BMC Digital Health

RESEARCH

Open Access

Impact of digital health technology on health insurance claims rejection rate in Ghana: a quasi-experimental study

Godwin Adzakpah[1] and Duah Dwomoh[2*]

Abstract

Introduction An efficient medical claims billing system is critical to mitigating the challenges associated with claim denials and ensuring the sustainability of providing healthcare services. This study assessed the impact of Digital Health Technology (DHT) in reducing the claim rejection rate of health insurance claims submitted by health facilities to the National Health Insurance Authority in Ghana.

Methods The study used longitudinal data on monthly claims adjustments due to errors from both paper-based and claims submitted using different DHT systems from 2010 to 2019. The claim rejection rate was estimated for each month. Prais-Winsten Segmented Interrupted Time-Series analysis was used to estimate the impact of DHT systems by comparing claims data before and after the system implementation for each facility. We employed meta-analysis techniques to generate a pooled impact estimate of DHT systems on the claim rejection rate of health insurance claims.

Results The total cost of deductions due to errors from the DHT system was significantly lower than the paper-based system (DHT = 8.15%, paper-based system = 10.13%). DHT contributed to an immediate impact of 1.31 percentage point reduction in the claim rejection rate of health insurance claims compared to the paper-based system.

Conclusion The DHT recorded lower denied claims costs than the paper-based claims system. Scaling up the use of DHT for claims submission will reduce the rate of claim denials and ensure the sustainability of providing healthcare services.

Keywords Segmented Interrupted Time Series, Meta-Analysis, National Health Insurance Scheme, Digital Health Technology, Paper-based system, Electronic Claims

Introduction

The implementation of health insurance schemes is at different stages across the globe, especially in developing countries with the primary goal of giving citizens high access to healthcare[1]. World Health Organisation (WHO) describes medical billing errors and healthcare fraud as 'the last great unreduced healthcare cost'. In 2014, WHO estimated that cost of fraud and incorrect payments in the world's healthcare systems is about 7%

*Correspondence:
Duah Dwomoh
duahdwomoh@ug.edu.gh
[1] Department of Health Information Management, College of Health and Allied Sciences, School of Allied Health Sciences, University of Cape Coast, Cape Coast, Ghana
[2] Department of Biostatistics, School of Public Health, College of Health Sciences, University of Ghana, Legon, Ghana

of total global health expenditure, or US$487 billion [2]. Health insurance companies reject 14% of healthcare providers' claims, amounting to US$262 billion annually. In addition, the denial of claims puts a cost burden such as cost recovery (i.e. identifying reasons for the denial and errors, correcting the errors, and resubmitting them for reimbursement) on healthcare providers [3]. In 2017 alone, the recovery cost is estimated as high as $120 per health insurance claim in the United States and is considered to be a waste within the US healthcare system [3].

Health insurance claim denials, also known as 'claim denial hereafter' are one of the pivotal contributors to the ever-increasing billing and insurance-related costs (BIR) [4]. Nsiah-Boateng et al.[1] estimated that adjusted paper-based claims due to errors in claims cost GHS2.81 million representing 4.9% of total reviewed claims of GHS57.50 million (USD15.09 million) to the healthcare provider. The ability to prevent claim denial before the health insurance claim is submitted to the insurers will increase profits, enhance the revenue cycle positively, and supports the general wellbeing of patients. Claim denial has the potential to prevent any healthcare provider from being on track. This widespread canker is not just time-consuming rework but also a delayed or lost revenue and put pressure on scarce resources [5]. The bureaucratic nature of claims reimbursement processes to providers results in an uncompensated claim due to claim errors and other administrative reasons [6].

The introduction of the eHealth strategy policy by the Ghanaian government in July 2010 has encouraged the use and adoption of DHT. The goal of the policy document was to improve healthcare delivery by streamlining and integrating ICT into the health sector. To achieve the goal of paperless records and reporting system, this procedure aims to improve healthcare operations, management, and decision-making based on evidence [7]. The government's ongoing efforts in the ICT sector have encouraged healthcare providers to use DHT. Health Administration Management System (HAMS), Laboratory Management Information Systems (LMIS), iHost (GHS), eClaims – NHIA, eRegister, Health Information Management System (HIMS), Ghana Health Service (GHS) iHost, Hospital Administration Management System, National Health Insurance Authority (NHIA) – eClaims, and eRegister are notable DHT utilized in Ghana [8, 9].

In order to provide people in Ghana with access to healthcare, the National Health Insurance Scheme was fully implemented in 2005 [10, 11]. The rollout of a number of programs, including the introduction of electronic claims processing, followed the implementation. The country's implementation of DHT increased as a result. DHTs have been implemented by health facilities under the National Catholic Health Service since 2013 to assist in automating the hospital's clinical and financial processes, and many are in various stages of implementation.

Several studies have underlined the benefits derived from Digital Health Technology in the area of improved quality of care, decreased mortality among patients, and a reduction in the cost of care [12–14]. However, the effect of DHT on care not being compensated by insurers due to errors in claim submission remains a gap in the medical literature. To examine the important role of DHT such as an electronic claim system in solving the challenge of uncompensated claims, we focus on denied claims as one of the major elements of uncompensated claims in the Ghanaian healthcare system. In this study, we refer to DHT as claims submitted from health facilities using different electronic claims systems. This study quantifies [1] the immediate impact of DHT implementation on the Health Insurance Claims Rejection Rate and [2] the sustained impact of DHT implementation on the Health Insurance Claims Rejection Rate using data from the National Catholic Health Service (NCHS) in Ghana.

Methods

This study followed the standard guidelines for reporting quasi-experimental studies using the Transparent Reporting of Evaluations with a Nonrandomized Design/Quasi-Experimental Study Design (TREND).

We confirm that all methods were carried out in accordance with relevant guidelines and regulations and in accordance with the declaration of Helsinki.

Study setting

The National Catholic Health Service (NCHS) is a private not-for-profit healthcare provider, owned by the Catholic Church in Ghana [15]. The institutional health facilities (i.e. hospitals and clinics) of the NCHS began in 1950 at a time when there was an urgent need to provide such facilities for rural dwellers who had virtually no access to modern orthodox health care [15]. Expatriate missionary professional staff supported by local auxiliary workers introduced and manned these institutions at the time [15]. Thus, all the hospitals of the NCHS started as little clinics and primary health care facilities. The NCHS has a total of 144 health facilities across the length and breadth of Ghana [16]. Out of the 144 health facilities, 47 are hospitals, 82 are clinics, 10 are health training institutions and 5 are specialized institutions [16]. All the health facilities are accredited National Health Insurance Scheme facilities providing the Ghanaian people healthcare. These health facilities account for an annual outpatient attendance of 3.2 million, 349,000 admissions, and 76,000 deliveries [16].

Study design

This is a quasi-experimental study that retrospectively assessed health insurance data before and after the introduction of the DHT claims system by the National Catholic Health Service (NCHS). NCHS is a private not-for-profit healthcare provider, owned by the Catholic Church in Ghana. This study focused on 25 NHIS-accredited health facilities that have provided healthcare services to NHIS clients since 2010 and have transitioned from paper-based claims processing to the use of DHT to process claims along the line to bring efficiency in claims transactions and clinical outcomes through the use of various electronic medical records (Fig. 1).

Overview of health facility claims processing and submission systems

Processing of clients' health insurance claims for both paper and electronic-based systems is the same in terms of workflow for all the 25 health facilities sampled. When a client enters the facility at the first point of call (Health Information Unit at the OPD), his or her NHIS card is verified. Once the card is invalid, he/she is processed for out-of-pocket payment. A valid NHIS

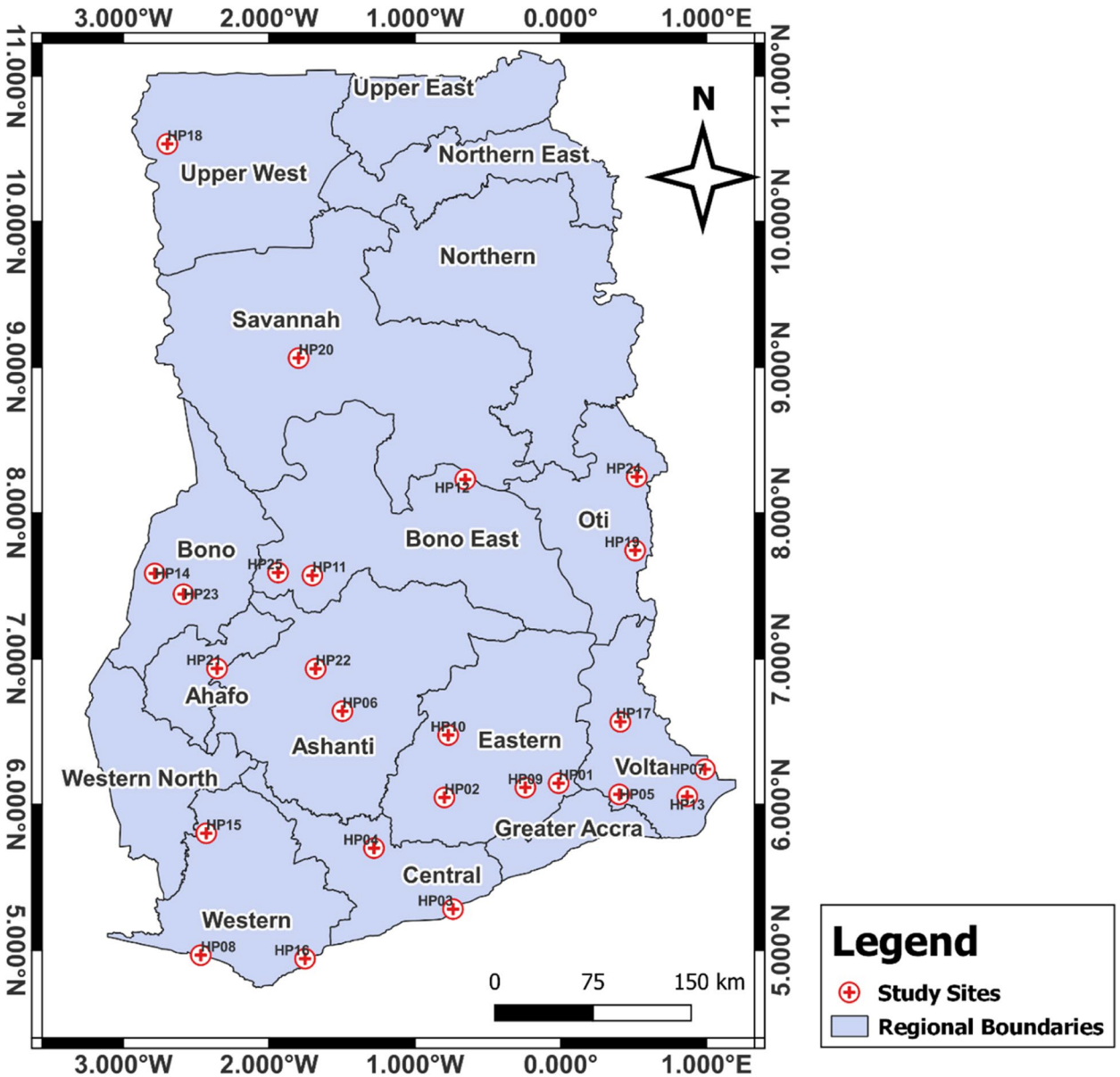

Fig. 1 Selected health facilities across the 16 administrative regions of Ghana. Source: Authors' analysis

card bearer is assigned to the NHIS and provision of service based on the NHIS benefit package is rendered. Billing of treatment is done manually or electronically and submitted to the NHIS for reimbursement. Details of the NHIS Claims processing in healthcare facilities can be found in Fig. 2.

Primary outcome

The primary outcome of interest is the health insurance claims rejection rate. This is defined as the ratio of the amount deducted due to errors in claims to the total amount of claims cost submitted, multiplied by 100%.

Intervention

For this study, DHT refers to any health insurance claims captured on a storage drive (i.e. CD, pen-drive, etc.), real-time online or web-based, or through any hospital-based health information management systems. The aim of moving from paper-based claims to electronic-based claims was to reduce human engagement in the claims process and reduce errors that come with claims processing at the healthcare provider level and its review at the National Health Insurance Scheme (NHIS) level. The NHIS has established Claims Processing Centre (CPC) to process electronic claims from health providers throughout the country. All the 25 selected health facilities submit electronic claims through; [1] an XML file that converts health insurance claims from the hospital's electronic medical records systems and [2] a web-based electronic system that submits claims data. This claims information is submitted to NHIS' CPC located in Accra, Kumasi, Cape Coast and Tamale of Ghana, where the authorities vet the submitted electronic claims [17]. The paper-based claims, on the other hand, are done through completing manual claims forms by the healthcare providers for each valid subscriber, compiling all the completed forms for a respective period, and submit to the NHIS at the district level for reimbursement.

Data collection

We developed an excel data collection template to obtain monthly data from January 2010 to December 2019. Data on the following indicators were obtained: the month of health insurance claims, the date upon which claims were submitted, the total amount of claims cost, amount of claims cost reimbursed, reasons for deductions, and clinical data (i.e. OPD attendance, OPD attendance insured, admissions, admission insured, maternal health data, laboratory data, etc.). Dates for the introduction of electronic systems to enhance health insurance claims and clinical processes were also obtained. Name and types of software were also collected. Below is the summary of different periods when DHT was implemented at the facilities (Table 1).

Statistical analysis

Descriptive statistics (such as frequencies, means, and standard deviations) were used to describe the data. The Shapiro–Wilk and Bartlett test statistics were used to assess the normality and the equal variance assumptions of all continuous variables respectively. Two independent samples t-test was also performed to test for differences in the rate of error margins of the claims between the pre-electronic claims and post-electronic claims.

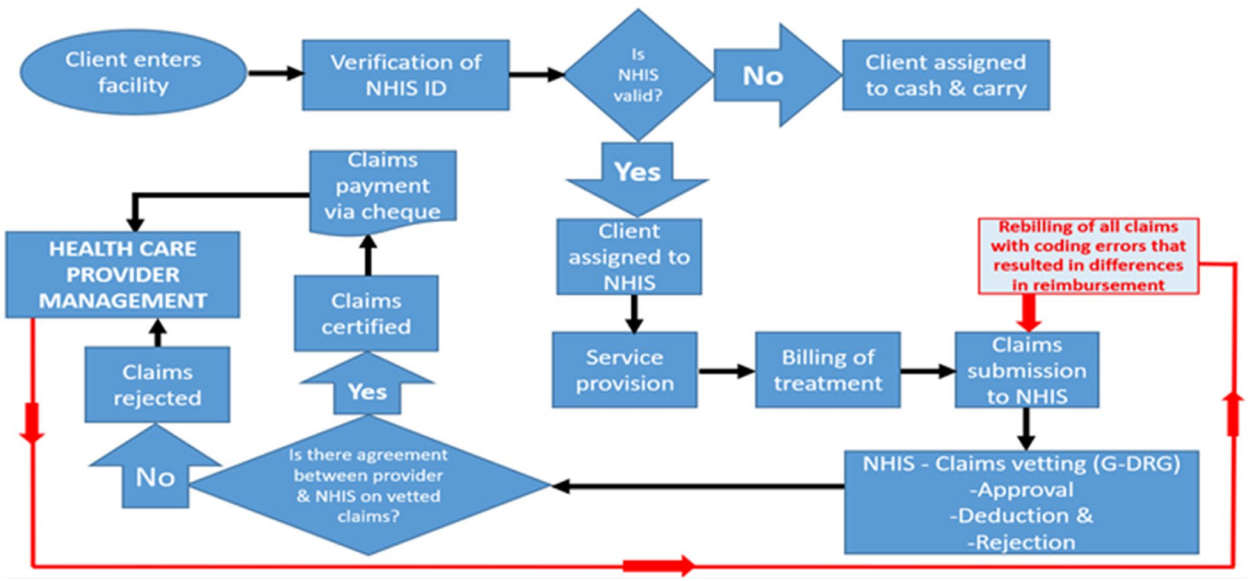

Fig. 2 Flowchart on NHIS Claims processing in healthcare facilities. Source: Authors' Analysis

Table 1 DHT implementation period for each health facility

Hospital Code	Region	Date of DHT implementation
HP01	Eastern	April 2014
HP02	Eastern	January 2014
HP03	Central	January 2019
HP04	Central	January 2012
HP05	Volta	October, 2013
HP06	Ashanti	March 2018
HP07	Volta	March 2018
HP08	Western	January 2014
HP09	Eastern	April 2012
HP10	Eastern	January 2014
HP11	Bono East	January 2014
HP12	Bono East	June 2013
HP13	Volta	January 2014
HP14	Bono	January 2014
HP15	Western	June 2019
HP16	Western	May 2019
HP17	Volta	January 2019
HP18	Upper West	January 2018
HP19	Oti	January 2014
HP20	Savannah	January 2014
HP21	Ahafo	June 2019
HP22	Ashanti	January 2014
HP23	Bono	January 2012
HP24	Oti	January 2013
HP25	Bono East	January 2015

Segmented Interrupted time-series (ITS) analysis

In time series, changes in the dependent variable of the intervention are divided into 2 general categories: changes in level and changes in slope. A change in the level indicates a quick or short-term change (in the first month after the intervention) and the change in slope (monthly trend) represents a long-term change in the dependent variable [18, 19]. The Fig. 3 shows the conceptual framework concerning the effect of DHT on the health insurance claim rejection rate.

The regression model (Eq. 1) used to estimate the effect of DHT on health insurance claim rejection rate is as follows (Eq. 1):

$$Y_t = \beta_0 + \beta_1\, Time + \beta_2\, Interventiont + \beta_3\, Time \times intervention + \varepsilon_t \quad (1)$$

where;

- Y_t is claim rejection rate in month t;
- Time represents time in months at time t from the start of the observation period;
- Intervention is a dummy (indicator) variable representing the intervention (pre-DHT period is 0, otherwise is 1), which was implemented at various months in the series;
- Time after intervention is counting the number of months after the implementation of DHT at time t;
- β_0 represents the intercept or starting level of the claim rejection rate;
- β_1 is the slope of claim rejection rate until the implementation of DHT.
- β_2 represents the changes in the level (in the first month after the intervention) of claim rejection rate in the period immediately following the implementation of DHT (compared to the counterfactual) [i.e. immediate impact of DHT implementation on error margins of health insurance claims];
- β_3 represents the difference between pre and post-DHT slopes of claim rejection rate [i.e. sustained impact of DHT implementation on error margins of health insurance claims]; and

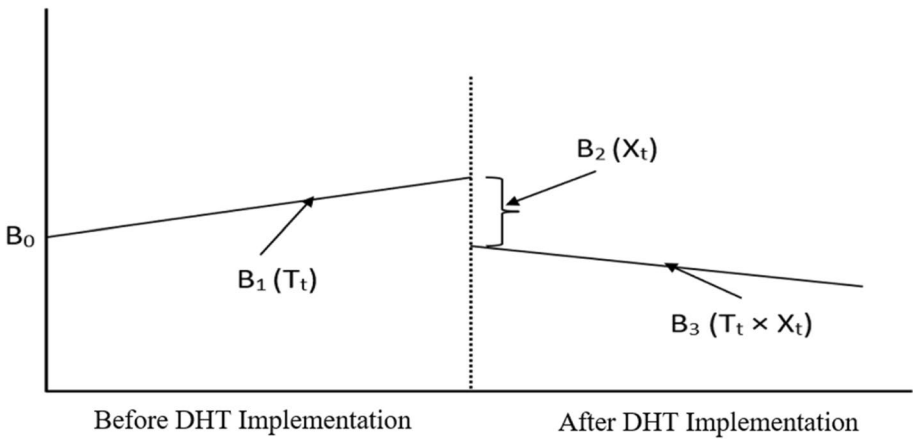

Fig. 3 Conceptual framework: The impact of DHT on health insurance claim rejection rate. Source: (Adapted from [19])

- ε represents error at time t

Segmented Interrupted time-series (ITS) analysis was used. A time series is a continuous sequence of observations on a population, taken repeatedly (normally at equal intervals) over time [18]. In an ITS study, a time series of a particular outcome of interest is used to establish an underlying trend, which is 'interrupted' by an intervention at a known point in time [18]. A 120-month data (January 2010 to December 2019) for pre and post-DHT submitted by health facilities were analyzed. This type of analysis is commonly used to analyze the effects of interventions in a situation where a control group is difficult or impossible to find [20, 21]. In this model, the variation within the data was partitioned into three components to provide independent tests for the;

1) Slope prior to the introduction of DHT (using paper-based),
2) Change in level (in the first month after the intervention) in the period immediately following the Introduction of DHT (compared with counterfactual) [i.e. immediate impact of DHT implementation on error margins of health insurance claims]
3) Difference between pre-DHT and post-DHT slopes [i.e. sustained impact of DHT implementation on error margins of health insurance claims]

In the model estimation, each outcome variable's growth over time will be linear before and after the DHT implementation. Three predictors were included in the linear regression model: MONTH, Pre-DHT, and Post-DHT. MONTH was coded as sequential numbers so that 1 represents January 2010 and 120 represents December 2019. DHT was set at a dummy variable as 0 before the DHT go-live date (for each health facility) and 1 thereafter. Post-DHT was created to measure months of DHT using experiences after the go-live date. The score of Post-DHT will be 0 for all months before the Post-DHT period and incremented by 1 in each month afterward. MONTH was used to estimate the outcome variable's slope in scores in the Pre-DHT period (test 1). DHT was used to estimate the change in levels for the Post-DHT period (test 2). Post-DHT was used to estimate the difference in slope from the Pre-DHT to the Post-DHT period.

Autocorrelation

The second assumption of standard regression models is that observations are independent. This assumption is often violated in time series data because consecutive observations tend to be more similar to one another than those that are further apart, a phenomenon known as autocorrelation. Fortunately, in many epidemiological data, autocorrelation is largely explained by other variables, in particular, seasonality; therefore, after controlling for these factors, residual autocorrelation is rarely a problem. Nevertheless, autocorrelation should always be assessed by examining the plot of residuals and the partial autocorrelation function and, where data are normally distributed, conducting tests such as the Breusch-Godfrey test [22, 23]. Where residual autocorrelation remains, this should be adjusted for using methods such as Prais regression or autoregressive integrated moving average (ARIMA), described in more detail elsewhere [24, 25]. For time series data, the Durbin–Watson statistic is the most common measure used to evaluate the presence of autocorrelation in the data [26].

In this study, Prais-Winsten (PW), a generalized least squares method, which provides an extension of OLS where the assumption of independence across observations is relaxed was used to adjust for autocorrelation assuming first-order autocorrelation (lag-1) [25, 27]. This method was chosen because it has been shown (through numerical simulations) to have improved confidence interval coverage relative to the methods commonly used in practice [28].

Determining effect size using random effect meta-analysis

To reveal the effectiveness of DHT on claim rejection rate, meta-analysis was employed to calculated Cohen's effect size. Based on Borenstein, Hedges [29] recommendation, the effect size for each health facility was first determined. As the Q-statistic is used for multiple significance testing across several means, it was used to determine heterogeneity among the sampled study properties. Borenstein, Hedges [29] indicated that the Q-statistic and p-value could be used for testing the null hypothesis but should not be used to estimate the true variance. For example, the significantly low p-value ($p < 0.001$) does not indicate greater heterogeneity than the p-value of ($p < 0.049$); however, the statistically significant p-value ($p < 0.05$) indicates that heterogeneity exists [30]. In addition to the Q-statistic and p-value, the I-square statistic can also be used to show that the variation is not due to chance, but rather indicates the heterogeneity of the sample; such heterogeneity exists only with high I-square values; a low I-square statistic is represented by a value of 25%, 50% represents a medium I-square statistic, whereas a high I-square statistic is represented by 75% [31, 32]. Finally, 95% confidence intervals (CI) were calculated, based on procedures suggested by Lipsey and Wilson [30], to test the statistical trustworthiness of the individual and averaged effect sizes. All statistical analyses were

conducted with Stata MP version 15 (StataCorp, College Station, Texas, USA), and a p-value < 0.05 was considered statistically significant.

Ethical consideration

The study secured ethical approval with reference number NCS/DOH/B2/2021/01 from the National Catholic Health Service (NCHS) to use the medical claims data from their hospitals for this study. All personal information of patients such as name, house address, and NHIS member number were excluded from the medical claims data to ensure anonymity before conducting the analysis.

Results

Summary of health insurance data from health facilities

Table 2 shows before-and-after DHT Health Insurance Data from Health Facilities in the 11 Selected Regions in Ghana. The total cost of claims submitted using the DHT was GH¢383.4 million (61.6%) compared to GH¢239.7million (38.4%) from the paper-based system. The total cost of deductions due to errors from the DHT was GH¢22.9million (49.1%) compared to GH¢23.8million (50.9%) from the paper-based system out of a total of GH¢46.58 million. Error margins of claims from the paper-based systems was 9.9% compared to 6.0% from the DHT.

Table 3 shows the summary of health insurance data obtained from the health facilities. Twenty-Five health facilities submitted a total cost of GH¢622.8 million (US$47.87 million) to National Health Insurance Scheme for reimbursement from January 2010 to December 2019. The total amount deducted due to errors represents GH¢46.6 million (US$3.58 million) for the period under consideration representing 7.48%.

Table 3 Summary of Health Insurance Data from Health Facilities in the 11 Selected Regions in Ghana from Jan 2010 to Dec 2019

Regions	Total Amount Submitted [GH₵]	Total Amount Deducted [GH₵]	Claims Rejection Rate (%)
Ashanti	47,700,000.00	393,164.60	0.82
Bono East	108,000,000.00	6,219,782.00	5.76
Central	51,900,000.00	4,311,421.00	8.31
Eastern	121,000,000.00	6,594,600.00	5.45
Volta	78,300,000.00	15,000,000.00	19.16
Western	52,900,000.00	7,714,442.00	14.58
Bono	65,300,000.00	1,380,290.00	2.11
Savannah	18,000,000.00	2,214,136.00	12.30
Oti	28,800,000.00	1,621,418.00	5.63
Ahafo	27,900,000.00	473,293.00	1.70
Upper West	23,000,000.00	654,807.50	2.85
Total	622,800,000.00	46,577,354.10	7.48

Exchange rate used as at 2nd November 2022 was US$1 = GH¢13.01 from Bank of Ghana Historical Interbank FX Rates. (Online) Available at: https://www.bog.gov.gh/treasury-and-the-markets/historical-interbank-fx-rates/ Accessed 03–11-2022

Table 2 Before-and-After DHT Health Insurance Data from Health Facilities in the 11 Selected Regions in Ghana from Jan 2010 to Dec 2019

Regions	Number of Health Facilities	Number of claims submissions	Before DHT Implementation			After DHT Implementation		
			Amount Submitted [GH₵]	Amount Deducted [GH₵]	Claims Rejection Rate (%)	Amount Submitted [GH₵]	Amount Deducted [GH₵]	Claims Rejection Rate (%)
Ashanti	2	240	9,680,000.00	209,496.20	2.16	38,000,000.00	183,668.40	0.48
Bono East	3	360	37,800,000.00	1,979,473.00	5.24	70,300,000.00	4,240,309.00	6.03
Central	2	240	16,900,000.00	2,095,532.00	12.40	35,100,000.00	2,215,890.00	6.31
Eastern	4	480	30,100,000.00	1,606,317.00	5.34	91,000,000.00	4,988,283.00	5.48
Volta	4	480	38,200,000.00	8,189,402.00	21.44	40,100,000.00	6,849,335.00	17.08
Western	3	360	32,800,000.00	6,536,967.00	19.93	20,100,000.00	1,177,475.00	5.86
Bono	2	240	14,900,000.00	894,447.70	6.00	50,400,000.00	485,842.20	0.96
Savannah	1	120	6,000,000.00	671,503.60	11.19	12,000,000.00	1,542,633.00	12.86
Oti	2	240	9,480,000.00	666,547.40	7.03	19,300,000.00	954,870.30	4.95
Ahafo	1	120	26,000,000.00	392,336.70	1.51	1,840,000.00	80,956.31	4.40
Upper West	1	120	17,800,000.00	515,173.10	2.89	5,260,000.00	139,634.40	2.65
Total	25	3000	239,660,000.00	23,757,195.70	9.91	383,390,000.00	22,858,896.61	5.96
Mean (SD)			156,364.30 (109,514.00)	15,140.10 (30,099.81)	9.95 (12.24)	265,265.30 (128,211.40)	15,985.78 (26,672.36)	6.13 (8.28)

Number of claims submissions made for before-DHT implementation were 1,586 whilst 1,414 were made for after-DHT implementation

SD Standard deviation

The largest cost of claims submissions came from the Eastern region costing GH¢121.00 million (19.43%). A high claim rejection rate was observed in the Volta region (19.16%) whilst the lowest was recorded in the Ashanti region (0.84%).

Differences in the mean claim rejection rate between Pre-DHT and post-DHT implementation

The results from the two independent sample t-tests showed that the average claim rejection rate in the pre-DHT (paper-based systems) was significantly higher than the post-DHT system ($p < 0.0001$). The regional analyses also showed that average claim rejection rates were statistically significantly higher for the paper-based system compared to when facilities started using DHT for claim submission in Ashanti, Bono East, Central, Volta, Western, Bono, and Oti regions respectively (Table 4). Only the Ahafo region showed that the average claim rejection rate was higher for electronic systems compared to paper-based system. However, there were no statistically significant differences in the average claim rejection rate between paper-based and electronic systems for the Eastern, Savannah, and Upper West regions.

Assessing the immediate impact of DHT implementation on the claim rejection rate of health insurance claims

The pooled effect estimate of the impact of DHT on the claim rejection rate in all 25 health facilities has been presented in Fig. 4. In the first month after the introduction of DHT, the facilities saw a reduction of about 1.31% in the claim rejection rate of health insurance claims. The analysis involving the 25 health facilities observed that there was high ($I^2 \geq 75\%$) within study sites variability and between study sites heterogeneity (Fig. 4).

Assessing the sustained impact of DHT implementation on error margins of health insurance claims

Except for a few health facilities that realized the sustained reduction in the claim rejection rate of health insurance claims due to the implementation of DHT, most of the health facilities have not experienced a reduction in the claim rejection rate of claims submitted to the insurance authority even after the introduction of the DHT and in even in some cases, the mean claim rejection rate has increased (Fig. 5). The overall sustained effect of DHT was minimal (Fig. 4). The analysis involving the 25 health facilities observed that there was moderate ($I^2 \geq 50\%$) within study sites variability and between study sites heterogeneity (Fig. 5).

Factors that account for variance in claims submitted and actual claim payment received from the insurance authority

Several factors may account for the variance in claims submitted and actual claim payment received from the insurance authority. The analysis revealed that among the top 10 reasons were treatment to diagnosis mismatch, Multiple antenatal care visits, duplication of claims, inappropriate prescription, oversupply of medication, wrong application of tariffs, no diagnosis,

Table 4 Differences in the mean claims rejection rate between before-DHT and after-DHT implementation

Regions	Mean Claims Rejection Rate (%)				*P*-value
	Before DHT (paper-based system)		After DHT (electronic-based system)		
	Mean (se)	[95% CI]	Mean (se)	[95% CI]	
Ashanti	10.25 (1.24)	[7.79—12.70]	2.92 (0.54)	[1.84—4.00]	< 0.0001**
Bono East	6.07 (0.99)	[4.11—8.04]	3.87 (0.51)	[2.87—4.47]	0.0295*
Central	12.34 (0.66)	[11.02—13.65]	7.57 (0.50)	[6.59—8.56]	< 0.0001**
Eastern	6.15 (0.83)	[4.50—7.79]	5.54 (0.31)	[4.93—6.16]	0.4109
Volta	16.35 (0.90)	[14.57—18.12]	13.58 (0.92)	[11.76—15.40]	0.0370*
Western	14.46 (0.78)	[12.92—16.00]	5.87 (0.72)	[4.43—7.31]	< 0.0001**
Bono	6.47 (0.43)	[5.61—7.33]	0.92 (0.08)	[0.75—1.08]	< 0.0001**
Savannah	11.84 (2.21)	[7.39—16.30]	12.34 (1.01)	[10.32—14.36]	0.8198
Oti	7.44 (0.49)	[6.47—8.42]	5.09 (0.40)	[4.30—5.87]	0.0003*
Ahafo	1.63 (0.28)	[1.07—2.18]	4.43 (0.74)	[2.62—6.24]	0.0155*
Upper West	2.81 (0.38)	[2.06—3.56]	2.57 (0.58)	[1.37—3.76]	0.7663
Overall	10.13 (0.32)	[9.50—10.75]	8.15 (0.20)	[7.77—8.54]	< 0.0001**

P-value notation: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

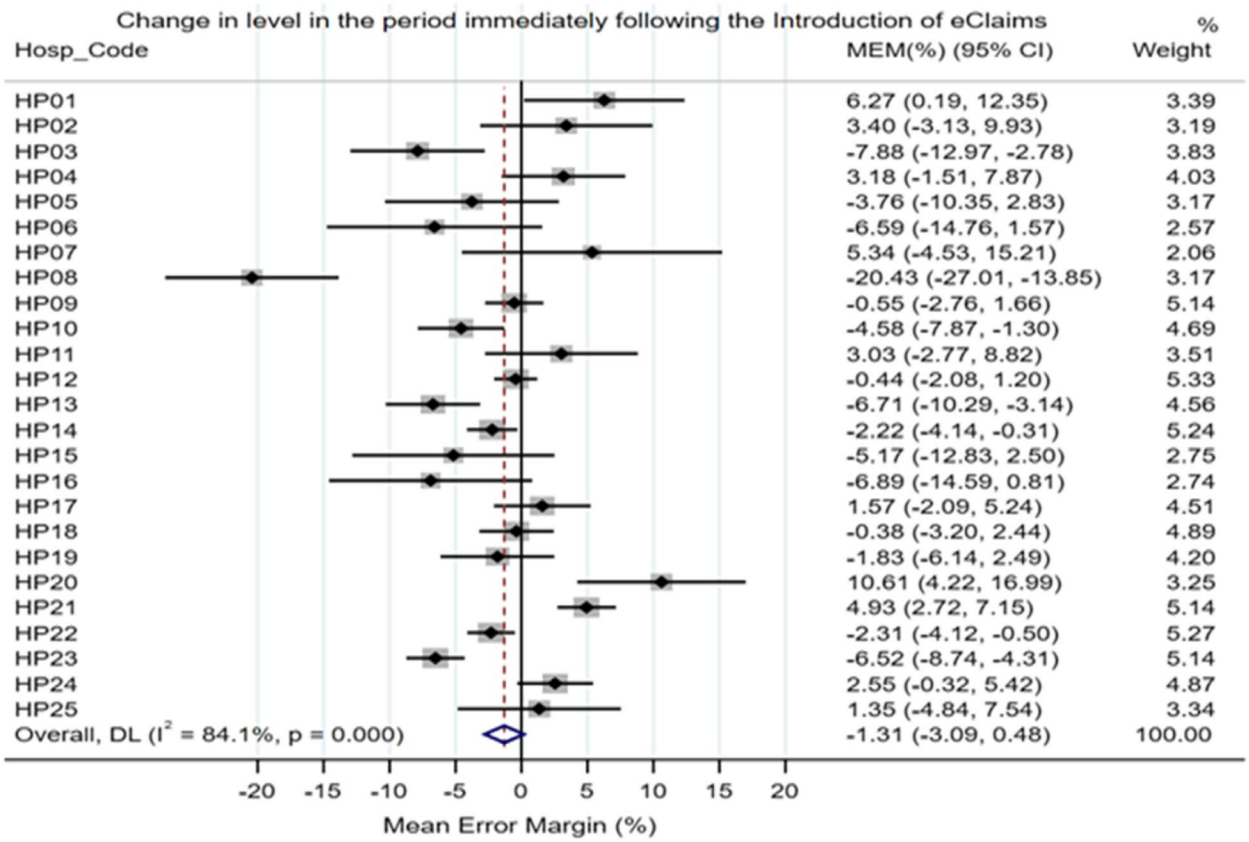

Fig. 4 Forest plot for change in level in the period immediately following the introduction of the DHT claims system compared with counterfactual (i.e. the immediate impact of DHT implementation on Health Insurance Claims Rejection Rate). The model is based on moment-based approximations to the expectation of the standard Cochran heterogeneity statistic Q [33] which is a ratio of observed variation to the within-study error. The weight (%) represents relative weights based on the number of subjects from each health facility and should sum to 100. Abbreviations: MEM: Mean Error Margin (or Average claim rejection rate); DL: DerSimonian and Laird

inactive member, unclear diagnosis, and age treatment mismatch (Table 5). It is important to note that these factors accounting for the deductions in claims due to errors are similar in terms of occurrence for the paper-based and DHT systems. However, the pre-DHT system's cost of these causes is significantly higher than the post-DHT system's (Table 5).

Discussions

This study quantified the impact of the DHT system on the claim rejection rate of Health Insurance claims in Ghana. The analysis shows that DHT claims processing saves costs in terms of denied claims compared to manual claims processing. The overall average claim rejection rate is lower for DHT systems compared to paper-based systems. Our study is in agreement with studies conducted by Nsia-Boateng et, al [1] who compared health insurance claim reviews for paper-based and electronic systems by the NHIS. This could be attributed to the laborious nature of processing paper-based claims which requires more labor force to accomplish. On the hand, the DHT system proves to be efficient due to its ability to flag some errors that cannot be identified by the paper-based system. Mostly the DHT target the human entry errors associated with claim submission. For instance, some systems are designed in such a way that you cannot enter figures that exceeds the predetermined amount for a particular drug. Paper-based system will allow you to go ahead but skip pattern implemented in DHT will only allow you to complete the form before submission if you put in the right figure.

In general, the use of DHT to process claims benefits healthcare providers by minimizing the claim rejection rate in health insurance claims compared to paper-based ones. The trend analysis revealed that in the first month after the introduction of DHT, a reduction of 1.31% was observed in the claim rejection rate of health insurance claims but was not statistically significant. This shows that if care providers monitor and invest in information systems to enhance electronic claims processing the gains

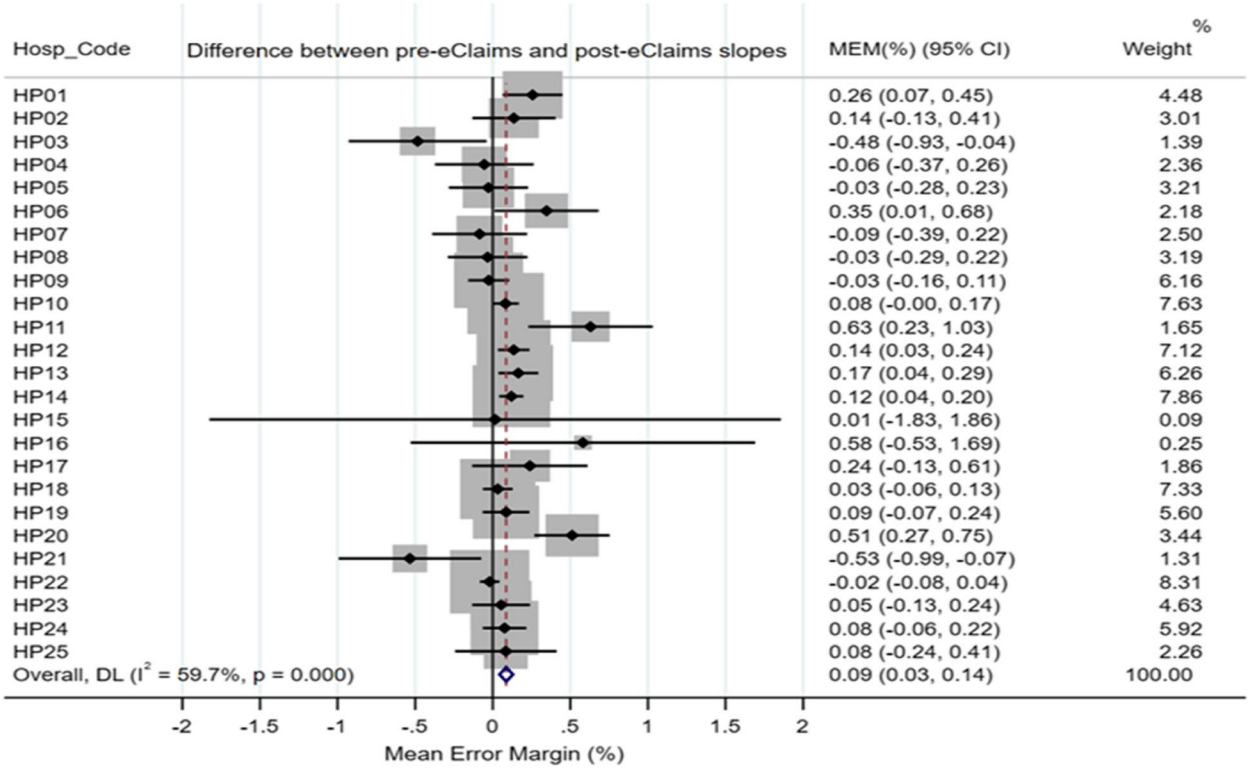

Fig. 5 Forest plot for Difference between pre-DHT claims system and post-DHS claims slopes (i.e. the sustained impact of DHT implementation on Health Insurance Claims Rejection Rate). The model is based on moment-based approximations to the expectation of the standard Cochran heterogeneity statistic Q [33] which is a ratio of observed variation to the within-study error. The weight (%) represents relative weights based on the number of subjects from each health facility and should sum to 100. Abbreviations: MEM: Mean Error Margin (or Average claim rejection rate); DL: DerSimonian and Laird

Table 5 Reasons accounting for deductions in claims due to errors in health insurance claims

Reasons	Total	Reasons for claim deductions	
		Yes *n* (%)	No *n* (%)
Treatment to diagnosis mismatch	2,713	2377 (87.62)	336 (12.38)
Multiple ANC visits	2,713	2361 (87.03)	352 (12.97)
Duplication of Claims	2,712	2360 (87.02)	352 (12.98)
Inappropriate prescription	2,713	2358 (86.91)	355 (13.09)
Oversupply of medication	2,713	2351 (86.66)	362 (13.34)
Wrong application of Tariffs	2,713	2338 (86.18)	375 (13.82)
No diagnosis	2,713	2338 (86.18)	375 (13.82)
Inactive member	2,712	2331 (85.95)	381 (14.05)
Unclear diagnosis	2,713	2330 (85.88)	383 (14.12)
Age treatment mismatch	2,712	2329 (85.88)	383 (14.12)
Duplication of Medication	2,711	2304 (84.99)	407 (15.01)
No diagnoses request evidence	2,713	2294 (84.56)	419 (15.44)
Wrong GDRG	2,986	1195 (40.02)	1791 (59.98)
Wrong medicine code	2,986	1194 (39.99)	1792 (60.01)

Source: Authors' analysis

can be overwhelming. This reduction can be attributed to the dedication attached to every go-live information system implementation because implementers would want to see the change yield the needed dividend. Further analysis revealed that the difference between pre-DHT and post-DHT trends observed an increase of 0.09% in the claim rejection rate of health insurance claims. This was statistically insignificant. In addition, the post-DHT trend saw a statistically insignificant increase of 0.01% in the claim rejection rate. However, the evidence from some healthcare providers (HP03, HP04, HP05, HP07, HP08, HP09, HP15, HP21 and HP22) show that lessons from previous deductions have been taken into consideration for subsequent claims preparations and submissions. Though, the DHT alone cannot be the only factor to reducing errors, certain steps such as thorough validation of claims by claim officers or internal claim validation teams are required at the provider level to ensure that these claim errors are reduced to the lowest level. The HPs that have not seen any significant reduction after DHT implementations could adopt best practices from their counterparts making progress in this direction.

The study also revealed that denied claims can be attributed to treatment to diagnosis mismatch, multiple antenatal visits, duplication of claims, inappropriate prescription, oversupply of medication, wrong application of tariffs, no diagnosis, inactive member, unclear diagnosis, and age treatment mismatch. These factors are peculiar to both paper-based and DHT systems in terms of occurrence. However, the cost of these causes are significantly higher for the pre-DHT system compared to post-DHT system. These causes of denied claims can be avoided if providers undertake vetting of their claims before submitting them to the insurers (NHIS). Training and supervision are required to enable the electronic claims processing system to function efficiently and effectively. Our study did not see a sustained significant effect of DHT systems in reducing the claim rejection rate of claims submitted by some health facilities to the NHI authority, and this may be attributed to the rate decline in the efficient use of DHT, complex architecture of the different system, inadequate knowledge of how the systems operate and the potential illegal manipulation of the systems to financially benefit the service providers. Healthcare providers would need to implement interventions aimed at hospital claim officers and all clinical documentation staff throughout the care process in order to reduce claim deductions. In addition, documentation standards for the DHT claim processing ought to be developed and implemented in order to instruct all of the system's active users regarding the advantages of lowering the cost of denied claims. Standard treatment guidelines for clinical processes should also be strictly followed to prevent age-treatment mismatch, inappropriate prescribing, overprescribing, no diagnosis, unclear diagnosis, and mismatch due to age. Specifically, Kimiaeimehr et al. in their study emphasized that effective solutions for the implementation of guidelines include access to information, motivation, attitude change, efficient management, the development of a systematic vision, the provision of appropriate feedback, and the development of standards for work processes [34].

This study widens the scope of Information Systems (IS) knowledge in the DHT by exploring the important role of electronic claims processing systems in resolving the challenges within the Ghanaian healthcare system. It is imperative the increasing cost of healthcare expenditure in Ghana cannot be sustained, a problem that has been worsened by uncompensated claims. Issues such as the nature of healthcare business, stakeholder incentives misalignment, and the strict administrative processes as a result of bureaucracy. The authors conclude that electronic claims have the potential to address this thorny issue in the healthcare industry. We add to the broader body of knowledge by proving that automating healthcare delivery processes can impact accuracy and compliance in health insurance claim processing.

This study would also offer healthcare providers and policymakers a thoughtful implication that can be used to mitigate errors in claims processing, thereby reducing the number of errors in health insurance claims leading to denied claims. This will increase the reserves and improve the financial viability of healthcare providers and medical schemes as well. These savings will ultimately result in a better quality of healthcare by investing in healthcare provisions.

Strengths and limitations

This is among the few studies that have comprehensively assessed the impact of DHT on insurance claim rejection. There are some limitations to this study. Several factors may contribute to the reduction in claim rejection rate but lack of data could not allow the study to account for their contribution. Though the study accounted for bias through the use of multiple random effects to control for unobserved heterogeneity, there may be some underlying confounders that are characterized by both electronic claims systems and paper-based systems regarding denied health insurance claims.

This study did not examine disaggregated data on claims adjustments for respective services such as outpatient and inpatient claims submitted by care providers to NHIS. However, the analysis of total adjustments due to errors for each month with respect to each healthcare provider in the study gives an overview of the costs of a claim denied to the care providers for the two systems (paper-based and electronic systems). Another limitation is that the results of the various DHT systems were put together and treated as one since the different systems may have their challenges.

This study also did not examine the burden of the cost of claim errors on insurance schemes. Future studies can however explore the cost of claim errors on third party payers (health insurance schemes).

Conclusion

This study assessed the role of the DHT systems in reducing denied claims due to errors that correlate with significant cost burden to healthcare providers in the Ghanaian healthcare systems. We conclude that the use of DHT systems used by healthcare providers has a significant effect in reducing the likelihood of errors associated with rejected claims compared to the paper-based claims system. The use of large-scale longitudinal data from both the manual claims and electronic claims systems over time confirms that the adoption of the DHT claims system by healthcare providers reduces the tendency of a health insurance

claim to be denied by the insurers even though the impact was not felt in all the health facilities. Scaling up the DHT systems in all facilities across the country would the reduced cost of denied claims to healthcare providers. These savings can be reinvested to expand healthcare services to the populace especially, those in rural areas to improve the quality of care. A robust system coupled with training and hiring the right personnel for claims processing and management would improve service provision.

Abbreviations

ITS	Interrupted Time Series
NCHS	National Catholic Health Service
DOH	Department of Health
NHIS	National Health Insurance Scheme
NHIA	National Health Insurance Authority
ANC	Antenatal Clinic
ARIMA	Autoregressive Integrated Moving Average
GLS	Generalised Least Squares
OLS	Ordinary Least Squares
GH¢	Ghana Cedis

Acknowledgements
The authors wish to thank the following for their enormous contributions to this project: The Director, Mr. Adjei George, Esq of NCHS, Mr. Esegbey Tetteh Ivan, NCHS, the 25 NCHS hospitals who willingly participated in the study, and Mr. Tikoli Frederick.

Authors' contributions
The study was conceptualized and designed by GA and DD. GA undertook a literature review for the study and coordinated the field data collection. GA, and DD undertook the analysis, interpreted the results, and produced a manuscript in line with the journal's guidelines. DD, and GA, reviewed the manuscript. All authors thoroughly reviewed the draft manuscript and approved the final version.

Funding
No specific funding for this study.

Availability of data and materials
The data will be made available upon reasonable request.

Declarations

Ethics approval and consent to participants
The study secured ethical approval with reference number NCS/DOH/B2/2021/01 from the Ethics committee/Institutional Review Board of National Catholic Health Service to use the medical claims data from their hospitals for this study. The data were de-identified and informed consent to participate was waived by the ethics committee/Institutional Review Board of National Catholic Health Service, because of the retrospective nature of the study. We confirm that all methods were carried out in accordance with relevant guidelines and regulations and in accordance with the declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 11 July 2022 Accepted: 26 January 2023
Published online: 02 February 2023

References

1. Nsiah-Boateng E, Asenso-Boadi F, Dsane-Selby L, Andoh-Adjei F-X, Otoo N, Akweongo P, et al. Reducing medical claims cost to Ghana's National Health Insurance scheme: a cross-sectional comparative assessment of the paper-and electronic-based claims reviews. BMC Health Serv Res. 2017;17(1):1–7.
2. Gee J, Button M. The financial cost of healthcare fraud 2014. What data from around the world shows. 2014. https://researchportal.port.ac.uk/portal/en/publications/the-financial-cost-of-healthcare-fraud-2014(07b9046e-db06-43b0-83fa-b26272c0a161).html. Accessed 23 Aug 2019.
3. Sanborn B. Change Healthcare analysis shows $262 billion in medical claims initially denied, meaning billions in administrative costs. Health Care Finance News. 2017.
4. Yong PL, Saunders RS, Olsen L, editors. Thehealthcare imperative. The Healthcare Imperative: Lowering Costs and ImprovingOutcomes: Workshop Series Summary; 2010: National Academies Press (US)
5. Farnen H. The Financial Impact Of Denied Claims: It's Bigger Than You Think. RXNT 2022;(Online) https://www.rxnt.com/the-financial-impact-of-denied-claims-its-bigger-than-you-think/. Accessed 02 July 2022.
6. Carroll L. More than a third of US healthcare costs go to bureaucracy. Reuters, Jan. 2020;6.
7. Ghana E-health strategy. National E-Health Strategy. 2010. (Online) Available at: https://www.isfteh.org/files/media/ghana_national_ehealth_strategy.pdf. Accessed 18 July 2022.
8. Afagbedzi SK, Obuobi H, Aryeetey R, Bosomprah S. A Review of Ghana's E-health Strategy. Journal of Health Informatics in Africa. 2013 1(1).
9. Afarikumah E. Electronic health in Ghana: current status and future prospects. Online J Public health informatics. 2014;5(3):230.
10. NHIA. National Health Insurance Authority 2013 Annual Report. 2013. (Online) Available at: https://www.nhis.gov.gh/files/2013%20annual%20report-final%20ver%2029.09.14.pdf. Accessed 19 July 2022.
11. Nsiah-Boateng E, Asenso-Boadi F, Dsane-Selby L, Andoh-Adjei F-X, Otoo N, Akweongo P, et al. Reducing medical claims cost to Ghana's National Health Insurance scheme: a cross-sectional comparative assessment of the paper-and electronic-based claims reviews. BMC Health Serv Res. 2017;17(1):115.
12. Atasoy H. PROFESSIONAL POSITIONS. Annu Rev Public Health. 2019;40:487–500.
13. Ayabakan S, Bardhan I, Zheng Z, Kirksey K. The Impact of Health Information Sharing on Duplicate Testing. MIS Quarterly. 2017;41(4).
14. Jones SS, Heaton PS, Rudin RS, Schneider EC. Unraveling the IT productivity paradox—lessons for health care. N Engl J Med. 2012;366(24):2243–5.
15. NCHS. History of National Catholic Health Service. 2022. [Online] Available at: http://www.nchs.org.gh/about/history/. Accessed 9 June 2022.
16. NCHS. National Catholic Health Service Bio-data. 2022a. [Online] Available at: https://www.nchs.org.gh/. Accessed 9 June 2022.
17. Naatogmah AK. NHIA'S digital revolution on track. 2020. (Online) Available at: https://www.nhis.gov.gh/News/nhia%E2%80%99s-digital-revolution-on-track---5319. Accessed 02 Nov 2022.
18. Bernal JL, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. Int J Epidemiol. 2017;46(1):348–55.
19. Linden A. Conducting interrupted time-series analysis for single-and multiple-group comparisons. Stand Genomic Sci. 2015;15(2):480–500.
20. Campbell SM, Reeves D, Kontopantelis E, Sibbald B, Roland M. Effects of pay for performance on the quality of primary care in England. N Engl J Med. 2009;361(4):368–78.
21. Singer JD, Willett JB, Willett JB. Willett JB. Applied longitudinal data analysis: Modeling change and event occurrence: Oxford university press. 2003.
22. Bhaskaran K, Gasparrini A, Hajat S, Smeeth L, Armstrong B. Time series regression studies in environmental epidemiology. Int J Epidemiol. 2013;42(4):1187–95.
23. Godfrey LG. Misspecification tests and their uses in econometrics. J Stat Plann Inference. 1996;49(2):241–60.
24. Nelson BK. Time series analysis using autoregressive integrated moving average (ARIMA) models. Acad Emerg Med. 1998;5(7):739–44.
25. Prais S, Winsten C. Trend estimators and serial correlation, Cowles Commission Monograph, no. 23. Yale University Press New Haven, CT. 1954.

26. Sen A, Srivastava M. Regression analysis: theory, methods, and applications: Springer Science & Business Media; 1997.
27. Press S. Churdle. Stata 15 Base Reference Manual: Stata Press College Station, TX; 2017.
28. Turner SL, Forbes AB, Karahalios A, Taljaard M, McKenzie JE. Evaluation of statistical methods used in the analysis of interrupted time series studies: a simulation study. BMC Med Res Methodol. 2021;21(1):1–18.
29. Borenstein M, Hedges LV, Higgins JP, Rothstein HR. Introduction to meta-analysis: John Wiley & Sons; 2021.
30. Lipsey MW, Wilson DB. Practical meta-analysis: SAGE publications, Inc; 2001.
31. Deeks J, Higgins J, Altman D. Available from www. training. cochrane. org/handbook. 2011.
32. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ. 2003;327(7414):557–60.
33. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials. 1986;7(3):177–88.
34. Kimiaeimehr F, Hosseini SM, Alimohammadzadeh K, Bahadori M, Maher A. The study of factors affecting the implementation of clinical guidelines in Iran. J Mil Med. 2019;21(3):300–10.

Publisher's Note