Impact of shifting blood donation policy from gift to honour model: staggered difference-in-differences analysis in China

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ABSTRACT

OBJECTIVE

To evaluate the impact of a new blood donation incentive policy—an honour model promoting blood donation quality and quantity to inform future policy changes in China and worldwide.

DESIGN

Staggered difference-in-differences analysis in China.

SETTING

Blood donation policies (from provincial government official websites), annual blood donation data (from China's reports on blood safety and annual reports on development of China's blood collection and supply industry), and demographic and socioeconomic indicators (from China city statistical yearbooks and provincial statistical yearbooks) from 2012 to 2018.

POPULATION

Blood stations from 30 provinces of China; four regions excluded because data not available.

INTERVENTION

The honour model (social recognition through an honour card granting frequent blood donors honorary incentives such as free access to public bus services and outpatient consultations in hospitals) was piloted to stimulate blood donations in intervention provinces.

MAIN OUTCOME MEASURE

Annual total count of blood donations and total count of whole blood donations to measure the quantity of blood donations, and annual donor eligibility rate to measure the quality of blood donations.

RESULTS

The honour model increased blood donation counts by 3.55% (95% confidence interval 1.30% to 5.80%, P=0.003) by the end of the second year of implementation. By the end of the fifth year, this effect had doubled to 7.70% (2.42% to 12.98%, P=0.006). Most of these increases were driven by absolute increases in whole blood donation of 3.34% (1.11% to 5.56%, P=0.005) and 7.23% (1.90% to 12.56%, P=0.01) by the end of the second and fifth years, respectively. The honour model did not significantly affect the donor eligibility rate. The Borusyak-Jaravel-Spiess difference-in-differences analysis, synthetic difference-in-differences analysis, and placebo test all suggested the results were robust.

CONCLUSIONS

The honour model of blood donation increased the quantity of blood donation in China, while donation quality remained unchanged. This impact was sustained after the introduction of the honour model within the study period.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Many countries, particularly developing countries, struggle to sustain an adequate blood supply owing to challenges in long term donor engagement under the gift model

Previous research on the effectiveness of blood donation incentives has yielded conflicting results, raising concerns that they may undermine altruistic motivation

Evidence of the long term impact of such incentives, especially from large, non-"western" nations, remains scarce

WHAT THIS STUDY ADDS

This study evaluated China's honour model, a policy granting frequent blood donors honorary access to public services

Using a staggered difference-in-differences design, the model increased total counts of blood donations by 3.55-7.70% after implementation without compromising safety

The model's core features—non-tradable, non-transferable, and hard-to-value incentives—provide a context independent framework for policy makers in other countries

Introduction

Sufficient blood supply is essential to support global healthcare because millions of lives are saved through blood transfusions each year.[1] However, inadequate blood donation is a global health issue faced by nearly two thirds of countries around the world, particularly low and middle income countries in central, eastern, and western sub-Saharan Africa, Oceania, and South Asia.[1-8] Substantial inequalities have been observed when comparing blood safety and availability between high income countries and low and middle income countries. Global blood collection comprises approximately 118.54 million donations each year, with high income nations, constituting 16% of the world's population, contributing 40% of this total.[1] A marked difference is evident in access to blood in high income countries compared with low and middle income countries. As of 2018, the median donation rate in high income countries was 31.5 units per 1000 people. However, median blood donation rates were much lower in low and middle income countries and low income countries (6.6 units and 5.0 units per 1000 people, respectively). Therefore, an urgent need exists for systematic strategies to ensure that blood and blood products are readily accessible to meet increasing healthcare demands, while maintaining safety standards.[9 10]

Blood donation principles: from commodity model to gift model

The principles underpinning blood donation systems have evolved considerably with changes in societal values, ethical considerations, and public health

priorities. In the early 20th century, blood was traded as a commodity to incentivise people to "transact blood,"[11 12] which was labelled as a commodity model.[13 14] However, the commodity model has been challenged by ethical disputes, quality control issues, and public confidence crises.[15-17] Therefore, many countries began implementing the voluntary non-remunerated blood donation mechanism, which is commonly referred to as the gift model.[18 19] According to the World Health Organization,[4] in 2018, 79 countries collected more than 90% of their blood supply from voluntary, non-remunerated blood donations, including 31 in the European region, 17 in the African region, 13 in the Western Pacific region, eight in the Americas region, six in the Eastern Mediterranean region, and four in the South-East Asia region. Sixty four countries reported collecting 100% or >99% of their blood supply from voluntary non-remunerated blood donations. The gift model has reoriented common perception away from transacting blood to donating blood, but has also led to improved public trust in the blood supply (appendix A in online supplementary materials).[20 21]

In China, voluntary non-remunerated blood donation began in 1998 after the official nationwide implementation of the gift model through the Law of the People's Republic of China on Blood Donation.[22] China has established an efficient national blood supply and collection system covering urban and rural areas (see appendix B in online supplementary materials). However, voluntary non-remunerated blood donation rates have plateaued while the gap between the supply and demand for blood grows. This widening gap is largely driven by increasing demand for blood stemming from advances in medical care and population ageing.[23-31] Under the gift model, the blood donation rate increased from 4.8 units per 1000 people in 1998 to 9.5 units per 1000 people in 2014 (fig 1).[32-36] However, the number of donations and volume of blood collected plateaued over 2012-14.[32] Approximately 60% of blood donations in China were from first time donors,[37] with a large number of those recruited to donate blood not retained.

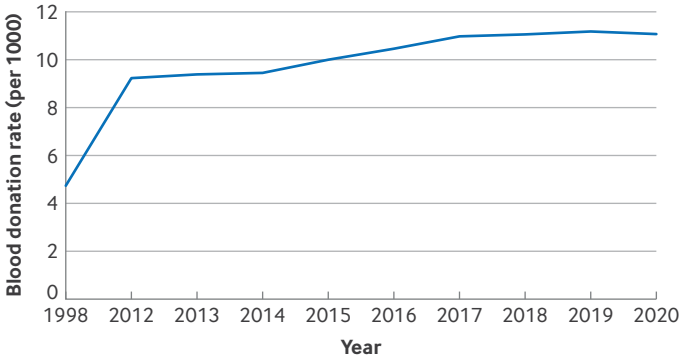

Fig 1 | Trend of blood donation rate from 1998 to 2020 in China.[32-36] Blood donation rates (per 1000) before 2018 were obtained from China's report on blood safety. 2019 and 2020 rates were obtained from the statistical communiqué of the National Health Commission of the People's Republic of China. The communiqué uses the same data source and calculation method

Adding incentives to blood donation: international experience

Policy makers explored granting incentives to blood donors to encourage donations around the world. Substantial field experiments on blood donation incentives were launched, primarily in developed countries, with only a few in low and middle income countries.[38] For example, in the United States, t shirts and coupons triggered 16% more donations, measured by the turnout rate (ie, numbers of donors presenting at American Red Cross drives).[38 39] In Italy, one day of paid leave resulted in a 40% increase in blood donation during their research.[40] In Switzerland, researchers launched a large field experiment with more than 10 000 previous donors and concluded that material rewards (eg, lottery tickets, free cholesterol test, etc) increased blood donation outcomes performance (including useable donations, rejected donations, etc).[41] In one field experiment launched in low and middle income countries, researchers found that coupons for donors increased turnout rates for blood donations and had no impact on blood safety.[42]

Many countries have introduced blood donor incentive policies or regulations. More than 30 countries provide financial incentives for blood donors—for example, cash and tax benefits, healthcare supplements and raffles, with the most common incentive being paid leave.[43 44] However, providing financial incentives for voluntary non-remunerated blood donation is subject to debate when considering regulations (eg, those covering substances of human origin) on unpaid and voluntary non-remunerated blood donations in European countries and findings that financial incentives could potentially crowd out intrinsic altruism.[45]

Despite substantial field experiments proving the effectiveness of blood donation incentives on blood donation performance, those frequently studied were primarily financial and could be converted to cash. Limited evidence has originated from low and middle income countries and quasi-experimental evaluations of blood donation incentive policies are lacking. Moreover, most blood donation policies were not evaluated at the country level. Therefore, our study aimed to address gaps in the evidence by evaluating a new honour model—a combination of social recognition and preferential treatments given to frequent donors through a quasi-experimental design in China. We aimed to characterise key features of the honour model, systematically assess the policy's effects on total counts of blood donations and donor eligibility rates, understand challenges of retaining blood donors, and leverage these findings to provide new guidance for policy makers.

Methods

Definition of honour model: China's initial practices

The gift model places emphasis on voluntariness and altruistic sharing, often at the expense of providing adequate social recognition and benefits to blood donors. For instance, the voluntary non-

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remunerated blood donation award is typically limited to a certificate, with limited preferential treatments for donors. This acknowledgment from the public may fail to generate a substantial social impact. The gift model did not sustain rapid blood supply growth in China because pure altruism is rare in reality. A combination of social recognition for altruism and non-monetary incentives to reward altruism should be considered to maintain the essential supply of blood products.[46]

A new incentive policy has been explored to boost blood donation through a combination of social recognition and honorary access to preferential treatment in addition to the gift model, which is referred to as the honour model. In 2014, the honour model was introduced when Zhejiang Province piloted the use of an honour card as a reward for frequent blood donation. The honour model is on top of the gift model, granting preferential or honorary access to some public services (eg, free access to bus transportation, park visits, outpatient consultations) to frequent blood donors. The aim of the honour model is to reward altruism through honorary non-monetary incentives, to validate their altruistic behaviour and moral integrity, leading to broader social recognition. The honour model ensures that blood donors receive the respect and appreciation they deserve and serves as a strategic mechanism to foster a culture of voluntary non-remunerated blood donation, potentially mobilising more people to donate blood. Figure 2 summarises features of the honour model and compares it with the commodity model and the gift model.

By 2018, three provinces had piloted the honour model: Zhejiang Province in 2014, Jiangsu Province in 2017, and Hebei Province in 2018. More details on the implementation of the honour model in these provinces are provided in appendix B in online supplementary materials. The difference in timing of these pilots across the three provinces and control provinces created a natural experiment evaluating the impact of the honour model in China. Using this natural experiment, we conducted a large quasi-experimental analysis with a staggered difference-in-differences approach to evaluate the long term impact of the honour model on blood donation quantity and quality.

Data sources

Our study period was from 2012 to 2018. We chose an end date one year before the start of the covid-19 pandemic to avoid potential confounding effects of the outbreak on blood donation outcomes and because only data from 2012 to 2018 are now available. The dataset encompassed information from three principal sources over the study period. Firstly, we thoroughly screened blood donation policies from all official websites of provincial and municipal governments from 2012 to 2018. For provinces and cities that implemented the honour model, the time (year and month) and geographical extent of its implementation were documented.

Annual blood donation data, including the aggregate number of blood donations, the count of whole blood donations, and the eligibility rate of blood donors, were extracted from China's reports on blood safety and annual reports on development of China's blood collection and supply industry for 2012-18. These reports included data from all blood stations on the Chinese mainland. We obtained provincial level blood donation information by aggregating data from blood stations for each city within each province. Finally, demographic and socioeconomic indicators were obtained from the China city statistical yearbooks and the provincial statistical yearbooks for the same timeframe. These indicators encompassed data on the population of permanent residents, gross domestic product (GDP) per capita, and the density of

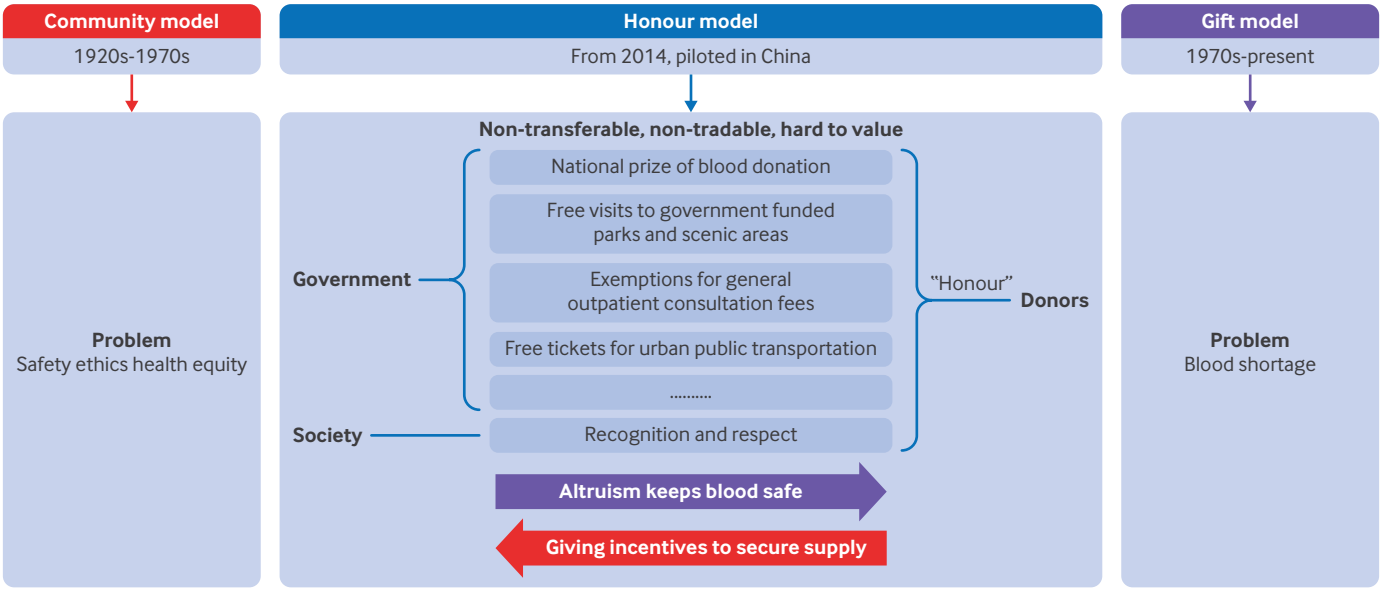

Fig 2 | Concepts of honour model and distinction between commodity, gift, and honour models

college students per 10 000 people, which were used as covariates to account for potential confounding variables in the analysis. We linked different sources of data according to provinces and years of the data.

Tibet was excluded from the study because blood stations were not required to collect and distribute blood during the study period (except in Lhasa), and so data on blood donations were not available. The study included a total of 30 Chinese provinces.

Variable construction

Honour model indicator

The primary explanatory variable in this study is the implementation of the honour model of blood donation, which is represented as a binary variable. Provinces were categorised according to whether and when they adopted this model during the study period of 2012-18. Only three provinces introduced the honour model during this time. Detailed information about the incentive policies implemented by these three provinces, which met the criteria of the honour model, is summarised and explained in appendix B in online supplementary materials. The remaining provinces, which served as the control provinces, continued to use the gift model of blood donation.

Dependent variables

The dependent variables include the total count of blood donations each year, which reflects the overall participation in blood donation activities in each province, and more specific measures (eg, the annual count of whole blood donations) that delineate distinct types of blood donation practices. These variables were subjected to logarithmic transformation to address skewness. The total annual count of blood donations and the annual count of whole blood donations were designated as primary outcomes because they reflect the predominant choices made by blood donors. The annual blood donor eligibility rate is also a critical outcome because it represents the proportion of people who passed the necessary health screenings and were deemed eligible to donate blood. This variable provides an important measure of the supply of safe blood (ie, blood quality) and the impact of donor recruitment efforts.

Covariates

The covariates, which have been log transformed, include the number of permanent residents, GDP per capita, and the number of college students per 10 000 people. These variables are incorporated to control for differences in population size, economic conditions, and educational attainment, respectively. Log transformed GDP per capita is a widely used measure to represent the socioeconomic profiles of each province. Economic development may exert influence on the implementation of policies and the performance of blood donation activities. We included the other two variables to account for population density and the presence of healthy people, given that permanent residents and college students represent two important subgroups of blood donors.

Study design

Comparisons of intervention group and control group

The intervention group comprised provinces that implemented the honour model during 2012-18. Provinces that had not yet implemented the model within the study period were included in the control group (table 1). The honour model is in addition to the gift model—that is, equal to the gift model plus an honorary award in the form of an honour card issued only to frequent blood donors who have donated more than 20 times. The honour model aims to promote blood donations by raising social recognition and respect for long term, frequent blood donors awarded honour cards. During the study period, donors given an honour card received free access to bus transportation, park visits, and outpatient consultations.

Quasi-experimental design for impact evaluation

Quasi-experimental methods can be applied when assignment is self-selected by programme administrators or by beneficiaries themselves and where one of the credible methods is the difference-in-differences (DiD) approach.[47] We implemented a staggered DiD approach, leveraging the staggered rollout of the honour model (ie, Zhejiang was the first province to implement the honour model in 2014, followed by Jiangsu in 2017 and Hebei in 2018), as a natural experiment. The core assumption of identifying the policy effects of the honour model is the parallel

Table 1 | Checklist of honour model and gift model

Checklist	Honour model (intervention group)	Gift model (control group)
Definition	On top of the gift model, granting honours (combination of social recognition and preferential treatments) to frequent blood donors owing to their longlasting altruistic behaviours	Blood is a gift to the most needed and more than a product. Blood donation should be voluntary and based on altruism
Aim	To reward altruism through honorary preferential treatments and raise social recognition and respect for frequent blood donors owing to their longlasting altruistic blood donation behaviours	To ensure blood donation is a voluntary action and altruism is the core value of blood donation
What donors gain	Altruism plus honour card plus honorary access to public services or preferential treatment (only eligible for frequent blood donors)	Altruism
Features of gain	Incentives in honour model should be non-tradable, non-transferable, and hard to value	Certificates with limited recognitions

In the gift model, altruism is the key feature of blood donation. However, appropriate subsidies and compensations are permitted for costs that have already been incurred (eg, leave for health recovery after donations).

trend assumption. This assumption requires a common trend of outcomes that would have evolved in parallel in the average outcome for the intervention and control groups if the policy or intervention had not occurred. A validated parallel trend assumption is the core of generating unbiased estimates of the policy impact.[48] In our setting, in the absence of the honour model, regardless of the baseline donation performance, blood donation outcomes in the intervention and control groups would have followed parallel trends—that is, the outcomes of the intervention group would have changed in the same way as those of the control group. Any divergence from this trend after the introduction of the honour model was attributed to the effect of shifting the model from gift to honour.

The intervention group consisted of regions that introduced the honour model during the study period, while the control group included regions that had not adopted the honour model and continued using the gift model until the end of the study period. By comparing changes in blood donation outcomes between these two groups, we estimated the impact of shifting blood donation policy from the gift model to the honour model. The staggered nature of policy adoption allows us to conduct a dynamic analysis, examining how the effects of the honour model evolved over time.

Statistical analysis

To evaluate the impact of the honour model on the quantity and quality of voluntary non-remunerated blood donation in China, we applied the Sun and Abraham[49] DiD estimator. This method addresses biases that arise from heterogeneity in treatment effects owing to staggered policy implementation across regions. Canonical DiD models typically use two way fixed effects, controlling for unit and time fixed effects (eg, region and year). However, recent research[48] indicates that the two way fixed effects model may produce biased estimates when treatment effects vary by timing or duration of policy exposure. In this study, we suggest that the effects of the honour model may differ depending on the adoption time, with greater effects manifesting over time as the model's influence on donation behaviour became more established. The Sun and Abraham estimator provides straightforward lead and lag estimates that eliminate two sources of bias by using the never treated regions as the comparison. Firstly, the estimator mitigates the contamination of before and after policy estimates caused by heterogeneous treatment effects across time periods. Secondly, it corrects bias that arises from variation in timing of policy implementation, ensuring the cohort specific average treatment effects on the treated (ATTs) are accurately captured.[48 49] By analysing each annual cohort of regions enacting the honour model, we use the robust Sun and Abraham estimator to determine the causal impact of the honour model on blood donation each year after implementation.

The Sun and Abraham DiD approach further allows for dynamic treatment effects by generating event study plots that show the ATT for each year before and after policy adoption. This approach helps visualise how the effects of the policy evolve over time, capturing immediate and longer term impacts. For each event study plot, we evaluated the parallel trends assumption by assessing whether estimates before policy implementation showed no major differences in outcomes between the provinces that adopted the policy and those that did not. The honour model is established by authorities at the regional level. Donors who are eligible for an honour card can decide whether to receive the honour card and the award, and if they want to use the preferential access to public services. Therefore, our results represent the real life, or intention-to-treat, impact of establishing the honour model on blood donation outcomes.[50]

We also conducted city level analyses to support the statistical power and reliability of our findings at the provincial level. Because each city in China has only one blood station to aggregate and examine all donated blood from collection points and mobile blood drives, city level analyses are simultaneously controlled for blood station fixed effects and city level fixed effects. In city level analyses, intervention groups are defined as cities or blood stations that have implemented the honour model during 2012-18 (appendix F in online supplementary materials).

We performed three robustness checks and one falsification test to show the robustness of our results. Firstly, we used alternative staggered DiD specifications (ie, Callaway and Sant'Anna DiD[51] estimation) and an imputation method (known as Borusyak-Jaravel-Spiess DiD estimation; appendix C in online supplementary materials)[52] and overlaid alternative DiD results with our main specification. Secondly, given that only three provinces piloted the honour model on blood donation, we adopted a synthetic DiD to further show the robustness of our results (appendix D in online supplementary materials).[53-55] Thirdly, we selected outcomes that could further evaluate the impact of the honour model on blood safety. These outcomes were rates of donations negative for transfusion transmitted infectious testing, including testing for alanine aminotransferase, hepatitis B virus, and syphilis (appendix E in online supplementary materials). Finally, a DiD falsification test was conducted that examined an outcome not expected to be affected by the staggered rollout of the honour model; however, to some extent, it was similar in nature to our primary outcomes (appendix H in online supplementary materials). In this study, we used annual social donated funding for education as the outcome because the social funding for education is similar in nature to voluntary non-remunerated blood donation that benefits collective goods.

We also conducted several additional analyses to enrich our findings. Firstly, because socioeconomic profiles generally varied across different regions and may generate distinct policy effects on blood donation outcomes, we conducted coarsened exact matching and used Sun and Abraham DiD specifications with the matched pairs from the intervention and control groups at the provincial level and the city level to

improve comparability between the intervention group and the control group (appendix G in online supplementary materials). Secondly, we evaluated the impact of the honour model on stimulating numbers of donors who received the national awards of voluntary non-remunerated blood donations; that is, the awarded donors were issued honour cards with free access to preferential treatments in the intervention group (appendix I in online supplementary materials).

Finally, we conducted additional data analyses from three perspectives to explore potential mechanisms of how the honour model affected blood donation outcomes (see appendix I in online supplementary materials). Firstly, we examined whether latency exists because generally most policies may have latency effects. Secondly, we analysed the impact on the numbers of honour cards issued and the numbers of national prizes awarded to evaluate how the honour model encouraged frequent blood donors to donate more often. Finally, we examined the effects on the revenue of popular scenic areas to show whether implementing the honour model caused any financial burdens to the authorities.

All statistical analyses were performed using Stata 18.0, with results presented as coefficient estimates and 95% confidence intervals. Statistical significance was set at the conventional 5% level.

Patient and public involvement

Patients and members of the public were not directly involved in the planning, design, or conduct of this study. In our research, the time of the public involvement was the same as the staggered rollout of the honour model during 2012-18. All people who are eligible for blood donations on the Chinese mainland are potentially influenced by the honour model. The introduction of the new honour model directly motivated the study question. The findings may inform policy makers and the public about the impact of China's honour model in the intervention group and may encourage more provinces to pilot the honour model.

Results

Sample characteristics

We analysed data from 30 provinces of China, accounting for more than 99% of the population on the Chinese mainland. Appendix figure J1 (online supplementary materials) shows the exclusion criteria for provinces. Table 2 summarises the descriptive statistics for the control and intervention provinces during the study period. Table 2 also shows the mean, median, and standard deviations of covariates to describe socioeconomic profiles. Over the study period, both groups of provinces experienced similar demographic and economic shifts. We observed increases in GDP per capita by 55.22% in the intervention provinces and by 60.90% in the control provinces, increases in the number of permanent residents by 5.12% in the intervention provinces and by 3.11% in the control provinces, and increases in the numbers of college students per 10 000 by 7.96% in

Table 2 | Descriptive statistics of covariates within the study period

	Control provinces (n=27)			Intervention provinces (n=3)			
Characteristics	Mean	Median	Standard deviation	Mean	Median	Standard deviation	Mean difference (95% CI)
GDP per capita (yuan)							
2012	38 970.30	32 609.00	17 900.79	53 158.00	61 097.00	18 657.50	−14 187.70 (−36 571.91 to 8196.50)
2013	44 546.22	35 139.00	25 883.48	57 073.00	65 105.00	20 902.35	−12 526.78 (19 336.73 to 44 390.28)
2014	45 776.70	37 580.00	19 758.33	60 595.67	68 569.00	23 155.54	−14 818.96 (−39 776.45 to 10 138.53)
2015	48 272.96	39 692.00	21 377.66	65 047.00	73 276.00	25 936.77	−16 774.04 (−43 869.40 to 10 321.33)
2016	51 893.41	43 009.00	23 508.15	69 910.00	78 384.00	27 965.10	−18 016.59 (−47 753.65 to 11 720.47)
2017	57 196.59	46 631.00	25 685.65	76 421.67	85 612.00	31 400.92	−19 225.07 (−51 805.97 to 13 355.82)
2018	62 703.78	51 658.00	27 951.57	82 515.33	93 230.00	34 616.84	−19 811.56 (−55 314.62 to 15 691.51)
Average	49 908.57	43 009.00	24 202.05	66 388.67	68 569.00	24 424.94	−16 480.10 (−28 464.84 to −5495.37)
No of permanent residents ($\times 10^4$)							
2012	4231.56	3724.00	2770.84	7022.33	7262.00	1235.07	−2790.78 (−6144.65 to 563.09)
2013	4256.11	3666.00	2794.35	7088.00	7288.00	1216.39	−2831.89 (−6213.05 to 549.27)
2014	4281.41	3677.00	2823.35	7164.67	7323.00	1203.34	−2883.26 (−6298.49 to 531.97)
2015	4300.81	3708.00	2852.92	7215.00	7345.00	1170.43	−2914.19 (−6363.44 to 535.07)
2016	4327.22	3758.00	2892.07	7276.00	7375.00	1157.68	−2948.78 (−6444.29 to 546.73)
2017	4349.19	3803.00	2926.78	7334.00	7409.00	1128.37	−2984.82 (−6520.73 to 551.10)
2018	4363.37	3822.00	2957.62	7381.67	7426.00	1087.18	−3018.30 (−6589.62 to 553.03)
Average	4301.38	3724.00	2814.77	7211.67	7345.00	988.45	−2910.29 (−4131.72 to −1688.85)
No of college students per 10 000 people							
2012	74.70	70.00	35.51	122.67	113.00	26.84	−47.96 (−91.55 to −4.38)
2013	76.30	70.00	36.29	125.33	118.00	27.74	−49.04 (−93.60 to −4.47)
2014	77.44	70.00	36.51	127.00	118.00	28.58	−49.56 (−94.43 to −4.68)
2015	78.41	71.00	36.75	128.33	118.00	29.87	−49.93 (−95.18 to −4.67)
2016	79.30	73.00	36.81	131.00	120.00	31.00	−51.70 (−97.12 to −6.29)
2017	80.52	77.00	37.19	131.67	121.00	31.39	−51.15 (−97.03 to −5.27)
2018	81.63	79.00	37.73	132.33	122.00	30.83	−50.70 (−97.18 to −4.23)
Average	78.33	74.00	36.17	128.33	118.00	24.92	−50.01 (−65.99 to −34.02)

CI=confidence interval; GDP=gross domestic product.

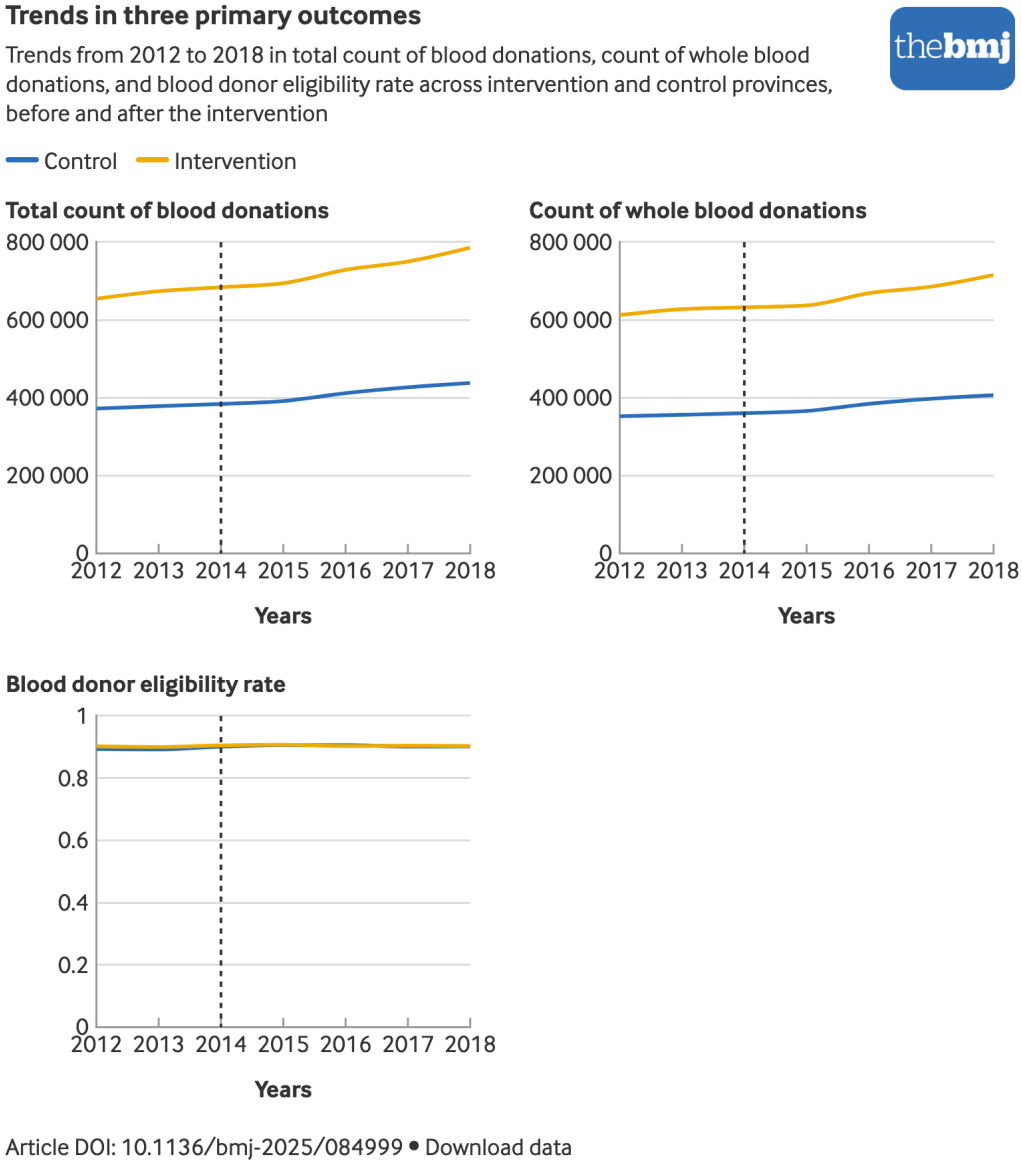

Fig 3 | Trends in three primary outcomes from 2012 to 2018: total count of blood donations, count of whole blood donations, and blood donor eligibility rate. An interactive version of this graphic and downloadable data are available at https://public.flourish.studio/visualisation/27108001/

the intervention provinces and by 9.22% in the control provinces. Figure 3 shows the trends over the study period for the three primary outcomes. For all three outcomes, a parallel trend was seen before 2014.

Sun and Abraham DiD estimation on blood donation quantity and quality

Table 3 shows the results of the staggered Sun and Abraham DiD estimates. We took the logarithmic forms of counting data and GDP per capita because they are usually subject to log normal distribution and this allows the coefficients of interest to be interpreted as ATTs measured as percentages. For the total count of blood donations, the estimated ATT was insignificant at period 0 (1.06%, 95% confidence interval (CI) −0.34% to 2.46%); that is, no statistically significant effects were generated at the time when the honour model was first introduced. However, statistically significant ATT estimates were observed from period 1 to period 4; that is, from the second year of adopting the honour model and onwards. The magnitude of estimated effects and the significance level for those estimates increased over time. Specifically, at period 1, the estimated ATT is 3.55% (95% CI 1.30% to 5.80%, P=0.003), indicating an average increase of 3.55% in the total count of blood donations attributable to the policy in provinces that were exposed to the policy. For periods 2 and 3, the estimated ATT is 3.65% (0.56% to 6.75%, P=0.02) and 4.42% (0.37% to 8.48%, P=0.03), respectively. By period 4, the ATT estimate reaches

7.70% (2.42% to 12.98%, P=0.006), suggesting an even greater impact on increasing the total count of blood donations.

A similar pattern can be observed when examining the count of whole blood donations. Statistically significant ATT estimates are observed from period 1 to period 4, with a consistent increase in magnitude (period 0: 1.12%, 95% CI −0.25% to 2.49%; period 1: 3.34%, 1.11% to 5.56%, P=0.005; period 2: 3.45%, 0.31% to 6.59%, P=0.03; period 3: 4.26%, 0.11% to 8.42%, P=0.05; period 4: 7.23%, 1.90% to 12.56%, P=0.01).

The staggered DiD analyses also showed that blood safety was not compromised after introducing the honour model. For the blood donor eligibility rate, positive ATT estimates can be seen from period 0 to period 4; however, none of these estimates are statistically significant at the 5% level, suggesting that no significant changes in blood donor eligibility rate occurred during the study period.

City level analyses of honour model on blood donation outcomes

We found the results of city level analyses aligned with provincial level analyses, with an absolute increase in total count of blood donations and count of whole blood donations during 2012-18. Statistically significant ATT estimates were observed during most periods after the intervention for total count of blood donations, with a consistent increase in magnitude (period 0: 1.55%, 95% CI −0.37% to 3.48%; period 1: 3.18%, 0.30% to 6.06%, P=0.03; period 2: 4.72%, 0.57% to 8.86%, P=0.03; period 3: 4.19%, −2.83% to 11.23%; period 4: 7.13%, −0.79% to 15.04%, P=0.08). We observed a similar trend for count of whole blood donations at the city level, with an absolute increase in magnitude (period 0: 1.36%, 95% CI −0.64% to 3.35%; period 1: 2.97%, −0.07% to 6.00%, P=0.06; period 2: 4.59%, 0.32% to 8.87%, P=0.04; period 3: 4.39%, −2.96% to 11.73%; period 4: 7.35%, −1.36% to 16.07%, P=0.10). We did not find a decrease in blood donor eligibility rate. Additional analyses were also conducted by using Callaway and Sant'Anna DiD estimation and similar and consistent results were generated, showing the robustness at the city level. Appendix figures F1-F6 show event study plots; appendix tables F1-F3 summarise the coefficient estimations (online supplementary materials).

Robustness checks using alternative DiD estimations

We used the event study framework to show the dynamic results before the introduction of the honour model. Although Sun and Abraham DiD analysis requires parallel trends between the intervention group and the control group in the absence of policy implementation, it does not require two groups to be similar, which allows us to evaluate the effects of the honour model. The results shown in figure 4 align with the parallel trends assumption because the ATT estimates for the periods before implementation of the honour model remain close to zero, showing no significant pre-existing trends. With the introduction of the honour model, the magnitudes of ATT estimates show a clear upward trend, reflecting the increasing effectiveness of the policy in motivating blood donors over time. In appendix figures C1-C3 (online supplementary materials), we overlaid different estimators in the event study plots. The overlaid coefficient plots show a consistent insignificant trend before the implementation of the honour model at the provincial and the city level, confirming the credibility of the parallel trend assumption in our setting.

Four additional robustness checks were done to show the consistency of our results. Firstly, we used alternative DiD estimations, including Callaway and Sant'Anna DiD and Borusyak-Jaravel-Spiess DiD estimations, to show the robustness of our results under the event study framework. Appendix tables C1-C3 (online supplementary materials) compare the magnitudes and significance of the estimates from these analyses with those from our main specification. This comparison shows that the ATT estimates for each normalised period in the event study setting do not vary. Appendix figures C1-C3 (online supplementary materials) overlay the event study plots constructed using Sun and Abraham DiD estimation and the other two alternative DiD estimations. With the exception of a violation of the parallel trends assumption for blood eligibility rates when using Borusyak-Jaravel-Spiess DiD estimators, all other results show similar magnitudes and trends.

Table 3 | Sun and Abraham difference-in-differences analysis: effects of blood donation incentive policy in each period after the intervention compared with changes over normalised time period in China

	Difference in total count of blood donations		Difference in count of whole blood donations		Difference in blood donor eligibility rate	
Period	Estimate (%)	P value	Estimate (%)	P value	Estimate (percentage points)	P value
Period 0	1.06 (−0.34 to 2.46)	0.13	1.12 (−0.25 to 2.49)	0.11	0.16 (−0.65 to 0.98)	0.69
Period 1	3.55* (1.30 to 5.80)	0.003	3.34* (1.11 to 5.56)	0.005	0.01 (−1.75 to 1.73)	0.99
Period 2	3.65* (0.56 to 6.75)	0.02	3.45* (0.31 to 6.59)	0.03	0.05 (−2.03 to 1.95)	0.97
Period 3	4.42* (0.37 to 8.48)	0.03	4.26* (0.11 to 8.42)	0.05	0.64 (−2.00 to 3.28)	0.62
Period 4	7.70* (2.42 to 12.98)	0.006	7.23* (1.90 to 12.56)	0.01	0.60 (−2.65 to 3.85)	0.71

95% confidence intervals are given in brackets.
Estimated ATTs (average treatment effects on the treated) for total count of blood donations and count of whole blood donations are given as percentages, and estimated ATTs for blood donor eligibility rate are presented as percentage points. Period 0 is normalised as period when honour model was implemented in staggered rollout, and consecutive periods 1-4 represent one to four years after implementation, or second to fifth year of implementing honour model.
*Estimates are statistically significant at α level of 0.05.

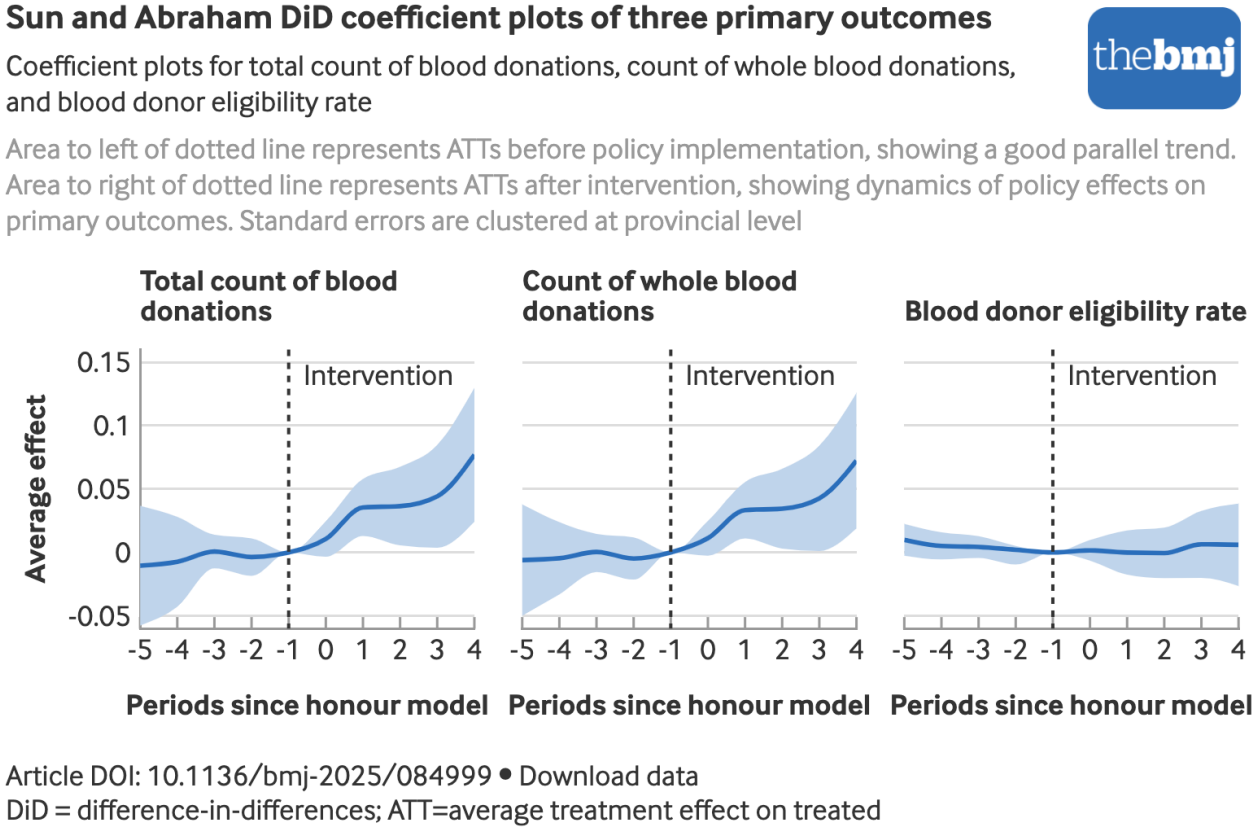

Fig 4 | Sun and Abraham difference-in-differences coefficient plots of three primary outcomes: total count of blood donations, count of whole blood donations, and blood donor eligibility rate. An interactive version of this graphic and downloadable data are available at https://public.flourish.studio/visualisation/27108117/

Secondly, we conducted a synthetic DiD estimation because there are only three intervention provinces. We obtained a similar monotonical increasing trend of the ATT estimates on count of blood donations and a similar stable trend of blood donor eligibility rate, despite a lower significance level of 10% (see appendix figures D1-D3 and appendix table D1 in online supplementary materials). Thirdly, our blood safety evaluations (ie, rates of donations negative for transfusion transmitted infectious testing for alanine aminotransferase, hepatitis B virus, and syphilis) showed that the honour model did not significantly affect rates of detection of these markers, and so provided evidence that blood safety was maintained in the intervention group under the honour model within our study period (appendix figures E1-E3 in online supplementary materials).

Finally, to enhance comparability between the intervention group and the control group, we performed coarsened exact matching and used Sun and Abraham DiD specifications for policy evaluations at the provincial and city levels. Appendix G (online supplementary materials) shows details of coarsened exact matching. In appendix figures G1 and G2, provincial and city level analyses showed an increasing trend in total counts of blood donations, and the magnitudes of each estimate are lower than the main specifications.

Sensitivity analysis

We performed a falsification test that examined an outcome not expected to be affected by the staggered rollout of the blood donation policy, but similar in nature to the primary outcomes. We selected social funding for education as the outcome for the falsification test because the behaviour induced by the honour model could spill over to other similar prosocial behaviours that benefit collective goods. The falsification test was conducted under the event study framework using Sun and Abraham DiD estimation to visualise the dynamics before and after the honour model was introduced. Appendix H (online supplementary materials) shows the coefficient plot. The result in appendix figure H1 suggests that introducing the honour model did not generate similar effects to the behaviour of donating social funding for education.

Several additional analyses aimed to explore the mechanisms of how the honour model had an impact on blood donation outcomes. In appendix I (online supplementary materials), we used semi-dynamic DiD estimations to show the latency of policy effects on blood donation counts. The strong policy effects were

primarily attributed to periods after implementation (appendix table I2). We also selected the numbers of honour cards issued and national prizes awarded for blood donation as outcomes to show that the honour model increased these numbers. Finally, we selected ticket revenues from scenic areas as an outcome to show that the honour model did not have a negative impact on ticket revenues.

Discussion

Our findings show that the honour model can drive sustained improvements in blood donation counts without compromising blood safety. We discuss in detail how our findings contribute to the blood donation literature.

Absolute increase in blood donation quantity

After introducing the honour model, the total count of blood donations increased from 1.06% to 7.70% monotonically, and simultaneously, the count of whole blood donations increased from 1.12% to 7.23%. Previous studies from the United States, Switzerland, and Italy showed that explicit incentives for blood donations, ranging from small coupons to a paid day off work, can increase blood donations,[38 40] which aligns with our findings. The trend of increasingly larger effects on blood donations over time could be explained by the following: higher response rates to the honour model owing to more intensive announcements about the model over time; regular blood donors responding more frequently to the honour model and donating blood over time; and strengthening policy effects with increasing length of implementation in the intervention group.[56] We prefer the third explanation because we did not observe substantial changes in the intensity of announcements within the intervention group over the study period. Analyses in appendix I (online supplementary materials) show that the honour model is more likely to affect those who have previously been aware of blood donation and is not likely to receive support from or reach those who seldom care about blood donation.

Not compromising blood safety

Our findings suggest that introducing the honour model did not compromise blood safety as shown by insignificant ATTs on the blood eligibility rate. The blood eligibility rate assesses the quality of donated blood when donors are screened. After the honour model was implemented, the blood eligibility rate remained stable throughout the study period. Additional analyses on the rates of donors negative for alanine aminotransferase, hepatitis B virus, and syphilis detection provided evidence that implementing the honour model had no impact on blood safety related outcomes. We also conducted an analysis using the annual incidence of HIV/AIDS for each province from 2012 to 2018 as the outcome to further prove that the honour model did not affect blood safety (see appendix figure E4 in online supplementary materials).

Previous literature has shown the importance of ensuring the safety of donated blood products.[18] To mitigate the risk of adverse events caused by blood transfusions, China has implemented a series of regulations to safeguard the blood supply. The proportion of people with newly diagnosed HIV/AIDS after HIV transfusion transmitted infectious testing has reduced from 29.6% in 2005 to less than 0.15% in 2013.[22] This decrease has been attributed to the implementation of standardised procedures for donor screening and introducing the gift model.[29] Our analyses found that while the honour model contributed to an increase in the count of blood donations, the additional volume of blood donations did not affect the quality of blood products in China. The quality of the blood supply is likely because of the continued implementation of standardised donor screening procedures, which preserve the advantage of the gift model.[31]

Blood donation incentive policy implications

Our findings have important policy implications. Previous researchers have summarised two phases of blood donation over the past hundred years—the commodity model phase and the gift model phase. The commodity model was characterised by monetary incentives for those willing to sell blood, while the gift model was driven by altruism, emphasising the act of granting the gift of life.[14] Researchers summarised blood donation incentives from 63 countries across six continents.[43] The results showed that 28 of 63 countries reported high level financial incentives, including Nigeria and the Democratic Republic of Congo (Africa), Indonesia (Asia), Poland (Europe), and the US and Panama (North America). In contrast, South American countries, New Zealand, and Australia generally did not provide financial incentives.[43 44] However, we are only aware of a few countries that have combined incentives with social recognition. Therefore, China is currently implementing the honour model, which combines non-monetary incentives, such as preferential treatment, with social recognition.

Because the blood donation rate has plateaued under the gift model, we explored a new model that could integrate the strengths of the commodity model and the gift model. We proposed “honour” to be the core value of the new model. The honour model aims to recruit more blood donors by granting free access to some public services to those who have received the honour card. This approach conveys a message of respect for blood donors to both donors and the public, and has several key attributes. Firstly, any economic incentives offered under the honour model should not be in the form of money. The incentives should only be usable by those with an honour card and not be sold for monetary gain. Secondly, the honour model also introduced a social incentive in the form of recognition for the act of blood donation; this incentive is difficult to value. By honouring the act of blood donation, local authorities can set positive examples for society and promote altruistic values. Finally, countries

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considering the honour model should ensure a rigorous and standardised blood donation screening process, adequate transfusion training, and robust enforcement of voluntary blood donation laws to guarantee blood safety.

In essence, the honour model works by encouraging blood donors to be proud of their own achievements and to be recognised as respectable and moral people.[57 58] The general attributes of honour related incentives—non-tradable, non-transferable, and hard to value—ensured the honour model worked as expected. As long as the general attributes are satisfied, policy makers can design culture related incentives similar to (or different from) those we have used here. Even in China, the incentives of the honour model are evolving from the initial forms of free access to public transportation, outpatient consultations, or park visits. For example, Jiangxi Province implemented an honour model in 2025 where honoured donors can enjoy priority outpatient consultations at medical institutions.

However, our study adds a new dimension to the literature on blood donation incentives, inviting replication of the success in other countries, especially low and middle income countries where resources are relatively limited. Previous studies from the US, Switzerland, and Italy showed that explicit incentives for blood donation, ranging from small coupons to a paid day off work, increased blood donations[38-40 59] through direct and instantaneous compensation that is easy to value and received after each donation. We found one report of a similar practice in a middle income country (Argentina), where giving donors incentives of $60 and $100 vouchers triggered a 0.5-1.1% increase in turnout, but had no effects on useable blood donation rate.[42] Interestingly, effects of incentives on prosocial behaviours appeared to be highly context dependent and heterogeneous.[60 61] In Argentina, purely social recognition incentives (ie, a newspaper mention) did not generate effects on blood donor recruitment.[42] However, a symbolic prize (medal) for donors in Italy enhanced blood donation frequency.[62] Our findings indicated that a combination of social recognition and preferential treatments yielded positive intention-to-treat effects on total counts of blood donation without any negative impact on blood safety in China. Obviously, further research on implementing the honour model in different countries is warranted.

Strengths of this study

Our study has the following strengths. The findings provide robust evidence on the effectiveness of a blood donation incentive policy in China, a country that accounts for approximately 20% of the global population and has the potential to influence the worldwide blood supply. This study evaluated the effectiveness of a blood donation policy at the national level in a large middle income country. The findings are expected to raise awareness among policy makers about implementing a similar honour model to enhance blood donation in other provinces of China and in other countries that have blood supply shortages.

We observed a causal impact of the honour model on blood donation quantity. The staggered introduction of the honour model offers an ideal setting for using the DiD approach by comparing changes in blood donation quantity and quality in the intervention group with the control group at the provincial and city level in China. We identified 30 provinces (including all cities under each province) that had a blood donation policy document available on their respective government official websites. Other permissible strategies to reimburse donation related costs, as outlined in the Law of the People's Republic of China on Blood Donation, include waived blood transfusion fees, donor specific health examination services, and so forth. These practices did not confound our results because this law is enforced nationwide across provinces in the intervention and control groups. Appendix B (online supplementary materials) provides details. Our study identified the causal relation at the national level using robust DiD estimators to address heterogeneous treatment effects. Additionally, we conducted comprehensive robustness tests, coarsened exact matching analyses, and a falsification test to further validate the robustness of our results.

Our study introduced the concept of the honour model of blood donation, which builds upon the well established gift model. We argue that the honour model could serve as a new guiding principle for blood donation in which altruism is rewarded by non-monetary social incentives to show respect to blood donors. These incentives should be non-tradable, non-transferable, and hard to value. The reason for labelling the features of the honour model in this way was to summarise some context independent features that could benefit policy makers from other countries. The honour model is more than free access to public transportation, outpatient consultations, and park visits. Policy makers could design their own feasible incentives according to the context independent features of the honour model.

Limitations

Our study has several limitations. The study is limited by observations from only three provinces that implemented the honour model, and the intervention duration was relatively short in Jiangsu Province and Hebei Province. However, by using the staggered DID approach and a synthetic DiD approach for robustness checks, we argue that the parallel trends assumption holds within our study, despite the existence of a violation of this assumption when using Borusyak-Jaravel-Spiess DiD estimation. Our findings are consistent across different robust DiD specifications, which mitigates concerns over their validity. Comprehensive city level analyses were also conducted to improve the statistical power and reliability of our findings.

During our study period, some cities within control provinces also announced they were implementing a similar honour based incentive policy. We did not include these cities in the intervention group because

we analysed our outcomes at the provincial level. Therefore, to mitigate these concerns, we provided city level analyses and included all cities that implemented similar honour based incentive policies during the study period. The consistent increasing trends in quantity outcomes and insignificant results in quality outcomes further showed the robustness of our findings at the provincial level. We decided to refrain from including the period after the covid outbreak in our study because the pandemic might have had an unexpected impact on blood donation performance, potentially leading to imprecise estimation of the impact of the honour model. We did not include data from before 2012 owing to limited availability.

We acknowledge that our findings may be influenced by the early adopters within our setting. At the provincial level, because Jiangsu and Hebei have limited intervention periods, the major contribution of the increasing effects was from Zhejiang Province. However, by adding city level analyses, we enhanced the statistical power and generated more reliable results that were consistent with our findings at the provincial level. Furthermore, although we conducted comprehensive robustness checks and sensitivity analyses to show the validity of our findings, we could not rule out concerns about generating a context dependent conclusion where the honour model may not be as effective as it was in China. However, we tried to label the context independent features of the honour model (ie, non-tradable, non-transferable, and hard to value) for policy makers in different contexts to design feasible incentive strategies under the guidance of the honour model framework. Finally, because our research is an intention-to-treat analysis, we could not explore donor level characteristics and mechanisms under the honour model. In future research, researchers could use routinely collected donor profiles to explore how donors respond to the honour model at the donor level; for example, by using a machine learning approach to investigate donor characteristics.[63]

Conclusion

After quasi-experimental evaluation, we concluded that the honour model showed positive effects by increasing the number of blood donors while maintaining the quality of donations in China. We summarised the key features of the policy (ie, to provide frequent donors non-monetary incentives to reward altruism) and called for a new guiding model for blood donation to be established—the honour model (ie, social recognition through an honour card and granting cardholders free access to some public services or other social incentives that are non-tradable, non-transferable, and hard to value). Policy makers in other countries should consider the feasibility and desirability of using the honour model and designing their own incentives to address potential blood shortage concerns.

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Ethical approval: This study used aggregated, deidentified, province and city level data from statistical yearbooks. No individual level data were used in this study. Therefore, this study was considered exempted from review by the board at the Chinese Academy of Medical Sciences and Peking Union Medical College.

Data sharing: Province level and city level data used for this study were obtained from various sources. Data on blood donations were obtained from China's reports on blood safety and annual report on development of China's blood collection and supply industry. Some underlying data on blood donations reported in the manuscript are not shared owing to regulatory restrictions. Socioeconomic data were from China city statistical yearbooks, provincial statistical yearbooks, and National Statistics Bureau. Province level prevalence and incidence data were from China health statistical yearbooks. All yearbooks can be purchased within the Chinese mainland but cannot be publicly shared owing to copyright and institutional regulations. The codes used for the empirical analyses in this study are available at https://github.com/zzhoutao/blood-donation-did-analysis.

Transparency: The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported, and that no important aspects of the study have been omitted.

Dissemination to participants and related patient and public communities: Findings will be disseminated through academic conferences, educational sessions, social media, and newsletters. The authors will collaborate with blood centres and government authorities to codevelop plain language information to introduce the honour model to the public.

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Web appendix: Supplementary materials