Impact of an Educational Program and Decision Tool on Choice of Maternity Hospital: The Delivery Decisions Randomized Clinical Trial

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Abstract

Background: Reducing cesarean rates is a public health priority. To help pregnant people select hospitals with lower cesarean rates, numerous organizations publish hospital cesarean rate data. Few pregnant people use these data when deciding where to deliver. We sought to determine whether making cesarean rate data more accessible and understandable increases the likelihood of pregnant people selecting low-cesarean rate hospitals.

Methods: We conducted a 1:1 randomized controlled trial in 2019-2021 among users of a fertility and pregnancy mobile application. Eligible participants were trying to conceive for fewer than five months or were 28-104 days into their pregnancies. Of 189,456 participants approached and enrolled, 120,621 participants met entry criteria and were included in analyses. The intervention group was offered an educational program explaining the importance of hospital cesarean rates and an interactive tool presenting hospital cesarean rates as 1-to-5-star ratings. Control group users were offered an educational program about hospital choice and a hospital choice tool without star ratings. The primary outcome was the star rating of the hospital selected by each patient during pregnancy. Secondary outcomes were the importance of cesarean rates in choosing a hospital and delivery method (post-hoc secondary outcome).

Results: Of 120,621 participants (mean [SD] age, 27.8 [7.9]), 12,284 (10.2%) reported their choice of hospital during pregnancy with similar reporting rates in the intervention and control groups. Intervention group participants selected hospitals with higher ratings (2.52 vs 2.16; difference, 0.37 [95% CI, 0.32 to 0.43] $p<0.001$), were more likely to believe that the hospital they chose would impact their chances of having a cesarean delivery (38.5% vs 33.1%, $p<0.001$), but did not assign higher priority to cesarean delivery rates when choosing their hospital (76.2% vs 74.3%, $p=0.05$). There was no difference in self-reported cesarean rates between the intervention and control groups (31.4% vs 31.4%, $p=0.98$).

Conclusion: People offered an educational program and interactive tool to compare hospital cesarean rates were more likely to use cesarean data in selecting a hospital and selected hospitals with lower cesarean rates but were not less likely to have a cesarean.

Clinical Trial Registration: Registered December 9, 2016 at clinicaltrials.gov, ID NCT02987803.

Background

Across the United States, hospital cesarean delivery rates vary dramatically, independent of demographic differences and pregnant people's risks and preferences.[1,2] While cesarean deliveries are often clinically necessary, up to 45% may be unindicated.[3] Compared to vaginal deliveries, cesarean deliveries are associated with three-fold higher rates of maternal complications and 50% higher costs.[4–7] Over three-quarters of pregnant people would prefer to not have an unindicated cesarean delivery[8] and an individual's likelihood of a cesarean section is associated by the choice of hospital at which they deliver.[9]

To help patients select hospitals with lower cesarean rates and thereby lower the likelihood that they undergo cesarean sections, many states and consumer advocates such as The Leapfrog Group, Consumer Reports, and U.S. News and World Report have begun to publicly report hospital-level cesarean delivery rates.[10–16] However, few patients know where to access or seek out these data.[17] Furthermore, many prioritize the selection of their obstetrician or midwife over selection of their hospital and believe that a hospital's cesarean delivery rate will not impact the care they receive.[8,17,18]

In a pragmatic randomized control, we tested the hypothesis that an intervention that explained why a hospital's cesarean rate data was important, simplified the presentation of data, and made hospital quality data easier more accessible would lead more pregnant patients to select lower cesarean rate hospitals.[19,20] Our intervention consisted of educational modules in a maternal mobile app explaining the importance of a hospital's cesarean delivery rate, translating hospital cesarean rate data into star ratings, using the language of "labor-friendly hospitals," and providing an interactive tool that made it easier to find a hospital with a low cesarean rate.

Methods

Trial Platform and Recruitment

We conducted this randomized controlled trial in 2019–2021 using the Ovia Fertility and Pregnancy mobile applications (apps). These apps, only available in English at the time of the study, offer a series of tools including articles customized to the patient and their interests (e.g., an article explaining the size of the fetus at the user's stage of pregnancy) (Figure S1.1). To recruit participants, we presented a post in the "newsfeeds" of the app users who had been trying to conceive for fewer than five months or were 28–104 days into their pregnancies based on the last menstrual period. If the participants expressed interest, they were immediately randomized 1:1 based on the last digit of the app user ID which is automatically generated when they sign up for the app. Participants were excluded if: (i) they had already selected a hospital or obstetrician/midwife for their pregnancy or (ii) if they were enrolled in two other Ovia programs: a health plan/employer program or a high-risk depression pregnancy intervention. We excluded participants who did not report their last menstrual period, had a due date that was outside the study period, reported an age outside of 18–49, or indicated they did not live in the United States. Trial recruitment and exclusions are outlined in the CONSORT diagram (Fig. 1).

Intervention

Our intervention builds on the learnings of a prior pilot trial in which a similar intervention using information tools increased participants' familiarity with cesarean delivery rates but did not increase the likelihood of users selecting low-cesarean rate hospitals.[21] In the current trial, people in the intervention group were shown a series of educational modules on why it was important to select a hospital with a higher "labor-friendly" star rating. We used a 5-star rating system instead of showing users the hospital cesarean rate because prior interviews suggested that many people had trouble translating a numerical rate into an actionable choice and prior research highlighted that simplifying quality data was key to increase accessibility.[22,23] We chose the term "labor-friendly" (paralleling the "baby friendly" designation) based on feedback from interviews that this phrase was appealing and accessible as well as research evidence that hospitals with low cesarean section rates were more likely to provide additional support for labor (e.g., doulas).[24–26] Educational modules answered questions such as "Why does it matter if a hospital is labor-friendly?" and "What labor-friendly hospital is right for you?" Finally, the intervention group was given an interactive tool that showed hospital star ratings for the 10 closest hospitals within 50 miles of any zip code (how star ratings determined below).

People randomized to the control group were given access to modules that focused on hospital choice and encouraged hospital tours and were provided an interactive hospital look-up tool that was similar but did not display any quality data (Screenshot of educational materials and tools for both arms available in supplemental materials).

Issues of blinding were less relevant in this study because researchers did not have any personal interaction with participants in the trial and all outcomes were self-reported by participants.

Categorizing hospitals into star ratings based on cesarean rates

We used two data sources for hospital cesarean rates. For five states (Alabama, California, Massachusetts, Vermont, West Virginia), we used publicly reported primary cesarean rate data for all hospitals reported by the state government.[12–16] For all other states and D.C. for which such public data was not available, we used the self-reported nulliparous, term, singleton, vertex (NTSV) cesarean rates submitted by hospitals to the Leapfrog Group. Among known hospitals in these other states and D.C, 54.3% of hospitals did not submit data to Leapfrog. In Supplemental Materials, we detail dates of the data and differences in how the cesarean rate was measured based on data source (Table S1).

Within each state, we categorized hospitals into quintiles and hospitals were given star ratings based on their quintiles (e.g., 5 stars if cesarean delivery rate was in the lowest quantile for the state). Hospitals for which cesarean rates were unavailable were marked “no data” and listed last on the interactive tool.

Outcomes

Our primary outcome was the star rating of the delivery hospital each participant selected using the interactive hospital selection tool during pregnancy (hospital choice during pregnancy) (Figure S1.5 how participants entered these data). Participants were shown posts in their newsfeeds in the app each week asking them to report their chosen hospitals through the tool until they submitted choices. They were offered the opportunity to be entered into a $100 lottery for reporting.

Our secondary outcomes were survey questions focused on the importance of cesarean rate data and whether it was used in the participants’ decisions (survey questions provided in table). Starting in the second month after entry in the trial, participants had posts in their feeds asking them to fill out this survey. Again, participants were entered in a lottery for $100 for filling out the survey. If they responded to the survey more than once, we used their later response.

All users of the app (trial participants and non-participants) were asked to fill out a post-delivery survey. Post-hoc, we added two secondary outcomes from this survey: hospital choice and the self-reported delivery method (language of question in supplemental materials). We linked the participant’s hospital choice to the star rating.

Demographic and Other Data

Limited demographic data were collected by the Ovia apps including enrollees’ ages, and zip codes of residence. Using each participant’s zip code, we linked our dataset with data from the American Community Survey on median annual household income and the education levels of women ages 18–45 to estimate the incomes and education levels of the participants.[27,28] Additionally, we used participant zip codes to determine which participants lived in urban areas as defined by the Census.[29]

Analysis

We compared the demographic characteristics of participants in the trial to those of pregnant people nationally using data from the Census and CDC.[30–33] We compared the star ratings of hospitals by conducting Welch’s *t*-tests, both for the primary outcome of choice during pregnancy and the secondary outcome of choice after pregnancy. We grouped Likert survey responses into binary categories and then used chi-squared tests to compare responses. We compared delivery methods between the control and intervention groups using a Pearson’s chi-squared test across all participants who indicated their delivery method as a post-hoc secondary outcome analysis.

In exploratory post-hoc subgroup analyses, we examined if the intervention's impact was mediated by participant socioeconomic status (as measured by the median income in zip code) as well as several measures of degree of choice of hospitals in the community: whether the participant lived in a state that reported hospital cesarean rates, how many hospitals with a three star rating or higher were within 10 miles of the participant's zip code, whether or not there were hospitals with a difference in star ratings of at least two stars within 10 miles of the participant's zip code. We calculated the star rating differences between the control and intervention arms in each subgroup. To determine if this difference was significant, we used a linear regression model which included whether the participant was in the intervention or control, the sub-group (e.g., number of hospitals with a star rating of three or higher within 10 miles), and the interaction term between the two (variable of interest). All analysis was performed using R version 3.6.2.

The trial was approved by the Institutional Review Board of the Harvard T.H. Chan School of Public Health and registered at clinicaltrials.gov (Registration number NCT02987803, registered 09/12/2016). All participants consented through their agreement to the terms of use and privacy policy for the Ovia apps. A Data Safety Monitoring Board (DSMB) comprised of experts in the study content and statistical methods reviewed interim results in September 2020.

Results

We enrolled 120,621 people in our trial (60,352 intervention and 60,269 control). Most participants were ages 25–34 (57.9%) and lived in urban zip codes (78.3%) (Table 1). Half (49.7%) of the participants resided in zip codes with median household incomes of less than $57,000. Sample characteristics were balanced across the control and intervention groups.

Table 1
Demographic Baseline Characteristics

Participant Characteristics	Control	Intervention
	n = 60,269	n = 60,352
	n (%)	n (%)
Age		
18–24	18,444 (30.6)	18,341 (30.4)
25–34	34,792 (57.8)	34,995 (58.0)
35+	7,033 (11.7)	7,016 (11.6)
Region [a]		
Midwest	12,588 (20.9)	12,662 (21.0)
Northeast	9,422 (15.6)	9,652 (16.0)
South	24,741 (41.0)	24,338 (40.4)
West	13,601 (22.5)	13,617 (22.6)
Median household income in zip code [b]		
< $25,000	1,051 (2.5)	1,089 (2.6)
$25,000 - $49,999	13,535 (32.6)	13,301 (32.1)
$50,000 - $74,999	16,465 (39.6)	16,316 (39.4)
$75,000 - $99,999	6,896 (16.6)	7,033 (17.0)
> $100,000	3,587 (8.6)	3,656 (8.8)
Proportion with Bachelor's degree in zip code [c]		
< 20%	11,375 (27.3)	11,149 (26.9)
20% - <30%	10,730 (25.8)	10,527 (25.4)
30% - <50%	12,849 (30.9)	13,137 (31.7)
≥ 50%	6,637 (16.0)	6,628 (16.0)

Notes:

(a) Regions as listed in https://www.nationalgeographic.org/maps/united-states-regions/.

(b) Source: U.S. Census American Community Survey, 2015–2019 5-year estimates from https://data.census.gov/cedsci. Median income in past 12 months by ZCTA, Table S1903. Data missing for 31.2% of participants due to low zip code population or incorrect zip code entry.

(c) Source: U.S. Census American Community Survey, 2015–2019 5-year estimates from https://data.census.gov/cedsci. Educational attainment by ZCTA, Table S1501. Data missing for 31.1% of participants due to low zip code population or incorrect zip code entry.

(d) Source: U.S. Census 2010 Urban Area to ZCTA Relationship File. Data missing for 8.4% of participants due to incorrect zip code entry.

Participant Characteristics	Control	Intervention
	n = 60,269	n = 60,352
	n (%)	n (%)
Rural or urban county [d]		
Urban	43,321 (78.5)	43,097 (78.1)
Rural	11,898 (21.5)	12,084 (21.9)
Notes:		
(a) Regions as listed in https://www.nationalgeographic.org/maps/united-states-regions/.		
(b) Source: U.S. Census American Community Survey, 2015–2019 5-year estimates from https://data.census.gov/cedsci. Median income in past 12 months by ZCTA, Table S1903. Data missing for 31.2% of participants due to low zip code population or incorrect zip code entry.		
(c) Source: U.S. Census American Community Survey, 2015–2019 5-year estimates from https://data.census.gov/cedsci. Educational attainment by ZCTA, Table S1501. Data missing for 31.1% of participants due to low zip code population or incorrect zip code entry.		
(d) Source: U.S. Census 2010 Urban Area to ZCTA Relationship File. Data missing for 8.4% of participants due to incorrect zip code entry.		

Compared to the national population of people giving birth, our study sample was slightly younger, more likely to reside in lower-income and less-educated areas, and more likely to reside in a rural area (Table S2).

Choice of hospital during pregnancy

Among people enrolled in the trial, 10.2% (9.8% intervention, 10.5% control) reported their choice of hospital during pregnancy and the average gestational age was 12 weeks at the time they provided this information. Compared to those who did not report this outcome, participants who reported this outcome lived in higher income communities (27.0% vs. 25.5% live in zip codes with median incomes higher than $75,000) and were more likely to live in an urban area (84.1% vs. 77.6% in an urban area) (Table S3).

The average star rating of the hospitals selected by people in the intervention population was significantly higher than in controls (average star rating 2.61 (SD 1.60) intervention vs. 2.24 (SD 1.44), $p < 0.001$) (Fig. 2A). Of the participants who reported their hospital, 19.0% of the intervention group selected 5-star hospitals while 10.8% of the control group selected 5-star hospitals.

Choice of hospital reported after delivery

Among participants, 8,035 (6.7%; 6.6% intervention, 6.7% control) reported the hospital in which they gave birth after the delivery.

The average star rating of the hospitals selected by the intervention population was significantly higher than in controls (average star rating 2.30 (SD 1.42) intervention vs. 2.19 (SD 1.42) control, $p = 0.001$) (Fig. 2B). Of the participants who reported their hospital, 11.5% of the intervention group selected 5-star hospitals while 9.2% of the control group selected 5-star hospitals.

Among the 1,681 (1.4%) of participants who reported their hospital choice both during pregnancy and after delivery, 60.5% and 54.5% reported the same hospital at both instances for the control and intervention groups, respectively (Table S4).

Secondary outcomes

People in the intervention group were more likely to believe that the choice of hospital impacts the likelihood of having a cesarean delivery (38.5% vs. 33.1%, $p < 0.001$, response rates of 6.9% and 6.7%). However, there were no differences in respondents' beliefs that hospitals in their communities had different care quality levels (91.0% vs. 90.0%, $p = 0.10$, response rates of 7.3% and 7.2%) or that cesarean delivery rates are important to consider when choosing a hospital (76.2% vs. 74.3%, $p = 0.050$, response rates of 7.3% and 7.2%) (Table 2)

Table 2
Participant survey responses regarding the importance of cesarean rates in selection of hospital

Survey Question	Response	Control	Intervention	p-value
Hospital Impact on Delivery *(Do you think the facility where you plan to deliver will impact your chance of having a C-section?)*		n = 4,064	n = 4,136	
	Very or somewhat likely	1,345 (33.1)	1,591 (38.5)	< 0.001
Use in Hospital Selection *(How much does the C-section rate of a facility matter to you when deciding where you'll deliver?)*		n = 4,340	n = 4,390	
	High or medium priority	3,226 (74.3)	3,343 (76.2)	0.05
Knowledge of Variation *(How different are healthcare facilities when it comes to quality of care?)*		n = 4,338	n = 4,390	
	Very or somewhat different	3,903 (90.0)	3,995 (91.0)	0.10

After delivery, 18,066 (29.9%) people in the intervention group and 18,139 (30.0%) people in the control group reported how their babies were delivered. There was no difference in the fraction of participants reporting they had cesarean deliveries (31.4% intervention, 31.4% control, $p = 0.98$).

Sub-group analysis

Among the participants randomized to the intervention, 50,611 (83.9%) did not open any educational modules offered as part of the intervention and 50,241 (83.4%) did not use the hospital-look up tool. Among those in the intervention group who reported a delivery hospital, 3,419 (57.8%) did not open any educational modules. There were no clear differences in the mean star ratings of hospitals chosen during pregnancy stratified by the number of educational modules opened (0 modules 2.62, 1 module 2.62, 2 modules 2.65, 3 + modules 2.54) (Table S5).

We conducted exploratory analyses on the differential impact of the intervention across several subgroups (Fig. 3). We hypothesized that participants with more resources and higher education would be more likely to respond to the intervention. Using median income of the zip code of residence as a proxy for resources and education, we did not observe any substantive difference in the impact of the intervention between participants who lived in higher and lower education zip codes ($p = 0.85$).

Many hospitals did not report their cesarean rates, and therefore some participants had limited choice of hospitals with a star rating when they used the hospital look-up tool. This was less of an issue in the five states where we used state government data because hospitals were mandated to respond. The star rating differences between intervention and control groups was 0.47 stars for participants living in these five states vs. 0.36 stars for the rest of the nation (test of interaction, $p = 0.18$).

To further understand the influence of hospital choice, we examined the relationship between the number of hospitals with a 3-star or higher rating nearby and the impact of the intervention (0.31 difference in star ratings between intervention and controls among participants with no hospitals with a 3 star or higher rating within 10 miles, 0.36 for one hospital, 0.44 for more than one hospital, test of interaction $p = 0.03$). Finally, we compared participants who had a choice of hospitals with disparate star ratings (0.42 difference in star ratings between intervention and controls among participants where the maximum star rating is at least two stars greater than the minimum star rating among hospitals within 10 miles of the participant, 0.34 if this is not true, $p = 0.25$).

Discussion

Principal Findings

This randomized trial was motivated by the hypothesis that making cesarean delivery data more interpretable and accessible would encourage and enable pregnant people to use these data in the selection of a hospital to deliver their baby. Participants subject to the intervention were more likely to believe that cesarean rates were important in choosing a hospital and were more likely to select a hospital with a lower cesarean rate. However, there was no difference in the participant's likelihood of having a cesarean.

Our findings help inform the scientific literature on whether and how patients use publicly reported quality data to select a provider. With some notable exceptions in areas of choice of nursing homes or health plans, prior reviews have highlighted that few patients are aware of publicly-reported quality data and it rarely impacts the choice of provider.[34–37] Our results support prior laboratory studies that patients are more likely to use quality data to inform their provider choice if the data is more interpretable (e.g., uses star ratings, simplified presentations, patient-friendly language) and they understand how the information can impacts their own care.[23]

Clinical Implications

The findings inform ongoing public reporting efforts of cesarean rate data which are motivated by the goal of empowering pregnant people to make more informed decisions about their choice of a hospital. Our findings argue that simplifying data presentation through star ratings and using more patient-friendly terminology such as will increase usability and therefore the impact of these data. Because the intervention included many different components, we do not know which component was most important.

It is also important to emphasize that despite the inclusion of the educational program in the intervention explaining that the choice of a low-cesarean rate hospital could reduce their personal risk of delivery by cesarean, most participants in the intervention arm still did not believe this to be true. This belief will be a substantial barrier on influencing people's choice of a delivery for any public reporting effort moving forward.

Additionally, despite a shift in choice of hospital, we did not observe any difference in self-reported cesarean rates. This does not support the assumption underlying our study, and the rationale for public reporting of cesarean

section data by states and other groups in general, that if more people shift to lower cesarean-rate hospitals, the overall cesarean rates in the population. will fall.

Research Implications

Although there was a difference in the star ratings of hospitals selected during pregnancy (on average chosen in the first trimester), this difference was only modest and the difference in star ratings of hospitals actually used for delivery was smaller. This shift between hospital choice early in pregnancy versus actual delivery might be attributable to constraints based on proximity of the hospital or insurance. Further, only a minority of those randomized to the intervention engaged with the educational modules or hospital look up tool. Future research is needed to understand how to increase engagement in hospital cesarean rate data and what are the key barriers in using this information.

Strengths and Limitations

This pragmatic clinical trial was able to recruit a large national and diverse study population of over 100 thousand participants using a mobile app. The intervention included low-cost and simple innovative tool that gives pregnant people readily comprehensible and actionable information. The intervention can be implemented relatively easily.

However, our results should be interpreted in the context of several key limitations. First, response rates were low for all outcomes, particularly survey results, and we reported outcomes on only those who responded. Second, the hospital data we used to create star ratings had limitations: the Leapfrog Group data did not have ratings for many hospitals, and the data were several years old at the time of the trial. Third, many participants had limited hospital choice and therefore could not act on the data provided in the intervention.[39] More than a third of participants did not live within ten miles of a rated hospital, and almost half of participants did not live in zip codes within 10 miles of a hospital with a 3 star rating or higher. We had limited demographic data, so we are unsure of the representativeness of our study population across many categories, particularly race. The absence of race/ethnicity data is particularly notable given the substantial racial inequities in maternal health.[40] The study was conducted in part during the COVID-19 pandemic and it is unclear how the pandemic changed patients' delivery plans.[38]

Conclusions

In this randomized controlled trial of a large national and diverse study population, an intervention composed of educational modules, translation of cesarean rates into patient-friendly star ratings, and an interactive tool to help select a for hospital, increased the likelihood that people will select hospitals with lower cesarean rates for the birth of their child. However, there was no difference in the participants' likelihood of having a cesarean.

Declarations

Ethics approval and consent to participate

The trial was approved by the Institutional Review Board of the Harvard T.H. Chan School of Public Health and registered at clinicaltrials.gov (Registration: NCT02987803). All participants gave informed consent through their agreements to the terms of use and privacy policy for the Ovia apps. A Data Safety Monitoring Board (DSMB) comprised of experts in the study content and statistical methods reviewed interim results in September 2020. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

All deidentified individual participant data analyzed for this manuscript along with data dictionaries, a statistical analysis plan, and analytic code may be available upon request. After publication, researchers may email the corresponding author. Valid requests may be fulfilled through online secure file transfer methods.

Competing interests

Several authors work for Ovia Health, which will be using this intervention in their products moving forward.

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Authors' contributions

AM helped design study and intervention, oversaw analyses and interpretation of results, and engaged in both writing and critical review of manuscript. AWolfberg participated in the of design the study and intervention, interpretation of results and edited the manuscript. NS participated in study design, provided resources, and engaged in critical revision of manuscript. AP contributed to the design of the intervention and study, interpretation of analyses, and critical revision of the manuscript. A. Weiseth participated in the of design the study and intervention, interpretation of results and edited the manuscript. AB was part of the Clinical Team at Ovia Health that ran the RCT in the Ovia Health apps, ensuring proper execution and adherence to the protocol, as well as ensuring that the analyses and manuscript were aligned with how the trial was carried out. KN assisted with design and implementation of intervention, extraction of the necessary data, and provided critical review of the manuscript. CN revised code for data cleaning and analysis, analyzed final data, and drafted the manuscript. JR assisted with analyses and provided critical review of manuscript. DB contributed to the study design, technology build and design, content creation and review, data architecture schema, and created the concept of star ratings for hospital choice.

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Figures

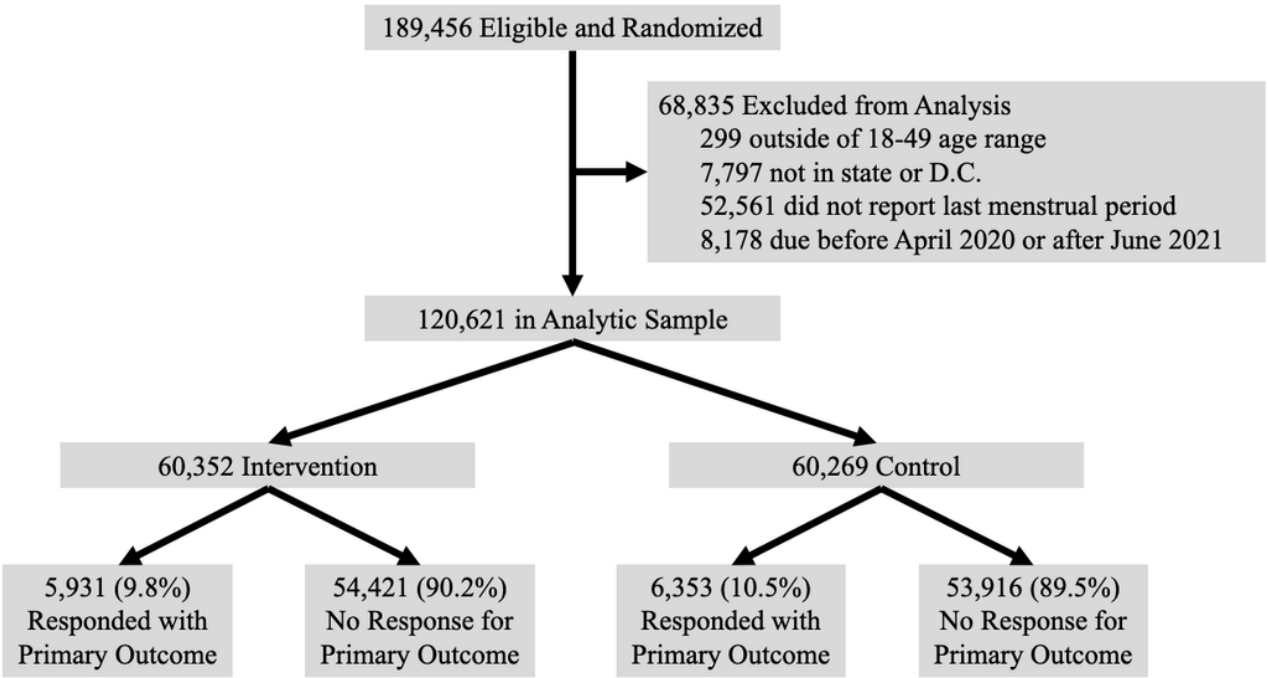

Figure 1

CONSORT Flow Diagram

Note: Exclusion occurred after the randomization step in this pragmatic trial. Participants were immediately enrolled. Exclusion criteria were self-reported by participants before randomization at their time of signing up for the app.

Figure 2

Cesarean-rate star ratings of hospitals selected by participants who reported choice of hospital

Panel A. Choice of hospital reported during pregnancy (n=5,931 intervention, n=6,353 controls)

Panel B. Choice of hospital reported after delivery (n=3,703 intervention, n=3,808 controls)

*Hospitals with assigned a star rating based on their cesarean rate with higher star ratings assigned to hospitals with lower cesarean rates.

**If participants selected a hospital without a star rating, this was put in the one-star category

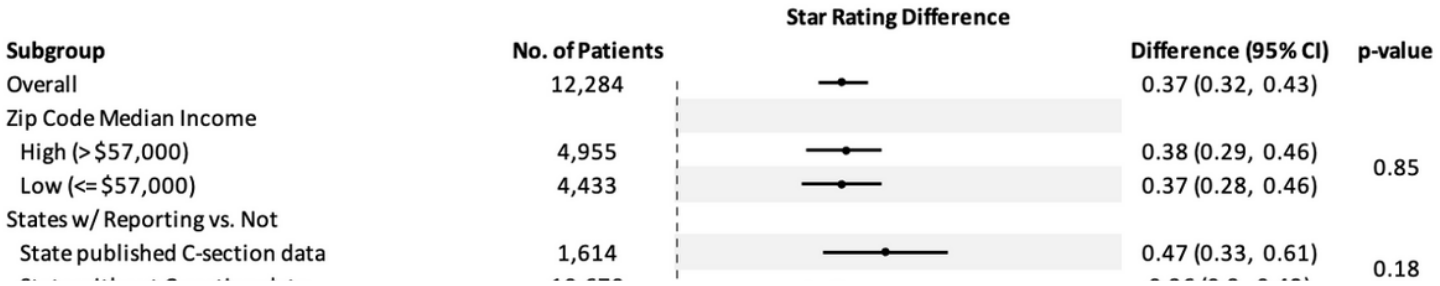

Figure 3

Difference in Average Star Ratings for Hospitals Selected by Intervention and Controls During Pregnancy, Subgroup analyses

p-values are based on the interaction between the subgroup and the intervention.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- MehrotraSupplement.docx