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Abstract

This study investigates the effect of a large-scale comprehensive intervention in Costa Rica aimed at reducing adolescent pregnancy among the poorest districts by integrating reproductive health services into the national health system with an intersectoral approach. The model was designed and developed under Salud Mesoamerica Initiative, an innovative public-private partnership that sought to improve reproductive, maternal and child health services among the poorest in the Mesoamerican region. Using a difference-in-differences approach and district-level vital records from 2000-2019, findings reveal a significant reduction in adolescent fertility rates for those aged 10 to 19 (11.3% reduction relative to the pre-treatment mean), particularly among females aged 10-14 (24% reduction relative to the pre-treatment mean). Our findings provide valuable lessons on how primary care systems of low-middle-income countries could address the sexual and reproductive health needs of adolescents which are often an underserved population.

JEL Codes: I18, I14, I10, N36
Keywords: Adolescent fertility; Primary Health Care; Health Systems

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I. Introduction

Adolescent pregnancy is a pressing issue in low- and middle-income countries (LMICs), where access to contraceptive methods that enable control over reproduction and facilitate human capital investment is more limited (Goldin, 2002), and violence toward women is more prevalent and acceptable (Anderson et al., 2010; Doepke et al., 2009; Jayachandran, 2015). Adolescent pregnancy is both a public health and a social problem, since pregnancies during this period of the life cycle pose risks to maternal and infant morbidity and mortality (Nelson, 2014; Noori et al., 2022; Sabet et al., 2023), mother's mental health (Agampodi et al., 2021), and are associated with worse adult life outcomes for both the mother and her offspring (Rich-Edwards, 2002; Hoffman, 2014). Since teenage pregnancy can have long lasting consequences, and it can result in large social costs, interventions that are effective in reducing teenage pregnancy can have substantial benefits for society (Vivo, 2012).

Numerous prevention strategies have been employed globally in an effort to address this pressing issue. Yet, few studies have specifically delved into effective strategies for preventing and postponing pregnancies among adolescents, and findings in this regard remain mixed and dependent on context (McQueston et al. 2013; Goesling et al., 2014; Oringanje et al., 2016). There is a large body of evidence focused on how to effectively promote contraceptive use among adolescents. Two systematic reviews focus on access to contraceptives among adolescents. Gottschalk and Ortayli (2014) conclude from their systematic review that effective programs are multifaceted and that only few rigorous studies have been conducted in LMICs that measure contraceptive behaviours and reaching the young and vulnerable out of school. Desrosiers et al. (2020)'s review reveals that sexual and reproductive health interventions are effective in promoting contraceptive use in for young in humanitarian and LMIC settings, but mostly focusing on the prevention of HIV/AIDS as opposed to adolescent pregnancy.

Notably, the bulk of research in low- and middle-income countries (LMICs) tends to concentrate on sexual health education programs within schools, instruction out of school to change gender norms and attitudes, and programs that promote female empowerment (Chong et al., 2019; Bandiera et al. 2020). The evidence base, however, offers limited insights into the role of healthcare providers and the quality of services they render (Rankin et al., 2016). Furthermore, those studies that assess service quality rely on adolescents' opinions about these services or their utilization of them as proxies, rather than presenting objective measures of quality (Aninanya et al., 2015, Cowan et al., 2011).

Another critical observation is the scarcity of research that furnishes results specific to very young adults (aged 10-14), despite evidence suggesting the importance of promoting safe behavior from an early stage in adolescence (Pick et al., 2007). Bergstrom and Ozler's (2022) review of interventions to delay childbearing for adolescent girls in LMICs concludes that more research is needed to understand the long-term effects of interventions that target the provision of sexual and reproductive health services, and that an explicit focus on the effectiveness of these services on all adolescents, inclusive of all ages, parity and marital status is long overdue.

Overall, the evidence points out that programs that are effective in reducing unintended pregnancies during adolescence tend to combine both educational and contraceptive interventions to improve knowledge about healthy sexual behaviours, enhance skills and personal development, and improve access and information regarding the proper use of family planning methods.

In this paper, we evaluate the effectiveness of a large-scale comprehensive intervention in Costa Rica that targeted adolescents at risk and provided greater and better access to sexual and reproductive health

care, alongside the distribution of contraceptive methods. The case of Costa Rica is a particularly relevant one to study. Latin America is the second region with the highest prevalence of teenage pregnancy, with 15 % of pregnancies occurring in women under the age of 20 (PAHO, 2018). The female adolescent fertility in Costa Rica was almost twice as large the OECD rate in 2015, 47 births per 1,000 females ages 15-19, compared to 25 (World Bank Group, 2020).

The intervention was implemented in 52 out of 469 districts in Costa Rica in two phases. The first phase, spanning from 2012 to 2014, entailed strengthening the capacity of government agencies, including improvements in the availability of contraceptive methods, importantly long-term methods, incorporating enhanced protocols focused on privacy in consultations and adolescent-specific time of care, and training personnel to adapt this new protocol and on how to address adolescents. Starting in 2015, the second phase focused on implementing the model by enrolling adolescents into the system, conducting a risk-assessment and adapting services and the distribution of contraceptive methods depending on the level of risk. The aims of this comprehensive intervention were to provide greater and better access to sexual and reproductive health care to adolescents, including the delivery of contraceptives for free, to reduce adolescent fertility rates among the poorest. The 52 targeted districts where the model was implemented were among the poorest in the countries.

To identify the effect of the comprehensive intervention on adolescent fertility we use a difference-in-differences strategy and panel data of vital records at the district-level for every year spanning 2000-2019. In addition, we combine administrative data on the program with district-level population projections to estimate the coverage of key components of the comprehensive intervention.

We enhance the existing body of evidence regarding strategies for preventing and delaying adolescent pregnancies by making three significant contributions. First, we provide valuable insights into the effectiveness of an at-scale comprehensive intervention to prevent adolescent pregnancy, which was seamlessly integrated into the existing healthcare system. The intervention uses an intersectoral approach to do outreach and educational activities and has a risk-based approach in which adolescents at higher-risk received more tailored services, such as additional counselling and follow-up. Second, our study offers objective evidence on how this initiative has led to enhancements in both the coverage and quality of health and reproductive health services. We draw upon comprehensive administrative data from the healthcare system to substantiate these improvements, providing a robust foundation for our findings. Third, our focus extends to an initiative that inclusively targets all adolescents, regardless of gender, age, marital status, or health condition. In doing so, we ensure that our analysis encompasses a diverse range of adolescents, and we present disaggregated results by age group within this broader adolescent population. Finally, this study offers valuable lessons in how primary care systems can address the needs in terms of sexual and reproductive health of adolescents in the setting of middle-income countries.

II. The Comprehensive Care Model in Costa Rica

The Salud Mesoamerica Initiative (SMI) is a public-private partnership that seeks to improve maternal and child mortality amongst the most vulnerable populations in the Mesoamerica Region. SMI supports demonstrated cost-effective interventions in maternal, neonatal, child and reproductive health, through results-based financing agreements with the governments in the region. The objective of the Initiative is to increase access, quality and utilization of primary health services for the poorest 20 percent, and to guarantee the political and financial commitment needed to close the prevailing health gaps in these populations in the Mesoamerican countries.

To assure the relevance and applicability of the interventions to be financed in the different Mesoamerican countries, SMI defines in agreement with each government the health issues to prioritize according to the specific country needs. In Costa Rica, SMI focused primarily on sexual and reproductive health for teenagers in the poorest areas of the country. This responds to the fact that despite its overall tradition of positive and improving health outcomes, Costa Rica had been unable to reduce persisting high levels of teenage pregnancy. General fertility rates in the country for females aged 20-44 had fallen at double the pace than they had for females aged 15-19, between 1980 and 2010.[1]

In this context, SMI and several Costa Rican government institutions designed a comprehensive reproductive health care model for adolescents based on primary care and an intersectoral approach. The design was joint with several institutions providing services for adolescents including the Costa Rican Social Security Fund (CCSS, Spanish acronym), the Ministry of Education and the National Child Welfare Agency (PANI, Spanish acronym). Supplementary Appendix A contains a more detailed description of the functions of each institution and their role in the intervention. The aim of the intervention was mainly to reduce adolescent fertility, but also to provide support and services for adolescent mothers to return to school and for adolescents at risk.

The keystone of the model was adolescent comprehensive care, which was provided in primary care centers. This was a preventive care visit designed for adolescents in which they received information on sexual and reproductive health and contraceptive methods, a physical examination, and a sexual and reproductive risk assessment. The assessment allowed to screen and classify adolescents according to their mental, social, and sexual and reproductive health risks. The model stipulated the set of services for each adolescent depending on their type and level of risk (see Appendix B for a description of the assessment and the set of services by risk level). For example, adolescents classified as medium or high sexual and reproductive risk received additional counselling on contraceptive methods and sexual and reproductive health and received the contraceptive method of their choice. However, all adolescents regardless of their risk could receive a contraceptive method if they chose to. The comprehensive care visit, contraceptive methods, and related health services were provided free of charge through the CCSS, which provides health care coverage to 94.7% of the population in the country (OECD,2017). Children and adolescents' health services are covered by the CCSS regardless of the affiliation or contributions of their parents.

Primary care services, in the targeted districts had to be adapted to provide the adolescent comprehensive visit. First, a consultation time of twice the usual allotted time (30 instead of 15 minutes) was allowed by the CCSS for this type of care to provide enough time for the risk assessment and related activities. Second, health care providers had to receive training on the model, risk assessment, and more importantly on communicating effectively with adolescents. Third, primary care units had to adapt special areas to ensure privacy, and some designated specific times for adolescent care only. The presence of a parent or tutor was not required to receive the comprehensive care visit. Finally, availability of modern contraceptive methods, including long-acting reversible contraceptives, were ensured through country guidelines adaptation, inclusion in the national essential medicine list, and removing barriers to access by having a stock available in the same facilities where comprehensive visits took place.

[1] 98 % for women 20 to 44 compared to 43 % among women 15 to 19. Data available at Centro Centroamericano de Poblacion (CCP).

The comprehensive health visit was provided at the local level by the Basic Teams for Comprehensive Health Care (EBAIS, Spanish acronym), which are teams of doctors, nurses, and health promoters, providing primary care services in a predefined catchment area and constitute the main unit of care in the Costa Rican health system. Due to the intersectoral nature of the intervention, services provided spanned not just health-related, but also educational, or of social support. For example, for adolescents with mental or social risks they could entail referrals to individual counseling by psychologists and social workers; for pregnant adolescents they included in addition to health services such as prenatal care visits and counseling on post-partum contraception, additional services like scholarships and support from schools to continue their education. Local coordination units (LCUs) were formed to manage and coordinate the provision, and follow-up of this set of services for adolescents across different institutions, and to implement and monitor the model at the local level. They were formed with representatives of all participating institutions. LCUs oversaw the implementation of the model in a health area, which could encompass up to 15 EBAIS. Regional coordination units (RCUs) were also created to oversee the work of LCUs and were also constituted from representatives of all participating institutions. Finally, to facilitate case management, a nominal information system for adolescents (SINA, its Spanish acronym) was created so that EBAIS, LCUs, RCUs, and participating institutions could keep track of the services provided and needed by adolescents based on the model of care.

As part of the model, multiple outreach and educational activities were conducted to promote the uptake of the comprehensive visit among adolescents as well as to improve knowledge on sexual and reproductive health. Health personnel from the EBAIS conducted educational activities at schools and informed students about the new health service. Teachers that mentor and advise students (a common figure in the Costa Rican education system) also facilitated that adolescents could attend the comprehensive care visit. Adolescent leaders in schools were trained so they could provide peer support, education, and promotion of the comprehensive care visit. Finally, referrals to the comprehensive visit could be made by all participating institutions if they identified adolescents in need.

The design and implementation of the model was organized in two distinct phases as part of SMI: preparation and implementation. The first phase, preparation, spanning from 2012 to 2014, entailed strengthening the capacity of the government agencies involved. This included improving the availability of long-term contraceptive methods; and incorporating adolescent-friendly protocols (requirements of privacy in consultations, establishing an adolescent-specific time for care, personnel training on how to address adolescents, among others) into the targeted EBAIS. The preparation phase also included activities such as updating clinical guidelines, procurement of contraceptive methods, design of educational materials, and development of the risk screening tool and associated risk-based referral system. The second phase, spanned from 2015 to 2018, and focused on the implementation of the model at the selected EBAIS. That is, it started enrolling adolescents into the system designed during the first phase, conducting the risk-assessment and providing the related services based on the risk. SINA became operational in this phase in SMI targeted districts. It is important to note that in 2013, the Ministry of Education introduced into the secondary level science curricula a thematic unit on affectivity and sexuality. This was implemented in all schools in the country, including SMI targeted districts.

As part of the results-based financing model of SMI, between 8 and 10 indicators were selected per phase, and targets agreed to measure performance. Indicators followed closely the key results expected in each phase. For instance, in the first they were focused on system readiness, whereas in the second one, they focused on key processes and results. According to SMI's financing model, the intervention was financing in equal parts by donation funds from SMI and national funds, but if the country achieved 80% of the targets set, it received an amount equal to 50% of the national funds contributed to be used in the health

sector. A key part is the donation and local funding to complete the intervention was provided upfront, but the performance tranche was provided only at the end of each phase. Costa Rica achieved the targets set in SMI in both phases.

In total 52 out of 469 districts were targeted for the intervention in Costa Rica. The selected districts were those with the lowest levels of social development in the country, i.e, they had a Social Development Index (IDS, Spanish Acronym) value lower than 45.5. The IDS is a composite measure of social development that is constructed by the Costa Rican government based on district level indicators of health, education, economic activity, and electoral participation and is used by the government to guide social policy and planning (MIDEPLAN, 2013). In addition to the value of the IDS, some operational considerations were also done, such as concentrating the intervention in some districts within two health regions: Huetar Atlántica and Brunca, which are among the most remote and vulnerable in the country (see Appendix C for a map of targeted districts). The targeted districts were served by the 2 regional authorities that oversaw 11 health areas comprising around 124 EBAIS. Pre-intervention, there were on average yearly 88,937 adolescents aged 10 to 19 in the targeted districts.

III. Data

The main outcome of interest is the female adolescent fertility rate, measuring the fertility rate for females aged 10 to 19 years. We construct a panel data of this outcome at the district level for every year between 2000 and 2019 combining several administrative and census data. For the numerator, we use live births by mother's age between 10 and 19 years old from vital registries. For the denominator, we use population projections by age group for the same age range. These data were obtained from the Institute of Statistics of Costa Rica (INEC, Spanish acronym). Appendix D presents the detailed methodology for the construction of the fertility rates.

While there were 52 targeted districts for the intervention, only 45 were full intervened. That is, 7 districts were only partially intervened since only a fraction of them were served by the 11 health areas corresponding the regions prioritized due to operational considerations. Our analysis focuses on only fully intervened districts. In addition, since we could not merge data over time in one district we have 44 districts in the intervention group for our analysis.

The treatment variable is defined as being a district targeted to offer the comprehensive model to adolescents, based on the intervention records. We use data from the 2011 Census and data from the IDS to identify districts that could serve as a comparison group.

We also construct several indicators to measure the coverage of key components of the intervention such as the percentage of adolescents that received a comprehensive visit, that were assessed for sexual and reproductive risk, and that received contraceptive methods. To do so we combine de-identified data from SINA, the information system for adolescents created as part of the intervention, and INEC's population projections. SINA was an information system that captured information of the services received by each adolescent in the target districts as part of the intervention linking multiple administrative records including health services provided by the CCSS based on medical records and pharmacy records among others. This data spans from 2015 to 2018, so it captures the implementation phase of the intervention. While we could not obtain data for 2019, the accumulated data from 2015 to 2018 still captures the bulk of the implementation period. We construct aggregated data, counting individual adolescents from SINA to build the coverage indicators by gender and in total.

IV. Estimation strategy

We use a difference-in-differences (DID) strategy comparing targeted and comparison districts before and after the implementation of the comprehensive model. For our main comparison group, we use districts not located in the targeted regions with a similar level of poverty than those intervened (IDS <45.5) – a total of 67 districts. Appendix C contains the geographical location of targeted and comparison districts in the country. As the intervention was implemented in phases, we estimate the following linear regression to capture the effects of the first phase (preparation) and second phase (implementation):

$$F_{dt} = \beta_1 P1_{dt} + \beta_s P2_{dt} + \delta_d + \lambda_t + \nu_{dt} \quad (1)$$

where F_{dt} is the female adolescent fertility rate per 1,000 females aged 10 to 19 in district d and calendar year t. We also estimate this model separately for the fertility rate per 1,000 females aged 10 to 14 and for the fertility rate per 1,000 females aged 15 to 19. $P1_{dt}$ is a binary indicator equal to one during the preparation phase (2012-2014) of the comprehensive model in targeted districts, and 0 otherwise. $P2_{dt}$ is a binary indicator equal to one during the implementation phase (2015-2019) in targeted districts, and 0 otherwise. We include district fixed effects (δ_d) and year fixed effects (λ_t) to control for time-invariant district characteristics and common year shocks, respectively. We cluster standard errors at the district level to deal with serial correlation in the panel data structure.

The DID strategy hinges on the assumption that the outcomes in targeted and comparison districts would have followed similar trends absent the implementation of the comprehensive model to prevent adolescent pregnancy. While this assumption is untestable, we provide evidence commonly used in the literature that gives us confidence that the result holds. We test for differences in pre-treatment trends by estimating a fully dynamic difference-in-differences specification. For this, we use leads and lags of the treatment indicator P_{dt} (equal to one after 2012 for targeted districts), using the first lead (2011) as the reference year and test for joint significance of the leads (see Figure 2). Failing to reject the hypothesis that they are jointly equal to zero, i.e. that pre-trends in outcomes are not related to treatment status, bolsters our confidence in the assumption of parallel trends and the adequacy of the comparison group for the DID empirical strategy.

In addition, we conduct several robustness checks. First, we perform a falsification test estimating the fully dynamic DID specification on fertility rates of women not affected by the intervention, i.e., those age 30 to 39 and we find no effect (see Appendix E1). Second, we estimate the model with a method akin to instrumental variables in which causal inference is valid even when endogeneity leads to pre-trends in the outcome of interest (Freyaldenhoven, Hansen and Shapiro, 2019) and our main results hold (see Appendix E2). Finally, we use two alternative comparison groups to estimate the DID model: districts with a similar level of rural population and non-intervened districts within the same regions of targeted districts. On these alternative comparison groups, we estimate the fully dynamic DID specification as well as the falsification test and instrumental variables approach (see Appendix E3). Overall, our results hold in the robustness checks performed.

V. Results

We start by exploring descriptively the reach of services associated with the intervention in the targeted districts. **Table 1** shows that according to population projections a total of 88,937 adolescents were living in the targeted districts, 51% of these were males and the remaining females. Out of the projected adolescent population, around 82% received a comprehensive visit, 39% undertook a risk evaluation of their sexual and reproductive health, and 21% received contraceptives at the health services, at least once. Across these services, the coverage was greater among female adolescents relative to males. For instance, while the coverage of the comprehensive visit was close to 95% for females it was only around 70% for males. This large difference in coverage by gender can also be seen in the reception of contraception, since while around 38% of females received contraception only 4.5% of males did.

Table 1. Cumulative coverage of key components of the intervention in targeted districts by 2018

	Male	Female	Total
Adolescents age 10 to 19	45,500	43,437	88,937
Percent of adolescents that at least once...			
…attended a comprehensive visit (%)	69.5%	94.7%	81.8%
…were assessed for sexual and reproductive health risk (%)	33.0%	44.9%	38.8%
…received contraceptives in health services (%)	4.5%	38.2%	21.0%

Notes: This table reports descriptive statistics of the adolescents registered in SINA for the 44 districts where the ISM was implemented. All values include adolescents aged between 10 and 19 years old, for every year spanning 2015-2018. Adolescents age 10 to 19 is the average from populations projections from 2015 to 2018. At least once means at least once during the period of analysis.

A central part of the intervention was the adolescent risk classification that allowed to target efforts among those at higher risk. For instance, adolescents classified at medium and high risk were expected to receive additional counselling on contraceptive methods and were prescribed a method according to their choice (See Appendix B). This could explain in part the gap in coverage between the comprehensive visits (82%) and reception of contraception (21%). In Table 2 we examine the coverage of contraceptives based on the risk classification of adolescents. Table 2 (Panel A) shows that out of the total adolescents that had a risk assessment (34,507), 57% were classified with no risks, 18.7% with low sexual and reproductive health risk (SRR) and 9.5% and 10.9% were classified in the medium and high SSR categories respectively. Just 3.9% of adolescents with risk evaluation had a mental or social risk detected.

As expected from the intervention, the coverage of contraception increased with the level of risk going from 8.9% among those with no risk classification to 70.5% among those classified at high SSR risk, with the highest levels of coverage among those at medium and high risk. The coverage of contraception within each of the risk groups is higher among females than males, with 78.1% of the female adolescents classified as high risk having received a type of contraceptive, compared to only 27% of registered males. Around 43% of females classified as medium or high SSR received long-acting reversible contraception such as intrauterine devices (IUDs) or implants. It is likely that the reception of contraception is underestimated among males, since the figures are based on receipt of method according to pharmacy records, and as the intervention progressed, condoms, which are the main contraception for men, became available without prescription to remove barriers. Hence the delivery of condoms was not registered by pharmacies in the later years. The results from the previous tables show that the coverage of the

comprehensive visit for adolescents was high and that while the reception of contraception was much lower, it was higher among those adolescents classified as high sexual and reproductive risk.

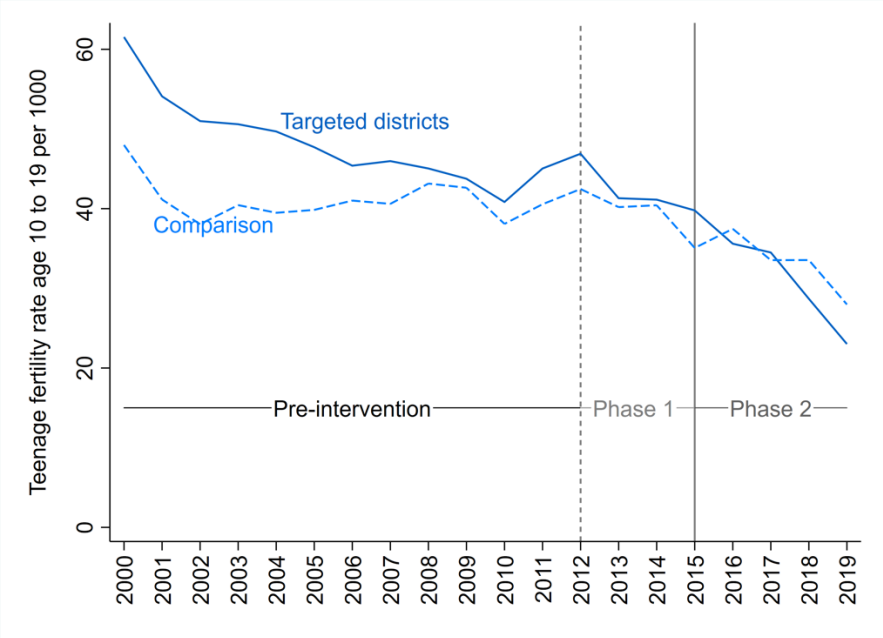
Table 2. Distribution of adolescents by risk classification and contraception reception during 2018 in targeted districts

	Risk classification					
	No Risk	*Sexual and reproductive health risk*			*Mental or social risk only*	Total
Adolescents…		*Low*	*Medium*	*High*		
Panel A. …by risk classification (%)						
% of adolescents with risk classification	57.0%	18.7%	9.5%	10.9%	3.9%	100.0%
Panel B. ...by risk classification and gender (number)						
Male	9,250	3,280	1,329	556	607	15,022
Female	10,419	3,176	1,956	3,209	725	19,485
Total	19,669	6,456	3,285	3,765	1,332	34,507
Panel C. ...that received contraceptives within each risk classification (%)						
Male	2.2%	5.0%	19.5%	27.0%	5.1%	5.4%
Female	14.8%	26.4%	70.9%	78.1%	21.7%	33.0%
Total	8.9%	15.5%	50.1%	70.5%	14.1%	21.0%

Notes: This table reports descriptive statistics of the adolescents registered in SINA for the 44 districts where the ISM was implemented. All values include adolescents aged between 10 and 19 years old, for every year spanning 2015-2018. All figures are based on the number of adolescents that were assessed at least once for risk during the period of 2015-2018. All percentages are computed using as denominator the total corresponding to each sample.

We now focus on estimating the effects on the adolescent fertility rate in targeted districts. Figure 1 shows the trends in the adolescent fertility rate per 1,000 females aged 10 to 19, separately for targeted and comparison districts. While both groups start at different fertility levels, with adolescents' fertility rates higher on treated than comparison districts, they follow similar trends in the pre-intervention period, except for a few years, particularly between 2003 and 2006, in which the fertility rate in the treated districts is decreasing and remains mostly constant in the comparison period. For this reason, starting in 2007, the difference in levels between both groups is much smaller. During the implementation phase (phase 1) the adolescent fertility rate decreases at similar rates in both the treatment and comparison districts. However, it is during the implementation phase (phase 2) that fertility rates start declining at a steeper rate in the treated districts and even go below the fertility rates of the comparison group for the first time in the whole period of analysis.

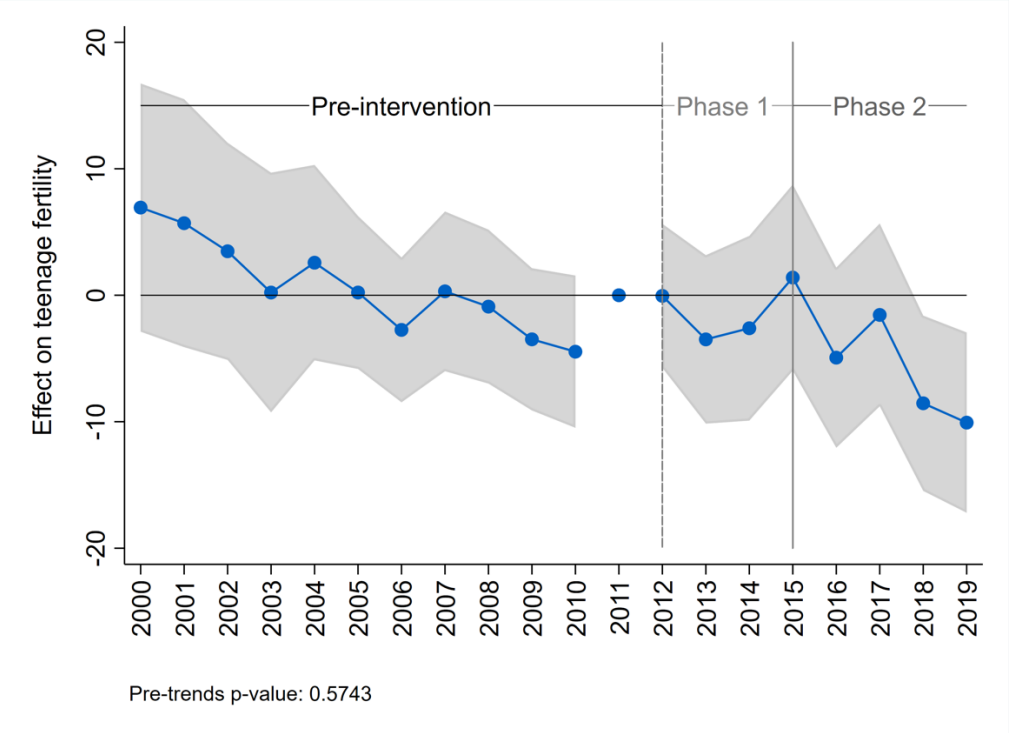
Figure 1. Female adolescent fertility trends for treatment and comparison groups



Note: Targeted districts include all districts that where fully intervened with the comprehensive model and comparison refers to those districts outside the treated regions that had similar poverty levels than those intervened. Adolescents' fertility refers to that of women 10 to 19 years old. Phase 1 refers to the preparation phase of the intervention between 2012 and 2014. Phase 2 refers to the implementation phase of the intervention between 2015 and 2019.

In Figure 2, we formally test for the difference in trends between the treatment and comparison group using the dynamic DID specification. Here we plot the lead and lag coefficients of the treatment indicator variable, which essentially correspond to the interaction of each calendar year with the treatment indicator. We also test for pre-trends in the pre-intervention period, considering the 11 years prior, which span between 2000 and 2010 (2011 is the reference year). There are a couple of observations worth highlighting. First, the point estimates of all leads are statistically insignificant during the pre-intervention period, and they are jointly insignificant (p-value=0.5743). This finding serves as evidence in support of the parallel trends assumption, validating the difference-in-differences strategy. Second, there is no significant effect during the preparation phase, which is to be expected, since the comprehensive model of care started operating until 2015. Finally, there is a statistically significant reduction in fertility rates during the last part of the implementation phase, 2018 and 2019, coinciding with a more mature implementation of the comprehensive model. The magnitude of the decline in fertility in these last two years is large, of around 10 births per 1,000 females, which is about a 22% reduction relative to the average fertility in the pre-treatment years in the treated districts (45.35). The effect of the reduction in adolescent fertility during 2018 and 2019 is very robust, as it is of similar magnitude and significance irrespective of the use of alternative comparison groups or adjusting for pre-trends using instrumental variables (see Appendix E).

Figure 2. Effects in female adolescent fertility rate by year



Note: This figure plots the coefficients of the interaction between each year and an indicator for treatment status. The shaded area around each coefficient is the 95% confidence interval. The reference year is 2011, the last pre-intervention year. Since it is the reference year, it is normalized to zero and no confidence intervals can be calculated for this year. The comparison group is composed of districts with similar poverty levels outside the treated regions. Phase 1 (Preparation) starts in 2012 (dashed vertical line), but the implementation takes place in Phase 2 from 2015 onwards, denoted by the solid vertical line. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions. Adolescents' fertility refers to that of women 10 to 19 years old.

Finally, we present the estimates of the difference-in-difference estimation using Equation (1) in Table 3. We split the effect by phases of the intervention, with the reference category being no intervention implemented. Outcomes by column correspond to: (1) Adolescent fertility rate per 1,000 females for those aged 10 to 19; (2) Adolescent fertility rate per 1,000 females for those aged 10 to 14; and (3) Adolescent fertility rate per 1,000 females for those aged 15 to 19.

We find that the intervention decreased on average the female adolescent fertility rate by 5.14 births per 1,000 females aged 10-19 during the implementation phase (phase 2) in targeted districts. This effect translates into a 11.3% decrease in the mean adolescent fertility rate across treated districts in the analysis, as measured before the start of the intervention. The effects on adolescent fertility for young females aged between 10 and 14 is a drop by 1.4 births per 1,000 females aged 10-14 (24.4% drop from the pre-intervention district average rate). The comprehensive model decreased the fertility rate for those aged 15-19 by 8.46 births per 1,000 females in this age group (9.7% drop from the pre-intervention district average rate), however, this effect is not statistically significant.

While the impact on the female adolescent fertility rate when considering all age-groups is negative during Phase 1, it is not statistically significant. Notably, the coefficient's magnitudes are much smaller during Phase 1, than during Phase 2, and in the case of adolescents age 10-14 the effect is close to zero. This indicates that the reduction in adolescent fertility becomes substantial when the comprehensive model was fully implemented, the coverage of the comprehensive visit became high, and the risk assessment became fully operational.

Table 3. Effects on female adolescent fertility rate by age-group and phase

	Age Group		
	10-19	**10-14**	**15-19**
Phase	(1)	(2)	(3)
Phase 1 (2012-2014)-Preparation	-2.17	-0.11	-3.12
	(2.35)	(1.02)	(4.45)
	[0.36]	[0.92]	[0.48]
Phase 2 (2015-2019)-Implementation	-5.14*	-1.40**	-8.46
	(2.77)	(0.62)	(5.46)
	[0.07]	[0.03]	[0.12]
Pre-intervention treatment mean	45.35	5.72	87.31
District-year	2,220	2,220	2,220
Districts	111	111	111

Note: Estimation based on equation (1) specified in the estimation strategy section using fully treated districts and districts with similar poverty levels outside treated regions as a comparison. We display only the coefficients of intertest B_1 and B_2 which are the effects of Phase 1 (preparation) and Phase 2 (implementation) respectively. Phase 1 is an indicator equal to 1 for treated districts between 2012-2014 and 0 otherwise; and Phase 2 is an indicator equal to 1 for treated districts after 2015 (strong onset of ISM) and 0 otherwise. The model is estimated in three outcome variables separately. Column (1) presents results for adolescents 10 to 19 fertility rate, column (2) results for adolescent 10 to 14 fertility rate and column (3) adolescents 15 to 19 fertility rate. All fertility rates are express per 1000 females. All estimates include district and year fixed effects. Standard errors are clustered at the district level and are displayed in parenthesis. P-values are displayed in square brackets. Statistical significance denoted by *p < 0.1, **p< 0.05, ***p<0.01.

VI. Discussion and Conclusion

Adolescent fertility can have long lasting implications for health and living standards. Despite reductions in unmet contraceptive needs and information regarding sexual behaviour, teenage pregnancy is still a pressing issue worldwide, particularly among the poorest. While there are multiple and complementary evidence-based interventions to address this issue, there is still limited evidence on how to effectively integrate most of them into health systems of low- and-middle-income countries and on how to coordinate multisector action. Our study provides evidence on the effectiveness of a multi-sector and systemic approach to address adolescent fertility in Costa Rica spearhead by the MoH. We show that the comprehensive model implemented in the poorest districts in Costa Rica, was effective in reducing adolescent fertility rate by 11.3% relative to the average rate pre-intervention. Moreover, we also show that there were substantial gains among adolescents aged 10 to 14 (a reduction of 24.4% relative to the average rate pre-intervention).

The reductions in adolescent fertility rates we observe occur only in the last years of the implementation phase (2018 and 2019). In contrast, we do not observe any meaningful reductions in adolescent fertility during the preparation phase of the program. During this phase, several components of the model often associated with making health services more adolescent-friendly such as personnel training on how to address adolescents, adapting primary health services to provide privacy for them during consultations, and improving availability of contraceptive services were put in place. While these isolated interventions could have an effect on their own, it is only until the comprehensive model became fully operational and achieved high levels of coverage that the reductions in adolescents' fertility materialized. This suggests

that the integration of these and other elements into the comprehensive model rather than isolated interventions were fundamental for the results.

The model was effective in providing health services for vulnerable and at-risk adolescents. First, by design, it was targeted to adolescents living in the poorest districts in the country. Second, it achieved a higher coverage of the comprehensive visit, risk assessment and contraception receipt among adolescent girls, which are especially vulnerable to the impact of poor sexual and reproductive health services. Third, it achieved a higher take-up of contraception among adolescents at higher sexual and reproductive risk. While 70% of adolescents classified as high risk received contraception, only around 9% did among those classified without risk. To do so, they were first identified through the sexual and reproductive risk assessment and then provided additional counselling, services and follow-up if classified as high-risk. Finally, the model was able to achieve reductions in fertility even among adolescents age 10 to 14, which are a particularly hard to reach group.

The model was implemented under SMI, which had a results-based financing (RBF) scheme. Hence a key question is the role the incentives of the RBF scheme had on the effects we see on adolescent fertility. However, we cannot untangle its contribution quantitatively. Yet qualitative studies on SMI provide some insights. According to interviews with country participants, the systemic approach on integrating cost-effective interventions by SMI, created a path towards results and the RBF scheme helped accelerate performance improvement by creating a sense of urgency, promoting a results-based culture, creating a regional sense of competition, and encouraging countries to develop spaces for organizational learning (El Bcheraoui, 2017; Eicher, 2017). According to a Minister of Health in the country "*the evaluation was fundamental as there was a challenge and commitment at the country level to do well [while] most of the money was provided by the country, it hurt more to invest it badly"* (Valverde, 2020).

Our study expands the evidence base on the effectiveness of at-scale interventions aimed at reducing adolescent fertility in low- and middle-income countries. While there is substantial evidence of multiple cost-effective interventions to address adolescent sexual and reproductive health needs, there is a persistent challenge on how to integrate them into an existing health system. Moreover, while it is clear addressing this issue requires an intersectoral approach, there is scant evidence of how to make them effective. The comprehensive model in Costa Rica, provides evidence on how an intersectoral approach could be implemented, with clear functions, responsibilities, performance metrics, and local and regional implementation strategies to maintain coordination of the agencies involved. The implications drawn from our study draw valuable lessons on addressing adolescent fertility in underserved regions.

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Supplementary Appendix

Appendix A. Participating government institutions in the intersectoral model for adolescent care

Institution	Main function	Role in the model
Caja Costarricense del Seguro Social (CCSS)/ Costa Rican Social Security Fund	Main provider and financer of health services in the country. It operates a network of EBAIS, clinics and hospitals throughout the country.	Manages the provision of the adolescent comprehensive visit, associated health services, and contraceptive methods in the eligible EBAIS.
Ministry of Health (MoH)	Governing body of the health sector in charge of policy direction, health regulation, and guidelines of care.	Oversaw the design of the model, guidelines for the model of care, as well as updated guidelines for modern contraceptives for adolescents.
Dirección Nacional de los Centros de Educación y Nutrición y de los Centros Integrales de Atención a la Infancia (CEN-CINAI)/ National Directorate of Education and Nutrition Centers and Comprehensive Child Care Centers	It is an institution that operates under the MoH that provides comprehensive services to children and families in poverty or social risk through a network of centers focused on nutrition, education, and comprehensive care for children.	Provided nutritional services for pregnant adolescents and mothers in situation of poverty and childcare for adolescent mothers to facilitate their return to the educational system.
Ministry of Education	Oversees the education system in the country, from early childhood to tertiary education.	Educational and informational activities for adolescents on sexual and reproductive health in schools, referral and facilitating the attendance of adolescents in the school system to the comprehensive visit, support for pregnant adolescents to continue their education.
Patronato Nacional de la Infancia (PANI)/ National Child Welfare Agency	An autonomous institution responsible for protecting and promoting the rights and integral development of children and adolescents.	Provided assistance and support for adolescents in situation of risk, such as victims of abuse, violence or negligence, including legal, psychological, social and educational services. Provided scholarships for adolescent mothers. Trained and oversaw the work of the adolescent leaders that provided peer education and support.

Sources: Author's elaboration based on program documents.

Appendix B. Risk assessment and key services by risk level

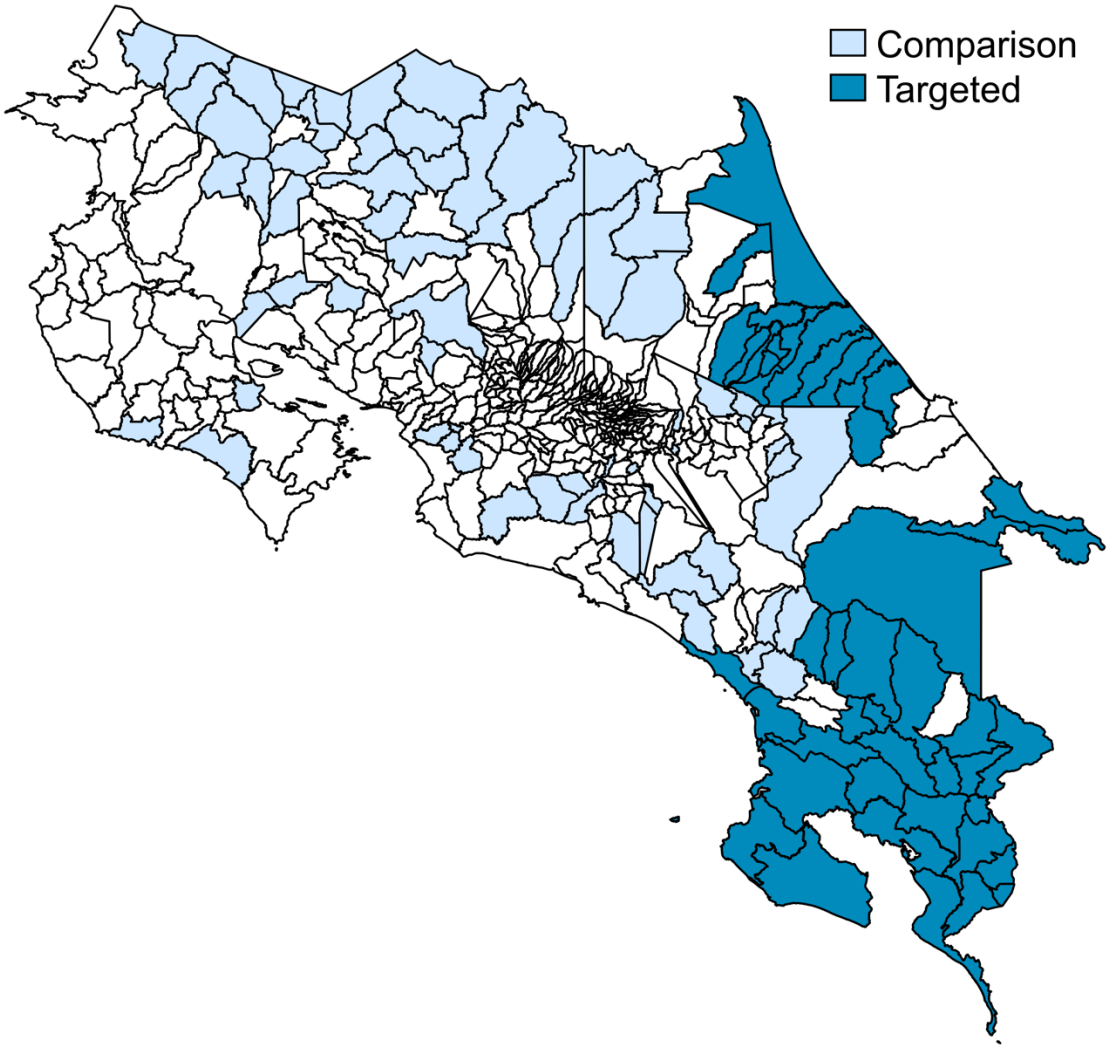
During the adolescent comprehensive visit a risk assessment was conducted. The assessment was designed for the model of care and allowed to classify adolescents according to their social, sexual and reproductive and mental health risks. Social risks included abandonment, adolescents less than 15 years old living with a couple, being outside the education system among others. Mental risks included suspicion of substance abuse, depression, eating disorders and suicide ideation. Sexual and reproductive health risks were categorized in three levels (low, moderate, and high) depending on sexual activity, use of contraceptive methods, diagnosis or history of sexually transmitted diseases and prior pregnancies among others. The table below summarizes the distinct risk levels and the main services provided for each risk level.

Table B.1 Risks and illustrative services in the model of care

Risk	Illustrative services
No risks/ Low social and reproductive risk (no sexual activity)	Scheduling of next comprehensive visit
Medium social and reproductive risk	Counseling on contraceptive methods and protection against STDs Prescription & delivery of contraceptive methods based on the adolescents choice
High social and reproductive risk	Counseling on contraceptive methods and protection against STDs Individual counseling on sexual and reproductive health Prescription & delivery of contraceptive methods based on the adolescents choice Referral to additional services as needed (for example to PANI in case of suspicion of sexual violence)
Mental Risk	Psychological health services Referral to additional services as needed
Social Risk	Referral to additional services as needed (for example to PANI in case of abandonment, or to the school system if the adolescent is outside the education system).

Sources: Author's elaboration based on program documents.

Appendix C. Geographical location of targeted and main comparison districts



Notes: Dark-shaded districts are targeted, and light-shaded districts are the main comparison group, i.e., districts with similar level of poverty than those targeted and outside the targeted regions. Districts in white were not targeted nor selected to be in the main comparison group.

Appendix D. Data

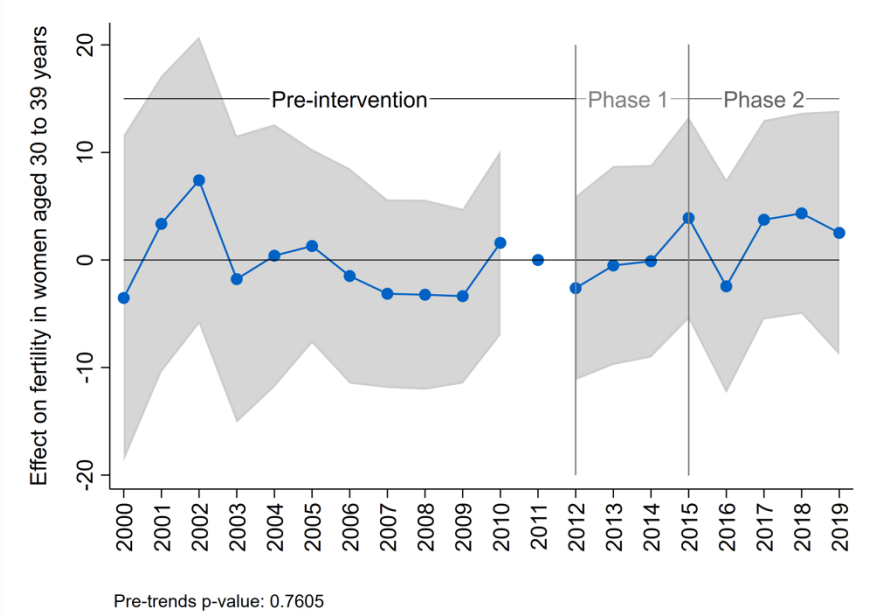
The adolescent fertility date is computed as the ratio between live births and the female population at risk in a given district and year, as follows:

$$F_{adt} = \frac{Births_{adt}}{Female\ population_{adt}}\ x\ 1{,}000$$

Here, F is the fertility rate in age group a, district d and year t. $Births$ correspond to the live births and $Female\ population$ to the corresponding female population at risk of pregnancy, per age group of the women, district and year.

Appendix E. Robustness checks

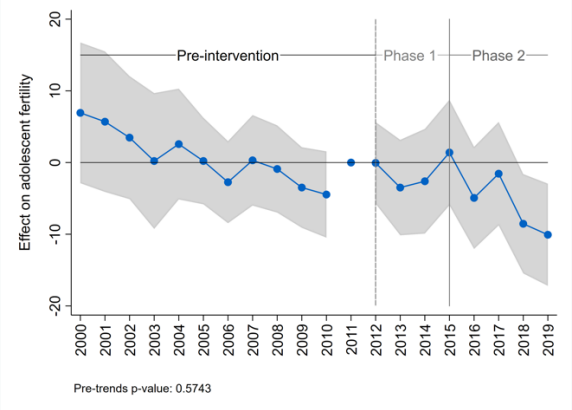
E1. Falsification test-Effects in female fertility age 30 to 39 by year



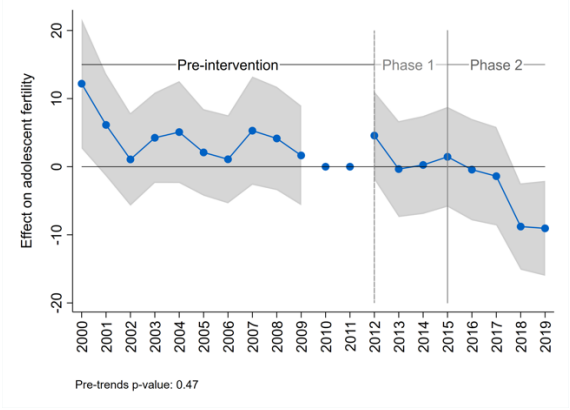
Note: This figure plots the coefficients of the interaction between each year and an indicator for treatment status. The shaded area around each coefficient is the 95% confidence interval. The reference year is 2011, the last pre-intervention year. Since it is the reference year, it is normalized to zero and no confidence intervals can be calculated for this year. The comparison group is composed of districts with similar poverty levels outside the treated regions. Phase 1 (Preparation) starts in 2012, but the implementation takes place in Phase 2 from 2015 onwards. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions.

E2. Effect on teenage fertility based on original estimation and estimation using instrumental variables based on Freyaldenhoven, Hansen and Shapiro (2019)

A. Original estimation (Figure 2)



B. Estimation using instrumental variables



Note: Both figures have the same targeted and comparison group (districts with similar poverty levels outside the treated regions). The shaded area around each coefficient is the 95% confidence interval. The figure on the left is the same as the one presented in Figure 2 in the paper and is presented as a comparison. The figure on the right is estimated using the methods described in Freyaldenhoven, Hansen and Shapiro (2019). It uses fertility of women 30 to 39 which were unaffected by the intervention as a proxy to account for trends affects fertility for all ages. It is instrumented using fertility for women 40 to 49 which were also unaffected by the intervention. The estimation using the instrumental variables requires an additional year to be normalized to zero, so 2010 and 2011 are considered reference years and hence have no confidence intervals. Phase 1 (Preparation) starts in 2012 , but the implementation takes place in Phase 2 from 2015 onwards. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions.

E3. Alternative comparison groups

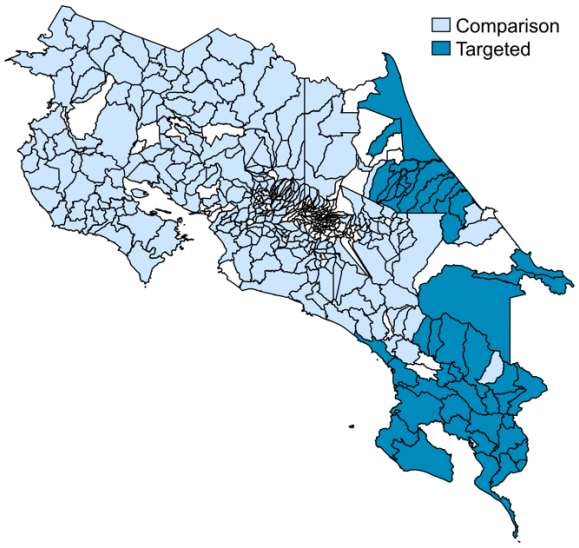
Table E3.1 Descriptive statistics of main and alternative comparison groups

	Total	Targeted	Comparison
Main Comparison Group			
Panel A. Districts with similar level of the social development index (IDS)			
Number of districts	111	44	67
Average % rural population	0.75	0.66	0.81
Average social development index (IDS)	37.72	37.24	38.02
Alternative Comparison Groups			
Panel B. Comparison 2: Districts with a similar share of rural population than targeted districts			
Number of districts	302	44	258
Average % rural population	0.72	0.66	0.74
Average social development index (IDS)	48.37	37.24	50.27
Panel C. Comparison 3: Non-intervened districts within the same regions of targeted districts			
Number of districts	80	44	36
Average % rural population	0.62	0.66	0.57
Average social development index (IDS)	43.24	37.24	50.62

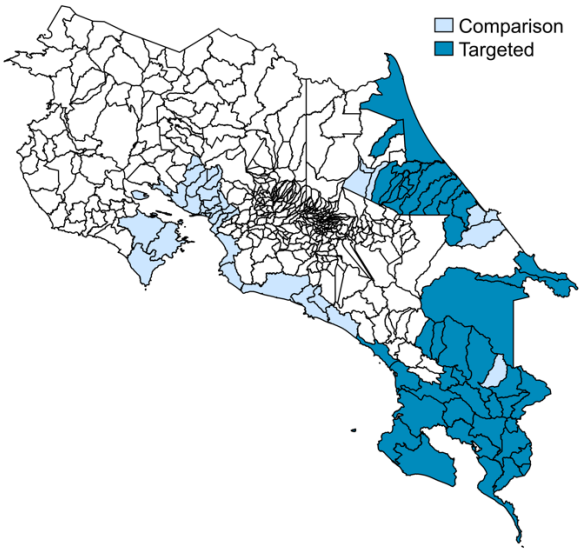
Note: The Social Development Index (IDS, Spanish Acronym) is a composite measure of social development that is constructed by the Costa Rican government based on district level indicators of health, education, economic activity, and electoral participation and is used by the government to guide social policy and planning (MIDEPLAN, 2013). The share of rural population comes from the 2011 Census.

E.3.2 Geographical location of targeted and alternative comparison districts

Comparison Group 2:
Districts with a similar share of rural population than targeted districts



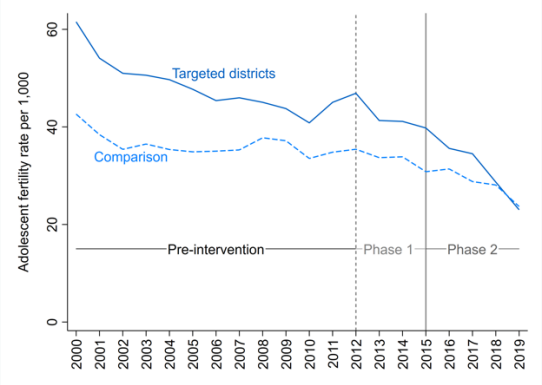
Comparison Group 3:
Non-intervened districts within the same regions of targeted districts



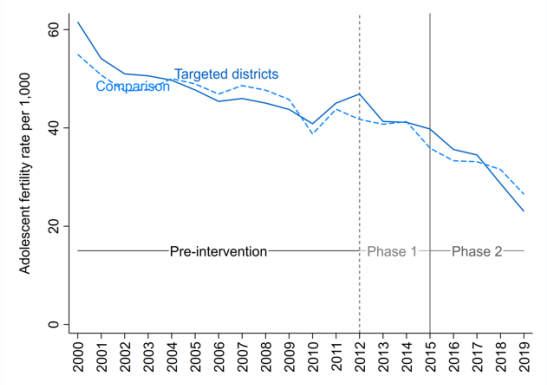
Notes: Dark-shaded districts are targeted, and light-shaded districts are the comparison group. Districts in white were not targeted nor selected to be in the comparison group.

E.3.3 Female adolescent fertility trends by year using alternative comparison groups

Comparison Group 2:
Districts with a similar share of rural population than targeted districts



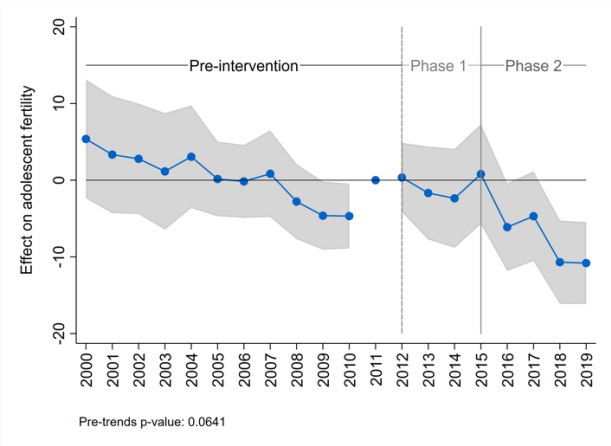
Comparison Group 3:
Non-intervened districts within the same regions of targeted districts



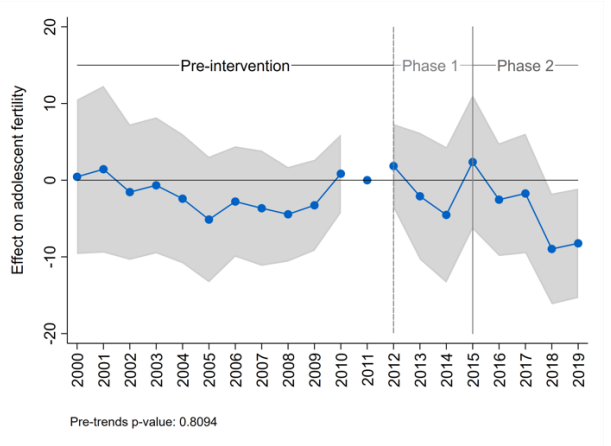
Note: Targeted districts include all districts that where fully intervened with the comprehensive model and comparison refers to those districts outside the treated regions that had similar poverty levels than those intervened. Adolescents' fertility refers to that of women 10 to 19 years old. Phase 1 refers to the preparation phase of the intervention between 2012 and 2014. Phase 2 refers to the implementation phase of the intervention between 2015 and 2019. The composition of the alternative comparison group is described in the title of each graph.

E.3.4 Effects in female adolescent fertility rate by year using alternative comparison groups

Comparison Group 2:
Districts with a similar share of rural population than targeted districts



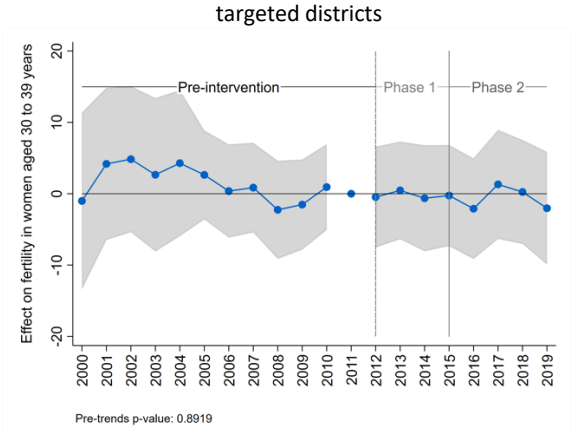
Comparison Group 3:
Non-intervened districts within the same regions of targeted districts



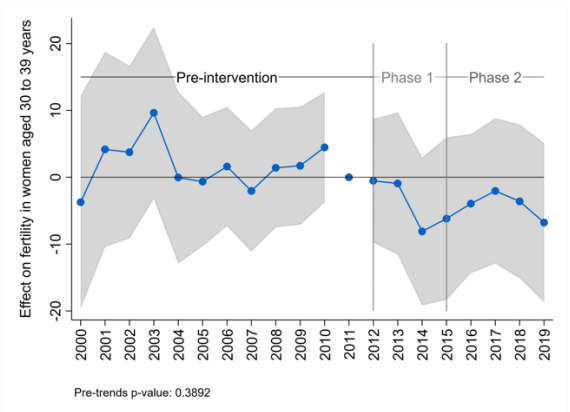
Note: This figure plots the coefficients of the interaction between each year and an indicator for treatment status. The shaded area around each coefficient is the 95% confidence interval. The reference year is 2011, the last pre-intervention year. Since it is the reference year, it is normalized to zero and no confidence intervals can be calculated for this year. Phase 1 (Preparation) starts in 2012, but the implementation takes place in Phase 2 from 2015 onwards. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions. The composition of the comparison group is described on the title of each graph.

E.3.5 Falsification test-effects on fertility of women aged 30 to 39 using alternative comparison groups

Comparison Group 2:
Districts with a similar share of rural population than targeted districts



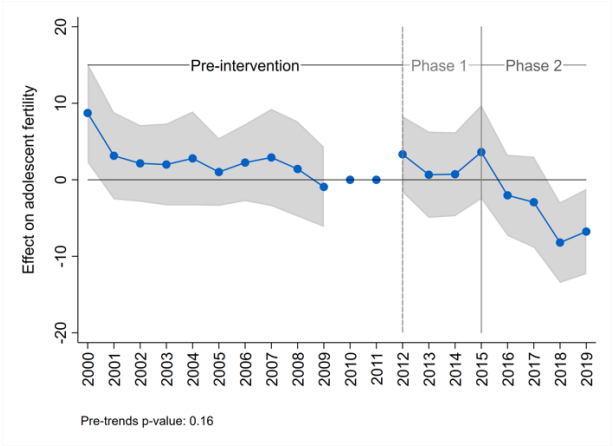
Comparison Group 3:
Non-intervened districts within the same regions of targeted districts



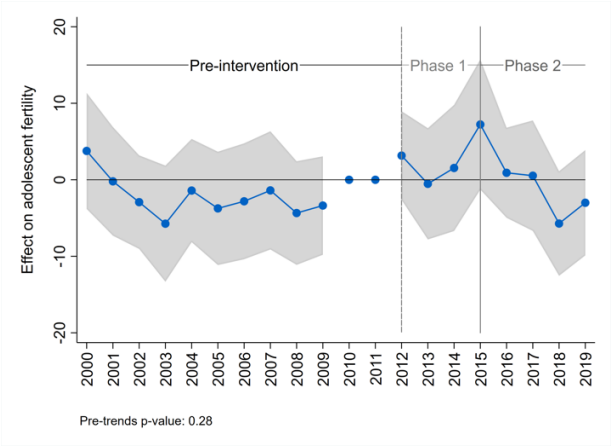
Note: This figure plots the coefficients of the interaction between each year and an indicator for treatment status. The shaded area around each coefficient is the 95% confidence interval. The reference year is 2011, the last pre-intervention year. Since it is the reference year, it is normalized to zero and no confidence intervals can be calculated for this year. Phase 1 (Preparation) starts in 2012, but the implementation takes place in Phase 2 from 2015 onwards. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions. The composition of the comparison group is described on the title of each graph.

E.3.6 Effect on teenage fertility based on original estimation and estimation using instrumental variables based on Freyaldenhoven, Hansen and Shapiro (2019) using alternative comparison groups

Comparison Group 2:
Districts with a similar share of rural population than targeted districts



Comparison Group 3:
Non-intervened districts within the same regions of targeted districts



Note: The shaded area around each coefficient is the 95% confidence interval. Both figures are estimated using the methods described in Freyaldenhoven, Hansen and Shapiro (2019). They use fertility of women 30 to 39 which were unaffected by the intervention as a proxy to account for trends affects fertility for all ages. It is instrumented using fertility for women 40 to 49 which were also unaffected by the intervention. The estimation using the instrumental variables requires an additional year to be normalized to zero, so 2010 and 2011 are considered reference years and hence have no confidence intervals. Phase 1 (Preparation) starts in 2012 , but the implementation takes place in Phase 2 from 2015 onwards. The pre-trends p-value refers to an F-test of joint significance of all pre-treatment interactions. The composition of the comparison group is described on the title of each graph.

E.3.7 Effects on female adolescent fertility rate by age-group, phase using main and alternative comparison groups

	Main Comparison Group	**Alternative Comparison Groups**	
	Districts with similar social development index	Districts with similar share of rural population	Non-intervened districts within targeted regions
	(1)	(2)	(3)
		Panel A. Fertility adolescents age 10 to 19	
Phase 1 (2012-2014)-Preparation	-2.17	-0.83	1.86
	(2.35)	(1.98)	(2.73)
	[0.36]	[0.68]	[0.50]
Phase 2 (2015-2019)-Implementation	-5.14*	-6.47***	-1.84
	(2.77)	(2.30)	(3.12)
	[0.07]	[0.01]	[0.56]
Pre-intervention treatment mean		45.35	
		Panel B. Fertility adolescents age 10 to 14	
Phase 1 (2012-2014)-Preparation	-0.11	0.22	0.58
	(1.02)	(0.69)	(0.81)
	[0.92]	[0.75]	[0.48]
Phase 2 (2015-2019)-Implementation	-1.40**	-1.64***	-1.76***
	(0.62)	(0.47)	(0.61)
	[0.03]	[0.00]	[0.00]
Pre-intervention treatment mean		5.72	
		Panel C. Fertility adolescents age 15 to 19	
Phase 1 (2012-2014)-Preparation	-3.12	-2.00	2.32
	(4.45)	(3.82)	(5.28)
	[0.48]	[0.60]	[0.66]
Phase 2 (2015-2019)-Implementation	-8.46	-12.18***	-3.71
	(5.46)	(4.53)	(5.96)
	[0.12]	[0.01]	[0.54]
Pre-intervention treatment mean		87.31	
District-year observations	2,220	6,040	1,600
Districts	111	302	80

Note: Estimation based on equation (1) specified in the estimation strategy section using fully treated districts the comparison groups described at the top of each column. We display only the coefficients of intertest B_1 and B_2 which are the effects of Phase 1 (preparation) and Phase 2 (implementation) respectively. Phase 1 is an indicator equal to 1 for treated districts between 2012-2014 and 0 otherwise; and Phase 2 is an indicator equal to 1 for treated districts after 2015 (strong onset of ISM) and 0 otherwise. The model is estimated in three outcome variables separately. All fertility rates are express per 1000 females. All estimates include district and year fixed effects. Standard errors are clustered at the district level and are displayed in parenthesis. P-values are displayed in square brackets. Statistical significance denoted by *p < 0.1, **p< 0.05, ***p<0.01.