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Creation of Local Health Units' Observatory:

Evaluating the Evolution of Integrated Care in Local Health Units

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Abstract

This project focuses on creating an observatory for Portugal's Local Health Units (LHU) to develop a health index measuring key performance metrics. The index evaluates the performance of 24 LHUs over the first two quarters of 2024, offering critical insights into efficiency and financing, quality, and access within the Portuguese NHS. Using a Differences-in-Differences methodology, it assesses the impact of vertically integrating primary and hospital care, finding no short-run effects on performance in the analyzed dimensions. By supporting resource allocation and service improvements through data-driven decision-making, the observatory provides a foundation for improving healthcare integration, sustainability, and patient-centered outcomes.

Keywords:

Local Health Units, Integration of Care, Health Data Analysis, Healthcare Quality, Healthcare Performance Evaluation

1. Introduction

The focus of the present paper is to understand the creation of an observatory for Portugal's Local Health Units (LHU) and develop a comprehensive health index that measures performance metrics such as prescription dynamics, healthcare consumption patterns, and key performance indicators (KPIs). Further, the goal of this research is to identify areas for improvement and best practices within the healthcare system. There are already many studies that examine various aspects of healthcare performance and integration. More and more, it is becoming evident how important it is to systematically measure and analyze healthcare delivery to improve patient outcomes and resource allocation. While LHUs had existed before, the generalization of the model, formalized at the beginning of 2024, represents a significant step towards vertically integrated health services, enhancing coordination and efficiency between primary care units and hospitals (Nunes 2024; IQVIA 2023).

The concept of creating a Local Health Units' Observatory is groundbreaking within this context. This observatory aims to develop an index that encapsulates critical variables such as prescription dynamics and healthcare consumption patterns. These indicators are essential for reflecting the operational efficiency and service quality of the LHU, providing a robust tool for policymakers and healthcare providers. Moreover, this paper will analyze the impact of the reform by comparing the performance of the recently created LHUs with those already existing before. This will be conducted using a Difference-in-Difference analysis. The theoretical foundations for this thesis draw upon established methodologies for constructing composite indexes, normalization techniques, and aggregation methods. These methodologies are crucial for developing a reliable and valid health index that can guide data-driven decision-making processes in the Portuguese National Health Service (NHS). The research is insightful and addresses a highly relevant topic in contemporary healthcare management. On one hand, it builds on the substantial body of literature that underscores the importance of integrated healthcare systems and their impact on service delivery. On the other hand, it leverages advanced data analytics to create a health index that can significantly improve the sustainability and effectiveness of healthcare services in Portugal (IQVIA 2023; Governo da República Portuguesa 2023). By systematically measuring and analyzing various aspects of healthcare delivery, this research aims to identify areas for improvement, benchmark performance, and promote best practices across different regions. The creation of a comprehensive health index will serve as a critical tool for enhancing the operational efficiency and service quality of LHU, ultimately supporting the continuous improvement of health service delivery and resource allocation within the Portuguese NHS.

This paper will continue with an in-depth literature review, exploring the evolution of the LHUs in Portugal, the benefits of vertically integrated units, and the organizational changes in primary care settings. Following the literature review, the thesis will delve into data and methodology, discussing the criteria for selecting relevant health indicators and the process of constructing and validating the health index. The discussion section will analyze the findings, and the conclusion will summarize the main points and suggest areas for future research.

2. Literature Review

This section outlines the creation of the Local Health Units Observatory and provides an overview by explaining the inter-relationships between key performance metrics. This overview is based on the organizational and functional integrations of these LHU, as proposed by the relevant legal frameworks and studies (Diário da República 1999-2012).

2.1. Creations of Local Health Units prior to 2024

In Portugal, the concept of LHUs emerged as a pivotal strategy to improve the efficiency and quality of healthcare services. The first LHU was established in Matosinhos in 1999 with Decree No. 207/99. This creation of LHUs marked a significant shift from the traditional healthcare model in Portugal, where hospitals and primary care services (PCS) were managed separately. Several LHU were established later on and before 2024, including LHU Norte Alentejano (2007), LHU Alto Minho, LHU Baixo Alentejo, LHU da Guarda (2008), LHU Castelo Branco (2009), LHU Nordeste (2011), and LHU Litoral Alentejano (2012). These units aimed to integrate hospitals and PCS into a single entity to improve coordination, efficiency, and the overall quality of care (Diário da República 1999-2023).

Previously, hospitals and PCS operated independently with separate governance, financing, and resource allocation, resulting in fragmented care, inefficiencies, and poor coordination. Patients often struggled with care transitions due to the lack of collaboration between services. The LHU model addresses these challenges by unifying hospitals and PCS, ensuring smoother patient experiences and better health outcomes, particularly in chronic disease management (Bentes et al. 2004). By consolidating resources and services, LHU also enhance efficiency, allowing for the shared use of facilities, personnel, and diagnostic tools, reducing redundancy and improving access to care. Managed by a single Board of Directors, LHU ensure centralized governance, in contrast to the traditional model's split management, which often resulted in conflicting priorities and inefficient resource use (Bentes et al. 2004).

The reform also introduced decentralization, granting some LHU units greater managerial autonomy and financial flexibility, moving away from the previously centralized control by the Ministry of Health. This localized decision-making allows for better responsiveness to regional health needs, further enhancing efficiency and patient outcomes. Although public-private partnerships (PPPs) were once a key feature in hospital construction and management with government oversight (Barros et al. 2011), many of these have been abolished or not renewed in recent years. Given this shift, the focus here is on the growing importance of vertical integration of care. For instance, LHU Litoral Alentejano adapted its management and service delivery models to the unique geographic and demographic challenges of the region, demonstrating the flexibility and effectiveness of decentralized governance (Diário da República 2012). Additionally, LHU promote integration across all levels of care and include support commissions for quality, safety, and other key areas, ensuring standardized practices. LHU are also involved in research and training, fostering continuous improvements in healthcare. This contrasts with the traditional model, where research and education were more isolated to hospital settings (Barros et al. 2011).

Overall, the LHU model introduced before 2024 provides a more cohesive, patient-centered approach, optimizing resources and improving the quality of healthcare services in Portugal by addressing the inefficiencies of the traditional separation between hospitals and primary care.

2.2. Expansion of the LHU model nationwide and other reforms in the NHS 2024

On January 1, 2024, a significant reform in the Portuguese NHS was initiated, marking the start of a new phase in its organizational structure. This includes expanding LHUs and generalizing Family Health Units (FHU) to model B. The reform involves creating 31 new LHU, bringing the total to 39, to integrate healthcare services, improve management between hospitals and health centers, and ensure continuity of care from prevention to rehabilitation. Simultaneously, the generalization of FHU model B will assign family doctors to 300,000 additional patients by establishing 222 new units. This shift will also affect over 3,500 healthcare professionals, who will receive performance-based incentives. FHU model B teams, including doctors, nurses, and secretaries, will organize care for specific populations and be rewarded for expanding patient lists, conducting home visits, and maintaining high-quality care (Serviço Nacional da Saúde 2024). The reform addresses the growing healthcare demands due to aging populations and rising expectations for quality care. By integrating primary and hospital care, the NHS aims to improve healthcare access, efficiency, and quality. Additionally, LHU units will streamline services within geographic regions, improving care delivery across Portugal (Simões et al. 2017). This comprehensive reform represents a critical step in enhancing the quality and accessibility of healthcare services in Portugal, ultimately benefiting both patients and professionals (Ministério da Saúde 2024).

2.3. Financing

The financing of the recent reforms in the Portuguese NHS is a critical element that supports the integration of care. The expansion of LHUs and the implementation of FHUs model B involve strategic financial planning to ensure sustainability and efficiency in resource utilization. The financing model for primary health care includes both internal and external contracting processes, underpinned by three-year action and performance plans. The external contracting process is at the level of the LHU, while internal contracting takes place with the primary care services. Furthermore, the introduction of institutional incentives represents a strategic approach to recognizing and rewarding the performance of functional units (Ministério da Saúde 2022).

The integration of hospitals and health centers under the LHU model centralizes financial management, which facilitates more effective allocation and utilization of resources. This centralization aims to reduce administrative overheads and eliminate redundancies, thereby enhancing the overall efficiency of the health system. This ensures that funds are directed towards areas with the highest needs, supporting comprehensive and continuous care (Serviço Nacional da Saúde 2024). The financing of LHUs in Portugal is based on capitation payments, adjusted for demographic factors such as age, gender, and disease burden (e.g., hypertension, diabetes). This capitation-based model allocates funds per registered citizen within the LHU's coverage area and aims to account for the specific healthcare needs of the population. According to "Termos de Referência para Contratualização de Cuidados de Saúde no SNS para 2024", the capitation financing is the base component of funding for a LHU, oriented towards health promotion, disease prevention, and primary healthcare. The capitation amount allocated to each institution is adjusted by population risk, using stratification tools that evaluate healthcare consumption based on factors like primary care, hospital care, and medication use. This ensures that funding reflects the varying healthcare needs of the population while simultaneously enhancing both the efficiency and equity of healthcare services in these integrated units (OECD 2015).

FHU model B introduces a performance-based remuneration system for healthcare professionals. This system incentivizes high-quality care by linking financial rewards to measurable outcomes. Professionals receive a base salary along with variable payments tied to their performance, such as expanding patient lists, conducting home visits, and maintaining high standards of clinical care. This model not only motivates healthcare providers but also ensures that financial resources are used effectively to improve patient outcomes (Serviço Nacional da Saúde 2024). As specified in "Termos de Referência para Contratualização de Cuidados de Saúde no SNS para 2024", the institutional incentives are designed to improve the performance and efficiency of healthcare services, with an additional 3% funding available based on the achievement of goals in areas such as access, quality, economic performance, and care integration. The 3% performance-based incentive is applied in the year following the evaluation of results, with the overall performance evaluated based on defined metrics like access to care, clinical outcomes, and efficiency of service delivery.

Overall, the financing strategies embedded in these reforms are designed to support the integration of care, improve resource management, and ensure the financial sustainability of the NHS. By aligning financial incentives with performance and integrating financial management across care levels, the reforms aim to improve the quality and accessibility of healthcare services in Portugal (Serviço Nacional da Saúde 2024).

2.4. Vertical Integration of Care

Vertical integration (VI) of care has been a strategic reform implemented across various health systems worldwide, notably in the United States and other countries. The implementation of integrated care has also been a focus in Central and Eastern European (CEE) countries, where efforts to address fragmented health systems and rising healthcare demands reflect a similar global movement. Initiatives in countries like the United States and the United Kingdom demonstrate that integrated care represents a widespread change in thinking rather than an isolated trend (Kurpas et al. 2021). These examples demonstrate that Portugal's recent reforms in the NHS are not isolated but part of a broader global trend toward coordinated care.

In the United States, the Affordable Care Act (ACA) has played a pivotal role in promoting VI through the creation of Accountable Care Organizations (ACOs). These organizations aim to coordinate care across providers, reduce costs, and improve quality. By leveraging bundled payment models, hospitals and healthcare systems are incentivized to integrate services across primary, inpatient, outpatient, and long-term care, thereby achieving economies of scope, lowering transaction costs, and enhancing patient outcomes (Diana et al. 2015). Wang et al.

(2024) highlight that the success of such systems depends on the degree of organizational integration, effective health information technology (HIT) infrastructure, and strong network relationships. While these factors improve care coordination and reduce inefficiencies, challenges such as financial burdens, administrative complexity, and encouraging patients to use local facilities remain significant. Robinson et al. (1996) similarly stress that while VI can improve efficiency through economies of scale, improving risk management, and fostering innovation in care, it is not without challenges. They caution that increased bureaucracy, misaligned incentives, and internal resource conflicts can undermine these benefits. Additionally, the initial costs required for infrastructure and staffing is often significant, making implementation a daunting prospect for many healthcare systems. In other countries, VI has been implemented to address systemic inefficiencies and improve care coordination. For instance, in some European countries, efforts have focused on aligning hospital and community care through shared governance and integrated care pathways. Studies from the Twin Cities area in the United States further spotlight the dual effects of VI, with improvements in preventive care and emergency department use but challenges like inconsistent quality outcomes and strained inter-organizational relationships (Carlin et al. 2015). Wang et al. (2024) and Robinson et al. (1996) both underscore that while VI can reduce inefficiencies and improve quality, its success hinges on careful management of costs, cultural alignment, and robust infrastructure investment.

Building on international experiences, the Portuguese NHS has undertaken significant reforms to implement VI, aiming to unify primary and secondary healthcare services under a single management structure. These efforts mirror global trends but are adapted to the unique context of Portugal’s healthcare system. The creation of LHUs serve as the center of this strategy, bringing together services within specific regions to ensure seamless care and address gaps caused by fragmented systems. The reforms align with principles outlined by Goiana-da-Silva et al. (2024), emphasizing the importance of creating people-centered care systems that include all levels of healthcare to improve efficiency and accessibility. Through streamlined governance and a focus on proximity-based care, the Portuguese model aims to deliver tailored care pathways that minimize inefficiencies and improve continuity across the healthcare system. This approach is further reflected by the establishment of Integrated Responsibility Centers (Centros de Responsabilidade Integrados - CRI), which emphasize patient-centered care delivery supported by management structures designed to improve performance and outcomes (Ministério da Saúde 2022). Wang et al. (2024) stress that such multidisciplinary collaboration and effective care coordination are critical to overcoming systemic fragmentation, while Robinson et el. (1996) highlight the importance of balancing efficiency gains with risks of internal inefficiencies and resource allocation conflicts. Furthermore, the expansion of FHUs under the LHU model incorporates multidisciplinary teams to improve care quality and accessibility. These reforms address persistent challenges such as the high costs and administrative demands of integration, while drawing on lessons from Goiana-da-Silva et al. (2023) on the importance of aligning health policies with local population needs. By integrating governance across geographic regions and expanding service coverage, the Portuguese NHS ensures a more connected and sustainable approach to care delivery.

The case of Portugal demonstrates that the adoption of vertical integration in healthcare is part of a larger global shift toward integrated care models. While challenges such as financial costs, bureaucracy, and inconsistent results persist across systems, the shared experiences underline the potential benefits of VI, including improved efficiency, care coordination, and patient satisfaction. Portugal’s reforms, rooted in the global context but tailored to local needs, reflect a strategic commitment to delivering better health outcomes through integrated care pathways.

2.5. Prevention / Health Outcome

The recent reforms in the Portuguese NHS prioritize the integration of care with a strong emphasis on prevention and improving health outcomes. The expansion of LHUs and the generalization of FHUs model B are central to these efforts, aiming to improve health promotion and disease prevention.

A significant aspect of the contracting process is the emphasis on health promotion and disease prevention. "Termos de Referência para Contratualização de Cuidados de Saúde no SNS para 2024" spotlights the importance of vaccination programs, early diagnosis, maternal and child health, family planning, and chronic disease management. These preventive measures are crucial for improving health outcomes and are integrated into the performance metrics and evaluation criteria used in the contracting process (Ministério da Saúde 2022). LHU are designed to integrate primary, secondary, and tertiary care, facilitating a holistic approach to patient health. This integration allows for more effective prevention strategies and better health outcomes by ensuring continuity of care. The unified management structure of LHU supports coordinated efforts in health promotion, disease prevention, treatment, and rehabilitation, addressing the full spectrum of patient needs (Ministério da Saúde 2024). FHU model B further reinforces the focus on prevention and health outcomes. These multidisciplinary teams, comprising family doctors, nurses, and clinical secretaries, are organized to provide comprehensive care to specific populations. By incentivizing performance based on preventive care measures, such as expanding patient lists and conducting home visits, FHU model B ensures that healthcare professionals are actively engaged in health promotion and disease prevention activities. This approach not only improves immediate health outcomes but also contributes to long-term health benefits for the population (Diário da República 2024).

Additionally, the Integrated Responsibility Centers within hospitals play an important role in enhancing health outcomes. CRI are autonomous management structures that focus on improving access to care and health results by adopting innovative organizational models. These centers facilitate the implementation of preventive measures and ensure that patients receive timely and effective care, which is essential for improving overall health outcomes (Ministério da Saúde 2024). The comprehensive approach to health care within LHU and FHU model B underscores the importance of prevention in achieving better health outcomes. By integrating care across different levels and incentivizing preventive measures, the NHS reform aims to create a more sustainable and effective health system that promotes the well-being of the Portuguese population.

3. Data and Methodology

3.1. Methodologies for Building Indexes

The Composite Indicators Handbook (OECD 2008) provides a comprehensive introduction to the various methods and steps involved in constructing composite indicators, offering a systematic guide aimed at helping policymakers and researchers scientifically develop and use composite indicators to analyze complex economic, social, and environmental issues (Marien 2009). The handbook gives priority to the need for transparency and scientific rigor in the construction of composite indicators to ensure that the conveyed information is accurate and effective. The process of building composite indicators in the handbook is divided into several key steps: First, a clear theoretical framework must be established to define the phenomena to be measured and select variables that represent these phenomena. Next, data gaps are addressed using techniques such as sole imputation, regression imputation, and multiple imputation. The multivariate analysis step employs methods like principal component analysis, factor analysis, and cluster analysis to understand the internal structure of the data and reduce dimensionality. However, these methods were not used in this study. This decision was made because the available data set was sufficiently complete and did not exhibit significant gaps that would require imputation techniques. Furthermore, the scope of the study does not require dimensionality reduction or exploration of underlying structure in the data, which are typically addressed through multivariate analysis. Data standardization, a crucial step for ensuring comparability between discrete variables, typically involves methods like Z-score standardization and min-max standardization. The weighting and aggregation steps involve merging multiple variables into a composite indicator, with common weighting methods including principal component analysis and data envelopment analysis, while aggregation methods include additive aggregation and geometric aggregation. To ensure the robustness of the indicators, uncertainty and sensitivity analyses are necessary to evaluate the sensitivity of composite indicators to different weighting choices and standardization methods. The handbook also provides a comprehensive "toolbox", listing various techniques and methods that might be used when constructing composite indicators, helping users make appropriate choices based on specific needs. In this study, techniques such as sole imputation, regression imputation, and multiple imputation were not used. Following the construction of the index, techniques such as descriptive statistics, difference-in-differences (DiD), and subgroup analysis were employed to assess the performance of newly established LHUs compared to those created before 2024. The selection and application of these methods are closely aligned with the research objectives, ensuring the accuracy of the analysis and the practicality of the results. Descriptive statistics, as a basic tool for data analysis, is used to conduct preliminary exploration of research data and help researchers quickly understand the distribution characteristics and trends of the data (Fisher & Marshall 2009). Research uses statistics such as mean, median, and standard deviation to summarize the basic characteristics of the data and uses visual tools such as histograms and boxplots to examine the distribution of the data and detect potential outliers and skewness issues. DiD is one of the main methods used in research to assess the impact of reforms. As a quasi-experimental method for policy effect evaluation, DiD controls the interference of time trends and fixed characteristics of the group by comparing the performance changes of the intervention group (newly established LHUs) and the control group (existing LHUs) before and after the reform (Angrist & Pischke 2009). In specific applications, the study first divided LHUs into intervention groups and control groups, then measured performance indicators before and after the reform respectively and finally calculated the difference between the performance changes of the two groups to obtain the net impact of the reform on LHUs. Subgroup analysis further explores the differential impact of reforms, especially the differences in performance among different regions or specific groups (Rothwell 2005). The study stratified the data according to regional characteristics and population registration numbers, and conducted separate analyzes for different subgroups. The results found that the impact of the reform on LHUs in urban areas was significantly higher than that in rural areas. This hierarchical analysis provides more detailed insights, reveals potential inequalities in the policy implementation process, and provides an important reference for targeted improvement measures. By integrating these methodologies, we aim to develop a robust composite indicator that not only meets the scientific rigor required for policy analysis but also supports decision-making in the complex healthcare environment. The table below summarizes the key stages and methods involved in the construction of the composite indicator.

Table 1: Key stages and methods involved in the construction of the composite indicator (based on OECD 2008)

Stage	Methodology	Purpose
Variable Selection	Theoretical framework and variable testing	To define and select variables relevant to the phenomenon being measured
Normalization	Z-score, Min-Max	To standardize data for fair comparison across variables

Weighting and Aggregation	PCA, DEA, Additive, Geometric	To determine the weight and combine variables into a composite indicator
Robustness Analysis	Sensitivity tests	To evaluate the stability and reliability of the composite indicator

3.2. Data Analytics in Healthcare

Data analytics plays a crucial role in the healthcare sector. This is particularly evident when exploring the application and importance of data quality assessment methods in healthcare data analysis, as highlighted by the Health Regulatory Agency (ERS, Entidade Reguladora da Saúde) in its studies on the performance evaluation of LHUs. ERS's research emphasizes the proximity analysis in the geographical and temporal dimensions of healthcare services, which requires a high degree of consistency and completeness in data collection and processing (Entidade Reguladora da Saúde 2024). Consistency evaluation helps identify conflicts between data from different sources and resolves these issues through standardized processing. Additionally, completeness assessment checks the proportion of missing values in data sets, ensuring that all critical medical information is recorded to avoid biases in analysis. Although LHU performs well in geographical and temporal proximity, it is still essential to ensure that data is updated promptly to provide the most current information for decision-making.

The provisions in Portugal's 2019 Basic Health Law Base 26 emphasizes that the health system must provide data in a scientific and accurate manner to effectively evaluate the quality, efficiency, and equity of health services (Diário da República 2023). This law outlines the framework and principles guiding the Portuguese health system, including the requirements for data quality and its role in evaluating and improving health services. The core of data quality assessment lies in assuring the accuracy, completeness, consistency, and timeliness of data, especially when analyzing data involving multiple health units. These assessment methods not only help identify and correct errors and inconsistencies in the data but also ensure that all decisions in policy-making and resource allocation are based on reliable data. In particular, in a complex vertically integrated health system like LHU, data quality assessment can effectively decrease misjudgments caused by data quality issues, ensuring the coordination and optimization of health services at all levels. This emphasis on data quality is a crucial means of fulfilling the responsibilities and goals of public health promotion as outlined in the law.

The report "Primary Health Care – Quality and Efficiency in UCSP and USF" provides a detailed assessment of the performance of different units within Portugal's primary healthcare system, particularly the performance of FHUs and Personalized Health Care Units (UCSP) between 2019 and 2022 (Entidade Reguladora da Saúde 2024). The analysis involves key data indicators such as the ratio of doctors to nurses, the prevalence of chronic diseases, and changes in pharmacological and diagnostic treatment expenditures, all of which rely on high-quality data collection and analysis. The report also uses Data Envelopment Analysis (DEA) to evaluate the efficiency scores of health units in distinct regions, further emphasizing the importance of high-quality data in uncovering regional disparities and improving the overall efficiency of the healthcare system.

3.3. Definition of domains included in the index

In dialogue with IQVIA, and based on IQVIA's advice, it was decided that an index would be created to assess the context and evolution of the Portuguese healthcare system along three key dimensions: access, financing and efficiency, and quality. Each dimension contains specific variables that reflect key aspects of health care services and outcomes. We obtained relevant data from NHS' Transparency Portal and IQVIA, and selected variables that were appropriate and had a significant impact. The access dimension evaluates the availability and timeliness of health care services, emphasizing the system's ability to provide equitable care to all patients. The financing and efficiency dimension examines the economic and operational aspects of health care systems, focusing on resource allocation and financial sustainability. Quality dimensions evaluate the outcomes and effectiveness of health care services, emphasizing patient safety, clinical effectiveness, and overall health system performance.

3.3.1. Selection of variables

The selection of variables is a critical step in establishing an index designed to assess integrated care within LHUs. Variables must be carefully selected to ensure that they accurately reflect dimensions of access, financing and efficiency, and quality. According to the World Health Organization (WHO 2016), effective health indicators should be relevant, reliable, and sensitive to change. In this case, the variables selected from the IQVIA data will be based on illustrating the performance of LHUs in providing comprehensive care, with key variables including market share of biosimilars, value of total hospital drug consumption, and total expenditure with antibiotic. These variables not only provide insights into resource allocation and utilisation but also highlight areas for potential improvement in patient care and outcomes (Arah et al. 2006). By emphasizing accurate metrics that reflect population needs more accurately and improve outcomes simultaneously with long-term sustainability in mind, this index will assist the Portuguese healthcare system in meeting population demands more effectively and improving results over time.

3.3.2. Challenges of selecting variables

The process of selecting appropriate variables is challenging. A major challenge is the availability and accessibility of reliable data. Data quality can vary significantly across different health systems, which may lead to inconsistencies in the evaluation of integrated care (Doran et al. 2014). Furthermore, the complexity of health care systems means that no single variable can reflect the multifaceted nature of care. The interaction between various factors such as socioeconomic status, demographic characteristics, and health outcomes requires careful consideration of how these variables interact (Baker et al. 2015). Additionally, the selection process must account for potential bias and ensure that the variables selected are representative of the population served by the LHU (Kirkpatrick et al. 2016).

3.3.3. Construction of the index

The construction of the index involves the synthesis of selected variables into a coherent framework to enable comparative analysis across different LHUs. This process typically requires standardizing the profiles to ensure comparability and then applying statistical techniques to derive a composite score that reflects overall performance (Morris et al. 2017). The construction of the index should also incorporate a weighting mechanism to take into account the relative importance of each variable in the context of integrated care (Nolte et al. 2014). By developing robust indices, stakeholders can identify strengths and weaknesses within LHUs and facilitate targeted interventions designed to improve the quality of care provided to patients. Selection and integration of metrics into an index present many obstacles for policymakers and administrators attempting to improve patient care outcomes and care quality, while stakeholders gain actionable insight to drive strategic decisions and quality improvement initiatives. It is critical that these issues are taken seriously to ensure that the index accurately represents the performance of the health care system while being effectively used as an aid tool by policymakers.

3.4. Data selection from NHS' Transparency Portal

The variable selection process began with a strategic meeting with IQVIA to identify potential indicators and dimensions for the index. Initially, it was planned to focus on five dimensions – access, efficiency and financing, quality, economic and financial performance, and integration of care – based on the "Termos de Referência para contratualização de Cuidados de Saúde no SNS para 2024". However, upon reviewing data availability, particularly for the year of 2024, significant limitations were encountered. Despite consulting multiple sources, including ACSS, the NHS Transparency Portal, and the Ministry of Health's Business Intelligence platform, there was not enough data available to cover all dimensions. Thus, it was decided to focus on three dimensions and integrated some indicators from the other dimensions into the selected ones. The chosen dimensions are access, efficiency and financing, and quality. As a result, the analysis was streamlined to concentrate on these three areas.

To ensure the relevance and usability of datasets for this analysis, various strategies and criteria were established. First, the level of granularity was a primary consideration; only datasets segmented at the LHU level were included. Data aggregated at a higher level, such as Regional Health Administrations (ARS) or Primary Care Services (PCS), were excluded because they do not allow for the differentiation of activities or trends specific to individual LHUs. Second, time relevance was prioritized, with preference given to datasets updated from 2023 until mid-year 2024 to ensure that the analysis reflects current insights. Third, indicator relevance was assessed based on the ability of each dataset to capture meaningful aspects of healthcare performance or outcomes. At last, completeness played an important role in the selection process. Datasets with significant gaps or outdated information, as well as those with overly complex or incomplete segmentation, were excluded to ensure the robustness and reliability of the analysis. This iterative process resulted in analyzing many variables for each domain based on publicly available data. Ultimately, only the indicators that met the above mentioned criteria were chosen. The selected indicators support a robust analysis of access, efficiency and financing, and quality, addressing data limitations while ensuring a focused evaluation of healthcare system performance (see appendix tables 10 to 12).

3.5. Description variables from IQVIA

The establishment of a LHU Observatory is intended to assess the progression of integrated care within these units, thereby enhancing the understanding of their operational performance. To facilitate this evaluation, it is imperative to select pertinent variables from credible datasets.

For this investigation, we employed data sourced from IQVIA, a recognized authority in healthcare analytics. From this dataset, we identified variables that correspond to two pivotal domains of healthcare performance: efficiency and quality. This selection was motivated by the significance of these variables in relation to integrated care and their capacity to yield actionable insights regarding the operations of LHUs. For each LHU, the data is standardized by the value of January 2024. That is, for each LHU the value of January 2024 of the variables provided by IQVIA are equal to 100. Then, for the remaining months, values above (below) 100 imply that the for that LHU that variable is above (below) the value registered in January 2024. This is a limitation as it implies that for the variables from IQVIA, in each point in time we are not able to evaluate differences between LHU. So that, the variables from IQVIA only allow us to monitor how each LHU is evolving, not to evaluate differences between LHU in each point in time. Nonetheless, it is significant that the data provided by IQVIA is valuable and not available to the public, providing unique insights that can enhance analysis and decision-making in various fields.

3.5.1. Efficiency and Financing Dimension

The efficiency and financing domain emphasizes optimal utilization of resources to provide healthcare services. In order to assess this aspect of LHUs' efficiency, we selected variables related to Market Share of Biosimilars and Value of Total Hospital Drug Consumption.

3.5.1.1. Market Share of Biosimilars

Biosimilar medicines offer healthcare systems considerable cost-cutting potential while still meeting therapeutic equivalency with their reference biologic products (WHO 2021). Biosimilar use by LHUs reflects their efforts to foster financial sustainability and optimize resource allocation (IQVIA 2021). This variable serves as a proxy indicator of cost efficiency; higher market shares for biosimilars tend to indicate that LHUs have successfully exploited cost-cutting opportunities without impacting patient care (Mulcahy, Hlavka & Case 2018).

Healthcare observatories can measure how effectively LHUs implement strategies to decrease pharmaceutical expenditures while still guaranteeing access to essential medicines (National Institute for Health and Care Excellence [NICE] 2017). By tracking biosimilar market shares within these units, observatories can ascertain if their strategies work (National Institute for Health and Care Excellence [NICE] 2017). Biosimilars have proven particularly valuable in resource-intensive domains like oncology and autoimmune conditions, where they serve as cost-cutting alternatives to reference biologics. Integral healthcare systems demonstrate their efficacy by being used for cancer and chronic disease treatment and management (EvaluatePharma; Global Cancer Observatory [GCO] 2018).

3.5.1.2. Total Hospital Consumption

This variable provides information on expenditure with medicines. It is crucial for assessing resource allocation and utilization in LHUs. High hospital consumption can indicate inefficiencies in the delivery of care, such as excessive use of services or insufficient preventive measures (Fisher et. al. 2003). This variable can give insight into the effectiveness of LHUs and identify areas that need improvement. By analyzing variations in hospital consumption, decision-makers can identify patterns of efficiency or inefficiency in resource usage. For instance, a LHU with high hospital consumption but stagnant or declining health outcomes might signal inefficiencies in care delivery. Conversely, units that manage resource consumption levels efficiently while improving health outcomes demonstrate effective resource management. This variable adds context and insight into resource deployment and utilization trends within hospitals.

3.5.2. Quality Dimension

This quality domain examines outcomes and safety in healthcare services, reflecting their conformance with evidence-based practices. From the variables provided by IQVIA, we selected Total Expenditure on Antibiotics as it directly corresponds with prescribing practices and infection management.

3.5.2.1. Total Expenditure on Antibiotics

Total expenditure on antibiotics is a key quality indicator in healthcare systems. Overprescription and inappropriate use of antibiotics can lead to adverse health outcomes, including antibiotic resistance (Ventola 2015). Monitoring antibiotic expenditures can help assess the quality of care provided in LHUs and inform strategies aimed at promoting responsible prescribing practices.

3.5.3. Rationale for Variable Selection

These variables were selected primarily based on their relevance to the core goals of integrated care and allow each variable to reflect insights into different aspects of health care delivery, including financing, efficiency, and quality. By focusing on these dimensions, the index aims to facilitate a comprehensive assessment of LHUs and guide policymakers and health care providers in improving and enhancing comprehensive care (Bodenheimer and Berry-Millett 2009). These variables were selected not only to reflect current health care practice conditions but also to be consistent with relevant health system goals, such as improving patient outcomes and ensuring sustainable health care financing. Moreover, these variables allows the observatory to track trends, evaluate interventions, and provide evidence-based recommendations to strengthen integrated care in LHUs. Furthermore, each of these variables are supported by reliable data from IQVIA to ensure reliability and validity in its analysis.

3.5.4. Distribution and weight of indicators in dimensions

The composite index is calculated by combining three key dimensions access, efficiency and financing (merged as one), and quality using a weighted formula. The weight assigned to each variable is based on the ones in "Termos de Referência para Contratualização de Cuidados de

Saúde". The weight distribution is access 40%, efficiency and financing 20%, and quality 40%, with equal weight given to indicators within each dimension. This approach aligns with the NHS goals of equitable access and high-quality care, ensuring the index provides a robust assessment of LHU performance over time (see figure 1). The table outlines the selected variables and their assigned weights.

Table 2: Distribution of weight for Dimensions and Indicators

Dimension		Weight of each variable	Variables
Access	**40%**	1/6	Emergency Care Attendance
		1/6	Inpatient Days
		1/6	Telemedicine consultations
		1/6	% Timely Consultations
		1/6	% Enrolled in Long-term Care Within 180 Days
		1/6	Surgical interventions
Efficiency and Financing	**20%**	1/4	Total Debt, Overdue Debt, and Payment Delays
		1/4	Value of Market Share of Biosimilars
		1/4	Value of Total Hospital Drug Consumption
		1/4	Economic and Financial Benchmarking
Quality	**40%**	1/6	Average Wait Time Before Surgery
		1/6	Hospital morbidity and mortality rate
		1/6	Outpatient surgeries
		1/6	% hip fractures surgeries in the first 48h
		1/6	30-Day Mortality Rate for Ischemic and Hemorrhagic Stroke
		1/6	Volume of total expenditure with Antibiotics

4. Results and Discussion of Analysis

4.1. Challenges during the analysis

The conduction of the analysis came with several significant challenges that influence both the methodology and results. These struggles required constant adaptation and refinement of the research process to ensure that meaningful insights could still be drawn despite the limitations encountered. Another limitation was that the data from IQVIA was only available for 24 LHUs, which restricted the analysis to those LHUs (see appendix table 26 to get more information on when each LHUs was created, and whether it was included in the analysis). Below, is an outline of the key challenges faced, their implications, and the approaches taken to address them.

4.1.1. Interpretation and Contextual Challenges

One of the most critical challenges faced was the lack of available data for the year 2024, which was a central focus of this study. As the research aimed to analyze the progress of LHUs during this year, the scarcity of data posed a significant limitation. Initially, datasets for 2024 were either incomplete or unavailable, making it difficult to assess the implementation progress comprehensively. This lack of recent data created a gap between the research objectives and the available resources. However, near the conclusion of the analysis phase, a breakthrough occurred. While double-checking the raw data on the Portal de Transparência, suspecting a potential error, it was discovered that the datasets had recently been updated to include 2024 data. This update provided us with critical information that had previously been inaccessible and allowed us to include more robust insights into our analysis. An additional challenge arose from the fact that our initial intent was to mirror the indicators outlined in the "Termos de Referência", as these were deemed essential for the evaluation progress. However, the lack of datasets that could adequately reflect these indicators forced us to reassess our approach (for additional insights refer to the table 27 in the appendix). Many of the specific indicators mentioned in the "Termos de Referência" lacked corresponding public datasets or data of sufficient granularity. As a result, a decision was made to supplement these indicators with others that were available and could still be seen as important for evaluating the progress and performance of LHUs. This adjustment required careful consideration to ensure that the newly added indicators were meaningful and consistent with the broader objectives of this research, even if they deviated from the specific metrics initially outlined in the NHS framework. This change in approach, though necessary, highlighted a larger issue regarding the coordination of public data with policy evaluation frameworks. It accentuates the importance of improving public data availability to facilitate accurate and thorough evaluations of health system reforms. Despite these challenges, the combination of updated datasets and alternative indicators allowed us to conduct an analysis that remained relevant and insightful, albeit somewhat different from the original plan.

4.1.2. Adaptation of Research Scope

Initially, the goal was to focus exclusively on the progress achieved in 2024. However, obtaining access to data from January 2023 to June 2024 provided an advantage, allowing a more robust statistical analysis through the Difference-in-Difference approach and improving the scope of the analysis. This method allowed for the evaluation of whether the transition to the LHU reform had a measurable impact on the performance of healthcare units converted to LHUs. By incorporating data from both years, the analysis gained depth and ultimately strengthened the study's capacity to assess the reform's effects.

4.1.3. Granularity and Availability of Datasets

Another significant challenge was granularity of the available data. Many of the datasets were not available at the LHU level but were instead aggregated at higher administrative levels or entirely unavailable. This limitation significantly narrowed the selection of usable data and therefore limiting the depth of the analysis. The absence of detailed LHU-level data required reliance on a smaller pool of datasets, which often fell short capturing the nuances needed for a thorough evaluation of the implementation progress. To address this issue, efforts were made to expand data sources by contacting the ACSS in hopes of obtaining more granular and comprehensive data. Unfortunately, there was no response, and therefore no additional data was provided, reinforcing the need to rely solely on publicly available data. Despite these limitations, efforts were made to make the most of the available public datasets by cross-referencing them with the NHS's "Termos de Referência" contract. This approach helped identify and use datasets that aligned with the parameters outlined, ensuring the analysis remained grounded in the established framework for monitoring LHU progress, even with the restricted data availability.

4.1.4. Quality and Usefulness of Data

In addition to availability challenges, some of the public available datasets lacked sufficient meaningful data to contribute effectively to the analysis. These datasets often had incomplete records, inconsistent reporting across months, or lacked the necessary variables to measure the outcomes of interest. As a result, many datasets had to be excluded, further narrowing the scope of analysis. This challenge required a careful evaluation of each dataset’s quality and utility, adding time and complexity to the research process.

4.1.5. Complexity in Data Cleaning and Preparation

The raw datasets available for this study were often extensive and required significant preprocessing to make them usable. The data cleaning process encountered several difficulties, including errors in formatting, inconsistencies in variable definitions, and missing values. These issues led to delays as the data had to be standardized and inconsistencies addressed before conducting a meaningful analysis. A critical step was calculating the monthly values for variables that were originally reported in a cumulative format. This adjustment ensured an accurate analysis of trends over time. By recalculating the monthly values, misleading interpretations of cumulative data was avoided. This issue only became apparent later in the analysis phase when constructing graphs for parallel trends, as the initially incorrect graphs prompted an investigation that revealed the cumulative nature of the data. Addressing this required revisiting and re-cleaning several datasets, recalculating the monthly values, and subsequently updating the analysis to reflect these corrections. Furthermore, the majority of the datasets used were divided by the number of enrolled patients. This adjustment normalized the data, making comparisons across LHUs more precise. After the normalization, a min-max adjustment was applied to further standardize the variables. This process scaled all variables between 0 and 100, facilitating accurate comparisons across variables. To ensure that an increase in all variables reflects improvements in performance, the respective variables were standardized by calculating the 100 minus the standardized value, when applicable. This ensured higher values of all variables are associated with performance improvements, aligning the metrics with the study's performance objectives.

4.2. Descriptive Statistics

In this study, we use descriptive statistics in charts and tables to give a concise and clear overview of the performance of LHUs over time.

4.2.1. Data Process

Before the process, we have to ensure that the variables between 0 and 100 as it mentioned in section 4.1.5. $\mathrm{Min}(\mathrm{Variable}_i)$ and $\mathrm{Min}(\mathrm{Variable}_i)$ denote the minimum and maximum usage within each variable certain LHU(i) and all time points, respectively. Subsequently, we synthesize the Indicators for Access, Efficiency and Financing, and Quality, according to the weights mentioned in section 3.5.4, and then combine them to form the final Composite Index. The specific method of indicator synthesis is as follows:

$$Composite\ Index_{it} = 40\% \times Access_{it} + 20\% \times Efficiency\&Financing_{it} + 40\% \times Quality$$

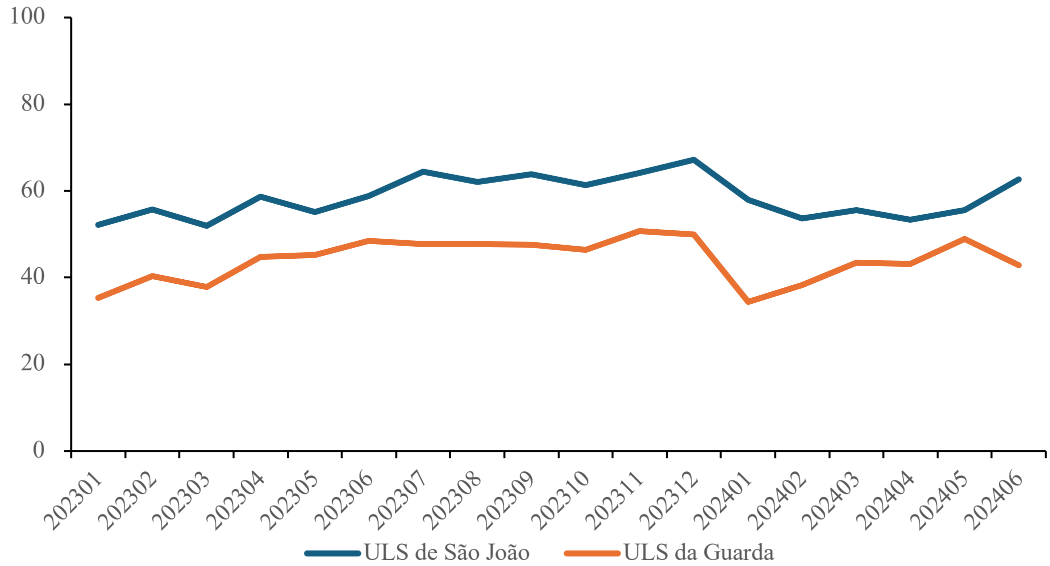
Table 3: Domain-specific scores and Composite Index for each institution from January 2023 to June 2024

LHU	Group	Domain-specific scores			Composite Index	Rank
		Access	Efficiency& Financing	Quality		
LHU de São João	Treated LHU	49.45	54.83	69.55	58.56	1
LHU de Santo António	Treated LHU	46.04	64.26	64.55	57.09	2
LHU de Gaia/Espinho	Treated LHU	46.17	55.09	66.48	56.08	3
LHU de Santa Maria	Treated LHU	45.90	56.75	65.87	56.06	4
LHU de Castelo Branco	Control LHU	49.47	53.88	61.76	55.27	5
LHU de Matosinhos	Control LHU	40.09	61.30	65.26	54.40	6
LHU de Entre Douro e Vouga	Treated LHU	49.01	54.01	59.37	54.15	7
LHU da Região de Aveiro	Treated LHU	38.87	62.40	63.60	53.47	8
LHU de São José	Treated LHU	43.89	61.10	59.09	53.41	9
LHU do Oeste	Treated LHU	41.27	54.57	64.92	53.39	10
LHU de Amadora/Sintra	Treated LHU	39.63	60.10	62.77	52.98	11
LHU do Litoral Alentejano	Control LHU	42.44	52.66	63.11	52.76	12
LHU da Cova da Beira	Treated LHU	53.28	48.48	53.20	52.29	13
LHU de Trás-os-Montes e Alto Douro	Treated LHU	42.71	53.84	60.93	52.22	14
LHU de Coimbra	Treated LHU	46.07	48.37	56.00	50.50	15
LHU do Alentejo Central	Treated LHU	37.86	62.04	57.14	50.41	16
LHU do Alto Minho	Control LHU	39.90	55.13	58.33	50.32	17
LHU da Arrábida	Treated LHU	35.96	58.53	59.11	49.73	18
LHU do Alto Ave	Treated LHU	39.35	50.94	57.61	48.97	19
LHU da Região de Leiria	Treated LHU	36.33	60.22	55.55	48.80	20
LHU do Arco Ribeirinho	Treated LHU	38.88	51.17	50.04	45.80	21
LHU de Almada-Seixal	Treated LHU	35.56	56.73	48.02	44.78	22
LHU do Algarve	Treated LHU	34.79	60.79	45.96	44.46	23
LHU da Guarda	Control LHU	36.19	52.06	47.96	44.07	24

4.2.2. Top and Bottom Performers

Figures 2 and 3 in the appendix present the 5 best performing LHUs and the 5 worst performing LHUs on average across all moths. The best performing LHU is LHU São João, and the worst performing LHU is LHU Guarda. From the results, the main reason for the higher performing LHUs is that these LHUs contain "Centros de Referência" (Reference Centers) and "Centros de Responsabilidade Integrada (CRI)" (Integrated Responsibility Centers), which are typically associated with hospitals or LHUs and are designed to address specific medical areas or streamline healthcare delivery. Figure 1 presents the change in Composite Index from January 2023 to June 2024 for the best and worst LHUs. As can be seen from table 3, the composite index of LHU São João is higher than LHU Guarda. Both organizations are characterized by a year-end composite index that reaches its highest point and a year-end composite index that reaches its lowest point at the beginning of the year. LHU São João has a composite index of 58.56, showing a relatively high performance and LHU Guarda's composite index is 44.07, showing a relatively low performance, on average across all months analyzed. According to the above data, during this period, LHU de São João's "Quality" dimension (69.55) was significantly higher than LHU Guarda (47.96), which may be an important driving force for the growth of its composite index. In addition, LHU de São João's "Efficiency & Financing" dimension (54.83) is also higher than LHU da Guarda (52.06), showing its advantages in resource utilization and financial management. At LHU São João, the increase in quality indicators is perhaps the most significant, reflecting the institution's continued efforts to provide high-quality care. In comparison, LHU Guarda showed lower growth in all indicators, especially weak growth in quality indicators, which may be the main reason for its overall poor performance.

Figure 1: Changes over Time in the Composite Indices of the Best and Worst Performing LHUs



4.2.3. Performance Variability

Table 14 and Figure 5 in the appendix show the mean and standard deviation of the composite indicators for each LHU. Since looking for LHUs with high mean M and small variance SD, although the first three have high mean, they have large variance. Therefore, postponed it to the fourth one, LHU Santa Maria, and classified it as a consistently good performer. LHU Santa Maria has a mean of 56.06, which is high among all LHUs, and a standard deviation of 3.47, which is a relatively low standard deviation, suggesting that its performance is not only at a high level but also relatively stable, and it can be categorized as a sustained high-performer. LHU Guarda has a relatively low mean of only 44.07 and a standard deviation of 5.01, which is relatively large in these data comparisons, indicating not only lower but also more fluctuating performance, which can be categorized as an unstable low performer.

As can be seen in table 15 in the appendix, comparing the composite indicators for January 2023 and June 2024, the index of LHU Castelo Branco increased 23.74%, showing significant improvement in performance or results for this specific healthcare sector between this period. This improvement was primarily driven by significant improvements in access and quality, with access increasing by 33.8% (from 38.37 to 51.33) and quality by 21.5% (from 54.14 to 65.77).

These results demonstrate tremendous progress in the availability and effectiveness of health care services. Improvements in health care indicate increased access to treatment for patients, which may be through expanded care, improved infrastructure, or reduced waiting times. At the same time, growth in quality reflects better clinical outcomes, likely due to stronger infection control measures, improved patient management strategies, and compliance with evidence-based guidelines. While efficiency and financing saw a smaller increase of 14.1% (from 54.83 to 62.59), it still contributed to overall growth by demonstrating better resource allocation and financial management such as the adoption of cost-saving measures such as biosimilars contribute. Together, these dimensions highlight LHU Castelo Branco's progress towards a more accessible, efficient, and higher-quality healthcare system.

Conversely, a decrease in the index of LHU Oeste index of 4.98% indicates a decrease in performance or results. This decrease was mainly due to a significant decrease in the efficiency and financing dimensions, which dropped by 36.47 points (from 69.28 to 32.81), a decrease of 52.62%. This sharp decline represents a challenge to financial and operational efficiency, which may be due to increased operating costs, inefficient resource allocation, or procurement issues. Nonetheless, the access and quality dimensions improved over the same period. Access rates increased by 5.99 points (from 34.54 to 40.53), reflecting enhanced health care availability and possible reduced wait times or expanded health care infrastructure. Likewise, quality rose 5.67 points (from 62.89 to 68.56), indicating better clinical outcomes and improved patient care, possibly due to stronger infection control measures or advances in medical practices. However, improvements in access and quality were not enough to offset significant declines in efficiency and financing, which remained a major factor in the overall decline in the composite index. To reverse this trend, LHU Oeste needs to address its financial and operational challenges while continuing to make progress in access and quality of care.

4.2.4. Domain-Specific Performance Analysis

Figure 6 in the appendix presents the scores of the organizations on Access, Efficiency and Financing, and Quality. For Access, LHU Cova da Beira has the highest score with a mean of 53.28 and a standard deviation of 13.90, while LHU Algarve has the lowest score with a mean of 34.79 and a standard deviation of 5.88. For Efficiency and Financing dimension, LHU Santo António has the highest score with a mean of 64.26 and a standard deviation of 5.62, and LHU Coimbra has the lowest score with a mean of 48.37 and a standard deviation of 8.66. On the Quality score, LHU São João scored the highest with a mean of 69.55 and a standard deviation of 5.99. LHU Algarve scored the lowest with a mean value of 45.96 and standard deviation of 3.59.

4.3. Difference-in-Difference Analysis

To evaluate the impact of the vertical integration of care on health care units' performance, the Difference-in-Differences (DiD) methodology was applied. This is a robust quasi-experimental approach frequently used in public health and policy research to assess causal relationships in situations where randomized controlled trials (RCTs) are infeasible. The DiD methodology leverages variations in treatment across groups and time to isolate the effect of an intervention, while accounting for unobservable time-invariant differences between the treatment and control groups. This approach is particularly useful for analyzing the impact of public health initiatives, given its ability to address potential confounding caused by non-random treatment assignment (Wing, Simon, and Bello-Gomez 2018).

4.3.1. Parallel Trends

The parallel trends assumption underpins the DiD methodology and assumes that, in the absence of the reform, the treated and control groups would have followed similar trajectories over time in terms of the performance of the composite index. Ensuring the validity of this assumption is essential for drawing causal conclusions from the observed data. To analyze parallel trends, average composite index values for treated and control LHUs were calculated over an 18-month period, including both pre- and post-intervention periods. The trends were then plotted, focusing particularly on the pre-reform period (January 2023 to December 2023). It is important to note that, within the LHU of Lisboa Ocidental, the Hospital de Cascais is not included in the main analyses due to its function as a public-private partnership hospital and its unique structural characteristics. This exclusion ensures the consistency and comparability of the data used in the analysis.

The graphical analysis, which can be found in the appendix under figure 7 and 8, shows that the treated and control groups had roughly similar pre-intervention trajectories, with slight changes that did not imply systematic divergence. The visual data indicates that any variations in trends before the intervention are probably the result of random fluctuations instead of inherent differences between the groups. This similarity in pre-intervention trends provides preliminary support for the parallel trends assumption, which is essential for ensuring that post-intervention differences can be attributed to the intervention rather than pre-existing disparities or confounding time-varying factors.

In addition to the visual inspection, a regression-based test was conducted to quantitatively confirm the parallel trends assumption. The analysis focused only on pre-intervention data, using 'Composite Index Values' as the dependent variable and 'Group (treated vs. control)' and 'Time (measured as months since January 2023)' as the independent variables. The regression results (see table 13 in appendix), indicate that the coefficient for the group variable was not statistically significant ($p = 0.161$). This result supports the visual data, verifying that there were no consistent differences in the changes of composite index values between the treated and control groups prior to the intervention. The lack of statistical significance in the group variable provides strong evidence that the parallel trends assumption holds, ensuring the validity of the DiD methodology for estimating the treatment effect.

4.3.2. Analysis of 24 LHUs

$$Composite\ index = \beta_0 + \beta_1 Group + \beta_2 Post_{intervention} + \beta_3 (Group \times Post_{intervention}) + u$$

The regression diagnostics indicate that the model, while limited in its explanatory power, is statistically significant. Specifically, the R-squared value of 0.099 suggests that the included predictors account for approximately 9.9% of the variation in the dependent variable. This level of explained variance, though seemingly modest, is consistent with research addressing complicated behavioral or policy outcomes, as these are influenced by numerous unobserved factors. The adjusted R-squared (0.093) further underlines the model's constraints by accounting for the degrees of freedom, confirming its limited capacity to explain the outcome variability.

The F-statistic of 15.69, with a highly significant p-value (1.07E-09) shows that the predictors collectively explain a nonrandom portion of the variance. This supports the inclusion of covariates and interaction terms, demonstrating the model's ability to capture meaningful patterns in the data. Nevertheless, the relatively low R-squared values emphasize the need for caution when interpreting the results and highlight the possible role of unobserved confounders.

The estimated coefficients, available in the table 4, provide insight on the relationships between the predictors and the outcome variable. The intercept ($\beta 0$), which represents the baseline level of the outcome in the absence of treatment and all other predictors, is statistically significant (51.63, $p < 0.001$). This indicates a strong baseline effect. The coefficient for the group ($\beta 1$) is positive yet not statistically significant (0.91, $p = 0.241$). This suggests a slight pre-intervention difference between the treatment and control groups. However, this finding is uncertain, as indicated by the wide confidence interval (-0.61 to 2.43), which could be attributable to heterogeneity among groups or unobserved factors not accounted for in the model. The coefficient for post_reorg ($\beta 2$) reflects the overall effect of the intervention period across all groups. Its coefficient (-2.16, p = 0.071) points to a marginally negative trend in the outcome variable after the intervention period, though this effect is not statistically significant at the 5% significance level it is statistically significant at the 10% significance level. Such a trend might reflect external influences or secular changes unrelated to the intervention itself. The interaction term Group × Post ($\beta 3$), reflects the varying effect of the intervention on the treatment group compared to the control group, is also negative (-1.89, p = 0.160) but not statically significant. This suggests a potential decrease in the outcome variable for the treated group compared to the control group. This lack of significance indicates that the intervention's differential impact cannot be conclusively attributed to the policy changes alone, as other unmeasured factors may be influencing this outcome.

The results have significant implications for public health policy and intervention design. The non-significant interaction term strengthens the complexities of evaluating policy impacts, suggesting that factors like implementation challenges, unintended behavioral responses, or inequitable benefit distribution may have mitigated the intervention’s intended effects. It is important to note that the calculations account for only half a year following the reform, which may be insufficient to capture the effect of the transition. Furthermore, the model’s limited explanatory power suggests that unmeasured factors may have influenced the outcomes, while the non-significant interaction term does not eliminate the possibility of bias from time-varying confounders. Despite these limitations, the study uses the strengths of the DiD design to separate causal effects and identifies potential unintended consequences for the treatment group. These findings underscore the importance of a thorough understanding of intervention mechanisms and contextual factors to improve policy effectiveness.

Table 4: DiD LHUs

SUMMARY OUTPUT	**DiD LHUs**
Regression Statistics	

Multiple R	0.315
R Square	0.099
Adjusted R Square	0.093
Standard Error	5.344
Observations	432

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1344.255	448.085	15.690	0.000
Residual	428	12222.823	28.558		
Total	431	13567.078			

	Coefficients	*Standard Error*	*P-value*
Intercept	51.625	0.690	0.000
Group	0.910	0.775	0.241
post_reorg	-2.159	1.195	0.071
Group × Post	-1.889	1.343	0.160

4.3.3. Analysis of 24 LHUs including Hospital de Cascais

The addition of the Hospital de Cascais to the analysis brings a more detailed perspective to the evaluation of pre-intervention dynamics and outcomes. As a Public-Private Partnership (PPP), the Hospital de Cascais operates under a unique administrative and operational structure that requires treating its data separately in some analyses. Although geographically situated within the Lisbon area, it is not formally part of the LHU Lisboa Ocidental. Despite this distinction, its relevance to wider regional healthcare patterns makes its inclusion in the LHU Lisboa Ocidental relevant.

The regression results offer significant insights into the healthcare reforms, particularly regarding the Hospital de Cascais' role within larger regional structures. The R-squared value of 0.084 indicates that approximately 8.4% of the variance in the dependent variable is explained by the independent variables in the model. The adjusted R-Squared value of 0.077 confirms the model's limited explanatory capacity, indicating it struggles to comprehensively account for the observed outcomes. The overall model is statistically significant, as indicated by the F-statistic of 13.14 and its corresponding p-value of 3.19725E-08. This demonstrates that the predictors explain a proportion of the variance in the outcome, supporting the relevance of the included covariates. The intercept ($\beta 0$) is highly significant (p-value < 0.001), establishing a robust baseline for the dependent variable. The coefficient for group ($\beta 1$) is 0.759 with a p-value of 0.35. It suggests that group alone does not have a statistically significant effect on the outcome. The coefficient for post_reorg ($\beta 2$) is -2.195, with a p-value of 0.08. While not statically significant at the 5% significance level it is statistically significant at the 10% significance level. This indicates that post-reorganization effects might slightly reduce the dependent measure in some contexts. Finally, the interaction term Group × Post ($\beta 3$), representing the differential effect of the intervention on the treatment group compared to the control group, has a coefficient of -1.678 and a p-value of 0.234 and therefore is not statistically significant. This implies that the combined effect of group designation and post-reorganization status does not produce substantial measurable impacts. This likely stems from the unique nature of some instiutions The low explanatory power and missing factors limit impacts, while the composite index and aggregated data may overlook subtle changes. Overall, the limited explanatory power and lack of significance for key variables suggest that systemic reforms may not have uniformly impacted entities, with variations potentially influenced by factors such as the uniqueness of some organizations.

Table 5: DiD including Hospital de Cascais

SUMMARY OUTPUT	**DiD w Hospital de Cascais**
Regression Statistics	
Multiple R	0.290
R Square	0.084
Adjusted R Square	0.078
Standard Error	5.606
Observations	432.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.000	1238.730	412.910	13.138	0.000
Residual	428.000	13451.472	31.429		
Total	431.000	14690.202			

	Coefficients	*Standard Error*	*P-value*
Intercept	51.958	0.724	0.000

Group	0.759	0.813	0.351
post_reorg	-2.195	1.254	0.081
Group × Post	-1.678	1.409	0.234

4.4. Domain specific analysis

The analysis evaluates the impact of the intervention across three key domains: access, efficiency and financing, and quality. Separate analyses were conducted for each domain to account for their potential variations in response to the intervention. The data used is only from 24 LHUs, as IQVIA only had data available for this subset of LHUs.

In all three domains, the graphical analysis supports the validity of the parallel trends assumption, as the pre-intervention trends for treated and control LHUs are well aligned. However, the intervention's impact varied across the domains, with limited evidence of significant effects. In the domain of access, the graphical analysis shows alignment in the pre-intervention trends between treated and control LHUs, satisfying the parallel trends assumption. The DiD analysis (see in appendix tables 16, 17 and figure 9) reveals that the interaction term Group × Post (β3) is negative (-3.23, p = 0.109) but not statistically significant. This suggests a potential decline in access metrics for the treated group compared to the control group. For efficiency and financing, the graphical analysis shows a strong alignment in the pre-intervention trends, confirming the parallel trends assumption. The DiD regression results (see tables 18, 19 and figure 10 in appendix) indicate that the interaction term (β3) (-1.15, p = 0.210) is not statistically significant, suggesting that the observed post-intervention divergence may not be directly linked to the intervention but rather to wider contextual factors affecting efficiency across both groups. In the domain of quality, the graphical trends demonstrate that the pre-intervention trends for treated and control LHUs were aligned and therefore supporting the parallel trends assumption. The DiD regression (see tables 20, 21 and figure 11 in appendix) shows that the interaction term (β3) is negative but not statistically significant (-0.9169, p = 0.648). This suggest that the intervention did not have a meaningful impact on quality metrics.

Overall, the combined domain-specific analyses reveal that the vertical integration did not improve any of the dimensions analyzed (access, efficiency and financing, quality of care), at least in the short run.

4.5. Correlation and Subgroup Analyses

To better understand these results, we further assess the correlations of performance in three areas (access, efficiency and financing, and quality) and analyze LHU performance across regions and by size. This deeper exploration is critical to identifying systemic patterns and underlying factors that influence health care performance. For example, understanding whether improvements in one area (such as quality) are consistently associated with declines in another area (such as efficiency and financing) can reveal trade-offs in resource allocation or operational prioritization. Likewise, by comparing the performance of LHUs across regions or sizes, we can uncover differences, such as whether smaller LHUs face unique challenges in maintaining efficiency or whether regional health policies impact outcomes differently.

These analyzes are relevant because they provide a more comprehensive view of health care system performance, helping policymakers and managers develop interventions more effectively. By identifying correlations and regional or size-based differences, policymakers can implement targeted strategies to address specific weaknesses, such as improving financial management of underperforming LHUs or sharing best practices across regions. Ultimately, these insights are critical to driving more equitable, efficient, and high-quality health care delivery.

4.5.1. Correlation analysis

In order to explore the relationship between Group, Time, Domain-specific scores, and Composite Index, a correlation analysis of these variables was conducted, and the results are shown in the table 6. It was found that Group, Time, and their interactions were not significantly correlated with Domain-specific scores and Composite Index. Access was significantly negatively correlated with Efficiency&Financing (r=-0.244, p<0.001),and positively correlated with Quality (r=0.489, p<0.001). This means that as the value of Access increases, the value of Efficiency&Financing tends to decrease, while the value of Quality tends to increase. To address this, targeted measures can be taken to ensure that improvements in efficiency and financing do not come at the expense of access. For example, Integrated Planning and Resource Allocation that Allocate resources appropriately based on demand and ensure that cost reduction measures do not impact services in high demand or underserved areas.

Table 6: Correlations

	Access	**Efficiency& Financing**	**Quality**	**Composite Index**
Access	1			
Efficiency& Financing	-0.244***	1		
Quality	0.489**	-0.005	1	
Composite Index	0.786**	0.176***	0.851***	1

***Correlation is significant at the 0.001 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

4.5.2. Subgroup Analysis – Institutional Size

4.5.2.1. Grouping

Firstly, we calculate the average number of " Registered Patients in Primary Healthcare (utentes inscritos em cuidados de saude primaries)" for each LHU from January 2023 to December 2024 and then divide the LHUs into three size groups: "large”, "medium”, and "small" based on the tertiles. The grouping criteria are as follows:

Table 7: LHUs grouped by Size

Institutional Size	Samll	Medium	Large
Grouping Criteria	No. of users <242,683	242,683<= No. of users <=354,461	No. of users >354,461

4.5.2.2. Descriptive Analysis by Size

This study provides a statistical analysis of the mean, median, and standard deviation across four key performance indicators for local LHUs of varying sizes: Access, Efficiency, Quality, and Composite Index. The analysis is based on an equal number of LHUs in each category, with 8 units per size group. Below is a detailed examination of the performance across different indicators for each size group:

Access: Medium LHUs lead in terms of both mean (44.22) and median (43.57) Access scores, indicating superior accessibility. Large LHUs trail behind with the lowest mean (40.15) and median (39.08) scores. Variance analysis reveals that medium LHUs have the most uniform access levels within their group, as indicated by a standard deviation (sd) of 7.89, while small LHUs display greater variability with a sd of 9.64.

Efficiency: Large-sized LHUs excel with the highest mean (59.25) and median (60.74) efficiency scores, outperforming their smaller and medium counterparts. They also exhibit the lowest variance (sd of 8.94), suggesting a more consistent level of efficiency. Conversely, medium-sized LHUs have the lowest mean (54.39) and median (55.36). Efficiency scores, with the highest variance (sd of 9.65), indicating a significant disparity in service efficiency and a need for targeted improvements.

Quality: Medium-sized LHUs dominate in Quality, with the highest mean (62.88) and median (63.05) scores, and the smallest variance (sd of 6.97), indicating a high and consistent level of service quality. Small-sized LHUs have the lowest scores across these metrics, with a mean (56.50) and median (56.95) that suggest lower service quality. Large-sized LHUs have a moderate mean (56.94) and median (57.26), but the highest variance (sd of 8.43), implying significant disparities in the quality of services among them.

Composite Index: Medium-sized LHUs have the highest median (54.18), mean (53.83), and variance (sd of 4.93) in the Composite Index, indicating overall excellence in service quality, efficiency, and accessibility. Small-sized LHUs have the lowest scores in these dimensions, with a mean (51.34) and median (51.14) that suggest a need for improvement. Large-sized LHUs rank second, with a mean (52.11) and median (52.28), but their performance variation (sd of 5.53) suggests a range of service experiences within this group. Table 23 and figure 12 of the descriptive analysis by size is in the appendix.

4.5.2.3. Post-Hoc Analysis

In this analysis, we conduct pairwise comparisons of the composite index scores among LHUs of varying sizes by using t-tests. The results of the t-tests reveal significant disparities in performance. The t-test comparing Large and Medium-sized LHUs yielded a P-value of 0, which is well below the 5% significance level, demonstrating a statistically significant difference in their composite index scores. Similarly, the t-test between Small and Medium-sized LHUs also produced a P-value of 0, indicating a significant difference in their composite index scores. However, the t-test between Large and Small-sized LHUs resulted in a P-value of 0.07, exceeding the 5% significance level, which suggests that the difference in composite index scores between these two groups is not statistically significant. In summary, this analysis shows that there are significant differences in composite index performance between large and medium-sized LHUs and between small and medium-sized LHUs. In contrast, the performance of large and small-sized LHUs did not show significant differences when assessed through the composite index.

Table 8: Result of Post-Hoc Analysis

	Large vs Medium		**Large vs Small**		**Medium vs Small**	
Mean	52.11	53.83	52.11	51.34	53.83	51.34
Variance	30.54	24.28	30.54	29.43	24.28	29.43
Observations	144	144	144	144	144	144
Poisson Correlation Coefficient	0.12		0.36		0.33	
Assumed Mean Difference	0.00		0.00		0.00	
Degrees of Freedom	143		143		143	
t Statistic	-2.97		1.50		4.97	

P(T<=t) One-Tailed	0.00	0.07	0.00
t One-Tailed Critical	1.66	1.66	1.66
P(T<=t) Two-Tailed	0.00	0.14	0.00
t Two-Tailed Critical	1.98	1.98	1.97

4.5.2.4. Overview of Subgroup Analysis by Size

The results of this analysis reveal significant differences in performance metrics for LHUs of different sizes. Medium-sized LHUs stand out in the Composite Index with higher average and median scores, as well as lower variance, indicating their superior overall performance in healthcare services and smaller differences in service levels among them.

The domain-specific scores reveal that the advantage in service quality for medium-sized LHUs is primarily due to their high accessibility and efficiency. In terms of accessibility, medium-sized LHUs can allocate resources more evenly, ensuring that each service point has sufficient resources to meet patient needs. They may also be closer to the communities they serve, making their facilities more accessible to patients. In contrast, larger-sized LHUs may require patients to travel greater distances to access services due to their wider coverage, and uneven resource allocation or prioritization may result in reduced accessibility of certain service points. In terms of service quality, medium-sized LHUs show obvious advantages. They allocate resources more efficiently, equipped with advanced medical facilities and comprehensive personnel to improve service quality. Small-sized LHUs may have difficulty maintaining service quality due to limited resources and personnel, while large-sized LHUs may face challenges due to uneven resource allocation or complex management, affecting service quality. Management of medium-sized LHUs may be more flexible and efficient, able to respond quickly to patient needs and implement improvements. Small-sized LHUs may face management challenges, while large-sized LHUs may result in slower decision-making due to hierarchical management, affecting the timely improvement of service quality. Medium-sized LHUs are also likely to have closer interactions with patients, better understanding, and personalizing services to meet patient needs. Small-sized LHUs may have difficulty providing comprehensive services due to their larger size, while large-sized LHUs may not be able to give each patient adequate attention due to their large patient base. Large-sized LHUs' strong performance in the efficiency area significantly improved their composite index scores. Their larger scale allows for economies of scale, resulting in more efficient resource utilization and cost control. They may also optimize resource allocation, focus on key areas, and improve service efficiency. In addition, large-sized LHUs may have advanced technology and information systems, as well as more sophisticated management and organizational structures, which help improve service efficiency and faster execution. They may also have established standardized service processes to reduce unnecessary steps and improve efficiency through optimization. Furthermore, the analysis revealed significant differences in the composite index between large and medium LHUs and between medium and small LHUs. However, the service level gap between small and large LHUs is less pronounced. This is because large LHUs have advantages in efficiency and quality, while small LHUs excel in accessibility, and neither party has obvious advantages in various fields.

4.5.3. Subgroup Analysis -Region

4.5.3.1. Grouping

To conduct a regional analysis of LHUs' service performance, this study initially categorizes LHUs into three geographical areas: "North", "Center", and "South" based on the criteria established by the IQVIA Hospital Panel. The specific standards for regional division are shown in the table 24 in the appendix.

4.5.3.2. Descriptive Analysis by Region

The 24 LHUs are distributed across different regions, with 8 located in the North, 7 in the Center, and 9 in the South. This study conducts a statistical analysis of the mean, median, and standard deviation of four key performance indicators for LHUs across these regions: Access, Efficiency, Quality, and Composite Index. Below is a detailed examination of the performance across different indicators for each regional group.

Access: LHUs in the North region achieve the highest mean (44.09) and median (43.54) access scores, indicating superior accessibility. Those in the Center region follow with a mean (43.07) and median (40.64) but exhibit the greatest variance (sd of 10.32), suggesting significant disparities in accessibility. Southern LHUs lag behind with the lowest mean (39.31) and median (38.00) scores, indicating the poorest accessibility and relatively smaller variance (sd of 7.34).

Efficiency: Southern LHUs lead in efficiency, with the highest mean (58.55) and median (57.92) scores, and the smallest variance (sd of 7.84), denoting the most consistent and highest service efficiency. Northern LHUs rank second with a mean (56.17) and median (56.60). In contrast, Central LHUs display the largest variance (sd of 10.18), implying a wide range of efficiency levels and the lowest mean (54.28) and median (54.59) scores.

Quality: Northern LHUs excel in Quality, with a substantial lead in both mean (62.76) and median (62.72) scores, and the smallest variance (sd of 7.34), reflecting the best and most uniform service quality. Southern LHUs trail with the lowest mean (56.17) and median (56.78) scores, and the largest variance (sd of 8.07), indicating the poorest service quality and greater variability.

Composite Index: Central LHUs have the largest variance (sd of 5.57) in the Composite Index, with a mean (51.64) slightly higher than Southern LHUs (51.34), and a median (51.14) slightly lower than Southern LHUs (51.92). This suggests that while the average service level in the Central region is slightly better than in the South, the significant variation indicates a mix of high-performing and lower-performing LHUs, which lowers the median. Northern LHUs significantly outperform other regions in the Composite Index, with a mean (54.34) that is substantially higher, indicating a superior overall service level. Southern LHUs have the smallest variance (sd of 4.92), suggesting a more uniform service level across LHUs in this region. Table 25 and figure 13 of the result of descriptive analysis by region are in the appendix.

4.5.3.3. Post-Hoc Analysis

Given that different regions have different numbers of LHUs, this study used Welch's t test, suitable for varying sample sizes, to compare the composite index scores across regions. Welch's t test does not assume equality of variation between groups and is therefore appropriate for our analysis. According to the t-test results, the p-values for comparisons between northern and central regions and northern and southern regions are 0.0001 and 0.0000, respectively. Both are less than the 5% significance level, showing a significant difference in the mean composite index scores at the 95% confidence level. This shows that there are significant differences in the comprehensive service levels of LHUs in these areas. In comparison, the P value for the comparison between the central and southern regions is 0.6369, which is greater than 5%, showing that the difference in average composite index scores is not significant.

Table 9: Result of Post-Hoc Analysis

	North vs Center		North vs South		Center vs South	
Mean	54.3419	51.6401	54.3419	51.3427	51.6401	51.3427
Variance	27.5229	31.0486	27.5229	24.2398	31.0486	24.2398
Observations	144	126	144	162	126	162
Assumed Mean Difference	0.0000		0.0000		0.0000	
df	258		294		251	
t Statistic	4.0845		5.1379		0.4727	
P(T<=t) One-Tailed	0.0000		0.0000		0.3184	
t One-Tailed Critical	1.6508		1.6501		1.6509	
P(T<=t) Two-Tailed	0.0001		0.0000		0.6369	
t Two-Tailed Critical	1.9692		1.9681		1.9695	

4.5.3.4. Overview of Subgroup Analysis by Region

This study analyzes differences in service access, quality, efficiency, and overall performance of LHUs across regions. From the perspective of overall service level performance, the median and average LHUs in the northern region are higher, indicating a higher level of comprehensive medical services. The average medical service level in the central region is higher than that in the southern region. However, due to the large differences in medical service levels among regions and the lower medical service standards in some regions, the median comprehensive index is slightly lower than that in the southern region. Domain score analysis shows that the higher medical service level of LHUs in the northern region is mainly attributed to higher service access and quality. The higher medical accessibility and quality in northern Portugal are mainly affected by the level of economic development and medical resources. The north has a higher degree of economic development, higher population density, more medical service facilities, and convenient medical treatment for residents. Additionally, the North is home to some of the top medical schools and health services, such as the University of Minho - School of Health Sciences indicating that the region has more trained medical professionals and more advanced medical facilities, thereby improving the quality of medical services. In comparison, the south has a lower level of economic development and professional medical service personnel, and less convenient transportation, resulting in lower medical accessibility and quality. The medical service efficiency of hospitals in the southern region is slightly higher than that in the northern region, and significantly higher than that in the central region. This may be due to the fact that Southern Local Hospital is at the forefront of medical system reform and adopts innovative working models and optimized work processes to provide patients with more efficient medical services. In addition, pairwise analysis between regions shows that LHUs in the northern region have significant advantages in service levels, while there is not much difference in service levels between the southern and central regions.

5. Conclusion

The creation of the Local Health Units Observatory represents a significant step forward for Portugal's National Health Service. By adopting a comprehensive framework to evaluate performance, it accentuates the importance of access, efficiency and financing, and quality in building fair and sustainable health care systems. Using data-driven methodologies to create performance index, the Observatory offers valuable insights into the system's dynamics, addressing challenges while guiding targeted reforms. The LHU model's vertical integration of primary, secondary, and tertiary care under unified governance is key to improving efficiency and financing, and quality while reducing fragmentation. However, the analysis reveals complexities in operationalizing such models, including challenges with data granularity, availability, and alignment with policy monitoring frameworks. These findings underscore the need for stronger data systems and active stakeholder engagement to maximize the utility of health performance indices. The analysis of the 2024 NHS reforms through the LHU Observatory provides a multifaceted view of their impacts, revealing no significant improvement in the overall performance of the vertical integration of care, at least in the short run. Indeed, results from differences-in-difference methodology confirm that the reform did not result in differential performance improvements between treated and control LHUs, neither when considering the composite index, nor when analyzing the domains separately. In terms of access, the impact of the reforms was modest, as evidenced by the coefficient for post_reorg. The estimated coefficient (-2.16, $p = 0.071$) indicates a marginally negative trend in access during the post-reform period, though it is only statistically significant at the 10% level. This suggests that systemic trends, rather than direct policy effects, shaped the outcomes. The efficiency and financing domain showed trends suggesting improved resource usages and cost management, however the lack of statistically significance in Group × Post ($p = 0.21$) indicates that these outcomes cannot be attributed to the reforms. Metrics such as the market share of biosimilars and total hospital medicine consumption reflected strategic shifts toward cost-effective practices. These shifts are likely driven by market dynamics, increasing awareness, optimizing resource usage, and national policies. For example, increased biosimilar adoption emphasized cost-effective pharmaceutical strategies without compromising care quality. However, the lack of statistically significant interaction terms suggests that broader systemic adjustments or regional initiatives may also have influenced these outcomes. The quality domain was less favorable. A general decline in quality metrics across all LHUs points to systemic inefficiencies that reforms did not sufficiently address. While the DiD analysis confirmed the method's reliability, it found no impact from the intervention itself.

Challenges during the analysis, including data granularity and availability, significantly shaped the findings. The reliance on cumulative and aggregated datasets necessitated extensive preprocessing, adding complexity to the evaluation. The substitution of unavailable indicators from the "Termos de Referência" underlined the critical need for more comprehensive, LHU-specific data to support precise and actionable evaluations. Although the vertical integration of care had no effect in the performance of health care units, subgroup analysis found differences in the performance of LHUs based on their size (as measured by the number of patients registered in the LHU) and region.

In conclusion, the 2024 NHS reforms have laid a foundation for integrated care and operational improvements. These findings call for ongoing investments in data infrastructure, focused clinical quality initiatives, and policies addressing systemic barriers to equitable and high-quality care. Moving forward, the LHU Observatory will serve as an important instrument for monitoring and refining healthcare initiatives, ensuring that reforms are not only implemented but also effectively meet the diverse needs of the population. In particular, more targeted strategies must be adopted to address unit and regional differences in underperforming units. Future medical reform should be data-driven, optimize resource utilization through resource optimization, technological innovation and policy support, create a fair, efficient and sustainable medical service system, and provide residents in Portugal with higher quality health service guarantees. This specific composite index will support these efforts by providing a data-driven framework to assess the operational efficiency and service quality of LHUs, helping to identify underperforming areas and identify areas requiring intervention. By integrating key variables, the index can better allocate resources, track the impact of technology and policy reforms, and ensure improvements are measurable and aligned with long-term health care goals. It ultimately enables policymakers to implement targeted, evidence-based strategies to reduce disparities and improve overall health care performance. With its development of data infrastructure coupled, the LHU model may serve as a global health reform model which sets benchmarks in creating equitable sustainable high-quality systems of health care provision.

6. References

Amado, Guilherme C., Diogo C. Ferreira, and Alexandre M. Nunes. "Vertical Integration in Healthcare: What Does Literature Say About Improvements on Quality, Access, Efficiency, and Costs Containment?" *The International Journal of Health Planning and Management* 37, no. 3 (2022): 1252–1298.

Angrist, Joshua D., and Jörn-Steffen Pischke. Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press, 2009.

Arah, O. A., N. S. Westert, J. H. Hurst, and N. Klazinga. "Conceptual Framework for the OECD Health Indicators." *Health Policy* 76, no. 1 (2006): 1–15.

Baker, S. D., L. C. Hoffman, and E. L. Thomas. "The Role of Social Determinants in Health Care Quality." *International Journal for Quality in Health Care* 27, no. 5 (2015): 393–400.

Barros, Pedro Pita, Sara Ribeirinho Machado, Jorge de Almeida Simões, and World Health Organization. *Portugal: Health System Review.* (2011).

Bentes, Margarida, Carlos Matias Dias, Constantino Sakellarides, Vaida Bankauskaite, and World Health Organization. *Health Care Systems in Transition: Portugal.* (2004).

Berenson, Robert A. "A Physician's Perspective on Vertical Integration." *Health Affairs* 36, no. 9 (2017): 1585–1590.

Bodenheimer, T., and R. Berry-Millett. "Care Coordination: A Key to Transforming Health Care in the United States." *Health Affairs* 28, no. 1 (2009): 100–112.

Carlin, Caroline S., Bryan Dowd, and Roger Feldman. "Changes in Quality of Health Care Delivery After Vertical Integration." *Health Services Research* 50, no. 4 (2015): 1043–1068.

Cruz, João Ricardo Miranda da, Susana Rodríguez Escanciano, and Ana Belén Casares Marcos. "Local Health Units: A Vertical Integration Model of Health Care." *Revista de Enfermagem Referencia* 1 (2022).

Diaby, Vakaramoko, Kaitryn Campbell, and Ron Goeree. "Multi-Criteria Decision Analysis (MCDA) in Health Care: A Bibliometric Analysis." *Operations Research for Health Care* 2, no. 1–2 (2013): 20–24.

Diana, Mark L., Daniel M. Walker, Arthur M. Mora, and Yongkang Zhang. "Vertical Integration Strategies in Healthcare Organizations." *Journal of Health Administration Education* 32, no. 2 (2015): 223–244.

Diário da República. *Decreto-Lei n.º 207/99 de 9 de junho.* (1999). https://diariodarepublica.pt/dr/detalhe/decreto-lei/207-1999-310798.

Diário da República. *Decreto-Lei n.º 50-B/2007 de 28 de fevereiro.* (2007). https://diariodarepublica.pt/dr/detalhe/decreto-lei/50-b-2007-470072.

Diário da República. *Decreto-Lei n.º 183/2008 de 4 de setembro.* (2008). https://diariodarepublica.pt/dr/detalhe/decreto-lei/183-2008-453991.

Diário da República. *Decreto-Lei n.º 318/2009 de 2 de novembro.* (2009). https://diariodarepublica.pt/dr/legislacao-consolidada/decreto-lei/2009-216406787.

Diário da República. *Decreto-Lei n.º 67/2011 de 2 de junho.* (2011). https://diariodarepublica.pt/dr/detalhe/decreto-lei/67-2011-673399.

Diário da República. *Decreto-Lei n.º 238/2012 de 31 de outubro.* (2012). https://diariodarepublica.pt/dr/detalhe/decreto-lei/238-2012-191571.

Diário da República. *Decreto-Lei n.º 102/2023 de 7 de novembro.* (2023). https://diariodarepublica.pt/dr/detalhe/decreto-lei/102-2023-223906278.

Doran, T., M. McKee, J. L. Smith, and R. Robertson. "The Quality of Health Care Data: A Review of the Literature." *BMC Health Services Research* 14, no. 1 (2014): 1–10.

Entidade Reguladora da Saúde, ed. *Cuidados de Saúde Primários – Qualidade e Eficiência nas UCSP e USF.* (2024). https://www.ers.pt/media/1bkl53w5/estudo-csp-qualidade-e-efici%C3%AAncia-nas-usf-e-ucsp.pdf.

Fineide, Mona Jerndahl. "Achieving Horizontal and Vertical Integration in Local Services—Creating Sustainable Mechanisms?" *International Journal of Integrated Care* 21, no. S1 (2020): 164.

Fisher, E. S., D. E. Wennberg, T. A. Stukel, and S. M. Sharp. "The Implications of Regional Variations in Medicare Spending." *New England Journal of Medicine* 349, no. 22 (2003): 2195–2202.

Fisher, Mary J., and Andrea P. Marshall. “Understanding Descriptive Statistics.” Australian Critical Care 22, no. 2 (2009): 93–97. https://doi.org/10.1016/j.aucc.2008.11.003.

Gabow, Patricia, Sheri Eisert, and Richard Wright. "Denver Health: A Model for the Integration of a Public Hospital and Community Health Centers." *Annals of Internal Medicine* 138, no. 2 (2003): 143–149.

Global Cancer Observatory (GCO). Cancer Medicines and Resource Allocation. n.d. 2018. Retrieved from https://gco.iarc.fr.

Goiana-da-Silva, Francisco, Juliana Sá, Miguel Cabral, Raisa Guedes, Rafael Vasconcelos, João Sarmento, Alexandre Morais Nunes et al. "The Portuguese NHS 2024 Reform: Transformation Through Vertical Integration." *Frontiers in Public Health* 12 (2024): 1389057.

Governo da República Portuguesa. "Nova Organização dos Cuidados de Saúde: Conheça a Grande Reforma do SNS para 2024." (2023). https://www.portugal.gov.pt/pt/gc23/comunicacao/noticia?i=nova-organizacao-dos-cuidados-de-saude-conheca-a-grande-reforma-do-sns-para-2024.

Informação de Monitorização sobre Cuidados de Saúde Primários. (2024). https://www.ers.pt/media/p1spdb1t/im-csp-2024-052024.pdf.

IQVIA. The Impact of Biosimilar Competition in Europe. 2021. Retrieved from https://www.iqvia.com.

IQVIA. (2023). "Que financiamento para a nova organização dos cuidados de saúde? Recomendações do grupo de peritos." Presented at the session "2023, um ano de oportunidades", 2023.

Jolliffe, Ian T. "Principal Component Analysis and Factor Analysis." In *Principal Component Analysis,* 150–166. (2002).

Kirkpatrick, S. I., C. D. McIntyre, and H. L. Potvin. "The Role of Data Quality in Health Care Quality Measurement." *Health Services Research* 51, no. 2 (2016): 687–707.

Kurpas, Donata, Dorota Stefanicka-Wojtas, Andrei Shpakou, David Halata, András Mohos, Aelita Skarbaliene, Gindrovel Dumitra, Ludmila Klimatckaia, Jana Bendova, and Victoria Tkachenko. "The advantages and disadvantages of integrated care implementation in Central and Eastern Europe–perspective from 9 CEE countries." *International journal of integrated care* 21, no. 4 (2021).

Marien, M. "Handbook of Composite Indicators: Methodology and User Guide." *Futures Research Quarterly* 1, no. 1 (2009): 102–103. https://xueshu.baidu.com/usercenter/paper/show?paperid=196n0gy0m16x0tx0tp7j0r40vb192936&site=xueshu_se&hitarticle=1.

Ministério da Saúde. *Operacionalização da Contratualização nos Cuidados de Saúde Primários para 2022.* (2022). https://bicsp.min-saude.pt/pt/biblioteca/Biblioteca/Operacionalizacao_CSP_2022_VF.pdf.

Ministério da Saúde. "Relatórios de Atividade." *Biblioteca de Indicadores de Contratualização nos Cuidados de Saúde Primários (BICSP).* (2024). https://bicsp.min-saude.pt/pt/contratualizacao/relatoriosatividade/Paginas/default.aspx.

Morris, Z. S., S. Wooding, and J. Grant. "The Role of Indicators in Health Care Quality Improvement." *BMJ Quality & Safety* 26, no. 1 (2017): 1–3.

Mulcahy, A. W., Hlavka, J. P., and Case, S. R. “Biosimilar Cost Savings in the United States: Initial Experience and Future Opportunities”. *Santa Monica, CA: RAND Corporation, 2018. Retrieved from* https://www.rand.org.

Nardo, Michela, Michaela Saisana, Andrea Saltelli, Stefano Tarantola, Anders Hoffman, and Enrico Giovannini. Handbook on Constructing Composite Indicators: Methodology and User Guide. *OECD Publishing, 2005. https://doi.org/10.1787/533411815016.*

National Institute for Health and Care Excellence (NICE). *Position Statement on the Use of Biosimilars. n.d.* 2017. Retrieved from https://www.nice.org.uk.

Nolte, E., M. McKee, and A. Ritz. "The Role of Health System Efficiency in Health Care Quality." *Health Policy* 117, no. 1 (2014): 1–8.

Nunes, Alexandre. "Vertical Integration in Healthcare and Patient Satisfaction: An Exploratory Analysis of Portuguese Reforms." *Sustainability* 16, no. 3 (2024): 1078.

OECD. *OECD Reviews of Health Care Quality: Portugal 2015: Raising Standards.* Paris: OECD Publishing, 2015.https://doi.org/10.1787/9789264225985-en.

OECD, European Union, and EC-JRC. Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD Publishing, Paris, 2008. https://doi.org/10.1787/9789264043466-en.

Organization for Economic Co-operation and Development. *Data Explorer: Hospital Beds by Sector.* (2024). https://data-explorer.oecd.org/vis.

Robinson, James C., and Lawrence P. Casalino. "Vertical Integration and Organizational Networks in Health Care." *Health Affairs* 15, no. 1 (1996): 7–22.

Rothwell, Peter M. “Subgroup Analysis in Randomized Controlled Trials: Importance, Pitfalls, and Implications for Clinical Practice.” The Lancet 365, no. 9454 (2005): 176–86. https://doi.org/10.1016/S0140-6736(05)17709-5.

Saghafian, Soroush, Lina Song, Joseph Newhouse, Mary Beth Landrum, and John Hsu. "The Impact of Vertical Integration on Physician Behavior and Healthcare Delivery: Evidence from Gastroenterology Practices." *Management Science* 69, no. 12 (2023): 7158–7179.

Santana, Rui Manuel, Miguel Ferreira, João Sarmento, Ana Patricia Marques, Rosa Matos, and Julian Perelman. "The Impact of Creating Vertically Integrated Organizations on Hospital Inpatient Use." *International Journal of Integrated Care* 15 (2015).

Santana, Rui Manuel, Ana Patricia Marques, Ricardo Mestre, Teresa Torres, Pedro Lopes, Alexandre Lourenço, and Ricardo Gonçalves. "Recent Evolution of the Degree of Integration on Vertically Integrated Organizations." *International Journal of Integrated Care* 15, no. 5 (2015).

Serviço Nacional de Saúde. "Arranca Nova Fase da Organização do SNS." (2024). https://www.sns.gov.pt/noticias/2024/01/01/arranca-nova-fase-da-organizacao-do-sns/.

Serviço Nacional de Saúde. “Termos de Referência para Contratualização de Cuidados de Saúde no SNS para 2024. Ministério da Saúde, Portugal, 2024.

Simões, Jorge de Almeida, Gonçalo Figueiredo Augusto, Inês Fronteira, Cristina Hernández-Quevedo, and World Health Organization. *Portugal: Health System Review.* (2017).

Sood, Neeraj, Victoria Shier, Peter J. Huckfeldt, Lianna Weissblum, and José J. Escarce. "The Effects of Vertically Integrated Care on Health Care Use and Outcomes in Inpatient Rehabilitation Facilities." *Health Services Research* 56, no. 5 (2021): 828–838.

Sullivan, S. D., K. G. Mauskopf, and J. T. Davis. "The Impact of Biosimilars on the Future of Health Care." *Pharmacoeconomics* 34, no. 1 (2016): 1–10.

Ventola, C. L. "The Antibiotic Resistance Crisis: Part 1: Causes and Threats." *P&T* 40, no. 4 (2015): 277–83.

Wing, Coady, Kosali Simon, and Ricardo A. Bello-Gomez. "Designing Difference in Difference Studies: Best Practices for Public Health Policy Research." *Annual Review of Public Health* 39 (2018): 453–69. https://doi.org/10.1146/annurev-publhealth-040617-013507.

Wang, Xin, Enming Yang, Caiyun Zheng, and Shasha Yuan. "Effects of Vertical Integration on the Healthcare System in China: A Systematic Review and Meta-Analysis." *Health Policy and Planning* 39, no. 1 (2024): 66–79.

Wooldridge, Jeffrey M. Introductory Econometrics: A Modern Approach. 4th ed. South-Western Cengage Learning, 2010.

World Health Organization (WHO). *Biosimilars in the WHO Prequalification Program: Guidance for Evaluators*. Geneva: World Health Organization, 2021.

World Health Organization (WHO). *Health Indicators: A Guide to Selection and Interpretation*. Geneva: WHO Press, 2016.

Young, Sarah, Kevin Swarts, Sarah J. Prior, Douglass Doherty, and Steven J. Campbell. "Vertical Integration in the Australian Community Care Setting: Can It Work? A Theoretical Review of Current Literature." *The International Journal of Health Planning and Management* 37, no. 3 (2022): 1299–1310.

7. Appendix

Table 10: Overview of Access Indicators

Dimension	Indicator	Description	LHU Segmentation	Relevance	Selected	Source
Access	Emergency Care Attendance (Atendimentos em Urgência - Triagem Manchester)	Tracks emergency care attendance classified by the Manchester triage system.	Yes	Provides critical insights into emergency care trends and patient needs.	Yes	NHS Transparency Portal
Access	Inpatient Days (Dias de Internamento)	Measures inpatient days per registered patients in primary healthcare.	Yes	Reflects healthcare utilization and hospitalization trends within LHUs.	Yes	NHS Transparency Portal
Access	Telemedicine Consultations (Consultas em Telemedicina)	Tracks telemedicine consultations.	Yes	Highlights adoption of digital health solutions and access improvements.	Yes	NHS Transparency Portal
Access	% of Timely Consultations (% Consultas em Tempo Adequado)	Percentage of consultations conducted within an appropriate timeframe.	Yes	Measures accessibility and responsiveness of healthcare services.	Yes	NHS Transparency Portal
Access	% Enrolled in Long-term Care Within 180 Days (% Inscritos em LIC dentro do TMRG 180 Dias)	Percentage of patients enrolled in Long-term Integrated Care within 180 days.	Yes	Indicates timely access to long-term care, vital for assessing LHU efficiency.	Yes	NHS Transparency Portal
Access	Surgical Interventions (Intervenções Cirúrgicas)	Tracks surgical interventions.	Yes	Monitors surgical activity and its accessibility within the LHU.	Yes	NHS Transparency Portal
Access	Registered Patients in Primary Healthcare (Utentes Inscritos em Cuidados de Saúde Primários)	Tracks registered patients in primary healthcare.	Yes	Reflects patient registration and healthcare coverage within LHUs.	Yes	NHS Transparency Portal
Access	Primary Healthcare Activities (Atividade nos Cuidados Saúde Primários)	Tracks healthcare activities at the ARS level.	No	Lacks LHU-level segmentation; unsuitable for localized analysis.	No	NHS Transparency Portal
Access	Patients Waiting for a Long-term Care Slot (Utentes a Aguardar Vaga de Cuidados Continuados)	Regional data on patients waiting for care within RNCCI.	No	ARS-level segmentation limits its applicability to LHU-specific analysis.	No	NHS Transparency Portal

Access	Nursing Contacts in Primary Healthcare (Contactos de Enfermagem nos Cuidados de Saúde Primários)	Tracks nursing contact evolution.	No	Data only available at the ARS level.	No	NHS Transparency Portal
Access	Access to Medical Consultations by Registered Population (Acesso a Consultas Médicas pela População Inscrita)	Utilization rates for primary health consultations.	No	ARS-level segmentation excludes LHU applicability.	No	NHS Transparency Portal
Access	Certification of Healthcare Units (Certificação de Unidades de Saúde)	Tracks certifications of healthcare units.	No	ARS-level data segmentation prevents its use for LHU-specific analysis.	No	NHS Transparency Portal

Table 11: Overview of Efficiency and Financing Indicators

Dimension	Indicator	Description	LHU Segmentation	Relevance	Selected	Source
Efficiency	Total Debt, Overdue Debt, and Payment Delays (Dívida Total, Vencida e Pagamentos em Atraso)	Monthly evolution of debt values from SNS institutions to external suppliers.	Yes	Tracks total debt, overdue debt, and arrears, reflecting financial management.	Yes	NHS Transparency Portal
Efficiency	Economic and Financial Benchmarking (Benchmarking - económico financeira EUR)	key indicator for tracking financial performance and efficiency	Yes	with relevance for total financial benchmarking but is limited by LHU segmentation and complexity.	Yes	ACSS
Efficiency	Dispensing of Generic Medicines (Dispensa de Medicamentos Genéricos)	Tracks quotas of generic medicines dispensed in pharmacies.	No	ARS-level data segmentation prevents its use in LHU-focused analysis.	No	NHS Transparency Portal
Efficiency	Workforce by Professional Group (Trabalhadores por Grupo Profissional)	Monitors workforce distribution by professional group.	No	Overly complex data and insufficient segmentation.	No	NHS Transparency Portal
Efficiency	Public Contracts in Healthcare (Contratos Públicos na Saúde)	Tracks public contracts in health.	No	Data is overly complex and lacks LHU segmentation.	No	NHS Transparency Portal

Table 12: Overview of Quality Indicators

Dimension	Indicator	Description	LHU Segmentation	Relevance	Selected	Source
Quality	Average Wait Time Before Surgery (Demora Média Antes da Cirurgia)	Measures average wait time before surgeries.	Yes	Key indicator of surgical efficiency and healthcare system responsiveness at the LHU level.	Yes	NHS Transparency Portal
Quality	Hospital Morbidity and Mortality Rates (Taxa de Morbilidade e Mortalidade Hospitalar)	Tracks hospital morbidity and mortality rates.	Yes	Provides insights into the health status of the population served by LHUs, vital for outcome evaluation.	Yes	NHS Transparency Portal
Quality	Outpatient Surgeries (Cirurgias em Ambulatório)	Measures the number of outpatient surgeries conducted.	Yes	Indicates quality and efficiency in surgical care, reducing hospital stays and improving patient outcomes.	Yes	NHS Transparency Portal
Quality	% of Hip Fractures Operated Within 48 Hours (% Fraturas da Anca Cirurgias nas Primeiras 48h)	Percentage of hip fracture surgeries conducted within 48 hours.	Yes	Reflects timeliness of critical surgical interventions, impacting patient recovery and quality of care.	Yes	NHS Transparency Portal
Quality	30-Day Mortality Rate for Ischemic and Hemorrhagic Stroke (Taxa Média de Mortalidade por AVC Isquémico e Hemorrágico em 30 Dias)	Tracks average 30-day mortality rates for ischemic and hemorrhagic strokes.	Yes	Measures effectiveness and quality of stroke care, essential for health outcomes analysis.	Yes	NHS Transparency Portal
Quality	Certification of Healthcare Units (Certificação de Unidades de Saúde)	Tracks certifications of healthcare units.	No	ARS-level data segmentation prevents its use for LHU-specific analysis.	No	NHS Transparency Portal
Quality	Electronic Prescription of Medicines (Prescrição Eletrónica de Medicamentos)	Tracks electronic prescriptions by region.	No	ARS-level segmentation excludes its use in the analysis.	No	NHS Transparency Portal
Quality	Hospital Morbidity and Mortality by Gender (Morbilidade e Mortalidade Hospitalar por Sexo)	Tracks admission and mortality rates by gender.	No	Regional-level segmentation, not suitable for LHU analysis.	No	NHS Transparency Portal

Quality	Women's and Children's Health (Saúde da Mulher e Criança)	Monitors indicators related to women's and children's health.	No	Data is segmented at the ARS level, unsuitable for LHU-specific analysis.	No	NHS Transparency Portal
Quality	Patients with Addictive Behaviors and Dependencies (Utentes com Comportamentos Aditivos e Dependências)	Monitors patients with addictive behaviors.	No	Lack of sufficient segmentation at the LHU level.	No	NHS Transparency Portal

Table 13: Regression Pre-intervention

SUMMARY OUTPUT	**Regression LHUs pre-intervention**
Regression Statistics	
Multiple R	0.607
R Square	0.369
Adjusted R Square	0.365
Standard Error	4.460
Observations	288.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2.000	3316.382	1658.191	83.344	0.000
Residual	285.000	5670.309	19.896		
Total	287.000	8986.691			

	Coefficients	*t Stat*	*P-value*
Intercept	45.274	59.626	0.000
Group	0.910	1.406	0.161
Date	0.977	12.834	0.000

Table 14: Descriptive Statistics of the Composite Index

LHU	Min	Max	M	SD	Rank
LHU de São João	51.94	67.18	58.56	4.73	1
LHU de Santo António	50.61	65.90	57.09	5.11	2
LHU de Gaia/Espinho	47.88	63.20	56.08	4.38	3
LHU de Santa Maria	50.89	63.21	56.06	3.47	4
LHU de Castelo Branco	47.97	62.61	55.27	4.70	5
LHU de Matosinhos	46.11	61.12	54.40	4.60	6
LHU de Entre Douro e Vouga	48.17	61.60	54.15	3.64	7
LHU da Região de Aveiro	45.37	58.81	53.47	4.23	8
LHU de São José	44.00	61.89	53.41	4.99	9
LHU do Oeste	45.91	61.22	53.39	4.41	10
LHU de Amadora/Sintra	46.67	57.37	52.98	2.62	11
LHU do Litoral Alentejano	49.30	58.03	52.76	2.60	12
LHU da Cova da Beira	42.75	67.06	52.29	7.26	13
LHU de Trás-os-Montes e Alto Douro	44.36	59.97	52.22	4.57	14
LHU de Coimbra	40.28	59.69	50.50	5.58	15
LHU do Alentejo Central	44.86	56.42	50.41	3.46	16
LHU do Alto Minho	42.15	60.90	50.32	5.65	17
LHU da Arrábida	41.76	54.62	49.73	3.79	18
LHU do Alto Ave	41.26	56.03	48.97	3.96	19
LHU da Região de Leiria	41.74	55.92	48.80	3.44	20
LHU do Arco Ribeirinho	38.56	53.43	45.80	4.57	21
LHU de Almada-Seixal	34.35	52.03	44.78	4.33	22
LHU do Algarve	39.47	51.10	44.46	2.96	23
LHU da Guarda	34.39	50.73	44.07	5.01	24

Table 15: Changes in Composite Indicators

LHU	Jan-23	Jun-24	value of change
ULS de Castelo Branco	47.97	59.36	23.74%
ULS da Cova da Beira	42.75	52.41	22.60%
ULS da Guarda	35.37	42.92	21.35%
ULS de São João	52.11	62.63	20.19%
ULS de São José	50.18	59.53	18.63%
ULS do Alto Minho	43.32	50.13	15.72%
ULS de Entre Douro e Vouga	49.59	56.05	13.03%
ULS de Trás-os-Montes e Alto Douro	49.6	54.43	9.74%
ULS do Alentejo Central	45.67	50.09	9.68%
ULS de Matosinhos	51.45	56.39	9.60%
ULS de Amadora/Sintra	46.67	50.77	8.79%
ULS do Algarve	43.27	45.53	5.22%
ULS de Almada-Seixal	43.2	45.06	4.31%
ULS da Região de Aveiro	50.37	52.36	3.95%
ULS de Coimbra	46	47.42	3.09%
ULS do Arco Ribeirinho	42.99	44.13	2.65%
ULS de Santa Maria	54.14	55.35	2.23%
ULS de Santo António	52.85	52.61	-0.45%
ULS de Gaia/Espinho	54.64	53.9	-1.35%
ULS da Região de Leiria	47.18	45.91	-2.69%
ULS da Arrábida	47.17	45.89	-2.71%
ULS do Alto Ave	48.3	46.87	-2.96%
ULS do Litoral Alentejano	52.57	50.47	-3.99%
ULS do Oeste	52.83	50.2	-4.98%

Table 16: Pre-Intervention Regression for Access

SUMMARY OUTPUT **Regression Access pre-intervention**

Regression Statistics	
Multiple R	0.721
R Square	0.519
Adjusted R Square	0.516
Standard Error	6.127
Observations	288.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2.000	11567.156	5783.578	154.042	0.000
Residual	285.000	10700.456	37.545		
Total	287.000	22267.612			

	Coefficients	*Standard Error*	*P-value*
Intercept	31.182	1.043	0.000
Group	1.617	0.889	0.070
Date	1.826	0.105	0.000

Table 17: DiD Access

SUMMARY OUTPUT **DiD Access**

Regression Statistics	
Multiple R	0.383
R Square	0.147
Adjusted R Square	0.141
Standard Error	7.988
Observations	432.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.000	4694.078	1564.693	24.524	0.000
Residual	428.000	27307.203	63.802		
Total	431.000	32001.281			

	Coefficients	*Standard Error*	*P-value*
Intercept	43.051	1.031	0.000
Group	1.617	1.159	0.164
post_reorg	-4.299	1.786	0.017
Group × Post	-3.226	2.007	0.109

Table 18: Pre-Intervention Regression for Efficiency and Financing

SUMMARY OUTPUT	**Regression Efficiency and Financing pre-intervention**
Regression Statistics	
Multiple R	0.342
R Square	0.117
Adjusted R Square	0.111
Standard Error	3.054
Observations	288.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2.000	351.166	175.583	18.827	0.000
Residual	285.000	2657.971	9.326		
Total	287.000	3009.137			

	Coefficients	*Standard Error*	*P-value*
Intercept	52.544	0.520	0.000
Group	1.463	0.443	0.001
Date	-0.270	0.052	0.000

Table 19: DiD Efficiency and Financing

SUMMARY OUTPUT	**DiD Efficiency and Financing**
Regression Statistics	
Multiple R	0.540
R Square	0.292
Adjusted R Square	0.287
Standard Error	3.667
Observations	432.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.000	2373.343	791.114	58.837	0.000
Residual	428.000	5754.857	13.446		
Total	431.000	8128.199			

	Coefficients	*Standard Error*	*P-value*
Intercept	50.792	0.473	0.000
Group	1.463	0.532	0.006
post_reorg	5.778	0.820	0.000
Group × Post	-1.157	0.922	0.210

Table 20: Pre-Intervention Regression for Quality

SUMMARY OUTPUT	**Regression Quality pre-intervention**
Regression Statistics	
Multiple R	0.319
R Square	0.102
Adjusted R Square	0.095
Standard Error	7.752
Observations	288.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2.000	1939.711	969.855	16.138	0.000
Residual	285.000	17127.509	60.097		
Total	287.000	19067.219			

	Coefficients	*Standard Error*	*P-value*
Intercept	55.731	1.320	0.000
Group	-0.073	1.125	0.948
Date	0.752	0.132	0.000

Table 21: DiD Quality

SUMMARY OUTPUT	**DiD Quality**
Regression Statistics	
Multiple R	0.270
R Square	0.073
Adjusted R Square	0.066
Standard Error	8.009
Observations	432.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3.000	2157.337	719.112	11.212	0.000
Residual	428.000	27451.861	64.140		
Total	431.000	29609.198			

	Coefficients	*Standard Error*	*P-value*
Intercept	60.617	1.034	0.000
Group	-0.073	1.162	0.950
post_reorg	-3.989	1.791	0.026
Group × Post	-0.917	2.013	0.649

Table 22: Coefficient of variation of Composite Index

LHU	M	SD	CV	Rank
LHU da Cova da Beira	52.29	7.26	13.89%	1
LHU do Alto Minho	50.32	5.65	11.22%	2
LHU de Coimbra	50.50	5.58	11.06%	3
LHU de Santo António	57.09	5.11	8.96%	4
LHU da Guarda	44.07	5.01	11.38%	5
LHU de São José	53.41	4.99	9.35%	6
LHU de São João	58.56	4.73	8.07%	7
LHU de Castelo Branco	55.27	4.70	8.51%	8
LHU de Matosinhos	54.40	4.60	8.45%	9
LHU de Trás-os-Montes e Alto Douro	52.22	4.57	8.76%	10
LHU do Arco Ribeirinho	45.80	4.57	9.98%	11
LHU do Oeste	53.39	4.41	8.27%	12
LHU de Gaia/Espinho	56.08	4.38	7.81%	13
LHU de Almada-Seixal	44.78	4.33	9.67%	14
LHU da Região de Aveiro	53.47	4.23	7.92%	15
LHU do Alto Ave	48.97	3.96	8.09%	16
LHU da Arrábida	49.73	3.79	7.63%	17
LHU de Entre Douro e Vouga	54.15	3.64	6.72%	18
LHU de Santa Maria	56.06	3.47	6.19%	19
LHU do Alentejo Central	50.41	3.46	6.87%	20
LHU da Região de Leiria	48.80	3.44	7.06%	21
LHU do Algarve	44.46	2.96	6.66%	22
LHU de Amadora/Sintra	52.98	2.62	4.95%	23
LHU do Litoral Alentejano	52.76	2.60	4.92%	24

Table 23: Summary statistics for each size group

Index	Statistics	Large	Medium	Small
Access	mean	40.15	44.22	41.63
	median	39.08	43.57	39.64
	sd	7.91	7.89	9.64
Efficiency	mean	59.25	54.39	55.90
	median	60.74	55.36	56.00
	sd	8.94	9.65	9.05
Quality	mean	56.94	62.88	56.50
	median	57.26	63.05	56.95
	sd	8.43	6.97	7.79
Composite index	mean	52.11	53.83	51.34
	median	52.28	54.18	51.14
	sd	5.53	4.93	5.43
LHU	**Count**	**8**	**8**	**8**

Table 24: Distribution of LHUs by region

LHU	Region
LHU da Cova da Beira LHU da Guarda LHU da Região de Aveiro LHU da Região de Leiria LHU de Castelo Branco LHU de Coimbra LHU do Oeste	Center
LHU de Entre Douro e Vouga LHU de Gaia/Espinho LHU de Matosinhos LHU de Santo António LHU de São João LHU de Trás-os-Montes e Alto Douro LHU do Alto Ave LHU do Alto Minho	North
LHU da Arrábida LHU de Almada-Seixal LHU de Amadora/Sintra LHU de Santa Maria LHU de São José LHU do Alentejo Central LHU do Algarve LHU do Arco Ribeirinho LHU do Litoral Alentejo	South

Table 25: Summary Statistical by region

Index	Statistics	North	Center	South
Access	mean	44.09	43.07	39.31
	median	43.54	40.64	38.00
	sd	7.67	10.32	7.34
Efficiency	mean	56.17	54.28	58.55
	median	56.60	54.59	57.92
	sd	9.92	10.18	7.84
Quality	mean	62.76	57.57	56.17
	median	62.72	58.08	56.78
	sd	7.34	7.85	8.07
Composite index	mean	54.34	51.64	51.34
	median	54.55	51.14	51.92
	sd	5.25	5.57	4.92
LHU	**Count**	**8**	**7**	**9**

Table 26: All LHUs with Creation Dates and Inclusion in the Analysis

LHU Name	Included in IQVIA Data	Existed Before 2024
LHU da Arrábida	Yes	No
LHU da Cova da Beira	Yes	No
LHU da Guarda	Yes	Yes
LHU da Lezíria	No	No
LHU da Póvoa de Varzim/Vila do Conde	No	No
LHU da Região de Aveiro	Yes	No
LHU da Região de Leiria	Yes	No
LHU de Almada-Seixal	Yes	No
LHU de Amadora/Sintra	Yes	No
LHU de Barcelos/Esposende	No	No
LHU de Braga	No	No
LHU de Castelo Branco	Yes	Yes
LHU de Coimbra	Yes	No
LHU de Entre Douro e Vouga	Yes	No
LHU de Gaia/Espinho	Yes	No
LHU de Lisboa Ocidental	No	No
LHU de Loures-Odivelas	No	No
LHU de Matosinhos	Yes	Yes
LHU de Santa Maria	Yes	No
LHU de Santo António	Yes	No
LHU de São João	Yes	No
LHU de São José	Yes	No
LHU de Trás-os-Montes e Alto Douro	Yes	No
LHU de Viseu Dão-Lafões	No	No
LHU do Alentejo Central	Yes	No
LHU do Algarve	Yes	No
LHU do Alto Alentejo	No	Yes
LHU do Alto Ave	Yes	No
LHU do Alto Minho	Yes	Yes
LHU do Arco Ribeirinho	Yes	No
LHU do Baixo Alentejo	No	Yes
LHU do Baixo Mondego	No	No
LHU do Estuário do Tejo	No	No
LHU do Litoral Alentejano	Yes	Yes
LHU do Médio Ave	No	No
LHU do Médio Tejo	No	No
LHU do Nordeste	No	Yes
LHU do Oeste	Yes	No
LHU do Tâmega e Sousa	No	No

Table 27: Indicators from Termos de Referência

Indicator Code	Description	Desired but not available
1. Healthcare		
A. Access		
A.1	Performance Index of the Access Sub-area	Not Desired
A.2	Percentage of requests on the Waiting List for Consultation (LEC) within the Maximum Response Time (TMRG)	Desired
A.3	Percentage of patients on the Surgical Waiting List (LIC) within the Maximum Response Time (TMRG)	Desired
B. Quality of Care		
B.1	Performance Index of the Healthcare Management Sub-area	Not Desired
B.2	Performance Index of the Disease Management Sub-area	Not Desired
B.3	Performance Index of the Prescription Qualification Sub-area	Not Desired
B.4	Percentage of readmissions within 30 days in the same broad diagnostic category	Desired
B.5	Percentage of ambulatory surgeries for procedures typically performed as outpatient	Available
B.6	Percentage of hip surgeries performed within the first 48 hours	Available
B.7	Adjusted average waiting time	Available
B.8	Average waiting time before surgery	Available
B.9	Health value in cataract surgery	Not Desired
B.10	Number of clinical trials initiated during the year	Desired
B.11	Percentage of patients discharged under home hospitalization (GDH) relative to total discharged patients	Desired
B.12	Percentage of decentralized, domiciliary, and mental health hospital consultations communicated as a share of the total hospital consultations carried out	Not Desired
2. Economic-Financial Performance		
C.1	Operating costs per resident	
C.2	Standard patient per ETC (Full-Time Equivalent) physician	Desired
C.3	Standard patient per ETC (Full-Time Equivalent) nurse	Desired
C.4	Percentage of spending on overtime, allowances, supplements, and external services (selected) relative to total personnel costs	Desired
C.5	EBITDA	Not Desired
3. Care Integration		
D.1	Performance Index of the Care Integration Sub-area	Not Desired

D.2	Percentage of population screened for Cervical Cancer (RCCU) within the eligible population	Desired
D.3	Percentage of population screened for Colorectal Cancer (RCCR) within the eligible population	Desired
D.4	Percentage of frequent Emergency Service users (> 4 episodes per year)	Desired
D.5	Percentage of episodes triaged as green, blue, or white in Emergency Services	Available
D.6	Hospitalization rate for lower limb amputation among diabetic patients (adjusted for a standard population) (ID 360)	Not Desired
D.7	Rate of avoidable hospitalizations in the adult population (adjusted for a standard population) (ID 365)	Desired
D.8	Proportion of psychology, nutrition, and dental medicine consultations referred by primary care physicians or hospital physicians conducted within less than 90 days	Not Desired
D.9	Evaluation of patient satisfaction levels	Desired

Figure 2: Distribution of Indicators in Dimensions

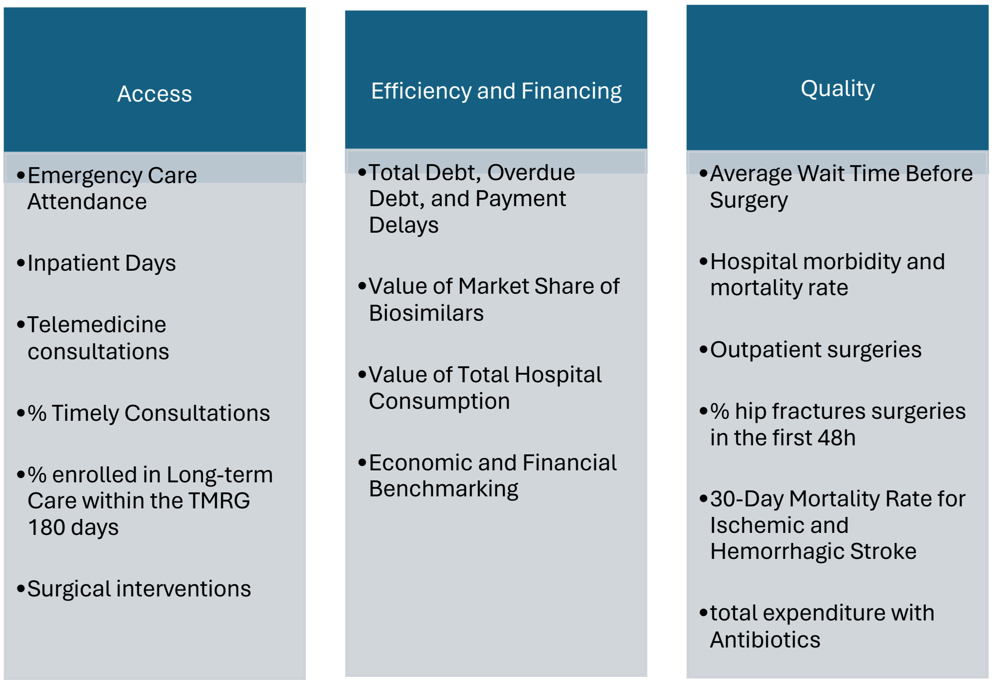


Figure 3: Top 5 performing LHUs

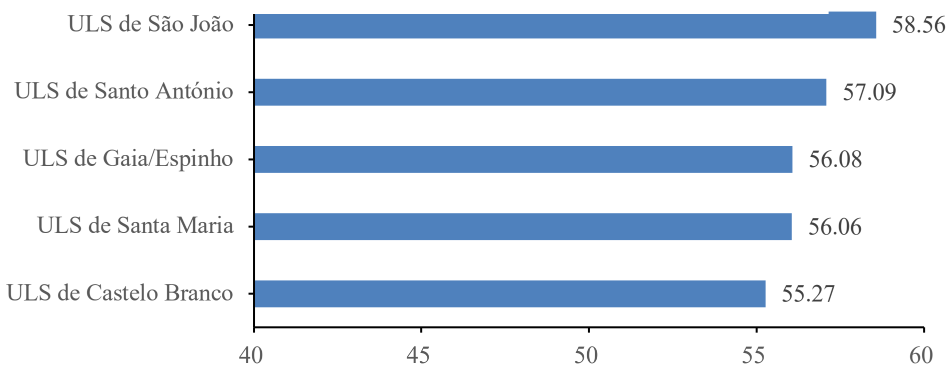


Figure 4: The 5 worst performing LHUs

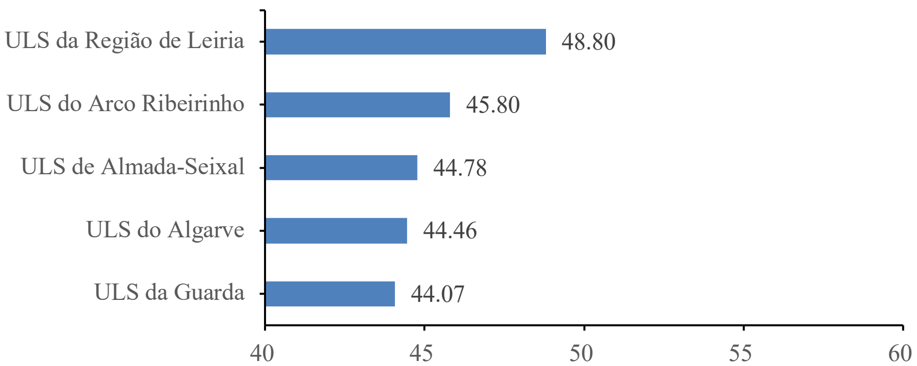


Figure 5: Bar Chart of the Composite Index

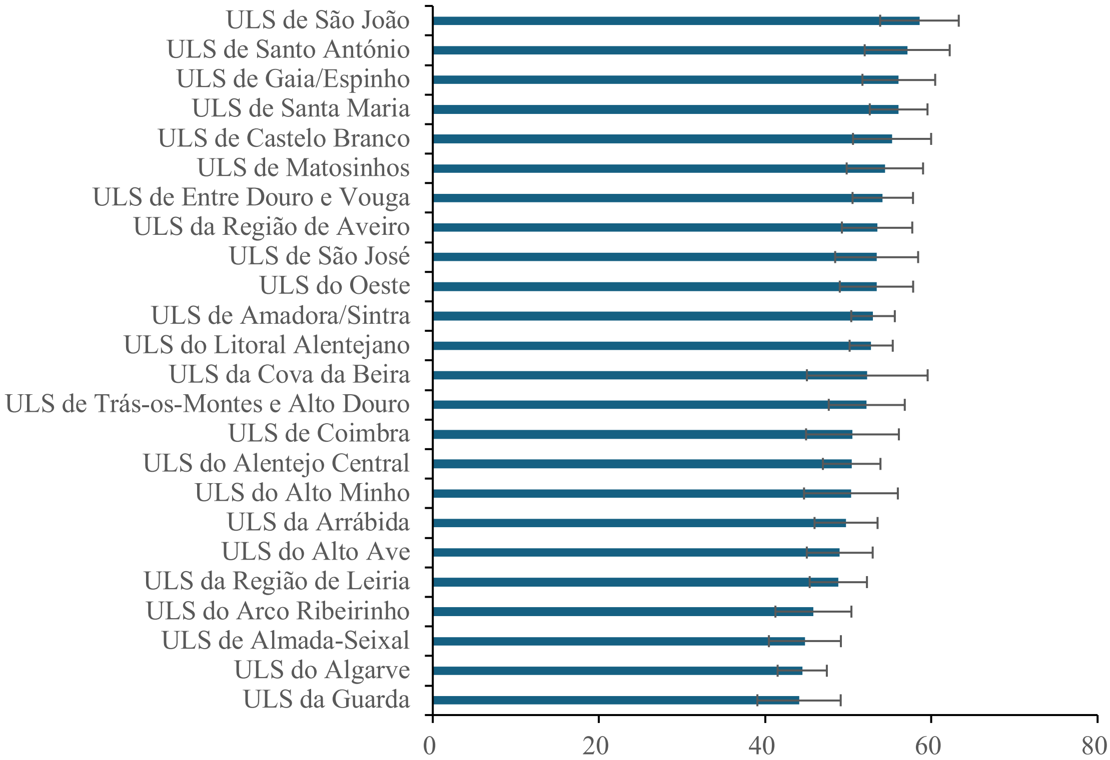


Figure 6: Radar Chart of Domain-specific Scores

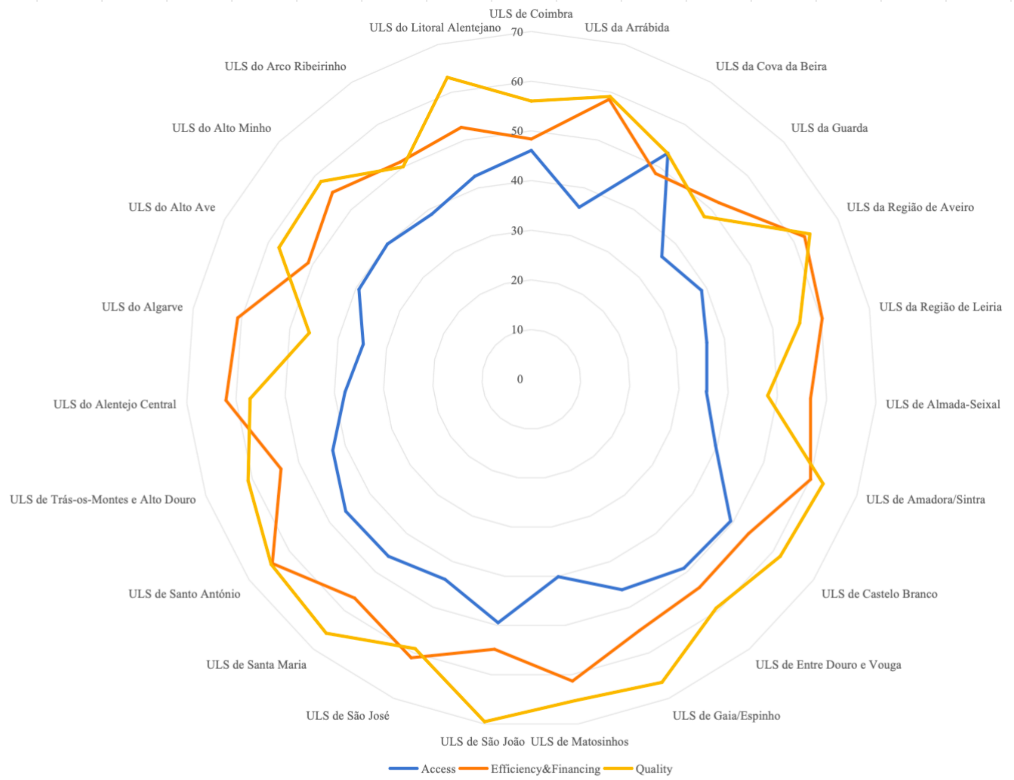


Figure 7: Pre 2024 Reform

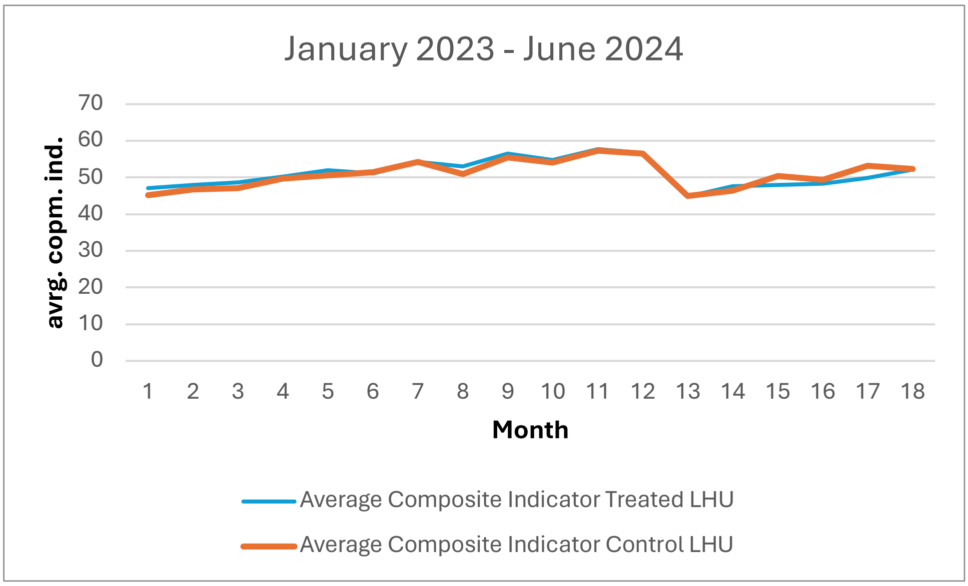


Figure 8: Trajectory of Treated vs Control LHUs

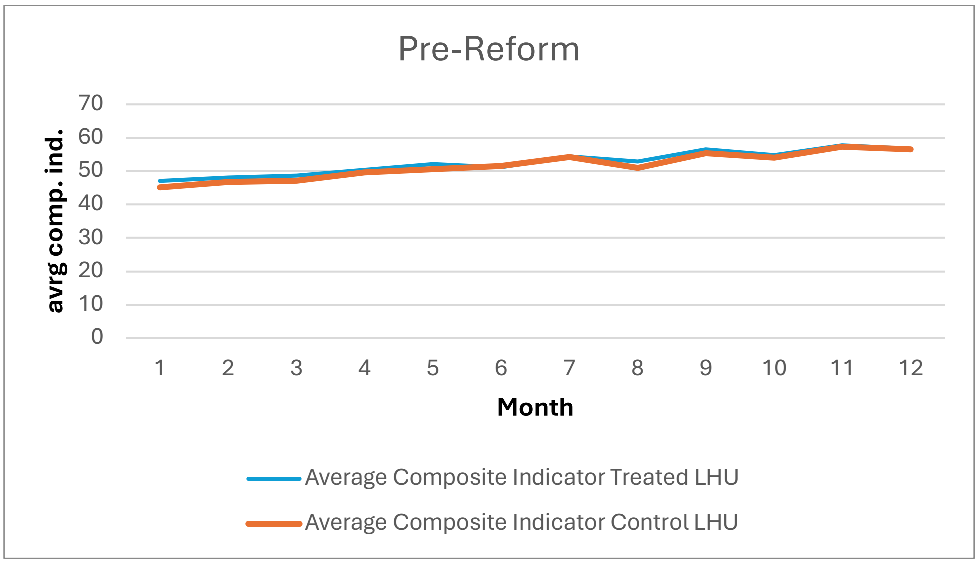


Figure 9: Access Parallel Trend

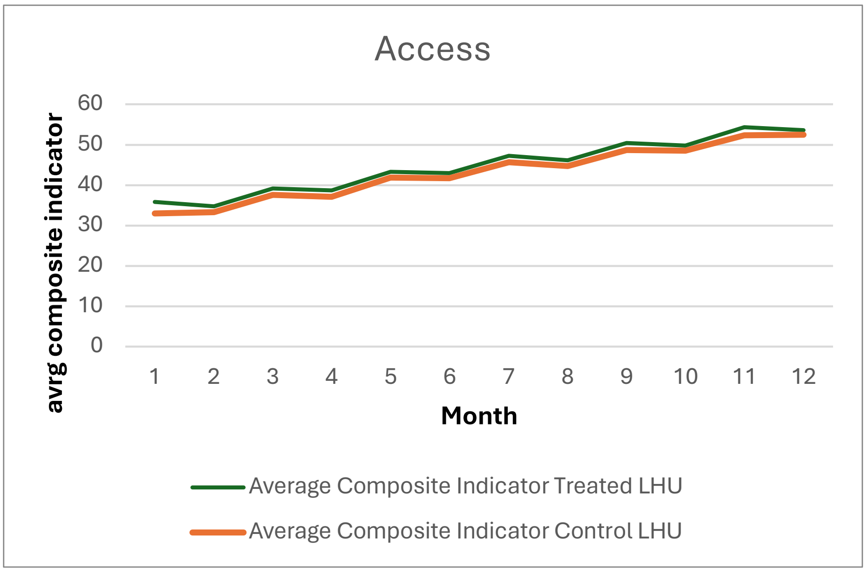


Figure 10: Efficiency and Financing Parallel Trend

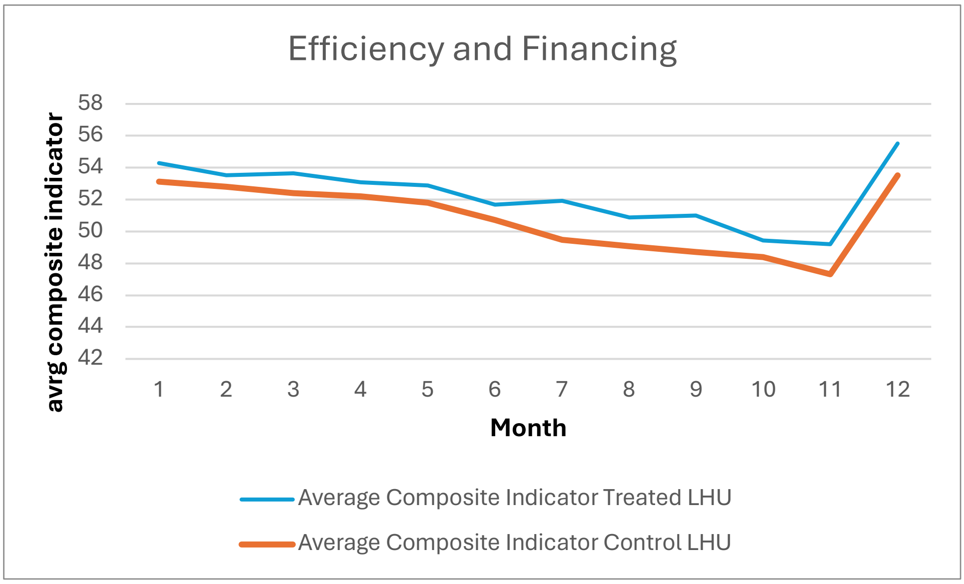


Figure 11: Quality Parallel Trend

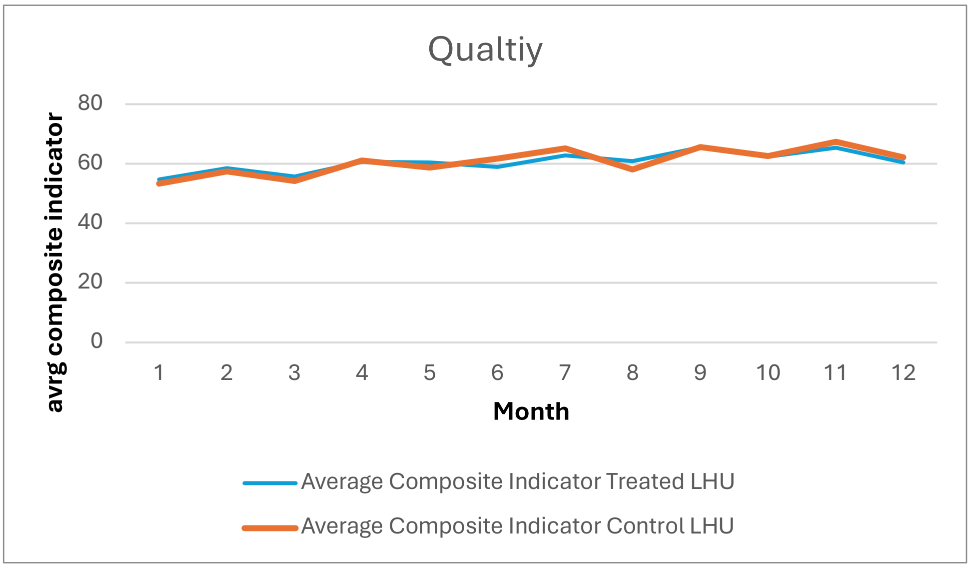


Figure 12: Compare metrics across size groups

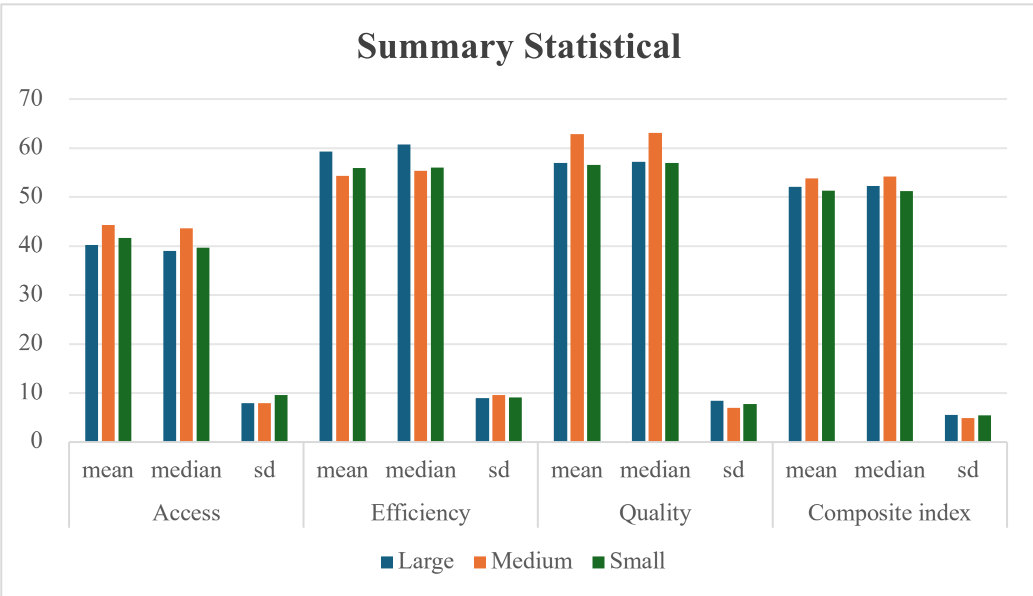


Figure 13: Summary Statistical by Region