

The impact of demonetisation on the utilisation of hospital services, patient outcomes and finances: a multicentre observational study from India

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ABSTRACT

Background This study assessed trends in healthcare utilisation in relation to the implementation of an economic policy in India wherein 500 and 1000 rupee notes were demonetised.

Methods In this ambidirectional observational study of private not-for-profit hospitals, data on hospital outpatient and inpatient numbers, surgeries, emergency department (ED) visits, obstetric admissions and mortality were obtained for pre-demonetisation (September/October 2016), early (November/December 2016) and late demonetisation (January/February 2017), and post-demonetisation periods (March/April 2017) and compared with the control period (2015–2016) from 11 centres (three tertiary hospitals; eight secondary). A Bayesian regression analysis was performed to adjust for seasonal (winter) effect. Monthly financial data, including the proportion of cash versus non-cash transactions, were collected.

Findings Overall, at the pooled all-hospital level, Bayesian analysis showed non-significant increase in outpatients (535.4, 95% CI –7097 to 8116) and decrease in deaths (–6.3 per 1000 inpatients, 95% CI –15.45 to 2.75) and a significant decrease in inpatients (–145.6, 95% CI –286.4 to –10.63) during demonetisation. Analysis at the level of secondary and tertiary hospitals showed a variable effect. For individual hospitals, after adjusting for the seasonal effect, some hospitals observed a significant reduction in outpatient (n=2) and inpatient (n=3) numbers, ED visits (n=4) and mortality (n=2) during demonetisation, while others reported significantly increased outpatient numbers (n=3) and ED visits (n=2). Deliveries remained unchanged during demonetisation in the hospitals that provided the service. There was no significant reduction in hospital incomes during demonetisation. In tertiary hospitals, there was a significant increase in non-cash component of transactions from 35% to 60% (p=0.02) that persisted beyond the demonetisation period.

Conclusions The effect of demonetisation on healthcare utilisation was variable. Some hospitals witnessed a significant reduction in utilisation in some areas, while others reported increased utilisation. There was an increase in non-cash transactions that persisted beyond the period of demonetisation.

Key questions

What is already known?

- The effects of an economic depression on the health of populations are associated with heterogeneous outcomes based on the country and nature of illness. The demonetisation policy in India was a short-term cash crunch and the healthcare impact of this has not been extensively studied.

What are the new findings?

- In this study of non-profit private hospitals, we found the effect of the policy on healthcare utilisation variable; income was not significantly affected, and the non-cash component of financial transactions rose during the period. These were probably secondary to measures adopted in these centres to facilitate patient care.

What do the new findings imply?

- Resilience of people and proactive measures by the health system can mitigate the barriers to access and utilisation of care during transient economic impact. Organisations may be able to plan and prepare for these situations to prevent reduction in access to healthcare by the public.

INTRODUCTION

Healthcare in India is delivered through public and private hospitals. Although the government's public sector provides free healthcare, over 70% of the population accesses the private sector.¹ The currency in India is rupee (Rs), and cash, in denominations of 5, 10, 20, 50, 100, 500 and 1000,² is the primary mode of transaction in sizeable segments of the country.³ The informal sector comprising agriculture, services and industry employs about 80% of the working class and is predominantly cash dependent without capability for electronic fund transfer, cheques,

debit or credit card services.³ On 8 November 2016, at 20.15 local time, through an unscheduled live televised address, the government withdrew the legal tender status (demonetised) for the 500 and 1000 rupee notes.⁴ This was done with the intent of targeting the parallel 'black' economy. At the time, these were the highest denomination notes, and 86% of the value of circulating cash was in these two denominations.^{5,6} The populace was allowed to deposit or exchange their devalued currency for other denominations in the banks until 30 December 2016, and the use of cashless transactions was encouraged. Certain essential services, such as public hospitals and petrol outlets, were exempt from this legislation.⁷ Purchase of medications was also permitted with the old notes until the midnight of 15 December 2016.⁷

The demonetisation drive is believed to have impacted India's informal economy—agricultural, construction workers, small business outlets and shops, potentially affecting the lives of about 400 million people who are predominantly poor.^{8,9} During the ensuing days and weeks, hardships faced by people were reported in the newspapers and media outlets. These included the inability to reach hospitals during an emergency, an increase in the number of cases of myocardial infarctions, mental anguish and deaths. Anecdotal reports of significant depressive and anxiety disorders were reported and these were observed in the population seemingly not directly linked to black money.¹⁰ Once in the hospital system, the acquisition of drugs and payment of bills were also difficult due to non-availability of cash and the low prevalence of digital transactions.^{10–12} However, other reports based on interviews with patients, physicians and pharmacists did not suggest an adverse impact on healthcare delivery, prompting calls from public health experts and commentators for a systematic evaluation of the effects of this monetary policy.¹³

Unlike major and lasting economic crises such as the 2008 global financial crisis that demonstrated heterogeneous effects on health, particularly with increased suicides and deterioration in mental health, demonetisation was a sudden short-term economic cash crunch for a few months.¹⁴ Published literature shows that recession-induced unemployment and income decline are associated with poor mental well-being, mental disorders and ultimately increased suicides.^{15,16} The 2008 financial crisis had heterogeneous effects on other health outcomes, and the 1997 Asian financial crisis was associated with reduced household health expenditure and healthcare utilisation.^{14,17,18} Although demonetisation was not a lasting economic crisis, in a healthcare system which is predominantly cash based, this could have had significant health consequences. However, the effects of such a policy on healthcare utilisation in India have not been evaluated in a systematic manner.

The aim of the study was to determine the hospital-based impact of demonetisation on utilisation of health services, mortality and financial implications. We hypothesised that, compared with the corresponding months

in the previous year, the period of demonetisation and remonetisation (between November 2016 and February 2017) would witness decreased hospitalisation rates, outpatient attendance, elective surgeries, antenatal and emergency visits. Delayed presentations to hospital during the demonetisation period would be reflected in worse outcome such as increased mortality. On the financial aspect, we expected that there would be a drop in income with an increase in the proportion of non-cash transactions during the demonetisation period.

METHODS

We conducted an ambidirectional observational study with serial measurements for the relevant variables. We collected data prior to the event of interest and prospectively to ascertain the effect of demonetisation on the variable of interest.

Participating centres

The study was led by a tertiary, not-for-profit, teaching hospital in South India. Eleven institutions (all private and non-profit institutions) that run 15 centres (primary, secondary or tertiary healthcare hospitals) were invited to participate, based on prior collaborative affiliations with the lead-centre, regional representation and availability of electronic repository of data. Of these, one tertiary-care teaching hospital declined to participate as it could not obtain regulatory approvals and three hospitals (one tertiary, two secondary) were unable to provide data by the predetermined deadline. The characteristics of the hospitals are provided in online supplementary appendix 1.

Study period

The demonetisation period (2016–2017) was divided into four: the pre-demonetisation (September/October 2016), early demonetisation (November/December 2016), late demonetisation (January/February 2017) and post-demonetisation (March/April 2017) periods. The *pre-demonetisation* period (viz., September and October 2016) was taken as the 2 months preceding the announcement of demonetisation. The *early demonetisation* period was chosen until December 2016 since cash crunch was maximal during this time and new notes were scarce. The *late demonetisation* period was the time when although new notes were available, there was a demand–supply mismatch until late February 2017 in most places, except the major metropolitan cities. The *post-demonetisation* period (March and April 2017) was the period when sufficient quantity of new currency was available to all. To account and adjust for seasonal variation, the corresponding period in the previous year (2015–2016) was taken as the control period and divided as control periods 1 to 4.

Data

All centres were requested to provide monthly data of the number of outpatients, inpatients, surgeries, obstetric

visits, deliveries, emergency visits and hospitals deaths. In addition, we collected monthly financial details of total income and the proportion of cash and non-cash payments (cheque, bank transfer, electronic transactions). Since the breakdown of specialty-specific (eg, ophthalmology, psychiatric, cardiology) or nationality-specific (local vs foreign) patient data was not available from most participating hospitals, these details were collected post hoc from the lead centre. Foreign (overseas) patients were those patients who were resident outside India and holding a passport other than that issued by the Republic of India. At the outset, data were collected for the two 8-month periods outlined above. However, it became evident that seasonal trends may play a significant role in the interpretation of data. Thus, additional post hoc analyses were undertaken from the lead centre using data from over 4.5 years to assess the effect of time and season on patient numbers and mortality. It was not possible to obtain these data from all the other participating centres for this period. We defined winter months as November, December, January and February. Data from participating hospitals were entered into data abstraction forms by the primary investigator, anonymised, reorganised as a single Excel file and provided to the statisticians at the lead centre for analysis.

Statistical analysis

All rates were expressed in terms of per 1000 inpatients (IPs) or outpatients (OPs). IP and OP numbers were reported as actual numbers. The mean and SD for each of the 2 monthly periods were computed. The pre-demonetisation phase (September/October 2016) was taken as the reference period. The subsequent phases of early, late and post-demonetisation periods were compared with this reference period using t-test. Similar comparisons were performed for the control periods. The results were presented as pooled all-hospital, tertiary and secondary hospitals and data of individual hospitals. Since there were multiple comparisons, Bonferroni correction was applied, and $p < 0.02$ was considered as significant.

Analysis of financial data included change in income during the demonetisation periods and the proportion of cash and non-cash transactions. For the financial data, since the data on total income had a skewed distribution, the data were log-transformed and analysed using a generalised linear model.

To adjust for the seasonal effect and the hospital characteristics (interaction between hospitals and log of number of beds and hospitals and log of number of doctors, and teaching status) during the demonetisation period and to get robust 95% credible intervals, Bayesian regression was done using WinBUGS software. The priori information for regression coefficients was based on normal priors. This was done for pooled all-hospital, secondary, tertiary and individual hospitals. A Bayesian regression analysis was also done for post hoc hospital data from the lead centre and an interrupted time series

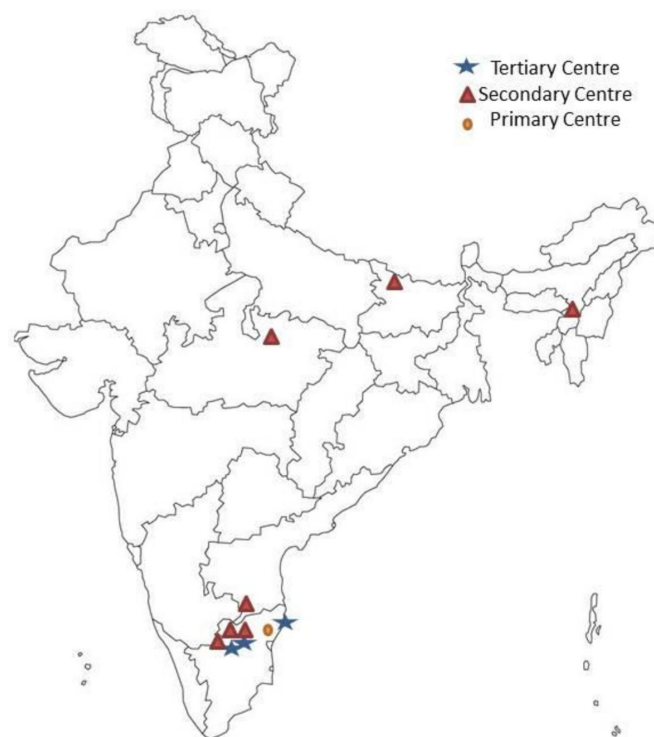


Figure 1 Regional distribution of the hospitals in various states in India.

analysis for the non-cash financial trends. Interrupted time series analysis was performed for data on foreign patients. We also analysed post hoc, pharmacy data from the lead centre and its four affiliated secondary centres for a 5-year period from January 2015 to assess if the lack of cash affected the purchase of medications. The data were double-checked by the statisticians to assess transcription errors. The analysis was done using SPSS V.25.0 and STATA V.15.

Patient and public involvement statement

The study was initiated to assess the difficulties faced by people during the demonetisation period. The authors represented from the various hospitals were aware of ongoing patient struggles and made contributions towards the design and analysis of the reports. We also had an economist and other members of society who provided input on the design and interpretations of the results. There were no patients directly recruited or involved in the development of the research question. We plan to disseminate relevant aspects of the study through media outlets and academic forums.

RESULTS

Data were obtained from 11 participating centres that included primary ($n=1$), secondary ($n=7$) and tertiary ($n=3$) healthcare centres (online supplementary appendix 1) from four geographical regions (figure 1), namely, South ($n=8$), Central, East and North ($n=1$ each) of India. For the purpose of the analyses, primary and

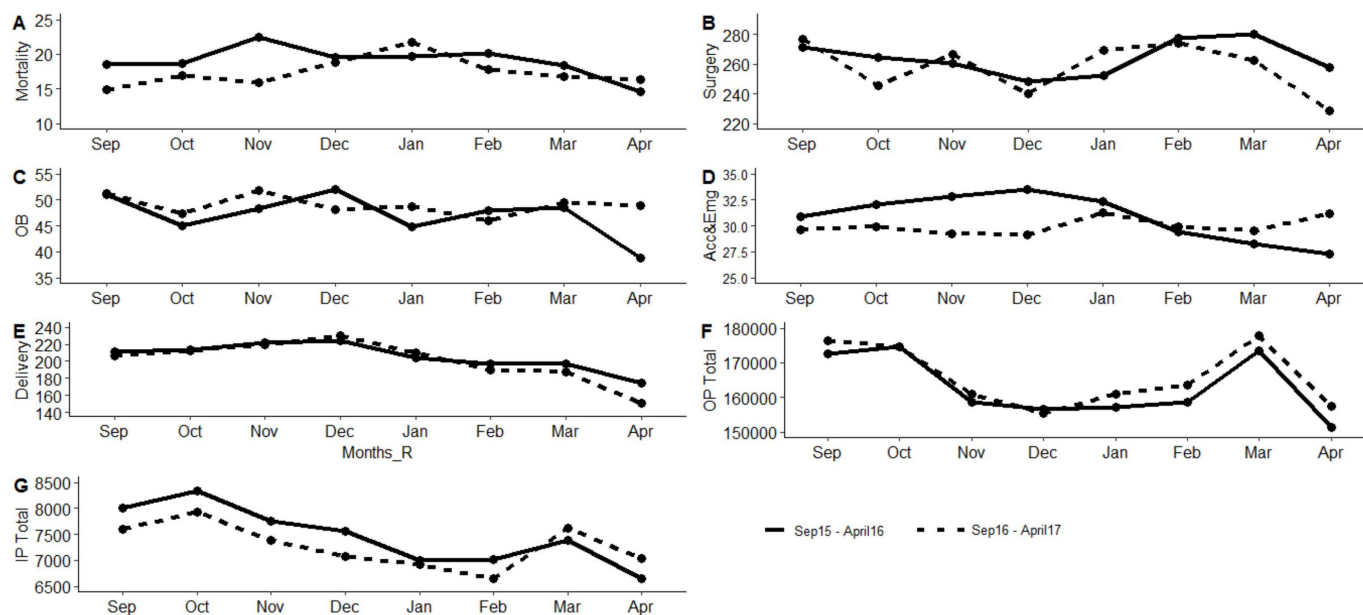


Figure 2 Analysis of pooled data of all participating hospitals. The demonetisation period was taken from September 2016 to April 2017 and this was divided into four: the pre-demonetisation period (viz., September and October 2016) being taken as the 2 months preceding the announcement of demonetisation. November 2016 and December 2016 was the early demonetisation period, January 2017 and February 2017 was the late demonetisation period, and March 2017 to April 2017 was the post-demonetisation period. The control period was taken as September 2015 to April 2016. (A) mortality rate, (B) surgery rate, (C) obstetric rate, (D) accident and emergency rate, (E) delivery rate, (F) total outpatients and (G) total inpatients. Rate calculations were for every 1000 outpatients for obstetric (OB) rate and accident and emergency (Acc&Emg) rate and per 1000 inpatients for surgery and delivery rates. Total outpatients (OP Total) and total inpatients (IP Total) are actual numbers.

secondary centres were clubbed together. All hospitals were not-for-profit private institutions.

Pooled analysis

In the all-hospital pooled data, monthly comparison of the variables between the demonetisation (2016) and the control periods (2015) suggested that the number of IPs and emergency services were lower in November and December, and obstetric visits were higher in November (figure 2). However, comparison of means between the reference pre-demonetisation period and the subsequent early, late and post-demonetisation periods did not show a significant difference in all the variables of interest in both the demonetisation and the control periods (data not shown). After adjusting for seasonal trends and hospital characteristics in the Bayesian analysis, the all-hospital pooled data showed (table 1) a non-significant increase of 535.4 outpatients (95% CI -7097 to 8116) and a decrease in 6.32 deaths per 1000 IPs (95% CI -15.45 to 2.746) during demonetisation. There was a significant decrease of 145.6 IPs (95% CI -286.4 to -10.63). There was no significant difference in surgery, obstetric, delivery and emergency rates during the demonetisation or post-demonetisation periods (table 1). We performed the difference in difference analysis for the pooled all-hospital data between the pre-demonetisation and early demonetisation period and there was no significant difference noted.

Analysis of pooled secondary and tertiary centres showed a significant ($p < 0.04$) reduction in delivery rate

in tertiary centres during the late demonetisation and post-demonetisation periods and a reduction in OP and IP numbers in secondary centres during demonetisation (online supplementary appendix 2). However, similar reductions were seen during the preceding control periods also (online supplementary appendix 2). However, after Bayesian analysis of tertiary and secondary hospital data (table 1), the following were significant: an increase in surgery rates by 37.1 (95% CI 2.65 to 71.94) during demonetisation period and 41.5 (95% CI 0.87 to 83.11) during the post-demonetisation period in tertiary hospitals and a decline in the mortality rate of 10.64 deaths (95% CI -20.69 to -0.6269) during the demonetisation period in secondary hospitals.

Individual hospital analysis

Bayesian regression analysis (online supplementary appendix 3) showed a heterogeneous and variable effect of demonetisation on healthcare utilisation. Some hospitals observed a significant reduction in OP ($n=2$) and IP ($n=3$) numbers, ED visits ($n=4$) and mortality ($n=2$) during demonetisation, while others reported significantly increased OP numbers ($n=3$) and ED visits ($n=2$). Delivery rate remained unchanged during demonetisation in the eight hospitals that provided the service (online supplementary appendix 3).

Post hoc analysis

Data from the lead centre of 4.5 years (online supplementary appendix 4) corroborated the seasonal effect

Table 1 Adjusted Bayesian regression analysis for pooled data of all-hospitals, tertiary and secondary hospitals

Variables	All-hospitals	Tertiary	Secondary
	Estimates (95% CI)	Estimates (95% CI)	Estimates (95% CI)
Outpatients			
Constant (average)	−9436 (−16490 to −2305)	−30610 (−466300 to 395400)	−12920 (−23480 to −2355)
Demonetisation	535.4 (−7097 to 8116)	2770 (−1253 to 6833)	−244.9 (−10380 to 9859)
Post-demonetisation	−896.3 (−10090 to 8421)	1061 (−3683 to 5917)	−1653 (−13690 to 10590)
Winter	−2769 (−9836 to 4377)	−5678 (−9357 to −1972)	−1720 (−11180 to 7832)
Inpatients			
Constant (average)	1188 (1034 to 1343)	−2329 (−437500 to 425 300)	1232 (1059 to 1405)
Demonetisation	−145.6 (−286.4 to −10.63)	−171.6 (−401.8 to 61.28)	−120 (−288 to 51.39)
Post-demonetisation	−139.8 (−298.5 to 20.36)	−176.3 (−448 to 101.7)	−108.6 (−297.8 to 83.04)
Winter	−60.5 (−191.9 to 68.7)	−190.3 (−401.2 to 22.25)	−3.44 (−162.9 to 158.4)
Mortality rate			
Constant (average)	26.08 (15.32 to 37.14)	−12.63 (−1963 to 1934)	42.92 (32.39 to 53.63)
Demonetisation	−6.32 (−15.45 to 2.75)	1.41 (−2.50 to 5.24)	−10.64 (−20.69 to −0.63)
Post-demonetisation	−2.25 (−13.2 to 8.78)	2.51 (−2.04 to 6.94)	−4.94 (−17.03 to 7.52)
Winter	6.10 (−2.56 to 14.81)	2.78 (−0.691 to 6.278)	8.1 (−1.49 to 17.77)
Surgery rate			
Constant (average)	232.8 (194.1 to 272.8)	50.22 (−1896 to 1946)	298.6 (254.3 to 342)
Demonetisation	11.35 (−23.81 to 46.07)	37.1 (2.65 to 71.94)	−4.685 (−46.25 to 37.41)
Post-demonetisation	−2.061 (−44.57 to 41.22)	41.54 (0.87 to 83.11)	−30.1 (−80.52 to 21.34)
Winter	−10.57 (−43.2 to 22.36)	−29.66 (−61.18 to 2.15)	0.92 (−36.43 to 40.02)
Obstetric rate			
Constant (average)	245.9 (197.1 to 295.9)	7.837 (−1939 to 1953)	230.8 (160.7 to 300.9)
Demonetisation	18.98 (−26.98 to 64.5)	−3.532 (−17.48 to 10.11)	31.81 (−43.18 to 107.4)
Post-demonetisation	10.47 (−43.95 to 65.65)	5.694 (−10.52 to 21.49)	13.42 (−73.46 to 101.9)
Winter	6.515 (−36.14 to 49.63)	9.567 (−2.82 to 22.02)	5.18 (−61.96 to 75.65)
Delivery rate			
Constant (average)	629.1 (576.1 to 683)	−23.99 (−1973 to 1888)	681.9 (614.8 to 749)
Demonetisation	−10.53 (−58.49 to 36.34)	2.16 (−6.40 to 10.8)	−17.69 (−83.82 to 48.84)
Post-demonetisation	−25.01 (−83.07 to 33.57)	−5.60 (−15.7 to 4.73)	−35.57 (−115.4 to 46.36)
Winter	3.49 (−40.83 to 48.3)	−3.77 (−11.6 to 4.12)	8.31 (−53.36 to 71.04)
Accident emergency rate			
Constant (average)	114.1 (99.37 to 129.1)	−25.55 (−1976 to 1921)	125.3 (114.4 to 136.5)
Demonetisation	−0.25 (−11.36 to 10.68)	2.50 (−1.34 to 6.26)	−1.95 (−11.17 to 7.34)
Post-demonetisation	−3.18 (−16.21 to 9.83)	2.04 (−2.44 to 6.39)	−6.25 (−16.94 to 4.64)
Winter	−0.21 (−10.52 to 9.86)	2.22 (−1.2 to 5.65)	−1.60 (−9.85 to 7.08)

The above estimates of parameters are adjusted by the teaching status, interactions between hospital with log no. of beds and hospital with log no. of doctors. Constant is the mean value of all the months used in the analysis. This gives a reference to compare the change in the variables. 'Demonetisation' was between November 2016 and February 2017 (4 months) where the periods early and late have been clubbed together. 'Post-demonetisation' was March and April 2017. The winter months were taken as November, December, January and February of both demonetisation and control periods. Winter values represent the seasonal changes, and this is compared with the non-winter months. All rates are represented per 1000 inpatients. Rate calculations were per 1000 outpatients for obstetric rate and emergency rate, and per 1000 inpatients for surgery and delivery rates. CI, credible intervals.

of significantly higher mortality and reduced OP attendance and IP numbers during winter, justifying the need to adjust for seasonal trends in the above analyses. It also

demonstrated that in the analysis of long-term trends, a significant increase in OP attendance and IP admissions and a significant reduction in mortality occurred over

Table 2 Financial analysis of all-hospitals, tertiary and secondary centres

Period	Total income (log-transformed values)								
	All-hospitals			Tertiary centres			Secondary centres		
	Mean (SD)	% change	P value	Mean (SD)	% change	P value	Mean (SD)	% change	P value
Demonetisation period									
Pre-demonetisation (September 16–October 16)	4.46 (2.50)	Ref	–	7.49 (1.30)	Ref	–	3.16 (1.57)	Ref	–
Early demonetisation (November 16–December 16)	4.40 (2.47)	–6.11	0.93	7.40 (1.32)	–8.88	0.89	3.11 (1.51)	–4.88	0.93
Late demonetisation (January 17–February 17)	4.43 (2.47)	–3.15	0.97	7.46 (1.30)	–2.96	0.96	3.13 (1.49)	–3.25	0.95
Post-demonetisation (March 17–April 17)	4.62 (2.56)	17.59	0.83	7.80 (1.14)	36.34	0.64	3.26 (1.55)	10.41	0.86
Control period									
Control 1 (September 15–October 15)	4.18 (2.61)	Ref	–	7.22 (1.51)	Ref	–	2.88 (1.72)	Ref	–
Control 2 (November 15–December 15)	3.97 (2.73)	–18.78	0.80	7.17 (1.49)	–5.26	0.94	2.60 (1.82)	–23.97	0.66
Control 3 (January 16–February 16)	4.06 (2.71)	–11.22	0.88	7.29 (1.44)	6.93	0.93	2.68 (1.74)	–17.96	0.75
Control 4 (March 16–April 16)	4.27 (2.58)	9.09	0.91	7.35 (1.46)	13.54	0.87	2.95 (1.63)	7.36	0.91

Total income is presented as log-transformed values. Demonetisation periods are from September 2016 to April 2017. Control periods are from September 2015 to April 2016.

time. In the lead centre, after adjusting for the effect of time and seasonality, Bayesian analysis did not show an effect of demonetisation on OP visits, IP numbers and mortality.

Specialty-specific analysis was also undertaken in the lead centre to assess if there was any difference in attendance for the various services. Although it was hypothesised that non-emergent services such as ophthalmology would be less used and other emergent (eg, chest pain, emergency visits) and stress-related (eg, psychiatric visits) services would witness increased numbers during the demonetisation period, no statistically significant trends were observed (online supplementary appendix 5). There was a non-significant reduction in numbers of overseas patients during the early demonetisation period that was followed by a significant ($p<0.001$) increase in the late and post-demonetisation periods (online supplementary appendix 6).

Financial analysis

There was no significant change in the income during demonetisation (table 2) or in the post-demonetisation period in all-hospital pooled data as well as secondary and tertiary centres. The proportion of non-cash component of income (table 3) increased significantly from 35% to 60% ($p=0.02$) in tertiary centres and from 3% to 12% ($p=0.06$) in secondary centres, respectively, during

the demonetisation period. Post hoc analysis of long-term trends over 40 months of non-cash transactions from the lead centre showed a gradual increase in the proportion of non-cash transactions from 17% to 24% in the 14 months prior to demonetisation which peaked around 49% during demonetisation and settled to a new baseline of around 34% in the subsequent 22 months (figure 3). Analysis of these data demonstrates that there was a 25% increase in non-cash transactions during the combined early and late demonetisation period (online supplementary appendix 7).

We observed that patient subsidy varied greatly from 4.7% to 50% of the annual income across hospitals, and hence, a pooled analysis was not possible due to the heterogeneity. Post hoc, we analysed pharmacy data from the lead centre and its four affiliated secondary centres for a 5-year period from January 2015. There was a significant effect of time on pharmacy revenue with a gradual increase in monthly pharmacy revenue over the 5-year period. There was a small non-significant reduction in pharmacy revenue during winter months. After adjusting for time and winter, Bayesian analysis demonstrated a significant reduction in monthly pharmacy revenue of 12.3 million rupees (95% CI –22.0 to –2.6) (USD –184 000; 95% CI –330 000 to –39 000; USD ~Rs 67 in November 2016¹⁹) during demonetisation (online supplementary appendix 8).

Table 3 Percentage of non-cash income among tertiary and secondary centres

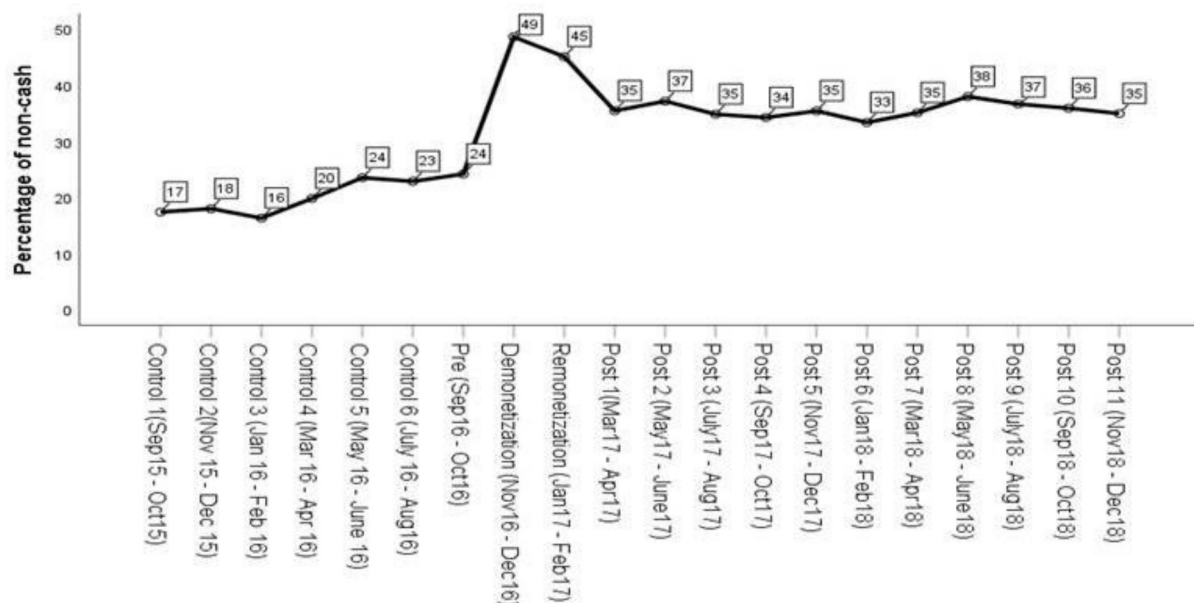
Variable	Tertiary centres						
	September–October Reference period	November–December	P value	January–February	P value	March–April	P value
Non-cash							
Demonetisation periods	34.52 (16.70)	60.05 (15.46)	0.02	54.07 (16.53)	0.07	55.11 (19.41)	0.08
Control periods	30.35 (15.10)	30.74 (15.55)	0.97	31.86 (14.92)	0.86	30.63 (20.44)	0.98
Secondary centres							
Non-cash							
Demonetisation periods	2.80 (4.14)	12.31 (14.46)	0.06	11.34 (12.55)	0.38	6.38 (6.02)	0.98
Control periods	1.93 (3.41)	1.89 (3.46)	0.99	1.86 (3.66)	0.43	2.00 (3.16)	0.96

Here, non-cash transactions are represented as a percentage (S.D.) of the total transactions. As there are multiple comparisons, $p < 0.02$ is considered as significant. Only three secondary centres had non-cash facilities. The demonetisation periods were from September 2016 to April 2017 and September–October 2016 was the pre-demonetisation reference period, November–December 2016 was the early demonetisation period, January–February 2017 was the late demonetisation period and March–April 2017 was the post-demonetisation period. The control periods were taken as corresponding months from September 2015 to April 2016.

DISCUSSION

This study is the first multicentre systematic longitudinal evaluation of the effects of demonetisation. In this study of 11 hospitals mainly from South India that were predominantly not-for-profit institutions, the effect of demonetisation on healthcare utilisation was heterogeneous and variable. The cardinal findings were that while some hospitals witnessed significant reduction in OP and IP numbers, emergency visits and mortality, others reported significantly increased OP numbers and emergency visits. Overall, at the pooled level, there were no significant changes in OP visits, surgery, delivery, mortality rates and finances during the different phases of the demonetisation period (tables 1 and 2); the small but significant reduction in admission in the all-hospital level and mortality in the secondary level during demonetisation could have been incidental given the wide CI. Some of the trends observed in tertiary and secondary centres

(online supplementary appendix 2) were not significant in a Bayesian regression analysis. Using episodes of psychiatric IP admissions, psychiatry outpatient visits and acute chest pain presentations as surrogates of acute stress, data from the lead centre did not demonstrate an increase in these stress-related presentations (online supplementary appendix 4). Although there were no overall significant changes to hospital income patterns, individual centres experienced significant challenges in financial transactions and payments. There was a spike in cashless transactions during and post-demonetisation phase evident only in tertiary hospitals but not in the rural and regional areas. The lack of cash adversely affected the patients' ability to buy medications as evidenced by the significant drop in pharmacy income in the aggregate of five centres that were analysed. However, this phenomenon was short-lived and did not persist in the late demonetisation phase when cash was infused into the system from January 2017.

**Figure 3** Percentage of non-cash trends from the lead centre from September 2015 to December 2018.

This is the first study that examined trends in accessing healthcare services in relation to the implementation of an economic policy in India. We evaluated multiple domains—hospital presentations, admissions, surgery and obstetric admission and delivery rates, mortality and financial impact to hospitals. This was a multicentre study, from different geographical locations in the country. We adjusted our analysis for seasonal variation, hospital beds and number of doctors. The post hoc analysis of long-term hospital data from the lead tertiary centre showed significant effects of healthcare utilisation (IP and OP numbers) and outcome (mortality) over time as well as during winter, justifying the regression analysis of the primary data to adjust for seasonality.

There are several possible explanations for the lack of a consistent effect or an adverse impact of demonetisation on healthcare utilisation. The effects of such a policy on healthcare utilisation may be complex and are dependent on (1) geographical location (urban vs rural), (2) socioeconomic status (poorer patients more affected due to restricted access to electronic payments), (3) type of hospital (secondary vs tertiary) and (4) type of healthcare need (emergency vs routine). Further, because the period of economic hardship was short and the demonetisation period coincided with the winter months (when numbers are usually lower, as evidenced by the post hoc Bayesian analysis of long-term data), the effects were less pronounced. It is also likely that attendance to the complementary free public service hospitals may have increased. However, this was not assessed in this study. Although urban populations may be more affluent and have access to cashless transactions, no significant differences were noted between the tertiary hospitals that were situated in urban areas and secondary hospitals that were predominantly situated in rural areas.

There are some limitations to the study. Monthly data were used for analysis. During the demonetisation period, the most impactful time was the initial 7 weeks leading up to the deadline of 31 December 2016, to exchange or deposit the devalued currency; hence, a weekly analysis may have provided a better understanding of the trends. However, due to logistic reasons, this was not easily available from all centres. A large proportion of the participating centres were from South India and from one state, hence the results may not be representative of the national trend. There were no public centres, only one primary care centre and no non-allopathic centres. The latter contributes to a significant provision of healthcare in India.²⁰ Our data were from private, not-for-profit centres and hence its generalisability may be limited. These not-for-profit centres are well known for its long-standing charitable work and hence patients came to the hospitals knowing that they would not be turned back. Some institutions had a policy not to turn away any patient with an acute problem, irrespective of the ability to pay, others offered deferred payments or charitable work. One hospital (the lead centre) even provided food coupons for patients to eat in the hospital canteen

during the cash crunch period. In one centre, there were regional causes that had a reduction in patient numbers during the control periods. Some centres had the state or national health insurance for below the poverty line and hence some patients may have had access to essential services. The proportion of income and patients who used direct insurance for healthcare was not available. A reduced power from studying only 11 centres was another limitation.

It was unclear if the study had sufficient power to detect a difference between the time periods. As this was an observational study with no baseline data to inform power analysis, a realistic sample size calculation a priori was not possible. A post hoc analysis revealed that to detect an increase in mortality rate by 3 units (SD of 2.5 units) during the demonetisation period (ie, from 16 to 19 per 1000 admissions) at an alpha and beta of 5% and 20%, respectively, we needed to study 11 hospitals. However, with the observed mortality difference of 1.45 units and SD of 1.75 units, the study was underpowered with a beta of 50%. To detect a significant effect of demonetisation on mortality, we would have needed to include 23 hospitals. This was a limitation.

Our data were limited to a hospital dataset. We could not capture data on other aspects of healthcare use such as visits to family practitioners, purchase of medicines in pharmacies, attendances for immunisation and allied healthcare use. Other areas of interest such as the acute change in patient behaviour to medication adherence, vaccinations, alcohol consumption, smoking and the lag effects of these consequences were not studied. The impact on the health workforce and medical supplies obtained would have been useful. Access to national mortality registry besides hospital data would have provided an estimate of attributable mortality caused by lack of access to healthcare; however, such data are lacking.

While our data demonstrated variable effects of demonetisation on healthcare utilisation, precise assessment of the healthcare usage has a number of caveats. In general, over a short period of time, the state of health of communities and thus healthcare demand is relatively constant except for sudden concomitant emergencies such as epidemics or mass casualties, when there may be a sudden surge in healthcare needs. Healthcare demand and outcome can also change gradually over long periods of time as a result of changing prevalence of infectious diseases or non-communicable diseases.^{21 22} Health of the community and healthcare utilisation may follow different patterns during economic crisis. Sustained period of economic depression is likely to affect not only healthcare utilisation but also the health of the population. On the other hand, brief periods of 'cash crisis', as was the case with demonetisation, is likely to result in reduced healthcare utilisation in the short term rather than affecting the health status of the community. In our study, some centres reported reduced attendance during the cash crunch period, although in most hospitals there

was no change. There was no demonstrable increase in mortality during demonetisation; in fact, mortality was lower in three hospitals during that period (online supplementary appendix 3).

The evidence on the effects of economic recession on health is varied, with some high-income countries reporting beneficial effects but low- and middle-income countries demonstrating a countercyclical effect. Studies from the USA and Ireland have suggested that economic crises may actually have some beneficial effects on health, probably as a result of reduction in health-compromising behaviours such as smoking, heavy drinking, sweetened beverages, fast food and transport accidents.^{23 24} However, studies from Brazil and other Latin America countries have demonstrated an increase in mortality with recession and rising unemployment.^{25 26} The reasons for the absence of a consistent effect in our study are uncertain and it may reflect reduced hospital attendance of sick patients or premature discharges before terminal events to offset additional costs. Alternatively, it is possible that patients were able to prioritise health, arrange for funds by borrowing and, especially in the tertiary, urban setting were able to switch to a cashless mode of payment. Since the hospitals in our study do not represent the entire healthcare landscape in India, it is likely that we are observing a partial hospital market where patients changed their preferences of centres based on affordability, access and availability of funds, hence explaining the variation in numbers.

We believe that the results from this study inform the debate on the effects of a short-term economic policy on private healthcare providers. Understanding population behaviour during acute economic stress may help us prepare effective ameliorative measures in times of difficulty. Prior to demonetisation, although 53% of the population had bank accounts, only around 5% used them for digital transactions.²⁷ Even from our study, the trends in cashless usage in rural and regional India indicate that the population is probably not yet prepared for digital transactions. However, 2 years after the policy, it is reported that there has been a 440% increase in digital transactions and the number of account holders has increased to 79%; but only a third of the account holders used them in a year.²⁸ Setting up systems for collaboration of economic studies would help in providing valuable population-level data for future research that can prepare the health system in planning policy and to respond effectively to the needs of the country.

CONCLUSIONS

In conclusion, our study has shown that the implementation of the economic policy of demonetisation in the short term was associated with a heterogeneous effect on healthcare utilisation and outcomes. There was an increase in non-cash transactions in tertiary centres that persisted beyond the period of demonetisation. Future research focusing on the broader public sector, for-profit

corporate hospitals, primary and the AYUSH system of healthcare would provide a better understanding of the overall impact of economic policies on healthcare organisations.

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