

Socioeconomic inequalities in major behavioral cancer risk factors in Poland: evidence from a nationally representative health survey

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Abstract

Introduction: Cancer remains a major public health burden in Poland, with a substantial proportion of cases attributable to modifiable behavioral risk factors such as smoking, obesity, and physical inactivity. These factors are socially patterned, contributing to health inequalities across socioeconomic groups. The study aimed to quantify socioeconomic gradients in key behavioral cancer risk factors in Poland.

Material and methods: A cross-sectional analysis was conducted using data from the Polish wave of the European Health Interview Survey (EHIS) 2019, covering a nationally representative sample of individuals aged ≥ 15 years. Educational attainment was used as an indicator of socioeconomic status (SES; high, middle, low). Prevalence of smoking, obesity (body mass index ≥ 30 kg/m²), and lack of recreational physical activity were estimated across educational groups. Socioeconomic gradients were assessed using prevalence ratios (PRs), and the estimated number of individuals exposed to each risk factor was calculated using national population estimates.

Results: Clear socioeconomic gradients were observed for all analyzed risk factors. Individuals with low education had higher prevalence of smoking (23.6% vs. 11.6%, PR = 2.03), obesity (21.9% vs. 11.9%; PR = 1.84), and physical inactivity (59.5% vs. 39.3%; PR = 1.51) compared to those with high education. The low-education group (41% of the population) accounted for ~47–49% of all exposures, indicating a disproportionate concentration of behavioral cancer risk. Reducing these inequalities could substantially decrease the population burden of risk factors.

Conclusions: Behavioral cancer risk factors in Poland are unequally distributed and disproportionately concentrated among socioeconomically disadvantaged groups. Addressing these inequalities through targeted, equity-oriented prevention strategies may help reduce the future cancer burden.

Key words: inequalities, cancer prevention, risk factors, Europe, Poland.

Introduction

Poland faces a substantial burden of cancer, which remains one of the leading causes of death in the population [1]. A substantial share of this burden is attributable to modifiable behavioral risk factors and therefore

largely preventable. In Poland, the most important of these include tobacco use, obesity, alcohol consumption, and low levels of physical activity, all of which contribute significantly to cancer incidence and mortality [2].

Tobacco remains the single most important behavioral risk factor for cancer mortality in Poland, accounting for a substantial proportion of cancer-related deaths [3]. Although some improvements in smoking patterns have been observed over time, tobacco use continues to shape long-term cancer trends, including lung cancer mortality, which remains a leading cause of cancer death in both men and women [1]. At the same time, new challenges are emerging in younger populations. Data from the Global Youth Tobacco Survey indicate that Polish adolescents remain highly exposed to tobacco-related influences, including declining awareness of the harms of smoking and secondhand smoke, as well as persistent exposure to tobacco marketing and pro-smoking norms. These patterns may translate into sustained or even increasing exposure to tobacco in future adult populations [4].

Beyond tobacco, other modifiable behavioral risk factors are also highly prevalent. Alcohol consumption is an important modifiable cancer risk factor in Poland. OECD data indicate that the prevalence of alcohol consumption in the country is higher than the European Union (EU) average, placing Poland among countries performing worse in this domain. Moreover, overweight and obesity, as well as insufficient physical activity, are widespread in Poland and show marked variation across population groups [2]. These factors not only increase the risk of several common cancers, but also interact with broader social and environmental determinants, amplifying health inequalities. Evidence from European studies suggests that cancer prevention behaviors are shaped by a complex interplay of individual capabilities, social norms and structural conditions, including education, economic resources and access to health-promoting environments [5]. In this context, socioeconomic inequalities play a key role in the distribution of cancer risk. Individuals with lower socioeconomic status (SES) are more likely to be exposed to behavioral risk factors and face barriers to adopting healthier lifestyles, leading to unequal cancer outcomes across the population. Understanding how these risk factors are distributed across socioeconomic groups is therefore essential for designing effective and equitable prevention strategies [2, 5].

The aim of this study was to quantify socioeconomic gradients in major modifiable behavioral cancer risk factors in Poland using nationally representative health survey data. Specifically,

the study assessed differences in the prevalence of smoking, obesity and recreational physical inactivity across educational groups and estimated the population distribution of these exposures. The findings were intended to identify the extent to which behavioral cancer risk factors are concentrated in socioeconomically disadvantaged populations and to inform equity-oriented cancer prevention strategies using the most recent nationally available data. Although socioeconomic gradients in behavioral risk factors are well documented internationally, recent nationally representative evidence quantifying the population distribution of major cancer-related behavioral risks across educational groups in Poland remains limited. The added value of the present study is therefore not in identifying socioeconomic inequalities as a new phenomenon, but in providing an updated, transparent and population-based quantification of their scale in the Polish context. By combining prevalence estimates with national population data, the study illustrates how these inequalities translate into the distribution of risk-factor burden at the population level.

Material and methods

Study design and data source

This study was a cross-sectional analysis based on data from the Polish wave of the European Health Interview Survey (EHIS) [6]. EHIS is a harmonized population health survey conducted periodically across European Union Member States to support the development of a European public health monitoring system. The survey collects information on health status, health determinants, health care utilization, and preventive health behaviors in the general population.

In Poland, EHIS is implemented by Statistics Poland as part of the national program of statistical surveys. Data are collected using standardized questionnaires developed at the European level and adapted for national implementation. The survey includes modules covering health status, chronic conditions, mental health, lifestyle behaviors, preventive practices, and the use of health services.

The target population of the survey consists of individuals aged 15 years and older living in private households in Poland. Persons residing in institutional settings such as hospitals, nursing homes, or other collective households are not included in the sampling frame. The survey therefore represents the non-institutionalized population of the country.

Sampling design

The survey uses a multistage stratified sampling design to ensure representativeness of the

national population. Households are selected from the national sampling frame maintained by Statistics Poland. In the first stage, primary sampling units are selected from territorial strata, and in the second stage households are randomly selected within these units.

Within each sampled household, individual respondents are selected for participation in the survey. The sampling procedure ensures adequate representation across regions, urban and rural areas, and major demographic groups.

Sampling weights provided in the survey dataset allow extrapolation of survey results to the national population. The analyzed data represent approximately 31.6 million persons aged 15 years and older living in Poland.

Data collection

Data were collected as part of the Polish implementation of the EHIS conducted in 2019. The survey was carried out by Statistics Poland as part of the national statistical program and followed the methodological guidelines developed by Eurostat.

Fieldwork was conducted throughout 2019, with data collected from individuals aged 15 years and older living in private households in Poland. Information was obtained through structured questionnaires administered by trained interviewers using computer-assisted personal interviewing, complemented by self-administered modules for selected topics.

In total, interviews were completed in 11,024 households, yielding information on 23,753 individuals, including 19,959 adults aged 15 years and older. Sampling weights provided by the survey allow extrapolation of results to the national population.

The results of the survey were published in 2021 in the report *Health Status of Population in Poland in 2019* prepared by Statistics Poland. At the time of analysis, these represented the most recent nationally representative data available for Poland.

The analysis was based on publicly available aggregated results from the Polish EHIS 2019 published online by Statistics Poland, rather than on individual-level raw survey data. The authors recalculated and summarized these publicly available aggregated data for the purposes of the present study.

Socioeconomic indicator

Educational attainment was used as the primary indicator of socioeconomic status. Education is commonly used in epidemiological research as a stable measure of socioeconomic position and is generally considered less affected by reverse causation than income or employment status.

Education was used as a pragmatic and stable measure of socioeconomic position available in the EHIS dataset. However, education does not capture all dimensions of socioeconomic status, such as income, wealth, occupational class, material deprivation, or neighborhood-level disadvantage. Therefore, the findings should be interpreted as educational inequalities in behavioral cancer risk factors rather than a comprehensive assessment of all socioeconomic inequalities.

Educational attainment was categorized into three groups: (1) high education – tertiary education; (2) middle education – secondary or post-secondary education; (3) low education – basic vocational education, primary education, lower secondary education, or no formal education. These categories were defined to reflect meaningful gradients in socioeconomic position within the Polish population.

Behavioral cancer risk factors

The analysis focused on major behavioral risk factors associated with cancer development: (1) Smoking status was determined based on self-reported current smoking behavior. Respondents reporting daily or occasional use of tobacco products were classified as current smokers. (2) Obesity was defined as body mass index (BMI) ≥ 30 kg/m². BMI was calculated from self-reported body weight and height reported by respondents during the survey interview. (3) Physical inactivity was defined as absence of recreational physical activity, operationalized as reporting no bicycling or sports activity during a typical week. (4) Alcohol consumption was measured in the survey as drinking alcohol at least once per week. Because this indicator primarily reflects drinking frequency rather than harmful alcohol consumption patterns, it was not included in the primary inequality analysis of behavioral cancer risk factors. The variable was analyzed descriptively but excluded from the main gradient analysis.

Statistical analysis

Prevalence estimates were calculated for each behavioral risk factor across educational groups. Socioeconomic gradients were quantified using prevalence ratios (PRs) comparing the prevalence of each risk factor in the low-education group with that observed in the high-education group.

To assess the population distribution of cancer risk exposures, prevalence estimates were combined with national population size to estimate the number of individuals exposed to each risk factor. The distribution of exposures across educational groups was used to assess the concentration of behavioral cancer risk factors within the population.

Table I. Population characteristics and prevalence of behavioral cancer risk factors by educational attainment in Poland

Educational attainment	Population share (%)	Smoking (%)	Obesity (BMI ≥ 30 kg/m ²) (%)	No recreational physical activity (%)	Alcohol $\geq 1\times/\text{week}$ (%)
High (tertiary education)	24.3	11.6	11.9	39.3	21.2
Middle (secondary or post-secondary education)	34.5	20.8	19.2	52.7	18.2
Low (vocational, primary, lower secondary or none)	41.0	23.6	21.9	59.5	16.5
Total population	100	19.7	18.5	52.1	18.2

Data source: Polish wave of the European Health Interview Survey (EHIS). Population aged 15 years and older living in private households. Physical inactivity defined as no bicycling or sports activity during a typical week. Alcohol consumption presented descriptively and not included in the main inequality analysis. Percentages may not sum to 100% because observations with missing values were excluded from the denominator for individual variables.

Population estimates were derived from national demographic statistics published by Statistics Poland [7].

The analysis was descriptive in nature and was intended to quantify the distribution of selected behavioral risk factors across educational groups. No causal interpretation was assumed. The prevalence ratios should therefore be interpreted as descriptive measures of relative inequality rather than adjusted estimates of independent associations. Similarly, the estimates of the population burden of behavioral risk factors were used to illustrate the scale and distribution of exposures, not to estimate the effect of a specific intervention.

Ethical considerations

The study used publicly available aggregated results from the Polish EHIS 2019 published by Statistics Poland. The authors did not access in-

dividual-level raw survey data and did not process any identifiable personal data. Therefore, the analysis did not require additional ethical approval.

Results

Clear and consistent socioeconomic gradients were observed across all analyzed behavioral cancer risk factors. Individuals with lower educational attainment had substantially higher prevalence of smoking, obesity, and lack of recreational physical activity compared to those with higher education (Table I, Figure 1).

Smoking prevalence was more than twofold higher in the low- than in the high-education group (23.6% vs. 11.6%, PR = 2.03) (Table II). Similarly, obesity prevalence was nearly doubled (21.9% vs. 11.9%, PR = 1.84), while lack of recreational physical activity was also markedly more common (59.5% vs. 39.3%, PR = 1.51).

In contrast, alcohol consumption at least once per week was more frequently reported among individuals with higher education (21.2%) than those with lower education (16.5%) (Table I).

An estimated 6.2 million individuals were current smokers, 5.9 million had obesity, and 16.5 million reported no recreational physical activity (Table III).

Despite representing approximately 41% of the population, individuals with low educational attainment accounted for nearly half of exposures (47-49%), indicating a disproportionate concentration of behavioral cancer risk in socioeconomically disadvantaged groups (Table II).

In a descriptive counterfactual scenario, applying the risk-factor prevalence observed in the high-education group to all educational groups would correspond to approximately 2.5 million fewer smokers, 2.1 million fewer individuals with obesity, and 4.0 million fewer individuals reporting no recreational physical activity (Table III, Figure 2). These figures should be interpreted as an illustra-

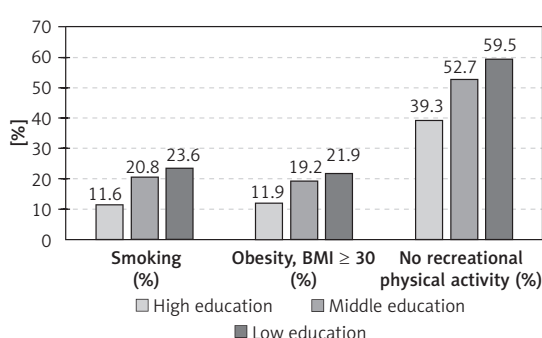


Figure 1. Socioeconomic gradients in major behavioral cancer risk factors in Poland. Prevalence of smoking, obesity (body mass index ≥ 30 kg/m²) and absence of recreational physical activity by educational attainment among individuals aged 15 years and older in Poland. Data are derived from the European Health Interview Survey (EHIS). Educational attainment was categorized as high (tertiary education), middle (secondary or post-secondary education), and low (basic vocational, primary, lower secondary, or no formal education)

Table II. Socioeconomic gradients and population distribution of behavioral cancer risk factors in Poland

Risk factor	Prevalence, high education (%)	Prevalence, low education (%)	Prevalence ratio (low vs. high education)	Estimated population exposed (millions)	Share of exposure in low education (%)
Smoking	11.6	23.6	2.03	6.2	49
Obesity (BMI ≥ 30 kg/m ²)	11.9	21.9	1.84	5.9	48
No recreational physical activity	39.3	59.5	1.51	16.5	47

Data source: Polish wave of the European Health Interview Survey (EHIS). Population aged 15 years and older living in private households. Estimated population aged 15 years and older ≈ 31.6 million. Prevalence ratios calculated as prevalence in the low-education group divided by prevalence in the high-education group. Percentages may not sum to 100% because observations with missing values were excluded from the denominator for individual variables.

Table III. Potential reduction in population exposure if educational inequalities were eliminated

Risk factor	Expected prevalence if all groups had the prevalence observed in the high-education group (%)	Current number of exposed individuals (millions)	Potential reduction in exposed individuals (millions)
Smoking	11.6	6.2	~2.5
Obesity	11.9	5.9	~2.1
Physical inactivity	39.3	16.5	~4.0

tion of the magnitude of educational inequalities in exposure distribution, rather than as estimates of directly achievable reductions through policy intervention.

Together, these findings indicate that socioeconomic inequalities are a major determinant of the overall population distribution of behavioral cancer risk factors.

Discussion

The present study does not suggest that socioeconomic gradients in smoking, obesity or physical inactivity are a new phenomenon. Rather, its contribution lies in providing an updated, nationally representative and policy-relevant description of how major behavioral cancer risk factors are distributed across educational groups in Poland. By combining prevalence estimates with national population data, the analysis illustrates not only relative differences between educational groups, but also the extent to which exposures are concentrated in the lower education group at the population level. This descriptive perspective may be useful for public health planning, particularly in settings where prevention strategies increasingly aim to address social inequalities in cancer risk.

The particularly strong gradient for smoking is in line with previous evidence from Europe. Tobacco use has long been recognized as a behavior that is socially patterned, with higher prevalence, earlier initiation, and lower cessation rates among individuals with lower socioeconomic status. These differences are not solely the result of

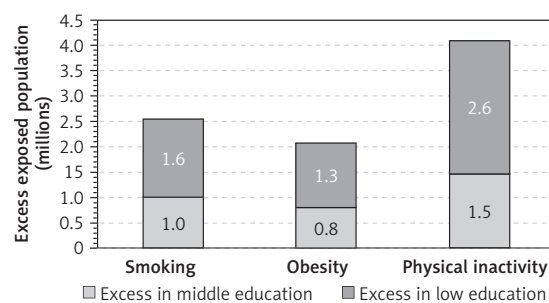


Figure 2. Population exposure to behavioral cancer risk factors attributable to educational inequalities in Poland. Estimated number of individuals exposed to smoking, obesity, and absence of recreational physical activity attributable to educational inequalities. The figure shows the excess population exposed in middle- and low-education groups compared with the prevalence observed in the high-education group. Estimates are based on prevalence data from the European Health Interview Survey (EHIS) and national population statistics. Results illustrate the concentration of behavioral cancer risk exposures among socioeconomically disadvantaged populations

individual choices but reflect broader structural factors, including differential exposure to tobacco marketing, access to cessation support, and varying responsiveness to public health policies. Consequently, smoking continues to play a major role in generating inequalities in cancer outcomes across populations [8, 9].

A similar, although slightly weaker, gradient was observed for obesity. The higher prevalence of obesity among individuals with lower educational

attainment is consistent with a large body of evidence indicating that, in high-income countries, obesity is more common in socioeconomically disadvantaged groups. This relationship has been shown to persist over several decades and across different measures of body composition. The association between socioeconomic status and obesity is complex and potentially bidirectional, with both social disadvantages contributing to weight gain and obesity affecting socioeconomic trajectories. Recent research has also highlighted multiple pathways underlying this gradient, including behavioral, environmental, psychological, and biological mechanisms. These findings support the interpretation that the observed inequalities in obesity are not solely driven by individual choices but reflect broader social and structural determinants [10, 11].

Unlike smoking and obesity, physical inactivity was highly prevalent across all educational groups, suggesting that it represents a population-wide issue rather than a risk factor concentrated primarily in disadvantaged groups. Physical inactivity did not differ as sharply as other risk factors, but a clear gradient was still present. Recreational activity was low in all groups, yet individuals with lower education were less likely to be active in their leisure time. This reflects well-known differences between domains of physical activity. Individuals with higher socioeconomic status are more likely to engage in leisure-time physical activity, which is the form most strongly associated with health benefits. In contrast, those with lower status may be more physically active at work, but this type of activity does not confer the same protective effects. This distinction is important when interpreting inequalities in physical activity and their implications for cancer prevention [12].

From a population perspective, the concentration of risk factors in the lower education group is particularly notable. Although this group represents approximately two-fifths of the population, it accounts for nearly half of all exposures to the examined risk factors in the present analysis. This disproportionate concentration of behavioral risk factor exposure suggests that reducing socioeconomic inequalities could have a substantial impact on overall population health. Previous studies have shown that socioeconomic disadvantage is itself strongly associated with premature mortality, with an effect size comparable to that of major behavioral risk factors. This underscores the importance of addressing social determinants alongside traditional prevention strategies [13]. However, the counterfactual estimates presented in this study should not be interpreted as predictions of the effects of specific interventions. Equalizing behavioral risk-factor prevalence across education-

al groups would require changes in the broader social, economic and environmental determinants that shape health behaviors. Therefore, these estimates are best understood as an indication of the scale of inequality-related exposure differences, rather than as a directly attainable reduction under any single policy scenario.

Alcohol consumption did not follow the same pattern as the other risk factors. In the present study, more frequent alcohol use was reported among individuals with higher educational attainment. This finding should be interpreted with caution, as frequency of drinking does not necessarily reflect the level of risk. Evidence suggests that individuals with lower socioeconomic status are more likely to engage in harmful drinking patterns and to experience alcohol-related health consequences, despite not always drinking more often. This phenomenon, often described as the “alcohol harm paradox,” indicates that simple measures of frequency may underestimate inequalities in alcohol-related cancer risk. For this reason, excluding alcohol from the main inequality analysis was considered justified [14, 15].

Finally, the clustering of behavioral risk factors within disadvantaged groups may have implications beyond exposure alone. There is evidence that individuals with lower socioeconomic status are less likely to participate in preventive services, including cancer screening. When combined with higher exposure to risk factors, this may contribute to widening inequalities in cancer incidence and outcomes. Addressing these disparities therefore requires a comprehensive approach that integrates risk factor reduction with improved access to prevention and early detection services [16, 17].

Several methodological limitations are related to the descriptive design of the analysis. The study did not adjust prevalence ratios for potential confounders such as age, sex, place of residence, or other socioeconomic characteristics. Therefore, the estimates should not be interpreted as independent effects of educational attainment. In addition, statistical uncertainty measures were not presented, which limits the ability to assess the precision of the estimates. Future studies using individual-level survey data should apply multivariable models and report confidence intervals to further examine these associations.

Further, key variables such as smoking, body weight, height and physical activity were self-reported and may be subject to reporting bias. In particular, body mass index derived from self-reported data may underestimate the true prevalence of obesity. The definition of physical inactivity was limited to the absence of recreational bicycling or sports activity and did not capture other domains of physical activity, including occu-

pational, household or transport-related activity. As a result, the measure should be interpreted specifically as lack of recreational physical activity rather than total physical inactivity.

Moreover, the survey includes only individuals living in private households and excludes people residing in institutional settings, which may limit the generalizability of the findings to the entire population. Apart from that, alcohol consumption in the survey reflects drinking frequency rather than harmful drinking patterns and was therefore not included in the main inequality analysis.

Finally, the counterfactual population exposure estimates are based on simplified assumptions and should be interpreted cautiously. They do not account for the structural determinants of health behaviors or for the feasibility, timing or effectiveness of specific interventions. Their purpose is illustrative: to show the scale of exposure differences associated with educational inequalities.

Despite these limitations, the use of nationally representative health survey data provides valuable insights into the socioeconomic distribution of major behavioral cancer risk factors in Poland.

This study demonstrates clear socioeconomic gradients in major behavioral cancer risk factors in Poland. Smoking, obesity and lack of recreational physical activity were consistently more prevalent among individuals with lower educational attainment, indicating a substantial concentration of modifiable cancer risk factors in socioeconomically disadvantaged groups.

These findings suggest that behavioral risk exposures relevant to cancer prevention are not evenly distributed across the population. A considerable share of these exposures occurs among individuals with lower socioeconomic status, highlighting the importance of addressing social inequalities in cancer prevention strategies.

These findings also support the need to consider educational inequalities when designing cancer prevention strategies in Poland. However, because the analysis was descriptive and cross-sectional, the results should not be interpreted as evidence of causal effects of education on behavioral risk factors or as estimates of the expected impact of specific interventions. Equity-oriented public health policies may contribute to reducing the future burden of cancer, but such efforts should address not only individual behaviors, but also the broader social and structural determinants that shape them.

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Ethical approval

Not applicable.

Conflict of interest

The authors declare no conflict of interest.

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