

The impact of COVID-19 pandemic on health service utilization in Ghana – a retrospective analysis of DHIMS-2 data

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Abstract

Background

The COVID-19 pandemic led to disruption in health services globally, Africa and in Ghana leading to reduction in health service utilization (HSU). Most studies on HSU in Ghana are facility or disease-based. The impact of COVID-19 pandemic on HSU has not been studied generally in Ghana. We aimed to assess trends in COVID-19 incidence and changes in HSU from the pre-pandemic to the pandemic period, and to compare these changes between an epicentre and a non-epicentre region in Ghana.

Methods

We conducted a retrospective study using data from the District Health Information Management Software 2 (DHIMS-2) at the National and Regional levels from 1st March 2018 to 31st March 2022. Monthly counts and quarterly proportional changes were computed to determine changes in hospital admissions, out-patient clinic attendance, non-communicable disease (NCD) clinic attendance, ante-natal care (ANC) and childhood vaccination clinics attendance in the Ashanti and Northern regions in Ghana.

Results

Four waves in the incidence of COVID-19 cases were identified during the pandemic period in Ghana. The lowest monthly counts were recorded in April 2020 with 1,905,242 outpatient clinic visits and 119,894 inpatient admissions, considerably lower than the median of 2,643,136 and 156,074 respectively for the study period. Generally, there were proportionally greater reductions in HSU in the Northern region than in the Ashanti region. For the Ashanti region and Northern regions, the percentage changes in admission utilization were – 9.5% vs -23.7%, -16.0% vs -28.1% for out-patient clinic utilization, -1.7% vs -11.2% for NCDs clinics and – 1.8% vs 4.1% for childhood vaccination clinic respectively. However, there was however an increase in ANC service utilization by 5.5% in the Northern region as compared to a reduction of 2.0% in the Ashanti region.

Conclusion

The COVID-19 pandemic led to reduction in HSU in a non-epicentre as compared to an epicentre in Ghana implying that measures to mitigate the effect of a pandemics should consider its effect on HSU even in non-epicentres regions in future pandemics.

Introduction

The COVID-19 pandemic will go down in history as one of the most impactful pandemics experienced globally leading to significant disruptions in health services utilization (HSU)[1]. Efforts to reduce the spread of the COVID-19 infection led to a further reduction in HSU, especially in low-and lower middle-income countries like Ghana[2, 3]. HSU is defined as the process of seeking professional healthcare and submitting oneself to the application of regular health services with the purpose of preventing or treating health problems. HSU is an individual's choice but mostly framed in the social context through cultural, social and family ties [4]. HSU is a reflection of the health-seeking behaviour of a people, which is dependent on demographic, socioeconomic status, geographical location and the severity of the health condition [5]. HSU usually serves as a good surrogate measure of access to healthcare that influences health outcomes as well as the satisfaction of the healthcare consumer [6].

During the COVID-19 pandemic, healthcare services were shown to be disrupted in 94% of 135 participating countries according to the World Health Organization (WHO) [7]. Primary care, rehabilitative, palliative and long-term care were the most affected in 40% of countries, and life-saving emergency, critical and operative interventions were disrupted in 20% of countries with 66% of countries reporting disruption in the number of elective surgeries performed. The magnitude of disruption however, reduced in 2021 compared to the second and third quarter of 2020 [8]. A recent scoping review including studies in 39 countries in sub-Saharan Africa (SSA) showed a decrease in HSU amongst 84.4% of the 262 studies included, with a median decrease in HSU of 35.6%. Cardiovascular disease had the largest percentage decrease in HSU with a median decrease of 68% in SSA [9]. These reductions in HSU may have contributed to excess mortality during the COVID-19 pandemic due to lack of access to health care services[10].

Ghana recorded the first COVID-19 case in March 2020 and the government's initial response to the pandemic included internal lockdowns, air travel restrictions, and the reallocation of healthcare resources to manage patients with COVID-19 infection[11]. In response to pandemic-related restrictions and concerns about COVID-19 infection, many individuals postponed or avoided seeking care for chronic conditions, mental health issues, acute illnesses, vaccinations, and other preventive services [8, 12, 13]. This raised concerns about the potential long-term health implications of delayed care, particularly for people requiring routine management of chronic conditions.

In Ghana, urban areas recorded higher COVID-19 cases than rural areas[11] and the government's interventions to reduce the spread of the COVID-19 infection were more pronounced in urban areas than rural areas[14] leading to a further reduction in HSU. The COVID-19 pandemic and government interventions also had effects on the social and economic wellbeing of Ghanaians. The socio-economic impact may also have led to a further reduction in HSU[15]. A study in the Northern region of Ghana also showed that there was a decline in adult and paediatric in-patient and out-patient HSU in March–April 2020 but not for malaria and ante-natal clinics[16]. HSU slightly increased later in 2020 but was still below the previous year's average. Another facility recorded almost 50% reduction in outpatient attendance in Ghana with associated decrease in revenue in a university hospital in Ghana [17].

Studies on HSU in Ghana are few and are facility-based or disease-based in single health facilities [17, 18]. The impact of the COVID-19 pandemic on outpatient clinics (including hypertension and diabetes), in-patients, childhood vaccination and ante-natal clinic (ANC) services, nationally and regionally have not been studied in Ghana. We aimed to assess monthly counts of the COVID-19 infection rate and determine the impact of the COVID-19 pandemic on HSU. We also sought to describe the monthly changes in HSU from 2018 to 2022 focusing on in-patients and outpatient HSU before and during the COVID-19 pandemic and to compare the changes in HSU in an epicentre region to a non-epicentre region in Ghana.

Methods

We conducted a retrospective study using data from the District Health Information Management Software 2 (DHIMS-2) at the National and Regional levels from 1st March 2018 to 31st March 2022. The District Health Information Management System version 2 (DHIMS-2) is Ghana's national electronic routine health information system used by the Ghana Health Service (GHS) and the Ministry of Health (MoH) for collecting, managing, analyzing, and reporting health service delivery data across all levels of the healthcare system[19].

District Health Information Management Software 2 (DHIMS-2)

District Health Information Management Software 2 (DHIMS-2) was introduced nationally in 2012 and built on the open-source District Health Information Software 2 (DHIS2) platform. DHIMS-2 serves as the principal repository for routine health facility data and supports evidence-based planning, monitoring, resource allocation, and policy formulation. It captures aggregated service statistics from both public and selected private health facilities in Ghana, ensuring standardized reporting from the community to the national level[20].

Data collection begins at the health facility level, healthcare providers document patient encounters in standardized registers and clinical records during routine service delivery. For outpatient departments (OPDs), clinicians record demographic information, diagnoses using the International Classification of Diseases (ICD-10), treatments provided, and patient outcomes in outpatient registers[21]. Monthly summaries are prepared from these registers, including the total number of outpatient visits, disease-specific attendances, referrals, admissions, and deaths. These aggregated data are subsequently entered into the DHIMS-2 electronic platform by trained health information officers or designated data managers at the facility[20].

For inpatient services, hospitals maintain admission, discharge, and ward registers documenting patient demographics, admission diagnoses, procedures performed, duration of hospitalization, discharge status, and mortality. At the end of each reporting month, these data are aggregated into standardized inpatient reporting forms before being uploaded into DHIMS-2. Indicators generated include total

admissions, disease-specific admissions, inpatient deaths, bed occupancy rates, average length of stay, and cause-specific mortality. These data provide valuable information for monitoring hospital performance, disease burden, and healthcare utilization.

Study procedure

We extracted the monthly counts of patients recorded for general out-patients' clinic attendance, in-patients' admission, patients with selected non-communicable disease (NCD) clinic such as hypertension and diabetes mellitus, ante-natal clinic (ANC) attendance and childhood vaccination attendance. We computed quarterly percentage changes in monthly counts from the aggregate data to determine changes in HSU during the COVID-19 pandemic nationally, in the Ashanti and the Northern regions of Ghana.

We also collected monthly incidence of COVID-19 cases at the national and regional levels - in the Ashanti and Northern Regions. We used descriptive statistics and figures to describe the trends in COVID-19 infection cases and HSU with respect to outpatient clinic attendance, in-patient admissions, NCD clinic attendance (hypertension and diabetes clinics), ANC clinic attendance and childhood vaccination clinic attendance. We computed quarterly counts of the HSU and compared the quarterly percentage changes between the second quarter and third quarter of the pandemic in 2020. Seasonal variation in HSU utilization with quarterly proportional changes were also compared to 2019 and 2021 nationally and in the Ashanti and Northern regions.

Ethical approval

was obtained from the Ghana Health Service Ethics Review Committee with approval number GHS-ERC/010/01/24 and the Committee on Human Research and Publication Ethics (CHRPE) of KNUST with approval number CHRPE/AP/1045/23 before the conduct of the study.

Results

Within the pandemic period, four waves were identified in the monthly incidence of COVID-19 infection cases. The peaks of the waves were in July 2020, February 2021, August 2021 and December 2021. The peaks decreased with time during the pandemic period. The peaks in COVID-19 monthly infection counts were duplicated also in the Ashanti region of Ghana but less so in the Northern region. There were higher number of recorded COVID-19 cases in the Ashanti region as compared to the Northern region. The cumulated number of COVID-19 infected cases in Ghana as at March 2022 was 149,298 with average monthly case count of 5,972. The cumulated number of COVID-19 cases in Ashanti region was 22,062 cases as compared to the Northern region with cumulative of 1,835 (Fig. 1).

The effect of COVID-19 on out-patient department attendance and in-patient admissions

Monthly outpatient service utilization declined sharply during the first peak of the COVID-19 pandemic. The lowest level observed during the study period was reached in April 2020, with 1,905,242 outpatient visits compared with 2,383,606 in March 2020, corresponding to a 20.1% decrease. Utilization subsequently increased, with the highest monthly count recorded in October 2021, when 3,428,637 outpatient visits were reported. Across the study period, the average monthly number of outpatient visits in Ghana was 2,643,136 (Fig. 2).

There was a greater decline in hospital admissions during the first peak of the COVID-19 pandemic in April 2020, followed by a subsequent increase. Hospital admissions fell by 12.7% between March and April 2020, reaching the lowest level observed during the study period, before peaking in July 2021. Non-communicable disease clinic utilization also declined in April 2020, although less strongly, with attendance at the hypertension and diabetes mellitus clinics reducing by 8.4% and antenatal care clinic utilization remained relatively stable during this period, decreasing by only 1.4% in the second quarter of 2020 (Fig. 3).

Changes in health service utilization during the COVID-19 pandemic in Ghana

There was general reduction in HSU in outpatient clinic attendance, hospital admission, ANC clinic attendance and childhood vaccination attendance during first peak of the COVID-19 pandemic in Ghana. Out-patients' clinic utilization had the greatest percentage reduction of 17.3% with the least reduction in ANC attendance of 2.5% during April 2020. The hospital admission utilization reduced by 10.0%, NCDs clinic of both diabetes and hypertension utilization reduced by 11.7% and childhood vaccinated recorded a 3.4% reduction in Ghana during the COVID-19 pandemic (Fig. 4). There was a subsequent rise in all the modalities of HSU studied after the peak of the first pandemic except ANC visit which continued to experience a reduction of 1.1% in the third quarter of 2020. The percentage rise in HSU was highest among OPD attendants (12.1%), childhood vaccination (11.1%), admissions (10.9%), NCD clinic utilization of (5.8%) and hypertension (4.4%) (Fig. 4).

Seasonal changes in health service utilization in Ghana

There were seasonal reductions in HSU in some health services in the second quarter of the year 2020. The reductions in second quarter of 2020 were compared with 2019 and then 2021. Admission utilization experienced quarterly increases in 2019 (9.0%) and 2021 (11.0%) with a reduction of 10.0% in 2020 during the COVID-19 pandemic. Outpatient clinic service utilization also experienced an increase of 5.8% and 6.1% in 2019 and 2021 respectively but showed a reduction of 17.3% during the pandemic (Fig. 5).

Though NCD clinic utilization showed a reduction in 2019 (-4.9%) and 2021(-2.7%), there was a proportionally greater reduction in 2020 (-11.7%). ANC clinic attendance utilization in 2020 (-2.5%)

showed a lower reduction as compared to the year 2019 (-5.8%) and 2021 (-4.4%). Childhood vaccination showed a reduction of 4.4% in 2019, 3.4% in 2020 and an increase of 1.1% in 2021 (Fig. 5).

Comparison of health service utilization in Ashanti and Northern regions

Generally, there were proportionally greater reduction in HSU for hospital admission, outpatient clinic attendance, NCD clinics and childhood vaccination clinic attendance in the Northern region than in the Ashanti region. For the Ashanti region and Northern region, the changes reduction in admission utilization were -9.5% vs -23.7%, -16.0% vs -28.1% for out-patient services utilization, -1.7% vs -11.2% for NCDs service and -1.8% vs -4.1% for childhood vaccination respectively. There was an increase in ANC clinic service utilization by 5.5% in the Northern region as compared to a reduction of 2.0% in the Ashanti region (Fig. 6).

Admission and outpatient clinic utilization increased proportionally higher in the Northern region than in the Ashanti region in the third quarter of the COVID-19 pandemic. NCD clinic utilization decreased in the Northern region by 9.3% but increased the Ashanti region by 5.3% and ANC decreased proportionally higher in the Ashanti region by 7.3% as compared to the Northern region 2.6%. The admission cases rose proportionally by 24.4% in the Northern region as compared to no change in admission utilization in the Ashanti region. The outpatient services utilization also rose by 0.6% in the Ashanti region as compared to 35.3% in the Northern region. Childhood vaccination was however increased proportionally higher in the Ashanti region by 9.0% as compared to 5.2% in the Northern region in the third quarter of 2020 (Fig. 7).

Discussion

This is the first study reporting national and regional changes in HSU comparing the pre-pandemic to the pandemic period as well as comparing changes in an epicentre (Ashanti region) to a non-epicentre (Northern region) in Ghana. We found that there were four waves in the incidence of COVID-19 infection during the study period. There was proportionally greater reduction of HSU in the Northern region than the Ashanti region though the Ashanti region had higher COVID-19 cases and stringent lockdown measures than the Northern region. There was greater reduction in outpatient clinic attendance, hospital admissions, NCD clinics attendance and the lowest reduction was observed with ANC clinic attendance.

The four waves in COVID-19 infections cases identified in Ghana was similarly reported globally [22] and in Africa [23, 24]. However some countries like Kenya experienced seven COVID-19 infection waves within our study period and nine waves as at 2025 [25]. The four COVID-19 infection waves were replicated in the Ashanti region and to a very less extent in the Northern region of Ghana. The first wave was identified as the worst after COVID-19 infection was declared a pandemic by the WHO [26, 27] and this was also replicated globally [2] and in Africa [28]. The first wave of the COVID-19 infection led to the declaration of lockdown by the government when Ghana recorded her first case of COVID-19 and death

on the 12th March 2020 and 22nd March 2020 respectively [14]. The President of Ghana, Nana Akufo-Addo authorized closure of the borders and announced lockdown measures which included avoidance of social gathering, closure of schools and religious gatherings but the number of COVID-19 cases continued to increase to a peak in July 2020 [14]. These measures may have led to the decrease in out-patients clinic attendance and general admission utilization to an ebb of 1,905,242 and 132,851 respectively by 20th April 2020 as shown by our study. The percentage reduction in HSU in the second quarter varied depending on the HSU measure.

Health Service Utilization variations in Ghana

There was a greater reduction in out-patient service utilization (17.3%) than in inpatient admissions (10.0%). This was similar to another study in Canada reporting reduction of 14% in hospital admissions[29] and in Germany reporting a reduction in hospital admission by 10%[30]. These reductions in HSU were lower as compared to a single study where there was 50% reduction in OPD clinic services in a university hospital in Ghana [17]. There is evidence to show that HSU decreased globally [8] and in Africa [1, 31] which was also confirmed in a recent scoping review in SSA including 262 articles with a median reduction in HSU of 36% in Africa as a result of the pandemic [9]. The observed reduction in our study was because measures to curb the spread of COVID-19 in health facilities were targeted at reducing OPD attendance load as these patients were deemed to be generally stable [14] but very sick patients warranting admission could not be deferred especially when they were reporting with complications. This led to increased emergency department visits as also shown in a study in Thailand with an increase in intensive care unit and emergency department admission of 28.3% and 33.5% respectively[32] as a result of the lockdown. There was also a nationwide fear of COVID-19 infection spread leading to patients staying away from health facilities in sub-Saharan Africa [12] and in Ghana [13].

The NCD service utilization was found to be reduced by 9.8% in Ghana during the COVID-19 pandemic. Reduction in NCD health service utilization has also been shown in a systematic review in SSA including 18 studies. In the study, the disruption in NCD care was influenced by health system overloads, patient fear of contracting COVID-19 and public health measures to limit access to routine care[33]. The reduction in HSU among patients with NCDs in our study may have contributed to a reduction in HSU health insurance claims by 20% and increase in NCD complications by 18.6% as reported in a study in Ghana [34]. These disruptions in NCD service utilization is not isolated to Ghana but has been reported in 59% of countries in SSA [35]. Another study in Ghana by Sarfo et al, reported an increase in NCD related complications such as stroke in a tertiary institution with increase in case fatality rate of 29.3% in 2020 as compared to 24.2% in 2019 [18], though seasonal variations were not accounted for in their study.

According to our study, ANC had the lowest percentage reduction in HSU of 2.5% which showed the pandemic did not affect utilization of health services by pregnant women so much in Ghana. This was less than reported in a mixed methods study in Mozambique showing a reduction in first ANC visits by 26% [36] but our study findings was similar to another study done in six hospitals in four SSA countries

that found no statistical significant reduction in ANC visits though it showed reduction in hospital admissions, vaccination and out-patients HSU [31].

There was a subsequent increase in all the modalities studied in the third quarter of 2020 during the COVID-19 pandemic by 4.4% to 12.1% but there was still reduction in ANC clinic utilization by 1.1% in the third quarter. The percentage increase in the HSU was due to easing of the COVID-19 restrictions in the third quarter which was driven by socio-economic impact of the lock-down measures [14]. The effect of the lockdown was also reported in other countries such as South Africa [37] and among nine countries in SSA [38]. Patients may have reported to seek their much needed healthcare which they may have been denied as a result of the lockdown measures during the period for fear of contracting the COVID-19 infection [12].

The rise in HSU was not seen for ANC clinic attendance in the third quarter as a result of the fact that ANC attendance did not remarkably reduce in the first place during the second quarter of 2020 and also possible spill-over effect of the lock down measures or continuous fear of the pandemic even after the easing of restrictions [14]. Ghana adopted the Focused Antenatal Care introduced by the WHO in 2020 to replace the traditional ANC with a minimum of four visits recommended [39] with evidence of high ANC adherence rate of 84.8% reported in Ghana [40]. This program may have accounted for the marginal decrease in HSU in ante-natal services even at the peak of the COVID-19 pandemic in Ghana as reported in our study.

Some studies have suggested that there are general seasonal variations in HSU for various reasons including climatic, seasonal infections and socio-economic conditions [41, 42]. There was no seasonal reduction in the second quarter of the year in our study for admission and OPD service utilization. There was rather an increase in HSU in the second quarter of 2019 and 2021 while there was rather a proportional reduction in NCDs, ANC and childhood vaccination attendance during the COVID-19 pandemic as shown in our study. This emphasizes the real impact of the COVID-19 pandemic on HSU in Ghana as also shown in other studies[2, 9, 43].

Health service utilization in the Ashanti and Northern region

Though COVID-19 infection rates were higher in the Ashanti region than the Northern region, there was proportionally greater reduction in HSU in hospital admissions, OPD clinic attendance, NCD clinic attendance and childhood vaccination in the Northern region than the Ashanti region. This was however not the case for ANC which was identified to have increased in the Northern region by 5.5% during the second quarter of 2020 when it was still reduced in the Ashanti region by 2%. Though there was an increase in HSU with ANC services, there is evidence from a recent study in the Northern region reporting that only 31.2% of women have quality ANC services [44]. An earlier study also in the Ashanti region also reported decreasing trends in ANC as a result of poor education, remote residence from facility, poor roads, believe in the spiritual bases of disease and hence reduced HSU [45]. There may be local

initiatives by staff of ANC clinics to encourage the patients to utilize health service irrespective of the COVID-19 pandemic in the Northern region.

Generally, the inhabitants of the Northern region were very averse to health utilization during the COVID-19 pandemic and were not ready to visit the facility though they had need for it. The reduction was as a result of lower educational status as 85% of respondents in a previous study held a view that COVID-19 infection was a punishment from God [16]. The Daily Statesman, a local newspaper in Ghana, reported fear in Savelugu with residents relocating to other areas when there was a report that 60 health workers tested positive for COVID-19 which led to a partial shutdown of the hospital for two weeks with opening only of the emergency department and labour wards for deliveries [13]. This state of fear and panic in the Northern region may have accounted for the significant reduction in HSU in the Northern region though it was not a known as a COVID-19 epicentre region in Ghana [11].

There was commensurate rise in HSU in the third quarter of 2020 which was proportionally higher in the Northern region than the Ashanti region in hospital admissions and out-patient attendance. This rise may be as a result of the short duration of the lockdown to have the desired significant impact as compared to the epicentre where lockdowns were more enforced and quite prolonged. This could also be as a result of the easing of restrictions after the lockdown measures and possible relative rebound increases in HSU during the third quarter of 2020[14]. The Northern region suffered a greater impact from the COVID-19 pandemic leading to more significant reduction in HSU and may have led to increased complications and increase in HSU after the lockdown. There were still continuous reductions in HSU in the third quarter of 2020 for ANC services proportionally higher in the Ashanti region than the Northern region. Interestingly, there was an increase in HSU for ANC in Ashanti region but there was continual decrease in the Northern region. This may be as a result of fear of patients contracting the COVID-19 infection and which may still have lingered especially in the Northern region [13]. Fear on contracting COVID-19 infection has also been expressed in another study in Ethiopia leading also to delays in initiating ANC services and hence reduction in HSU [12].

Our study however had some limitations. It employed the use of DHIMS-2 aggregate data which may have been poorly documented especially during the COVID-19 pandemic. The aggregate data made it difficult to conduct statistical analysis to establish the statistical significance of the results when comparing HSU modalities or comparing the Ashanti to the Northern regions. The study was also restricted to health facilities on the DHIMS-2 and may have missed valuable information from patients in private facilities not using DHIMS-2.

The implications of our study to policy makers include the need to put measures in place to reduce the impact of a future pandemic on HSU in Ghana even in regions with less COVID-19 infection. We recommend strengthening of primary health care for proper pandemic response with better training and deployment of health care workers to reduce the infection rate in future pandemics. Provision of personal protective equipment (PPEs), adequate staff training on infection prevention and evidence-based scheduling of appointment to reduce spread of infection. Healthcare managers should provide PPEs,

adequate staff training on infection prevention and evidence-based scheduling of appointments to reduce spread of infection. They should also ensure HSU for NCDs are not affected in pandemic situations as they were at an increased risk of infection and mortality with COVID-19 infection. There is the need for intensification of public education by health institutions to allay fears and encourage HSU when needed as fear was a major reason for the decreased HSU in Ghana. Further studies are recommended to understand from patients' perspective the real reasons behind the reduction in HSU especially in the Northern regions. Conducting an interrupted time series analysis to determine the statistical difference in the changes seen in the Northern region and Ashanti region and compare the pre-pandemic period to the pandemic period is strongly recommended.

Conclusion

Ghana experienced reduction in HSU in the second quarter of 2020 especially for outpatient attendance and hospital admissions. There was a greater reduction in HSU in the Northern region than the Ashanti Region though there were more cases of COVID-19 reported in the Ashanti region than in the Northern region. This implies the need for policymakers to focus also on non-epicentres in pandemic situations to prevent reduction in HSU that may have increased mortality especially among patients with NCDs in Ghana.

Declarations

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Authors contributions

EKT initiated the study and put together the initial draft with ideas and inputs from SN, WQ, RB, JA. Data analysis was done by EKT. WQ and SN contributed to the write-up of the discussion in the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The District Health Information Management System (DHIMS-2) data that support the findings of this study are available with the Ghana Health Service, but restrictions apply to the availability of these data, which were used with permission and so are not publicly available. The data are, however, available upon request and with the permission of Ghana Health Service.

Ethical approval and consent to participate

Ethical clearance was granted from the Ghana Health Service Ethics Review Committee with approval number GHS-ERC/010/01/24, the Committee on Human Research and Publication Ethics (CHRPE) of KNUST with approval number CHRPE/AP/1045/23 and the institutional review board of the Komfo Anokye Teaching hospital with approval number KATH/IRB/AP/009/24 before the conduct of the study. The need for consent to participate was waived by the Institutional Review Boards. We confirm that all methods were carried out in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Figures

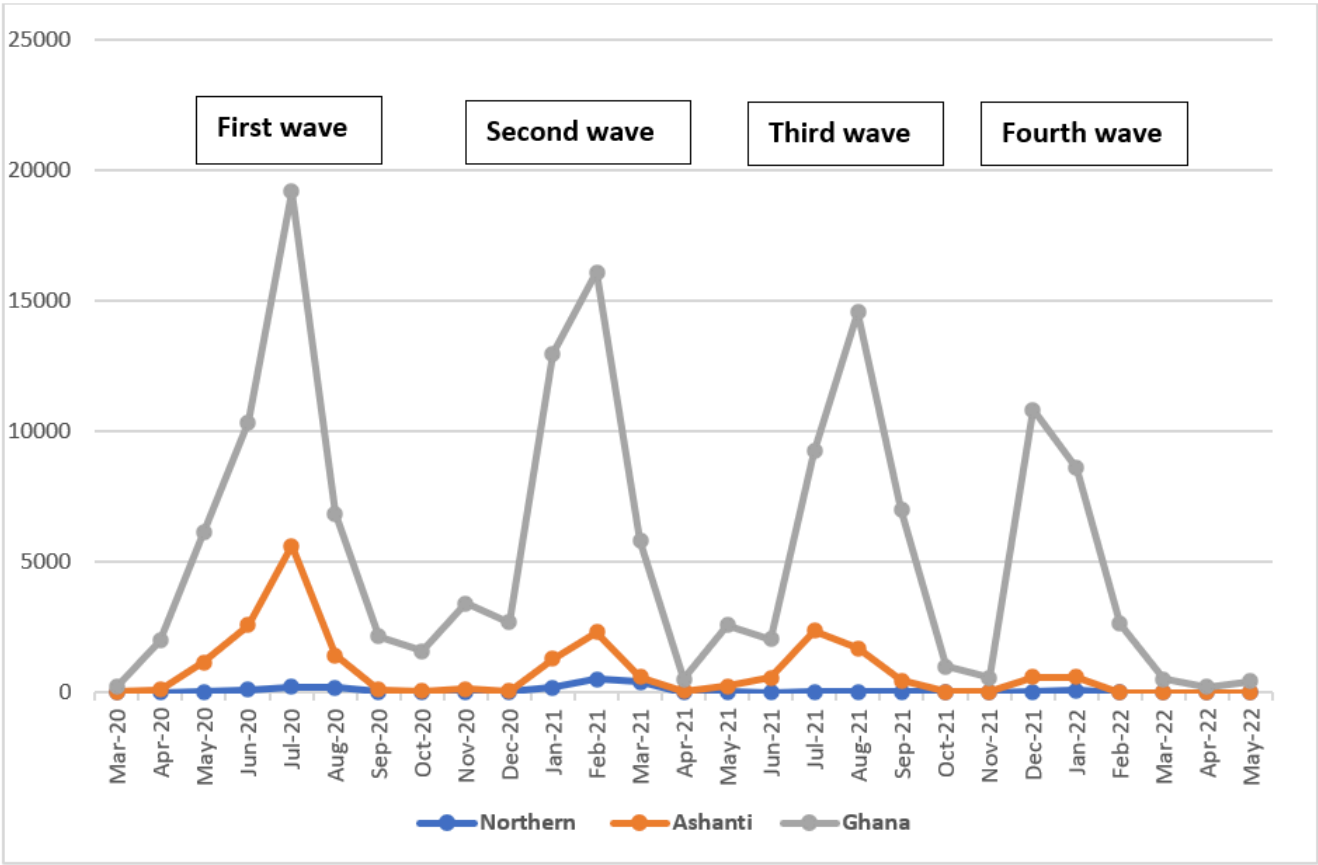


Figure 1

Trends of COVID-19 infection monthly incidence from March 2020 to May 2022 in Ghana, the Northern and Ashanti regions

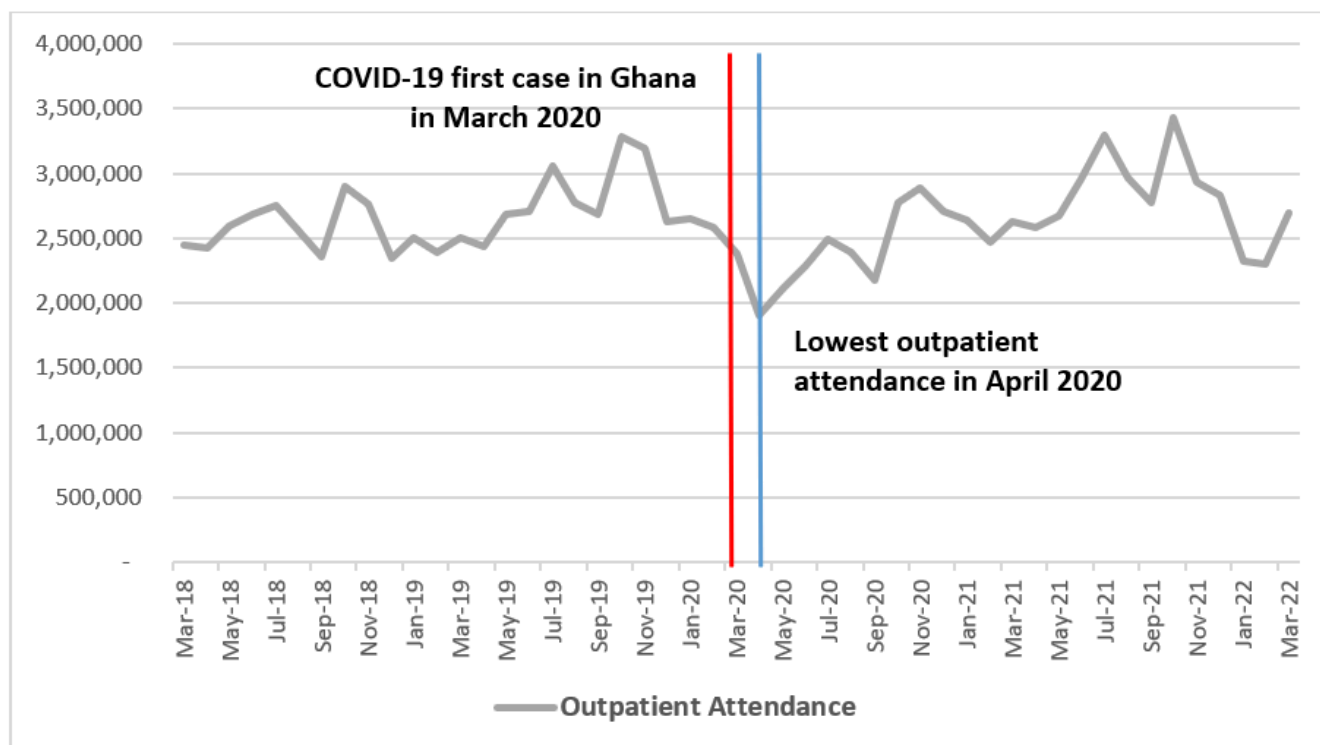


Figure 2

Monthly counts of Outpatient department attendance in Ghana from 2018 – 2022

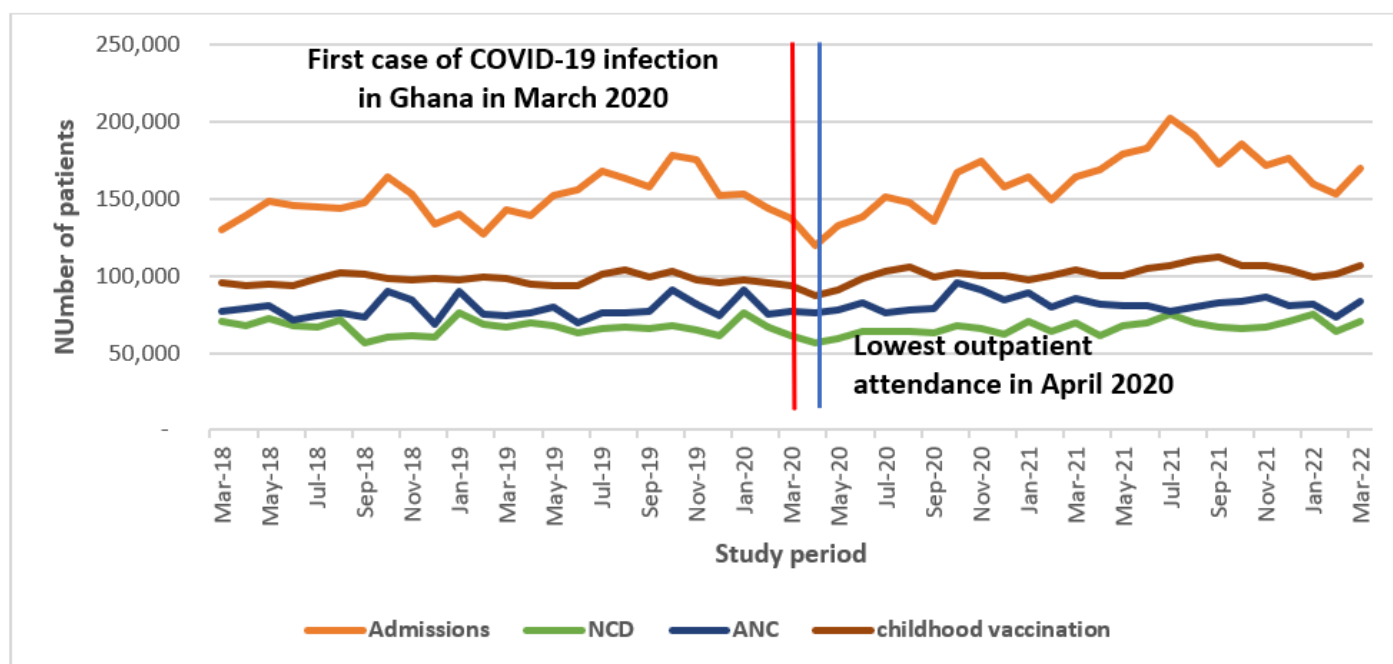


Figure 3

Trends in hospital admissions, non-communicable disease (NCD) and ante-natal clinic (ANC) service, childhood vaccination also showing the time Ghana reported the first COVID-19 case during the study period in Ghana.

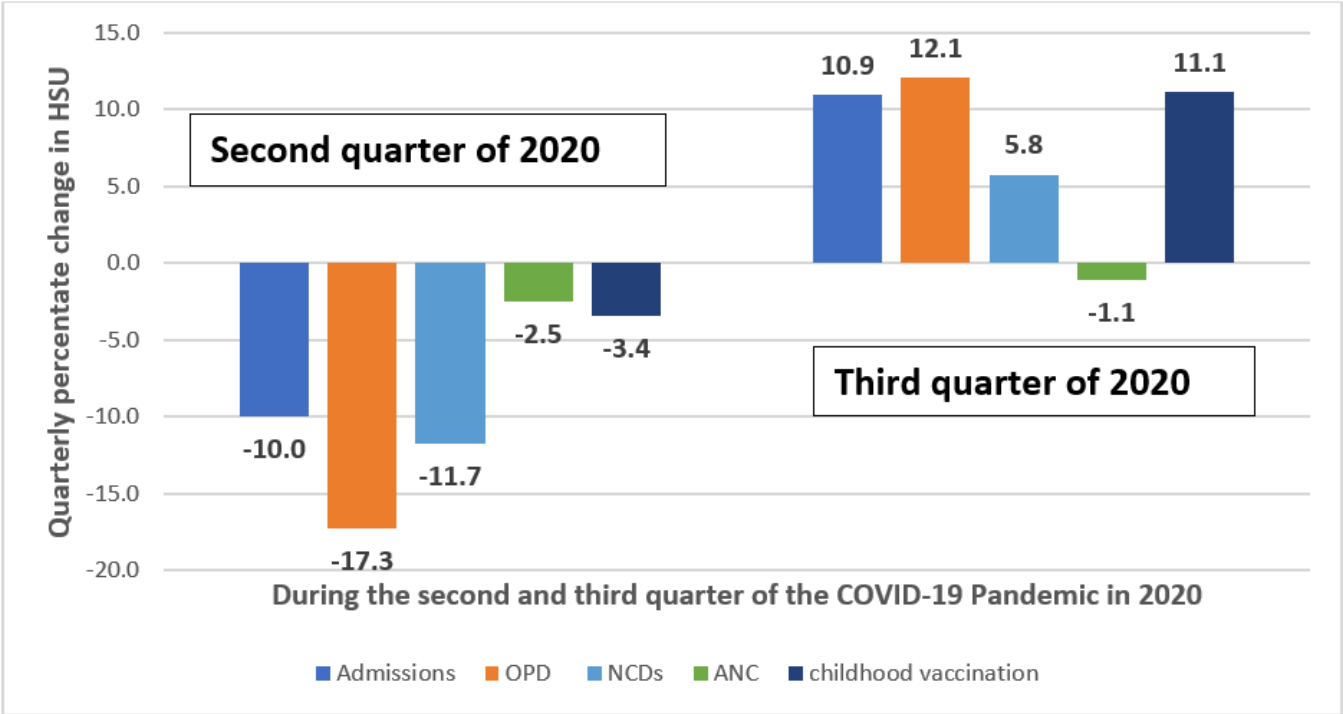


Figure 4

Percentage changes in health service utilization (HSU) during the second and third quarter of the COVID-19 pandemic lockdown in Ghana. NCD, non-communicable disease; ANC, antenatal clinics

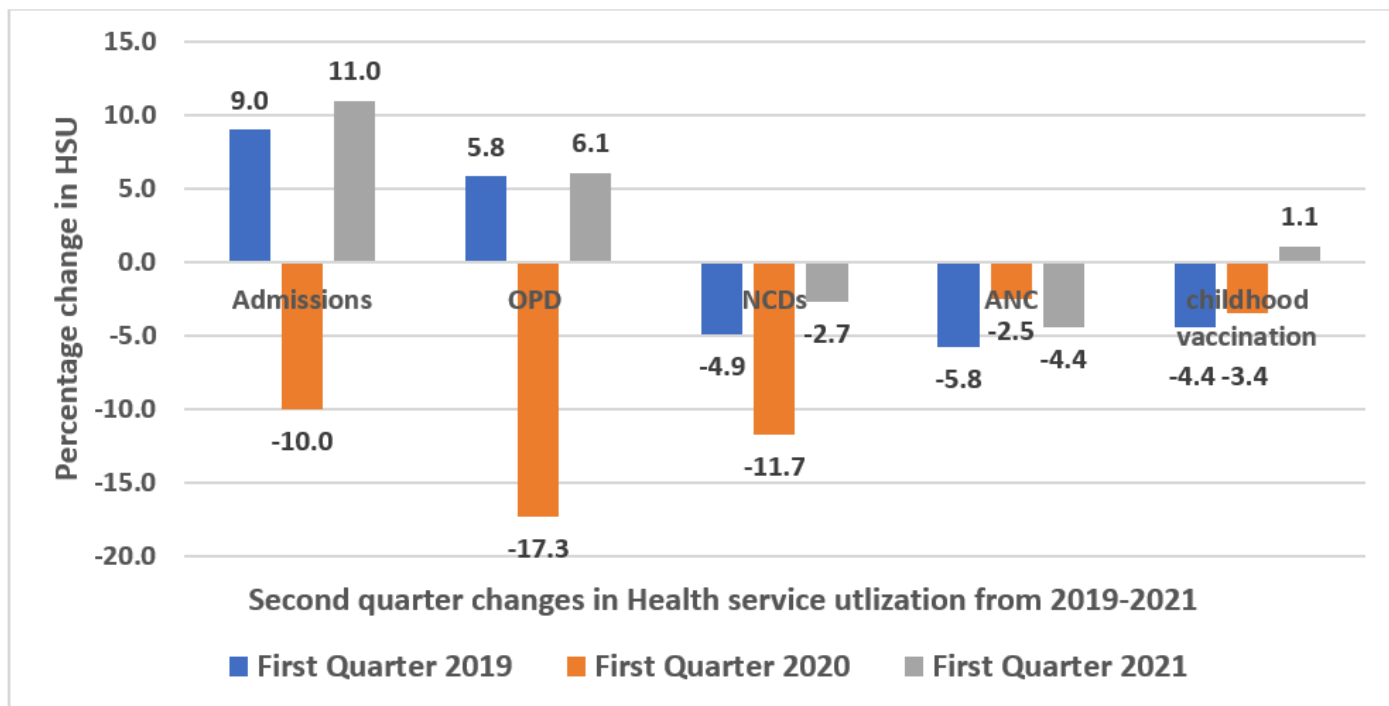


Figure 5

Seasonal changes in health service utilization in Ghana from 2019 – 2021 OPD, out-patients department; NCDs, non-communicable diseases; ANC, antenatal care clinic

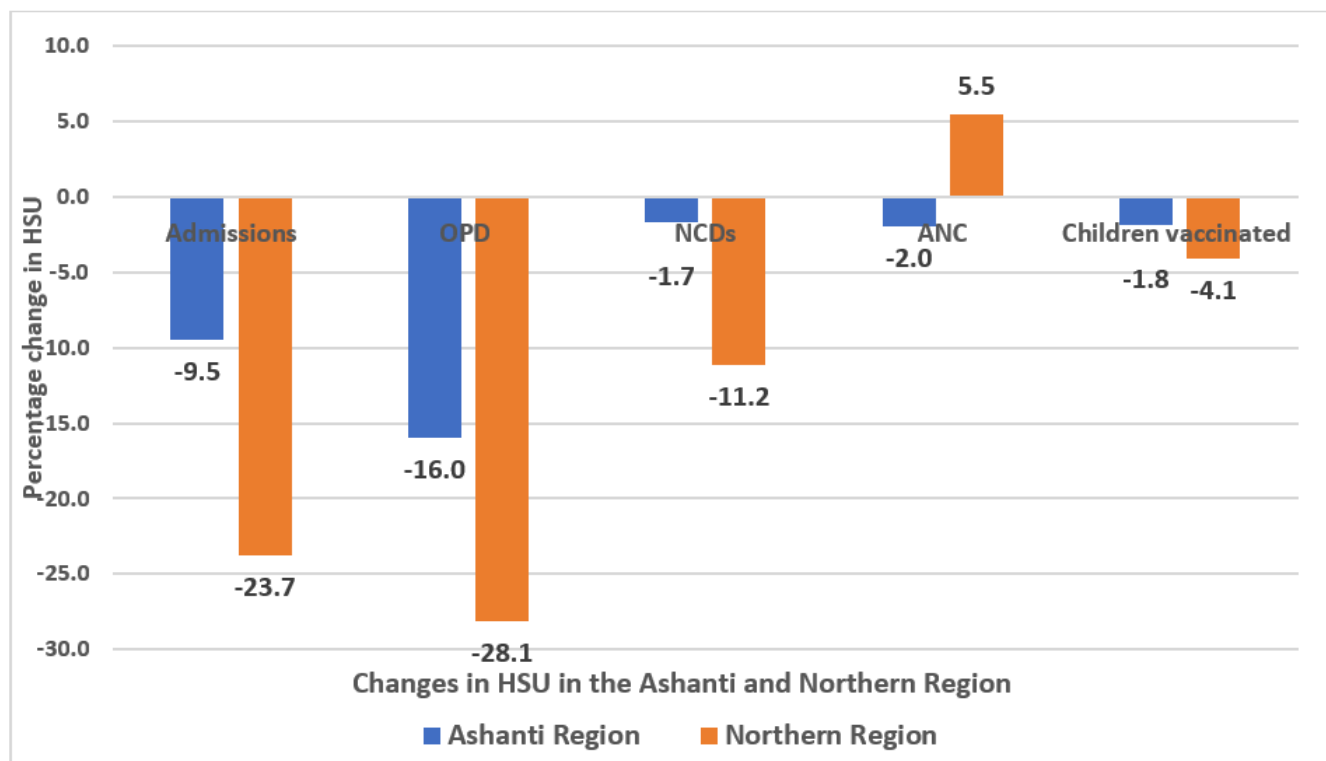


Figure 6

Comparison of quarterly changes in HSU in Ashanti and Northern regions in the first quarter of 2020
OPD, Out-patients Department; NCD, non-communicable disease; ANC, antenatal care clinics

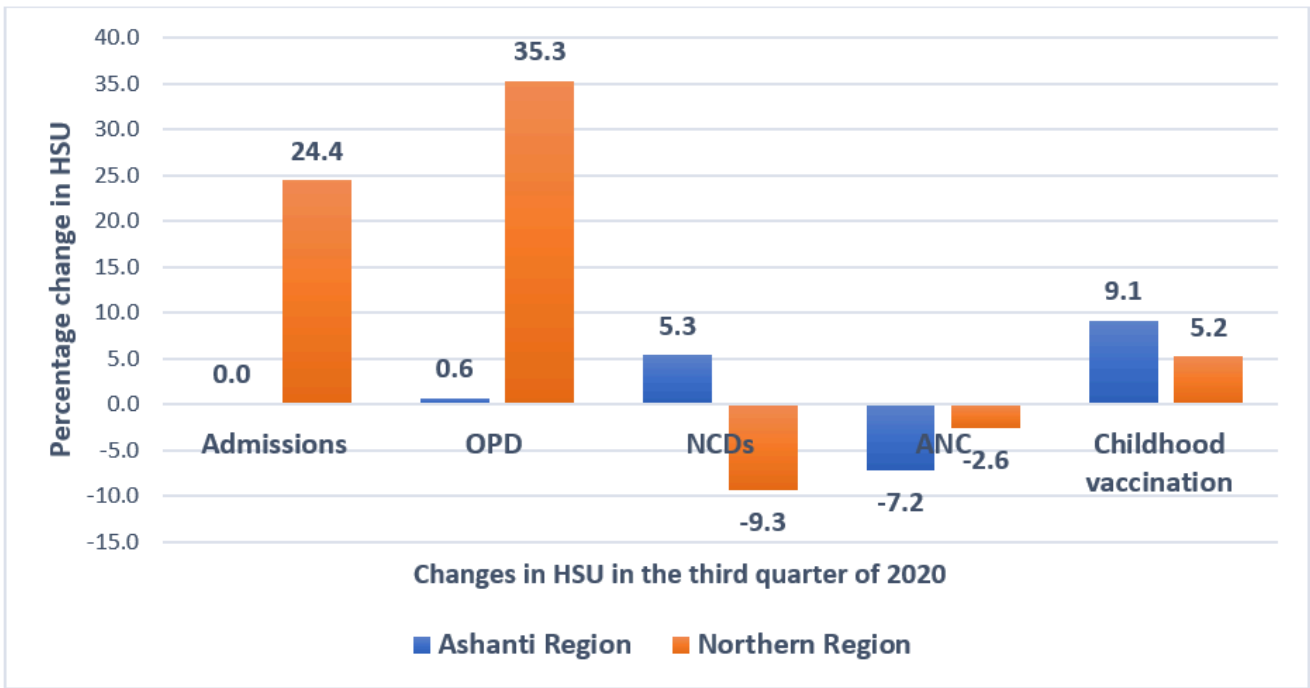


Figure 7

Comparison of changes in health service utilization (HSU) in the Ashanti and Northern in the third quarter of 2020 during the COVID-19 pandemic. OPD, Out-patients Department; NCD, non-communicable disease; ANC, antenatal care clinics