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From crisis to crisis: Assessment of financial performance of SMEs in the healthcare sector in Visegrad Countries

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ABSTRACT

The living standards of the population in Visegrad Countries (V4) have long been below the EU and OECD averages, and the increase of negative impacts and crisis phenomena may be detected in their health systems, too. Our study examines the similarities and differences of the SMEs of healthcare sector in Visegrad Countries and their characteristics and common hallmarks of the overburdened healthcare system in which they are integrated. The aim of our research is to explore the similarities the financial indicators (liquidity, profitability, indebtedness, and efficiency) of SMEs in the healthcare sector of the four Visegrad Countries and to identify the possible clusters with similar financial typology. The research covers two crisis periods – from the 2008 financial and capital market crisis to the 2020 Covid-19 health crisis – and analyses the relationship and patterns in the financial performance of healthcare SMEs using correlation and cluster analysis. Based on our primary research results we found that the financial typology of SMEs in the healthcare sector in the Visegrad Countries shows similar characteristics in terms of liquidity – profitability – indebtedness – efficiency. Financial indicators of indebtedness and efficiency were significantly similar for all four countries. In addition, three relatively homogeneous groups could be formed according to the typical financial characteristics of each country.

1. Introduction

The geographic scope of our research is the Visegrad Countries (Czech Republic, Hungary, Poland, Slovakia), as this grouping is the main reference group for comparative studies (Kotosz and Lengyel, 2018; Majerová, 2018; Paulikné, 2019; Éltető et al, 2022; Kézai, 2022) because of their proximity, similar geopolitical conditions, history, tradition, culture, and values (Janusz and Kowalczyk, 2022). Similarities can be found in many areas in the comparison of the V4 countries, and in this study, the similarities in the performance of micro, small and medium-sized enterprises working in the health sector are explored. Our research used the study of Vitéz-Durgula et al. (2023) on the financial performance of healthcare SMEs as a starting point. As a continuation of this research, we analyse the relationships and patterns in the financial performance of healthcare SMEs from crisis to crisis – from the 2008 financial and capital market crisis to the 2020 health crisis – using correlation and cluster analysis.

The healthcare industry is a specific market, with an extremely specific supply and demand (Mihályi, 2003; Paulikné, 2019). This suggests that the financial indicators characterising the activities of individual players follow different trends than other sectors of the national economy. In our research, we examine the performance of SMEs in the healthcare industry from the 2008 financial and capital market crisis to the 2020 healthcare crisis based on four selected financial indicators: liquidity, indebtedness, profitability and efficiency, to get deeper insights into the industry's processes and firms' performance. The combined analysis of these indicators provides a comprehensive overview on the financial situation of the examined SMEs.

The research aims to explore whether the financial indicators of healthcare SMEs in the V4 countries show similar characteristics and

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whether groups can be described by the same financial typology, through testing two hypotheses:

- Hypothesis 1: The financial performance of SMEs in the healthcare sector shows significantly similar characteristics in the V4 countries.
- Hypothesis 2: Clusters of healthcare SMEs in the V4 countries can be formed with the same financial typology, and there is no interoperability between these clusters in the examined period (2008–2021).

2. Study background

2.1. Healthcare sector in the Visegrad Countries

The living standards of Visegrad Countries are below the OECD and EU averages (OECD, 2021a, b, c, d). Healthcare systems of these countries experience an increasing crisis phenomena resulted by the emigration of doctors, shortage of nurses and general practitioners, hospital indebtedness, increase in waiting lists, radical change in the doctor-patient relationship, burn-out of the workforce (Orosz, 2009). It is worth comparing the healthcare systems of the countries under study, as these, among other factors (e.g. socio-economic interests, regulations affecting domestic and international companies, access to credit, sources of funding), have a major impact on the performance of health enterprises. Kincses (2011) draws attention to the difficulties of typifying healthcare systems, which are highly diverse and unique. Health systems do not evolve according to systems theories, but in response to historical, economic, political and health policy changes in a country (Hegedűs, 2019). Table 1 compares the health systems and health insurance models in the examined countries. It clearly shows the differences, similarities and commonalities that largely determine the position of the healthcare sector.

It is seen that Poland and Hungary are close to each other according to the selected criteria, as are Slovakia and the Czech Republic. Nevertheless, it is worth to explore whether these similarities may be applied to SMEs in the healthcare sector.

Table 1
Comparison of healthcare systems in the Visegrad Countries.

	Czech Republic	Hungary	Poland	Slovakia
Soviet Union model	Semashko model			
Social security model during the political transition in 1990s	Bismarck model (from1991)	Bismarck model (from 1989)	Bismarck model (from 1999)	Bismarck model (from 1993)
Current health model	Mixed / transitional system (Bismarck and Beveridge model)			
Single or multi-insured health scheme	several insurance schemes	an insured health system		several insurance schemes
Property form	mainly private property	mainly public property		mixed
Funding source	social security (from contributions)			
Market	strong competition, public and private providers	regulated, public and private service providers		strong competition, significant private operators

Source: own summary based on Bunker (1998); GYEMSZI (2014); Hegedűs (2015); van der Zee-Kroneman (2007); Hankó (2019); Paulikné (2019)

2.2. SMEs in the Visegrad Countries

As our research focuses on the SMEs in the health industry, a brief introduction of the SMEs of the examined countries is also important as this sector represents entrepreneurship, supports innovation, and thus, plays a crucial role in promoting competitiveness. Table 2 presents the size of the SMEs sector in the different Visegrad Countries in general. It is seen that the share of SMEs enterprises is above 99 % in all the four countries, the share of persons employed is at least two thirds of large enterprises and value added is above 50 % in 2022.

Among SMEs, it is also worth to highlight innovation-driven enterprises/startups, which are prominent representatives of healthcare developments and innovations. From legal aspect, startup companies are SMEs. We adopt the definition of Kollmann et al. (2016), according to which a startup is defined as a company that is less than ten years old, uses innovative technologies and/or business models and is capable of significant growth (in terms of sales and/or employment) and scalability.

A large number of publications deals with entrepreneurial networks and their funding opportunities (Mohan, 2022). According to Retterath and Braun (2020) most important new startup and venture capital databases are Angellist, CB-Insights, Crunchbase, Dealroom, Pitchbook, Preqin and Tracxn, VentureSource. It is found that VentureSource, Pitchbook and Crunchbase databases have the largest coverage and the most accurate overall data in terms of company, founder, and funding data (Retterath and Braun, 2020; Kézai, 2022). For the V4 countries and the healthcare industry, we found that VentureSource, Crunchbase, Dealroom and Pitchbook have the widest coverage.

2.3. Innovation in the healthcare sector

The directions of innovation in the healthcare sector are multiple. Mishra and Jain (2025) highlighted 3 main innovation types in the healthcare sector: consumer-focused innovations (CFIs), which improve consuming and utilizing healthcare products and service as well as customer satisfaction; business model innovations (BMIs), which optimizes service delivery and improves cost-efficiency; and technological innovations (TIs), which represent new products, services, and solutions that helps enhancing clinical outcomes. One of the most widely used innovative solution is E-health which includes methods and practices of tele-medicine, digital patient records, remote surgery, by which the health of the population might be improved and the cooperation between doctors and patients might be faster and more cost effective. These innovative solutions need strong information and technology background, by smart devices, applications, special programs. Another field of innovations in healthcare is different implants, which are such medical devices that replace or support missing or damaged biological structures (e.g. pacemakers, hip or knee prosthesis, cochlear implants). These creations require strong and well-built cooperation with engineers and R&D partners (Flessa and Huebner, 2021).

The role of open innovation in healthcare is becoming increasingly important. The WHO Global Digital Health Strategy 2020–2024 calls for supporting people-centred health systems, promoting global collaboration and strengthening governance of global digital health practices. This requires a new approach to open innovation, which means that stakeholders from regional administrations, hospitals, companies and intermediary organisations collaborate openly to achieve jointly defined global and regional digital health goals (Pikkarainen et al., 2020).

Biancone et al. (2019) believe that the need for open innovation management is relevant to improving and increasing the performance of healthcare organisations.

A similar conclusion was reached by Cesario et al. (2022). They argue that a rigid and structured internal innovation process presupposes that control and exclusivity are necessary for successful innovation. Technological and scientific progress is constantly evolving in the biomedical field; therefore, a closed approach to innovation is no

Table 2
Statistics on the SME sector in the V4 countries (2022).

Country	Company type	Number of enterprises		Number of persons employed		Value added	
		Number	%	Number	%	billion EUR	%
Czech Republic	*SMEs*	1 082 947	99.8	2 551 953	67.4	74.4	53.5
	Large	1 639	0.2	1 236 587	32.6	64.7	46.5
Hungary	*SMEs*	713 411	99.9	2 051 172	70.2	46.5	56.2
	Large	957	0.1	872 712	29.8	36.3	43.8
Poland	*SMEs*	2 155 183	99.9	6 911 789	66.9	162.3	50.1
	Large	3 210	0.1	3 417 074	33.1	161.6	49.9
Slovakia	*SMEs*	522 575	99.9	1 195 009	73.9	25.2	56.0
	Large	495	0.1	421 559	26.1	19.8	44.0

Note: Figures for 2022 are JRC estimates based on 2008–2020 data from national and Eurostat databases.
Source: own editing based on European Commission (2023a), b, c, d)

longer sustainable in an increasingly competitive, globalized and dynamic environment.

This paradigm contrasts with the paradigm described as closed, as it assumes that the locus of innovation is not necessarily within the organization, but can also be directed outwards towards a collaborative network that shares ideas and products through dynamic processes of change (Chesbrough, 2006).

Carrilho et al. (2023) believe that two key concepts define the common thread of all open innovation measures in the healthcare sector: “validation” and “user-centricity”.

However, it can also be stated that the healthcare sector’s participation in open innovation is limited. Innovative technologies and services are expected to improve the quality of medical care and reduce costs. Most of the experiments focus on the areas of pharmaceutical research (drug discovery) and health informatics (health information systems and infrastructures), which have been developed as concepts or have been used as pilot projects and prototypes (Torab-Miandoab et al., 2024).

Wass and Vimarlund (2016) also confirmed that the healthcare sector’s participation in open innovation is limited and that further research is needed, focusing on how to manage open innovation in healthcare. They argue that innovation primarily results in products and services through innovation networks. However, they also identified factors that limit open innovation in healthcare, including the complex organizations of healthcare, the need to develop routines for collecting knowledge from patients and clinicians, regulations and legislation on health data, and patient empowerment.

Agarwal et al. (2010) demonstrated that digital transformation in healthcare can increase the efficiency of care and management, and lead to higher productivity rates.

With the help of artificial intelligence technology and information capabilities focused on mobilizing and integrating human resources, the healthcare sector can improve its innovation performance within hospitals. As a result, owners and senior management should focus on developing innovation networks (Nassani, 2023).

Futri and Naruetharadhol (2025) analyzed the impact of open innovation on the digital healthcare market in Indonesia. The results showed that open innovation can improve access to healthcare services, especially in remote areas, through the introduction of telemedicine and healthcare applications. However, infrastructural, regulatory, and digital literacy challenges remain significant barriers.

Among the databases and institutions that list healthcare developments and companies, we should mention Europe’s leading health innovation network, EIT Health, which is the health innovation support organisation of the European Institute of Innovation and Technology (EIT). This institute created the EIT InnoStars Innovation Index, which is the first comprehensive analysis for the health innovation ecosystems in each country. The EIT Health runs several programmes to support health startups in the countries covered by the report. EIT Health InnoStars’ methodology uses soft and hard indicators to measure the development of the health ecosystem. Soft indicators measure the country’s funding opportunities, government support, innovation and know-how, network development and talent pipeline, i.e. the human capital of the ecosystem and the innovative mentality of people. Hard indicators assess the performance of startups participating in EIT Health programmes according to current firm value, number of employees, ability to raise capital and funding, percentage of firms successfully entering the market, etc. (Horesh et al., 2023).

Based on this analysis, the EIT Health Innovation Index for the Visegrad Countries were examined and evaluated for both soft and hard indicators. Results are presented in Fig 1 and Table 3.

On the basis of the performance indicators, the Ecosystem Maturity Model developed by Rozalska-Lilo (n.d.) was used to classify each country into five categories: 1:"beginner", 2: “builder”, 3: “experimenter”, 4: “connector” and 5: “expert”. It is important to underline that the collected performance indicators are limited to the participants of the EIT Health startup programme (2014–2022), the scale is not a ranking but an indicator of progress to innovation maturity in comparison to the reference country, Israel, a global leader in health innovation (Horesh et al., 2023). In this sense, among the Visegrad Countries, Slovakia is still in a building phase, while the other three countries are in an experimental phase *(*Table 3*)*.

Health entrepreneurship has a huge potential to bring about positive changes in the health industry and healthcare such as treatments on existing and new diseases, procedures, diagnostics, or addressing gaps in the healthcare system. Despite the many challenges and uncertainties, there is huge opportunity for the health entrepreneurs to create added value in socio-economic aspects.

3. Materials and methodology

The programs used for data analysis and visualization in the empirical research were Microsoft Office Excel program and SPSS statistical software package (IBM SPSS Statistics 27). In our research, we performed Pearson’s correlation and variance (standard deviation), the most commonly used dispersion indicator in univariate analyses. For the cluster analysis we opted for a non-hierarchical cluster analysis and used the K-means clustering method.

3.1. Description of the database

The healthcare SMEs in the Visegrad Countries were selected by country from the Crefoport Scholar company information database (https://www.crefoport.hu). The companies should meet the following selection criteria:

– The core activity of the company is in the scope of the health industry. To better define the health industry, we have built on Varga and Szabó (2021) research report, as a starting point, we used the definition of Kincses (2010) and Szakálné (2018) and applied the TEÁOR’08 classification. The Hungarian activity classification (TEÁOR’08) is identical with the EU Statistical Classification of

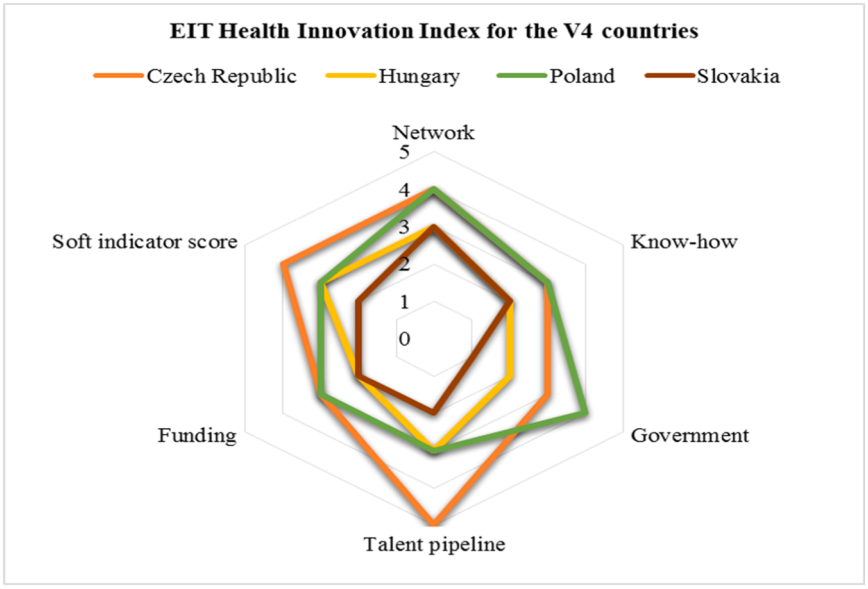

Fig. 1. EIT Health Innovation Index for the V4 countries - soft indicators, Source: own figure based on Horesh et al# (2023).

Table 3
EIT Health Innovation Index for the V4 countries - hard indicators.

Country	Hard indicators					*Hard indicator score*	*Category*
	Valuation (EUR million)	*Total external funding raised (EUR million)*	*Successful market entry (%)*	*Total external grants obtained (EUR million)*	*Employment (FTE)*		
Hungary	36	14.8	59 %	0.8	232	3	Experimenter
Poland	2	2.1	50 %	16.7	243	3	Experimenter
Czech Republic	4	0.7	67 %	0.2	68	2	Experimenter
Slovakia	3	0.8	33 %	0.04	30	1	Builder

Source: own summary based on Horesh et al. (2023)

Economic Activities for 2008 in the European Community, 2008. It is used to determine the principal activities of enterprises, in the calculation of economic and social indicators and at the publication of statistical data (HSO, n.d.). Although Szakálné (2018) have given the earlier used four-digit TEÁOR'03 classification for each subsector, the code of these detailed sectors can be easily converted to TEÁOR'08 classification (Varga and Szabó, 2021). Although, the countries under study do not use the same main activity numbers, they can be matched to a good approximation according to the global industry classification standard (Scafarto et al., 2023).

- To ensure comparability, the provisions of Act XXXIV of 2004 on small and medium-sized enterprises and support for their development in Hungary, which was written in line with EU Recommendation 2003/361/EC (Commission of The European Communities, 2003) were applied.
- In the examined last 2 years (2020–2021), the company met the SME criteria (number of employees and balance sheet total or turnover) in euro equivalent at the mid-rate of 31.12.2021 of the European Central Bank.
- The company was in an active status and submitted annual accounts for at least the years 2020–2021 (Vitéz-Durgula et al., 2023).

In order to clarify the content of the indicators used in the research, the content and calculation formulas of the indicators are summarized in Table 4.

Table 4
Formulae of indicators used in the research.

Liquidity	$Liquidity\ rate = \frac{Current\ assets}{Short-term\ liabilities}$
Indebtedness	$Indebtedness = \frac{Foreign\ capital}{Equity}$
Return on assets (ROA)	$ROA = \frac{Net\ income(Profit\ after\ tax)}{Average\ total\ assets}$
Efficiency	$Efficiency = \frac{Revenue}{Total\ assets}$

Source: own summary based on primary research

3.2. Description of the sample

Table 5 illustrates the distribution of the ten health sub-industries among the companies surveyed in each country. In all the countries, "Human health and social care (Q)" activities are dominant. This sub-industry accounts for 60.7 % of the examined SMEs in the Czech Republic, 73.1 % in Hungary, 43.4 % in Poland and 65.9 % in Slovakia. The activities of the sub-industry "Wholesale of pharmaceuticals and medical products" are also significant: it accounts for 6.0 % of the Czechs, 1.5 % of the Hungarians, 11.3 % of the Polish and 2.6 % of the Slovaks. Similar proportions are included in the "Retail sale of pharmaceuticals" industry (Czech: 8.7 %; Hungarian: 9.4 %; Polish: 6.5 %; Slovak: 8.8 %), the "Scientific R&D industry" (Czech: 4.9 %; Hungarian: 2.7 %; Polish: 12.6 %; Slovak: 5.7 %) and the artificially created "Other health industry production and services" (Czech: 7.0 %; Hungarian: 3.2 %; Polish: 15.5 %, Slovak: 7.5 %).

Fig 2 provides information on the foundation of the enterprises included in the survey. The Hungarian and Slovak healthcare SMEs showed high differences, while the distribution of start-up dates of Czech SMEs in the health sector is relatively even. In Hungary, the

Table 5
Distribution of health enterprises by activity.

Type of activity	*Czech Republic*	*Hungary*	*Poland*	*Slovakia*
Manufacture of pharmaceutical raw materials	1.5	0.1	1.6	0.3
Manufacture of medical devices	5.3	3.6	2.9	1.3
Wholesale of pharmaceuticals and medical products	6.0	1.5	11.3	2.6
Retail sale of pharmaceuticals	8.7	9.4	6.5	8.8
Retail sale of medical products	1.8	1.7	3.6	2.2
Scientific R&D	4.9	2.7	12.6	5.7
Veterinary healthcare services	1.6	2.9	0.3	0.4
Human health and social care	60.7	73.1	43,4	65.9
Physical well-being services	2.4	1.8	2.3	5.3
Other human healthcare-related production and service activities	7.0	3.2	15.5	7.5

Source: own compilation based on Crefoport database

highest number of health SMEs was established in 1995–1996, while in Slovakia the highest number of SMEs in the sector was established in 2005–2006. The reasons for this are likely to be related to health (and economic) reforms and measures. In Hungary, the role of the private sector was recognised and its legal framework established in the first half of the 1990s, and legislation allowing the establishment of enterprises was passed in 1989 (Orosz, 2018). In Hungary, the privatisation process in hospitals was started in the early 1990s and became more pronounced from the mid-1990s. Hospitals outsourced not only non-medical services (laundry, catering, maintenance, etc.) but also some medical activities (in particular diagnostics, physiotherapy, on-call services, but also the operation of certain wards) (Orosz, 2001). During the first democratically elected Hungarian government (1990–1994), major innovations in financing mechanisms were introduced and proved to be long-lasting. General practitioners were allowed and even encouraged to become self-employed. Shortly afterwards, the privatisation of formerly state-owned pharmacies took place. In addition, a number of specialists: obstetricians-gynaecologists, dentists, psychologists, etc., set up private practices and treated patients in their own practices (Mihályi, 2017).

As to the reason why such a high proportion of Slovak SMEs established in 2005–2006 were included in the sample, a possible explanation could be the introduction of market competition in 2004 and the incorporation of additional market elements into the healthcare system through healthcare-related policy measures. Two of the most important of these were the liberalised prices and defined criteria based on flexible contracting, and a minimum network of providers defined by the Ministry of Health to ensure access to healthcare. Other important factors could include the abolition of the state monopoly on healthcare, privatisation, increased participation of municipalities in health systems, and the transformation of health insurance funds into joint stock companies to improve efficiency and stop debt accumulation (Nemec, 2007; HPI.sk, 2014).

4. Results

4.1. Testing of hypothesis 1

For testing the first hypothesis (The financial performance of SMEs in the healthcare sector shows significantly similar characteristics in the V4 countries) correlation analysis was carried out to verify the relationship between the indicators, the correlation measures were calculated for the four selected indicators by country and by year.

Based on the results obtained, there is a strong negative relationship between liquidity and indebtedness of the analysed Hungarian healthcare SMEs, which increased over the studied time period. According to the coefficient of determination, 87.8 % of the variation of indebtedness can be explained when the liquidity is fed to the regression model (Fig 3).

There is a strong negative correlation between the liquidity ratio and the indebtedness ratio as the linear correlation coefficient ($r = 0.937$) shows. Thus, there is a detectable relationship between liquidity and the total indebtedness of the company, liquidity influencing the leverage ratio of companies. Companies with ample liquidity are not forced to borrow to the same extent as less liquid companies. They use their own liquid assets to finance their investments and developments, i.e. if the company has internal resources available, of which after-tax profits are an important element and thus has a high self-financing capacity, it will

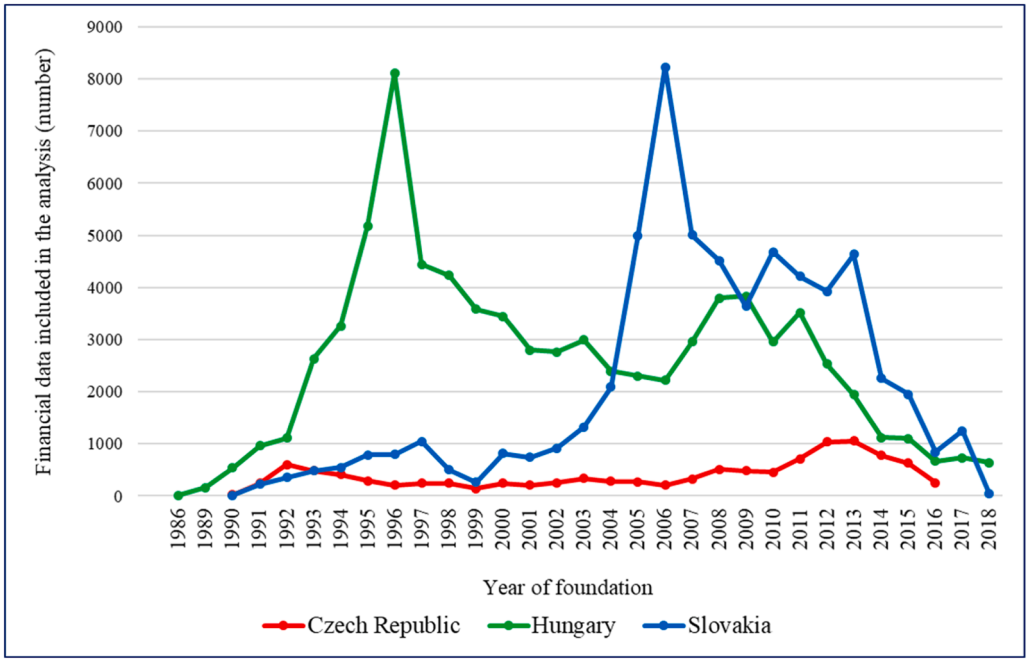

Fig. 2. Date of foundation of healthcare companies in three Visegrad Countries, Note: Polish healthcare SMEs are not displayed due to missing data., Source: own figure based on Crefoport database.

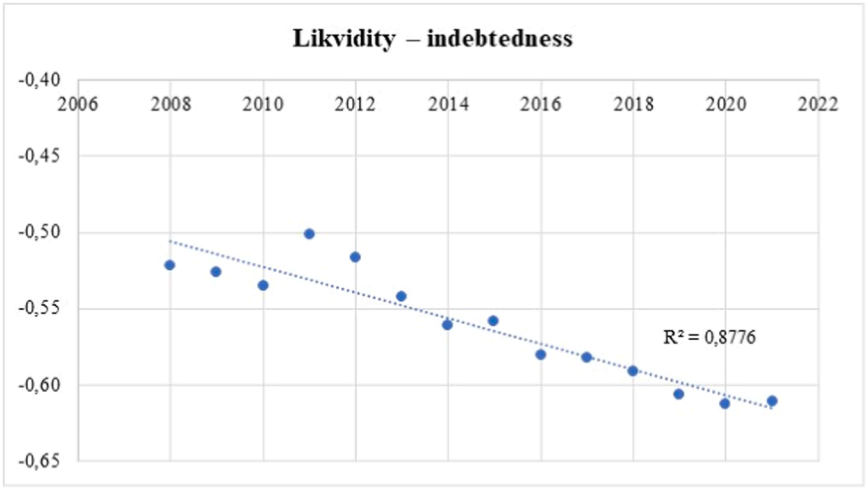

Fig. 3. Correlation values between liquidity and indebtedness among Hungarian healthcare SMEs over the examined period Source: own research results.

meet its financing needs from these internal resources and not by credits. A similar result was obtained by Szemán (2017), who investigated the validity of capital structure theories in the services sector.

A negative correlation between indebtedness and liquidity is usually a sign of a company's financial health. The variation in the strength of the relationship can be explained by the components of each financial indicator. A decrease in leverage indicates that firms are able to use their own capital efficiently for financing and investment. Such firms may be self-sustaining and less dependent on external financing. As the number of businesses is growing in this industry – for example General Practitioners and dental practices - they can be set up with little registered capital (an equity component). Reduced debt burdens can reduce financial risk, and increased liquidity can allow companies to be more resilient to financial crises and market volatility. Strong negative linear relationship may suggest that firms that use less debt and have high liquidity may be more inclined to use their own resources efficiently to improve growth and profitability. Financial stability and self-sustainability may create opportunities for Hungarian healthcare SMEs to pursue a sustainable growth strategy.

Further examining the relationship between the two financial indicators using analysis of variance, we find that the null hypothesis is rejected at the 95 % confidence level based on the value of the test statistic ($F = 86.031$; $p = 0.000$). 87.8 % of the variation in indebtedness can be explained by changes in liquidity.

Given our data of Hungarian healthcare SMEs, no linear regularity can be described for the other pairs of financial indicators in the years under study, i.e. no relationship (correlation measure = 0 or very close) or a weak relationship (correlation measure between 0 and 0.2). In the case of the Hungarian healthcare SMEs under study, it can be shown that the financial indicators under study are correlated, significance can be confirmed, but the closeness decreases over time.

When illustrating correlation relationships between selected financial indicators (Fig 4), significant changes can be observed from 2016 onwards. Until 2015, the relationship between the liquidity ratio and return on assets (ROA) is weak and gradually weakening; thereafter, the relationship strengthens, although it remains within the weak range (below 0.3). These patterns are closely associated with shifts in the macroeconomic environment.

In Hungary, the central bank base rate declined below 1 % in 2016 and remained at historically low levels until 2021. In parallel, lending rates – particularly those on longer-term loans – also declined to very low levels. This low interest rate environment stimulated investment activity among healthcare enterprises as well. During the period of "cheap money," improvements in firms' liquidity positions (as reflected in higher liquidity ratios) were accompanied by an increase in ROA values leading to a slight strengthening of the relationship between these two indicators.

Among real investments, investments in quickly yielding current assets became increasingly prominent. These investments contributed to an increase in the numerator of the liquidity ratio (while, naturally, also affecting the denominator, except for the portion financed by own resources), and simultaneously exerted a favourable effect on income generation.

Based on the data presented in Fig 4, the relationship between indebtedness ratio and ROA of Hungarian healthcare SMEs appears to be weakly positive up to 2015 and subsequently shifts to a weak negative association in the later period. The positive relationship observed prior to 2015 may suggest that, during this period, increases in indebtedness

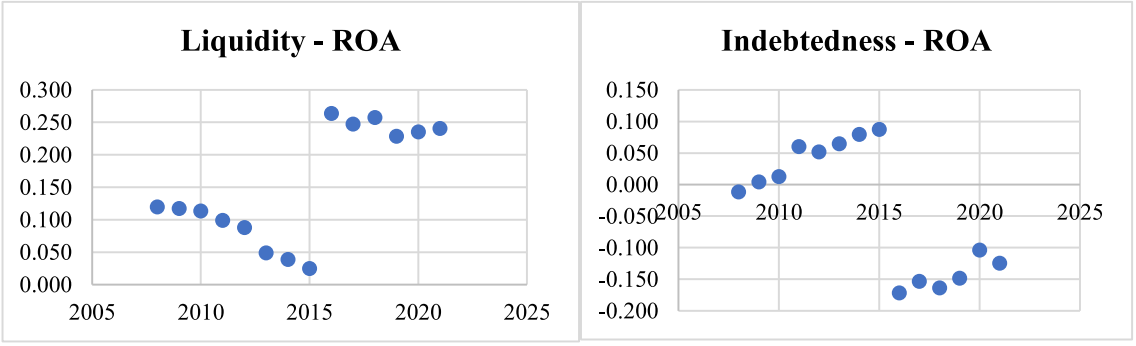

Fig. 4. Trends in Pearson correlation coefficients between liquidity ratio and ROA, and between indebtedness ratio and ROA among Hungarian healthcare SMEs over the examined period, Source: own research results.

were generally associated with higher ROA, despite relatively high lending rates. One possible explanation is that debt financing was allocated to assets generating returns that exceeded the corresponding interest costs.

In contrast, after 2015 – when lending rates declined to historically low levels – the relationship between indebtedness and ROA turned negative, albeit remaining weak. This pattern is consistent with the interpretation that the availability of cheaper credit may have led firms to adopt less disciplined borrowing and investment behaviour, with comparatively less emphasis on the efficiency of debt-financed resource allocation.

In case of the examined SMEs both the hierarchical and the capital structure choice theories may be observed. In the context of capital structure theories, various liquidity-related approaches are proposed, though a number of these remain unsupported by empirical evidence. The hierarchical (pecking order) theory states that companies with a high liquid asset base mobilize this asset base to finance their investments and do not turn to banks for credit (or to investors for capital). There are also views that companies with a high liquidity ratio can undertake and receive credit with a good chance, since they are able to fulfil their loan repayment obligations to the bank. According to the hierarchy theory, companies do not aim to ensure a constant leverage ratio but have preferred sources from which to finance their capital needs. (Myers, 1984). Companies prefer internal financing and adjust the size of dividend payments to investment opportunities. Even when using external resources, the company strives for security. The hierarchy theory does not assume an optimal debt-equity ratio. Choice theory is another important theory describing the capital structure of enterprises which assumes that management chooses among the resources in a way that influences the value of the company and that those resources are preferred that can achieve tax savings. (Brusov - Filatova, 2023) An important element of the trade off, i.e. the choice theory, is that interest has a tax shield, but with the increase in the debt ratio and the decrease in the value of the company, the costs of financial difficulties also appear. In the interpretation of the choice theory, therefore, there is an optimal credit ratio, which can explain the differences between sectors.

Among the Czech healthcare SMEs of the sample, the correlation is most evident for the Indebtedness – ROA indicator and Indebtedness – Efficiency indicator pairs. In the former case, empirical results suggest that the among the surveyed Czech enterprises, the leverage is steadily improving, as well as profitability has increased since 2014 (the period under study). An ideal situation in which the efficiency of the companies in the industry increases while leverage improves, debt burden decreases.

For the indebtedness – efficiency indicator pair, the linear relationship is strong at 0.778, i.e. 77.8 % of the change in efficiency can be explained by the change in indebtedness (Fig 5).

The strong negative linear relationship, probably due to that the sample's debt stock is decreasing and efficiency shows a mixed picture (initially increasing, stagnating and then decreasing), may indicate a lack of efficiency-enhancing investments; accumulated debt in the past; changes in external environmental factors (business cycles, prices, market competition and legal regulation). Based on the test statistic ($F = 42.11$; $p = 0.000$), the null hypothesis is rejected at the 95 % confidence level.

In case of the examined Slovak healthcare SMEs, medium and strong relationships are observed in Liquidity – Efficiency, Indebtedness – ROA and Indebtedness – Efficiency financial indicator pairs.

Liquidity and efficiency of the Slovak SMEs in the sample show a moderately strong correlation ($r = 0.7321$). The linear negative relationship is probably due to excess liquidity. As it has been already seen, the industry under study has high liquidity (too many liquid assets on its balance sheet in the form of large amounts of cash or readily marketable investments), and therefore liquidity may reduce efficiency, as the firms under study do not make adequate use of the available cash resources for investments or to increase the efficiency of their operations.

When examining the relationship between indebtedness and profitability for the Slovak SMEs studied, it can be concluded that there is a weak negative relationship between the two indicators ($r = 0.6579$). Thus, there is a detectable relationship between profitability and the total indebtedness of the company. Profitability affects the debt to equity ratio of the company. This leads to the conclusion that profitable companies are not forced to use debt to the same extent as less profitable ones. They are able to finance a higher proportion of their investments and improvements exclusively from internal sources. In Slovakia, indebtedness shows a stagnating and decreasing trend, while profitability shows a stagnating and slightly increasing trend. There may be several reasons for this discrepancy: it is possible that most of the SMEs in the health sector has accumulated higher levels of debt in the past and that the resulting debt burden is still present, which may have an impact on current profitability. In addition, investments to improve profitability (introduction of new products or services, efficiency gains in customer acquisition, production process) that reduce debt levels little or only to a small extent may be considered.

There is a strong positive linear relationship between indebtedness and efficiency ($r = 0.8803$) for the Slovak health SMEs, which can be

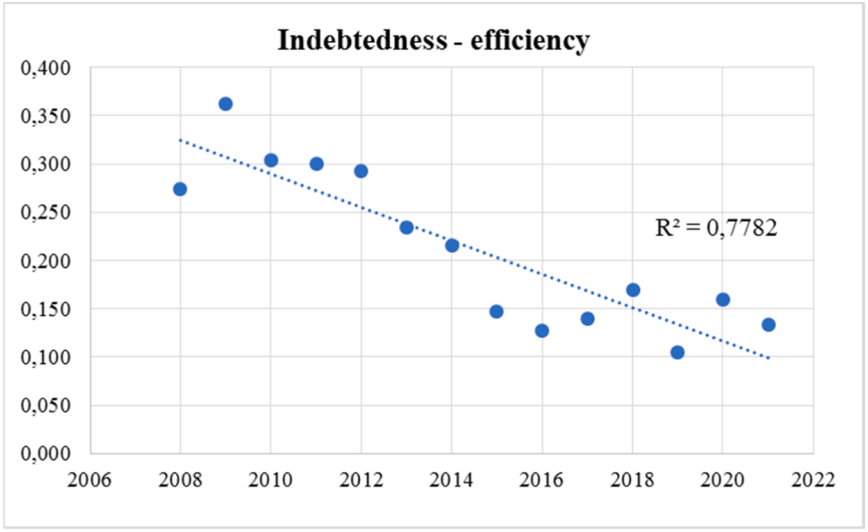

Fig. 5. Correlation values between indebtedness and efficiency among Czech healthcare SMEs over the examined period Source: own research results.

attributed to two factors: the borrower firms (in the start-up phase or in case of new investment) are efficient, their profits exceed their periodic borrowing costs, or the share of equity in the capital structure increases (e.g. based on the test statistic ($F = 24.09$; $p = 0.000$), the null hypothesis is rejected at the 95 % confidence level (Fig 6). The phenomenon may seem counterintuitive but let us look at the possible reasons: if firms have previously managed higher debt, but now have successfully reduced this debt burden, the previous debt management may contribute to the current efficiency improvement, with a parallel increase in equity. Firms may make capital injections that increase efficiency but do not require significant debt raising (financed from own resources). Increasing revenues and/or reducing costs may also have an efficiency-enhancing role.

Polish healthcare SMEs included in the study have a shorter time series (5 years) and the correlation metrics are quite different from those of the other 3 countries studied. The relationship between liquidity and indebtedness is significant and has a negative sign, a phenomenon consistent with hierarchy theory.

Fig 7 shows that there is a strong negative relationship between liquidity and indebtedness ($r = 0.8652$). This suggests that there is a detectable relationship between liquidity and total indebtedness of the enterprises in the Polish SMEs under study, i.e. liquidity affects the debt to equity ratio of the enterprise.

A negative linear correlation between liquidity and indebtedness can occur when liquidity is high and indebtedness declines or remains stable. Companies tend to rely more on their own resources and try to minimise debt burdens, which may keep indebtedness low and liquidity high, leading to a negative correlation. Based on the test statistic ($F = 8.93$; $p = 0.000$), the null hypothesis is rejected at the 95 % confidence level. In 74.8 % of cases, the change in indebtedness explains the change in liquidity (Fig 7).

In a shorter time series analysis of the Polish SMEs in the healthcare sector, it is seen that indebtedness is stagnating or decreasing, which does not imply that they are initiating costly initial investments from external sources, are pursuing intensive R&D activities, while at the same time the growing demand creates opportunities to increase their revenues. The strong positive linear correlation between indebtedness and efficiency in this context may suggest that firms are able to use their equity capital efficiently to improve growth and efficiency. A reduction in leverage may indicate the autonomy, viability, and sustainability of firms. Based on the test statistic ($F = 7.97$; $p = 0.000$), the null hypothesis is rejected at the 95 % confidence level. 74.9 % of the variation in indebtedness explains the change in efficiency.

Continuing the series of statistical tests, in order to detect the concordance of the expected values, the Levene test was first performed to determine the homogeneity of variance. If the concordance of variance can be detected, ANOVA can be used, if not, it is necessary to continue the analysis with robust tests, e.g. Brown-Forsythe or Welch test (Welch, 1938) (Table 6).

As indicated in Table 6, in case of Indebtedness – ROA, the application condition of ANOVA, the equality of variances within the group is met, so the variance analysis could be performed. Based on the value of the test statistic ($F=15.522$; $p = 0.000$), a significant relationship between indebtedness and ROA can be found, which is not due to chance. Further analysing the other pairs of indicators with Welch and Brown-Forsythe tests for heteroscedasticity, the concordance of group means could not be confirmed. The Welch test for Liquidity – Indebtedness, Liquidity – ROA, Liquidity – Efficiency confirmed that the standard deviation averages were different. The Brown-Forsythe test for Liquidity – Indebtedness showed that the standard deviations were different.

There are two types of mean comparison tests that complement analysis of variance: 1) preliminary, so-called a priori contrasts and 2) post hoc analyses. The post hoc analysis (Table 7) concludes that for the financial indicators of the Visegrad Countries included in the study, only the correlation coefficients between indebtedness and efficiency are similar (i.e. the same for all four countries). For all other pairs of indicators examined, there are differences.

The result, which emerged from the verification of our first hypothesis is the following: the financial typologies of the Visegrad Countries' health SMEs show similarities in terms of liquidity-viability-indebtedness-efficiency. They are significantly similar for indebtedness-efficiency in all four countries under study.

4.2. *Testing of hypothesis 2*

For testing the second hypothesis (Clusters of healthcare SMEs in the V4 countries can be formed with the same financial typology, and there is no interoperability between these clusters in the examined period between 2008 and 2021) cluster analysis was conducted. The cluster analysis aims to classify SMEs in the health sector in each country into relatively homogeneous groups based on the financial indicators examined. We opted for a non-hierarchical cluster analysis and used the K-means procedure because of the large number of data and the lower dependence on the data showing extreme deviations. Several cluster numbers were given, and finally the three-cluster solution was chosen as it was considered to provide the most specific clusters.

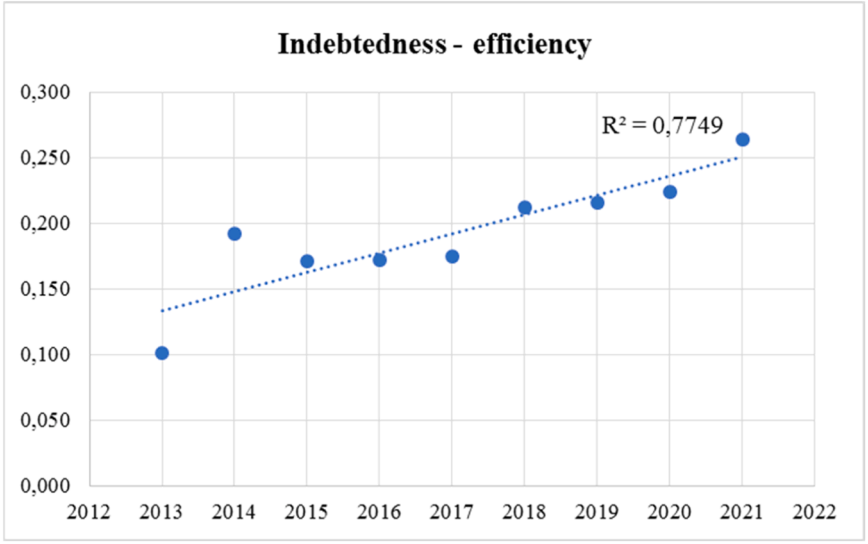

Fig. 6. Correlation values between indebtedness and efficiency among Slovak healthcare SMEs over the examined period, Source: own research results.

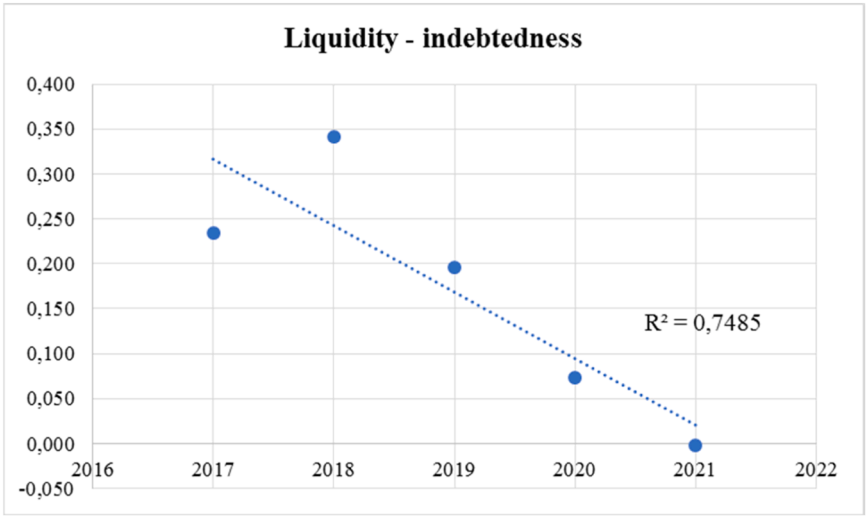

Fig. 7. Correlation values between liquidity and indebtedness among Polish healthcare SMEs over the examined period, Source: own research results.

Table 6
Summary table of correlation analysis.

Relationship	Levene test				ANOVA				Welch test				Brown-Forsythe test			
	Levene	*df1*	*df2*	*p*	*F*	*df1*	*df2*	*p*		*df1*	*df2*	*p*		*df1*	*df2*	*p*
Liquidity – Indebtedness	10.5	3	41	0.001					45.80	3	13.122	0.000	67.928	3	14.52	0.000
Liquidity – ROA	3.506	3	34	0.026					9.908	3	12.628	0.001	7.040	3	7.060	0.016
Liquidity – Efficiency	17.779	3	38	0.000					21.564	3	12.822	0.000	15.766	3	4.688	0.007
Indebtedness – ROA	1.725	3	35	0.180	15.522	3	35	0.000								
Indebtedness – Efficiency	8.775	3	38	0.000					6.795	3	12.477	0.006	2.607	3	7.935	0.124
ROA – Efficiency	17.305	3	32	0.000					6.322	3	10.685	0.010	9.177	3	7.042	0.008

Source: own research results

Table 7
Correlation analysis using post hoc analysis.

Relationship examined	post-hoc analysis		
	subset1	*subset2*	*subset3*
Liquidity – Indebtedness	Hungary, Slovakia, Czech Republic	Poland	
Liquidity – ROA	Hungary, Czech Republic	Slovakia, Czech Republic	Slovakia, Poland
Liquidity – Efficiency	Hungary, Slovakia, Czech Republic	Poland	
Indebtedness – ROA	Slovakia, Czech Republic	Hungary, Czech Republic	Poland
Indebtedness – Efficiency	Hungary, Slovakia, Czech Republic, Poland		
ROA – Efficiency	Hungary, Slovakia, Czech Republic	Poland	

Source: own research results

Cluster 1: Frontrunners, the liquidity legends of the healthcare industry

Their main characteristics are maximum liquidity, minimum indebtedness, maximum ROA, medium efficiency. This group has remarkably high liquidity (above 4) in all four countries, which may indicate that they have a very conservative, cautious investment approach. They have untapped capacity that could be used either for innovation or product/service development. In addition, they have the lowest capital structure index of the three clusters (around 0.2), indicating less reliance on external sources, a stable and balanced capital structure, dominated by equity.

According to ROA, all assets of the companies under study generated on average a return of 10–20 % over the period under study, i.e. these companies use their assets efficiently to achieve profitability. This is also confirmed by the efficiency ratio, which is in the middle of the three clusters (except for the Polish values) with a value of 1.2–1.4. This higher efficiency indicates that the health SMEs in the cluster are running their businesses efficiently and managing their resources optimally. Overall, the financial ratios studied characterise a cluster of health SMEs that is highly liquid, with low indebtedness, but at the same time highly profitable and operating sufficiently efficiently to maximise profits.

Cluster 2: Survivalists, the effective profit makers of the healthcare industry

Their main characteristics are the medium to remarkably high liquidity, medium to high indebtedness, medium ROA, maximum efficiency. The common feature of the healthcare SMEs in the second cluster is a lower but still high liquidity (except for Poland) of 1.9–2.3, which is considered to be quite ideal, for all four countries under study. This group has a medium-high to high capital structure value, which generally indicates that this established group of companies relies more on debt capital for its operational processes and investments and has less equity capital.

ROA is lower in this group (lowest in the Czech Republic at 9 % and in Poland at 12 %), ranging from 16 % to 17 %, meaning that the efficiency of the companies in this group in making their assets profitable is more moderate. On the other hand, this cluster has the highest efficiency ratio (apart from Hungary) above 2.0, meaning that these companies are highly efficient. To summarise the characteristics of this cluster, this group of enterprises is less liquid but still very liquid, relies more on external sources, but operates with high efficiency and good to medium profitability.

Cluster 3: Breakaways, the inefficient players of the healthcare industry

Their main characteristics are the minimum liquidity, high indebtedness, minimum ROA, minimum efficiency. The liquidity of this group is the lowest of the three clusters formed. The companies in this group may face challenges in financing their short-term liabilities, as the indicator is below 1 when the company's liquid assets cover its short-term liabilities. The highest indebtedness is found here, excluding Poland, i.e. companies in this group rely heavily on debt and have a low equity ratio. Enterprises with the lowest return on assets and the lowest efficiency may be found here, so there are areas where they need to improve and develop. In summary, this group of enterprises has low liquidity and high capital structure and, although their profitability is satisfactory, there may be room for improvement in their efficiency.

Table 8 displays how the indicators relate to each other in the four countries and the three clusters. It can therefore be stated that relatively homogeneous groups can be formed on the basis of typical financial characteristics in each country, and the clusters formed in each country can be closely matched to the group representing the Visegrad countries together. There are differences among the Polish SMEs examined, probably due to the smaller number of elements. Due to the greater distance between the individual clusters, interoperability is difficult and not typical.

The total number of cases is 151,210, of which 68,514 missing values represent 45.3 %. A case can only be classified into a cluster if the values of all variables used are available. In these cases, with missing values, one of the four variables is missing.

5. Discussion

In the present study, we investigated whether health SMEs also show similarities across countries and whether they bear the characteristics of the burdened health system of which they are an integral part. Our empirical investigations have confirmed both hypotheses.

Table 8
Results of the cluster analysis.

		Cluster 1	Cluster 2	Cluster 3
Czech Republic	Liquidity	4.613	1.970	0.558
	Capital structure	0.220	0.716	0.698
	ROA	0.115	0.095	0.065
	Efficiency	1.414	2.089	0.903
Hungary	Liquidity	4.985	2.361	0.806
	Capital structure	0.162	0.470	0.797
	ROA	0.174	0.166	0.119
	Efficiency	1.380	1.849	1.229
Slovakia	Liquidity	4.704	2.115	1.110
	Capital structure	0.223	0.729	0.909
	ROA	0.202	0.180	0.104
	Efficiency	1.216	2.087	0.681
Poland	Liquidity	4.065	1.137	0.107
	Capital structure	0.248	0.635	0.194
	ROA	0.108	0.123	0.006
	Efficiency	0.899	2.382	0.074
V4 countries combined	Liquidity	4.743	2.087	0.945
	Capital structure	0.198	0.625	0.814
	ROA	0.181	0.168	0.106
	Efficiency	1.299	2.109	0.883
Case numbers included in the cluster analysis				
Clusters	1.	32 348		
	2.	21 519		
	3.	28 829		
Total number of cases involved		82 696		
Missing number of cases		68 514		

Source: own research results

There is a good number of works available on other aspects of the topic, including a study of the health sector in some V4 countries (Dettenhofer et al., 2018; Ben-Am et al., 1999), focusing on healthcare reforms and the state of the healthcare system (Anton and Onofrei, 2012; Orosz, 2017; Hejduk ova and Kureková, 2017; Horváthová and Dobbins, 2021; Nemec et al., 2023) or on industry-specific firm performance (European Commission - EISMEA, 2022, European Investment Bank, 2023). Beyond this baseline studies we could not find any empirical research based on the comparison and clustering of financial indicators of aggregate health SMEs in the V4 countries to compare our results with. However, if we look at the sub-industries or at the full set of companies, there are already some comparable studies on company performance and financial indicators. Fenyves et al. (2019) report on the profitability of pharmaceutical companies in the Visegrad Countries. Scafarto et al., (2023)), among others, examine the financial performance of V4 healthcare companies in the context of digitalisation.

The main focus of our study is the enterprise segment, as healthcare enterprises (especially startups and SMEs) play a key role in innovation, improving healthcare and the economic growth of the healthcare industry. Research can be pursued in a number of directions. The primary data collection can be extended by mapping innovation in the health sector in the CEE region, looking at the performance of projects, enterprises and companies that are innovators. Separating and examining the public and private health (healthcare) sectors would provide further relevant explanations for the indicators and processes under study.

Due to the peculiarities of the Crefoport database, the number of Polish companies included in the study is smaller and shorter than in the Czech, Slovak and Hungarian datasets, so our results cannot be considered representative for Poland. A future study focusing on representative financial indicators could provide further clarifications/confirmations. When looking at the financial performance of the SME sector of the healthcare industry, aggregate data for the sector as a whole do not allow to identify changes and trends in the individual industries of the healthcare industry in the given years, and a more detailed analysis of these could be a basis for further research. Valuable results could be obtained by adding a bankruptcy forecast. This would allow businesses, investors and public actors to better manage risk and prepare for crises.

The results of the research can help to better understand the economic role of SMEs in the health sector in the countries studied in a period of crisis. It provides a deeper insight into the financial performance of the sector and helps to identify the economic characteristics that affect the competitiveness of the enterprises. It can inform policy makers in determining support for the SME sector; it can also support the background analysis of health policy measures.

6. Conclusions

Today, 30 years after the collapse of communism, Central and Eastern European countries continue to struggle to provide sufficient public funding for healthcare and catch up with Western European countries (Thomson et al., 2016). The 2008 global economic crisis has perpetuated the disparities between Eastern and Western Europe (Kieny, 2017), highlighted by the coronavirus pandemic. In comparison with OECD member states, the V4 countries' health systems continue to underperform, with high population exposure to health risks and health system deficiencies contributing significantly (OECD, 2021a, b, c, d).

Our empirical analysis shows that similar processes have been taking place in the financial processes of SMEs in the health sector in the V4 countries during the period under review, but with different outcomes, as the health sector is also affected by measures in a number of other areas. For this reason, with health, social and economic measures being similar in many cases, there are already major differences when comparing health SMEs.

Our results show that the same trends are taking place in the

countries studied, with significant differences in their strength. These findings allow for a better understanding and future projection of trends and phenomena affecting the health sector and the health industry in the V4 countries. The many similarities allow business models and financial-financing strategies that work well to be easily replicated in the other countries studied. From the point of view of international usability, it may be relevant to examine healthcare SMEs in the other former socialist countries; do they show similar characteristics? This would allow the development of a coherent strategy and action plan based on the region's healthcare SMEs, taking into account common historical, geographical, and cultural characteristics and focusing on improving the quality of healthcare.

Our findings and conclusions will enable policy makers to better take into account the specificities and needs of SMEs in the health sector in the V4 countries when designing and implementing SME and health policies.

CRediT authorship contribution statement

Dunay Anna: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Funding acquisition, Conceptualization. **Hoschek Mónika:** Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Vitéz-Durgula Judit:** Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Formal analysis, Data curation, Conceptualization. **Pataki László:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization. **Illés Csaba Bálint:** Validation, Supervision, Project administration, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Ethical statement

This study was conducted in accordance with ethical guidelines and principles. Since no human participants, animals, or sensitive data were involved, formal ethical approval was not required. All applicable ethical considerations were adhered to throughout the research process.

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Declaration of Competing Interest

The corresponding author declares that the authors (Anna DUNAY, László PATAKI, Csaba Bálint ILLÉS, Mónika HOSCHEK, Judit VITÉZ-DURGULA) **have declared no conflict of interest,** i.e there are no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The data that support the findings of this study are available from the corresponding author, [L.P, J. V-D.], upon reasonable request.

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