“The influence of health insurance on coverage of a country’s population with medical services”

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THE INFLUENCE OF HEALTH INSURANCE ON COVERAGE OF A COUNTRY'S POPULATION WITH MEDICAL SERVICES

Abstract

One of the effective ways to increase the level of population coverage with medical services is health insurance. The paper aims to determine what type of health insurance (compulsory, social, or voluntary) has the greatest impact on a country's ability to provide large-scale and timely medical services to citizens, as measured by the number of unmet needs for medical examination, treatable and preventable mortality. The control variables included a country's population size, the level of economic well-being, and the scale of the public health system (number of doctors and hospital beds) based on EUROSTAT data for all 27 EU countries in 2012–2021. Modelling (regression models of panel data with fixed and random effects in STATA 18, Wald test, Hausman test, Breusch and Pagan test) proved that only one of three researched types of insurance – voluntary health insurance – positively influences a country's ability to provide large-scale and timely medical services to citizens: an increase in its volume by 1% leads to a decrease in unmet needs in medical examination on average across all EU countries by 0.26%, treatable mortality rate by 0.08%, preventive mortality rate by 0.27%. The influence of the other two types – compulsory and social – was not confirmed (received regression coefficients for these variables are not statistically significant). This emphasizes the importance of citizens' conscious attitude to their health (due to the increase in voluntary health insurance) both in strengthening public health and in ensuring faster and better access to medical services.

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INTRODUCTION

Global targets for universal health coverage are a public health priority. This is stated in the Sustainable Development Goals, particularly Goal 3, "Good Health and Well-Being," which aims to ensure the healthy lives of people of all age groups and should contribute to increasing the level of well-being and quality of life.

The importance of this direction of public policy is determined by many prerequisites, challenges, and reasons, including the high mortality rate of the population from many types of fatal diseases, the emergence of new strains of deadly viruses, etc., which ultimately affects the demographic, social and economic indicators of a country. There are mutual cause-and-effect relationships between the achievement of SDG 3 and other SDG covering aspects of economic growth, overcoming poverty, ensuring affordable housing and satisfactory housing and sanitary conditions, education, building a safe environment in cities, environment protection, etc.

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Both the coverage of medical services for the population in general (meeting medical needs in inpatient and outpatient care, surgical interventions in various areas of service provision, etc.) and levels of access to quality health care, unmet needs for medical examination, treatable mortality and preventable mortality are unsatisfactory in many countries of the world, including not only developing countries, low-income countries, etc. but also highly developed countries. This indicator varies from country to country. Even within the EU, this level differs significantly depending on the studied indicators and the influence of a number of internal and external factors. The COVID-19 pandemic and other crises and global challenges (wars, natural disasters, anthropogenic disasters) were and remain restraining factors in improving the health of the population. Inequalities in access to health care still exist, despite significant advances in health care delivery in the context of the digitalization of health care and many international humanitarian missions.

One of the efficient ways to strengthen public health and to increase the level of the coverage of a country's population with medical services is health insurance. However, the implementation of different health insurance schemes and their financing by different sources can give different results and benefits. These expected effects of compulsory, social, and voluntary health insurance are not always justified in practice and, therefore, require empirical confirmation. The above determines the relevance of the chosen topic of scientific research.

1. LITERATURE REVIEW

One of the vectors of scientific development on the researched problem is limiting social security and medical care and ways to improve them, including through health insurance (Gentle, 2023). The medical system and the social protection system function under numerous challenges, which actualize the inclusiveness of social protection through the introduction of microsocial insurance (Ignatyuk et al., 2023).

The COVID-19 pandemic strengthened even more challenges for healthcare systems and transformations both during and after the pandemic (Kostenko et al., 2023; Bianco-Mathis & Burrell, 2023; Jatav et al., 2023).

Healthcare determinants include institutional, social, economic, and behavioral ones (Lyeonov et al., 2021a; Pozovna et al., 2023).

Kuzior et al. (2022b) described the interaction between health insurance, public health financing, and household income, while Zhuchenko et al. (2023) provided affordable housing and links with mortality from socially dangerous diseases. The factor of healthcare financing has a restraining effect, which determines the need for the development of health insurance (Mugo, 2023).

Mańak-Szulik et al. (2023) studied the health insurance market using Ukraine as an example. The object of the research is the time series of gross insurance premiums on health insurance for forecasting the dynamics of gross insurance premiums in conditions of instability and crisis.

Insurance companies are in a unique position due to their ability to assess and mitigate risk, providing comprehensive coverage and assistance in the event of unforeseen events (Hizia, 2023). In turn, health insurance is crucial for the efficiency of the state's work; it reliably protects health and ensures high productivity (Koibichuk et al., 2023).

In scientific circles, attention is also paid to the positive influence of the insurance market and key indicators of its development on the level of financial security, and economic and social stability of society, because it is precisely the effectively functioning insurance market that minimizes threats to individuals, society, and the state (Onyshchenko et al., 2023). Achieving sustainable competitive advantage in this sphere is a significant task (Takawira & Mutambara, 2023; Tu et al., 2023).

The payment of health insurance contributions by analogy with the payment of taxes and other mandatory payments should not create a desire to avoid this payment and significantly reduce the standard of living of the payer and his family (Barannyk et al., 2021). Resistance to change, skill shortages, dissonant communication, and other factors (Houfaf Khoufaf & Nouiri, 2023) can restrain the development and popularity of health insurance. Therefore, the insurance status should consider the state of health, the social and financial situation, educational level, etc.

Moreover, the effectiveness of insurance requires practical methods of estimating the exact values of premiums that will minimize economic losses (Rakotoarisoa & Mapp, 2023).

It is also important to create a conceptual model of decision-making regarding the key parameters of the insurance contract, including health care, social and financial policy, behavioral and personal finances, financial inclusion, and literacy (Djamal et al., 2023; Didenko et al., 2023; Njegovanović, 2023; Kobiyh et al., 2023; Kozhushko, I., 2023; Patel et al., 2023; Zohra et al., 2023) to receive not only personal, but also macro effects from health insurance development.

Research (Kuzior et al., 2022a; Zomchak & Nehrey, 2022; Kachula et al., 2023) pays attention to determining the economic efficiency of the healthcare system and its resilience to COVID-19. The results of a comparison of the economic efficiency of the public health care system showed that the system built according to the Beveridge principle is the most resistant to the pandemic and, at the same time, has the highest economic efficiency indicators. Insurance under the Beveridge system provides universal coverage for all risk cases for all citizen groups.

Awojobi and Adeniji (2023) and Awojobi et al. (2023) evaluated the effects of social health insurance on under-five mortality rates, maternal mortality rates, and out-of-pocket costs and demonstrated a positive effect on these indices using the case of Ghana. They also paid attention to the conditions of the COVID-19 pandemic in this context. Some cases of health care policy for South Africa were characterized by Mayimele et al. (2023).

Regardless of the available scientific work on the selected issues, in the context of quantitative measurement of the impact of health insurance on the coverage of medical services for a country's population, there is no ambiguity and clarity based on different research samples, different indicators, changes in approaches over time, etc., therefore, formalization based on a sample of EU countries is quite relevant.

The research purpose is to find out what type of health insurance (compulsory, voluntary, or social) has the greatest influence on the ability of EU countries to provide large-scale and timely medical services to citizens (in this article, it is measured by the number of unmet needs for medical examination, treatable and preventive mortality) taking into account different scales of public health systems in the studied countries (by the number of doctors and hospital beds), as well as the size of their population and the level of economic well-being.

2. METHODS

This study covers a sample of 27 EU member countries. The informational base includes statistical data provided by the statistical office of the European Union for 2012–2021 within the following indicators:

1) health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure (CHI) (Eurostat, n.d.a);

2) health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure (SHI) (Eurostat, n.d.a);

3) health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure (VHI) (Eurostat, n.d.a);

4) self-reported unmet needs for medical examination (by all genders aged 16+, and all income quintiles for main reasons: too expen-

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sive or too far to travel or waiting list) (UN), total annual percentage (Eurostat, n.d.e);

5) treatable mortality of residents by all genders and all causes, rate (TM) (Eurostat, n.d.g);

6) preventable mortality of residents by all genders and all causes, rate (PM) (Eurostat, n.d.g);

7) GDP per capita, annual chain-linked volumes, Index 2015 = 100 (GDP) (Eurostat, n.d.c);

8) total population, annual number, thousand persons (P) (Eurostat, n.d.f);

9) available beds in hospitals, annual per hundred thousand inhabitants (B) (Eurostat, n.d.b);

10) physicians by all genders and age, total annual number (D) (Eurostat, n.d.d).

The indicators of GDP per capita, total population, available beds in hospitals, and the annual number of physicians are used as additional control variables for more qualitative modeling.

The entire study involves 270 observations from 27 countries and 10 years. Since input variables have different dimensions, the data were previously normalized according to the following formula:

$$nI = \frac{I - \min I}{\max I - \min I}, \tag{1}$$

where I – the value of certain indicators; min$I$, max$I$, and nI – minimum, maximum, and normalized values of the certain indicator.

General research methods include cross-country, comparative, dynamic, statistical, and graphical analysis. Specific research methods are regression modeling, in particular regression with fixed and random effects for panel data estimation (Allison, 2009; Baltagi, 2013; Schunck, 2013). The general regression model has the following view:

$$y_{it} = a + x_{it}b + v_i + \varepsilon_{it}, \tag{2}$$

where v_i is the unit-specific error term; ε_{it} is the usual error term with the usual properties.

A model with fixed effects is characterized by the fact that v_i – fixed parameters, ε_{it} – residual disturbances that are independent identically distributed random variables. This is a model for estimating the β coefficients of a regression model with deterministic individual effects, which allows one to eliminate unobserved individual effects from the model.

In a model with random effects, v_i are random parameters, and individual heterogeneity is taken into account in the covariance matrix, where within each group the random effects are correlated with each other. A random effects model is usually used when some items from a large population of items are randomly selected.

So, after building two panel data models – with fixed and random effects – it is necessary to apply certain tests to confirm quality of built regression models and identifying its specification – Wald test, Hausman test, and Breusch and Pagan Lagrangian multiplier test for random effects (Hausman, 1978; Stata, n.d.a; Stata, n.d.b) using instruments of MS Excel and STATA 18 programs.

Firstly, the Wald test allows to find out whether the fixed-effects model is more efficient than the ordinary regression. It tests the hypothesis that all individual effects are equal to zero.

Secondly, the Breusch and Pagan test helps show different predictions, including a random effect based on estimates, and thus confirm or refute the need to choose a random-effects model over ordinary regression.

And thirdly, the Hausman specification test compares the fixed-effects model with the random-effects model, which ultimately allows choosing the most adequate model specification for estimating panel data.

3. RESULTS AND DISCUSSION

In modern society, unmet needs for medical examination take place in any country independent of the level of its economic and social development, taking into account a number of personal and behavioral reasons, the financial condition

Source: Eurostat (n.d.g).

Figure 1. Geographical map of treatable and preventable mortality of EU countries residents in 2021

of specific households, the national mentality, the sanitary-epidemiological situation and the effectiveness of the policy in the direction of health care, etc. At the same time, the last factor may be the dominant one for a lot of countries.

The results of a cross-country analysis of the shared dynamics of unmet medical examination needs in EU member countries for 2012–2021 show that in many EU countries the situation in terms of unsatisfied medical examination needs is significantly worse than the EU average (Appendix A). This indicator covers the unmet needs of all residents aged 16+, and the main reasons are "too expensive," "too far to travel," or "waiting list". An unequivocal trend regarding the improvement or deterioration of the situation in the dynamics has not been determined, considering the opposite trends depending on the specific EU member state. The most negative situation is in Estonia, Greece, Latvia, Romania, and Slovenia and the best is in Germany, the Netherlands, and Malta (Eurostat, n.d.e).

However, in most of the studied countries, in recent years, a decrease in the level of dissatisfaction of the population regarding the need for a medical examination can be observed.

The other indicator that characterizes the coverage of medical services for the country's population is treatable and preventable mortality of residents. The reasons for such mortality are determined according to the International Statistical Classification of Diseases and Related Health Problems. Figure 1 presents the developed geographical map of the to-

Source: Eurostat (n.d.g).

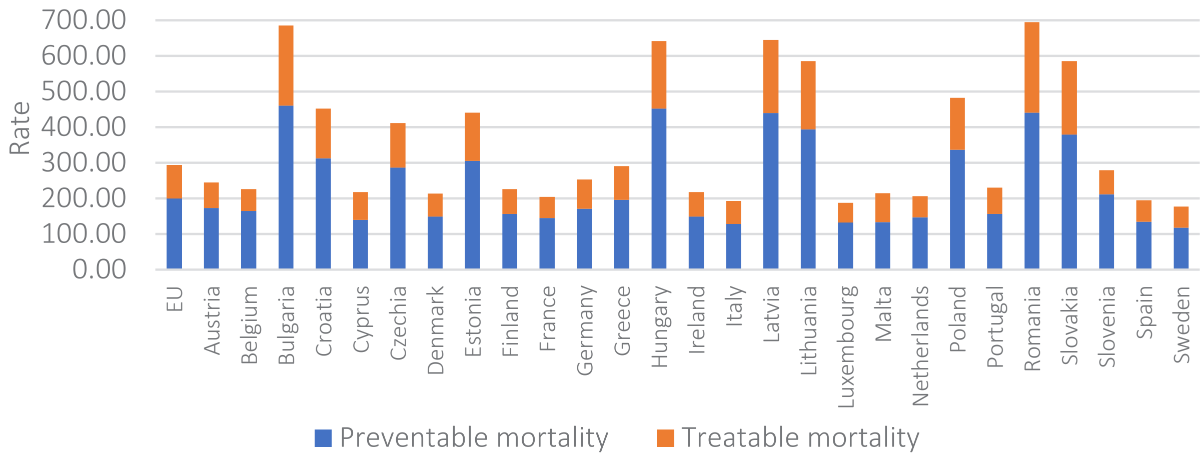

Figure 2. Comparative analysis of the rate of treatable and preventable mortality of EU countries residents in 2021

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tal annual rate of treatable and preventable mortality for EU countries in 2021.

A darker color indicates a significantly higher level of total rate of treatable and preventable mortality. A significantly higher level of total rate of treatable and preventable mortality is in Czechia, Greece, Slovenia, Germany, Austria, and Portugal.

Accordingly, the border comparison with division by the level of treatable mortality and the level of preventable mortality is given in Figure 2.

There is also a visualization of the overall level of treatable and preventable mortality of EU countries' residents thanks to the cumulative histogram. There are two groups of countries where the value of the studied indicator is less than the EU average (Austria, Belgium, Denmark, Ireland, Finland, Germany, Sweden, Luxemburg, Spain, and others) and where, on the contrary, there is a significant excess (Bulgaria, Hungary, Latvia, Lithuania, Romania, and Slovakia).

In the context of this issue, it is expedient to find out whether the development of health insurance, especially voluntary health insurance, has an impact on the improvement of the indicators of medical coverage for the population outlined above.

In this regard, Figure 3 contains the results of a comparative analysis of the share of three main types of insurance, namely compulsory, social, and voluntary, as an annual percentual share of total current health expenditure.

In almost all EU countries, mandatory and social health insurance prevails over voluntary health insurance. At the same time, the last species is widespread in Ireland, Spain, Slovenia, Austria, Belgium, France, Poland, etc.

To investigate and formalize the effect of health insurance on the coverage of medical services of the country's population at the country panel level (EU panel data), regression analysis tools and STATA 18 software were applied.

Table 1 shows descriptive statistics of all indicators included in the analysis.

Given the different dimensions of the above data, they have been normalized. Newly created (generated and normalized) variables were marked with the letter "n" before the indicator abbreviation.

After that, panel data regression models with fixed and random effects were built, and the model specification was substantiated.

At the first stage of the regression analysis, the impact of different types of health insurance on the level of unmet medical examination needs was investigated. The results of fixed-effects regression are in Table 2.

Source: Eurostat (n.d.a).

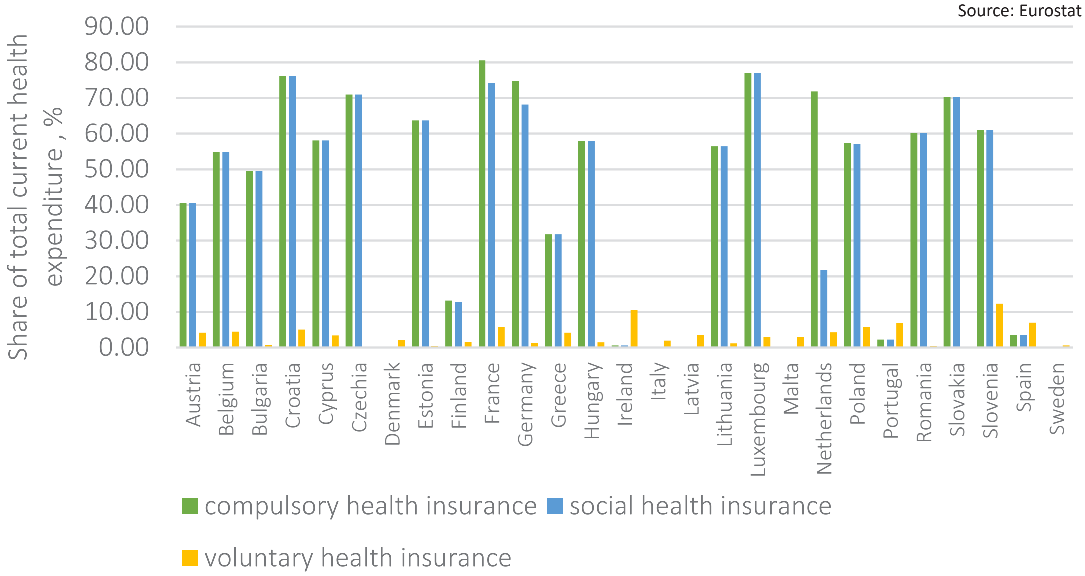

Figure 3. Cross-country analysis of the share of key health insurance types as a source of financing health care in 2021

Table 1. Descriptive statistics results

Variable	Obs	Mean	Std. dev.	Min	Max
UN	270	3.05	3.32	0.00	45398.00
TM	270	111.63	51.70	54.69	254.72
PM	270	195.73	80.66	99.81	459.97
CHI	270	41.34	31.48	0.00	82.15
SHI	270	39.06	30.63	0.00	82.15
VHI	270	4.04	3.87	0.00	14.74
GDP	270	103.84	8.98	74.52	145.92
P	270	16,496.85	21,777.72	419.76	83,196.00
B	270	503.24	167.87	200.09	833.62
D	270	61,918.48	83,877.45	1,381.00	376,852.00

Note: UN – self-reported unmet needs for medical examination (by all genders aged 16+, and all income quintiles for main reasons: too expensive or too far to travel or waiting list); TM – treatable mortality of residents by all genders and all causes, rate; PM – preventable mortality of residents by all genders and all causes, rate; CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

Table 2. Fixed-effect regression results to formalize the impact of different types of health insurance on the level of unmet needs for medical examination

nUN	Coefficient	Std. err.	t	P > |t|	[95% conf. interval]
nCHI	–.217123	.3958387	–0.55	0.584*	–.9969517 .5627058
nSHI	–.0915619	.3808168	–0.24	0.810*	–.8417965 .6586727
nVHI	–.2252558	.1049966	–2.15	0.033	–.4321061 –.0184056
nGDP	–.2916006	.0469107	–6.22	0.000	–.3840178 –.1991834
nP	5.050944	1.937256	2.61	0.010	1.23442 8.867468
nB	–.313763	.1301019	–2.41	0.017	–.5700724 –.0574536
nD	–1.672626	.3880836	–4.31	0.000	–2.437177 –.9080758
_cons	–.0408782	.4010224	–0.10	0.919*	–.8309191 .7491628

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the t-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; UN – self-reported unmet needs for medical examination (by all genders aged 16+, and all income quintiles for main reasons: too expensive or too far to travel or waiting list); CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

The significance level of the built model (Prob > F = 0.0000) means its quality.

Applying Wald test allows to find out whether the fixed-effects model is more efficient than the ordinary regression. It tests the hypothesis that all individual effects are equal to zero. So, the result of Wald test in this case confirms that the fixed effects model is better than the stepwise regression model: F (7, 236) = 15.33 corr (u_i, Xb) = –0.9820, Prob > F = 0.0000.

The results of random-effects GLS regression are in Table 3.

The built model's significance level grounds its adequacy (Prob > chi2 = 0.0000).

To confirm or reject the need to choose a random-effects model over ordinary regression, to show different predictions, including a random effect based on estimates, the Breusch and Pagan test is made (Figure 4).

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Breusch and Pagan Lagrangian multiplier test for random effects

        nUN[Code,t] = Xb + u[Code] + e[Code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                     nUN |   .0409223       .2022925
                       e |   .0067266       .0820159
                       u |   .0334618       .1829257

        Test: Var(u) = 0
                             chibar2(01) =   753.09
                          Prob > chibar2 =   0.0000
```

Figure 4. Results of the Breusch and Pagan Lagrangian multiplier test for random effects (STATA 18 screen).

Table 3. Random-effect GLS regression results to formalize the impact of different types of health insurance on the level of unmet needs for medical examination

nUN	Coefficient	Std. err.	z	P > |z|	[95% conf. interval]	
nCHI	–.2158179	.2388221	–0.90	0.366*	–.6839006	.2522649
nSHI	.0841856	.2431417	0.35	0.729*	–.3923634	.5607345
nVHI	–.2558541	.0737293	–3.47	0.001	–.400361	–.1113473
nGDP	–.3017065	.0457749	–6.59	0.000	–.3914236	–.2119894
nP	1.031428	.3156826	3.27	0.001	.412702	1.650155
nB	–.1981972	.1014796	–1.95	0.051	–.3970935	.0006992
nD	–1.239178	.3304934	–3.75	0.000	–1.886933	–.5914228
_cons	.5429423	.0762459	7.12	0.000	.3935031	.6923815

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the z-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; UN – self-reported unmet needs for medical examination (by all genders aged 16+, and all income quintiles for main reasons: too expensive or too far to travel or waiting list); CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

The result of Breusch and Pagan's Lagrangian multiplier test for random effects shows that the random-effects model is more qualitative than the stepwise regression model (p-value is obtained by the indicator Prob > chibar2 that is lower than 0.05).

Accordingly, the Hausman test was applied to choose the specification between the two built models. It is specification test that compares the fixed-effects model with the random-effects model, which ultimately allows choosing the most adequate model specification for estimating panel data (Figure 5).

The results of Hausman test confirm that the second model with random effects should be chosen from the two constructed models with fixed and random effects, respectively (p-value is obtained by the indicator Prob > chi2 that is more than 0.05).

That is why it was confirmed that voluntary health insurance has a positive influence on the level of unmet medical examination needs. If the share of voluntary health insurance increases by 1%, the value of the indicator of unmet medical examination needs will decrease by 0.26%.

The influence of compulsory and social insurance on this indicator was not confirmed.

```
                 ── Coefficients ──
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fe           re          Difference          Std. err.
-------------+----------------------------------------------------------------
        nCHI |   -.217123    -.1535377        -.0635853        .3186993
        nSHI |  -.0915619     .0268945        -.1184564        .2961727
        nVHI |  -.2252558     -.249036         .0237802        .0758075
        nGDP |  -.2916006    -.2514157        -.0401849               .
          nP |   5.050944      1.01041         4.040534        1.912137
          nB |   -.313763     -.298916         -.014847        .0702414
          nD |  -1.672626    -1.155804        -.5168225        .2059329
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  10.62
Prob > chi2 = 0.1558
(V_b-V_B is not positive definite)
```

Figure 5. Hausman test results (STATA 18 screen) (1st stage).

Table 4. Results of fixed-effects regression to formalize the impact of health insurance on the treatable mortality rate

nTM	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
nCHI	–.1165828	.1638751	–0.71	0.478*	–.4394277	.2062622
nSHI	.0887385	.1576561	0.56	0.574*	–.2218546	.3993316
nVHI	–.0844564	.043468	–1.94	0.053	–.1700913	.0011785
nGDP	–.1193405	.0194208	–6.14	0.000	–.1576007	–.0810803
nP	–2.657538	.8020137	–3.31	0.001	–4.237558	–1.077517
nB	.3494422	.0538615	6.49	0.000	.2433315	.455553
nD	.4544252	.1606645	2.83	0.005	.1379053	.7709451
_cons	.6489863	.1660211	3.91	0.000	.3219136	.9760591

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the t-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; TM – treatable mortality of residents by all genders and all causes, rate; CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

In the second stage of the regression analysis, the impact of health insurance on the treatable mortality rate was investigated. The results of fixed-effects regression are in Table 4.

The built model's p-level (Prob > F = 0.0000) indicates its quality.

Applying Wald test allows to find out whether the fixed-effects model is more efficient than the ordinary regression. It tests the hypothesis that all individual effects are equal to zero. For this case Wald test results (F test that all u_i = 0: F (26, 236) = 233.02, Prob > F = 0.0000) confirm that the fixed-effects model is better than the stepwise regression model.

The results of random-effects panel regression are in Table 5.

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Table 5. Results of random-effects regression to formalize the impact of health insurance on the treatable mortality rate

nTM	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
nCHI	–.1842529	.1380799	–1.33	0.182*	–.4548846	.0863787
nSHI	.1760406	.1359032	1.30	0.195*	–.0903247	.442406
nVHI	–.063174	.036865	–1.71	0.087*	–.1354281	.0090802
nGDP	–.1008098	.01974	–5.11	0.000	–.1394994	–.0621202
nP	–.5589135	.171436	–3.26	0.001	–.8949219	–.2229051
nB	.4370741	.0496118	8.81	0.000	.3398368	.5343115
nD	.2385581	.1490593	1.60	0.110*	–.0535927	.5307089
_cons	.2133623	.0494202	4.32	0.000	.1165005	.3102242

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the z-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; TM – treatable mortality of residents by all genders and all causes, rate; CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

The significance level of the built model grounds its adequacy (Prob > chi2 = 0.0000).

To confirm or reject the need to choose a random-effects model over ordinary regression, to show different predictions, including a random effect based on estimates, the Breusch and Pagan test is made (Figure 6).

The results of the Breusch and Pagan test show that the random-effects model is more qualitative than the stepwise regression model (p-value is obtained by the indicator Prob > chi2 that is lower than 0.05).

The results of the Hausman test are shown in Figure 7.

Hausman specification test compares the fixed-effects model with the random-effects model, which ultimately allows choosing the most adequate model specification for estimating panel data. In this case test result (p-value is obtained by the indicator Prob > chi2 = 0.0047) is lower than 0.05, so the first model with fixed effects should be chosen.

Thus, it was confirmed that voluntary health insurance has a positive influence on the treatable

```
Breusch and Pagan Lagrangian multiplier test for random effects

        nTM[Code,t] = Xb + u[Code] + e[Code,t]

        Estimated results:
                    |       Var     SD = sqrt(Var)
            --------+-----------------------------
                nTM |   .0667913       .2584401
                  e |   .0011529       .0339542
                  u |   .0199914       .1413909

        Test: Var(u) = 0
                             chibar2(01) =   984.52
                          Prob > chibar2 =   0.0000
```

Figure 6. Results of the Breusch and Pagan test (STATA 18 screen).

```
             ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fe           re          Difference          Std. err.
-------------+----------------------------------------------------------------
        nCHI |  -.1165828    -.1842529        .0676702        .0882553
        nSHI |   .0887385     .1760406       -.0873021        .0799111
        nVHI |  -.0844564     -.063174       -.0212825        .0230312
        nGDP |  -.1193405    -.1008098       -.0185307               .
          nP |  -2.657538    -.5589135       -2.098624        .7834766
          nB |   .3494422     .4370741       -.0876319        .0209697
          nD |   .4544252     .2385581        .2158671        .0599536
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  20.43
Prob > chi2 = 0.0047
(V_b-V_B is not positive definite)
```

Figure 7. Hausman test results (STATA 18 screen) (2nd stage).

mortality rate. If the share of voluntary health insurance increases by 1%, the value of the treatable mortality rate will decrease by 0.08%.

Just as in the first stage, the influence of compulsory and social insurance on this indicator was not confirmed (the p-values for received regression coefficients for these variables are not statistically significant).

At the third stage of the regression analysis, the impact of health insurance on the rate of preventable mortality of residents was formalized. The results of the fixed-effects regression are in Table 6.

The built model's p-level (Prob > F = 0.0000) shows its quality.

Table 6. Results of fixed-effects regression to formalize the impact of health insurance on the preventable mortality rate

nPM	Coefficient	Std. err.	t	P > |t|	[95% conf. interval]	
nCHI	–.3970246	.3250397	–1.22	0.223*	–1.037375	.2433253
nSHI	.2143131	.3127046	0.69	0.494*	–.4017358	.830362
nVHI	–.2706921	.0862171	–3.14	0.002	–.4405455	–.1008387
nGDP	.0546515	.0385203	1.42	0.157*	–.0212361	.1305391
nP	–5.355311	1.590762	–3.37	0.001	–8.489218	–2.221404
nB	.3404354	.1068321	3.19	0.002	.1299691	.5509018
nD	1.287738	.3186716	4.04	0.000	.6599332	1.915542
_cons	1.085608	.3292962	3.30	0.001	.4368725	1.734344

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the t-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; PM – preventable mortality of residents by all genders and all causes, rate; CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

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Table 7. Results of random-effects regression to formalize the impact of health insurance on the preventable mortality rate

nPM	Coefficient	Std. err.	z	P > |z|	[95% conf. interval]	
nCHI	–.1684205	.1810064	–0.93	0.352*	–.5231865	.1863455
nSHI	.1388737	.1860401	0.75	0.455*	–.2257581	.5035056
nVHI	–.1217608	.0583841	–2.09	0.037	–.2361915	–.0073302
nGDP	.0971007	.0379625	2.56	0.011	.0226957	.1715058
nP	–.7715568	.250648	–3.08	0.002	–1.262818	–.2802958
nB	.4767414	.0806697	5.91	0.000	.3186317	.6348511
nD	.5791944	.2688994	2.15	0.031	.0521613	1.106228
_cons	.1069124	.0576113	1.86	0.063*	–.0060037	.2198284

Note: * – the received coefficient for the certain variable is not statistically significant (the p-value of the z-criterion is above 0.05, so the probability is less than 95%); 'n' before the indicator abbreviation – newly created (generated and normalized) variables; PM – preventable mortality of residents by all genders and all causes, rate; CHI – health care expenditure financing by compulsory health insurance and compulsory medical saving schemes, the annual percentual share of total current health expenditure; SHI – health care expenditure financing by social health insurance schemes, the annual percentual share of total current health expenditure; VHI – health care expenditure financing by voluntary health insurance schemes, the annual percentual share of total current health expenditure; GDP – GDP per capita, annual chain-linked volumes, Index 2015 = 100; P – total population, annual number, thousand persons; B – available beds in hospitals, annual per hundred thousand inhabitants; D – physicians by all genders and age, total annual number.

Applying Wald test allows to find out whether the fixed-effects model is more efficient than the ordinary regression. It tests the hypothesis that all individual effects are equal to zero. The Wald test results (F test that all u_i = 0: F (26, 236) = 42.35 Prob > F = 0.0000) confirm that the fixed-effects model is better than the stepwise regression model.

The results of random-effects panel regression are in Table 7.

The significance level of the built model grounds its adequacy (Prob > chi2 = 0.0000).

To confirm or reject the need to choose a random-effects model over ordinary regression, to show different predictions, including a random effect based on estimates, the Breusch and Pagan test is made (Figure 8).

The results of the Breusch and Pagan test show that the random-effects model is more qualitative than the stepwise regression model (Prob > chibar 2 is lower than 0.05).

The results of Hausman test are shown in Figure 9.

Hausman specification test compares the fixed-effects model with the random-effects model, which ultimately allows choosing the most adequate model specification for estimating panel data. For this stage the Hausman test result of Prob >

```
Breusch and Pagan Lagrangian multiplier test for random effects

        nPM[Code,t] = Xb + u[Code] + e[Code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                     nPM |   .0501623       .2239694
                       e |   .0045356       .0673467
                       u |   .0168727       .1298949

        Test: Var(u) = 0
                             chibar2(01) =   673.77
                          Prob > chibar2 =   0.0000
```

Figure 8. Breusch and Pagan test results (STATA 18 screen)

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
nCHI	-.3970246	-.1684205	-.2286041	.2699768
nSHI	.2143131	.1388737	.0754393	.2513429
nVHI	-.2706921	-.1217608	-.1489313	.0634404
nGDP	.0546515	.0971007	-.0424492	.006532
nP	-5.355311	-.7715568	-4.583754	1.570891
nB	.3404354	.4767414	-.136306	.0700392
nD	1.287738	.5791944	.7085431	.1710108

```
                         b = Consistent under H0 and Ha; obtained from xtreg.
          B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  24.70
Prob > chi2 = 0.0009
(V_b-V_B is not positive definite)
```

Figure 9. Hausman test results (STATA 18 screen) (3rd stage)

chi2 = 0.0009 is lower than 0.05, so the model with fixed effects should be chosen.

It was confirmed that voluntary health insurance also has a positive influence on the preventable mortality rate. If the share of voluntary health insurance increases by 1%, the value of the preventable mortality rate will decrease by 0.27%.

Just as in the previous stage, the influence of compulsory and social insurance on this indicator was not confirmed (the p-values for received regression coefficients for these variables are not statistically significant).

At the same time, this study has temporal and space limitations due to the collaborative sample, which is planned to be expanded in further studies, as well as the list of indicators of health insurance and the coverage of medical services of the country's population.

Formulated conclusions are consistent with the results obtained by Mugo (2023), who confirmed the existence of a relationship between insurance status and mortality in the example of Kenya – insurance contributes to lower mortality. The conclusion regarding the reduction of unsatisfied needs in medical care under the influence of the development of medical insurance also takes place in Zhou et al. (2021), however, with an emphasis on the impact of health insurance on reducing non-use of outpatient services, inpatient services, or early hospital discharge. As for the coverage of medical services, there is also a positive effect of health insurance on the number of medical visits and hospitalizations, in particular, uninsured status leads to a 40% reduction in emergency room visits and a 61% reduction in the number of hospitalizations (Anderson et al., 2012). Availability of hospital beds and current health care costs were chosen to establish the relationship between indicators to assess not only medical coverage but also quality of life, which was confirmed for 30 European countries (Vasylieva et al., 2023).

Health insurance, including a beneficiary program for the poor, can reduce the risks of unmet healthcare needs by 7.7%, while a program without beneficiaries can reduce the risks of unmet healthcare needs for the non-poor by 10.4% (Firori & Wisana, 2023). Dragos et al. (2022) found the impact of voluntary health insurance on the health and longevity of the population based on a sample of 26 European OECD countries and

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showed that the relationship between the variables is characterized by a threshold effect, the estimated value of which is approximately 6.3% of total health care funding. Voluntary health insurance reduces average out-of-pocket costs by about 200%, with a much greater reduction in costs for the poor than for the rich (Jowett et al., 2003). So, in future research, it is important to distinguish the impact depending on the income group.

CONCLUSION

The purpose of the paper was to find out which type of medical insurance (compulsory, voluntary, or social) has the greatest influence on the ability of EU countries to provide large-scale and timely medical services to citizens (, it is measured in this paper by the number of unmet needs for medical examination, treatable and preventive mortality) taking into account different scales of public health systems in the studied countries (by the number of doctors and hospital beds), as well as the size of their population and the level of economic well-being.

Based on regression panel data estimation results for 27 EU member countries for 2012–2021, it was confirmed that voluntary health insurance has a positive influence on the level of unmet needs for medical examination (if the share of voluntary health insurance increases by 1%, the value of unmet needs for medical examination will decrease on average by 0.26%), on the treatable mortality rate (contributes to a decrease in a result indicator by 0.08%) and on the preventable mortality rate (contributes to a decrease by 0.27%). Instead, the influence of compulsory and social insurance on these chosen indicators of the coverage of medical services for the country's population was not confirmed (the results obtained are identified as not statistically significant).

This indicates that, at least in the EU countries, voluntary health insurance and, accordingly, a conscious approach of citizens to their health provide a better result in comparison with a compulsory, imposed approach. Health insurance should be developed as much as possible in the direction of voluntary health insurance, which has potential advantages not only of a personal but also of a general societal nature.

This study has temporal and space limitations due to the collaborative sample, which is planned to be expanded in further studies, as well as the list of health insurance indicators and the coverage of a country's population with medical services. The results will be useful both for further research by scientists and for the government, managers, insurers, and other interested parties in developing insurance medicine and obtaining positive consequences from its implementation and development.

AUTHOR CONTRIBUTIONS

Conceptualization: Olena Dobrovolska, Wolfgang Ortmanns, Svitlana Kachula, Ralph Sonntag.
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Writing – review & editing: Olena Dobrovolska, Wolfgang Ortmanns, Svitlana Kachula, Oksana Pavlenko, Ralph Sonntag.

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APPENDIX A

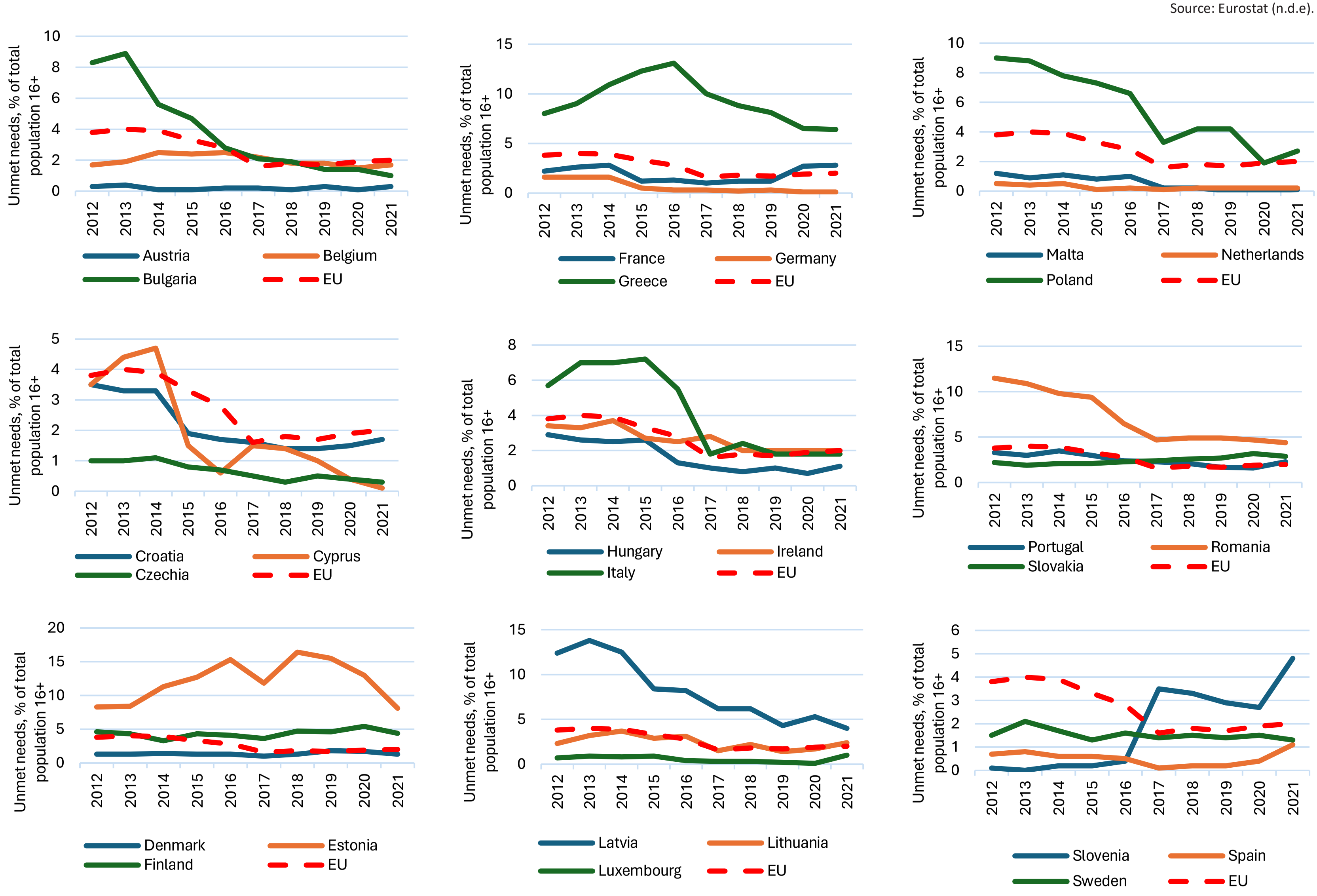

Figure A1. Cross-country analysis of the share dynamics of unmet needs for medical examination in the EU for 2012–2021