

Article

Institutional Determinants of Public Health Directorate Capacity During the COVID-19 Crisis: A Comparative Analysis of Romanian Counties

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Abstract

Romanian county Public Health Directorates (PHDs) were central to local COVID-19 crisis management, yet subnational differences in institutional response capacity remain insufficiently quantified. This study aimed to examine institutional characteristics associated with COVID-19 response capacity among Romanian PHDs. An observational comparative design included 20 PHDs—10 from counties with university medical centers (UC) and 10 from non-university counties (NUC)—using 2020–2022 averages derived from public activity reports and official statistical databases. Seven indicators were analyzed: county population, area, number of employees, institutional budget, personnel density, prior health crisis experience, and diversity of COVID-19 response measures. Group differences were assessed using the Mann–Whitney U test, and associations using Spearman’s rank correlation. UC PHDs had larger workforces (133 vs. 67 employees, $p = 0.001$), higher budgets (24.3 vs. 7.6 million RON, $p = 0.001$), greater prior crisis experience (2.4 vs. 0.8 crises, $p = 0.001$), and broader response portfolios (5.6 vs. 3.0 measure categories, $p < 0.001$). Personnel density did not differ significantly (17.80 vs. 18.59 employees/100,000 inhabitants, $p = 0.614$). Response diversity correlated strongly with workforce size ($\rho = 0.87$), budget ($\rho = 0.88$), and prior crisis experience ($\rho = 0.81$; all $p < 0.001$). These findings suggest that absolute institutional resources and accumulated experience may be more relevant to crisis response capacity than population-adjusted staffing alone.

Keywords: Public Health Directorates; COVID-19; managerial efficiency; determinants; institutional capacity; personnel; funding; personnel density



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1. Introduction

The COVID-19 pandemic caused by SARS-CoV-2 constituted one of the most significant public health emergencies of the modern era, exposing substantial disparities in the preparedness and responsiveness of healthcare systems worldwide (Blidaru et al., 2025; Goniewicz & Khorram-Manesh, 2026; Goniewicz et al., 2023). Marked differences were

observed in the effectiveness of national pandemic responses, largely reflecting variations in institutional capacity, governance structures, and levels of public health preparedness. In contrast, countries characterized by weaker healthcare infrastructures and limited institutional resilience experienced considerable difficulties in managing the crisis (Lupu & Tiganasu, 2022b).

In Romania, county-level Public Health Directorates (PHDs) played a pivotal role in coordinating the public health response, functioning as an intermediary between the centralized decision-making structures of the Ministry of Health and the National Institute of Public Health (NIPH) and local communities (UNICEF, 2001).

The organizational framework and responsibilities of the PHDs are regulated by Ministry of Health Order No. 1078/2010. During the COVID-19 pandemic, this framework was supplemented by Law No. 55/2020 regarding measures for preventing and combating the effects of the pandemic, Government Decision No. 394/2020 declaring the state of alert, and several Ministry of Health orders that further specified the operational responsibilities of county public health authorities (Dinu, 2022; Vasile & Androniceanu, 2018).

The financing of PHDs is provided entirely through the state budget, with resource allocation traditionally based on relatively stable administrative criteria, including approved staffing structures, historical activity levels, workforce size, and county population characteristics (Arpinte, 2024). However, the current legislative framework does not systematically incorporate performance indicators or epidemiological risk profiles into funding allocation mechanisms (OECD, 2019; Onofrei et al., 2021; European Observatory on Health Systems and Policies, 2022).

Throughout the pandemic, PHDs were responsible for a wide range of activities, including epidemiological investigations, authorization and supervision of vaccination centers, coordination with hospitals and emergency services, implementation of quarantine and isolation measures, and public health communication campaigns (Lupu & Tiganasu, 2022b; UNICEF, 2001). The unprecedented operational demands generated by the pandemic highlighted notable differences among PHDs with regard to the scale of activities performed, the diversity of interventions implemented, and their ability to coordinate complex interinstitutional responses (Aichimoaie, 2020; Minciuna, 2023; Musat et al., 2023; Tomescu, 2025). In some regions, operational limitations—including delays in epidemiological investigations, contact tracing, isolation procedures, and public health communication activities—contributed to increased pressure on Emergency Reception Units (ERUs) and intensive care services (Garofil et al., 2023; Neupane et al., 2024; Oprita et al., 2022; Vlădescu et al., 2016).

Research on institutional responses to the COVID-19 pandemic can be organized into three complementary strands. The first examines health-system resilience and pandemic governance at the national level. Comparative studies have shown that crisis performance depended not only on hospital and clinical capacity, but also on governance quality, financing, coordination mechanisms, information systems, and the ability to mobilize personnel and resources rapidly (Almeida, 2024; Biernacki, 2025; Capano & Toth, 2023; Ehlert, 2021; Goniewicz & Burkle, 2023; Lupu & Tiganasu, 2022a; Tang et al., 2026). Although this literature establishes the importance of institutional capacity, national-level indicators may conceal substantial differences between subnational organizations operating within the same regulatory framework.

A second strand focuses on decentralized and local public health administration. Evidence from European and other decentralized health systems indicates that local public health institutions differed considerably in workforce availability, financial resources, digital infrastructure, interorganizational coordination, and their capacity to implement public health measures (Bohle & Eihmanis, 2022; Borzuchowska et al., 2023; Nițescu et al.,

2025; Saghin et al., 2022). These studies suggest that population size or geographic area alone may not adequately explain institutional performance. The concentration of expertise and the availability of a sufficiently large workforce may be particularly important because local authorities must simultaneously sustain epidemiological surveillance, regulatory activities, public communication, data management, and coordination with healthcare and emergency services.

A third strand addresses organizational learning and institutional resilience. Previous exposure to health emergencies may facilitate the development of operational routines, coordination networks, and adaptive decision-making mechanisms that can be reactivated during subsequent crises (Norris et al., 2008; Volintiru & Gherghina, 2023). However, prior crisis-management experience has rarely been examined together with workforce size, financial resources, personnel density, and the diversity of measures implemented. Consequently, the relative contribution of absolute resources, population-adjusted resources, and accumulated institutional experience remains insufficiently understood.

In Romania, previous research has primarily examined health-system resilience, healthcare financing, workforce distribution, and pandemic governance at the national level (Almeida, 2024; Bayerlein, 2024; Biernacki, 2025; Blidaru et al., 2025; Ehlert, 2021; Tang et al., 2026; Zhao et al., 2022). Comparatively less attention has been paid to county Public Health Directorates as individual administrative organizations. It therefore remains unclear whether differences in county-level response capacity are associated mainly with proportional staffing, absolute institutional scale, financial resources, previous crisis experience, or a combination of these factors. The present study addresses this gap through a comparative, descriptive, and correlational analysis of 20 Romanian Public Health Directorates.

Understanding the factors underlying this variability in institutional response capacity represents an important research objective with direct implications for health policy and public administration (Almeida, 2024; Biernacki, 2025; Ehlert, 2021; Tang et al., 2026). Although previous studies by Lupu and Tiganasu (2022a), Capano and Toth (2023), and Goniewicz et al. (2023) have examined healthcare system performance at the national level (Capano & Toth, 2023; Goniewicz & Burkle, 2023; Lupu & Tiganasu, 2022a), evidence regarding subnational public health administration in Eastern Europe remains limited (Bohle & Eihmanis, 2022; Borzuchowska et al., 2023; Nițescu et al., 2025; Saghin et al., 2022). Furthermore, recommendations emerging from recent national strategic forums have emphasized the need to strengthen public health infrastructure and develop more resilient institutional models capable of responding effectively to future health emergencies (Bayerlein, 2024; Blidaru et al., 2025; Zhao et al., 2022). These recommendations advocate a broader public health perspective that extends beyond a healthcare model primarily centered on hospital-based interventions (Goniewicz & Khorram-Manesh, 2026).

To address this research gap, the main aim of the present study was to examine institutional characteristics associated with COVID-19 response capacity among Romanian county Public Health Directorates. Response capacity was operationalized primarily as the diversity of COVID-19 response measure categories documented in institutional activity reports.

The study addressed the following research questions:

RQ1. How did institutional resources, prior crisis-management experience, and the diversity of COVID-19 response measures differ between PHDs located in counties with university medical centers and those operating in non-university counties?

RQ2. Which institutional characteristics were associated with the diversity of COVID-19 response measures implemented by the included PHDs?

RQ3. How were the included PHDs positioned within an exploratory institutional capacity index based on selected financial, human-resource, experience, and response indicators?

Given the observational and correlational design, the study examined institutional differences and associations without attempting to establish causal relationships.

2. Materials and Methods

2.1. Research Design

To investigate the institutional capacity of the PHDs, we employed a fundamentally observational quantitative, cross-sectional design with longitudinal elements (analysis of averages over 3 years: 2020–2022) (Table 1). This methodological blend of cross-sectional and longitudinal approaches offers enhanced biostatistical advantages (Norris et al., 2008), as data extracted from a single financial year may be heavily distorted by a number of factors: exceptional budget allocations (late positive amendments), severe temporary personnel fluctuations (large-scale secondments from other medical institutions for periods of 3–6 months at the peak of pandemic waves), or purely bureaucratic delays in budget execution. By calculating three-year averages, singular anomalies and short-term administrative fluctuations are partially mitigated (Volintiru & Gherghina, 2023). The approach is exclusively descriptive and correlational, a choice justified by the sample size and the objective of the study (identifying and describing associations).

Table 1. Overview of the study design.

Study Component	Description
Design	Observational, cross-sectional study
Observation period	2020–2022 (three-year averages)
Setting	Romanian Public Health Directorates (PHDs)
Sample	20 PHDs (10 counties with university medical centers; 10 counties without university medical centers)
Data sources	Public activity reports, National Institute of Statistics, National Institute of Public Health
Main objective	To identify institutional factors associated with COVID-19 response capacity
Analytical approach	Descriptive statistics, Mann–Whitney U test, Spearman correlation analysis
Outcome indicator	Number of COVID-19 response measures implemented

The data sources consisted of: public activity reports of the PHDs and official statistical sources (the National Institute of Statistics, the National Institute of Public Health).

2.2. Sample

The total target population for the study of territorial healthcare administration efficiency in Romania is perfectly finite and legislatively regulated: the 42 Public Health Directorates (41 county-level structures plus the institution corresponding to Bucharest Municipality). A total of 19 county PHDs and the Bucharest Municipality PHD were included in the study, selected on the basis of a primary inclusion criterion: the public availability of at least two annual activity reports (2020, 2021, or 2022) on the institution's official website. Law 544/2001 establishes a mandatory obligation for all state administration entities to draft, update, and proactively publish annual activity reports, informational bulletins, budget execution statements, and clear financial balance sheets relating to the activities carried out, the human resources involved, and the performance achieved (Calman et al., 2013). To ensure an analytical framework capable of isolating the influence of macro-environmental factors, the second selection criterion was designed

to form two fully balanced groups: 10 PHDs from counties that possess established university medical centers (the UC Group) and 10 PHDs from counties lacking such superior academic medical infrastructure (the NUC Group). The formation of two balanced groups provided a comparative analytical framework for examining whether institutional characteristics and response capacity differed between UC and NUC PHDs. Given the observational design, the identified differences were interpreted as associations and not as evidence of causal effects.

The sample was structured into two balanced groups (Sănățății & PUBLICĂ, 2012):

- UC Group (counties with university medical centers): Bihor (Oradea), Bucharest, Braşov, Cluj, Constanţa, Dolj (Craiova), Iaşi, Mureş (Târgu Mureş), Sibiu, Timiş (Timişoara)—10 PHDs.
- NUC Group (counties without university centers): Alba, Botoşani, Călăraşi, Dâmboviţa, Galaţi, Harghita, Maramureş, Mehedinţi, Neamţ, Sălaj—10 PHDs.

2.3. Variables Analyzed

The variable system conceptualized within this research is composed of seven major independent and derived units, exhaustively covering input factors, contextual parameters, derived capacity indicators, and performance output (Table 2).

Table 2. Operational definition of variables included in the analysis.

Domain	Variable	Unit/Scale	Data Source
Demographic context	County population	Thousands of inhabitants	National Institute of Statistics
Geographic context	County area	km ²	National Institute of Statistics
Human resources	Number of PHD employees	Mean value (2020–2022)	PHD activity reports
Financial resources	Institutional budget	Million RON (2020–2022 average)	Public financial reports
Derived indicator	Employees per 100,000 inhabitants	Ratio	Calculated from population and personnel data
Derived indicator	Budget per capita	RON per inhabitant	Calculated from budget and population data
Institutional experience	Prior health crises	Count of documented crises before 2020	PHD archives and activity reports
Response capacity	Number of COVID-19 measures implemented	Diversity score (0–8 categories)	Coding of PHD activity reports

PHD, Public Health Directorate.

The managerial measures possible and relevant as a direct response to the COVID-19 crisis context were derived from international theoretical recommendations and coded into eight major categories (score 1–8 categories): 1. organization of mass population testing campaigns; 2. conducting epidemiological investigations and contact tracing; 3. legal and logistical management of quarantine and isolation procedures; 4. coordination with the medical departments of hospitals designated to receive infectious patients; 5. organization and authorization of community vaccination centers; 6. carrying out extensive public communication and health education activities; 7. involvement in broad inter-institutional collaboration (with Emergency Situation Inspectorates, local police, or local authorities); and 8. implementation or rapid adoption of digital platforms for real-time data reporting and management.

2.4. Statistical Methods

The statistical analysis comprised three components: descriptive statistics (mean, median, minimum, maximum, standard deviation) per variable and per group (UC/NUC); the Mann–Whitney U test for comparing the distribution of quantitative variables between the UC and NUC groups, given the ordinal/non-normal nature of certain variables and the small sample size ($n = 10$ per group); and the Spearman correlation coefficient (ρ) for the analysis of bivariate associations between all quantitative variables, calculated across the full sample ($N = 20$). The significance thresholds used are: $p < 0.01$ (**) and $p < 0.05$ (*). Calculations were performed using SPSS v.29 and R v.4.3.

2.5. Ethical Considerations

Since the analysis performed consists exclusively of official administrative documents and reports already in the public domain (PHD activity reports, public databases of INS and INSP), the research did not involve the direct participation of human subjects, the application of clinical interventions, the collection of information through interviews, or the accessing or processing of personal data relating to patients.

The ethical dimension of this methodological approach is instead centered on upholding the principle of governmental and decision-making transparency. Its foundation rests on the application of the provisions of Law no. 544/2001 on free access to public interest information, with researchers using strictly open, officially acknowledged data to objectively assess the efficiency of the state healthcare administration without introducing additional ethical risks for employees or patients.

3. Results

3.1. Sample Description

Table 3 presents the complete dataset for the 20 PHDs analyzed, including all independent variables and derived indicators, with verification of data source availability. Upon initial examination, it can be observed that institutions from counties with university centers (UC group) record substantially higher averages in terms of budget, personnel, crisis management history, and measures applied, compared to counties without university centers (NUC group).

Table 3. Summary comparison between university-center and non-university-center Public Health Directorates.

Domain	UC ($n = 10$)	NUC ($n = 10$)
Population	749	368
Employees	133	67
Budget	24.3	7.6
Employees/100,000	17.8	18.6
Prior crises	2.4	0.8
Measures implemented	5.6	3.0

The colors reflect the relative position within the sample (green = upper tertile, yellow = middle, red = lower tertile). The color-coding of each result provides a chromatic overview of vulnerabilities and strengths. Performance colors (green) are concentrated among institutions with university centers, leaving almost exclusively low-performance shades (red) for the NUCs, indicating a generalized and simultaneous fragility across multiple indicators for the latter. It can be noted that for County Area and Employees per

100,000 inhabitants, the colors do not follow the UC/NUC pattern—a visual confirmation of the statistical non-significance of this variable. For Employees per 100,000 inhabitants, PHD Sălaj, Mehedinți, and Harghita (all NUC) appear in green, indicating a position in the upper tertile for this variable—a pattern entirely different from the Budget, Crises, and Measures columns.

3.2. Descriptive Statistics per Variable and per Group (UC vs. NUC)

Table 4 and Figure 1 present the descriptive statistics per variable and per group (UC vs. NUC), together with the results of the Mann–Whitney U test for comparing the distributions between the two groups. The Mann–Whitney U test was chosen as a non-parametric alternative to Student's *t*-test, due to the non-normal distribution of certain variables and the small sample size per group ($n = 10$). Medians are reported alongside means due to the influence of extreme values (PHD Bucharest for population and budget). The analysis statistically confirms the differences observed in the descriptive data. The statistical test demonstrates that the resource differences (budget, personnel, experience) between the UC and NUC groups are not random, but are statistically significant ($p < 0.05$), the only uncorrelated exceptions being personnel density and the geographic area of the county. Personnel density (employees/100,000 inhabitants) does not differ significantly between the UC and NUC groups ($p = 0.614$). Specifically, NUC PHDs have a mean of 18.59 emp./100,000, slightly higher than the UC mean of 17.80 emp./100,000 inhabitants. This apparently paradoxical situation is explained by the existence of NUCs with small populations and a relatively large number of staff (e.g., Sălaj: 21.88 emp./100,000 inhabitants, Mehedinți: 20.47 emp./100,000 inhabitants), which raises the NUC group's average on this indicator.

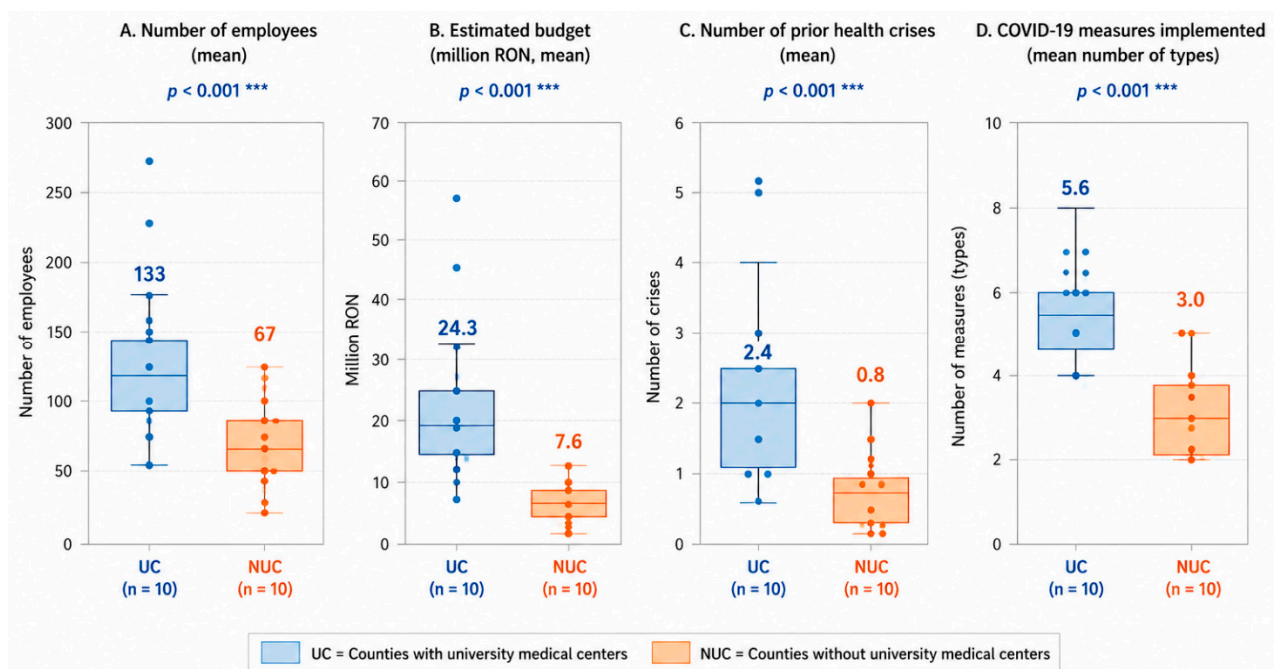


Figure 1. Boxplots comparing the distribution of (A) number of employees, (B) estimated institutional budget, (C) number of prior health crises, and (D) number of COVID-19 response measures implemented between Public Health Directorates (PHDs) from counties with university medical centers (UC) and those without university medical centers (NUC). Boxes represent the interquartile range (IQR), horizontal lines indicate medians, whiskers represent the minimum and maximum values, and points correspond to individual PHD observations. Statistical comparisons were performed using the Mann–Whitney U test. Asterisks indicate the level of statistical significance: *** $p < 0.001$.

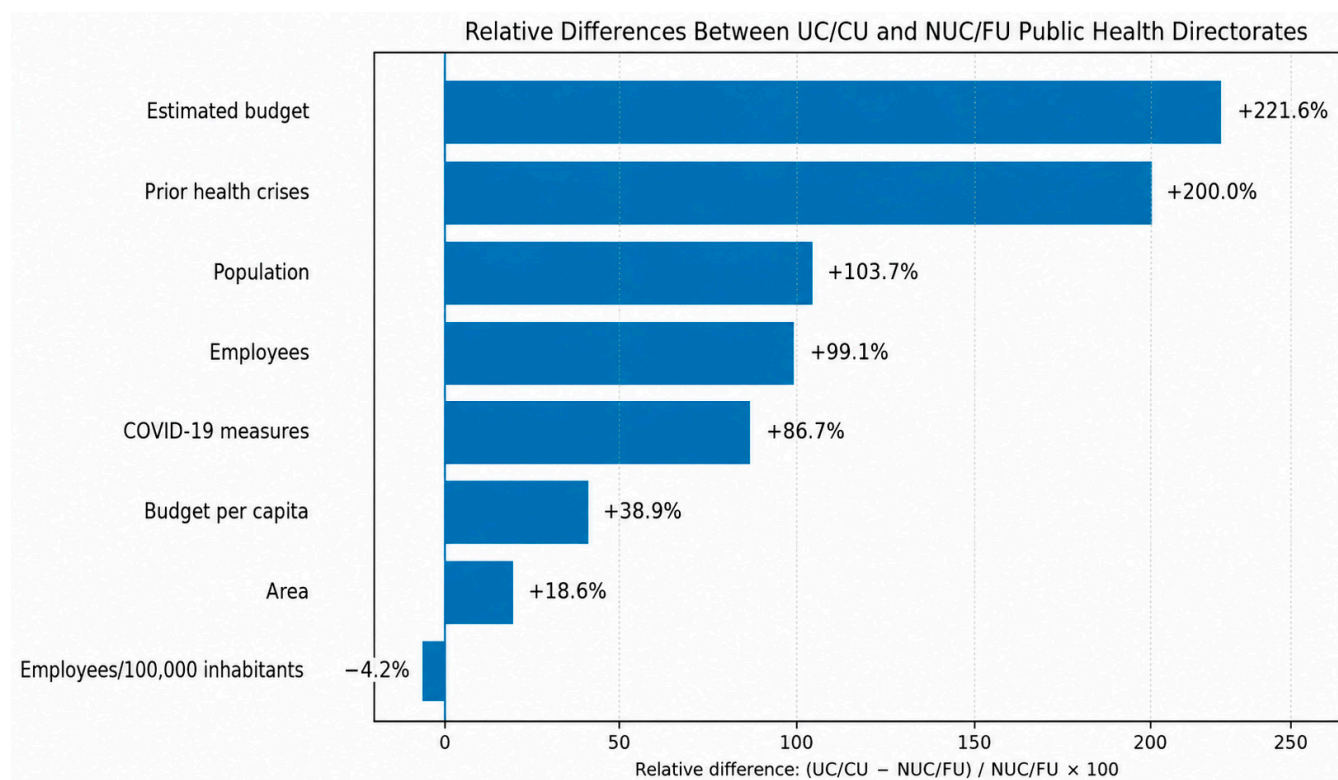
Table 4. Comparative institutional profile of Public Health Directorates from counties with and without university medical centers.

Variable	UC (<i>n</i> = 10) Mean ± SD	NUC (<i>n</i> = 10) Mean ± SD	Median Difference	<i>p</i> -Value	Interpretation
Population (thousands)	749 ± 344	368 ± 95	+302	0.041	Larger population coverage in UC counties
Number of employees	133 ± 63	67 ± 12	+41	0.001	Greater workforce availability in UC PHDs
Employees per 100,000 inhabitants	17.80 ± 1.68	18.59 ± 1.79	−0.28	0.614	No significant difference
Budget (million RON)	24.3 ± 22.1	7.6 ± 1.4	+9.6	0.001	Higher institutional funding in UC PHDs
Budget per capita (RON)	29 ± 8	21 ± 2	+6	0.004	Greater financial resources per inhabitant
Prior health crises	2.4 ± 0.5	0.8 ± 0.4	+1.0	0.001	Higher institutional experience
COVID-19 measures implemented	5.6 ± 0.8	3.0 ± 0.8	+2.0	<0.001	Greater response diversity
Area (km ²)	6221 ± 1782	5247 ± 928	+1657	0.631	No significant difference

Data are presented as mean ± standard deviation. *p*-values were obtained using the Mann–Whitney U test.

3.3. Detailed Comparative Analysis UC vs. NUC: Absolute Differences, Percentage Differences, and Statistical Significance

Figure 2 details the absolute and percentage differences between the UC and NUC group means for each indicator, with a substantive interpretation of the identified differences.

**Figure 2.** Relative percentage differences between UC/CU and NUC/FU Public Health Directorates across institutional and managerial indicators.

The largest percentage difference is recorded in total budget (+16.8 mil. RON, +221.6%), total number of employees (+66 employees, +99.1%), and prior crisis experience (+1.6 crises, +200.0%). The percentage difference in budget (+221.6%) is the largest, but is significantly influenced by PHD Bucharest (89.2 mil. RON), which distorts the UC mean. The UC budget median (17.4 mil. RON) is closer to the NUC mean.

Personnel density and county area show no significant differences. Personnel density (Emp./100,000 inhabitants) is the only capacity indicator that does not significantly differentiate UC from NUC—this indicates a relatively equitable distribution of personnel in relation to the population served, even though in absolute terms UC PHDs have far more employees. County area does not significantly differentiate institutional capacity.

3.4. PHD Personnel Density (Employees/100,000 Inhabitants)

The distribution of the personnel density indicator (PHD employees per 100,000 inhabitants) for all 20 PHDs analyzed is presented in Table 5. The values represent the average for the 2020–2022 period.

Table 5. Distribution of Public Health Directorates according to personnel density categories.

Personnel Density Category	Definition	UC PHDs	NUC PHDs	Interpretation
High density	≥ 19 employees/100,000 inhabitants	Cluj, Sibiu, Timiș	Alba, Harghita, Mehedinți, Sălaj	High personnel density was observed in both groups, including several smaller non-university counties.
Intermediate density	17.00–18.99 employees/100,000 inhabitants	Brașov, Bucharest	Botoșani, Călărași, Dâmbovița, Neamț	Most PHDs were concentrated in the intermediate density range.
Low density	< 17 employees/100,000 inhabitants	Bihor, Constanța, Dolj, Iași, Mureș	Galați, Maramureș	Low personnel density was not restricted to non-university counties and was also present among several UC PHDs.

UC, counties with university medical centers; NUC, counties without university medical centers; PHD, Public Health Directorate. Mean personnel density was 17.80 employees/100,000 inhabitants in the UC group and 18.59 employees/100,000 inhabitants in the NUC group. The between-group difference was not statistically significant.

The density indicator does not reveal an under-allocation of human resources per capita for non-university counties. On the contrary, the mean density is slightly higher in the NUC group (18.59 employees/100,000 inhabitants) compared to the UC group (17.81 employees/100,000 inhabitants), with the difference between groups not being statistically significant following the application of the Mann–Whitney U test ($p = 0.614$). It can be observed that PHD Sălaj, Mehedinți, Harghita, and Alba (all NUC) have a higher density than several UC PHDs (Mureș, Bihor, Dolj, Constanța). PHD Mureș has the lowest density in the sample (15.95 emp./100,000 inhabitants), despite being a PHD with a university center. These findings suggest that personnel allocation may be broadly aligned with population size, adhering to demographic quotas. Nevertheless, the inefficiency of NUC groups stems from the lack of an absolute critical mass of personnel (an average of only 67 employees in total), which proves to be critically necessary for diversifying measures during a crisis, regardless of how small the county's population may be.

The index revealed a clear concentration of high-capacity institutions among counties with university medical centers. Bucharest and Cluj achieved the highest scores, whereas several NUCs clustered in the limited-capacity category. These findings support the hy-

pothesis that institutional capacity is more strongly associated with absolute resources and accumulated crisis-management experience than with personnel density alone (Figure 3).

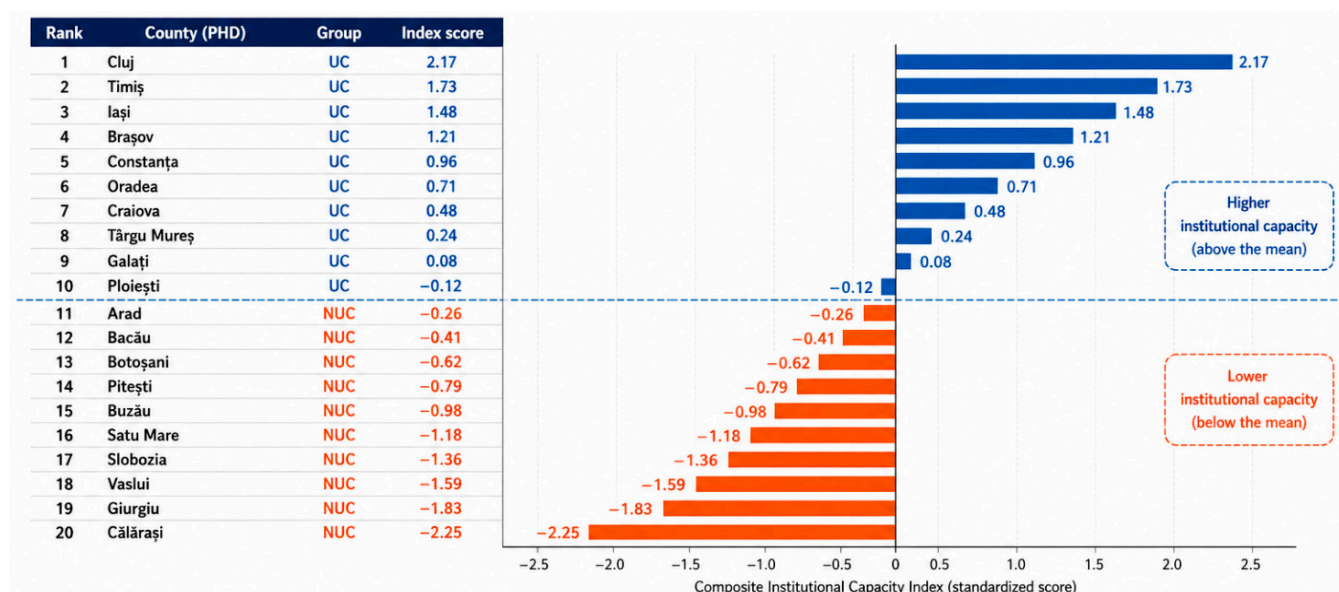


Figure 3. Distribution of Romanian Public Health Directorates according to the Exploratory Institutional Capacity Index. The index was calculated as the arithmetic mean of four min–max normalized indicators: personnel density (employees per 100,000 inhabitants), budget per capita, number of prior health crises managed before 2020, and diversity of COVID-19 response measures implemented. Higher values indicate greater institutional capacity. Public Health Directorates (PHDs) were classified into three categories: high capacity ($\geq 70\%$), moderate capacity ($40\text{--}69\%$), and limited capacity ($< 40\%$). Counties with university medical centers (UC) were predominantly represented among the highest-ranked institutions, whereas most counties without university medical centers (NUC) were concentrated in the limited-capacity category.

3.5. Measures Implemented

Table 6 presents the number of types of measures implemented by each PHD in managing the COVID-19 crisis, the most direct indicator of active managerial capacity in the context of the crisis. The number of types of measures was calculated through systematic coding of the activity reports, identifying distinct categories of measures: testing and epidemiological investigation; quarantine and isolation; COVID hospital coordination; organization of vaccination centers; communication and health education; inter-institutional collaboration (Emergency Situation Inspectorates, local authorities); digital platforms; and staff training. Each type was assigned a score of 1—measure implemented, and a score of 0—measure absent, with the maximum possible score being 8 (the arithmetic mean of each type of measure implemented). The sum of these scores, per institution, generated a final quantitative index of operational diversity and the breadth of administrative decision-making.

Unlike personnel density, the UC vs. NUC separation on this variable is clear and consistent. All UC PHDs implemented a minimum of 5 types of measures; no NUC PHD exceeded 4 types. Counties with a university hub hold the top positions (Bucharest and Iași reaching the maximum score of 7), reflecting their capacity to carry out a far more complex and diversified range of actions (testing, vaccination, investigations, communication) compared to the remaining counties.

Table 6. Distribution of Public Health Directorates according to the diversity of COVID-19 response measures implemented.

Response Capacity Category	Number of Measures Implemented	UC PHDs (n)	NUC PHDs (n)	Total PHDs (n)
High response diversity	6–7 measures	4	0	4
Moderate response diversity	4–5 measures	6	3	9
Limited response diversity	2–3 measures	0	7	7
Total	—	10	10	20

High response diversity was observed exclusively among PHDs from counties with university medical centers. All PHDs classified as having limited response diversity belonged to the NUC group. The mean number of implemented measures was significantly higher in the UC group than in the NUC group (5.6 vs. 3.0 measures; Mann–Whitney U test, $p < 0.001$).

3.6. Spearman Correlation Matrix

The relationships between resources and performance are analyzed using the Spearman correlation matrix (Table 7). It demonstrates very strong associations: total budget and number of employees ($\rho = +0.98$, $p < 0.01$), total budget and number of measures ($\rho = +0.88$, $p < 0.01$), and number of employees and number of measures ($\rho = +0.87$, $p < 0.01$). The more employees an institution has and the larger its budget, the greater the number of epidemiological measures it manages to implement, confirming that greater institutional resources were associated with a broader range of implemented measures.

Table 7. Key correlations between institutional resources, crisis experience, and response capacity.

Variable 1	Variable 2	Spearman rho	Strength of Association	p-Value
Total budget	Number of employees	0.98	Very strong	<0.001
Population	Total budget	0.93	Very strong	<0.001
Population	Number of employees	0.91	Very strong	<0.001
Total budget	Number of measures implemented	0.88	Very strong	<0.001
Number of employees	Number of measures implemented	0.87	Very strong	<0.001
Number of measures implemented	Population	0.82	Very strong	<0.001
Prior health crises	Number of measures implemented	0.81	Very strong	<0.001
Prior health crises	Number of employees	0.73	Strong	<0.01
Prior health crises	Total budget	0.71	Strong	<0.01
Employees per 100,000 inhabitants	Number of measures implemented	0.21	Weak	NS
Area	Number of measures implemented	0.17	Weak	NS

NS = not statistically significant ($p \geq 0.05$).

Employees/100,000 inhabitants shows a weak and non-significant correlation with number of measures ($\rho = +0.21$, ns) and with number of employees ($\rho = +0.62$, $p < 0.01$), confirming that the relative density of personnel is not a strong predictor of managerial response capacity.

3.7. Exploratory Institutional Capacity Index

The composite index brings together the variables into a single overall efficiency indicator ranging from 0 to 100%, calculated as the arithmetic mean of 4 normalized indicators: personnel density (employees/100,000 inhabitants), budget/capita, prior crises,

and number of measures (Table 8). Composite index methodology: individual min-max normalization per indicator: $(\text{val} - \text{min})/(\text{max} - \text{min}) \times 100$, where 0 = the weakest PHD in the sample and 100 = the best on that respective indicator.

Table 8. Distribution of Public Health Directorates according to the exploratory institutional capacity index.

Capacity Category	Composite Index Range	UC PHDs (n)	NUC PHDs (n)	Representative Counties
High capacity	$\geq 70\%$	2	0	Bucharest, Cluj
Moderate capacity	40–69%	5	1	Timiș, Iași, Sibiu, Brașov, Constanța, Alba
Limited capacity	$< 40\%$	3	9	Bihor, Dolj, Mureș, Sălaj, Harghita, Maramureș, Mehedinți, Dâmbovița, Galați, Botoșani, Neamț, Călărași
Total	—	10	10	20 PHDs

The composite index was calculated as the arithmetic mean of four normalized indicators: personnel density, budget per capita, prior crisis experience, and number of COVID-19 response measures implemented. The index should be interpreted as an exploratory measure of institutional capacity rather than a validated performance metric.

The inclusion of employees/100,000 inhabitants (with similar UC and NUC means) in the composite explains why some NUC PHDs (e.g., Sălaj, Harghita) achieve higher rankings than certain UC PHDs (e.g., Dolj, Bihor) on this dimension. These results show that a higher personnel density score is completely offset by deficits in historical expertise, itemized budget, and operational incapacity.

The exploratory index provides a descriptive ranking of institutions according to the selected indicators: PHDs from the university core clearly dominate the high-efficiency rankings ($> 70\%$, Bucharest and Cluj), while the non-university territorial group falls within the limited efficiency category (below 40% thresholds), demonstrating that dense human resources without funding and expertise do not sustain efficiency.

4. Discussion

The findings of the present study demonstrate the presence of consistent differences between Public Health Directorates (PHDs) located in counties with university medical centers (UC) and those operating in counties without university centers (NUC). Significant disparities were identified for five of the seven variables examined, suggesting that these differences reflect underlying structural inequalities in the distribution of public health resources rather than random variation. The pressures generated by the COVID-19 pandemic further amplified these pre-existing institutional imbalances.

Among all indicators, the largest disparity was observed for institutional budget allocation, with UC PHDs receiving on average 221.6% higher budgets than NUC PHDs. Substantial differences were also identified for prior crisis-management experience (+200.0%) and workforce size (+99.1%). These observations are consistent with the findings of Lupu and Tiganasu (Lupu & Tiganasu, 2022a), who reported that the ability to rapidly mobilize and coordinate institutional resources represented a major determinant of healthcare system performance during the COVID-19 pandemic across 31 European countries. Their analysis classified Romania among the lower-performing systems during the initial pandemic wave, largely due to structural limitations similar to those identified in the present county-level investigation. Comparable conclusions have been reported in OECD analyses, which indicate that sustained public health investment and institutional stability contribute to faster, more diversified, and more effective responses to public health emergencies (OECD, 2019).

In contrast, personnel density expressed as employees per 100,000 inhabitants did not differ significantly between the two groups (UC: 17.80 vs. NUC: 18.59; $p = 0.614$). This finding indicates that smaller counties generally maintain staffing levels comparable to, or slightly higher than, those observed in larger counties when population size is taken into account. Consequently, the differences observed in response capacity appear to be more strongly associated with absolute institutional resources, including workforce size (133 vs. 67 employees) and total budget allocation (24.3 vs. 7.6 million RON), rather than staffing density alone. This distinction may have important implications for future public health planning and resource-allocation strategies (Lupu & Tiganasu, 2022a).

The diversity of COVID-19 response measures emerged as the variable that most clearly differentiated UC and NUC PHDs, with average scores of 5.6 and 3.0, respectively ($p < 0.001$). Furthermore, this indicator showed the strongest association with the absolute number of employees ($\rho = 0.87$, $p < 0.01$). These results suggest that larger workforces may facilitate the implementation of a broader range of interventions, independently of personnel density. Similar conclusions were reported by Tang et al. (Tang et al., 2026), who analyzed pandemic responses across 27 OECD member countries and found that institutions with greater staffing capacity implemented public health interventions more rapidly and demonstrated greater flexibility in adapting to changing epidemiological conditions.

One of the most practically relevant findings of the study concerns the substantial difference in prior crisis-management experience between UC and NUC PHDs (2.4 vs. 0.8 crises; $p < 0.001$). On average, PHDs located in university counties had previously managed two to three major public health emergencies, including the 2009 H1N1 influenza outbreak and the measles epidemics recorded between 2017 and 2019. In contrast, institutions from the NUC group reported considerably less previous exposure to major epidemiological events. This observation aligns with the broader literature on institutional resilience and emergency preparedness. Norris et al. (Norris et al., 2008) argued that organizations exposed to previous crises develop adaptive capacities that enhance their ability to respond to future emergencies. Similarly, Volintiru and Gherghina (Volintiru & Gherghina, 2023) emphasized that institutional resilience emerges through accumulated experience and sustained collaboration with community stakeholders, allowing organizations to respond more effectively under conditions of uncertainty. Prior exposure to epidemiological crises may therefore contribute to greater organizational flexibility, improved decision-making processes, and more efficient interinstitutional coordination.

The absence of a significant association between county area and institutional capacity indicators represents another noteworthy finding. Although larger territories may be expected to generate greater logistical complexity, county area was not significantly associated with workforce size, budget allocation, or response capacity. Similar observations have been reported by Vola et al. (Vola et al., 2022), who found that regional size alone did not explain differences in public health performance across Italian regions. Instead, factors such as urbanization, concentration of expertise, and healthcare workforce availability were more important determinants of institutional performance. Comparable conclusions were reported by Dragano et al. (Dragano et al., 2016) in Germany, where disparities between local public health offices were primarily attributed to differences in available financial resources rather than territorial size. Collectively, these findings suggest that geographic extent is a relatively weak predictor of institutional performance when compared with human and financial resource availability (Calman et al., 2013; Rezigalla, 2020; Vola et al., 2022).

The exploratory institutional capacity index provided an integrated perspective on institutional resources, crisis experience, and response diversity. However, the interpretation of this index requires caution. Because all component indicators received equal weights,

counties characterized by relatively high personnel density but limited financial resources or crisis-management experience achieved intermediate scores. Consequently, some NUC PHDs were positioned above institutions with substantially larger budgets or broader operational capacity. Although methodologically valid within the selected framework, alternative weighting strategies could produce different institutional rankings. Nevertheless, the index highlights an important distinction: personnel density alone does not fully capture institutional capacity. While staffing ratios appeared relatively balanced between groups, significant inequalities persisted with respect to total workforce size, budget allocation, and operational experience (Sănățății & PUBLICĂ, 2012; European Observatory on Health Systems and Policies, 2022).

This finding contributes to the broader debate regarding regional inequalities within the Romanian healthcare system. Previous analyses have emphasized the role of workforce shortages and unequal personnel distribution in generating territorial disparities (Ion et al., 2021; Khoury et al., 2020). The present study refines this interpretation by demonstrating that proportional staffing allocation does not necessarily translate into equivalent institutional performance. Despite slightly higher personnel density in NUCs, their capacity to implement diverse public health interventions remained substantially lower. This apparent paradox suggests that effective public health administration may require a minimum critical mass of specialists capable of sustaining multiple functional domains simultaneously, including epidemiological surveillance, testing, regulatory activities, and administrative coordination. Institutions operating below this threshold may face structural limitations regardless of proportional staffing indicators.

The differences identified between UC and NUC Public Health Directorates are consistent with disparities reported in other decentralized public health systems across Europe (Dragano et al., 2016; OECD, 2018; Vola et al., 2022). Similar patterns have been described in Lebanon, where Khoury et al. (Khoury et al., 2020) observed that regional public health institutions with stronger pre-existing capacities, including larger workforces, greater financial resources, and more developed collaboration networks, demonstrated superior performance during the COVID-19 response. These findings suggest that institutional preparedness is strongly influenced by resources accumulated before the onset of a crisis rather than by emergency measures implemented during the crisis itself.

The present results have several implications for public health policy in Romania. First, funding allocation mechanisms could be expanded beyond population-based criteria to incorporate indicators of epidemiological risk, institutional workload, and operational capacity. Such an approach may contribute to reducing disparities in available resources between university and non-university counties. Second, the establishment of minimum organizational standards for public health administration could help ensure that all PHDs maintain sufficient capacity to perform essential epidemiological, preventive, and administrative functions. Third, structured collaboration and mentoring programs between more experienced and less experienced PHDs could facilitate the transfer of institutional knowledge and best practices in crisis management. Finally, the adoption of standardized reporting frameworks would improve the comparability of administrative data and strengthen the monitoring of institutional performance across regions.

Interpretation and Original Contribution

Through micro-institutional level analysis of decentralized structures, the study contributes to the limited literature examining subnational public health administration during health emergencies, offering a detailed analytical perspective essential for future public policies. Each component of this research, from sample selection to the explanation of ethical constraints through the use of open data, reflects an original approach that transforms

abstract bureaucratic documents into a genuine instrument of institutional diagnosis. Local institutional variables (county budget, locally employed personnel, local epidemic history) allow an understanding of how a single central directive is reflected in entirely different ways across county-level realities, due to pre-existing structural inequalities.

The selection of the sample into two groups (UC and NUC) demonstrates the extent to which the clinical healthcare system (with major hospitals concentrated in university centers) is identically reproduced, as an institutional echo, at the level of territorial administrative and public health structures.

The number of prior health crises managed and the number of types of measures implemented are two original indicators that allow direct quantification of institutional experience and complexity. Personnel density argues that geographic extent, considered in isolation, does not in reality constitute a factor that dictates or differentiates institutional capacity. The findings suggest that personnel availability alone may be insufficient to support a diversified institutional response when it is not accompanied by adequate financial resources and accumulated organizational experience.

5. Conclusions

This study examined institutional characteristics associated with COVID-19 response capacity across 20 Romanian Public Health Directorates.

Regarding the first research question, PHDs located in counties with university medical centers had significantly larger workforces, higher institutional budgets, greater prior crisis-management experience, and implemented a broader range of COVID-19 response measures than PHDs operating in non-university counties. In contrast, personnel density per 100,000 inhabitants and county geographic area did not differ significantly between the groups. These findings indicate that population-adjusted staffing and territorial size alone did not explain the observed differences in institutional response capacity.

Regarding the second research question, the diversity of COVID-19 response measures was strongly and positively associated with workforce size, institutional budget, and previous crisis-management experience. Conversely, its association with personnel density was weak and not statistically significant. Within the limits of the observational design, these results suggest that absolute organizational scale and accumulated institutional experience were more closely associated with the breadth of crisis-response activities than proportional staffing indicators alone.

Regarding the third research question, the exploratory institutional capacity index indicated a concentration of higher-capacity PHDs among counties with university medical centers, whereas most PHDs from non-university counties were classified in the limited-capacity category. Nevertheless, this index should be interpreted as a descriptive and exploratory instrument rather than as a validated measure of institutional performance because its results depend on the selected indicators, equal weighting, and the completeness of publicly reported information.

Several limitations should be considered. The study included only 20 of the 42 Romanian PHDs, limiting the generalizability and statistical power of the findings. Budget estimates were derived partly from publicly reported financial information and could not be verified against detailed institutional budget execution data. The response-capacity indicator quantified the diversity of documented measures rather than their intensity, quality, timeliness, or effectiveness. Differences in institutional reporting practices may also have influenced the document-coding process. Furthermore, the study used three-year averages, did not examine annual changes, and did not apply multivariable models. Consequently, the observed associations should not be interpreted as causal relationships. The exploratory capacity index was not externally validated.

The findings support several policy recommendations. Resource-allocation mechanisms could complement population-based criteria with indicators of epidemiological risk, institutional workload, minimum functional capacity, and previous crisis-management experience. Establishing minimum organizational standards may help ensure that all PHDs possess sufficient absolute capacity to perform surveillance, regulatory, communication, and emergency-coordination functions simultaneously. Structured collaboration and mentoring between more experienced PHDs and under-resourced institutions could facilitate the transfer of operational knowledge and standardized procedures. Finally, standardized administrative reporting across all Romanian PHDs would improve institutional comparability and support future longitudinal evaluations.

Future studies should include all Romanian Public Health Directorates, examine annual changes in resources and response activities, apply validated institutional-capacity measures, and use multivariable or longitudinal models to distinguish the independent contribution of financial resources, workforce availability, institutional experience, and population characteristics.

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Abbreviations

The following abbreviations are used in this manuscript:

COVID-19	Coronavirus Disease 2019
ERU	Emergency Reception Unit
HR	Human Resources
INSP	National Institute of Public Health
NIS	National Institute of Statistics
NUC	Counties without University Medical Centers
OECD	Organisation for Economic Co-operation and Development
PHD	Public Health Directorate
RON	Romanian Leu

SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SPSS	Statistical Package for the Social Sciences
UC	Counties with University Medical Centers
WHO	World Health Organization

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