Economic Research-Ekonomska Istraživanja

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rero20

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To cite this article: Beata Gavurova, Matus Kubak & Zuzana Vaculcikova (2024) Quantification of factors influencing differences in the Case Mix Index and their significance for health systems sustainability, Economic Research-Ekonomska Istraživanja, 37:1, 2341216, DOI: 10.1080/1331677X.2024.2341216

To link to this article: https://doi.org/10.1080/1331677X.2024.2341216

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA
2024, VOL. 37, NO. 1, 2341216
https://doi.org/10.1080/1331677X.2024.2341216

Quantification of factors influencing differences in the Case Mix Index and their significance for health systems sustainability

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ABSTRACT

Case Mix Index (CMI) represents a standard indicator of hospital disease seriousness at both the national and international level. CMI is structured to compute hospital payments and not to follow up disease seriousness. It is considerably related to the data accuracy as well as patients' medical records. The main aim of the study was to quantify the factors influencing the differences in CMI depending on the types of healthcare facilities, their geographical location, as well as the procedural aspects within the Slovak healthcare system. We use data published by the Institute for Economic and Social Reforms, which continuously surveys the quality and outputs of healthcare provided in the Slovak Republic. The data comes from multiple datasets that are issued by healthcare authorities and stakeholders is the Slovak Republic such as insurance companies, the Ministry of Health of the Slovak Republic, the Ministry of Finance of the Slovak Republic, healthcare facilities, the National Health Information Centre etc. Regression analysis indicates that the positive impact on the Case Mix Index is possessed by the Operating experience of doctors and Overall inpatients satisfaction; whilst the negative impact on Case Mix Index values is documented for variables Total rehospitalisation within 30 d, Intensive care unit mortality, Economy, and Transparency.

ARTICLE HISTORY
Received 11 October 2022
Accepted 5 April 2024

KEYWORDS
Case Mix Index; inpatient satisfaction; health system sustainability; medical and economic demands of patient; hospitalised patient

SUBJECT CLASSIFICATION CODES
I10; I11; I14

1. Introduction

The issue of the sustainability of the countries' health systems has been of interest to professional and scientific teams for many decades. Heterogeneity of the health systems, the policy systems, the demographic structure and many other factors affect the

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methodological complexity of the evaluation of the health processes. In the recent years, the Case Mix Index (CMI) has been intensively used as a baseline for the development of new economic and health assessment systems in hospitals. The CMI expresses the average economic and medical demands of patients hospitalised in a hospital. CMI is the arithmetic mean of the relative weights of all the hospitalisation cases over a certain time period. The relative weight of a hospitalisation case is an empirically determined value that expresses the ratio of the average cost per hospitalisation case of the respective DRG group (Diagnosis Related Groups), where the cases are grouped with similar clinical characteristics and similar treatment costs to the average cost per average case (INEKO, 2021).

With an increase in the number of cases with the highest complexity, it is also important to record secondary diagnoses, which it is necessary to revaluate standard payment models in hospitals, the effects of changes in coding on the standard payment model, and so forth. There are many interventions aimed at improving clinical documentation and coding that can also have the effect of increasing the number of hospitalisations in different hospitals despite providing similar healthcare to the same type of patients with the same disease severity. This calls for educational systems in the field of coding, for hiring specialists in clinical documentation, and so on. There are assumptions that public hospitals will have lower CMIs than private hospitals because public hospitals are not profitable, they have a less financial incentive to increase reimbursements, and may have poorer access to funding for documentation and coding improvement projects (Cousineau & Tranquada, 2007, Dobson et al., 2009). Also, many other factors can affect the differences in CMI values between the hospitals. These consistent facts were a motivation for us to carry out a study, whose main goal was to examine the factors influencing the differences in CMI depending on the type of healthcare facilities, their geographical location as well as the procedural aspects within the Slovak health system.

2. Literature review

The Covid-19 pandemic highlighted the need to examine hospital management and to put strong pressure on the hospital systems both procedurally and financially. Many studies have linked these aspects to the sustainability processes of the health systems (Lyeonov et al., 2021; Sarihasan et al., 2022). The health systems of many developed countries were relatively stable before the pandemic, but each country has its own specifics in the management of inpatient healthcare and its own health policy (Briestenský & Ključnikov, 2020; Gavurová et al., 2019).

During the pandemic, many health systems were burdened by a large number of patients who relied on a reduced number of hospital beds and specialists. The forecast of the development and application of crisis scenarios, which in the conditions of the Covid-19 pandemic lost their validity and timeliness, was problematic too. Even before the pandemic caused by Covid-19, the significant regional differences in health burden were identified not only between the countries, but also within the countries (Chang & Zhang, 2019; Preyra, 2004; Sopko & Kočišová, 2020) and the need to optimise inpatient allocation processes was emphasised in order to achieve a

balance between patient service and resource utilisation. This requires the development of new inpatient bed allocation algorithms in order to improve patient admission rate or higher bed occupancy rate. Chang and Zhang (2019) point out that it is necessary to create a hierarchical medical system that specifies exactly which types of hospitals (for instance primary, secondary, tertiary institutions) will be responsible for the treatment of each complex critical type of disease.

The importance of the creation of optimisation algorithms for the efficiency of treatment processes in hospitals as well as for the sustainability of the health system is also confirmed by the studies by Du et al. (2012), Alam et al. (2014) and others. Pónusz et al. (2019) examine changes in CMI associated with the Diagnosis Related Groups (DRG) system in one-day surgery care for 10 years in a publicly financed Hungarian hospital (almost 2 million publicly funded one-day surgery cases). The authors confirm that the constant increase of the one-day surgery processes use does not affect the increase in CMI at the national level, but the value of CMI is influenced by the type of healthcare institution. This is confirmed by a study by Gratz et al. (2018), who researched the privately financed health care services of Hungarian publicly financed hospitals according to medical fields. For this reason, it is important to develop new methodologies or to improve the ones used so far to evaluate and to compare the efficiency of hospitals, but each methodology works with a number of key assumptions and limitations. This is also pointed out by Nuttall et al. (2015), who developed a methodology for the case-mix adjustment of patient-reported outcome measures (PROMs) data permitting the comparison of the outcomes between the healthcare providers.

Linden and Goldberg (2007) emphasise that revaluation of the methodologies applied in the health management program is important for the correct evaluation of medical requirements. This eliminates an incorrect classification of the cases as low-risk. The properly identified and risk-stratified diseases of patients will allow to set the treatment programme and to adapt the interventions so that the rate of hospitalisation of chronic diseases are positively influenced and a positive return on investment is achieved. Many authors consider the application of CMI in the various hospital wards as an economical tool for finding alternative ways to reduce costs (for instance, Behling & Bierl, 2019; Mabotuwana et al., 2017). CMI is also applied as a tool to optimise the number of nursing staff, social workers and care workers per total staff number in the facilities for the elderly providing long-term care services (Liu et al., 2014; Song & Song, 2019. The design and weights of the individual CMI components also play an important role. Other analytical methods, such as the analytical hierarchical process as well as data envelopment analysis and others, can also significantly help in their determination.

Many studies apply them for evaluation of the health systems at the macro level as well as at the micro level (Faye, 2012), or as a tool for more efficient redistribution of inputs (for instance, physicians between workplaces). Mendez et al. (2013) point to the different CMIs between the hospitals. Their analysis was focused on several types of hospitals and it was performed for the data covering a 14-year time period. The teaching hospitals and larger hospitals had higher average CMI that is consistent with a marker of disease severity, but only for the private hospitals. The public hospitals

had lower CMI across all the subgroups. Although CMI had some characteristics of a disease severity marker, it was lower across all the strata for the public hospitals. Therefore, it is important to use caution carefully to adjust for disease severity across public versus private hospitals. Park et al. (2017) point out the importance of information technologies in improving coding processes within CMI, while considering information technologies systems implemented in hospitals as a tool for preventive upcoding and improving financial processes in hospital accounting systems. Sophisticated information technology tools could also support more accurate records and documentation to calculate CMI and thus, to more accurately determine disease severity and mortality risk. This is also confirmed by the study by Frazee et al. (2015), who point out the importance of an investigation of the effect of patient comorbidities, patient complications and major complications on CMI changes. Joya et al. (2020) recommend a combination of the DRG and CMI systems applied in order to summarise hospital morbidity and mortality.

Corti et al. (2018) proposes the use of a case mix classification system that takes into account the age and gender of patients. According to the authors, aging itself is not the main determinant of increasing healthcare costs, but rather the chronic conditions of patients and the resulting multimorbidity. Halter et al. (2018) draws attention in this relation to the limitations of the individual case mix classification systems and to the need to modify them through the data from physicians treating patients. This will make it possible to better classify the differences between health professions and thus, to shift tasks in primary healthcare provision.

All the presented research studies and their findings declare the influence of several determinants on the differences in the reported CMI between hospitals that also affects the quality and efficiency of healthcare provision, its availability, and the sustainability of the health systems. This encourages research teams to further explore these aspects within national health systems and thus, to support the development of a methodological platform for benchmarking economic and medical processes and increasing the efficiency of their health systems.

3. Methodology

The survey uses data published by the Institute for Economic and Social Reforms, a non-governmental non-profit organisation that monitors economic and social reforms in the Slovak Republic. Institute for Economic and Social Reforms continuously surveys the quality and outputs of healthcare provided in the Slovak Republic and creates the ranking of hospitals. Inputs for ranking coming from multiple datasets that are issued by healthcare authorities and stakeholders is the Slovak Republic. Institute for Economic and Social Reforms retrieves data from health insurance companies, the Ministry of Health of the Slovak Republic, the Ministry of Finance of the Slovak Republic, medical facilities, the National Health Information Centre, self-governing regions, the Health Care Surveillance Authority, Operational Centre of Medical Rescue Service of the Slovak Republic and Transparency International Slovakia (INEKO, 2021). The rankinǵs methodology is governed by the following principles: availability and relevance of information, universality and time stability of data. The

ranking evaluate all 11 university hospitals, and 33 out of 53 general hospitals that operate in the Slovak Republic. To be included in the ranking, hospital have to provide institutional health care in at least five of the following seven specialisations, while the number of hospitalised or operated inpatients is at least 100: internal medicine, surgery, paediatrics, neurology, gynaecology and obstetrics department, neonatology and department of anaesthesiology and intensive care. University hospitals are rated separately and general hospitals likewise. The rating consists of 6 components that are finally reflected into the overall raking of healthcare quality. The overall rating of healthcare facility, resp. hospital consists of six categories of indicators, which are briefly described in Table 1. For an analysis, we use data from 2018 to 2021 for all healthcare facilities that are included in the rating. All indicators are scaled on the scale 0–100, whilst the higher the score of the indicator, the better the healthcare facility is the given domain. Table 1 propose a quick overview on the category of indicators, indicators itself and the weight, which the given indicator contributes to the overall assessment of healthcare facilities.

The purpose of the study is to document the severity of the inpatients diagnosis, thus the average economic and medical intensity of inpatients hospitalised in the hospitals. The severity of the inpatients diagnosis is expressed by the variable Case Mix Index which reflect the ratio of the average costs per hospitalisation case of the respective diagnosis-related group. In other words, the Case Mix Index express the severity, complexity and diversity of inpatient illnesses treated at a given hospital or healthcare facility. The analysis is divided into two parts. The first part of the analysis use descriptive analysis to describe the severity of the inpatients diagnosis due to spatial dimension and due to type of the hospital. In the second part of the analysis, we run regression model to detect statistically significant indicators that affect the Case Mix Index.

4. Results

Firstly, we plot the Case Mix Index distribution during the period of 2018–2021 on the Figure 1. General hospitals are plotted by blue colour, university hospitals are plotted by red colour, whilst a black dashed line outline the average value of the Case

Table 1. Ranking components.

	Category of indicators	Weight	Indicators
Overall Ranking	Quality of provided health care	40%	Reoperation
			Total rehospitalisation within 30 d
			Postoperative mortality Mortality due to acute stroke
			Femur fracture mortality (65+ years)
			Intensive care unit mortality
			Inpatient mortality after transfer from intensive care unit
			Emergency waiting time
			Fines from the Health Care Surveillance Authority
	Experience	10%	Evidence-based hospital referrals
	Severity of inpatient diagnoses	10%	Case Mix Index
	Overall inpatient satisfaction	18%	Overall inpatient satisfaction inpatient complaints
	Economy	12%	Ability to generate own resources
			Overdue debt and its year on year change
	Transparency	18%	Transparency index

Source: own processing.

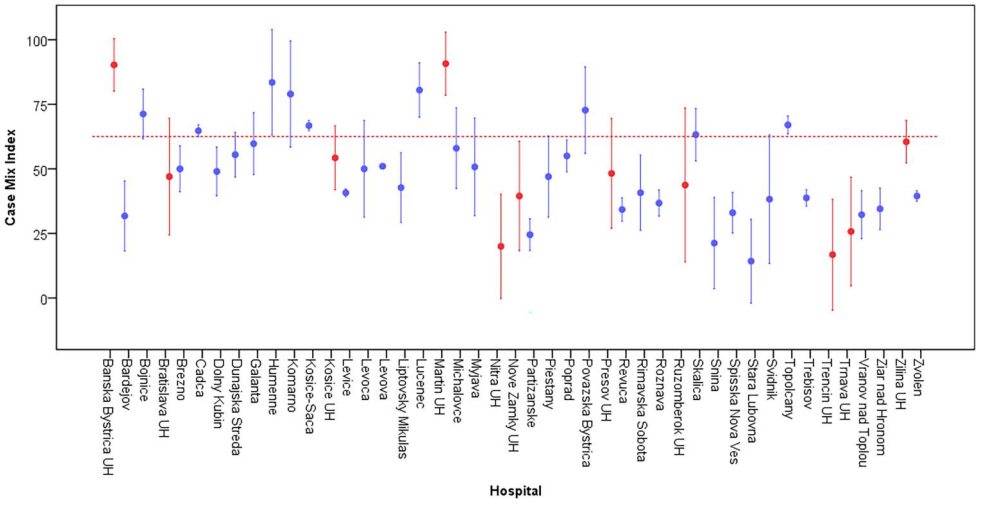

Figure 1. Case Mix Index.
Source: The authors.

Mix Index for the whole sample. It holds that the healthcare facility with a higher Case Mix Index value has on average inpatients with more demanding diagnoses than a hospital with a lower Case Mix Index. It cannot be said that Case Mix Index values, resp. severity, complexity and diversity of inpatient illnesses treated at the given hospitals are proportionally distributed among healthcare facilities in Slovakia and some hospitals are relatively far from the average. Surprisingly, the lowest values of the Case Mix Index are spotted in the majority of the university hospitals, which could be expected to be treating highly sever, complex and diverse diagnoses. Most complex diagnoses are treated in Banska Bystrica university hospital, Martin university hospital, and Humenne, Komarno and Lucenec general hospitals. Hospitals with inpatients with the least demanding diagnoses are Trencin, Trnava, Nitra and Nove Zamky university hospitals and Stara Lubovna, Snina, Partizanske and Bardejov general hospitals.

Further we look on the regional disparities in Case Mix Index distribution, where we bin Case Mix Index values which are continuous variable from the interval [0; 100] into five bins with an equally broad range. The newly created variable takes values from intervals [0; 20], [21; 40], [41; 60], [31; 80], [81; 100]. Figure 2 propose an overview of the distribution of the Case Mix Index with respect to spatial dimension, resp. with respect to the region, where the hospital is located. The mostly bounded cluster is the cluster of mid demanding diagnoses with values of Case Mix Index within the interval [41; 60], where we find mostly hospitals from Bratislava, Trnava and Zilina region. Subsequently the cluster of the relatively low economic and medical intensity of treated diagnosis with Case Index Values from the interval [21; 40] can be defined, where hospitals from Kosice and Presov regions are present. Hospitals with the highest Case Mix Index values are located in the Banska Bystrica region. Finally, we define a cluster of hospitals from Nitra and Trencin regions, where heterogeneous types of hospitals are present as far as Case Mix Index values are concerned, because in these regions we find hospitals with relatively high Case Mix

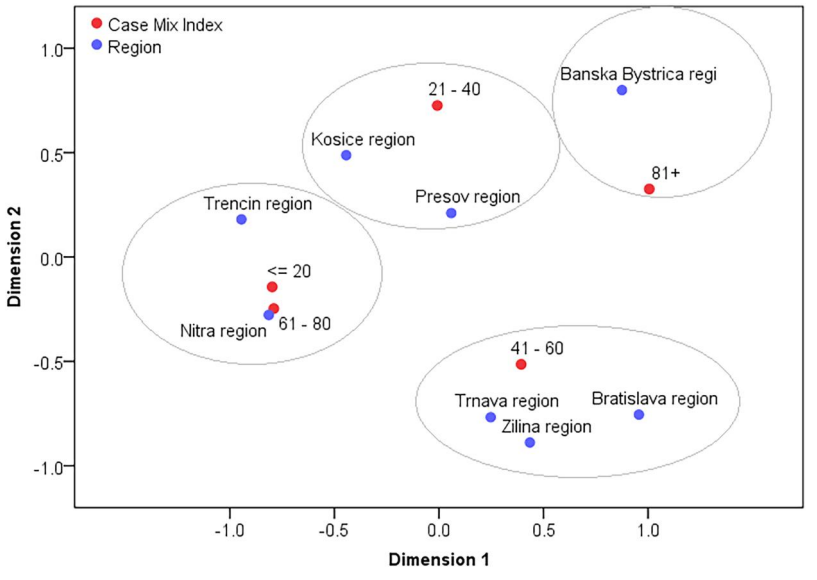

Figure 2. Spatial distribution of Case Mix Index.
Source: The authors.

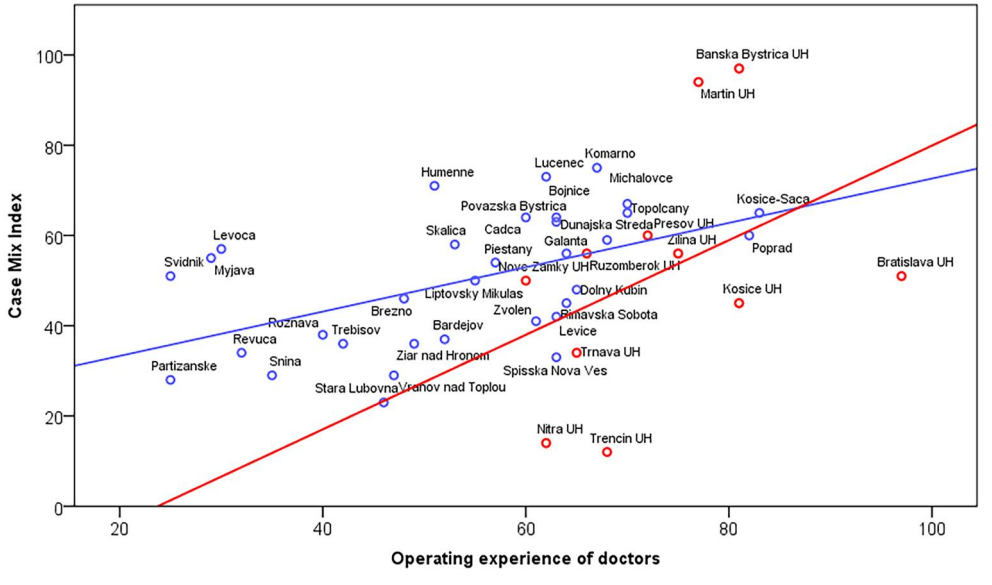

Figure 3. Operating experience of doctors and Case Mix Index.
Source: The authors.

Index values, especially in Nitra region, but also hospitals with lowest values of Case Mix Index.

In following part of the analysis, we look closer on selected characteristics of health-care facilities in relation to the Case Mix Index. Figure 3 plot the relationship between Operating experience of doctors and the Case Mix Index. We note that there is a meaningful relationship between the Operating experience of doctors and the Case Mix Index, especially in the case of university hospitals. Quite interesting is also the

fact that in the case of low values of the variable Operating experience of doctors in general hospitals (blue points and blue regression line) we observe a relatively high values of the Case Mix Index variable, which means that in general hospitals a relatively highly difficult surgeries are performed with lower Operating experience of doctors. Among general hospitals, Svidnik, Myjava and Levoca hospitals are the facilities where most severe, complex and diverse illnesses are treated at markedly weak Operating experience of doctors. The good performance of general hospitals is also documented in a cluster of hospitals above the blue line which is delimited by Humenne and Kosice-Saca hospital. Regarding university hospitals (red points and red regression line), we observe in the case of the variable Operating experience of doctors only above-average values of this variable, which is due to the nature, mission, and complexity of the provided healthcare of university hospitals. In the case of university hospitals, it can be argued that above-average severe, complex, and diverse health care services are provided in the university hospitals in Martin and Banska Bystrica. However, the most complex medical care is provided in the university hospital of Bratislava, although the severity of the medical procedures is relatively low. Below average severe, complex, and diverse health care with respect to the Operating experience of doctors is provided by Nitra and Trencin university hospitals. To conclude, we note that there exists substantial difference in the Operating experience of doctors and Case Mix Index values between general hospitals and university hospitals.

As for the Overall inpatients' satisfaction, which is the summary indicator of the perception of provided healthcare by hospitalised patients, and its relation to Case Mix Index, matters are captured on the Figure 4.

Overall inpatients satisfaction indicator is formed as an aggregate index of the hospital evaluation from the patients' point of view covering the evaluation of their satisfaction with overall care, behaviour and information provided by medical staff, evaluation of accommodation quality, cleanness of the department, dietary

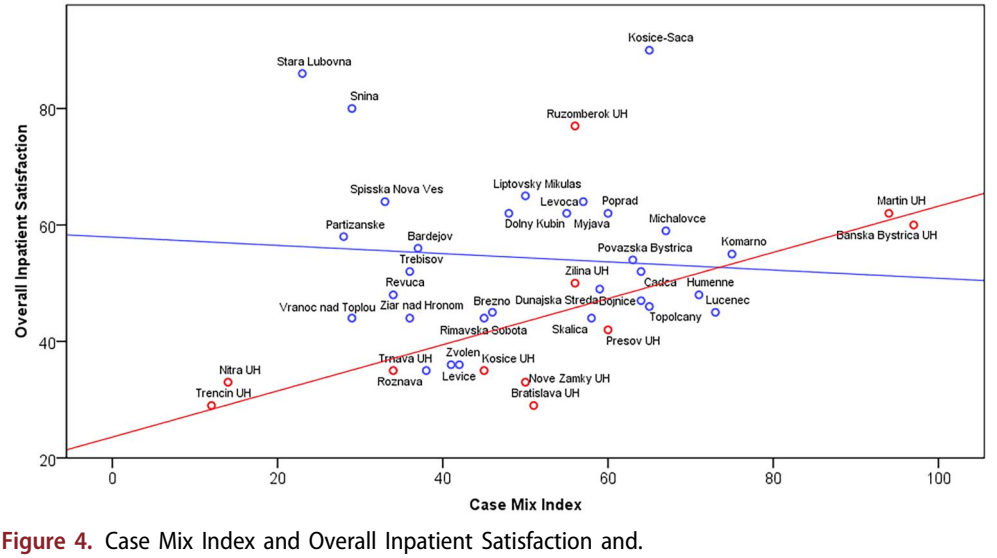

Figure 4. Case Mix Index and Overall Inpatient Satisfaction and.
Source: The authors.

satisfaction, evaluation of satisfaction with provided health care and subjective perception of treatment success. Figure 4 indicates that there exists a substantial difference between Case Mix Index evolution and Overall inpatient satisfaction between general and university hospitals. Regarding general hospitals, we note that with increases in the Case Mix Index, average Overall Inpatient Satisfaction is subtly diminishing, meaning that there is an invert relationship between inpatients satisfaction and the average economic and medical intensity diagnoses/patients treated in a given hospital. On the other hand, in the case of university hospitals, we observe a significant positive dependence between the Case Mix Index and Overall Inpatients Satisfaction. This can be interpreted as the sensitivity of inpatients on the severity, complexity, and diversity of treated illnesses at a given hospital to their overall satisfaction with the medical facility. The lowest ratio of Case Mix Index and Overall Inpatient Satisfaction is observed in Trencin and Nitra University hospitals.

As far as the overall Quality of the healthcare facility and the Case Mix Index of a given healthcare facility is concerned, facts are captured on Figure 5. To remind, the Quality variable is composite indicator composed of Reoperation, Total rehospitalisation within 30 days, Postoperative mortality, Mortality due to acute stroke, Femur fracture mortality (65+ years), Intensive care unit mortality, Inpatient mortality after transfer from intensive care unit, Emergency waiting time and Fines from the Health Care Surveillance Authority. Principally, in the case of the Quality and Case Mix Index variable, there exist differences between general and university hospitals. General pattern is that increases in Case Mix Index variable induce subtle decreases in overall Quality of the healthcare facility in case of university hospitals. In case of

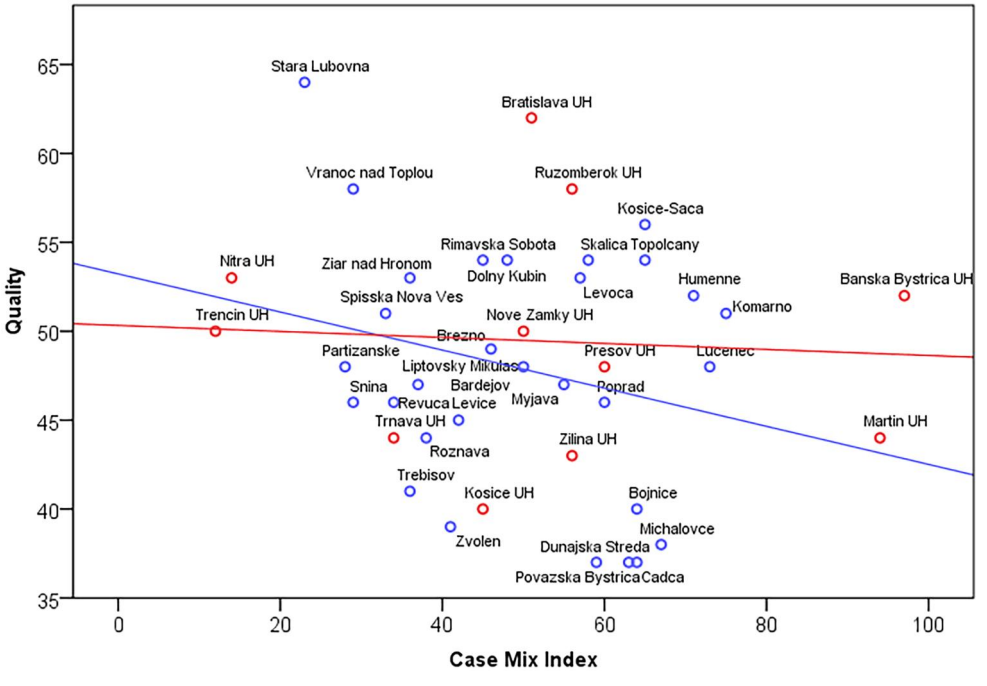

Figure 5. Quality and Case Mix Index.
Source: The authors.

general hospitals, decreases in Quality caused by increases in Case Mix Index are substantial.

Following part of the analysis is devoted to regression analysis which aim is to reveal the variables which significantly influence the Case Mix Index variable values in healthcare facilities. We use linear regression model, which has the following equation:

$$Case\ Mix\ Index = \beta_0 + \sum_{i=1}^{n} \beta_i \times x_i + \varepsilon_i \tag{1}$$

- β_0 is and intercept,
- β_i are the estimated regression coefficients,
- X_i are the set of explanatory variables,
- ε_i error term.

At the beginning of the modelling, we assumed all possible explanatory variables from the ranking, plus basic information about healthcare facilities that were accessible. The initial list of explanatory variables included in the model contained following variables: Total number of inpatients, Total number of operated inpatients, Number of doctors, Number of nurses, Number of inpatients per nurse, Number of inpatients per doctor, Number of operated inpatients per nurse, Number of operated inpatients per doctor, Overall inpatients satisfaction, Reoperation, Total rehospitalisation within 30 d, Postoperative mortality, Mortality due to acute stroke, Femur fracture mortality (65+ years), Intensive care unit mortality, Inpatient mortality after transfer from intensive care unit, Emergency waiting time, Fines from the Health Care Surveillance Authority, Evidence-based hospital referrals, Case Mix Index, Ability to generate own resources, Overdue debt and its year on year change, Transparency index. In the analysis, we also controlled for the type of the hospital, but the regression coefficient is not statistically significant, thus we assume the nature/type of the hospital does not affect the Case Mix Index in a decisive manner. Final, resp. best fitted regression model that comprises only statistically significant explanatory variables has following equation:

$$\begin{aligned} Case\ Mix\ index = {} & \beta_0 + \beta_1 Overall\ Inpatiens\ Satisfaction_i \\ & + \beta_2 Total\ rehospitalization\ within\ 30\ days_i \\ & + \beta_3 Intensive\ care\ unit\ mortality_i \\ & + \beta_4 Operating\ experience\ of\ doctors_i + \beta_5 Economy_i \\ & + \beta_6 Transparency_i + \varepsilon_i \end{aligned} \tag{2}$$

As for the model fit, regression residuals are normally distributed, adjusted R squared is equal to 0.601, thus the model captures the fair volume of the variability of dependent variable. F test suggests that the fit of the intercept-only model is significantly reduced compared to the estimated model ($F = 11.795$, df $= 6$, $p$value $= .00$). Regression outcomes containing standardised beta coefficients, t-test of

Table 2. Regression model.

Predictor	Standardised Coefficients Beta	t-statistic		95% Confidence Interval for Beta		Collinearity Statistics Variance inflation factor
		t-test	Sig	Lower Bound	Upper Bound	
Intercept	62.102	5.28	0.000	38.802	85.402	
Overall inpatient satisfaction	.168	2.07	0.041	0.007	0.346	1.297
Total rehospitalisation within 30 days	−0.276	−3.65	0.000	−0.470	−0.140	1.115
Intensive care unit mortality	−0.168	−2.13	0.035	−0.286	−0.011	1.208
Operating experience of doctors	0.501	6.09	0.000	0.356	0.698	1.321
Economy	−0.166	−2.24	0.027	−0.264	−0.017	1.074
Transparency	−0.194	−2.51	0.013	−0.574	−0.068	1.163

Source: own processing.

beta coefficients, 95% Confidence interval for beta coefficients and multicollinearity diagnoses are in Table 2.

The intercept/Constant of the model is equal to 62.102, meaning that the average value of the Case Mix Index is 62.102, when all explanatory variables are set to 0. Among all explanatory variables, positive impact on values of the Case Mix Index is possessed by Operating experience of doctors and Overall inpatients satisfaction. We can interpret coefficients in the following way: when the Operation experience of doctors rise by one point, Case Mix Index rise by 0.501 points. This value is an average value, 95% confidence interval suggest that the true value of the Case Mix Index change can be from interval [0.356, 0.698]. The second variable having a positive effect on Case Mix Index is Overall inpatient satisfaction, meaning that in healthcare facilities where more severe, complex, and diverse inpatient illnesses are treated, inpatients tend to be more satisfied. One-point increase of inpatients satisfaction can induce a rise the Case Mix Index value from 0.007 to 0.346, on average by .168. Negative impact on Case Mix Index values is documented for variables Total rehospitalisation within 30 d, Intensive care unit mortality, Economy, and Transparency. The strongest negative effect is caused by Total rehospitalisation within 30 d, where regression coefficient is equal to −0.276. Intensive care unit mortality is also negatively related to Case Mix Index, beta coefficient is equal to −0.168. The negative impact of Case Mix Index has also non-medical variables Economy and Transparency, meaning that in healthcare facilities where economic performance is better and information provided for patients and the general public is better, the Case Mix Index variable is lower.

5. Discussion and conclusion

The subject of the analytical part of the study was to examine the factors influencing the differences in CMI depending on the types of healthcare facilities, their geographical location as well as the procedural aspects in the conditions of the Slovak

Republic. The results of the analytical part brought interesting findings. The lowest CMI values were found in a majority of the university hospitals, despite the fact that we expect them in order to treat difficult and complex cases. The most complex and demanding diagnoses were treated in the University Hospital Banská Bystrica, in the University Hospital Martin and in the general hospitals in Humenné, Komárno and Lučenec. It is also caused by the uneven distribution of the hospitals and specialised facilities in the Slovak Republic that causes the concentration of selected treatment processes in given localities (Pažitný, 2008, Smatana et al., 2016).

From a geographical point of view, we also find the differences between the regions. In the cluster with moderately demanding treated cases, we mainly find hospitals from the Bratislava Region, the Trnava Region, and the Žilina Region. In the cluster with relatively low economic and medical demands of treated cases, we find hospitals from the Košice Region and the Prešov Region. The hospitals with the highest CMI values are located in the Banská Bystrica Region. The group of hospitals from the Nitra Region and the Trenčín Region includes the hospitals with different CMI values, because in these regions there are hospitals with relatively high CMI values (especially in the Nitra Region) as well as hospitals with the lowest CMI values.

From a point of view of the structure of CMI and the influence of its individual components, we find interesting results. The existence of a significant relationship between the Operating experience of doctors and the CMI has been confirmed, especially in the university hospitals. If low values of the Operating experience of doctors' variable prevailed in the general hospitals, the CMI would reach relatively high values and it means that relatively demanding operations with lower Operating experience of doctors are performed in the general hospitals. The differences between the types of procedures and the types of hospitals are also declared by the research studies (Cousineau & Tranquada, 2007, Dobson et al., 2009; Mendez et al., 2013; Murante et al., 2014).

There are relatively significant differences between the Operating experience of doctors and the CMI values within the teaching and general hospitals. It is also caused by a long-term problem in the healthcare system of the Slovak Republic, namely the lack of medical staff. Insufficient financial evaluation of experienced physicians and medical staff can be one of the serious reasons for their leave to work abroad or migration respectively (Glinos, 2015; Tupá & Krajčo, 2019; Tupa et al., 2021; Yeats, 2010).

There is a significant difference between the general and university hospitals in the field of the development of the Case Mix Index and the overall satisfaction of hospitalised patients. In general hospitals, the average CMI values decrease slightly with the overall satisfaction of hospitalised patients meaning that there is an inverse relationship between the satisfaction of hospitalised patients and the average economic and medical demands of patients treated in a given hospital. The differences between the types of hospitals in the examined aspects are also confirmed by the studies by González-Valentín et al. (2005), Held (2015), Nuti et al. (2016), Gratz et al. (2018) and others. In the university hospitals, we observe a significant positive relationship between the overall satisfaction of hospitalised patients and CMI. Some research studies confirm the relationship between treatment intensity and patient satisfaction (Otani et al., 2015), as strong dependence on healthcare professionals is most felt in

the complex and demanding treatment processes (Alam et al., 2014; Du et al., 2012; Riklikiene et al., 2020; Sjetne et al., 2007).

Some studies point to the need to examine the location of a hospital as well as the type of hospital and its size as the determinants affecting patient satisfaction (Al-Amin et al., 2021; Gratz et al., 2018; Mazurenko et al., 2017; Sundström et al., 2015; Xu et al., 2022).

There are no differences between general and university hospitals when assessing the relationship between the overall quality of healthcare provided and the CMI values. The trend meaning the increase in the CMI variable causes a slight increase in the overall quality of healthcare provided in the general as well as in university hospitals is confirmed. The results of the logistic regression declare that the variables Overall satisfaction of hospitalised patients and the Operating experience of doctors possess a positive effect on the CMI values. The variables influencing the CMI values in a negative way are Total rehospitalisation within 30 days, Intensive care unit mortality, Economic performance of the hospital, and Transparency. The fact that CMI, reimbursement of hospital costs, and future payments for performance indicators can be affected by accurate documentation of patient complications, serious complications, and comorbidities is important for hospital managers and coding specialists. Many hospitals introduce new systems and models to create value-based healthcare (Spaulding et al., 2018), but the different organisational structures of the hospitals and market characteristics may perform as obstacles to their implementation (Cousineau & Tranquada, 2007; Dobson et al., 2009; Liu et al., 2014; Song & Song, 2019). Good quality economic hospital systems and collaboration with healthcare professionals directly involved in the diagnostic and treatment processes, creation of quality records of patients will represent a fundament for the construction of the reliable CMIs and their efficient use in the economic and financial payment mechanisms in the health systems. They will also make it possible to better classify the differences among the health professions and to distribute the health processes in the primary healthcare provision. The constant development of the economic models in hospitals will also support the creation of a new methodological platform that will reflect on changes in the health insurance market, as well as on the demographic and health aspects of the population in individual countries.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Internal Grant Agency of FaME Tomas Bata University in Zlin [RVO/2022].

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