Clinical and Diagnostic Research*, *11*(3), LE01–LE04.

Williams, M. S. (2022). Population Screening in Health Systems. *Annual Review of Genomics and Human Genetics*, *23*, 549–567.