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Balancing the scales? Evaluating the impact of results-based financing on maternal health outcomes and related inequality of opportunity in Zimbabwe

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ABSTRACT

This study evaluates the impact of results-based financing (RBF) on maternal health outcomes and the inequality of opportunity (IOP) in these outcomes in Zimbabwe. We employ a difference-in-differences approach that leverages the staggered implementation of the programme across 60 districts, exploiting temporal variation in the introduction of RBF and individual-level variation in birth timing. Our analysis uses nationally representative, pooled cross-sectional data from the 2005/2006, 2010/2011, and 2015 Zimbabwe demographic and health surveys. Employing the extended two-way fixed effects (ETWFE) estimator to address biases associated with staggered rollouts, we find significant positive effects of RBF on maternal health outcomes. The programme is associated with an increase in the number of prenatal care visits by 0.185 units ($p < 0.01$), first-trimester care by 7.7 percentage points (pp) ($p < 0.01$), facility births by 8.6 pp ($p < 0.01$), and professional delivery assistance by 3.4 pp ($p < 0.01$), while reducing C-section rates by 1.3 pp ($p < 0.01$). Additionally, RBF is associated with reductions in IOP in prenatal care visits, early prenatal care, facility births, and professional delivery assistance by 3.8, 1.3, 8.4, and 4.9 pp ($p < 0.01$), respectively. These findings underscore the potential of RBF to enhance maternal health outcomes and promote health equity. Integrating equity considerations into health system strengthening initiatives is essential. Policymakers should ensure that health interventions improve access and balance opportunities across various socio-economic and demographic groups. This evidence suggests that RBF schemes can improve access to and equity in healthcare services, particularly in low-income settings such as Zimbabwe.

1. Introduction

In recent years, the global health agenda has increasingly prioritised maternal and newborn health, a central focus of the Sustainable Development Goals (SDGs) (United Nations, 2015). Despite notable progress in reducing inequalities in maternal health outcomes in sub-Saharan Africa (SSA) (Ataguba et al., 2023), significant challenges persist, exacerbated by financial constraints, poor infrastructure, and other factors (Li et al., 2020). These barriers hinder progress towards achieving the SDG targets and contribute to SSA continuing to bear one of the highest burdens of maternal mortality globally (World Health Organization, 2023). The COVID-19 pandemic has further highlighted the need for resilient health systems, as it disproportionately impacted vulnerable groups, including women and children (Makate and Makate, 2023). This situation highlights the necessity for comprehensive policy strategies to enhance health system efficiency and responsiveness to global health challenges (Gebremeskel et al., 2021).

Results-based financing (RBF) programmes have emerged as critical tools in low-income countries, aiming to improve health system efficiency and outcomes through supply-side and demand-side incentives (Eichler and Levine, 2009; Musgrove, 2011). These programmes seek to enhance both the quantity and quality of health services. While RBF initiatives have shown promise in improving service provision and outcomes in SSA, their effectiveness in reducing maternal and child health inequalities remains debated (Priedeman Skiles et al., 2013). Existing research offers mixed evidence regarding RBF's impact on maternal and child health in low- and middle-income countries, particularly in SSA (Diaconu et al., 2022; Fichera et al., 2021; Gage and Bauhoff, 2021). These studies often overlook the programmes' effects on health disparities arising from circumstances beyond an individual's control, such as socio-economic status, geographic location, or parental education. Closest to our work, Makate and Mahonye (2023) examined

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the role of RBF on asset wealth-related inequality in maternal health outcomes, where this inequality is measured using the corrected concentration index (Erreygers, 2009). However, this approach offers a narrower view by focusing on economic disparities alone, which, while significant, do not fully capture the broader range of social challenges affecting maternal health outcomes faced by individual women in low-income countries. Moreover, the evidence on the impact of RBF on maternal health outcomes is limited (De Walque et al., 2021) and often lacks the econometric rigour to draw robust inferences. This gap underscores the need for comprehensive research that evaluates the effectiveness of RBF initiatives in reducing inequality of opportunity (IOP) in maternal health outcomes, thereby contributing to broader health equity. Such research is essential for informing policies that promote equitable health improvements across societal strata.

While research on RBF programmes is expanding, a crucial aspect often overlooked is their impact on health inequality, particularly IOP in health outcomes. IOP refers to disparities induced by factors beyond an individual's control, such as socio-economic class, geographic location, or parental education (Davillas and Jones, 2020; Ferreira and Gignoux, 2011; Li Donni et al., 2014). This concept aligns with the capabilities approach, emphasising real opportunities to achieve desired health outcomes, like living a long, healthy life free from preventable diseases (Sen, 1999; Zheng, 2011). Addressing IOP is vital in the health sector as it seeks to eliminating inequities that hinder fair health outcomes (De Barros et al., 2009). In low-income countries like Zimbabwe, where structural barriers significantly affect health outcomes, tackling IOP is essential for effective health interventions (Baciu et al., 2017). Policymakers can target the root causes of health disparities by focusing on IOP, leading to more effective and equitable health reforms (Fleurbaey and Schokkaert, 2011). Furthermore, exploring IOP extends beyond maternal health outcomes, addressing systemic inequities perpetuating cycles of disadvantage across generations. Incorporating IOP into health policies promotes social justice and ensures that all individuals can achieve their full health potential, regardless of their background.

This paper examines the impact of RBF on maternal health outcomes, including prenatal care visits, initiation of prenatal care in the first trimester, professional delivery assistance, facility birth delivery, caesarean section (C-section) delivery, prenatal care quality, and modern contraceptive use in Zimbabwe. Furthermore, we investigate whether RBF influences IOP in these outcomes. Our quasi-experimental design leverages temporal variation in the introduction of RBF and individual-level variation in birth timing. The RBF rollout in Zimbabwe involves temporal and geographic variations, differing from the traditional 2×2 setup. While researchers commonly use the conventional two-way fixed effects (TWFE) model in policy evaluation for its ability to control for time-invariant unobserved heterogeneity, it has limitations, such as potentially biased estimates when treatment effects are heterogeneous over time (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Goodman-Bacon, 2021). To address these limitations, we employ the extended two-way fixed effects (ETWFE) estimator, as proposed by Wooldridge (2021), adapted for pooled cross-sectional data to capture temporal variations and ensure robust estimation of treatment effects. This econometric approach accommodates heterogeneity in treatment effects across time, entry cohorts, and exposure duration, maintaining the original properties of TWFE while allowing for more specific fixed effects and covariates. We use data from the nationwide Zimbabwe demographic and health survey (DHS), geo-linked to health facility locations to effectively account for the distance to these facilities, which plays a crucial role in determining maternal healthcare access and utilisation.

The structure of this paper is as follows: Section 2 reviews the relevant literature and provides background on the RBF programme in Zimbabwe; Section 3 details the data and methodology; Section 4 interprets the findings; and Section 5 discusses the implications of these findings and offers concluding remarks.

2. Background and literature

2.1. Background

RBF schemes have emerged as transformative tools in healthcare financing, particularly in low-income settings where healthcare inequities are most significant. These schemes play a crucial role in improving maternal health outcomes in countries like Zimbabwe by incentivising healthcare providers to enhance service quality and mitigate health disparities. RBF programmes rely on fundamental economic principles such as incentives, efficiency, and optimal resource allocation. They aim to enhance the quality and accessibility of maternal healthcare services by linking financial rewards to measurable health outcomes. Although Kenneth Arrow's work was not explicitly cited in the design of these programmes, his seminal insights into the unique dynamics of health markets and the critical role of efficient resource management in achieving health equity, especially in resource-constrained environments, provide a solid theoretical foundation for understanding the potential impact of RBF initiatives (Arrow, 1963).

In evaluating the effectiveness of RBF, the Theory of Change (TOC) framework is frequently used to clarify and guide the mechanisms by which these programmes achieve policy goals (Renmans et al., 2016, 2017; World Bank, 2016a). The TOC provides a conceptual model that delineates the steps needed to achieve desired outcomes, detailing the causal pathways from inputs to outputs. Specifically, for RBF in healthcare, the TOC is intricate and dynamic, suggesting that various factors influence the progression from inputs, such as improved service availability, to desired health outcomes. This framework includes intervention design, immediate effects, and contextual variables (Fritsche et al., 2014; Renmans et al., 2017). Our study uses the TOC as a guide to provide a comprehensive roadmap that explains how and why stakeholders expect desired changes to occur in a particular context. Regarding RBF schemes, which reward healthcare providers based on measurable outcomes, the TOC posits that such incentives will significantly enhance service delivery and maternal health outcomes. This approach aims to create a more equitable distribution of healthcare resources, thereby reducing disparities in these outcomes. The TOC framework emphasises the interplay between immediate measures, such as enhanced service accessibility, and broader contextual elements, that drive substantial health improvements (Fritsche et al., 2014; Renmans et al., 2017). Therefore, RBF is not merely a financial tool, but a strategic intervention designed to address inequalities in maternal health outcomes, particularly in low-income countries like Zimbabwe.

The concept of IOP in health refers to disparities in health outcomes caused by factors beyond an individual's control, such as socio-economic status, geographic location, ethnicity, and several others (Davillas and Jones, 2020; Li Donni et al., 2014; Roemer, 1998). According to Roemer (1998), IOP is the inequality that remains after accounting for these circumstantial factors, distinguishing between legitimate and illegitimate inequalities. This concept is rooted in Amartya Sen's capabilities approach, which underscores the importance of enabling individuals to achieve their desired outcomes through equitable access to opportunities (Sen, 1999). The Fairness Principle of IOP differentiates between legitimate inequalities arising from personal effort or choice and illegitimate inequalities stemming from factors beyond an individual's control (Roemer, 1998). Roemer (1998) argues that social justice should aim to neutralise the impact of circumstances while rewarding effort. Similarly, Fleurbaey and Maniquet (2011) assert that a fair society acknowledges the role of individual responsibility but must also address disparities caused by unequal opportunities. Addressing IOP is crucial because it highlights and seeks to mitigate these illegitimate inequalities, ensuring everyone has a fair chance to achieve positive outcomes based on their efforts rather than their circumstances. This approach emphasises the importance of providing individuals with the means to attain valuable functions, thus moving beyond mere equality of resources. By focusing on both effort and

circumstances, policies can more effectively promote social justice and reduce the systemic barriers that perpetuate inequality (Dworkin, 2002).

Two main approaches to measuring IOP exist: ex-ante and ex-post (Roemer and Trannoy, 2016). The ex-post approach promotes the equality of outcomes among individuals who demonstrate comparable levels of effort, irrespective of their circumstances (Roemer, 2002; Roemer and Trannoy, 2016). In the Zimbabwean context, this would involve comparing various maternal health outcomes, such as prenatal care, skilled birth attendance, and postnatal care, for women who have made similar efforts but come from different socio-economic backgrounds or geographic locations. Conversely, the ex-ante approach in this study emphasises ensuring equal access to opportunities before individual efforts and achievements are realised (Juárez and Soloaga, 2014; Roemer and Trannoy, 2016). This perspective aligns closely with the objectives of RBF in Zimbabwe, which aims to improve the availability and quality of maternal health services across diverse communities. Under this approach, equality of opportunity exists if there are no expected inequalities in outcomes due to different circumstances (Roemer, 1998; Roemer and Trannoy, 2016).

Our study employs the ex-ante approach to measure IOP in selected maternal health outcomes across districts in Zimbabwe. The ex-ante method ensures equal opportunities before individuals realise their efforts and achievements (Davillas and Jones, 2020; Fleurbaey and Schokkaert, 2009; Juárez and Soloaga, 2014; Li Donni et al., 2014; Roemer and Trannoy, 2016). By analysing the disparity in outcome distribution among women based on their circumstances, our research sheds light on the structural inequalities in Zimbabwe's healthcare system. This approach enables us to assess how factors beyond an individual's control, such as socio-economic status, geographic location, and other relevant circumstances, influence maternal health outcomes. Such an assessment is crucial in a country like Zimbabwe, where historical disparities in healthcare infrastructure and socio-economic development have created significant variations in outcomes including maternal health outcomes between regions and social groups. Our study provides insights on the potential for health financing initiatives like RBF as viable health system-strengthening alternatives that can make a significant difference and potentially level the playing field in healthcare access and outcomes. Utilising cross-sectional data from the Zimbabwe DHS suits the ex-ante measurement approach as it captures a snapshot of different social groups at a single point in time, providing a clear picture of how various circumstances influence maternal health outcomes without the confounding effects of individual efforts over time (Davillas and Jones, 2020).

Addressing IOP is crucial for developing effective policies in low-income countries (Kanbur and Wagstaff, 2016). Health policies that address disparities in opportunity can ensure that health interventions effectively reach the most disadvantaged communities, fostering social justice and enhancing overall health outcomes. By targeting health inequality, such policies can contribute to breaking the cycle of poverty and illness, a particularly urgent concern in low-income countries where resources are limited and health disparities are widespread (Marmot et al., 2008). Policymakers can build more effective and inclusive health systems by concentrating on the structural determinants of health and ensuring that all people have equitable access to healthcare services. This strategy aligns with global health priorities, such as the SDGs, which promote equitable healthcare access and the reduction of health inequities globally (World Health Organisation, 2023).

2.2. Related literature

Studies have shown that access to maternal and child healthcare services in low-income countries often favours individuals from relatively wealthy families (Ataguba and McIntyre, 2012; Creanga et al., 2011; Gage, 2007; Houweling et al., 2007; Makate and Makate, 2017; Zeng et al., 2018)). Despite recent evidence in SSA showing that inequalities in maternal health outcomes are declining (Ataguba et al., 2023), disparities in access and coverage of healthcare services persist, often exacerbated by limited financial resources and poor infrastructure (Li et al., 2020). Hence, progress towards the SDG targets for maternal and child health remains slow (United Nations, 2015). Organisations such as the World Bank, World Health Organisation (WHO), and various international development agencies suggest RBF programmes as potential tools for strengthening health systems and reducing health inequalities. These programmes incentivise health providers to enhance service quality and quantity by rewarding performance against agreed targets (World Bank, 2013). However, despite their widespread implementation in several low-income countries, the impact of such programmes on IOP remains underexplored in the literature. Moreover, existing studies in low-income countries such as Zimbabwe have either focused on evaluating the RBF based on the pilot programme data (World Bank, 2016a) or, where more current, have provided evidence on only a few select maternal health outcomes (Fichera et al., 2021). By focusing on a broader range of maternal health outcomes and the IOP in these outcomes and by employing the latest econometric methods best suited to address the staggered rollout of the RBF in Zimbabwe (Wooldridge, 2021), our study contributes a crucial dimension to the understanding of RBF's effects on maternal health outcomes and IOP of such outcomes.

While expanding, the growing body of evidence on RBF programmes in low-and middle-income countries presents mixed results (Diaconu et al., 2022). Studies show varying impacts on healthcare services, from tetanus vaccination coverage among pregnant women to utilisation of antenatal care and institutional deliveries (Diaconu et al., 2022). Recent evidence from Zimbabwe indicates that the RBF programme is associated with reductions in under-five mortality, increased institutional deliveries, and reduced C-section rates, but no significant effects on other incentivised services (Fichera et al., 2021). In another study, Gage and Bauhoff (2021) used data from Burundi, Lesotho, Senegal, Zambia and Zimbabwe and found no evidence of the impact of RBF on neonatal health outcomes, and health care utilisation. Moreover, an evaluation by the World Bank of the RBF programme in Zimbabwe demonstrated that its implementation was associated with accelerated improvements in delivery outcomes (delivery by health professional, facility delivery and delivery by C-section), coverage of postpartum care, antenatal care, and health worker satisfaction in RBF districts relative to non-RBF districts (World Bank, 2016a).

Further research in countries like Burundi, Haiti, Zambia, Cambodia and the DRC suggests RBF's potential to enhance health service use and financial management capabilities (Chansa et al., 2020; Falisse et al., 2012; Matsuoka et al., 2014; Meessen et al., 2006, 2007; Soeters et al., 2006, 2011; Zeng et al., 2013). Implementing the RBF programme has been associated with an increased probability of using prenatal care in DRC and Cambodia (Matsuoka et al., 2014; Soeters et al., 2011). The programme showed promising signs of impact on the health system in Chad. However, it failed to make it through the national policy agenda and was subsequently abandoned due to inadequate or lack of committed policy practitioners in the country (Kiendrébéogo et al., 2017).

In Rwanda, Basinga et al. (2011) examined the impact of RBF on use and quality of child and maternal health care services. Their results showed that the policy was associated with a 23% increase in institutional deliveries, 56% increase in preventive care visits by children aged 23 months and younger (132% increase among children aged 24–59 months), 0.157 standard deviation increase in prenatal quality but no improvements were observed concerning the frequency of prenatal care and full immunization schedules for children (Basinga et al., 2011). In Malawi, Brenner et al. (2018) assessed the impact of the RBF programme on the coverage of facility-based obstetric care services. Their results indicated no effect on crude coverage but revealed a significant impact on effective coverage of these services (Brenner et al., 2018). The authors emphasised the need for further research to assess the

programme's impact over a longer period (Brenner et al., 2018). In another study for Malawi, De Allegri et al. (2019) used a controlled interrupted time series methodology. They found that the RBF programme was associated with a reduction in facility-based maternal mortality. Despite these promising signs, the comprehensive impact of RBF on IOP in maternal health outcomes has not been the focus of these studies. Our analysis, builds upon this existing literature, aiming to assess the impact of RBF on a broad range of maternal health outcomes and the IOP of such outcomes.

2.3. Overview of results-based financing programme in Zimbabwe

The initiation of the RBF programme in Zimbabwe in July 2011 marked a significant transformation in the country's healthcare delivery and financing. This programme targeted improvements in both the quality and quantity of maternal and child health services, while aiming to enhance system efficiency, equity, and accountability (World Bank, 2013). Initially launched in the districts of Zvishavane and Marondera, the RBF programme expanded to include 16 additional districts: Gokwe north, Headlands, Binga, Nkayi, Kariba, Chegutu, Mutare, Chipinge, Mwenezi, Chiredzi, Mutoko, Chikomba, Gweru, Gwanda, Mangwe, and Centenary by March 2012. The 18 districts have a catchment area of 385 health facilities with an estimated population coverage of about 3.5 million people. This systematic expansion, illustrated in Fig. 1, showcases the programme's scale-up nationally, focusing on sustainable health improvements. Cordaid, a Dutch non-governmental organization, implemented the programme with support from a $15 million grant from the World Bank's Health Results Innovation Trust and co-funding from Zimbabwe's Ministry of Finance and Economic Development. Central to the RBF strategy was subsiding rural health facilities that met specific service provision targets, mainly offering cost-free care for pregnant women and children below age five (World Bank, 2013).

As the RBF programme expanded across the 18 districts in the country, it implemented a standardised structure encompassing results-based contracting, management and capacity building and rigorous monitoring (Makate and Mahonye, 2020, 2023). This contracting phase rewarded health facilities for verified service delivery and offered incentives to facilities in more remote areas to meet specific performance benchmarks. In line with this approach, the Ministry of Child Health identified 16 essential health indicators for per-unit payment (World Bank, 2013, 2016a), encapsulating a wide range of maternal and child health services. These indicators spanned from outpatient department consultations to initial and subsequent antenatal care visits within the first 16 weeks, encompassing comprehensive HIV testing during antenatal care and provision of antiretroviral treatments to prevent mother-to-child transmission (PMTCT) of HIV. Other priority indicators included administering tetanus toxoid vaccinations, conducting syphilis RPR tests, facilitating standard birth deliveries, managing high-risk perinatal referrals, ensuring multiple postnatal care visits, offering various family planning methods, providing intermittent preventive treatment of malaria during pregnancy, conducting child immunisations, distributing vitamin A supplements, monitoring growth for children under five years, and effectively treating and discharging children under five suffering from acute malnutrition.

District hospitals were also compensated based on five key indicators relating to birth deliveries including: normal birth deliveries; deliveries with complications; C-sections; family planning tubal ligations; high risk perinatal referrals and acute malnutrition cured and discharged children below five years. Additionally, facilities received a remoteness bonus which was calculated based on the population density, availability of road infrastructure, public transportation and communication, and distance to the closest referring facility. In addition to linking all payments to results the RBF programme was also built around five other crucial elements including a segregation of functions between the service provider, purchaser, and the regulator. Contracting was not only done with health facilities but also with other stakeholders including district and provincial health executives. The programme also recognised the need for decentralising all the planning and health decision making around investments at the health facility level. Furthermore, health facilities in RBF districts and in close consultation with the health centre committees had the power to exercise autonomy to use any proceeds they had received through the programme. An estimated 25% of the total proceeds from RBF activities was allowed to be re-invested at the facility level to maintain and enhance the physical infrastructure.

A vital feature of the RBF programme was its focus on diminishing health outcome inequalities. To promote equitable health outcomes, the programme abolished user fees at primary and selected secondary-level facilities within the intervention districts. Additionally, facilities located in remote areas and serving smaller populations were granted extra incentives to bolster healthcare access. The RBF programme also embraced community engagement by incorporating feedback through client tracer and satisfaction surveys, offering a holistic view of service delivery. The incentive scheme of the programme was diverse, comprising bonuses for service quantity, quality, and patient satisfaction, reflecting a thorough and integrated approach to healthcare enhancement.

3. Data and methods

3.1. Zimbabwe demographic and health survey data

Our study on the impact of the RBF programme in Zimbabwe uses a blend of administrative, household-level, and geographic data to assess its impact on IOP in maternal health outcomes. The primary data source is the Zimbabwe DHS, a publicly accessible, nationally representative dataset. We focus on data from three waves of the Zimbabwe DHS, conducted in 2005/2006, 2010/2011, and 2015 (ZIMSTAT, 2012). This dataset, collating detailed health-related data for women aged 15–49 and their children born within five years preceding each survey including fertility, family planning, maternal and child health, nutrition, and socio-economic characteristics, is invaluable for analysing the impact of RBF on maternal health outcomes and IOP in such outcomes. From the original sample sizes of 8818; 8809; and 9920 women interviewed in the Zimbabwe DHS in 2005, 2010, and 2015 respectively, we

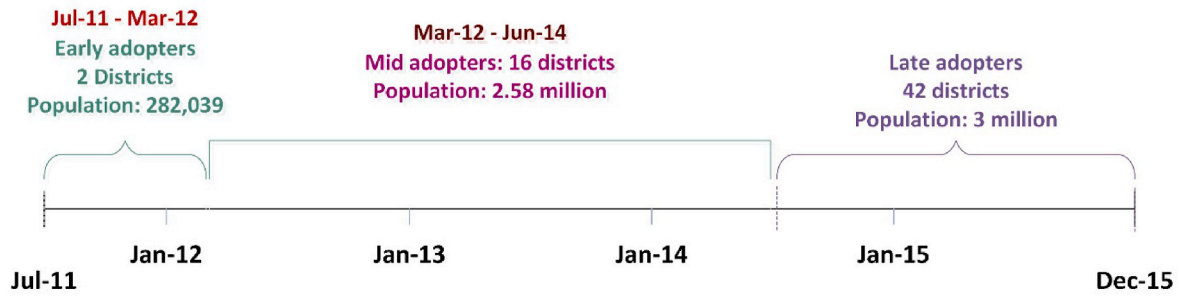

Fig. 1. Phased deployment schedule of Results-Based Financing (RBF) in Zimbabwe. Source: Adapted from (World Bank, 2016a).

focus on the sub-sample of women who had given birth in the three years preceding each survey, for which information on our outcome variables of interest was available. As shown in Table 1, the pooled cross-sectional sample available for our analysis is 14,374 women.

3.2. Zimbabwe DHS geo-linked to geographic data

Alongside the standard DHS data, we utilised geographic data from the Zimbabwe DHS, which contains the longitude and latitude of each household. While this data allows us to match households to primary sampling units (clusters), it does not include information on the second administrative unit, namely districts, which is the level at which RBF operates. To remedy this, we combined the DHS geographic data with administrative data from the Global Administrative Areas (GADM) for Zimbabwe (Global Administrative Areas, 2022). The GADM dataset, which delineates administrative regions such as provinces and districts at various levels with high-resolution spatial data, was instrumental in adding district information to our analysis. By mapping Zimbabwe DHS clusters to the corresponding districts using ArcMap version 10.4, we compiled a district-level pseudo panel dataset, documenting variables like cluster number, survey year, province name and number, and place of residence (rural or urban). A related working paper can be consulted for a detailed description of the data processing methodology (Makate and Mahonye, 2020, 2023).

We used the Haversine formula during the data integration process to estimate the minimum direct distance 'as the crow flies' from each household to the closest health centre. This technique provides a unique view by evaluating the geographical accessibility of health facilities, in contrast to Milcent (2023) approach, which calculates road distances. Our straight-line distance estimation provides a different perspective, capturing the geographical accessibility of health facilities, which is particularly relevant in rural settings where road networks may be less developed or direct, such as the case in rural Zimbabwe. The Haversine formular, renowned for its precise measurement of straight-line distances on the Earth's surface, is a widely accepted method for distance calculations (Hernæs and Skyrud, 2022). We applied this formula to determine how geographic proximity influences the RBF programme's effectiveness and to identify households' relative proximity to health facilities. Understanding these spatial dynamics of health service access in Zimbabwe is crucial, as it offers valuable insights for developing policies and programmes in similar environments.

Table 1
Weighted summary statistics of women in the analysis sample.

	Overall sample		Mid adopters		Late adopters	
Variables	Mean	SD	Mean	SD	Mean	SD
Age (in years) at survey date	27.94	(6.67)	28.04	(6.94)	27.91	(6.57)
Age at first birth	19.89	(3.22)	19.69	(3.21)	19.95	(3.22)
Years of completed schooling	8.41	(2.93)	7.98	(3.13)	8.55	(2.85)
Completed secondary school	0.60	(0.49)	0.53	(0.50)	0.62	(0.49)
Female head of household	0.39	(0.49)	0.39	(0.49)	0.39	(0.49)
Able to read and write	0.93	(0.25)	0.90	(0.30)	0.94	(0.23)
Apostolic church member	0.38	(0.49)	0.36	(0.48)	0.39	(0.49)
Asset quintile 1 (poorest)	0.22	(0.42)	0.29	(0.45)	0.20	(0.40)
Asset quintile 2	0.21	(0.41)	0.21	(0.41)	0.21	(0.41)
Asset quintile 3	0.19	(0.39)	0.17	(0.38)	0.20	(0.40)
Asset quintile 4	0.22	(0.41)	0.19	(0.40)	0.22	(0.42)
Asset quintile 5 (richest)	0.16	(0.37)	0.14	(0.35)	0.17	(0.38)
Improved flooring	0.63	(0.48)	0.56	(0.50)	0.65	(0.48)
Piped water	0.58	(0.49)	0.56	(0.50)	0.59	(0.49)
Improved toilet	0.57	(0.49)	0.51	(0.50)	0.59	(0.49)
Currently employed	0.24	(0.43)	0.23	(0.42)	0.24	(0.43)
Rural resident	0.71	(0.45)	0.78	(0.42)	0.69	(0.46)
Distance to nearest health facility	7.39	(10.93)	10.98	(17.57)	6.03	(6.11)
Number of observations	14064		4141		9923	

Notes: Source: Data are from the 2005/2006, 2010/2011, and 2015 Zimbabwe demographic and health surveys. We exclude the smaller sample of women (n = 310) in the early adopting districts of Marondera and Zvishavane.

3.3. Circumstance variables

We identify numerous contextual factors presumed to encapsulate the multifaceted aspects of life in a low-income country like Zimbabwe, several of which have been noted in prior research (Aizawa, 2019). These factors include religious affiliation, parental education levels, demographic variables such as age at first birth, parental occupation, housing conditions, multidimensional poverty, and information access through regular engagement with newspapers or magazines, television, and radio. A comprehensive elaboration of these variable definitions is provided in the supplementary appendix.

3.4. Measuring inequality of opportunity in maternal health outcomes

To assess ex-ante IOP in maternal health outcomes, we utilise the regression approach outlined in the literature (Juárez and Soloaga, 2014). Within this framework, let MH represent the maternal health outcome of interest, and let C denote a matrix encompassing various circumstances beyond an individual's control that could potentially influence this specific maternal health outcome variable. The relationship between the maternal health outcome and these circumstances is encapsulated by the expected conditional outcome, which is formulated as follows:

$$\widehat{\mathrm{MH}} = \mathrm{E}(\mathrm{MH}|C) \tag{1}$$

Equation (1) provides an estimation of the expected health outcome ($\widehat{\mathrm{MH}}$) conditioned on the set of circumstances (C). This equation can be estimated through several methods, as suggested in the literature, with the choice of method often dependent on the nature or type of the dependent variable. In our study, many of the variables under consideration are binary in nature. Consequently, we adopt standard nonlinear models such as logistic regression approaches (Juárez and Soloaga, 2014). Once equation (1) is estimated, we proceed to compute IOP using a common measure, denoted as MHIOp(.), applied to the estimated health outcome $\widehat{\mathrm{MH}}$:

$$\theta_a = MHIOp(\widehat{MH}) \tag{2}$$

where θ_a represents the absolute measure of IOP, *MHIOp*. Here, the variation in the vector $\widehat{MH}$ is exclusively attributable to the circumstances, thereby justifying its designation as *MHIOp*. This measure is vital for capturing the extent to which variations in health outcomes are due to factors beyond individual control. We calculate *MHIOp* using equation (2) for all districts across each survey year in the DHS dataset. This approach provides a detailed and robust analysis of IOP in maternal health outcomes, reflecting the influence of various socio-economic and demographic factors. By applying this methodology, we aim to provide a clear understanding of how different circumstances impact health outcomes in Zimbabwe.

Table 1 provides weighted summary statistics for women within the analysis sample, outlining selected demographic and socio-economic characteristics for the overall sample and by RBF adoption status. In the overall sample, the average age of women at the survey date is 27.94 years, with mid adopters and late adopters averaging 28.04 and 27.91 years, respectively. Women in mid adopting districts tend to have their first birth slightly younger (19.69 years) compared to late adopters

(19.95 years). The years of completed schooling are lower for mid-adopters (7.98 years) compared to late adopters (8.55 years), and a similar pattern is observed for the likelihood of having completed secondary education (53% vs 62%). Regarding literacy, 93% of women can read and write, with mid adopters showing slightly lower literacy rates (90%) than late adopters (94%). Most of the sample belongs to the Apostolic church, especially among late adopters (39%). Socio-economic indicators show that mid adopters have a higher proportion of women in the poorest asset quintile (29%) than late adopters (20%). Access to improved infrastructure varies, with 63% of women overall having improved flooring, piped water (58%), and improved toilets (57%). Employment rates are similar across groups, with 24% of women currently employed. Rural residency is higher among mid adopters (78%) than late adopters (69%). The average distance to the nearest health facility is notably greater for mid adopters (10.98 km) than for late adopters (6.03 km).

3.5. Empirical strategy

To estimate the impact of RBF on maternal health outcomes and IOP in such outcomes in Zimbabwe, we employ a staggered difference-in-differences (DD) approach. For simplicity in notation, we will collectively label maternal health and IOP in maternal health outcomes as (Y). Our empirical strategy leverages the staggered roll-out of the RBF programme across 60 districts, facilitating a comparison of changes in health outcomes between RBF and non-RBF districts over time. The staggered implementation implies that all districts eventually receive the treatment, allowing us to capture the dynamic treatment effects of RBF on health outcomes.

Given the limitations of the traditional TWFE model, particularly its potential bias arising from treatment effect heterogeneity across different cohorts and periods (Callaway and Sant'Anna, 2021; De Chaisemartin; d'Haultfoeuille, 2020; Goodman-Bacon, 2021), we employ the ETWFE approach proposed by Wooldridge (2021). While commonly used with panel data, the ETWFE method is readily applicable to repeated cross-sectional data, where, in our case, we observe individual women only once, but districts are observed multiple times across survey years. Wooldridge's ETWFE approach accommodates repeated cross-sectional settings by excluding individual fixed effects.

Our ETWFE model is formulated as follows:

$$\mathrm{Y_{idt}} = \alpha + \sum_{r=q}^{T}\sum_{s=r}^{T}\tau_{rs}(w_{it} \times d_{ir} \times fs_t) + \gamma_t + \delta_d + X_{idt}\lambda + u_{idt} \tag{3}$$

where, $\mathrm{Y_{idt}}$ represents maternal health outcomes for individual i in district d at time t or IOP measured at the district level and time,[1] τ_{rs} are the treatment effect parameters for individuals in districts first exposed to RBF in period r and observed in period s, $\{d_{ir} : r = q, \ldots, T\}$ is a dummy indicating that district d was first treated in period r, $\{fs_t : t = 2, \ldots, T\}$ is a time dummy variable that equals one if $s = t$ and zero otherwise, w_{it} is a time-varying treatment indicator, X_{idt} is a vector of individual household-level characteristics to account for potential selection bias at the individual household level, and u_{idt} is an error term. We assume that there is at least one group of not-yet-treated districts initially, and that the treatment is irreversible. Our coefficient of interest is τ_{rs}. For every (r, s) combination where $r \in \{q, \ldots, T\}$ and $s \in \{r, \ldots, T\}$, we can derive an estimator. For cohort r, we can estimate average treatment effects (ATTs) for $r = q, \ldots, T$. We can calculate ATTs for $s = r, \ldots, T$ for a given calendar period s. Although we can obtain an estimator for each τ_{rs} combination with $r \in \{q, \ldots, T\}, s \in \{r, \ldots, T\}$, we often want to obtain a single coefficient that can reflect the overall ATT of a policy intervention like RBF. To generate an aggregated policy effect, Wooldridge (2021) recommends averaging all coefficients for a single effect representing the overall ATT. The overall ATT can formally be expressed as follows (Wooldridge, 2021):

$$\overline{\tau} = \frac{1}{(T-q+1)(T-q+2)/2}\sum_{r=q}^{T}\sum_{s=r}^{T}\tau_{rs} \tag{4}$$

The DD technique assumes that in the absence of the RBF intervention, the trajectory of maternal health outcomes and IOP in such outcomes would have been comparable between RBF and non-RBF districts. The ETWFE method provides a simple framework for testing the parallel trends (Wooldridge, 2021). In the ETWFE regression, we introduce heterogeneous linear trends $d_{iq} \times t, \ldots, d_{iT} \times t$ and perform a joint significance test. The equation for testing parallel trends is specified as follows (Wooldridge, 2021):

$$\mathrm{Y_{idt}} = \alpha + \sum_{r=q}^{T}\sum_{s=r}^{T}\tau_{rs}(w_{it} \times d_{ir} \times fs_t) + \ldots$$

$$+ \sum_{r=q}^{T}\delta_{rs}(d_{ir} \times t) + \gamma_t + \delta_d + X_{idt}\lambda + u_{idt} \tag{5}$$

The null hypothesis for the parallel trends test is as follows:

$$H_0 : \delta_{rs} = 0, r = q, \ldots, T; s = 2, \ldots, r-1$$

The null hypothesis for the parallel trends test states that the coefficients on the interaction terms between the time dummies and the treatment group dummies are jointly equal to zero. The p-values from the F-tests for joint significance of these interaction term coefficients are examined across the different groups analysed. Failure to reject the null hypothesis at conventional significance levels would suggest that the pre-treatment trends in the outcome variables are parallel between the treatment and control groups, lending credibility to the difference-in-differences approach. Nevertheless, we interpret the findings cautiously, considering the limitations of the test and conducting further robustness checks to ensure the validity of the identifying assumptions. Our F-test results uphold the parallel trends assumption for most of the prenatal care and delivery service outcomes, as evidenced by the p-values for the joint significance test of the interaction coefficients, which consistently indicate no violation of the assumption across all outcomes except for completion of four or more prenatal care visits and family planning. Table A1 in the supplementary appendix presents these results. Table A2 demonstrates that the parallel trends assumption holds for most prenatal care quality outcomes, except for urine sample and blood sample checks. For the IOP outcomes, Tables A3 and A4 show that the parallel trends assumption is upheld for most outcomes, except for IOP in first trimester prenatal care and delivery by C-section.

4. Results

4.1. RBF programme and inequality of opportunity in prenatal care and delivery services

Our empirical analysis begins with estimating the overall ATT using the ETWFE model, focusing on various prenatal care and delivery service outcomes. Table 2 presents these results, highlighting significant associations between the RBF and improvements in maternal health service outcomes. The ATT estimate for prenatal care visits is 0.185 ($p < 0.01$), indicating a significant increase in the number of prenatal care visits associated with the RBF programme. Similarly, the estimate for completing four or more prenatal care visits is 0.025 ($p < 0.01$), suggesting that the RBF programme is significantly associated with an increase in the likelihood of women completing four or more prenatal care visits by 2.5 percentage points (pp). For first-trimester prenatal care, the ATT is 0.077 ($p < 0.01$), demonstrating a 7.7 pp increase in the

[1] Although we specify our extended two-way fixed effects (ETWFE) model at the individual level with Y_{idt}, inequality of opportunity (IOP) is measured at the district level and over time, represented as Y_{dt}. For IOP, we created a pseudo-panel dataset where each district appears multiple times over different time periods.

Table 2
Estimation results for overall ATT by ETWFE for prenatal care and delivery services outcomes in Zimbabwe.

	Prenatal care visits	4 or more prenatal care visits	First trimester prenatal care	Facility birth delivery	Professional delivery assistance	Delivery by c-section	Family planning
ATT estimate	0.185	0.025	0.077	0.086	0.034	−0.013	0.194
Standard errors	0.046	0.007	0.018	0.008	0.008	0.002	0.005
P-value	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Observations	14,374	14,374	14,374	14086	14364	14351	14351

Notes: This table presents the aggregated overall ATT coefficients derived from the extended two-way fixed effects (ETWFE) estimator for prenatal care and delivery service outcomes in Zimbabwe. The model includes interaction terms for treatment cohorts and post-treatment periods, controlling for wealth quintiles, education years, minimum distance to a health facility, urban residence, duration of residence at current location, and fixed effects for birth year, survey year, region, and district. The regressions are weighted using survey probability weights provided in the Zimbabwe DHS to ensure representativeness of the estimates. Standard errors are robust and clustered at the district level. The ATT estimates represent the average treatment effect on the treated across the specified outcomes.

probability of receiving prenatal care during the first trimester. Facility-based deliveries show an ATT estimate of 0.086 ($p < 0.01$), indicating an 8.6 pp rise in the likelihood of such deliveries. The estimate for professional delivery assistance is 0.034 ($p < 0.01$), reflecting a 3.4 pp increase in the likelihood of receiving professional assistance during delivery. Conversely, the estimate for delivery by C-section is −0.013 ($p < 0.01$), suggesting that the RBF programme is significantly associated with a reduction in the likelihood of C-sections by 1.3 pp. Finally, the ATT estimate for family planning is 0.194 ($p < 0.01$), indicating that the RBF programme is significantly associated with increased use of family planning services by 19.4 pp.

Table 3 presents the estimation results for the overall ATT using the ETWFE model for various prenatal care quality outcomes. The ATT estimate for the prenatal care quality index is 0.037 ($p = 0.163$), indicating that the RBF programme is not significantly associated with changes in the overall quality index for prenatal care. The estimate for blood pressure checks is 0.032 ($p < 0.001$), suggesting that the RBF programme is significantly associated with an increase in the likelihood of blood pressure checks by 3.2 pp. Conversely, the estimate for urine sample checks is −0.039 ($p < 0.01$), indicating that the RBF programme is significantly associated with a decrease in the likelihood of urine sample checks by 3.9 pp. The ATT estimate for blood sample checks is 0.140 ($p < 0.01$), suggesting that the RBF programme is significantly associated with an increase in the likelihood of blood sample checks by 14 pp. The estimate for tetanus toxoid vaccinations is 0.016 ($p = 0.251$), indicating that the RBF programme is not significantly associated with changes in the likelihood of receiving tetanus toxoid vaccinations. Finally, the ATT estimate for iron tablets is 0.209 ($p < 0.01$), indicating that the RBF programme is significantly associated with an increase in the likelihood of receiving iron tablets by 20.9 pp.

4.2. RBF programme and inequality of opportunity in prenatal care and delivery services

Table 4 presents the estimation results for the overall ATT estimates for IOP in various prenatal care and delivery services outcomes, using the ETWFE model. For general prenatal care visits, the ATT estimate is −0.038 ($p < 0.01$), suggesting a significant reduction in IOP following the introduction of RBF programme in the implemented districts. This finding indicates that the RBF programme helped narrow the gap in prenatal care visits between women from different socio-economic backgrounds and varying circumstances. Similarly, for completing at least four prenatal visits, the ATT estimate is −0.048 ($p < 0.01$), indicating that the RBF programme is significantly associated with reducing IOP. This finding suggests that the programme notably improved access to comprehensive prenatal care for women in less advantaged situations, reducing disparities in prenatal care utilisation.

In the context of first-trimester prenatal care, the results in Table 4 show that the ATT estimate is −0.013 ($p < 0.05$), indicating a significant reduction in IOP. This reduction means that the RBF programme has helped make early prenatal care more accessible to women from disadvantaged backgrounds, thereby reducing disparities in early prenatal care access. For facility birth delivery and professional delivery assistance, the ATT estimates are −0.084 ($p < 0.01$) and −0.049 ($p < 0.01$), respectively, showing significant reductions in IOP. These findings underscore that the RBF programme substantially enhanced access to institutional and skilled birth services more equitably post-implementation, meaning that more women from disadvantaged groups can deliver in health facilities and receive professional assistance during delivery, reducing the disparities in these critical maternal health services. However, the ATT estimate for delivery by C-section is 0.004 ($p = 0.833$), suggesting no significant impact on IOP for this service. This observation indicates that the RBF programme did not affect the differences in access to C-sections between advantaged and disadvantaged groups. The estimated effect of the RBF programme on family planning is −0.001 ($p = 0.864$), signifying no significant change in IOP in family planning services, indicating that the disparities in access to family planning services remained unchanged.

4.3. RBF programme and inequality of opportunity in prenatal care quality outcomes

Table 5 presents the overall ATT estimates for IOP across various aspects of prenatal care quality, estimated using the ETWFE model. The

Table 3
Estimation results for overall ATT by ETWFE for prenatal care quality outcomes in Zimbabwe.

	Prenatal care quality index	Blood pressure check	Urine Sample check	Blood sample check	Tetanus toxoid vaccinations	Iron tablets
ATT estimate	0.037	0.032	−0.039	0.140	0.016	0.209
Standard errors	0.026	0.010	0.010	0.009	0.014	0.013
P-value	0.163	0.001	0.000	0.000	0.251	0.000
Observations	14374	14374	14374	14374	14374	14374

Notes: This table presents the aggregated overall ATT coefficients derived from the extended two-way fixed effects (ETWFE) estimator for prenatal care quality outcomes in Zimbabwe. The model includes interaction terms for treatment cohorts and post-treatment periods, controlling for wealth quintiles, education years, minimum distance to a health facility, urban residence, duration of residence at current location, and fixed effects for birth year, survey year, region, and district. The regressions are weighted using survey probability weights provided in the Zimbabwe DHS to ensure representativeness of the estimates. Standard errors are robust and clustered at the district level. The ATT estimates represent the average treatment effect on the treated across the specified outcomes.

Table 4
Estimation results for overall ATT by ETWFE for inequality of opportunity in prenatal care and delivery services outcomes in Zimbabwe.

	Inequality of opportunity in:						
	Prenatal care visits	4 or more prenatal care visits	First trimester prenatal care	Facility birth delivery	Professional delivery assistance	Delivery by c-section	Family planning
ATT estimate	−0.038	−0.048	−0.013	−0.084	−0.049	0.004	−0.001
Standard errors	0.005	0.009	0.005	0.008	0.007	0.018	0.005
P-value	0.000	0.000	0.014	0.000	0.000	0.833	0.864
Observations	2064	2064	1986	1971	1957	1332	2035

Notes: This table presents the aggregated overall ATT coefficients derived from the extended two-way fixed effects (ETWFE) estimator for inequality of opportunity in prenatal care and delivery service outcomes in Zimbabwe. The model includes interaction terms for treatment cohorts and post-treatment periods, controlling for wealth quintiles, education years, minimum distance to a health facility, urban residence, duration of residence at current location, and fixed effects for region and district. The regressions are weighted using survey probability weights provided in the Zimbabwe DHS to ensure representativeness of the estimates. Standard errors are robust and clustered at the district level. The ATT estimates represent the average treatment effect on the treated across the specified outcomes.

Table 5
Estimation results for overall ATT by ETWFE for inequality of opportunity in prenatal care quality outcomes in Zimbabwe.

	Prenatal care quality index	Blood pressure check	Urine Sample check	Blood sample check	Tetanus toxoid vaccinations	Iron tablets
ATT estimate	−0.047	−0.036	−0.016	−0.039	−0.045	−0.081
Standard errors	0.004	0.008	0.015	0.008	0.021	0.009
P-value	0.000	0.000	0.288	0.000	0.037	0.000
Observations	2064	2064	2064	2064	2064	2064

Notes: This table presents the aggregated overall ATT coefficients derived from the extended two-way fixed effects (ETWFE) estimator for inequality of opportunity in prenatal care quality outcomes in Zimbabwe. The model includes interaction terms for treatment cohorts and post-treatment periods, controlling for wealth quintiles, education years, minimum distance to a health facility, urban residence, duration of residence at current location, and fixed effects for region and district. The regressions are weighted using survey probability weights provided in the Zimbabwe DHS to ensure representativeness of the estimates. Standard errors are robust and clustered at the district level. The ATT estimates represent the average treatment effect on the treated across the specified outcomes.

ATT estimate for the prenatal care quality index is −0.047 ($p < 0.01$), indicating a significant decrease in IOP in the overall quality of prenatal care during the operation of the RBF programme in implemented districts. Examining specific service components of prenatal care quality, the ATT estimate for IOP in blood pressure monitoring is −0.036 ($p < 0.01$), signifying a significant reduction in IOP for this aspect of care. The ATT for urine sample testing is −0.016 ($p = 0.288$), showing no statistically significant effect on IOP for this component. The ATT estimate for blood sample testing is −0.039 ($p < 0.01$), indicating a significant reduction in IOP. For IOP in tetanus toxoid vaccinations, the ATT estimate is −0.045 ($p < 0.05$), showing a significant decrease in IOP. Lastly, the ATT estimate for iron supplementation is −0.081 ($p < 0.01$), indicating a significant reduction in IOP.

4.4. Robustness and sensitivity checks

In this section, we systematically conduct several checks to confirm the robustness of our empirical estimates regarding the impact of RBF on maternal health outcomes and IOP in such outcomes. To ensure the empirical validity of our analysis, we conduct placebo experiments, explore alternative definitions of IOP using the Human Opportunity Index (HOI) and perform additional robustness checks.

First, we employed the ETWFE estimator on outcome variables not initially targeted by the RBF programme. This step was crucial to determine if our model incorrectly attributes any effects to the RBF programme on these unrelated outcomes. Identifying significant effects in these outcome variables would suggest potential confounding factors, thereby questioning the integrity of our results. However, our analysis revealed no statistical significance in these unrelated outcomes, as detailed in Table A9 of the supplementary appendix. The lack of impact on outcomes not targeted by the RBF programme further reinforces the validity of our findings. This observation suggests that the RBF programme may be associated with the observed changes in our primary variables of interest—specifically, maternal health outcomes and IOP in these outcomes.

Second, we considered measuring IOP in maternal health outcomes using the Human Opportunity Index (HOI). The HOI, quantifies IOP, providing a complementary perspective to our analysis. Borrowing the notation from De Barros et al. (2009), we calculate the HOI by combining the coverage rate ($\bar{p}$) with the dissimilarity index (D), expressing it as follows:

$$\text{HOI} = \bar{p}(1 - D) \tag{6}$$

This formulation of IOP integrates overall access rates to healthcare services and a measure of the distribution of these opportunities (De Barros et al., 2009). It quantifies how access to maternal healthcare services, such as prenatal care and delivery services, is universally available and equitably distributed across different population segments. A HOI score ranges from 0 to 100, with a score of 100 indicating full coverage and an utterly equitable distribution of opportunities to achieve positive maternal health outcomes. Integrating the HOI adds critical scrutiny to our analysis, complementing our placebo tests and parallel trends analysis. The results from the ETWFE model, using the HOI as the outcome variable and presented in Table A10 of the supplementary appendix, confirm the robustness of our primary estimates and reinforce our conclusions regarding the potential of RBF to equalise access to maternal health services across different circumstances.

5. Discussion

This study examined the impact of the RBF programme on access to maternal health services and the distribution of opportunities in these outcomes in Zimbabwe. We aimed to assess how the implementation of RBF promotes fairness in access to prenatal care and delivery care services, with particular attention to addressing IOP. By integrating nationally representative data from the Zimbabwe DHS with information on the locations of health facilities, we developed a measure of proximity for each household to these health facilities. We employed the ETWFE model introduced by Wooldridge (2021) to account for the staggered rollout of the RBF programme across districts, adapting it to a

pooled cross-sectional data setting. This methodology allowed us to estimate models precisely, capturing the geographic variation and temporal phases of the RBF programme's implementation.

Our findings indicate progress in improving maternal health outcomes and reducing IOP, particularly in prenatal care visits and skilled delivery services. The RBF programme is significantly associated with increased prenatal care visits, the likelihood of completing four or more prenatal care visits, and an increased probability of initiating prenatal care within the first trimester. Additionally, the programme increased the probability of facility-based deliveries and professional assistance during delivery while reducing the likelihood of C-sections and increasing the use of family planning services. These results align with broader literature highlighting the positive impact of RBF on maternal health outcomes and healthcare access (Basinga et al., 2011; de Walque et al., 2022; Fichera et al., 2021; World Bank, 2016a). However, these studies predominantly address overall access improvements rather than explicitly examining reductions in inequality gaps. Moreover, existing evidence for Zimbabwe has predominantly focused on evaluating the RBF based on the pilot programme (World Bank, 2016a) or, in more recent studies, has provided insights into only a few selected maternal health outcomes (Fichera et al., 2021). While these studies are valuable, they often suffer from methodological limitations, such as using the TWFE estimator, which does not adequately address the staggered rollout of the RBF programme in Zimbabwe. By examining a broader range of maternal health outcomes and IOP associated with these outcomes and employing the latest econometric methods best suited for addressing staggered rollouts, such as the ETWFE approach (Wooldridge, 2021), our study contributes a crucial dimension to the understanding of RBF's effects on maternal health outcomes and health equity more broadly.

Further research shows that the RBF programme significantly reduces IOP in a variety of maternal health outcomes. For example, the RBF programme has significantly reduced the disparity in access to general prenatal care visits, at least four prenatal visits, first-trimester prenatal care, facility birth delivery, and professional delivery assistance. These findings demonstrate that the RBF programme significantly improved equitable access to essential maternal health services. However, the programme had no significant impact on the IOP for C-sections and family planning services, implying that disparities in these services remained unchanged. Furthermore, the RBF programme significantly reduced inequality in access to high-quality prenatal care. There is less inequality in blood pressure monitoring, blood sample testing, tetanus toxoid vaccinations, and iron supplementation. These findings indicate that the RBF programme improved the distribution of high-quality prenatal care components to disadvantaged women, thereby contributing to more equitable maternal healthcare. Our study provides strong evidence that the RBF can effectively reduce disparities in maternal health outcomes, using the ETWFE model to account for the RBF program's staggered rollout. This evidence supports the use of RBF schemes to improve access to and equity in healthcare services, especially in resource-constrained settings like Zimbabwe.

The intricate effects of the RBF programme on IOP within maternal healthcare underscore the critical role of context and implementation nuances in health intervention outcomes. This study's insights into the differential impacts of RBF, particularly its pronounced benefits in proximity to health centres, illuminate the importance of geographical accessibility in the effectiveness of health financing strategies. It also emphasises the necessity of incorporating equity-focused metrics into programme design and evaluation to ensure health interventions do not merely enhance overall access but actively work towards balancing the scales of opportunity across all societal strata. These considerations are critical for evolving health policies to improve healthcare quality and access, as well as eliminate entrenched disparities within health systems. The evidence we present supports a comprehensive approach to strengthening health systems. This approach should combine the principles of RBF's performance-based incentives with a firm commitment to equity and inclusivity, addressing both the quantitative and qualitative aspects of healthcare access and delivery.

5.1. How does RBF influence inequality of opportunity in maternal health outcomes?

Our study demonstrates that RBF significantly reduces IOP in maternal health outcomes in Zimbabwe. Traditionally, factors beyond an individual's control, such as socio-economic status, demographic characteristics, education, and other related factors, drive IOP (Roemer, 1998). Given this context, exploring the specific mechanisms through which RBF influences IOP in maternal health outcomes is essential. To understand these mechanisms, we ask: "*How do removing financial barriers, incentivising healthcare providers, and community education efforts contribute to reducing IOP?*" These strategies are crucial as they represent the primary ways RBF aims to improve healthcare access and quality outcomes. In this section, we elaborate on how RBF addresses circumstance-based inequality and discuss the potential pathways through which these changes could occur.

Our empirical analysis reveals that RBF significantly enhances the accessibility of maternal healthcare services in Zimbabwe. By incentivising healthcare providers to achieve specific targets – such as increasing the number of prenatal care visits and improving the quality of maternal health services – RBF programs drive improvements in healthcare infrastructure and service delivery (World Bank, 2016b). These enhancements disproportionately benefit disadvantaged groups who previously lacked access to high-quality care. For example, implementing RBF in Zimbabwe has contributed to better-trained staff and improved healthcare facilities, which reduce disparities in health outcomes caused by varying quality of care (Kane et al., 2019; World Bank, 2016b). Furthermore, RBF has also been instrumental in removing financial barriers to healthcare by eliminating user fees, thereby expanding access to maternal health services, particularly in rural areas (World Bank, 2012). This change has increased healthcare utilisation among disadvantaged groups, significantly improving health outcomes in marginalised communities (UNICEF, 2020). Eliminating financial barriers and incentivising high-quality service delivery through performance-based rewards enhances maternal health outcomes across different socio-economic strata. These improvements reduce disparities in access to maternal health services caused by socio-economic status, geographic location, and education, thereby diminishing IOP in maternal health outcomes. By eliminating user fees, RBF programs make maternal health services more accessible for disadvantaged groups, while performance-based rewards enhance service quality. This dual approach addresses financial and structural barriers to healthcare, promoting more equitable outcomes across different population groups.

Additionally, the RBF programme significantly impacts community factors and health education. Many RBF initiatives include components that educate communities about maternal health services, enhance health literacy and foster proactive health-seeking behaviours. In Zimbabwe, RBF programmes incentivise community health workers to disseminate information about prenatal care, skilled delivery, and postpartum care. By increasing awareness and knowledge, RBF standardises health-seeking behaviours across different population segments, reducing disparities in maternal health outcomes. This approach has contributed to increased health literacy and proactive behaviours, especially in rural areas, thereby reducing IOP as more women are empowered to utilise available healthcare services effectively regardless of their circumstances.

5.2. Study strengths and limitations

This study offers significant insights into the impact of RBF on maternal health outcomes and IOP in these outcomes in Zimbabwe. A key strength of our analysis is using a nationally representative dataset from the Zimbabwe DHS, which is geo-linked to health facility data,

allowing for a comprehensive examination of the effects across various districts. Additionally, we innovatively utilised this dataset to create a pseudo-panel dataset, enabling an in-depth exploration of the RBF program's impact on IOP in maternal health outcomes. This study pioneered such a novel approach, using the ETWFE econometric technique. This method fully accounts for the staggered rollout of the program and controls for confounders, thereby enhancing the reliability of our findings. Furthermore, we conducted several placebo checks to ensure the robustness of our results.

However, it is crucial to acknowledge several limitations. First, the cross-sectional design limits our ability to establish definitive causal links between RBF and outcomes. Some residual bias may remain despite employing advanced econometric methods to minimise these limitations. Second, our IOP measure employs a limited set of context factors, potentially underestimating the true IOP. Although our approach captures a lower bound of the true IOP, additional circumstance variables may clarify the differences. Future research should incorporate comprehensive circumstance variables to better measure IOP in maternal health outcomes. Our findings show that RBF interventions can reduce health inequities and improve maternal health in low-income settings, but further studies are necessary to confirm these effects. Third, a significant limitation is the potential bias introduced by migration between districts with varying treatment statuses. Although all districts eventually received the RBF intervention, individuals migrating from treated to untreated districts (or vice versa) may experience heterogenous treatment effects, as suggested by recent DD literature. To mitigate this potential bias, we included a control variable in our models for the duration of residence at the individual's current location. In our dataset, respondents have lived at their current location for an average of 7.76 years. However, unaccounted migration patterns may still introduce bias. We acknowledge this limitation and recommend further research to address this issue comprehensively. Lastly, focusing on Zimbabwe may limit the generalisability of our findings to other healthcare contexts. While we demonstrate that RBF interventions can improve access to and use of maternal health services and reduce IOP, we urge caution when applying these results to different settings. Further studies are necessary to confirm their applicability in various contexts.

The findings from this study have important implications for health policy in Zimbabwe, highlighting the crucial need to integrate equity considerations into health system strengthening initiatives. Our research highlights a pivotal shift towards acknowledging and addressing the distributional impacts of health interventions, particularly within the framework of RBF. By demonstrating RBF's potential to mitigate IOP in maternal health, this study adds a vital dimension to the existing literature. The ability of RBF to improve access while concurrently narrowing opportunity gaps presents a compelling case for rethinking health financing strategies. This re-evaluation is especially pertinent in resource-limited settings like Zimbabwe, where health disparities are most pronounced.

To effectively leverage these insights, policymakers must prioritise developing or refining existing RBF schemes to ensure they are sensitive to inequality and tailored to the diverse needs of Zimbabwe's population. Policymakers should craft and implement policies that ensure universal accessibility and enhance healthcare provision. Continuous monitoring and evaluation are imperative to refine RBF programmes and adapt them to evolving circumstances. Policymakers in Zimbabwe should consistently collect and analyse metrics that reflect the circumstances influencing women's use of maternal health services. These metrics could include the availability and effectiveness of community health education programs, support from community health workers, the impact of user fee removal on service utilisation, the reach and quality of mobile health clinics in remote areas, and the accessibility of essential services like blood pressure monitoring and iron supplementation. By integrating these equity-focused metrics into the design and assessment of RBF programmes, policymakers can ensure that health interventions not only improve overall access but also equitably distribute opportunities across all societal strata. Well-executed RBF schemes have the potential to significantly contribute to the creation of a more equitable health system in Zimbabwe, serving as a cornerstone in the broader effort to improve health equity globally.

6. Conclusion

This study suggests a significant positive association between the RBF programme and improvements in maternal health outcomes reduced IOP in Zimbabwe. Employing the ETWFE estimator to account for the staggered rollout of the RBF programme, we found that the RBF programme is associated with increased prenatal care visits, facility-based deliveries, and professional assistance during delivery while reducing IOP in access to these essential services among disadvantaged groups in RBF districts. These findings underscore the programme's potential to promote equitable access to maternal healthcare. Policymakers should prioritise developing and refining RBF schemes to address inequality and cater to the diverse needs of Zimbabwe's population. Continuous monitoring and evaluation, along with the integration of equity-focused metrics, are crucial for optimizing these programmes. By addressing the barriers disadvantaged women face, RBF can substantially contribute to creating a more equitable health system, serving as a cornerstone in improving health equity in low-income countries.

Ethical statement

Ethics approval for this study is not required since the study relies on secondary data for which approval was sought and granted through MEASURE DHS.

CRediT authorship contribution statement

Marshall Makate: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

The data used in this study is publicly available. Access to the DHS data requires formal authorisation from MEASURE DHS team. Instructions for securing the DHS data for Zimbabwe can be found at: https://dhsprogram.com/data/Access-Instructions.cfm.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

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