Health Policy OPEN 2 (2021) 100044

Contents lists available at ScienceDirect

Health Policy OPEN

journal homepage: www.elsevier.com/locate/hpopen

Utilization and cost sharing for preventive cancer screenings

Nicholas Jennings *, David O. Garcia, Howard Eng, Elizabeth Calhoun

University of Arizona, Mel and Enid Zuckerman College of Public Health, United States

ARTICLE INFO

Keywords:
Cost sharing
Health policy
Healthcare utilization
Mammography

ABSTRACT

Objective: The Patient Protection and Affordable Care Act (ACA) eliminated cost sharing for certain preventive cancer screenings beginning in September 2010. This paper examines the policy change's impact on three preventive screenings, mammography, colonoscopy, and cervical screening, among commercially insured individuals.

Methods: A retrospective longitudinal quasi-experimental design was utilized. Individuals in grandfathered plans were used as a comparison group because grandfathered plans are not subject to the preventive cost sharing benefit changes of the ACA. A multivariate logistic regression model matched individuals in treatment and comparison groups via propensity scoring. Monthly prevalence rates over the study period (2007–2014) were calculated as well as prevalence rates for the proportion of procedures with greater than 0 cost sharing. An interrupted time series regression analysis was conducted with the primary outcome variable the rate of preventive service utilization per person per month.

Results: The overall trend in utilization of preventive mammography and cervical cancer screening slightly decreased as a result of the ACA cost sharing benefit policy change. There was a non-significant decrease for colonoscopy utilization as a result of the ACA policy change.

Conclusion: The ACA's cost benefit policy change is not having the desired impact of increasing preventive screening utilization. Further research is needed to determine whether providing educational materials covering the cost sharing benefit at policy enrollment might increase procedure uptake.

1. Introduction

The Patient Protection and Affordable Care Act (ACA), passed in 2010, fundamentally altered health care in the United States. The landmark legislation included many innovative changes to how health care is administered in the United States [1]. These include eliminating lifetime and annual maximum benefits, prohibiting the rescission of insurance policies, prohibiting the denial of insurance and increased charges based on a pre-existing condition, and requiring insurance plans to cover, at no charge to the insured individuals, certain preventive services and immunizations [2]. The ACA provides the groundwork to move health care to more proactive accountable care by promoting the use of medical services that provide high value. Provisions such as the preventive service coverage with no cost sharing allow individuals to take control of their health with early diagnosis of potentially serious conditions such as cancer [3].

Cost sharing is defined as raising the effective price of a service to dissuade people from using too much of the service [4]. In health care cost sharing has been implemented in the form of co-pays and co-insurance. A co-pay is defined as a fixed amount an individual pays for a covered health care service, and varies by the type of service [5]. Co-insurance is defined as the patient's share of the costs of a covered health care service, calculated as a percent of the allowed amount for the service [5]. Cost sharing has been used as a device to regulate health service utilization since the 1960's [6].

Studies have shown that higher cost sharing can act as a barrier to receiving recommended medical care and reduce health care utilization [6-15]. Many of these studies have focused on the Medicaid or Medicare populations, while little research has been done on the commercially insured population (large and small employer groups), which represents the majority of Americans [16].The ACA seeks to increase the utilization of high value preventive health screenings by removing cost sharing thereby eliminating out of pocket costs as a barrier, making the services more affordable for much of the population. Reviewing use of preventive services is a logical step in determining the effectiveness of the ACA in addressing the cost barrier to receiving care. Cost sharing can have a significant impact on procedure utilization.

* Corresponding author at: University of Arizona, Mel and Enid Zuckerman College of Public Health, 1295 N Martin Ave., Tucson, AZ 85724, United States.
E-mail address: nbjennings@email.arizona.edu (N. Jennings).

https://doi.org/10.1016/j.hpopen.2021.100044
Received 12 November 2020; Revised 17 March 2021; Accepted 12 May 2021
Available online 24 June 2021
2590-2296/

Several studies have reviewed cancer screening utilizations rates after the ACA removed the out-of-pocket cost barrier and found mixed results [12,17-19]. These studies either focus on the Medicare population, rely on self-reported data such as the Medical Expenditure Panel Survey dataset, or are limited to a small population (i.e., Massachusetts). Only one studies known to the authors focuses on a population of commercially insured individuals with employer sponsored insurance plans [17]. This study focused specifically on breast cancer screening in a commercially insured population and found little to no increase in utilization after the ACA. The present study adds to this literature by expanding the scope of cancer screenings to include colonoscopy, breast, and cervical screening, and evaluating the full population of members enrolled in employer sponsored plans with a control group of individuals enrolled in employer sponsored grandfathered plans.

Removing cost sharing for procedures that have a high likelihood of preventing future health care use could significantly improve the effectiveness of the healthcare system. Understanding the impact of the removal of cost sharing as a barrier to receiving preventive services in a individuals with employer sponsored insurance could allow policy makers to successfully craft policies that maximize long term system wide cost savings while simultaneously driving procedure utilization and improving overall health. We hypothesize that the removal of cost sharing as a barrier to care will not lead to a significant increase in utilization of preventive cancer screening due to low awareness of the benefit among individuals with employer sponsored insurance. This study seeks to understand the effect of the ACA driven policy change removing the out-of-pocket cost barrier to receiving preventive services in a commercially insured population by evaluating utilization rates before and after the ACA.

2. Methods

This study utilized a retrospective longitudinal design with a pre- and post- period with a comparison group. De-identified medical claims and demographic data from 2007 to 2014 were obtained from a large national insurer for individuals covered by employer sponsored insurance plans. The database used contains longitudinally linked, statistically de-identified individual-level data on over 101 million current members an includes data going back to 1993. The database includes socio-demographic variables, billing information, and provides the ability to follow individuals over time. Individuals covered in plans sold on the ACA marketplaces are not included in this analysis.

Age-appropriate individuals were separated into treatment (non–grandfathered plans) and comparison groups (grandfathered plans) based on plan enrollment. Certain health plans or policies created or purchased on or before March 23, 2010 were not required to follow the cost sharing benefit changes of the ACA and are considered “grandfathered” into the ACA. The pre-ACA policy change period was defined as occurring from January 1, 2007 to September 22, 2010. The post period was defined as occurring from September 23, 2010 to December 31, 2014.

2.1. Population

For mammography and colonoscopy screenings, individuals with an age greater than or equal to 50 and less than 65 were selected. For cervical screening individuals with an age greater than or equal to 21 and less than 65 were selected. While the ACA provides coverage for mammography to women age 40 and older based on the 2002 recommendation from the USPSTF, the 2009 recommendation, which the ACA disregarded, was to begin screening at age 50 and continue to age 75. Ages ranges for this paper were selected based on the 2008–2009 USPSTF recommendations, with an upper limit of 65 as those members are more likely to enroll in Medicare. Individuals were allowed to age into and out of the study but needed to maintain continuous enrollment in either a grandfathered or non-grandfathered plan to be considered eligible for a screening.

Individuals with HIV, end stage renal disease, in hospice care, or with an active cancer diagnosis were excluded from the analysis as they are likely not seeking preventive services. Individuals receiving a mastectomy or hysterectomy procedure were removed from the analysis. For colonoscopy, individuals receiving a fecal occult blood test (FOBT) in the 365 days prior to their colonoscopy were excluded. The FOBT looks for blood in the stool and is generally followed by a diagnostic colonoscopy as opposed to a preventive colonoscopy. There were 36,667 members in the mammography sample, 68,138 in the colonoscopy sample and 61,468 in the cervical screening sample. The flow diagram for selection of individuals is presented in Fig. 1.

2.2. Outcomes and covariates

Monthly screening utilization rates were calculated for individuals in each group. Mammography, colonoscopy, and cervical cancer screening tests were identified in medical claims by diagnosis, procedure, and revenue codes (see Supplemental Appendix Table S1). A screening was defined to occur if an individual had at least one claim during a given month indicating a screening event. Cost sharing was evaluated based on a derived amount from the claim that included the amount of co-insurance, the co-pay, and the deductible for the preventive screening.

Covariates were identified from the database and literature and included patient age, gender, region of the country (based on Census regions), race, residence in a high-income zip code, residence in a rural zip code, family size, utilization of a primary care doctor, and a weighted indicator of the patient’s overall health risk. Residence in a rural zip code was defined using the Washington, Wyoming, Alaska, Montana and Idaho’s (WWAMI) Rural Health Research Center’s rural urban commuting area codes [20]. High income zip codes were defined as having a median salary of greater than or equal to $50,000 based on data reported through Internal Revenue Service’s income tax statistics [21]. The $50,000 median salary threshold was selected as this represented the median U.S. salary in 2007 according to the U.S. Census Bureau.

The Charlson Comorbidity Index (CCI) was used as a weighted indicator of a patients’ health risk. The CCI considers the number and the seriousness of comorbid conditions and outputs a risk score that indicates the patient level risk for succumbing to the comorbid conditions in the next year [22]. Seventeen conditions were considered by the CCI including myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, Diabetes, renal disease, liver disease, cancer, and HIV/AIDS [22]. These conditions were calculated using ICD-9 diagnosis codes on diagnosis positions one through three on the medical claim.

2.3. Propensity score matching

A multivariate logistic regression model was used to calculate a propensity score for each condition following the methodology defined by Rosenbaum [23]. The model controlled for all covariates. The propensity score indicates the probability of being assigned to the treatment group. If two subjects have the same propensity score and one is in the comparison group and one in the treatment group, they are equally likely to be in a non-grandfathered plan based on their covariates.

A matching algorithm was used to match members from the treatment and comparison groups based on their propensity score [24]. Matches first occurred at the eighth decimal point, then seventh, then sixth, then fifth, etc., until no further matches could be made. If a match did not occur the member was recycled into the available match

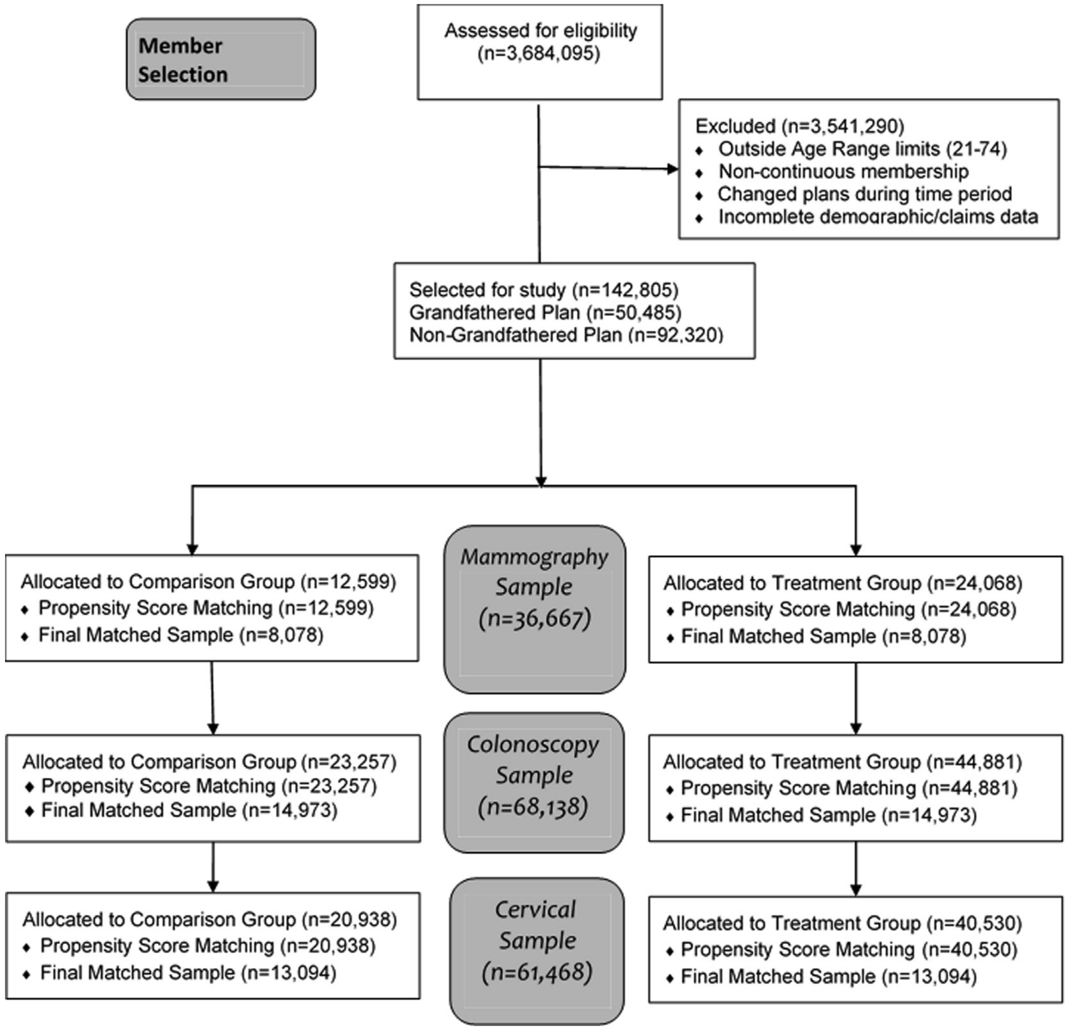

Fig. 1. Consort Diagram of Patient Sample Selection.

pool. The propensity score matched samples were then used as the basis for the analysis.

The propensity score models were evaluated for variable correlation and multicollinearity. A correlation matrix was created to test the appropriateness of the variables in each model. The variance inflation factor (VIF) and condition index were calculated for each propensity score model to determine if any of the predictor variables were collinear. Collinearity was not detected in the mammography, colonoscopy, or cervical cancer models.

Histograms were utilized to review the results of the propensity score analysis before and after the matching occurred to assess balance (Figures S1-8). Standardized differences and two independent sample t-tests were used to compare the difference in the covariates between the pre- and post- matched sample (Tables S2-S4). The standardized difference compares the difference in means in units of the pooled standard deviation [25]. A standard difference of 10% or less was used as a benchmark to indicate a negligible difference in the mean of a covariate between treatment and comparison groups [25]. For a further discussion of the results of the propensity scoring process, including a comparison of the pre-matched and non-matched population see the Supplemental Appendix.

2.4. Statistical analysis

Descriptive statistics of the population were examined for each group after matching by propensity score. The utilization rate of each preventive service was calculated by taking the total number of individuals receiving a procedure during a specific month and dividing by the total procedure eligible population. Utilization charts were created to trend the prevalence rate for each procedure during the time period. Utilization rates were statistically compared between and within plans using t-tests; differences were considered significant at the $\alpha = 0.05$ level.

For the analysis of cost sharing, individuals who received procedures with greater than zero cost sharing were identified. The amounts must have occurred on the same date of service and claim line as the preventive screening. The percentage of greater than $0 cost sharing was defined as the number of procedures with cost sharing greater than $0 divided by the total number of procedures for a given month. All analysis was conducted using SAS EG version 6.1 (SAS Institute, Cary, North Carolina), with charts and graphs being produced with Microsoft Excel 2013 (Microsoft, Redmond, Washington).

2.5. Interrupted time series regression

To determine whether the change in cost sharing policy was associated with the change in service utilization after the implementation of the ACA, an aggregate-level difference in difference interrupted time series was utilized following the methodology of Lagarde and Penfold [26,27]. This methodology represents the strongest, quasi-experimental design to estimate intervention effects in non-randomized settings [27]. The outcome of interest was the aggregate difference between the rate of preventive service utilization for the treatment and comparison group standardized to 1000 members; this was calculated at each monthly interval and resulted in 96 data points. A generalized linear regression model was used to determine the interaction. The specifications of the regression model can be found in the supplemental appendix.

3. Results

3.1. Descriptive statistics of population

Descriptive statistics of the post-matched study population are presented in Table 1 (For descriptive statistics of the pre-matched and non-matched population see Table S5 and S6). For the mammography sample the mean age in the treatment group was 50.53 (SD 5.59), and in the comparison group 50.55 (SD 5.60). Over four-fifths of the individuals in both treatment and comparison groups had seen a primary care provider (PCP) prior to the implementation of the ACA (89.37% vs. 86.61%). Both groups saw a slight drop in patients with a PCP visit occurring after the ACA changes were implemented (87.72% vs. 84.35%).

The majority of the individuals in both groups lived in urban areas (95.91% vs 96.11%) and resided in a high-income zip code (73.83 vs. 75.39%). At the start of the analysis period the mean family size for the treatment and comparison groups was equivalent (2 (SD 1.53 vs. 1.49)). The majority of both treatment and comparison groups from the mammography cohort were identified as Caucasian (79.03% vs. 79.67%). The mammography treatment and comparison groups were dispersed throughout the country with about 42% residing in the South, 24% in the Pacific region, 22% in the Midwest and about 11% in the Northeast.

The colonoscopy sample displayed similar covariate balance between treatment and comparison groups, including gender (53.78% female vs. 54.62%), median age (50, SD 5.63), percent with a PCP prior to the ACA (85.01% vs. 81.91%), percent in an urban zip code (95.90% vs. 96.23%), and percent in a high-income zip code (73.90% vs 75.00%). Both groups were primarily from the South (43.10% vs. 42.70%) and Pacific (25.20% vs. 23.86%) regions. The majority of both populations were Caucasian (78.78% vs. 79.30%). The mean family size was essentially equivalent in both groups 2.61 (SD 1.51) vs. 2.59 (SD 1.48), for treatment and comparison groups, respectively.

The Cervical cancer screening cohort saw a larger standard deviation of age for both treatment and comparison groups. The mean age was 43 (SD 13.16) in the intervention group and 44 (SD 13.16) in the comparison group. Similar to the other preventive screening groups, the majority of the population in the treatment and comparison groups saw a PCP (87.77% vs. 85.55%), lived in a high-income zip code (74.97% vs. 75.42%) and lived in an urban area (96.05% vs. 96.04%). The population in both groups was again segmented to the Southern (41.77% vs 41.82%), Pacific (24.91% vs 23.69%), and Midwest (22.12% vs 22.61%) regions of the U.S. The race distribution of the treatment and comparison groups mimicked that of the colonoscopy and mammography samples, with the majority of individuals being Caucasian (78.05% vs. 77.52%).

3.2. Utilization trends

3.2.1. Overall utilization

Utilization trend charts for each cancer screening are presented in Fig. 2. Month over month mammography utilization was relatively steady for both groups until the last part of 2013, where a reduction in procedures was observed for non-grandfathered plans. Colonoscopy utilization saw a similar drop in non-grandfathered plans in 2014. Cervical cancer screening utilization rates saw a significant increase for both groups beginning in 2011, followed by a downward trend until the end of the study period.

When comparing within plans (see Table S7), statistically significant increases in utilization ($\alpha = 0.05$) before and after the ACA was implemented were seen in all three cancer screenings for both grandfathered (GF) and non-grandfathered (Non-GF) plans. Cervical screenings in both grandfathered and non-grandfathered plans saw the steepest increase in mean utilization rates before and after the ACA mandated changes (Non-GF 1.17 vs 1.98, GF 0.96 vs. 2.40). When comparing utilization rates between grandfathered and non-grandfathered plans (see Table S8), statistically significant differences in utilization after the ACA was implemented were observed for all three cancer screening tests, with grandfathered plans showing higher utilization than non-grandfathered plans. Cervical screening utilization was statistically different before the ACA was implemented with non-grandfathered plans having higher utilization of the procedure.

Table 1
Characteristics of Preventive Screening Cohorts – Post-Match (as of beginning of study period 2007).

	Mammography		Colonoscopy		Cervical	
	Non-GF	GF	Non-GF	GF	Non-GF	GF
Individuals (n)	8078	8078	14,973	14,973	13,094	13,094
Percent Female	100.00%	100.00%	53.78%	54.62%	100.00%	100.00%
Mean age (years)	50.55	50.53	50.70	50.65	40.96	40.99
Median age (years)	50	50	50	50	43	44
SD of age (years)	5.60	5.59	5.63	5.63	13.16	13.16
Percent with Primary Care Doctor- Pre-ACA	89.37%	86.61%	85.01%	81.91%	87.77%	85.55%
Percent with Primary Care Doctor – Post–ACA	87.72%	84.35%	83.31%	79.64%	85.56%	82.85%
Percent in high income zip code (>$50,000)	73.83%	75.39%	73.90%	75.00%	74.97%	75.42%
Percent in urban zip code	95.91%	96.11%	95.90%	96.23%	96.05%	96.04%
Mean family size	2.62	2.62	2.61	2.59	2.66	2.66
SD Family size	1.53	1.49	1.51	1.48	1.60	1.57
Median Family Size	2	2	2	2	2	2
Percent Asian	2.76%	2.95%	2.79%	3.12%	3.14%	3.65%
Percent Black	2.92%	2.30%	2.65%	2.35%	2.93%	2.62%
Percent Caucasian	79.03%	79.67%	78.78%	79.30%	78.05%	77.52%
Percent Hispanic	6.50%	6.16%	7.09%	6.67%	7.29%	7.43%
Percent Unknown Race	8.79%	8.91%	8.69%	8.56%	8.58%	8.78%
Region						
Midwest	21.68%	22.34%	20.41%	21.51%	22.12%	22.61%
Northeast	10.89%	11.75%	11.29%	11.93%	11.20%	11.88%
Pacific	24.78%	23.24%	25.20%	23.86%	24.91%	23.69%
South	42.65%	42.67%	43.10%	42.70%	41.77%	41.82%
Percent withPharmacy Coverage	79.31%	78.22%	78.57%	76.95%	79.50%	78.30%

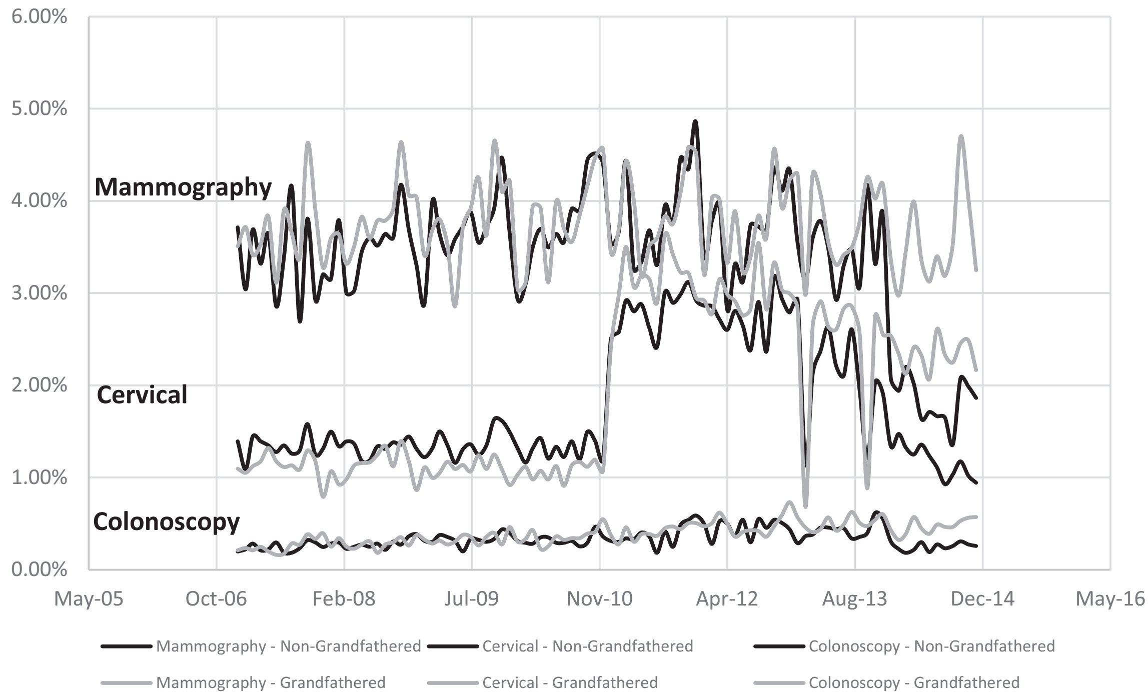

Fig. 2. Utilization of Preventive Cancer Screenings by Month, 2007 to 2014.

3.2.2. Cost sharing > Zero utilization

The utilization trend of procedures occurring with greater than zero cost sharing is presented in Fig. 3. For each cancer screening the number of procedures with greater than zero cost sharing decreased after the ACA policy change. When comparing utilization within plans (see Table S9), all three cancer screenings showed significant utilization differences ($\alpha = 0.05$) for both grandfathered and non-grandfathered plans, with the largest difference seen in the colonoscopy grandfathered group. When comparing between treatment and comparison groups (see Table S10), before the ACA cost sharing policy change there were significant differences in utilization for cervical screenings and mammography ($p < .0001$). After the policy change there were significant differences in utilization between treatment and comparison group for mammography (Non-GF 1.55 vs GF 2.31, $p < .0052$), and colonoscopy (Non-GF 2.13 vs GF 4.92, $p < .0003$).

3.3. Aggregated time series analysis

Coefficients of interest for the difference in difference interrupted time series analysis are presented in Table 2. The overall trend as indicated by the coefficient for time was not statistically significant for all three models (positive for mammography and cervical screening, negative for colonoscopy). The coefficient for policy change, which shows the immediate effect of the policy change, showed a non-statistically significant positive effect for colonoscopy and mammography and a negative effect for cervical screening in the non-grandfathered plans. While non-statistically significant, the mammography model indicates the policy change was associated with a 4.536 increase in the procedure rate per 1000 members of preventive mammography screenings immediately after the policy change.

The coefficient for Postslope, which captures the continuing effect of the policy change, was statistically significant for all three screening procedures. The coefficient showed a negative trend for mammography, indicating that the policy change resulted in a decrease of 0.439 in the rate per 1000 members of mammography screenings. Similarly, the cervical cancer screening model showed a significant negative trend for the postslope coefficient demonstrating a decrease in utilization per 1000 members of 0.249. The colonoscopy model also showed a statistically significant result for the post slope coefficient indicating the utilization of this preventive service decreased by 0.033 procedures per 1000 members as a result of the no cost sharing benefit policy change.

4. Discussion

This study evaluated the ACA using two groups of commercially insured individuals who maintained continuous insurance coverage

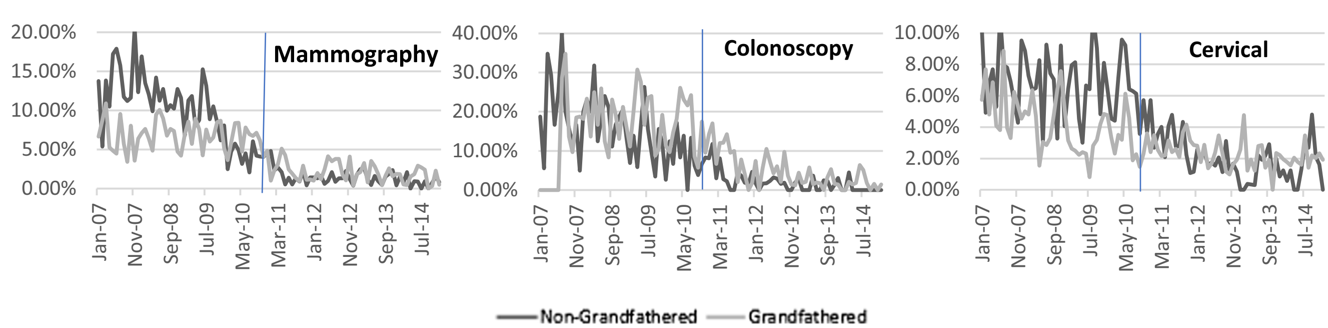

Fig. 3. Utilization of Preventive Cancer Screenings, Cost sharing > Zero, by Month, 2007 to 2014.

Table 2
Aggregated difference in preventive service utilization for grandfathered versus. non-grandfathered plans.

	Mammography		Colonoscopy		Cervical	
	Coefficient (SE)	P-value	Coefficient (SE)	P-value	Coefficient (SE)	P-value
Time	0.073 (0.074)	0.331	−0.007 (0.011)	0.5214	0.023 (0.051)	0.6491
Policy_Change	4.534 (2.414)	0.064	0.475 (0.383)	0.219	−1.525 (1.684)	0.3673
Postslope	−0.439 (0.099)	<0.001	−0.033 (0.012)	0.006	−0.249 (0.067)	0.0004

[a]Post Policy captures the absolute difference in percent screened between the study groups in the month immediately following the policy change.
[b]Postslope captures the continuing effect of the policy change in successive time periods; the change in slope after the policy was implemented.

from 2007 to 2014. The results from this study demonstrate the overall trend in utilization of preventive cancer screenings covered with no cost sharing slightly decreased after the ACA cost sharing benefit policy change. This is in line with similar research that has found the removal of cost sharing for preventive services has resulted in no or little change in utilization rates [13-15,17-19,28-30]. Several of these studies suffer from a short post policy change analysis period of nine months to one year, which limits their ability to capture the complete impact of the policy change. The longer runout period (51 months) of this study allows rates to normalize and provides a more robust picture of the impact of the policy change, as consumers are more likely to be fully aware of the policy.

The percentage of procedures occurring with zero cost sharing was decreasing before the ACA policy change for all three procedures studied. A small percentage of preventive screenings still had cost sharing associated after the ACA policy change. This is likely occurring due to provider network status. If the provider is out of network for the specific plan, the coverage determination guideline states the procedure would still be billed with cost-sharing. An analysis of network status was outside the scope of this work.

The potential bias from outside events, for example the economic recession of the late 2000′s, is not controlled for in the analysis and may impact the results of this study. Researchers have identified a decrease in utilization of health services, including colonoscopy [31], and health spending, and a corresponding increase in the number of uninsured as a result of the economic recession [32]. Between 2000 and 2010 the recommended intervals for receiving breast, colorectal and cervical cancer screenings were drastically changing [33]. Guideline changes occurred in several organizations including the American Cancer Society and the United States Preventive Services Task Force for breast cancer screening in 2002, 2007 and 2009, for cervical cancer screening in 2002, 2007, and 2012, and for colorectal cancer screening in 2001, 2003, 2006, and 2008 [33-36]. This information was regularly in the news and may have caused individuals to seek or delay care [37-40].

It is possible that consumers were not aware of the change in cost sharing for preventive cancer screenings. Studies have shown that consumers have poor knowledge of the ACA's preventive screening cost sharing benefit [41-44]. Researchers have shown that consumer knowledge of preventive service prices have a substantial positive effect on the use of preventive services [45].

Potential policy solutions to increase uptake of these services would include providing educational material, at time of enrollment, related to the importance of the preventive cancer screening and the cost sharing benefit. Further research is needed to determine the extent that the cost sharing policy benefit was understood by consumers after the policy change, and whether providing this information may compel individuals to seek preventive care.

4.1. Limitations

The aggregated difference in difference approach is only robust in instances of comparing the same populations. Variables not present in the data (i.e., education level, English fluency, incentives for primary care, etc.) may introduce selection bias to the sample. The study population may not be generalizable to the U.S. The study had limited representation of minority groups, and others that may have benefited from the ACA including individuals who purchased insurance through the healthcare marketplace. Further research is needed on these groups to determine disparities associated with receipt of preventive cancer screenings and the potential policy solutions to increase utilization.

The time period of the analysis may not be sufficient to see the potential impact from the ACA. The data utilized for this analysis covered an eight-year period, however the recommended screening interval for colonoscopy is ten years. A longer study period may be required to fully capture the colonoscopy utilization rate.

5. Conclusion

This study adds to the existing literature on preventive service utilization by determining the impact of the ACA's cost sharing benefit and preventive health screening utilization rates. The ACA has not had a significant positive impact on utilization rates for colonoscopy, mammography, or cervical cancer screening in a commercially insured population. Further research is required to determine ways to increase uptake of preventive cancer screenings aside from removing cost sharing for the procedures. Future research should focus on other factors that may impact utilization of a preventive cancer screening including family history, knowledge of the cost sharing reduction benefit, knowledge of an individual's insurance plan, and existing use of the health care system. Providing information about no-cost preventive screenings at time of plan enrollment may compel individuals to seek preventive care.

CRediT authorship contribution statement

Nicholas Jennings: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing - original draft, Writing - review & editing. **David O. Garcia:** Supervision, Writing - review & editing. **Howard Eng:** Supervision, Writing - review & editing. **Elizabeth Calhoun:** Writing - review & editing.

Declaration of Competing Interest

The author declare that there is no conflict of interest.

Acknowledgments

None.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hpopen.2021.100044.

References

[1] Patient Protection and Affordable Care Act. Sect. 18001 et seq. (2010).
[2] The Patient Protection and Affordable Care Act: Detailed Summary. In: Senate US, editor. 2010.
[3] Preventive Services Covered Under the Affordable Care Act: Department of Health and Human Services; 2010 [updated 2010-07-14 00:00:00.0]. Available from: http://www.hhs.gov/healthcare/facts/factsheets/2010/07/preventive-services-list.html.
[4] Rice T, Morrison K. Patient cost sharing for medical services: a review of the literature and implications for health care reform. Med Care Res Rev 1994;51(3):235–87.
[5] Glossary: U.S. Centers for Medicare & Medicaid Services; 2014 [cited 2014 05/20/2014]. Available from: https://www.healthcare.gov/glossary/.
[6] Scitovsky AA, Snyder NM. Effect of coinsurance on use of physician services. Soc Secur Bull 1972;35(3).
[7] Solanki G, BchD DrPH, Halpin Schauffler H, PhD MSPH. Cost-sharing and the utilization of clinical preventive services. Am J Prev Med 1999;17(2):127–33.
[8] Brian EW, Gibbens SF. California's Medi-Cal Copayment Experiment. Medical Care. 1974;12(12 (Supplement)):1-303.
[9] Lohr K, Brooke R, Kamberg C, Goldberg G, Leibowitz A, Keesey J, et al. Use of Medical Care in the Rand Health Insurance Experiment: Diagnosis- and Service-Specific Analyses in a Randomized Controlled Trial. Medical Care. 1986;24(9 (Supplement)):S1-S87.
[10] Chandra A, Gruber J, McKnight R. The impact of patient cost-sharing on low-income populations: evidence from Massachusetts. J Health Econ 2014;33:57–66.
[11] Fedewa SA, Goodman M, Flanders WD, Han X, Smith RA, Ward EM, et al. Elimination of cost-sharing and receipt of screening for colorectal and breast cancer. Cancer 2015;121(18):3272–80.
[12] Han X, Yabroff KR, Guy Jr GP, Zheng Z, Jemal A. Has recommended preventive service use increased after elimination of cost-sharing as part of the Affordable Care Act in the United States? Prev Med 2015;78:85–91.
[13] Busch SH, Barry CL, Vegso SJ, Sindelar JL, Cullen MR. Effects of a cost-sharing exemption on use of preventive services at one large employer. Health Aff 2006;25(6):1529–36.
[14] Jena AB, Huang J, Fireman B, Fung V, Gazelle S, Landrum MB, et al. Screening mammography for free: impact of eliminating cost sharing on cancer screening rates. Health Serv Res 2017;52(1):191–206.
[15] Mehta SJ, Polsky D, Zhu J, Lewis JD, Kolstad JT, Loewenstein G, et al. ACA-mandated elimination of cost sharing for preventive screening has had limited early impact. Am J Managed Care. 2015;21(7):511–7.
[16] Health Insurance Coverage of the Total Population: Kaiser Family Foundation; 2018 [cited 2020 01/18/2020]. Available from: https://www.kff.org/other/state-indicator/total-population/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D.
[17] Carlos RC, Fendrick AM, Kolenic G, Kamdar N, Kobernik E, Bell S, et al. Breast screening utilization and cost sharing among employed insured women after the Affordable Care Act. J Am College Radiol 2019;16(6):788–96.
[18] Alharbi A, Khan MM, Horner R, Brandt H, Chapman C. Impact of removing cost sharing under the affordable care act (ACA) on mammography and pap test use. BMC Public Health 2019;19(370):1–9.
[19] Steenland M, Sinaiko A, Glynn A, Fitzgerald T, Cohen J. The effect of the Affordable Care Act on patient out-of-pocket cost and use of preventive cancer screenings in Massachusetts. Prevent Med Repo 2019;15:1–11.
[20] Morrill R, Cromartie J, Hart G. RUCA Data, Version 2.0 Seattle, WA: WWAMI Rural Health Research Center, University of Washington; 2005. Available from: http://depts.washington.edu/uwruca/ruca-data.php.
[21] SOI Tax Stats - Individual Income Tax Statistics - ZIP Code Data (SOI): Internal Revenue Service; 2016 [cited 2016]. Available from: https://www.irs.gov/uac/soi-tax-stats-individual-income-tax-statistics-zip-code-data-soi.
[22] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Diseases 1987;40(5):373–83.
[23] Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika 1983;70(1):41–55.
[24] Parsons LS. Performing a 1:N Case-Control Match on Propensity Score. SAS Users Group International Conference 29; Montreal, CA2004. p. 1-11.
[25] Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivar Behav Res 2011;46(3):399–424.
[26] Lagarde M. How to do (or not to do)... Assessing the impact of a policy change with routine longitudinal data. Health Policy and Planning. 2012;27:76–83.
[27] Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. Academic Pediatrics. 2013;13(6S):S38–44.
[28] Trivedi AN, Rakowski W, Ayanian JZ. Effect of cost sharing on screening mammography in medicare health plans. The New England Journal of Medicine. 2008;358:375–83.
[29] Richman I, Asch MS, Bhattacharya J, Owens DK. Colorectal cancer screening in the era of the affordable care act. J Gen Intern Med 2016;31(3):315–20.
[30] Khatami S, Xuan L, Roman R, Zhang S, McConnel C, Halm EA, et al. Modestly increased use of colonoscopy when copayments are waived. Clinical Gastroenterology and Hepatology. 2012;10(7). 761–6e1.
[31] Dorn SD, Wei D, Farley JF, Shah ND, Shaheen NJ, Sandler RS, et al. Impact of the 2008–2009 economic recession on screening colonoscopy utilization among the insured. Clinical Gastroenterology and Hepatology 2012;10(3):278–84.
[32] Holahan J. The 2007–09 recession and health insurance coverage. Health Aff 2011;30(1):145–52.
[33] Smith RA, Manassaram-Baptiste D, Brooks D, Doroshenk M, Fedewa S, Saslow D, et al. Cancer Screening in the United States, 2015: A Review of Current American Cancer Society Guidelines and Current Issues in Cancer Screening. CA: A Cancer Journal for Clinicians. 2015;65:30-54.
[34] Guide to Clinical Preventive Services, 2014 | Recommendations of the U.S. Preventive Services Task Force. In: Quality AfHR, editor.: U.S. Department of Health & Human Services; 2014.
[35] American Cancer Society Guidelines for the Early Detection of Cancer: American Cancer Society; 2019 [04/6/2019]. Available from: http://www.cancer.org/healthy/findcancerearly/cancerscreeningguidelines/american-cancer-society-guidelines-for-the-early-detection-of-cancer.
[36] Moyer VA. Screening for Cervical Cancer: U.S. Preventive Services Task Force Recommendation Statement. Ann Intern Med 2012;156(12):880–91.
[37] Kolata G. New Guidelines Suggest Cutback in Mammograms. New York Times. 2009 11/17/2009;Sect. A.
[38] Stein R. Federal panel recommends reducing number of mammograms. Washington Post. 2009.
[39] Park A. New Cervical Cancer Screening Guidelines Include HPV Tests. Time. 2012 03/16/2012.
[40] Gray N, Picone G. The effect of the 2009 U.S. preventive services task force breast cancer screening recommendations on mammography rates. Health Serv Res 2016;51(4):1533–45.
[41] Eno V, Mehalingam S, Nathaniel TI. The patient protection and affordable care act and utilization of preventive health care services. Sage Open. 2016;6(1):1–13.
[42] Reed ME, Graetz I, Fung V, Newhouse JP, Hsu J. In consumer-directed health plans, a majority of patients were unaware of free or low-cost preventive care. Health Aff 2012;31(12):2641–8.
[43] Cho YI, Lee S-Y-D, Arozullah AM, Crittenden KS. Effects of health literacy on health status and health service utilization amongst the elderly. Soc Sci Med 2008;66:1809–16.
[44] Williams J, Ortiz SE. Examining public knowledge and preferences for adult preventive services coverage. PLoS ONE 2017;12(12:e0189661).
[45] Parente ST, Salkever DS, DaVanzo J. The role of consumer knowledge of insurance benefits in the demand for preventive health care among the elderly. Health Econ 2005;14:24–38.