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Health facility typology, a misleading proxy of health service availability: a case-study in Mali

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Abstract

Introduction: Using health facility types as a measure of service availability is a common approach in international standards for health system policy and planning. However, this proxy may not accurately reflect the actual availability of specific health services.

Objective: This study aims to evaluate the reliability of health facility typology as an indicator of specific health service availability and explore whether certain facility types consistently provide particular services.

Design: We analyzed a comprehensive dataset containing information from 1,725 health facilities in Mali. To uncover and visualize patterns within the dataset, we utilized two analytical techniques: Multiple Correspondence Analysis and Between-Class Analysis. These analyses allowed us to quantitatively measure the influence of health facility types on the variation in health service provisioning. Additionally, we developed and calculated a Consistency Index, which assesses the consistency of a health facility type in providing specific health services. By examining various health facilities and services, we sought to determine the accuracy of facility types as indicators of service availability.

Setting: The study focused on the health system in Mali as a case study.

Results: Our findings indicate that using health facility types as a proxy for service availability in Mali is not an accurate representation. We observed that most of the variation in service provision does not stem from differences between facility types but rather within facility types. This suggests that relying solely on health facility typology may lead to an incomplete understanding of health service availability.

Conclusions: These results have significant implications for health policy and planning. The reliance on health facility types as indicators for health system policy and planning should be reconsidered. A more nuanced and evidence-based understanding of health service availability is crucial for effective health policy and planning, as well as for the assessment and monitoring of health systems.

Article Summary

Strengths and limitations of this study

- The study utilizes a comprehensive dataset containing information from 1,725 health facilities in Mali, which provides a robust foundation for the analysis.
- Different analytical methods have been applied to study the underlying structures in the dataset. We have employed both a Multiple Correspondence Analysis and Between-Class Analysis. In addition to these techniques, we have also constructed a consistency index to ensure that we can also compare how consistent certain services are provided in different types of health facilities.

- The study also explores whether different geospatial patterns for the relationship between health facility typology and health service availability can be observed.
- The study's findings may be specific to the healthcare system in Mali and may not be directly applicable to other countries or settings. Future research should confirm whether similar patterns are observed in other countries.

Introduction

Universal health coverage aims to ensure that everyone can access the necessary health services they require, regardless of time, place, or financial constraints[1,2]. Understanding the geographical distribution of health services is crucial in identifying areas where access to health services may be limited[3,4]. Policymakers and practitioners have often used the distribution of specific types of health facilities relative to the population to address this issue. Health facility types are often grouped into different categories, such as health posts, health centers, clinics and district hospitals[3]. These classifications can vary depending on the country or context. Studies have used information on health facility typology to assess the geographical accessibility of different health services. However, there are inconsistencies in how these types are defined and categorized in different studies. For example, Ouma et al. (2018)[5] assumed that emergency care is available at all hospitals, while Hulland et al. (2019)[6] manually reclassified health facility types into self-defined categories, assuming distinct capabilities for different types. Additionally, Weiss et al. (2020)[7] selected specific facility types, such as hospitals and clinics, in different facility datasets without a common definition. According to guidelines for facility coverage, set by the Sphere Project in 2018[8] and the Global Health Cluster in 2021[9], one health facility should be available for every 10,000 people regardless of the type and one district or rural hospital should be available for every 250,000 people in a given administrative area. However, little is known about the relationship between facility type and the effective availability of essential health services at the health facility level[3], as health facility datasets typically do not include information on the type of services effectively provided by a facility[7,10]. Relatively few studies have examined the influence of facility type on the availability of specific health services[11,12] but to our knowledge no analysis of multiple essential services has yet measured the extent of this relationship more broadly.

The World Health Organization's (WHO) Health Resources and Services Availability Monitoring System (HeRAMS) gathers and presents core information on essential health resources and services[13]. This information is crucial for decision makers at national, regional and global levels. The initiative supports countries in standardizing and continuously collecting, analyzing, and disseminating information on essential health resources and services[13]. It provides a standardized process for the production and maintenance of an authoritative master facility list that includes core information on the availability of essential health services. Information gathered on healthcare institutions is compiled and verified by local service providers[3,14].

The HeRAMS Initiative provides an opportunity to clarify how accurately the typology of health facilities reflects the availability of specific health services and whether health facility types are a good indicator for assessing the distribution of and accessibility to health services. In Mali, HeRAMS has been operational since 2013. It currently provides regular information on 2,676 health facilities. A comprehensive report on the exhaustive mapping of health facilities in Mali was published in 2020[15], with an update published in October 2022[16]. As a result, Mali is now one of the countries where the accuracy of the typology of health facilities can be effectively assessed in relation to the availability of health services. Therefore, this study aims to analyze the accuracy of health facility types in representing health service availability using the most recent HeRAMS data for Mali. We assess whether the typology of a health facility explains the availability of a large set of health services at the facility level. The results can help to guide decision- and policymakers in redirecting health system assessments and surveillance strategies towards the most meaningful information and indicators and ultimately improve populations' access to healthcare.

2. Methods

2.1 Data collection

Mali health facility data were extracted from the HeRAMS database and included up-to-date information on essential health service provisioning at the facility level (as of October 4, 2022). For this study, we only focused on public health facilities that constitute the backbone of the three-level pyramidal health system in Mali, namely the Community Health Centers (CHCs), the Reference Health Centers (RHCs), and the Hospitals (Hs), giving us a total of 1,725 observations. CHCs, RHCs and Hs represented 95% (n = 1646), 4% (n = 66) and 1% (n = 13) of the facilities, respectively. All essential health services reported in the HeRAMS database (n = 92) were considered, and the response for each service in each health facility could be "Available", "Partially available", "Not available" or "Not normally provided. If a service is available, it is considered that a health service provider is able to provide the service without limitations or barriers. A partially available service is considered not fully available because the health service provider encounters obstacles or limitations in providing the service, such as financial constraints or insufficient equipment. An unavailable service is a service that should normally be provided but cannot currently be provided because of lack of human resources, medical supplies, financial constraints or other impeding factors. If a service is not normally provided, it means that the service is not available but also that it is not part of the package of services normally provided by that the health service provider.

2.2 Statistical analysis

In our study, we investigated the connection between different types of health facilities and the availability of essential health services. To simplify our analysis, we categorized the responses from HeRAMS into two groups: "Available" and "Not available". We combined the responses of "Available" and "Partially available" into the "Available" category, while grouping "Not available" and "Not normally provided" as "Not available".

To understand the underlying patterns in the data and determine the percentage of variance in health service provisioning explained by health facility types, we employed two statistical techniques. Firstly, we conducted a Multiple Correspondence Analysis (MCA), which is similar to Principal Component Analysis (PCA), but specifically designed for categorical data[17]. Next, we performed a Between-Class Analysis (BCA), which is a variant of PCA that incorporates instrumental variables (PCAIV), in which there is only a single factor as explanatory variable[18].

The ratio of BCA inertia to MCA inertia indicates the proportion of variance explained by the different health facility types. We assessed the significance of this percentage through a Monte-Carlo procedure involving 999 permutations.

2.3 Consistency index

We also developed and calculated a Consistency Index (CI) to measure the consistency of health facility types in providing specific essential health services. The formula for CI is:

$$CI = \frac{|a - b|}{a + b}$$

Here, CI represents the Consistency Index, and 'a' and 'b' are the counts of observations for the two possible responses, namely "available" or "not available". For example, 'a' could represent the number of responses indicating "available" while 'b' represents the number of responses indicating "not available". The CI values range from 0 (indicating low consistency) to 1 (indicating high consistency). We calculate the CI for each individual service within a particular type of health facility.

Since HeRAMS covers 92 services and our focus is on three types of health care providers, the CI values follow a specific distribution. We tested the differences in CI values between the three facility types using Wilcoxon tests and employed the Holm procedure to control the family-wise error rate. Additionally, we assessed how the CI varies among the five essential health service pillars, which include general clinical and emergency care services, child health and nutrition, communicable

diseases, sexual and reproductive health, and noncommunicable diseases.

Finally, focusing on the most frequent health facility type only (i.e, CHC), we analyzed how the health service availability varied across the ten Malian regions (i.e, Gao, Kayes, Kidal, Koulikoro, Ménaka, Mopti, Ségou, Sikasso, Taoudénit, and Tombouctou) and the capital district Bamako. We calculated the average probability of an essential health service being available in each region.

3. Results

3.1 Rethinking Health Facility Types as Indicators of Service Availability

Only a small portion of service availability can be attributed to health facility types, as demonstrated in Figure 1. The BCA reveals that health facility types explain merely 6.3% of the variance in service availability ($p = 0.001$). This indicates that the majority of variability in health service provisioning stems from differences within facility types rather than between them.

3.2 Examining Consistency in Health Facility Types for Service Provision

To avoid making broad generalizations about all facilities, it is important to recognize that some types of facilities may have a greater level of consistency in providing certain services compared to others. To account for this variation, we created a Consistency Index. Our analysis revealed that service availability or non-availability is most consistent within CHCs ($p < 0.001$). However, significant variability between services remains pronounced within each facility type (Figure 2a). For Hs and RHCs, the median CI values are relatively low, close to 0.5. This indicates that, on average, approximately one quarter of health facilities have a service provisioning pattern that differs from the other three quarters of facilities. Although service provisioning patterns show greater similarity among CHCs, the conclusion remains unchanged that health facility types are not a reliable indicator of health service availability.

3.3 Some essential health services are more consistently provided than others

In order to gain a comprehensive understanding of service availability, we delved deeper into the consistency of service provision across various essential health services at the different facility types. Our analysis revealed distinct variations in patterns, indicating that different sets of essential health services and facility types exhibit diverse levels of consistency (Figure 2b). Notably, when examining the delivery of sexual and reproductive health services in Hs, we observed high inconsistency (median = 0.23), suggesting a lack of clear patterns regarding the availability of these services. Conversely, in CHCs, the availability of general clinical services and emergency care demonstrated a high level of

consistency (median = 0.83). These findings reveal that the consistency of service provisioning differs among facility types across various service pillars, suggesting that health facility type can only serve as a reliable proxy for health service availability in very few specific instances. Moreover, even seemingly straightforward assumptions, such as the availability of maternal health services in Hs, cannot be universally assumed, as previously suggested by Wigley et al. (2020)[19].

Furthermore, to account for potential spatial variations in service availability, we conducted a comparison of service consistency among CHCs across the different regions of Mali. The results revealed substantial differences in service availability between regions (Figure 2c). Southern regions, including Bamako, Kayes, Koulikoro, Mopti, Ségou, and Sikasso, exhibited a higher probability of having essential health services available (median = 0.47), while the availability was notably low in Ménaka (0.21).

Discussion

This study reveals that it is misleading to rely solely on the typology of health facilities as a proxy of the availability of health services. Yet, health system performance indicators such as availability and accessibility are often presented by type of health facility[5,8,9,19], as if there is a common agreement on the service packages that a particular type of facility should offer. Additionally, certain policy documents and guidelines[8,9,20], particularly in the area of emegrencies, still use typology and service availability of services interchangeably and do not address the limitations and challenges of using such indicators. Our research shows that they are not as closely linked as previously thought and that their use for health system planning and monitoring should be reconsidered.

One key health indicator often used in health system planning or monitoring is the average population per functioning health facility by type and by administrative unit. The Sphere handbook discusses the need to consider combinations of types and to adjust coverage tresholds according to context[8], while the Global Health Cluster Guidance points out that this indicator is recommended as a proxy for geographic accessibility and equity of health facility availability across administrative units[9]. In both cases, there is no discussion of the importance or value of the accessibility of health facilities in the absence of information on the services they actually provide. Similarly the Humanitarian Indicators Registry[20] also does not discuss this indicator inadequacy to represent the availabilibility of and accessibility to essential health services but rather its incompleteness on other secondary dimensions, for example service quality.

This results also showed that the consistency of service provisioning between different facility types varies across different service pillars, indicating that health facility type may represent a good proxy for health service availability, but only in very few specific cases. Taking into account the most frequent health facility type, which occured to be also the most consistent type in terms of service provisioning (i.e., CHC), service availability largely differs from one region to another. This could be indirectly explained by political and security contexts and stresses the importance of assessing the service availability at the facility level and avoiding false assumptions.

In addition to being poor proxies of the availability of and accessibility to essential health services, indicators based on geolocation and health facility type may suffer from other limitations due to the availability and quality of the data to support them. These limitations include the persistance of large differences in typology between different health facility datasets within a country. South et al. (2021)[3] showed that even though the total number of facilities captured by different datasets within a country can be quite similar, the geographical distribution of the facility types is extremely different. Other limitations should be expected from the lack of information on the functionality of these facilities and their ability to actually deliver certain services. This limitation can be particularly acute in emergency settings where health facilities often face major disruptions.

Conclusion

For all these reasons, indicators based on geolocation and health facility type are not efficient proxies for assessing the availability and accessibility of essential health services. The results observed in Mali suggest that relying on such indicators could lead to misleading interpretations of needs, gaps, and priorities, which are crucial for decision makers striving to ensure equitable access to healthcare services in line with Sustainable Development Goal 3. Consequently, there is a need to redefine the nature and scope of health system assessments and monitoring. Instead of focusing solely on the availability of certain types of health facilities, assessments should explicitly prioritize evaluating service availability.

Other studies have examined the influence of facility type on the availability of specific health services[11,12] but this study is the first to focus on a wide range of essential health services. This case study was carried out in Mali and further research is needed to generalize our findings, however it is expected that similar patterns exist in other settings and countries.

Author Contributions

The study was initially conceptualized by SP and further supported by PT. The methodology was initially developed by PT and reviewed by FH, NR and SP. Data analysis and processing were done by PT. Writing of the original draft was done by FH, PT and SP supported by NR. Initial reviews on the figures were given by FH, SP, and NR. Initial reviews on the text were given by OT and CF. All authors have further assisted in thoroughly reviewing all figures and texts.

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Data and code sharing

The health facility data used in this study can be obtained upon reasonable request from HeRAMS. Additionally, the statistical code required to replicate the data analysis will be accessible through a dedicated Zenodo repository upon publication.

Conflicts of interest

The authors have no conflicts of interest to declare.

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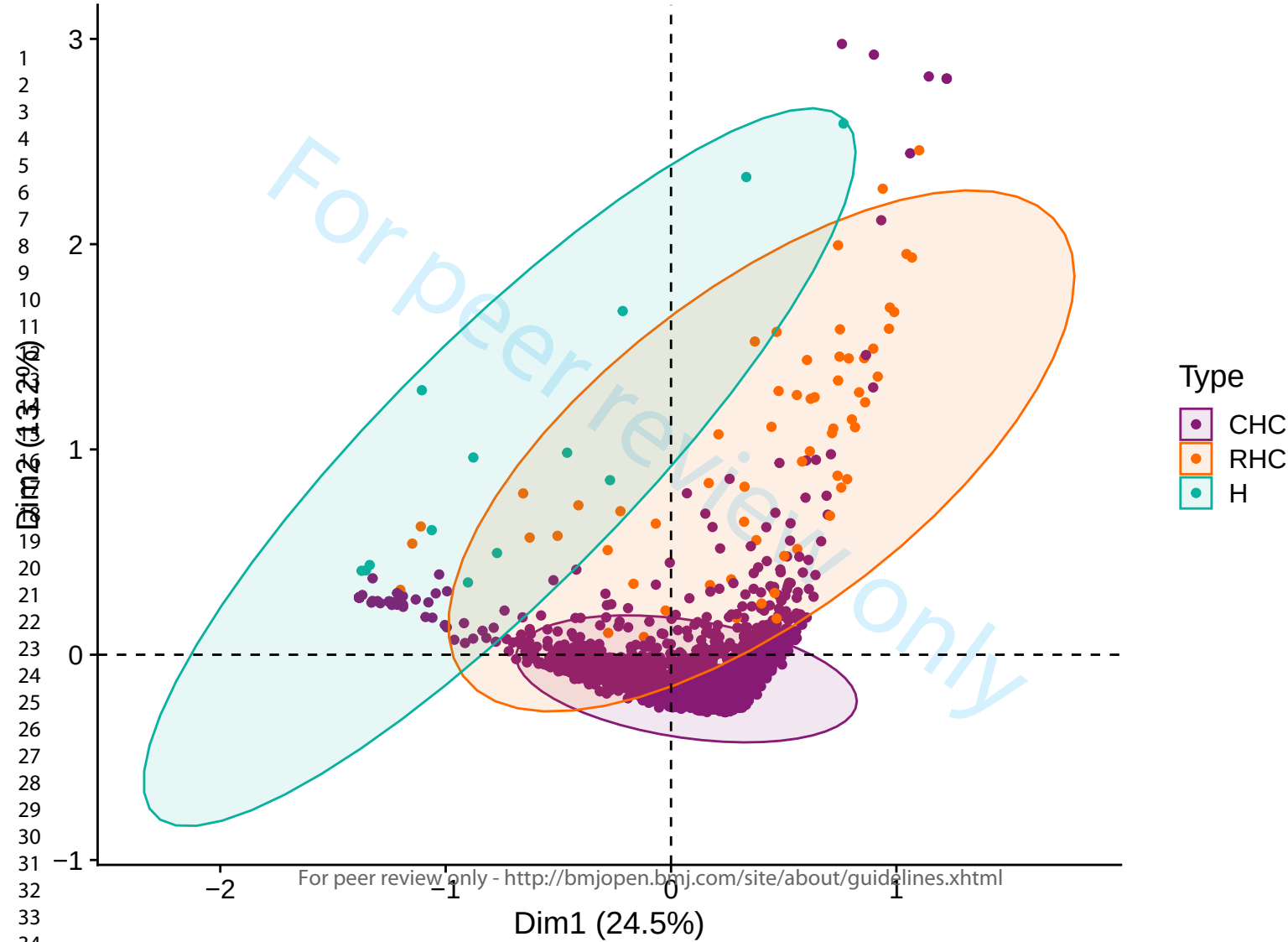
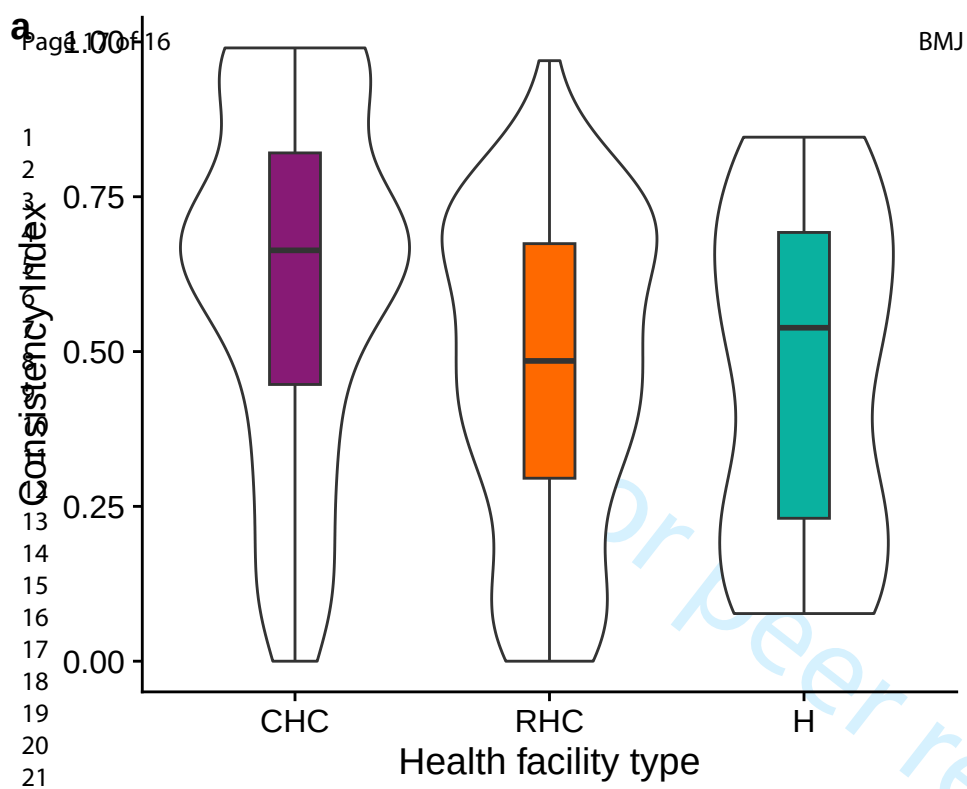
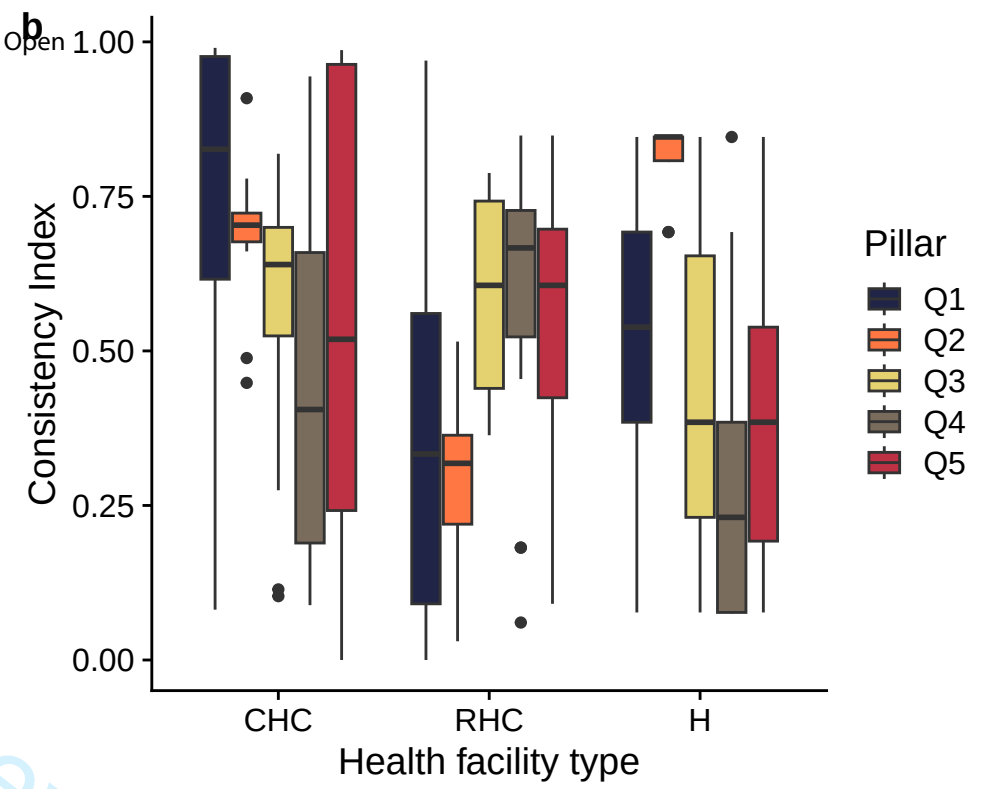
Figure legends

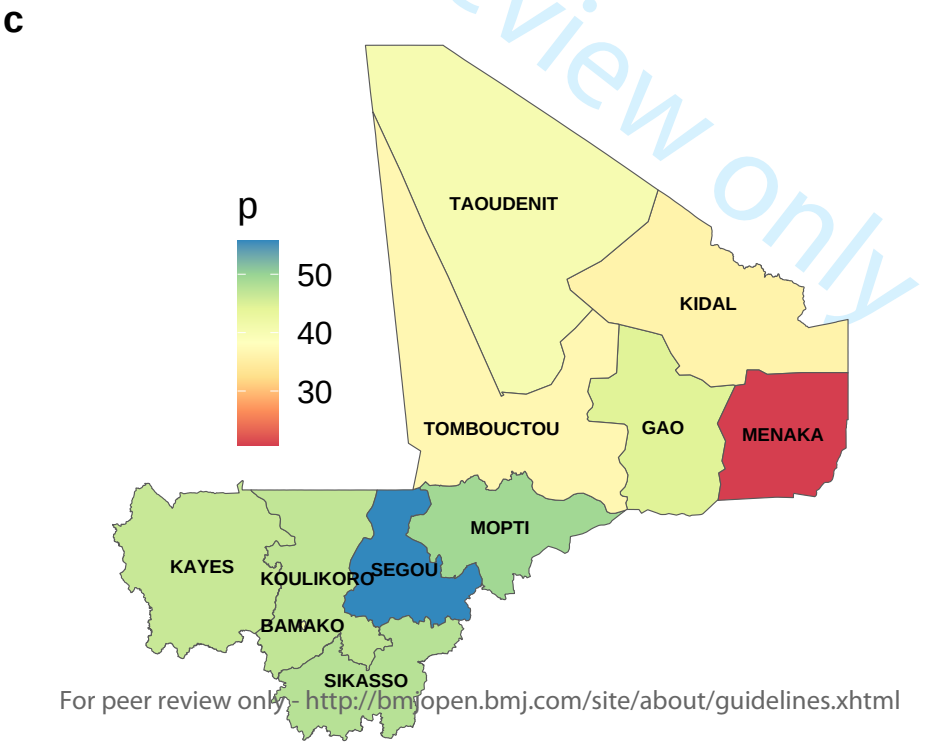
Figure 1. Multiple Correspondence Analysis (MCA) biplots of health facilities based on service availability. Colored ellipses assume multivariate t-distributions, and show the observations grouped by health facility type. Axis labels indicate how much of the variance is explained by each axis.

Figure 2. Violin and box plots of the Consistency Index (CI) values for each health facility type, based on service availability and map indicating service availability at the regional level in Mali. A) The violin plots show the distribution of the CI values taking into account all the essential health services, and the box plots show the median (horizontal line) and the interquartile range (IQR, box outline). The whiskers extend from the hinge to the highest and lowest value that are within 1.5*IQR of the hinge. B) CI values for each health facility type and essential health service pillar, based on service availability. Q1: general clinical and emergency care services; Q2: child health and nutrition; Q3: communicable diseases; Q4: sexual and reproductive health; Q5: noncommunicable diseases. C) The mean probability by region for an essential health service to be available at a Community Health Center.









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Abstract

Introduction: Using health facility types as a measure of service availability is a common approach in international standards for health system policy and planning. However, this proxy may not accurately reflect the actual availability of specific health services.

Objective: This study aims to evaluate the reliability of health facility typology as an indicator of specific health service availability and explore whether certain facility types consistently provide particular services.

Design: We analyzed a comprehensive dataset containing information from 1,725 health facilities in Mali. To uncover and visualize patterns within the dataset, we utilized two analytical techniques: Multiple Correspondence Analysis and Between-Class Analysis. These analyses allowed us to quantitatively measure the influence of health facility types on the variation in health service provisioning. Additionally, we developed and calculated a Consistency Index, which assesses the consistency of a health facility type in providing specific health services. By examining various health facilities and services, we sought to determine the accuracy of facility types as indicators of service availability.

Setting: The study focused on the health system in Mali as a case study.

Results: Our findings indicate that using health facility types as a proxy for service availability in Mali is not an accurate representation. We observed that most of the variation in service provision does not stem from differences between facility types but rather within facility types. This suggests that relying solely on health facility typology may lead to an incomplete understanding of health service availability.

Conclusions: These results have significant implications for health policy and planning. The reliance on health facility types as indicators for health system policy and planning should be reconsidered. A more nuanced and evidence-based understanding of health service availability is crucial for effective health policy and planning, as well as for the assessment and monitoring of health systems.

Strengths and limitations of this study

- The study benefits from a comprehensive dataset of 1,725 health facilities in Mali, contributing to a strong foundation for the analysis.
- By employing Multiple Correspondence Analysis, Between-Class Analysis, and constructing a consistency index, diverse analytical methods are used to explore underlying structures and compare service consistency across different facility types.
- The study investigates potential geospatial patterns in the relationship between health facility typology and health service availability.
- The findings are context-specific to the healthcare system in Mali, further research should validate whether similar patterns exist in other countries.

Introduction

Universal health coverage aims to ensure that everyone can access the necessary health services they require, regardless of time, place, or financial constraints[1,2]. Understanding the geographical distribution of health services is crucial in identifying areas where access to health services may be limited[3,4]. Policymakers and practitioners have often used the distribution of specific types of health facilities relative to the population to address this issue. Health facility types are often grouped into different categories, such as health posts, health centers, clinics and district hospitals[3]. These classifications can vary depending on the country or context. Studies have used information on health facility typology to assess the geographical accessibility of different health services. However, there are inconsistencies in how these types are defined and categorized in different studies. For example, Ouma et al. (2018)[5] assumed that emergency care is available at all hospitals, while Hulland et al. (2019)[6] manually reclassified health facility types into self-defined categories, assuming distinct capabilities for different types. Additionally, Weiss et al. (2020)[7] selected specific facility types, such as hospitals and clinics, in different facility datasets without a common definition. According to guidelines for facility coverage, set by the Sphere Project in 2018[8] and the Global Health Cluster in 2021[9], one health facility should be available for every 10,000 people regardless of the type and one district or rural hospital should be available for every 250,000 people in a given administrative area. However, little is known about the relationship between facility type and the effective availability of essential health services at the health facility level[3], as health facility datasets typically do not include information on the type of services effectively provided by a facility[7,10]. Relatively few studies have examined the influence of facility type on the availability of specific health services[11,12] but to our knowledge no analysis of multiple essential services has yet measured the extent of this relationship more broadly.

The World Health Organization's (WHO) Health Resources and Services Availability Monitoring System (HeRAMS) gathers and presents core information on essential health resources and services[13]. This information is crucial for decision makers at national, regional and global levels. The initiative supports countries in standardizing and continuously collecting, analyzing, and disseminating information on essential health resources and services[13]. It provides a standardized process for the production and maintenance of an authoritative master facility list that includes core information on the availability of essential health services. Information gathered on healthcare institutions is compiled and verified by local service providers[3,14].

The HeRAMS Initiative provides an opportunity to clarify how accurately the typology of health facilities reflects the availability of specific health services and whether health facility types are a good indicator for assessing the distribution of and accessibility to health services. In Mali, HeRAMS has been operational since 2013. It currently provides regular information on 2,676 health facilities. A comprehensive report on the exhaustive mapping of health facilities in Mali was published in 2020[15], with an update published in October 2022[16]. As a result, Mali is now one of the countries where the accuracy of the typology of health facilities can be effectively assessed in relation to the availability of health services. Therefore, this study aims to analyze the accuracy of health facility types in representing health service availability using the most recent HeRAMS data for Mali. We assess whether the typology of a health facility explains the availability of a large set of health services at the facility level. The results can help to guide decision- and policymakers in redirecting health system assessments and surveillance strategies towards the most meaningful information and indicators and ultimately improve populations' access to healthcare.

2. Methods

2.1 Data collection

Mali health facility data were extracted from the HeRAMS database and included up-to-date information on essential health service provisioning at the facility level (as of October 4, 2022). For this study, we only focused on public health facilities that constitute the backbone of the three-level pyramidal health system in Mali, namely the Community Health Centers (CHCs), the Reference Health Centers (RHCs), and the Hospitals (Hs), giving us a total of 1,725 observations. CHCs, RHCs and Hs represented 95% (n = 1646), 4% (n = 66) and 1% (n = 13) of the facilities, respectively. All essential health services reported in the HeRAMS database (n = 92) were considered, and the response for each service in each health facility could be "Available", "Partially available", "Not available" or "Not normally provided". If a service is available, it is considered that a health service provider is able to provide the service without limitations or barriers. A partially available service is considered not fully available because the health service provider encounters obstacles or limitations in providing the service, such as financial constraints or insufficient equipment. An unavailable service is a service that should normally be provided but cannot currently be provided because of lack of human resources, medical supplies, financial constraints or other impeding factors. If a service is not normally provided, it means that the service is not available but also that it is not part of the package of services normally provided by the health service provider. Our study did not require ethical approval from a research commission since the data collected did not involve any individual or patient-specific information.

Instead, it primarily consisted of data at the health facility level regarding service provision. As a result, no ethical clearance was necessary for this data collection.

2.2 Patient and Public Involvement

This study did not involve specific patient or public involvement due to its focus on analyzing health-facility level data and exploring broader geographical patterns regarding the representativeness of health facility typology in healthcare service availability.

2.3 Statistical analysis

In our study, we investigated the connection between different types of health facilities and the availability of essential health services. To simplify our analysis, we categorized the responses from HeRAMS into two groups: "Available" and "Not available". We combined the responses of "Available" and "Partially available" into the "Available" category, while grouping "Not available" and "Not normally provided" as "Not available".

To understand the underlying patterns in the data and determine the percentage of variance in health service provisioning explained by health facility types, we employed two statistical techniques. Firstly, we conducted a Multiple Correspondence Analysis (MCA), which is similar to Principal Component Analysis (PCA), but specifically designed for categorical data[17]. Next, we performed a Between-Class Analysis (BCA), which is a variant of PCA that incorporates instrumental variables (PCAIV), in which there is only a single factor as explanatory variable[18].

The ratio of BCA inertia to MCA inertia indicates the proportion of variance explained by the different health facility types. We assessed the significance of this percentage through a Monte-Carlo procedure involving 999 permutations.

2.4 Consistency index

We also developed and calculated a Consistency Index (CI) to measure the consistency of health facility types in providing specific essential health services. The formula for CI is:

$$CI = \frac{|a - b|}{a + b}$$

Here, CI represents the Consistency Index, and 'a' and 'b' are the counts of observations for the two possible responses, namely "available" or "not available". For example, 'a' could represent the number of responses indicating "available" while 'b' represents the number of responses indicating "not

available". The CI values range from 0 (indicating low consistency) to 1 (indicating high consistency). We calculate the CI for each individual service within a particular type of health facility.

Since HeRAMS covers 92 services and our focus is on three types of health care providers, the CI values follow a specific distribution. We tested the differences in CI values between the three facility types using Wilcoxon tests and employed the Holm procedure to control the family-wise error rate. Additionally, we assessed how the CI varies among the five essential health service pillars, which include general clinical and emergency care services, child health and nutrition, communicable diseases, sexual and reproductive health, and noncommunicable diseases.

Finally, focusing on the most frequent health facility type only (i.e, CHC), we analyzed how the health service availability varied across the ten Malian regions (i.e, Gao, Kayes, Kidal, Koulikoro, Ménaka, Mopti, Ségou, Sikasso, Taoudénit, and Tombouctou) and the capital district Bamako. We calculated the average probability of an essential health service being available in each region.

3. Results

3.1 Rethinking Health Facility Types as Indicators of Service Availability

Only a small portion of service availability can be attributed to health facility types, as demonstrated in Figure 1. The BCA reveals that health facility types explain merely 6.3% of the variance in service availability ($p = 0.001$). This indicates that the majority of variability in health service provisioning stems from differences within facility types rather than between them.

3.2 Examining Consistency in Health Facility Types for Service Provision

To avoid making broad generalizations about all facilities, it is important to recognize that some types of facilities may have a greater level of consistency in providing certain services as compared to others. To account for this variation, we created a Consistency Index. Our analysis revealed that service availability or non-availability is most consistent within CHCs ($p < 0.001$). However, significant variability between services remains pronounced within each facility type (Figure 2a). For Hs and RHCs, the median CI values are relatively low, close to 0.5. This indicates that, on average, approximately one quarter of health facilities have a service provisioning pattern that differs from the other three quarters of facilities. Although service provisioning patterns show greater similarity among CHCs, the conclusion remains unchanged that health facility types are not a reliable indicator of health service availability.

3.3 Some essential health services are more consistently provided than others

In order to gain a comprehensive understanding of service availability, we delved deeper into the consistency of service provision across various essential health services at the different facility types. Our analysis revealed distinct variations in patterns, indicating that different sets of essential health services and facility types exhibit diverse levels of consistency (Figure 2b). Notably, when examining the delivery of sexual and reproductive health services in Hs, we observed high inconsistency (median = 0.23), suggesting a lack of clear patterns regarding the availability of these services. Conversely, in CHCs, the availability of general clinical services and emergency care demonstrated a high level of consistency (median = 0.83). These findings reveal that the consistency of service provisioning differs among facility types across various service pillars, suggesting that health facility type can only serve as a reliable proxy for health service availability in very few specific instances. Moreover, even seemingly straightforward assumptions, such as the availability of maternal health services in Hs, cannot be universally assumed, as previously suggested by Wigley et al. (2020)[19].

Furthermore, to account for potential spatial variations in service availability, we conducted a comparison of service consistency among CHCs across the different regions of Mali. The results revealed substantial differences in service availability between regions (Figure 2c). Southern regions, including Bamako, Kayes, Koulikoro, Mopti, Ségou, and Sikasso, exhibited a higher probability of having essential health services available (median = 0.47), while the availability was notably low in Ménaka (0.21).

Discussion

This study reveals that it is misleading to rely solely on the typology of health facilities as a proxy of the availability of health services. Yet, health system performance indicators such as availability and accessibility are often presented by type of health facility[5,8,9,19], as if there is a common agreement on the service packages that a particular type of facility should offer. This indicates that when conducting research and making policy decisions, relying on assumptions about the delivery of specific services across certain health facility types, like emergency obstetric care in all hospitals, can lead to incorrect conclusions. Instead, it is more appropriate to consider the actual availability of the service at the facility level, rather than relying solely on the type of facility. Additionally, certain policy documents and guidelines[8,9,20], particularly in the area of emegrencies, still use typology and service availability of services interchangeably and do not address the limitations and challenges of using such indicators. Our research shows that they are not as closely linked as previously thought and that their use for health system planning and monitoring should be reconsidered.

One key health indicator often used in health system planning or monitoring is the average population per functioning health facility by type and by administrative unit. The Sphere handbook discusses the need to consider combinations of types and to adjust coverage tresholds according to context[8], while the Global Health Cluster Guidance points out that this indicator is recommended as a proxy for geographic accessibility and equity of health facility availability across administrative units[9]. In both cases, there is no discussion of the importance or value of the accessibility of health facilities in the absence of information on the services they actually provide. Similarly the Humanitarian Indicators Registry[20] also does not discuss this indicator inadequacy to represent the availabilibility of and accessibility to essential health services but rather its incompleteness on other secondary dimensions, for example service quality.

The results also showed that the consistency of service provisioning between different facility types varies across different service pillars, indicating that health facility type may represent a good proxy for health service availability, but only in very few specific cases. Taking into account the most frequent health facility type, which occured to be also the most consistent type in terms of service provisioning (i.e., CHC), service availability largely differs from one region to another. This could be indirectly explained by political and security contexts and stresses the importance of assessing the service availability at the facility level and avoiding false assumptions.

In addition to being poor proxies of the availability of and accessibility to essential health services, indicators based on geolocation and health facility type may suffer from other limitations due to the availability and quality of the data to support them. These limitations include the persistance of large differences in typology between different health facility datasets within a country. South et al. (2021)[3] showed that even though the total number of facilities captured by different datasets within a country can be quite similar, the geographical distribution of the facility types is extremely different. Other limitations should be expected from the lack of information on the functionality of these facilities and their ability to actually deliver certain services. This limitation can be particularly acute in emergency settings where health facilities often face major disruptions.

Conclusion

For all these reasons, indicators based on geolocation and health facility type are not efficient proxies for assessing the availability and accessibility of essential health services. The results observed in Mali

suggest that relying on such indicators could lead to misleading interpretations of needs, gaps, and priorities, which are crucial for decision makers striving to ensure equitable access to healthcare services in line with Sustainable Development Goal 3. Consequently, there is a need to redefine the nature and scope of health system assessments and monitoring. Instead of focusing solely on the availability of certain types of health facilities, assessments should explicitly prioritize evaluating service availability.

Other studies have examined the influence of facility type on the availability of specific health services[11,12] but this study is the first to focus on a wide range of essential health services. This case study was carried out in Mali and further research is needed to generalize our findings, however it is expected that similar patterns exist in other settings and countries.

Author Contributions

The study was initially conceptualized by SP and further supported by PT. The methodology was initially developed by PT and reviewed by FH, NR and SP. Data analysis and processing were done by PT. Writing of the original draft was done by FH, PT and SP supported by NR. Initial reviews on the figures were given by FH, SP, and NR. Initial reviews on the text were given by OT and CF. AI, YC, ISF have further assisted in thoroughly reviewing all figures and texts.

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Ethics statement

Our study did not require ethical approval from a research commission since the data collected did not involve any individual or patient-specific information. Instead, it primarily consisted of data at the health facility level regarding service provision. As a result, no ethical clearance was necessary for this data collection.

Data and code sharing

The health facility data used in this study can be obtained upon reasonable request from HeRAMS. Additionally, the statistical code required to replicate the data analysis will be accessible through a dedicated Zenodo repository upon publication.

Conflicts of interest

The authors have no conflicts of interest to declare.

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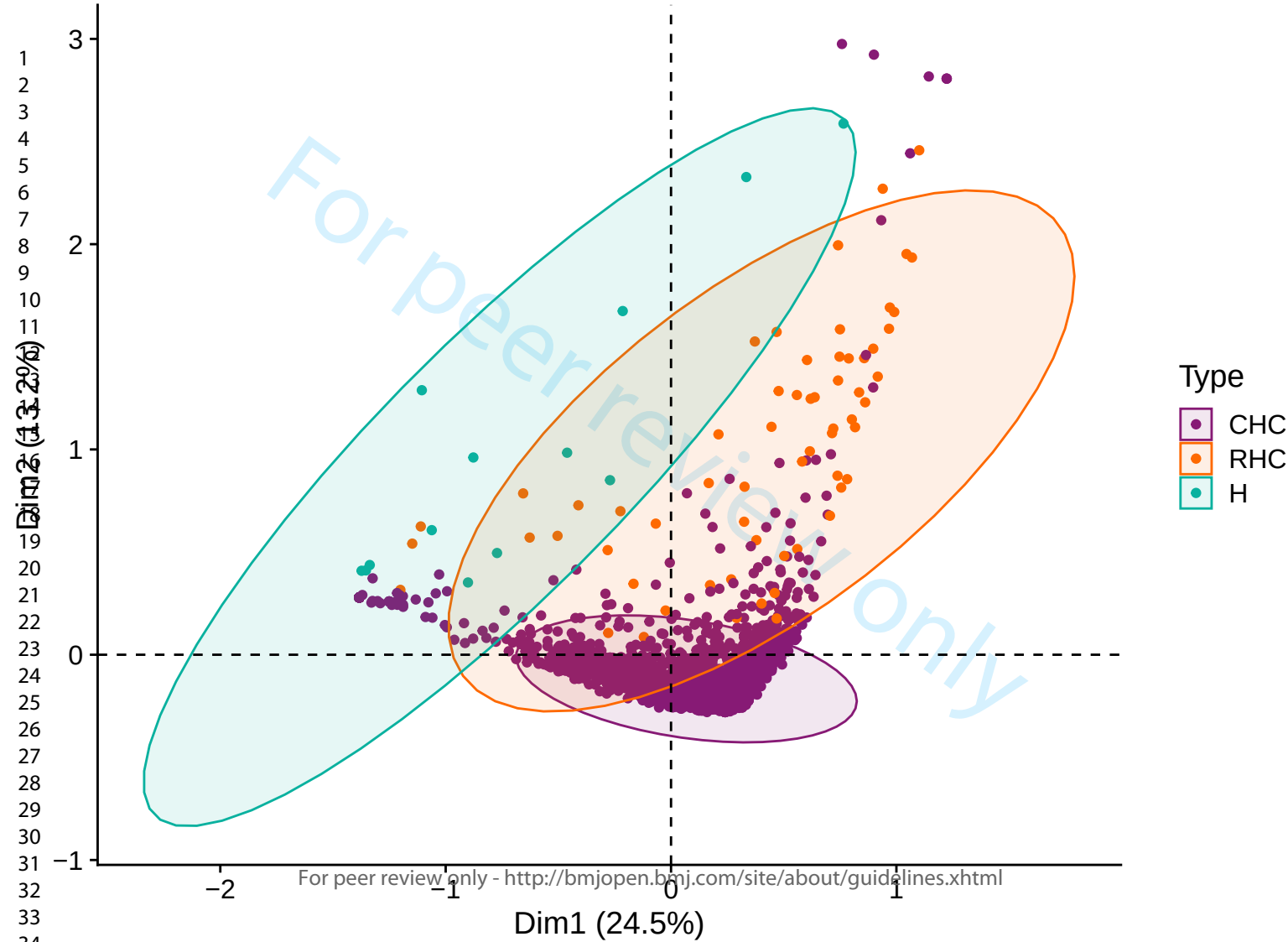
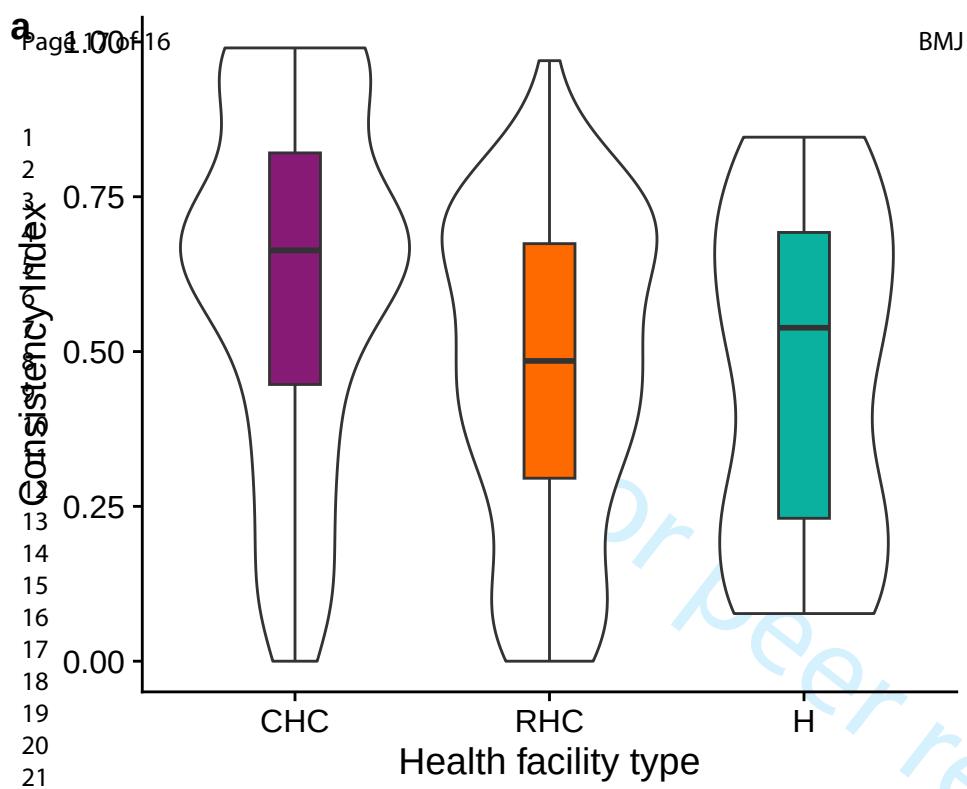
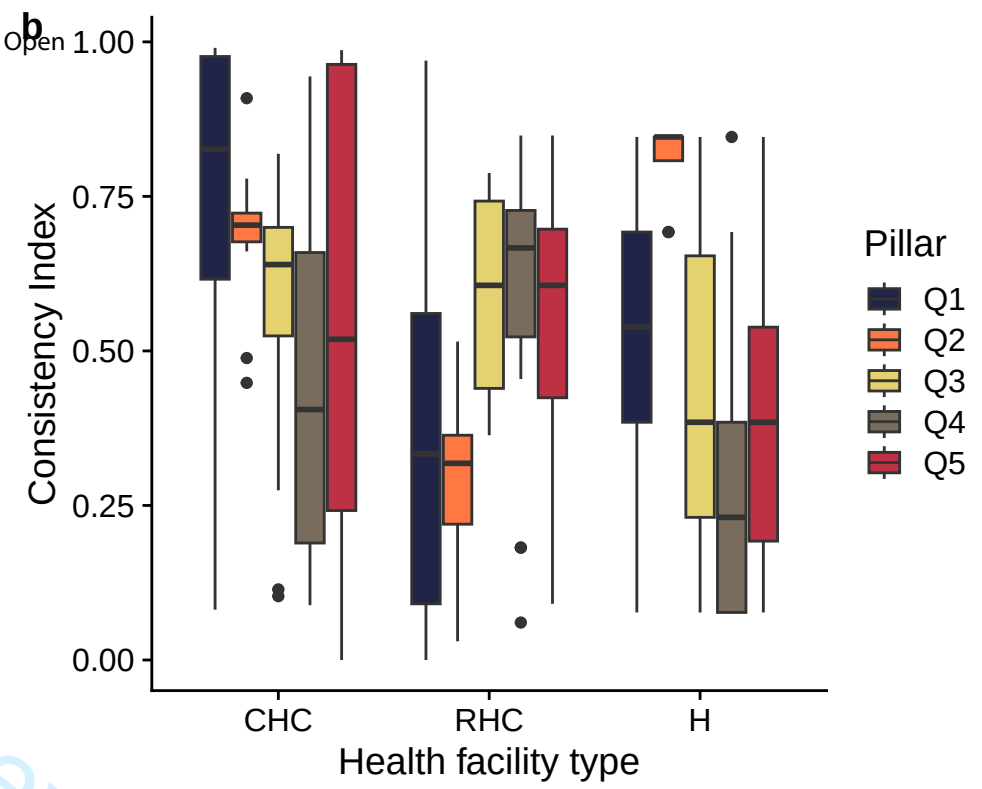
Figure legends

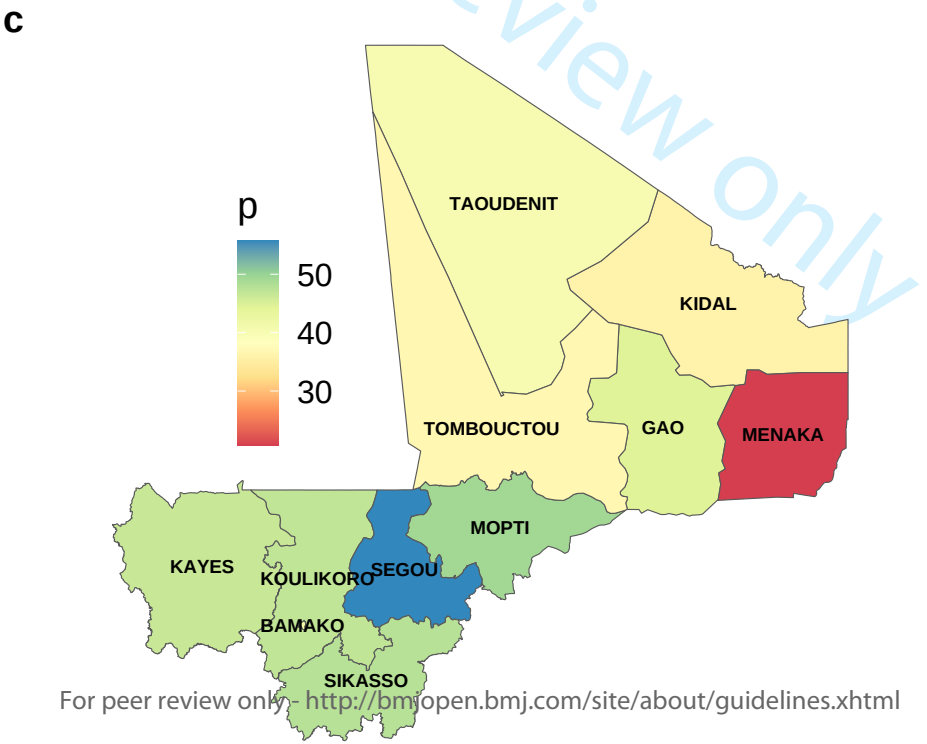
Figure 1. Multiple Correspondence Analysis (MCA) biplots of health facilities based on service availability. The figure shows the relationships between health facilities based on service availability. The points in this two-dimensional graph represent the health facilities. Closer points indicate more similarities in terms of service availability. Different types of health facilities are represented by different colors. The colored ellipses surrounding the points assume multivariate t-distributions. Each ellipse represents a different type of health facility, providing a visual representation of where most facilities of that type fall on the plot, thus capturing the multivariate dispersion of that group. The two axes of the graph depict the dimensions that account for the most variance in the data, with their labels indicating the proportion of the total variance explained by that axis. This means they represent the main patterns of differences in service availability between the health facilities.

Figure 2. Violin and box plots of the Consistency Index (CI) values for each health facility type, based on service availability and map indicating service availability at the regional level in Mali. A) The violin plots show the distribution of the CI values taking into account all the essential health services, and the box plots show the median (horizontal line) and the interquartile range (IQR, box outline). The whiskers extend from the hinge to the highest and lowest value that are within 1.5*IQR of the hinge. B) CI values for each health facility type and essential health service pillar, based on service availability. Q1: general clinical and emergency care services; Q2: child health and nutrition; Q3: communicable diseases; Q4: sexual and reproductive health; Q5: noncommunicable diseases. C) The mean probability by region for an essential health service to be available at a Community Health Center.









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Assessing the accuracy of health facility typology in representing the availability of health services: a case study in Mali

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Word count: 2413 words

Abstract

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Design: We analyzed a comprehensive dataset containing information from 1,725 health facilities in Mali. To uncover and visualize patterns within the dataset, we utilized two analytical techniques: Multiple Correspondence Analysis and Between-Class Analysis. These analyses allowed us to quantitatively measure the influence of health facility types on the variation in health service provisioning. Additionally, we developed and calculated a Consistency Index, which assesses the consistency of a health facility type in providing specific health services. By examining various health facilities and services, we sought to determine the accuracy of facility types as indicators of service availability.

Setting: The study focused on the health system in Mali as a case study.

Results: Our findings indicate that using health facility types as a proxy for service availability in Mali is not an accurate representation. We observed that most of the variation in service provision does not stem from differences between facility types but rather within facility types. This suggests that relying solely on health facility typology may lead to an incomplete understanding of health service availability.

Conclusions: These results have significant implications for health policy and planning. The reliance on health facility types as indicators for health system policy and planning should be reconsidered. A more nuanced and evidence-based understanding of health service availability is crucial for effective health policy and planning, as well as for the assessment and monitoring of health systems.

Strengths and limitations of this study

- The study benefits from a comprehensive dataset of 1,725 health facilities in Mali, contributing to a strong foundation for the analysis.
- By employing Multiple Correspondence Analysis, Between-Class Analysis, and constructing a consistency index, diverse analytical methods are used to explore underlying structures and compare service consistency across different facility types.
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- The findings are context-specific to the healthcare system in Mali, further research should validate whether similar patterns exist in other countries.

Introduction

Universal health coverage aims to ensure that everyone can access the necessary health services they require, regardless of time, place, or financial constraints[1,2]. Understanding the geographical distribution of health services is crucial in identifying areas where access to health services may be limited[3,4]. Policymakers and practitioners have often used the distribution of specific types of health facilities relative to the population to address this issue. Health facility types are often grouped into different categories, such as health posts, health centers, clinics and district hospitals[3]. These classifications can vary depending on the country or context. Studies have used information on health facility typology to assess the geographical accessibility of different health services. However, there are inconsistencies in how these types are defined and categorized in different studies. For example, Ouma et al. (2018)[5] assumed that emergency care is available at all hospitals, while Hulland et al. (2019)[6] manually reclassified health facility types into self-defined categories, assuming distinct capabilities for different types. Additionally, Weiss et al. (2020)[7] selected specific facility types, such as hospitals and clinics, in different facility datasets without a common definition. According to guidelines for facility coverage, set by the Sphere Project in 2018[8] and the Global Health Cluster in 2021[9], one health facility should be available for every 10,000 people regardless of the type and one district or rural hospital should be available for every 250,000 people in a given administrative area. However, little is known about the relationship between facility type and the effective availability of essential health services at the health facility level[3], as health facility datasets typically do not include information on the type of services effectively provided by a facility[7,10]. Relatively few studies have examined the influence of facility type on the availability of specific health services[11,12] but to our knowledge no analysis of multiple essential services has yet measured the extent of this relationship more broadly.

The World Health Organization's (WHO) Health Resources and Services Availability Monitoring System (HeRAMS) gathers and presents core information on essential health resources and services[13]. This information is crucial for decision makers at national, regional and global levels. The initiative supports countries in standardizing and continuously collecting, analyzing, and disseminating information on essential health resources and services[13]. It provides a standardized process for the production and maintenance of an authoritative master facility list that includes core information on the availability of essential health services. Information gathered on healthcare institutions is compiled and verified by local service providers[3,14].

The HeRAMS Initiative provides an opportunity to clarify how accurately the typology of health facilities reflects the availability of specific health services and whether health facility types are a good indicator for assessing the distribution of and accessibility to health services. In Mali, HeRAMS has been operational since 2013. It currently provides regular information on 2,676 health facilities. A comprehensive report on the exhaustive mapping of health facilities in Mali was published in 2020[15], with an update published in October 2022[16]. As a result, Mali is now one of the countries where the accuracy of the typology of health facilities can be effectively assessed in relation to the availability of health services. Therefore, this study aims to analyze the accuracy of health facility types in representing health service availability using the most recent HeRAMS data for Mali. We assess whether the typology of a health facility explains the availability of a large set of health services at the facility level. The results can help to guide decision- and policymakers in redirecting health system assessments and surveillance strategies towards the most meaningful information and indicators and ultimately improve populations' access to healthcare.

2. Methods

2.1 Data collection

Mali health facility data were extracted from the HeRAMS database and included up-to-date information on essential health service provisioning at the facility level (as of October 4, 2022). For this study, we only focused on public health facilities that constitute the backbone of the three-level pyramidal health system in Mali, namely the Community Health Centers (CHCs), the Reference Health Centers (RHCs), and the Hospitals (Hs), giving us a total of 1,725 observations. CHCs, RHCs and Hs represented 95% (n = 1646), 4% (n = 66) and 1% (n = 13) of the facilities, respectively. All essential health services reported in the HeRAMS database (n = 92) were considered, and the response for each service in each health facility could be "Available", "Partially available", "Not available" or "Not normally provided". If a service is available, it is considered that a health service provider is able to provide the service without limitations or barriers. A partially available service is considered not fully available because the health service provider encounters obstacles or limitations in providing the service, such as financial constraints or insufficient equipment. An unavailable service is a service that should normally be provided but cannot currently be provided because of lack of human resources, medical supplies, financial constraints or other impeding factors. If a service is not normally provided, it means that the service is not available but also that it is not part of the package of services normally provided by the health service provider. Our study did not require ethical approval from a research commission since the data collected did not involve any individual or patient-specific information.

Instead, it primarily consisted of data at the health facility level regarding service provision. As a result, no ethical clearance was necessary for this data collection.

2.2 Patient and Public Involvement

This study did not involve specific patient or public involvement due to its focus on analyzing health-facility level data and exploring broader geographical patterns regarding the representativeness of health facility typology in healthcare service availability.

2.3 Statistical analysis

In our study, we investigated the connection between different types of health facilities and the availability of essential health services. To simplify our analysis, we categorized the responses from HeRAMS into two groups: "Available" and "Not available". We combined the responses of "Available" and "Partially available" into the "Available" category, while grouping "Not available" and "Not normally provided" as "Not available".

To understand the underlying patterns in the data and determine the percentage of variance in health service provisioning explained by health facility types, we employed two statistical techniques. Firstly, we conducted a Multiple Correspondence Analysis (MCA), which is similar to Principal Component Analysis (PCA), but specifically designed for categorical data[17]. Next, we performed a Between-Class Analysis (BCA), which is a variant of PCA that incorporates instrumental variables (PCAIV), in which there is only a single factor as explanatory variable[18].

The ratio of BCA inertia to MCA inertia indicates the proportion of variance explained by the different health facility types. We assessed the significance of this percentage through a Monte-Carlo procedure involving 999 permutations.

2.4 Consistency index

We also developed and calculated a Consistency Index (CI) to measure the consistency of health facility types in providing specific essential health services. The formula for CI is:

$$CI = \frac{|a - b|}{a + b}$$

Here, CI represents the Consistency Index, and 'a' and 'b' are the counts of observations for the two possible responses, namely "available" or "not available". For example, 'a' could represent the number of responses indicating "available" while 'b' represents the number of responses indicating "not

available". The CI values range from 0 (indicating low consistency) to 1 (indicating high consistency). We calculate the CI for each individual service within a particular type of health facility.

Since HeRAMS covers 92 services and our focus is on three types of health care providers, the CI values follow a specific distribution. We tested the differences in CI values between the three facility types using Wilcoxon tests and employed the Holm procedure to control the family-wise error rate. Additionally, we assessed how the CI varies among the five essential health service pillars, which include general clinical and emergency care services, child health and nutrition, communicable diseases, sexual and reproductive health, and noncommunicable diseases.

Finally, focusing on the most frequent health facility type only (i.e, CHC), we analyzed how the health service availability varied across the ten Malian regions (i.e, Gao, Kayes, Kidal, Koulikoro, Ménaka, Mopti, Ségou, Sikasso, Taoudénit, and Tombouctou) and the capital district Bamako. We calculated the average probability of an essential health service being available in each region.

3. Results

3.1 Rethinking Health Facility Types as Indicators of Service Availability

Only a small portion of service availability can be attributed to health facility types, as demonstrated in Figure 1. The BCA reveals that health facility types explain merely 6.3% of the variance in service availability ($p = 0.001$). This indicates that the majority of variability in health service provisioning stems from differences within facility types rather than between them.

3.2 Examining Consistency in Health Facility Types for Service Provision

To avoid making broad generalizations about all facilities, it is important to recognize that some types of facilities may have a greater level of consistency in providing certain services as compared to others. To account for this variation, we created a Consistency Index. Our analysis revealed that service availability or non-availability is most consistent within CHCs ($p < 0.001$). However, significant variability between services remains pronounced within each facility type (Figure 2a). For Hs and RHCs, the median CI values are relatively low, close to 0.5. This indicates that, on average, approximately one quarter of health facilities have a service provisioning pattern that differs from the other three quarters of facilities. Although service provisioning patterns show greater similarity among CHCs, the conclusion remains unchanged that health facility types are not a reliable indicator of health service availability.

3.3 Some essential health services are more consistently provided than others

In order to gain a comprehensive understanding of service availability, we delved deeper into the consistency of service provision across various essential health services at the different facility types. Our analysis revealed distinct variations in patterns, indicating that different sets of essential health services and facility types exhibit diverse levels of consistency (Figure 2b). Notably, when examining the delivery of sexual and reproductive health services in Hs, we observed high inconsistency (median = 0.23), suggesting a lack of clear patterns regarding the availability of these services. Conversely, in CHCs, the availability of general clinical services and emergency care demonstrated a high level of consistency (median = 0.83). These findings reveal that the consistency of service provisioning differs among facility types across various service pillars, suggesting that health facility type can only serve as a reliable proxy for health service availability in very few specific instances. Moreover, even seemingly straightforward assumptions, such as the availability of maternal health services in Hs, cannot be universally assumed, as previously suggested by Wigley et al. (2020)[19].

Furthermore, to account for potential spatial variations in service availability, we conducted a comparison of service consistency among CHCs across the different regions of Mali. The results revealed substantial differences in service availability between regions (Figure 2c). Southern regions, including Bamako, Kayes, Koulikoro, Mopti, Ségou, and Sikasso, exhibited a higher probability of having essential health services available (median = 0.47), while the availability was notably low in Ménaka (0.21).

Discussion

This study reveals that it is misleading to rely solely on the typology of health facilities as a proxy of the availability of health services. Yet, health system performance indicators such as availability and accessibility are often presented by type of health facility[5,8,9,19], as if there is a common agreement on the service packages that a particular type of facility should offer. This indicates that when conducting research and making policy decisions, relying on assumptions about the delivery of specific services across certain health facility types, like emergency obstetric care in all hospitals, can lead to incorrect conclusions. Instead, it is more appropriate to consider the actual availability of the service at the facility level, rather than relying solely on the type of facility. Additionally, certain policy documents and guidelines[8,9,20], particularly in the area of emegrencies, still use typology and service availability of services interchangeably and do not address the limitations and challenges of using such indicators. Our research shows that they are not as closely linked as previously thought and that their use for health system planning and monitoring should be reconsidered.

One key health indicator often used in health system planning or monitoring is the average population per functioning health facility by type and by administrative unit. The Sphere handbook discusses the need to consider combinations of types and to adjust coverage tresholds according to context[8], while the Global Health Cluster Guidance points out that this indicator is recommended as a proxy for geographic accessibility and equity of health facility availability across administrative units[9]. In both cases, there is no discussion of the importance or value of the accessibility of health facilities in the absence of information on the services they actually provide. Similarly the Humanitarian Indicators Registry[20] also does not discuss this indicator inadequacy to represent the availabilibility of and accessibility to essential health services but rather its incompleteness on other secondary dimensions, for example service quality.

The results also showed that the consistency of service provisioning between different facility types varies across different service pillars, indicating that health facility type may represent a good proxy for health service availability, but only in very few specific cases. Taking into account the most frequent health facility type, which occured to be also the most consistent type in terms of service provisioning (i.e., CHC), service availability largely differs from one region to another. This could be indirectly explained by political and security contexts and stresses the importance of assessing the service availability at the facility level and avoiding false assumptions.

In addition to being poor proxies of the availability of and accessibility to essential health services, indicators based on geolocation and health facility type may suffer from other limitations due to the availability and quality of the data to support them. These limitations include the persistance of large differences in typology between different health facility datasets within a country. South et al. (2021)[3] showed that even though the total number of facilities captured by different datasets within a country can be quite similar, the geographical distribution of the facility types is extremely different. Other limitations should be expected from the lack of information on the functionality of these facilities and their ability to actually deliver certain services. This limitation can be particularly acute in emergency settings where health facilities often face major disruptions.

Conclusion

For all these reasons, indicators based on geolocation and health facility type are not efficient proxies for assessing the availability and accessibility of essential health services. The results observed in Mali

suggest that relying on such indicators could lead to misleading interpretations of needs, gaps, and priorities, which are crucial for decision makers striving to ensure equitable access to healthcare services in line with Sustainable Development Goal 3. Consequently, there is a need to redefine the nature and scope of health system assessments and monitoring. Instead of focusing solely on the availability of certain types of health facilities, assessments should explicitly prioritize evaluating service availability.

Other studies have examined the influence of facility type on the availability of specific health services[11,12] but this study is the first to focus on a wide range of essential health services. This case study was carried out in Mali and further research is needed to generalize our findings, however it is expected that similar patterns exist in other settings and countries.

Author Contributions

The study was initially conceptualized by SP and further supported by PT. The methodology was initially developed by PT and reviewed by FH, NR and SP. Data analysis and processing were done by PT. Writing of the original draft was done by FH, PT and SP supported by NR. Initial reviews on the figures were given by FH, SP, and NR. Initial reviews on the text were given by OT and CF. AI, YC, ISF have further assisted in thoroughly reviewing all figures and texts.

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Ethics statement

Our study did not require ethical approval from a research commission since the data collected did not involve any individual or patient-specific information. Instead, it primarily consisted of data at the health facility level regarding service provision. As a result, no ethical clearance was necessary for this data collection.

Data and code sharing

The health facility data used in this study can be obtained upon reasonable request from HeRAMS. Additionally, the statistical code required to replicate the data analysis will be accessible through a dedicated Zenodo repository upon publication.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Figure legends

Figure 1. Multiple Correspondence Analysis (MCA) biplots of health facilities based on service availability. The figure shows the relationships between health facilities based on service availability. The points in this two-dimensional graph represent the health facilities. Closer points indicate more similarities in terms of service availability. Different types of health facilities are represented by different colors. The colored ellipses surrounding the points assume multivariate t-distributions. Each ellipse represents a different type of health facility, providing a visual representation of where most facilities of that type fall on the plot, thus capturing the multivariate dispersion of that group. The two axes of the graph depict the dimensions that account for the most variance in the data, with their labels indicating the proportion of the total variance explained by that axis. This means they represent the main patterns of differences in service availability between the health facilities.

Figure 2. Violin and box plots of the Consistency Index (CI) values for each health facility type, based on service availability and map indicating service availability at the regional level in Mali. A) The violin plots show the distribution of the CI values taking into account all the essential health services, and the box plots show the median (horizontal line) and the interquartile range (IQR, box outline). The whiskers extend from the hinge to the highest and lowest value that are within 1.5*IQR of the hinge. B) CI values for each health facility type and essential health service pillar, based on service availability. Q1: general clinical and emergency care services; Q2: child health and nutrition; Q3: communicable diseases; Q4: sexual and reproductive health; Q5: noncommunicable diseases. C) The mean probability by region for an essential health service to be available at a Community Health Center.