Impacts of government supervision on hospitalization costs for inpatients with COPD
An interrupted time series study

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Abstract
To address the remaining medical mis conducts after the zero-makeup drug policy (ZMDP), e.g., over-examinations, China has given the priority to government supervision on medical institutions. This study evaluated the effect of government supervision on medical costs among inpatients with chronic obstructive pulmonary disease (COPD) in Sichuan province, the first province in China where the medical supervision was conducted.

A linear interrupted time series (ITS) model was employed to analyze data about 72,113 inpatients from 32 hospitals. Monthly average medicine costs, diagnostic costs, and medical services costs, nursing costs from January 2015 to June 2018 were analyzed, respectively.

The average hospitalization costs fell with a monthly trend of 42.90 Yuan before the implementation of supervision ($P < .001$), and the declining trend remained with the more dramatic rate ($-158.70$ Yuan, $P < .001$) after the government audit carried out. For western medicine costs, the monthly decreasing trend remained after the implementation of supervision ($-66.44$ Yuan, $P < .001$); meanwhile, the monthly upward trend was changed into a downtrend for traditional Chinese medicine costs ($-11.80$ Yuan, $P = .009$). Additionally, the increasing monthly trend in average diagnostics costs disappeared after government supervision, and was inversed to an insignificant decreasing trend at the rate of $26.18$ Yuan per month. Moreover, the previous upward trends were changed into downward trends for both medical service costs and nursing costs ($P = .066$, $-44.71$ Yuan; $P = .007$, $-11.17$ Yuan, respectively) after the supervision carried out.

Our findings reveal that government supervision in Sichuan province was applicable to curb the growth of medical costs for inpatients with COPD, which may reflect its role in restraining physicians’ compensating behaviors after the ZMDP. The government medical supervision holds promise to dismiss medical mis conduct in Sichuan province, the experience of which may offer implications for other regions of China as well as other low- and middle-income countries.

Abbreviations: COPD = chronic obstructive pulmonary disease, ITS = interrupted times series, TCM = traditional Chinese medicine, ZMDP = Zero-Makeup Drug Policy.

Keywords: chronic obstructive pulmonary disease, government supervision, medical costs, medical misconduct, Zero-Makeup Drug Policy

1. Introduction
The transition from the planned economy era to the market-oriented economic era in the 1980s has led to a reduction in revenues among China’s health providers. [11] To compensate for the reduction, health providers were allowed to charge an extra 15% profit margin based on drugs procurement prices as markup. [12] Thus, physicians were encouraged to over-prescribe drugs, even some of which may be unnecessary for patients. [13,4] Complaints about unaffordable healthcare expenses in public hospitals, the main providers of healthcare service in China, have
gradually increased. To restrain over-prescription and control health costs, the Ministry of Health of Chinese government proposed the Zero-Makeup Drug Policy (ZMDP) in 2009, which canceled the 15% drug markup. The initiative indeed achieved its goal of eliminating over-prescribing immediately. While the increase of health cost remained since physicians turned to other lucrative services, such as prescribing superfluous examinations and tests. In addition, citizens were more likely to pursue unnecessary prescriptions and tests since the reimbursement ratio of medical insurance have increased drastically in recent years, especially for retirees. Consequently, these proceeding misconducts have continuously contributed to the waste of scarce medical resources and unbearable financial burden for Chinese.

In order to deal with these public concerns about medical misconducts and over-treatments, the Chinese government proposed that supervising medical institutions via information technology might be an effective strategy to address these problems. As the pioneer in China, the Department of Health in Sichuan Province established the first electronic supervising platform with the aim of conducting full-process monitoring of medical behaviors and costs in December 2016. The platform has been successfully operated and connected with all medical institutions in Sichuan province since July 2017. Thirty measures, including unreasonable prescriptions, unreasonable tests, and average fees for each prescription, were monitored to analyze medical behaviors. As the first governmental initiative to supervise medical institutions electronically, it remains, however, unclear whether the implementation has achieved its intended goal of curbing health costs, such as diagnostic costs.

Chronic obstructive pulmonary disease (COPD), characterized by a progressive deterioration of lung function, is a major public health concern in China with its high prevalence, mortality, and fiscal costs. Patients with COPD are usually accompanied by both mental and physical comorbidities such as dystrophy and heart failure and require multiple medicines and radiographic examinations throughout their stay in hospitals. Therefore, our study aimed to evaluate the effectiveness of first China’s medical supervision program on the hospitalization costs for inpatients with COPD.

2. Materials and methods

2.1. Study setting

The present study included data about 72,113 insured inpatients in Sichuan province, which is located in Southwestern China, with land area of over 48.6 million square kilometers and 83.41 million population. The study sample consisted of inpatients from 32 medical institutions, which were representatives of medical institutions in Southwestern China for the following reasons. First, we included hierarchical (tertiary, secondary, and ungraded hospitals) and multifunctional (general, specialized, and traditional Chinese medical hospitals) medical centers. In addition, we included hospitals of different hospital bed capacity and the leading hospitals in the regional medical alliance. Table 1 presents the characteristics of the 32 hospitals in detail.

2.2. Specific policy intervention

The supervising program was carried out by the Department of Health in Sichuan Province with the tiered context of medical institutions, physicians and medical behaviors. First, the regulatory indicators were defined in several ways to ensure compliance with professional standards and clinical guidelines. Second, the supervising platform was operated to automatically audit those indicators and analyze whether there were any medical misconducts based on horizontal comparison between various institutions and medics, as well as vertical comparison of individual behaviors. If any abnormal behaviors were identified, the inspectors would visit both the administrator of the medical institutions and the physician himself or herself. Then the Department of Health would assess whether the abnormal behaviors are medical misconduct or reasonable ones by reviewing documents relative to the patient, such as treatment protocols and patient files. If the unusual behavior was identified as medical misconduct, then the organization and physician must take measures to dismiss their malpractices, which should be reported to the Department of Health in Sichuan Province. The inspectors are given the right to take mandated steps if the organization does not comply and there is insufficient faith in the organization to eliminate the improper conducts in time. For instance, the inspectors may frequently visit the institution, release media announcements, and penalize the physician including prohibiting him/her, temporarily or even permanently from accepting new patients.

2.3. Outcome variables and data sources

In this study, the total hospitalization costs for inpatients with COPD were mainly incurred by prescription drugs, diagnostic tests, medical services and nursing care. Among these, the drugs were comprised of western medicine and traditional Chinese medicine (TCM). Our primary outcome was defined as the monthly average medical costs, which were calculated via dividing the total expenditures of each medical expenses by the number of inpatients per month. This was done to avoid the bias of results attributes to fluctuations in the number of inpatients in each month. The supervising policy was officially implemented in July 2017, with data in a total of 42 monthly time periods from January 2015 until June 2018 (30 months before and 12 months after the implementations) collected.

After approved by the Institutional Review Board of West China Hospital of Sichuan University, data were derived from...
electronic health records at the 32 hospitals with personal and hospital identification information removed for protecting privacy. Inpatients (1) that hospitalized less than 2 days or more than 60 days; and (2) experienced surgical treatments were excluded.

2.4. Statistical analysis

The ITS, regarded as the strongest and quasi-experimental approach, was used to evaluate the longitudinal effects of the supervision platform.[22,23] The segmented regression analysis of ITS was employed to examine (1) how much an intervention changed an outcome of interest immediately and over time; and (2) whether factors other than the intervention could explain the change. The function of the model is specified as followed:

\[ Y_t = \beta_0 + \beta_1 \text{time}_t + \beta_2 \text{intervention}_t + \beta_3 \text{time after intervention}_t + \epsilon_t \]

Here, \( Y_t \) is the outcomes variable in time \( t \); \( \text{time}_t \) is a continuous variable counting the number of months at time \( t \) from the start of the observation period. In our study, the values of \( \text{time}_t \) range from 1(first period) to 42 (last period). The intervention, is a binary variable coded 0 for the period before the intervention and 1 for after the intervention, which was implemented at month 31. And time after intervention, is a continuous variable counting the number of months after the intervention at time \( t \), which was set at 0 before the reform and sequentially numbers after the supervision. The \( \epsilon \) represents the random variability not explained by the model at time \( t \). For parameters, \( \beta_0 \) estimates the baseline level of the outcome variable, while \( \beta_1 \) captures the monthly change in outcome variable that occurs with each month before the intervention (i.e., baseline trend), \( \beta_2 \) estimates the changes in the value of the outcome variable in the first month after the intervention (i.e., immediately effect of the intervention on outcome) and \( \beta_3 \) estimates the monthly change in the trend after intervention (compared with the pre-intervention trend).

A full set of seasonal dummy variables was incorporated to minimize the seasonal fluctuations in our data. Our interrupted time series regression model was estimated by auto-regressive integrated moving average method (“ARIMA”), with the first-order autoregressive procedure (“AR (1)”) to account for autocorrelation.[24] Lastly, Huber-White robust estimates of the standard errors were computed for each model parameters to control for heteroscedasticity.[25] All data analyses were performed using Stata/SE 15.0 (Stata Corporation College Station, TX, USA).

3. Results

Seventy two thousand and one hundred thirteen inpatients with COPD across 42 months were enrolled in our study. Figure 1 delineates that monthly average inpatient costs saw a decrease of 42.90 Yuan before the implementation of government supervision (\( P < .001 \)), whereas, it witnessed a sharper decrease of 158.70 Yuan in the following months (\( P < .001 \)). The regression model was demonstrated as:

\[ Y = 15718.82 - 42.90\text{time}_t + 498.18\text{intervention}_t - 158.70\text{time after intervention}_t + \epsilon_t \]

Table 2 further depicts the numerical details of level and trend changes in medical costs before and after the supervision. Specifically, the month-to-month decrease of western medicine costs continued with a statistically significant (\( P < .001 \)). Figure 2

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Trend in the monthly average Total hospitalization costs for 32 hospitals in Sichuan.
also depicted an intuitive display of monthly changes in average TCM costs, in which the upward trend before supervision was reversed to a downward trend by 11.80 Yuan ($P = .009$). It was worth mentioning that the previous monthly increasing rate of 10.24 Yuan of diagnostic disappeared and turned into a declining trend of 26.18 Yuan per month following the supervision continued (Fig. 3), but insignificant ($P = .17$). In terms of medical service costs and nursing costs, both the monthly increased trends before the supervision persisted at the first month of supervision were changed into the declining trends with rates of 44.71 Yuan and 11.17 Yuan per month as supervision carried out ($P = .056$, $P = .007$ respectively).

Furthermore, the proportion of total drug expenses accounted for the highest percentage of the total hospitalization costs (60%) in 2015, followed by diagnostic (26.3%) and medical service (13.1%). After 3 years, the ratio gradually changed respectively: drug (4.6% decrease), diagnostic (4.3% increase) and medical service (3.2% increase) considerably.

### 4. Discussion

This work represents the first step in understanding the realistic significance of government supervision in alleviating the financial burden for inpatients with COPD across China. Research suggests the implementation of the electronic supervision technology could be promising in low and middle-income countries (LMICs), which went through similar transitions of medical service model with China. Our findings contribute to the literature around governmental initiatives that hold the promise to promote healthcare reform.

Before the implementation of government supervision, we observed a remarkable decreasing trend in total hospitalization

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**Table 2**

| Parameters                      | Baseline trend $\beta_1$ | Level change after supervision $\beta_2$ | Trend change after supervision $\beta_3$ |
|--------------------------------|--------------------------|----------------------------------------|----------------------------------------|
| **Total hospitalization costs**| 15718.82                 | 498.1815                               | -158.6936                               |
| **Western medicine costs**     | 7306.696                 | -63.31734                               | 498.1815                               |
| **Traditional Chinese medicine costs** | 412.9913                 | -6.43708                                | 498.1815                               |
| **Diagnostic costs**           | 3722.233                 | 72.61699                                | 26.1818                                 |
| **Medical service costs**      | 2003.633                 | 216.7456                                | -44.7062                                |
| **Nursing costs**              | 277.097                  | 45.7024                                 | -11.1657                                |

Parameter estimates, and $P$ values from the full segmented regression models predicting various monthly average medical costs per COPD inpatients in 32 hospitals over time, which was obtained from the following time trend equation: $Y_t = \beta_0 + \beta_1 \text{time}_t + \beta_2 \text{intervention}_t + \beta_3 \text{time after intervention}_t + \epsilon_t.$

$^*P < .05.$
costs and western medicine costs which resulted from the launch of ZMDP,[26] and the results were consistent with those in previous studies.[27] However, our study demonstrated the average total hospitalization costs for inpatients with COPD were 15,609 Yuan before July 2017, equivalent with per capita annual income of rural people contemporary, which undoubtedly continued to pose a heavy economic burden in Chinese.[28,29] What’s worse, the magnitude of the reduction in total hospitalization costs was smaller than the western medicine costs due to the increasing diagnostic and nursing costs, which was also testified in another study, in which the declining effects of ZMDP on hospitalization costs had become weakened and turned into risen eventually.[30] This was because physicians turned to prescribe other lucrative services to compensate for the reduction in drug kickbacks after the ZMDP and insufficient government financial subsidies.[31,32] In our study, the TCM, which was not included in the list of ZMDP, has been excessively prescribed in order to increase revenues.[33] And the diagnostic costs, accounted for the second-largest proportion of total hospitalization costs for inpatients with COPD, no doubt became the target of health providers to offset their loss in drug revenues. Nursing costs, which were easily overlooked because of it taking up the smallest proportion of total medical costs, also appeared to become one of the providers’ targets for compensating the reduction of drug rebates in our study.

Although the Chinese government has tried a series of initiatives to control the soaring health expenses since 2009, the people did not benefit that much due to the persistent existence of various medical misconducts,[34,35] which motivated Chinese government to seek further methods to eradicate over-treatment and misconducts since 2016.[36] Previous studies have demonstrated that clinical supervision of health professionals could not only improve quality of care,[37–40] but also controlled the medical expenses.[41] Therefore, the medical supervision platform in Sichuan province was established to real-time audit medical behaviors, especially over-treatments evoked by improper intends. As the supervision program was implemented, declining trends for almost all medical costs were observed, which suggested the Sichuan supervision model has yielded initial success in decreasing the medical expenses of COPD. The remarkable impacts of the first supervision platform in China may ascribe to constraints of economy and reputation. The inspectors would interview the dean of the hospital and the director of the department once unreasonable medical behaviors were identified via the supervision platform, and physicians with serious medical misconducts would be deprived of medical qualification and lose their job. Meanwhile, the monitoring results would also be considered while evaluating the hospitals and personal, which directly affect the income and reputation of institutions and physicians. Health care professionals started to realize that inappropriate behaviors evoked by financial incentives may not only lead to punishment but also affect their reputation and career.

Reforming Chinese public hospitals is particularly difficult for the balance of physicians’ income and public welfare.[42,43] In the past, researchers paid considerable attention to internal incentives for medical staff to over-treatment, but have not given enough attention to the external role of government.[44] The supervision platform of Sichuan demonstrates that the government monitor could coordinate with other initiatives of China medical reform and serve as an effective tool to improve the performance of public hospitals and benefit the people. It was consistent with Brickley study that suggested both internal and external management have to be aligned to influence clinical
practices directly.[45] The Sichuan supervision model aligned with other policies could boost the success of health care reform in LMICs which are currently going through similar transitions of the medical service model.

4.1. Strength and limitations

This study was conducted in Sichuan province with a large-size study sample to represent the population in Southwestern China. We employed segmented regression analysis of ITS, which is a robust modeling method to measure the dynamic changes following intervention when randomization or identification of a control group was not applicable.[46]

Despite the strength, our study has several limitations. First, we were unable to determine the changes in outpatients with COPD, and that the overall picture regarding the overall costs for this disease could be increased, but also may decrease using the investigated intervention. Further research is needed to investigate the behavioral responses to the supervisions that led to the whole patients with COPD. Secondly, in the present study, we only included the diseases of COPD, thereby one should be cautious to generalize findings to patients with other diseases. Moreover, the impact of supervision on the outcome of treatment was not investigated. Further studies should examine changes in healthcare quality and safety in order to evaluate the government supervision model comprehensively.

5. Conclusions

The government supervision of Sichuan province had achieved its objectives of alleviating the economic burden and curbing misconducts, which were compensations for western medicine rebates after ZMDP. As China is planning to launch the deep round of medical reform in the next decades, the supervision platform of Sichuan province helps to set a demonstration of using information technology to provide early warning and real-time monitoring of medical behaviors via “Medical Three Supervision” platform. http://wsjkw.sc.gov.cn/xx/xwdt/mtxw/201711/t20171121_14235.html. Accessed Jul 11, 2017.

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Author contributions

JW was the principal designer of the proposed study. PY-L led the development of this manuscript and approved all changes. WM-L contributed to the research design and critically revise the manuscript. ZQ-D, ZW-Z were involved in data curations and revised the manuscript for important intellectual content. YZ-H was closely involved in data analysis and interpretation. All authors read and approved the final manuscript.

References

[1] Li L, Fu H. China’s health care system reform: Progress and prospects. Int J Health Plann Manage 2017;32:240–53.
[2] Yip WC, Hisao W, Meng Q, et al. Realignment of incentives for health-care providers in China. Lancet (London, England) 2010;375:1120–30.
[3] Mao W, Yu H, Xie Z, et al. Systematic review on irrational use of medicines in China and Vietnam. PloS One 2015;10:e0117710.
[4] Peng D, Wang X, Xu Y, et al. Antibiotic misuse among university students in developed and less developed regions of China: a cross-sectional survey. Global Health Action 2018;11:1496971.
[5] Mao W, Tang S, Zha Y, et al. Financial burden of healthcare for cancer patients with social medical insurance: a multi-centered study in urban China. Int J Equity Health 2017;16:180.
[6] Jiang C, Ma J, Zhang X, et al. Measuring financial protection for health in families with chronic conditions in Rural China. BMC Public Health 2012;12:988.
[7] Deng J, Tian H, Guo Y, et al. A retrospective and prospective assessment of the zero-markup drug reform in China from the perspective of policy diffusion. Int J Health Plann Manage 2018;33:e918–29.
[8] Yang C, Shen Q, Cai W, et al. Impact of the zero-markup drug policy on hospitalisation expenditure in western rural China: an interrupted time series analysis. Trop Med Int Health 2017;22:180–6.
[9] Tian W, Yuan J, Yang D, et al. Descriptive analysis on the impacts of Universal Zero-Markup Drug policy on a Chinese Urban Tertiary Hospital. PloS One 2016;11:e0162795.
[10] Fu H, Li L, Yip W. Intended and unintended impacts of price changes for drugs and medical services: Evidence from China. Sci Soc Med (1982) 2018;211:114–22.
[11] Huang F, Gan L. The impacts of China’s Urban Employee Basic Medical Insurance on healthcare expenditures and health outcomes. Health Econ 2017;26:149–63.
[12] Cassel CK, Guest JA. Choosing wisely: helping physicians and patients make smart decisions about their care. JAMA 2012;307:1801–2.
[13] He R, Miao Y, Ye T, et al. The effects of global budget on cost control and readmission in rural China: a difference-in-difference analysis. J Med Econ 2017;20:903–10.
[14] Arrow K, Auerbach A, Bertko J, et al. Toward a 21st-century health care system: recommendations for health care reform. Ann Intern Med 2009;150:493–5.
[15] Dorsey S, Pullmann MD, Deblinger E, et al. Improving practice in community-based settings: a randomized trial of supervision - study protocol. Implement Sci 2013;8:89.
[16] General Office of the State Council. Opinions on Reforming and Perfecting the Comprehensive Supervision System of the Medical Industry. http://www.gov.cn/zhengce/content/2018-08/03/content_5311548.htm. Accessed Aug 3, 2018.
[17] Health Commission of Sichuan Province. Comprehensive supervision of medical institutions, continuous supervision of medical personnel, and real-time monitoring of medical behaviors via “Medical Three Supervision” platform. http://wsjkw.sc.gov.cn/xx/xwdt/mtxw/201711/t20171121_14235.html. Accessed Jul 11, 2017.
[18] Guarascio AJ, Ray SM, Finch CK, et al. The clinical and economic burden of chronic obstructive pulmonary disease in the USA. Clinicoeconomics Outcomes Res 2013;5:235–45.
[19] Zhou M, Wang H, Zeng X, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2019;394:1145–58.
[20] Fang X, Wang X, Bai C. COPD in China: the burden and importance of proper management. Chest 2011;139:920–9.
[21] Statistical Bureau of Sichuan. NBS Survey Of Interrupted Time Series Studies in Medication Use Research. 2013:2013–63.
[22] Lagarde M. How to do (or not to do) ... assessing the impact of a policy change with routine longitudinal data. Health Policy Plan 2012;27:806–13.
[23] Wagner AK, Soumerai SB, Zhang F, et al. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther 2002;27:299–309.
[24] Bhauum SK. Principles of Econometrics. 2008.
[25] Xu Y, Cheung YB, Lam KF, et al. A simple approach to the estimation of incidence rate difference. Am J Epidemiol 2010;172:334–43.
[26] Hu S. Essential medicine policy in China: pros and cons. J Med Econ 2013;16:248–94.
[27] Tang W, Xie J, Lu Y, et al. Effects on the medical revenue of comprehensive pricing reform in Chinese urban public hospitals after removing drug markups: case of Nanjing. J Med Econ 2018;21:326–39.
[28] Wu M, Zhao Q, Chen Y, et al. Quality of life and its association with direct medical costs for COPD in urban China. Qual Health Outcomes 2015;13:57.
[29] Yang G, Wang Y, Zeng Y, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet (London, England) 2013;381:1587–2015.
[30] Yi H, Miller G, Zhang L, et al. Intended and unintended consequences of China’s zero markup drug policy. Health affairs (Project Hope) 2015;34:1391-8.

[31] Zhang S, Zhang W, Zhou H, et al. How China’s new health reform influences village doctors’ income structure: evidence from a qualitative study in six counties in China. Hum Resour Health 2015;13:26.

[32] He Y, Dou G, Huang Q, et al. Does the leading pharmaceutical reform in China really solve the issue of overly expensive healthcare services? Evidence from an empirical study. PloS One 2018;13:e0190320.

[33] Zhang Z, Zhan X, Zhou H, et al. Antibiotic prescribing of village doctors for children under 15 years with upper respiratory tract infections in rural China: a qualitative study. Medicine 2016;95:e3803.

[34] Wang J, Wang P, Wang X, et al. Use and prescription of antibiotics in primary health care settings in China. JAMA Intern Med 2014;174:1914-20.

[35] Yip WC, Huo WC, Chen W, et al. Early appraisal of China’s huge and complex health-care reforms. Lancet (London, England) 2012;379:833-42.

[36] Yue W. Great significance of accelerating publishing medical equipment supervision and management regulations. Chinese J Med Instrument 2013;37:40-3.

[37] Snowdon DA, Leggat SG, Taylor NF. Does clinical supervision of healthcare professionals improve effectiveness of care and patient experience? A systematic review. BMC Health Serv Res 2017;17:786.

[38] Dawson M, Phillips B, Leggat S. Clinical supervision for allied health professionals: a systematic review. J Allied Health 2013;42:65-73.

[39] Snowdon DA, Hau R, Leggat SG, et al. Does clinical supervision of health professionals improve patient safety? A systematic review and meta-analysis. Int J Qual Health Care 2016;28:447-55.

[40] Pitts S, Morgan SR, Schrager JD, et al. Emergency department resource use by supervised residents vs attending physicians alone. JAMA 2014;312:2394-400.

[41] Hill Z, Dumbaugh M, Benton L, et al. Supervising community health workers in low-income countries—a review of impact and implementation issues. Global Health Action 2014;7:24085.

[42] Xu J, Jian W, Zhu K, et al. Reforming public hospital financing in China: progress and challenges. BMJ (Clinical research ed) 2019;365:l4015.

[43] Zhao D, Zhang Z. Qualitative analysis of direction of public hospital reforms in China. Front Med 2018;12:218-23.

[44] Fu H, Li L, Li M, et al. An evaluation of systemic reforms of public hospitals: the Sanming model in China. Health Policy Plan 2017;32:1135-45.

[45] Brickley F SC, Zimmerman J. The Economics of Organizational Architecture. JAppl Corporate Finance 1995;8:13.

[46] Bernal JL, Cummins S, Gasparini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. Int J Epidemiol 2017;46:348-55.