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Changes in the risk of severe material and social deprivation in Poland in the crisis period after 2019

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Abstract

Aim: The aim of the paper was to assess the pure influence of the most fundamental socio-economic and socio-demographic factors on severe material and social deprivation (SMSD) in Poland, identify population groups at risk of SMSD and compare the results between 2019 and 2022.

Methodology: The research was based on binomial logit models, associated marginal means and their estimation and contrast analysis.

Results: The paper revealed that, compared to 2019, the risk groups for SMSD in Poland did not change in 2022. However, the threat of SMSD significantly increased for the most vulnerable groups (unemployed, disabled, low-educated persons, persons with poor health, unmarried persons). If a person belonged to multiple risk groups according to various relevant factors, a negative synergistic effect was observed in both years, with this effect being much greater in 2022.

Implications and recommendations: The results suggest that the recent crises (health, energy, inflation) in the early 2020s have caused a significant increase in the probability of SMSD for risk groups in the Polish population. Further research will be needed to confirm the causality between the increased risk of SMSD and the crises.

Originality/value: The use of marginal means analysis and contrast analysis in the field of poverty and social exclusion is original. Through these sophisticated statistical procedures, the paper provides an in-depth analysis of the differences in the probability of SMSD between different categories of relevant factors during the years considered.

Keywords: severe material and social deprivation, Poland, binomial logit model, marginal means, probabilities

1. Introduction

Living in poverty can be understood as a condition where the material, cultural, and social resources of persons or households are so limited that they do not reach the minimally acceptable level of living standards in the given social context. Many studies, when assessing the living standards of households, primarily focus on their incomes. However, low income is not the only attribute of poverty and according to Blasco (2023), it is not possible to achieve significant targeting of deep poverty using income data only, yet adding material deprivations allows considering non-income components of a household's standard of living. The severe material and social deprivation (SMSD) rate is currently used in the EU and EFTA countries to measure non-monetary poverty. This measure is based on the concept of "enforced lack" developed by Mack and Lansley (1985) and excludes lifestyle preferences. The SMSD rate is defined as the proportion of the population experiencing an enforced lack of at least 7 out of 13 deprivation items (see Eurostat 2023a). These items are tracked as part of the EU Statistics on Income and Living Conditions (EU-SILC) survey. The SMSD indicator is part of the at-risk-of-poverty or social exclusion (AROPE) rate used to monitor progress in combating poverty and social exclusion in the Europe 2030 strategy and the 2030 Agenda for Sustainable Development.

According to Lafortune et al. (2024), at the current pace of development, it is unlikely that the EU will achieve one third of the Sustainable Development Goals by 2030. Moreover, significant differences exist among European countries, with countries in Central and Eastern Europe potentially failing to achieve up to half of the goals. The authors highlighted stagnation and regression in the area of social goals, mainly due to growing poverty and material deprivation, which is at least partially attributed to multiple crises since 2020. The statement that the COVID-19 pandemic, high levels of inflation, and the impact of the Russian military aggression against Ukraine have negatively affected the social situation was also supported by Eurostat (2023a). It appears that the negative impacts were more pronounced in 2022, as according to Eurostat (2023b), in the area of multidimensional poverty, trends in the 2016-2021 period showed that fewer people were affected by severe material and social deprivation by the end of the period. Most of these improvements occurred up to 2019, while the SMSD rate remained fairly stable in 2020 and 2021. Poland, the focus of this paper, was among the countries that made significant progress in combating poverty and social exclusion in the period 2016-2021. In 2022, Poland recorded an SMSD rate of 2.8%, which was the 9th lowest value among EU countries and by 3.9 percentage points (p.p.) lower than the EU average. However, this relatively positive result for the entire population of Poland may overshadow the worsening situation in vulnerable population groups.

According to Menyhert (2023), recent inflation had negative welfare and social effects, which were, however, very unevenly spread across Northern Europe. Most households in Nordic countries experienced relatively small changes in their living expenses, as well as in the risk of poverty and/or social exclusion, whereas the Baltic countries saw a 30% increase in living expenses, and up to a third of their population may potentially face financial constraints, material and social deprivation, and energy insecurity. According to the Vidal and Villani (2022), the year-on-year inflation rate in Poland in March 2022 (11.0%) was comparatively high to that of Lithuania (11.5%), although it is worth mentioning that in Lithuania inflation was significantly higher for food and non-alcoholic beverages, but lower for housing-related items. Therefore one can assume that similarly to Lithuania, inflation in Poland also had a significant impact on material and social deprivation.

The above prompted the authors to analyse the impact of crises that Europe faced (and may still be facing) after 2019 on non-monetary poverty in Poland, hence the study focused on estimating the probability of SMSD for various population groups in Poland in 2019 and 2022. The aim was to assess the pure influence (by fixing the influence of other relevant factors) of the most fundamental socio-economic and socio-demographic factors on SMSD in Poland, identify population groups at risk of SMSD, and compare the results between the observed years. These objectives and the aforementioned situation led to formulating the following research questions:

RQ1: Did the groups of the Polish population that were most at-risk in terms of SMSD in 2019 remain as such in 2022, or did the crises after 2019 make other population groups most at-risk?
RQ2: Did the risk of SMSD among the Polish population increase during the crisis period after 2019?
RQ3: Which population groups in Poland experienced a significant increase in the risk of SMSD after the events of 2019?

2. Literature review

Monitoring poverty in EU countries relies on three indicators: the relative poverty indicator, the very low work intensity indicator, and the severe material and social deprivation (SMSD) indicator. According to Dudek (2019), and Łuczak and Kalinowski (2020), SMSD is a particularly important indicator for analysing absolute poverty because it does not compare poverty in relation to other households in the given country, which allows for better comparability of living conditions between countries. The paper analysed this dimension of poverty and social exclusion using logistic regression, which is a very popular method employed by many authors dealing with similar issues, including Dudek and Szczesny (2021), Dutta (2021), Fabrizi et al. (2023), Tøge and Bell (2016), and Verbunt and Guio (2019). Unlike those, this paper was based on an analysis of marginal means and a contrast analysis linked to the logit model, allowing for a more in-depth analysis of the differences between the various categories of relevant factors.

In selecting the factors to be included in the model, the authors relied on the results of his previous research and on other scientific studies. For instance, Verbunt and Guio (2019) revealed that household work intensity and educational attainment are key factors of severe material deprivation, while demographic characteristics of households, such as household type, age, and gender of the household head, most significantly influence income poverty. Fabrizi and Mussida (2020) found that structural characteristics of households are important determinants in assessing the state of poverty, showing that households with a larger number of children have a higher probability of falling into poverty. Chen et al. (2019) identified correlations between multidimensional poverty and factors such as marital status, age, and household size. Munoz Boudet et al. (2021) reached a similar conclusion, finding that demographic characteristics e.g. gender, age, and household type also influence the state of poverty.

Several studies showed that Poland has made significant progress in reducing the incidence of poverty and material deprivation (MD) over the past decade. Guio et al. (2021), based on a measure of LB ('left behind'), quantified that between 2013-2017, Poland significantly reduced the LB rate for the deprivation indicator among EU countries. Ciacci and Traversa (2021) performed a non-compensatory

time analysis of MD in Europe and found that in 2019, Poland demonstrated one of the most effective results in combating material deprivation. The measures implemented to address high levels of deprivation in 2005 led to an improvement in Poland's ranking by eight positions in 2019. Sedefoğlu and Dudek (2024) revealed that between 2015-2022, Poland – similarly to Slovenia, Czechia, Cyprus, and Italy – significantly improved its position in the EU rankings for severe material and social deprivation, achieving the 9th best SMSD status in 2022.

Since the methodology for measuring material deprivation changed quite recently (in 2021) from the severe material deprivation (SMD) indicator to the severe material and social deprivation (SMSD) indicator, there are still few studies that analyse SMSD. In addition to those aforementioned, Sedefoğlu and Dudek (2024), Fabrizi et al. (2023) and Mysíková (2021) also dealt with severe material and social deprivation in terms of tracking 13 items. Mysíková (2021) found that in 2018 in the V4 countries, the SMSD rate was approximately twice as high as the SMD rate.

This study is not just a supplement to the research on SMSD, but also aimed to provide a relevant, albeit not exhaustive, perspective on the impact that a series of global events which adversely affected the social situation of Europeans had on deprivation in Poland.

3. Data and methods

The analysis compared SMSD in 2019 and 2022. The year 2019 preceded a series of events (the COVID-19 pandemic, the Russian invasion of Ukraine, and inflation) that adversely affected the social situation in Europe, particularly in Poland. The authors assumed that by 2022, the adverse effects of these events had fully manifested themselves. Additionally, the most recent data from the EU-SILC survey, available for 2022, served as the dataset for the research. The statistical unit employed was a person, to whom, in addition to their socio-demographic characteristics, data about the household in which they lived were also assigned. The results presented in the paper were based on data for 42,377 persons in households from the EU-SILC 2019 survey and 40,556 persons in households from the EU-SILC 2022 survey in Poland, with microdata provided by Eurostat.

The definition of the target variable SMSD was given by the methodology used by Eurostat (see Eurostat 2023a) to monitor severe material and social deprivation. A person living in an SMSD household in the reference year was assigned a value of "Yes" or "No". The paper analysed SMSD in Poland in 2019 and 2022 using a binomial logit model with explanatory variables: EAS (RB211 – Main economic activity status), Education (PE041 – Educational attainment level), Health (PH010 – Self-perceived general health), Marital status (PB190 – Marital Status), HT (HX060 – Household type), Age (RX020 – Age at the end of the income reference period), Urbanisation (DB100 – Degree of urbanisation), Gender (RB090 – Sex). The paper primarily focused on the first four (most important) explanatory variables, as defined in Table 1. Definitions of the others can be found in the guidelines issued by the European Commission (2022). It is worth noting that the Age variable was divided into six age categories (up to 30 years, 30-40, 40-50, 50-60, 60-70, 70^{+} years).

Table 1. Description of input explanatory variables

Original variables (EU-SILC) – categories and description	Names of new dummy variables
RB211 – Main economic activity status (self-defined)	EAS
Employed	At_Work
Unemployed	Unemployed
Retired	Retired
Unable to work due to long-standing health problems	Disabled
Student, pupil	Student
Fulfilling domestic tasks	Person_in_HH
Other	Other

Original variables (EU-SILC) – categories and description	Names of new dummy variables
PE041 – Educational attainment level (ISCED)	EDUCATION
No formal education or below ISCED 1	ISCED 0-2
Primary education (ISCED 1)	
Lower secondary education (ISCED 2)	
Upper secondary education (ISCED 3)	ISCED 3-5
Post-secondary (not tertiary) education (ISCED 4)	
Short cycle of tertiary education (ISCED 5)	
Bachelor's or equivalent level (ISCED 6)	ISCED 6-8
Master's or equivalent level (ISCED 7)	
Doctoral or equivalent level (ISCED 8)	
PH010 – Self-perceived general health	HEALTH
Very good	Good
Good	
Fair (neither good nor bad)	Fair
Bad	Bad
Very bad	
PB190 – Marital Status	MARITAL STATUS
Never married	Unmarried
Married	Married
Separated	Separated
Widowed	Widowed
Divorced	Divorced

Source: own elaboration based on EU-SILC data and European Commission (2022).

From the set of explanatory variables listed in Table 1, the authors selected those factors that significantly affect SMSD using the stepwise regression method (see Wooldridge, 2016). The presented research results were based on a binomial logit model

$$\eta_i = \text{logit}(p_i) = ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik}, \quad (1)$$

where $\beta_j (j = 0, \ldots, k)$ are the unknown model parameters estimated using an iterative maximum likelihood method (see Allison 2012) and p_i represents the probability of SMSD for the *i*-th individual. Logistic regression falls into a broad class of generalised linear models (GLM, see Agresti, 2015). A deeper analysis of the influence of continuous numerical variables, but especially categorical explanatory factors, on the target variable can be conducted through marginal means (also known as LS Means – Least Squares Means), whose estimation is based on GLM, and through contrast analysis and estimates of linear combinations of model parameters. A more detailed discussion of marginal means estimation and its advantages over classical arithmetic means is provided by, for example, SAS Institute Inc. (1997), Suzuki et al. (2019), and Wang et al. (2018).

The study also employed contrast analysis (see Dean et al., 2017; Kim & Timm 2006; Schad et al., 2020). Through this analysis, the authors tested the general linear hypothesis (GLH) $H_0: \mathbf{L\beta} = \mathbf{0}$, where $\boldsymbol{\beta}$ is the vector of the model parameters (1) and $\mathbf{L}$ is the contrast matrix (see Littell et al., 2010; Searle & Gruber, 2017). In logistic regression, the GLH was tested using the Wald test statistic

$$\chi^2_W = \left(\mathbf{L}\widehat{\boldsymbol{\beta}}\right)^T \left(\mathbf{L}\mathbf{S}_{\widehat{\boldsymbol{\beta}}}\mathbf{L}^T\right)^{-1} \mathbf{L}\widehat{\boldsymbol{\beta}}, \quad (2)$$

where $\mathbf{S}_{\widehat{\boldsymbol{\beta}}}$ is the covariance matrix of the vector of the parameters estimates of the model (1). Wald statistic (2) has an asymptotically chi-square distribution, which has *l* degrees of freedom, where *l* is the rank of the matrix $\mathbf{L}$. In the case of testing one linear combination, it has 1 degree of freedom and for a simultaneous test of *l* linear combinations, it has *l* degrees of freedom (see Littell et al., 2010).

An important part of the presented analysis was the estimation of the probability of SMSD for different groups of persons. Point estimates of probabilities derived from the logistic model (1) are given by the equation

$$\hat{p}_i = \frac{1}{1+exp(-\hat{\eta}_i)}. \quad (3)$$

The limits of the $100 \times (1-\alpha)\%$ confidence interval were calculated according to the formula

$$\frac{1}{1+exp\left[-\hat{\eta}_i \pm z_{1-\frac{\alpha}{2}}\hat{\sigma}(\hat{\eta}_i)\right]}, \quad (4)$$

where $z_{1-\frac{\alpha}{2}}$ is the quantile of the standard normal distribution and $\hat{\sigma}(\hat{\eta}_i)$ is the standard error of the estimate $\hat{\eta}_i$ (see SAS Institute Inc. 2020).[1] η_i is the logit defined by equation (1), and the interval estimate of the logit is presented in square brackets in equation (4). While equation (3) transforms the point estimate of the logit into a point estimate of the probability, equation (4) transforms the interval estimate of the logit into an interval estimate of the probability.

4. Results

4.1. Relevant factors and quality of logit models

Based on the stepwise regression method, explanatory variables expressing economic activity, health status, education and marital status were included in both models within the first four steps (Figure 1). This confirmed that in 2022 and 2019, SMSD was most influenced by these four factors.

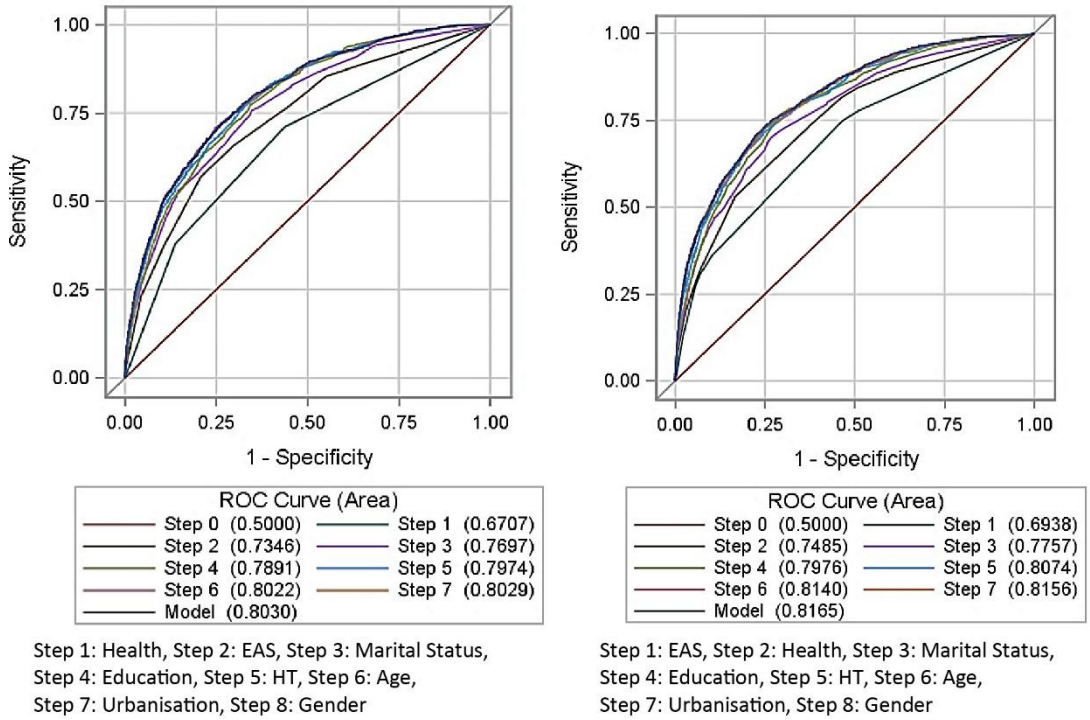

Fig. 1. ROC curves for all model building steps in 2019 (left) and 2022 (right)

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

[1] This paper utilised marginal mean analysis using the LSMEANS statement within PROC LOGISTIC (SAS Institute Inc., 2020) in the SAS programming language. Contrast analysis was carried out using the CONTRAST statement. Point and interval estimates of SMSD probabilities were obtained using the ESTIMATE option within the CONTRAST statement. The EFFECTPLOT statement was used for their visualisation.

Table 2. Verification of the significance of the factors' influence on the probability of SMSD in 2019 and 2022

Type 3 Analysis of Effects						
Effect	2019			2022		
	DF	Wald Chi-Square	Pr > ChiSq	DF	Wald Chi-Square	Pr > ChiSq
EAS	3	292.8732	<.0001	6	354.6250	<.0001
Health	2	306.5423	<.0001	2	233.1488	<.0001
Education	2	196.1075	<.0001	2	200.3209	<.0001
Marital Status	4	180.1945	<.0001	4	128.6772	<.0001
HT	9	111.2530	<.0001	9	114.0124	<.0001
Age	5	91.2567	<.0001	5	107.5481	<.0001
Urbanisation	2	5.0306	0.0808	2	8.0196	0.0181
Gender	1	0.1279	0.7206	1	4.2555	0.0391

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

There was also a significant impact of household type and age. In 2022, at a significance level of 0.05, SMSD was demonstrably determined also by the degree of urbanisation of the area where the person lived and the gender. Based on the ROC curve (Figure 1) and the AUC (area under curve) characteristic, the study found that the model for 2022 was slightly better, as its prediction accuracy was 81.7%, i.e. 1.4 p.p. higher than in 2019.

The following sections focus solely on the four most significant factors: EAS, Health, Education, and Marital status. As seen in Figure 1, the model with these factors achieved a prediction accuracy of 78.9% in 2019 and 79.8% in 2022, whilst in both years the other factors contributed less than 1 p.p. to the model's accuracy.

4.2. Analysis of marginal means and estimation of SMSD probabilities

From the logistic models with explanatory variables listed in Table 2, the analysis of marginal means depicted in Figure 2 and the estimates of SMSD probabilities provided in Table 3 emerged. Figure 2 shows 95% confidence intervals of marginal means of the logits (on the left *y*-axis). These interval estimates were defined based on the rule given in square brackets of relation (4). By the transformation according to formula (4), one can then obtain confidence intervals of the SMSD probabilities. These interval estimates (as well as point estimates) are presented in Table 3. Moreover, each diffogram (Figure 2) illustrates which pairs of categories (the grid between the categories on the *x*-axis and those on the right *y*-axis) of the respective factor exhibit a statistically significant difference (blue line) in the marginal means of the logits at the 0.05 significance level.

Based on Figure 2 and Table 3, it became evident that in both years the most at-risk were unemployed persons, who had a SMSD probability of up to 22.7% in 2022, which was 7.3 p.p. higher than in 2019 and 12.3 p.p. higher than those in the second most at-risk group in 2022. Disabled persons had a significantly lower probability of SMSD at the 0.05 significance level compared to unemployed persons (Figure 2), but a significantly higher probability than employed persons. In 2022, this probability approached 8%, which was 1.6 p.p. higher than in 2019. The probability of SMSD for employed persons remained comparable in both years, at approximately 3.6%. The difference in the probability of SMSD between employed persons and retired persons was insignificant in both assessed years. In 2022, students also did not significantly differ from these two groups (students were not separately monitored in 2019). In the same year, there was also no significant difference in the probability of SMSD for disabled persons, persons in the household, and other persons.

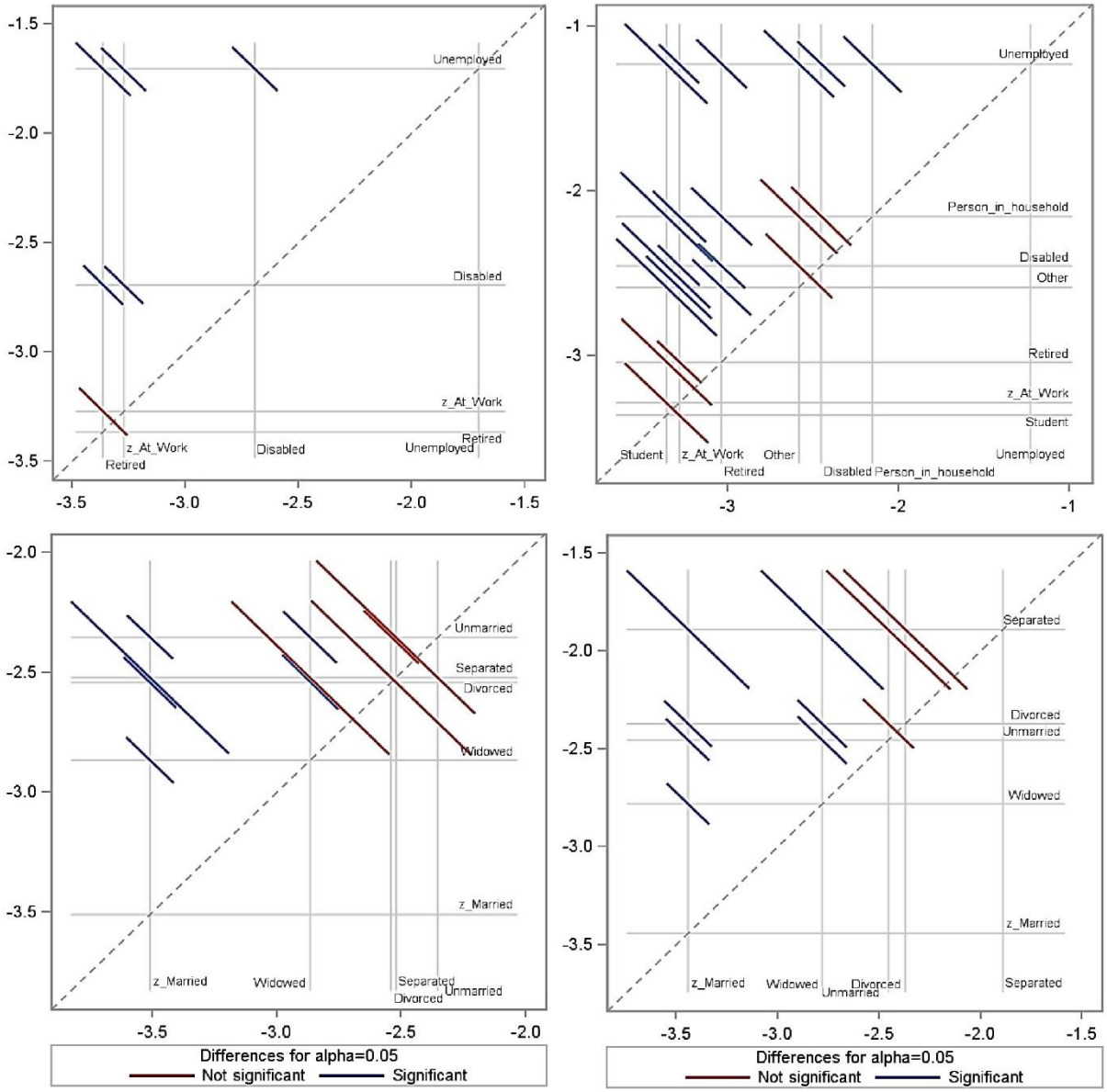

Fig. 2. Comparison of marginal mean logits of SMSD probabilities for various economic activity statuses (top) and marital statuses (bottom) in 2019 (left) and 2022 (right)

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

Among all the three categories of self-assessed health status, significant differences were evident in both years (for this reason a diffogram for this factor was not presented). Poorer self-assessed health was associated with a significantly higher probability of SMSD. Similarly to economic activity status, in terms of health, the least at-risk group (good health) had a comparable probability of SMSD in both 2019 and 2022 (approximately 3%, see Table 3). In the most at-risk group (poor health), this probability increased by 2 p.p. in 2022, reaching 13.7%.

A similar phenomenon was observed regarding education (similarly to the previous factor, the diffogram was not shown). The probability in the least at-risk group (tertiary education) increased slightly in 2022 compared to 2019 (by less than 0.5 p.p.). However, in the most at-risk group (persons with ISCED 0-2 education), this probability increased by 3 p.p., reaching 15.7% in 2022. It should be noted that in both years there were significant differences among all the three educational categories, indicating that even an increase in education by one level significantly reduces the risk of SMSD.

Table 3. Point and 95% interval estimates of the probabilities of SMSD for each category of the assessed factors in 2019 and 2022

Factor/categories		2019				2022			
		Estimate	Standard Error	Confidence Limits		Estimate	Standard Error	Confidence Limits	
EAS	Unemployed	**0.1537**	0.0153	0.1260	0.1862	**0.2265**	0.0224	0.1856	0.2735
	Person in HH	N/A	N/A	N/A	N/A	**0.1039**	0.0155	0.0772	0.1384
	Disabled	**0.0633**	0.0057	0.0530	0.0755	**0.0791**	0.0094	0.0625	0.0995
	Other	N/A	N/A	N/A	N/A	**0.0700**	0.0124	0.0492	0.0987
	Retired	**0.0334**	0.0036	0.0272	0.0411	**0.0457**	0.0053	0.0363	0.0573
	Employed	**0.0365**	0.0035	0.0302	0.0441	**0.0359**	0.0036	0.0294	0.0438
	Student	N/A	N/A	N/A	N/A	**0.0335**	0.0078	0.0212	0.0525
Health	Bad	**0.1165**	0.0101	0.0981	0.1378	**0.1369**	0.0126	0.1139	0.1636
	Fair	**0.0578**	0.0053	0.0483	0.0690	**0.0722**	0.0068	0.0599	0.0867
	Good	**0.0305**	0.0028	0.0254	0.0365	**0.0333**	0.0033	0.0274	0.0404
Edu-cation	ISCED 0-2	**0.1278**	0.0097	0.1099	0.1481	**0.1574**	0.0125	0.1345	0.1833
	ISCED 3-5	**0.0748**	0.0055	0.0647	0.0864	**0.0816**	0.0065	0.0698	0.0953
	ISCED 6-8	**0.0210**	0.0031	0.0157	0.0281	**0.0249**	0.0037	0.0186	0.0333
Marital status	Separated	**0.0742**	0.0221	0.0409	0.1310	**0.1311**	0.0349	0.0764	0.2158
	Divorced	**0.0730**	0.0070	0.0605	0.0880	**0.0855**	0.0092	0.0690	0.1054
	Unmarried	**0.0868**	0.0065	0.0749	0.1004	**0.0791**	0.0070	0.0665	0.0939
	Widowed	**0.0538**	0.0048	0.0451	0.0641	**0.0583**	0.0058	0.0480	0.0707
	Married	**0.0290**	0.0020	0.0253	0.0331	**0.0310**	0.0024	0.0266	0.0361

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

The analysis of marital status indicates that being married was associated with the lowest risk of SMSD, and in both 2019 and 2022, it was at approximately the same level of about 3% (Table 3). Significantly higher probabilities of SMSD (Figure 2) were observed for widowed persons (approximately 5.5%). No statistically significant differences in SMSD probabilities were found between the other marital status groups (Separated, Divorced, Unmarried), as confirmed by Figure 2 and the overlaps of the respective 95% confidence intervals presented in Table 3. The equality of the marginal means of SMSD logits for the above three marital statuses for 2019 ($p = 0.2490$) and 2022 ($p = 0.1849$) was confirmed by Table 4. Across these three most at-risk marital statuses, under the condition of ceteris paribus, the probability of SMSD was estimated at 7.8% in 2019 and 9.6% in 2022 (Table 5).

Table 4. Verification of the equality of the marginal mean logit probabilities of SMSD for the marital statuses (Separated, Divorced, and Unmarried) in 2019 and 2022

Contrast Test Results					
Year		2019		2022	
Contrast	DF	Wald Chi-Square	Pr > ChiSq	Wald Chi-Square	Pr > ChiSq
Separated=Divorced=Unmarried	2	2.7804	**0.2490**	3.3756	**0.1849**

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

Table 5. Point and interval (95%) estimates of SMSD probabilities across the marital statuses Separated, Divorced, and Unmarried in 2019 and 2022

Contrast Estimation and Testing Results by Row						
Year	2019			2022		
Contrast	Estimate	Confidence Limits		Estimate	Confidence Limits	
Separated-Divorced-Unmarried	**0.0778**	0.0621	0.0970	**0.0964**	0.0770	0.1199

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

The study then focused on the interaction of the three most important factors, i.e. EAS, Health, and Education in both years. As shown by previous analyses, Figure 3 also confirmed that unemployed persons faced the highest risk of SMSD. Figure 2 revealed that significantly lower SMSD probabilities were observed in 2022 for persons in the household, disabled persons, and those classified under the "other" economic activity status, among whom no significant differences were found. This was also evident in subpopulations characterised by different health statuses (Figure 3). Retired persons, students, and employed persons consistently exhibited the lowest probabilities. Based on Figure 3, it was evident that as educational attainment increases, the probability of SMSD significantly decreases across all the economic activity statuses, health statuses, and for both assessed years. When comparing Figure 3 top left to Figure 3 bottom left, one can observe that persons with poor health status had significantly higher probabilities of SMSD in 2019 compared to those with good health. These differences further increased in 2022, as confirmed by the comparison of Figure 3 top right to Figure 3 bottom right.

The most vulnerable group in both 2019 and 2022 comprised naturally unemployed persons with low education levels (ISCED 0-2). For such persons, the probability of SMSD was 42.1% in 2022, approximately 12.5 p.p. higher than in 2019. However, if unemployed persons with ISCED 0-2 education additionally reported poor health status, the respective probability in 2022 (Figure 3 top right) reached 60.6%, i.e. nearly 14 p.p. higher than in 2019 (Figure 3 top left). On the other hand, if unemployed persons with ISCED 0-2 education enjoyed good health, their probability of SMSD in 2022 (Figure 3 bottom right) reached 25.0%, i.e. 7.8 p.p. higher than in 2019 (Figure 3 bottom left).

In the case of employed persons, one can observe significantly smaller differences in the probability of SMSD between 2019 and 2022. Employed persons with the lowest education level (ISCED 0-2) had, in both these years, a 16% probability of SMSD regarding poor health and a 5% probability of good health. Employed persons with the lowest education level (ISCED 0-2) had comparable probability of SMSD to unemployed persons with tertiary education (ISCED 6-8).

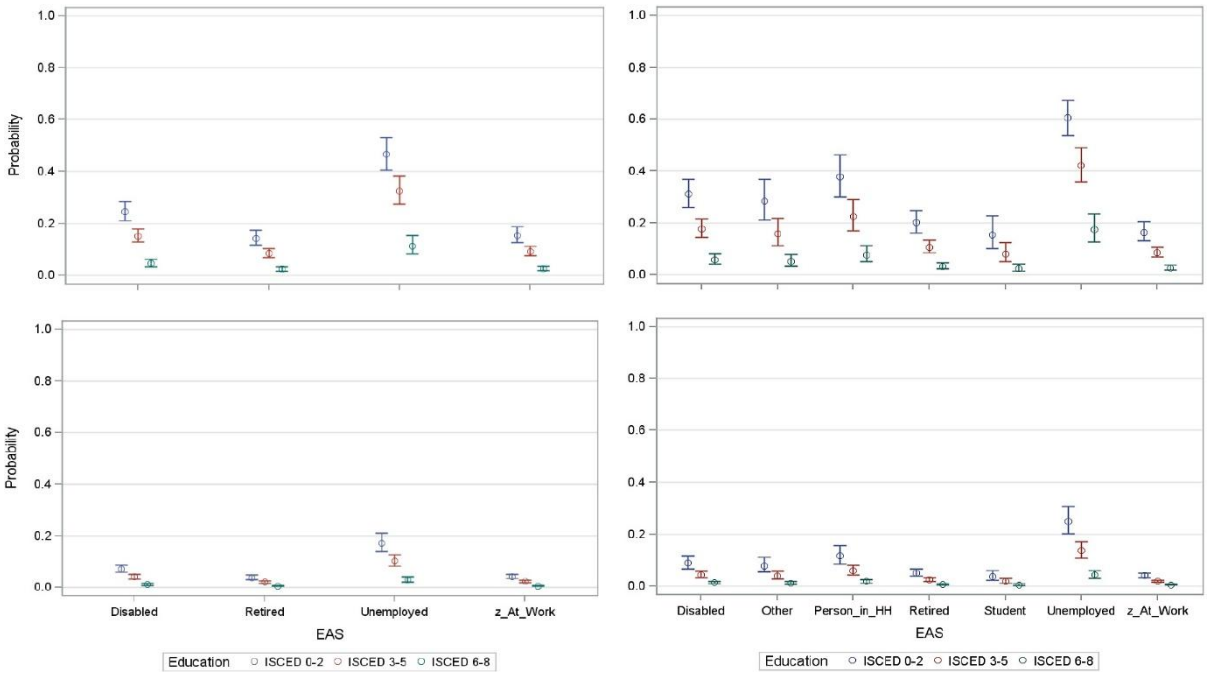

Fig. 3. Point and interval (95%) estimates of SMSD probabilities depending on economic activity and education for persons with poor health (top) and for persons with good health (bottom) in 2019 (left) and in 2022 (right)

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

This example not only demonstrates the significant impact of health status but also how recent adverse events profoundly influenced the societal situation in Europe, including Poland, disproportionately affecting vulnerable population groups. Table 6 demonstrates that the hypothetical gap between 2019 and 2022 significantly widened for the population group most at risk based on the four most relevant indicators considered in the analyses (see Table 3), and refers to unemployed and divorced, separated, or unmarried persons with education level ISCED 0-2 and poor health. For such persons the estimated probability of SMSD for 2022 was as high as 68.5%, approximately 14.7 p.p. higher than in 2019. Even greater disparities between 2022 and 2019 were found for disabled persons.

Table 6. Estimates of SMSD probability for the most vulnerable persons categorised by their economic activity in 2019 and 2022

EAS	2019			2022		
	Estimate	95% Confidence Limits		Estimate	95% Confidence Limits	
Unemployed	0.5381	0.4622	0.6122	0.6853	0.6103	0.7518
Disabled	0.3024	0.2504	0.3600	0.3896	0.3202	0.4638
Employed	0.1955	0.1536	0.2457	0.2171	0.1688	0.2746
All EAS Total	0.2889	0.2387	0.3449	0.3585	0.2986	0.4232

Source: EU-SILC 2019 and 2022, own processing in SAS EG.

When discussing disabled persons, their probability of SMSD was approximately 2.5 times lower in 2019 and 2022 compared to unemployed persons, reaching 6.3% in 2019 and 7.9% in 2022 (Table 3). Disabled persons with the lowest education level (ISCED 0-2) had an SMSD probability of 17.6% in 2022, which was 4.1 p.p. lower than in 2019. Moreover, if these persons were in poor health, their SMSD probability reached 24.6% in 2019 (Figure 3 top left) and up to 31.0% in 2022 (Figure 3 top right). Disabled persons who belong to the most vulnerable groups across all the four considered factors had even significantly higher respective probabilities, specifically 30.2% in 2019 and 39.0% in 2022 (Table 6).

Employed persons along with retirees, whose pension somewhat shields them from the threat of SMSD, had the lowest probability of SMSD in both years. If employed persons had only low education (ISCED 0-2), the probability of SMSD in both observed years did not exceed 10% (8.5% in 2022 and 8.1% in 2019). However, if it was additionally a person with poor health status (Figure 3 top left and top right), the respective probability was approximately 16% in both years (15.4% in 2019 and 16.4% in 2022). Moreover, if all the four profile parameters were negative, the probability of SMSD for employed persons was approximately one-fifth, reaching 19.6% in 2019 and even 21.7% in 2022 (Table 6).

5. Discussion and conclusions

Economic activity status, health condition, highest education attainment, marital status, age, and household type were factors that significantly influenced the risk of severe material and social deprivation (SMSD) among the population of Poland in 2019 and also in 2022. In 2022, population density and gender were added to these factors, whose significance was not confirmed in 2019. In the context of other findings, this finding is consistent with the hypothesis that social and economic inequalities increased due to multiple crises after 2019. The identified relevant predictors largely corresponded to those revealed by Grzybowska et al. (2023). Based on EU-SILC 2020 using machine learning methods, they found that essential characteristics affecting the occurrence of material deprivation among Polish households are the age and level of education of household members, household type, presence of disabled or unemployed persons in the household, and urbanisation. These predictors ensured high accuracy of the logit models in predicting the occurrence of SMSD for 2019 and 2022 (accuracy above 80%).

This paper focuses on the impact of four factors that contributed most significantly to the predictive power of the models, which include economic activity status, health, education, and marital status. Similar conclusions were drawn by Dudek and Szczesny (2021), who identified education, health, and economic activity status as the most significant factors influencing the risk of material deprivation in Polish households in 2015 and 2017. Similarly, Bedük (2018) demonstrated that these three factors, along with marital status, determined the risk and level of material deprivation in several EU-25 countries.

It is not surprising that in both years the study found the highest probability of SMSD among unemployed persons (22.7% in 2022 and 7.3 p.p. lower in 2019). Disabled persons had a SMSD probability of 7.9% in 2022 and 1.6 p.p. lower in 2019. Both in 2019 and 2022, the SMSD probability for disabled persons was significantly lower than for the unemployed but significantly higher than for the employed or retired, among which statistically significant differences were not confirmed. In both years, with an increase in education, the risk of SMSD decreased significantly. Even in terms of this factor, the probability of SMSD for the most at-risk group (education ISCED 0-2) increased in 2022, reaching 15.7% (an increase of 3.0 p.p. compared to 2019). Low education was also identified as a significant risk factor for social exclusion in other European countries by González et al. (2021), Sánchez-Sellero and Garcia-Carro (2020). With deteriorating health status, the probability of SMSD increased, with persons who rated their health as poor having a 13.7% probability of SMSD in 2022, which was 2.0 p.p. higher than in 2019. For the least risky groups across all the three factors (employed, tertiary education, good health), the authors quantified a comparable probability of SMSD in both years at around 2-3%. The synergistic effect of these three factors was significant in both years, particularly in 2022, when the estimated probability of SMSD for unemployed persons with low education and poor health was 60.6%, approximately 14 p.p. higher than in 2019. Regarding marital status, no significant difference was confirmed between separated, divorced, and unmarried persons, and for this cluster of the most risky marital statuses, the study quantified the probability of SMSD to be 9.6% in 2022, 1.8 p.p. higher than in 2019. In both years, married persons had the lowest threat of SMSD, similar to the least risky categories of the other factors (economic activity status, education, health), with a probability of SMSD at around 3%. These findings are consistent with Lee and Cagle (2018), who stated that better health status and being partnered reduce social exclusion.

Based on the findings obtained through the analysis of marginal means and contrast analysis derived from logit models, one can provide relatively clear answers to the research questions: 1) in 2022, compared to 2019, the most at-risk population groups in Poland in terms of SMSD did not change, and the most at-risk groups remained unemployed persons, persons with low education, persons in poor health and persons with a marital status of separated, divorced and unmarried; 2) and 3) in 2022, the risk of SMSD significantly increased for the most at-risk groups (unemployed, disabled, low-educated persons, persons with poor health, unmarried persons), however this does not apply to the least risky groups. If a person belonged to risk groups according to multiple relevant factors, a synergistic negative effect was observed in 2022, leading to an even more pronounced increase in the probability of SMSD compared to 2019. The results suggest that recent negative events (particularly the lingering impacts of the COVID-19 pandemic, historically high energy prices due to the Russian invasion of Ukraine, inflation crisis) have caused a significant increase in the probability of SMSD for risk groups in the Polish population. The actual gap between high-risk groups of the Polish population and less vulnerable groups of the population from the perspective of SMSD has widened significantly since 2019. However, this analysis does not show what impact the individual negative events after 2019 had on this widening gap and revealed only the resulting joint effect of all these events. Further research will be needed to quantify the partial effects of individual crises after 2019.

Unlike other studies focusing on severe material and social deprivation, this study, using a contrast analysis of marginal means, demonstrated which categories of relevant factors have a significant difference in the probability of SMSD. The study does not only provide an estimate of the probability of SMSD for individual categories of relevant factors, but also for groups of people who are determined by multiple factors, thus providing new information useful for social policy. However, there are some limitations related to the target variable as well as the explanatory variables as the authors focused

'only' on the presence or absence of severe material and social deprivation, and therefore there is room for research on the depth of deprivation. Since Poland, like many other countries, is characterised by significant regional differences in the area of social exclusion (Ćwiek et al., 2020), it is necessary to pay attention to this aspect in further research. Due to the limited microdata available, it was not possible to investigate these disparities.

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