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Vulnerable And Less Vulnerable Women In High-Deductible Health Plans Experienced Delayed Breast Cancer Care

J. Frank Wharam¹, Fang Zhang¹, Jamie Wallace¹, Christine Lu¹, Craig Earle², Stephen B. Soumerai¹, Larissa Nekhlyudov³, Dennis Ross-Degnan¹

¹Division of Health Policy and Insurance Research, Department of Population Medicine, at Harvard Medical School and the Harvard Pilgrim Health Care Institute, Boston, Massachusetts.

²IC/ES, Toronto, Ontario

³Dana-Farber Cancer Institute, Boston.

Abstract

High-deductible health plan (HDHP) effects on breast cancer diagnosis and treatment among vulnerable populations are unknown. We examined time to first breast cancer diagnostic testing, diagnosis, and chemotherapy among a group of women whose employers switched their insurance coverage from low-deductible health plans to HDHPs between 2004–2014. Primary subgroups of interest comprised 54,403 low-income and 76,776 high-income women continuously enrolled in low-deductible (\$500) plans for a year then up to 4 years in HDHPs (\$1000). Matched controls had contemporaneous low-deductible enrollment. Low-income women in HDHPs experienced relative delays of 1.6 months to first breast imaging, 2.7 months to first biopsy, 6.6 months to incident breast cancer, and 8.7 months to first chemotherapy. High-income HDHP members had shorter delays that did not differ statistically from low-income counterparts. HDHP members living in metropolitan, non-metropolitan, predominantly white, and predominantly non-white areas also experienced delayed breast cancer care. Policies might be needed to reduce out-of-pocket costs for breast cancer care.

Forty-six percent of US adults under age 65 have high-deductible health plans (HDHPs).¹ These arrangements require potential out-of-pocket spending each year of approximately \$1000-\$7000 per person for most non-preventive care. In 2018, 58% of workers with individual plans had deductibles of \$1000 and 26% had deductibles of \$2000.² Very few studies have examined whether HDHPs act as a barrier to receipt of essential, life-sustaining care.

In the early 2000s, a confluence of factors including rising health care costs, the managed care backlash, incentives in the Medicare Modernization Act, and advocacy from political and consumerist proponents helped stimulate the rise of HDHPs. This major payment policy change created a natural experiment with uncertain effects on consumer health. Our study seeks to understand one aspect of this natural experiment, namely, whether both vulnerable and non-vulnerable HDHP members delay potentially life-saving care.

Advocates of cost sharing in health care suggest that exposing patients to out-of-pocket costs will activate a subset of engaged consumers to shop for higher-quality, lower-cost care, ultimately driving competition and lowering prices.³ Others have raised concerns that conditions for value-seeking and competition are not present in health care markets, and that high out-of-pocket health costs will deter needed care while disproportionately burdening vulnerable patients.⁴

In the US, breast cancer is the most common non-dermatological malignancy among women and the second-leading cause of cancer mortality.⁵ Multiple studies have examined whether rates and types of cancer *screening* change among HDHP members,^{6–8} including vulnerable subgroups.^{9–11} These analyses have generally not detected changes, including among lower-income HDHP members. In contrast to breast cancer screening, which has little or no associated cost sharing even under HDHPs, breast cancer diagnosis and treatment require use of expensive services.^{12,13} Therefore, women in HDHPs who face decisions about breast cancer care must weigh the costs of services against the possibility of delaying diagnosis and treatment for a potentially life-threatening disease.

A 2004–2012 study found that mandated transition to HDHPs was associated with delays in breast diagnostic imaging, biopsy, incident breast cancer diagnosis, and chemotherapy.¹⁴ However, research has not examined whether there are differences in the timing of these crucial services among vulnerable and less vulnerable HDHP subgroups.

The RAND Health Insurance Experiment¹⁵ found that high out-of-pocket costs reduced most health services irrespective of income level, but other studies have found that such reductions do not occur in all clinical situations^{15–18} or for all demographic subgroups.^{17–19} For example, a study found that low-income but not high-income HDHP members with diabetes delayed outpatient visits for acute diabetes complications¹⁸ and that adverse outcomes were concentrated among low-income members.^{17,18}

We therefore hypothesized that breast cancer diagnostic testing, diagnosis, and treatment would be delayed among vulnerable women such as those with low incomes but not among less vulnerable women after mandatory transitions to HDHPs.

Methods

Population.

We used claims data purchased from Optum for the years 2003–2014. Our study population comprised women who were free of breast cancer and generally healthy at the beginning of the study period so that we could observe their progression along the pathway from breast cancer workup to diagnosis and treatment. These women were commercially insured members of a large national health plan enrolled between 1/1/2003–12/31/2014 (Details on the construction of the study group are found in Appendix A).²⁰ Their employers switched their health coverage from low-deductible (annual deductible \$500 or less) to high-deductible (\$1000 or more). We used a \$1000 threshold for HDHPs because the Internal Revenue Service set the minimum deductible level for qualifying HDHPs at \$1050 when Health Savings Account-eligible HDHPs came to market in 2005–2006. We set an upper

limit of \$500 for low-deductible plans after determining that a limit of \$250 would make the control group too small. We did not include members with deductibles between \$501–999 because this is an extremely small group.

We defined the index date for employers who switched to HDHPs as the beginning of the month of the switch. We defined the index date for employers who did not switch plans as the beginning of the month when their yearly insurance contract was renewed. For each woman, we defined time zero as 12 months before the index date and defined the time between time zero and the index date as the baseline period. The follow-up period began on the employer's index date, as illustrated in a diagram of the study design in Appendix Exhibit A2.²⁰

After applying exclusion criteria (described in Appendix A and Appendix Exhibit A3)²⁰ our sample included 318,084 women age 25–64 who did not have evidence of breast cancer before baseline and whose employers switched to HDHPs. The control group comprised 3,406,755 women whose employers kept low-deductible plans (Exhibit 1).

Study Design and Match.

This observational, longitudinal survival analysis study compared matched groups of women. The intervention group consisted of women in low-deductible plans for 1 year who were switched to HDHPs for an additional 1 month to 4 years. The control group consisted of matched women who remained in low-deductible plans. We matched women on the propensity²¹ of the employer to mandate HDHPs and of individuals to work for such employers, baseline annual out-of-pocket spending category (\$0–\$500, \$501–\$999, \$1000–2499, \$2500 and above); whether members had a baseline screening mammogram, breast diagnostic image, breast biopsy, early-stage breast cancer diagnosis, or breast cancer chemotherapy; follow-up duration categories (to minimize differential dropout); and age category (25–34, 35–44, 45–54, 55–64). Details on the study design, matching methods, and matching variables are contained in Appendices B and C and Appendix Exhibits A2 and A4.²⁰

We used coarsened exact matching²² to match the study groups. Because we were interested in effects of HDHPs by income level, we defined two primary income groups and matched intervention to control members within these income groups. Low-income women included those living in census tracts with at least 20% of households having incomes below the federal poverty level, and high-income women comprised those living in census tracts with fewer than 5% of households having incomes below the federal poverty level.²³ These corresponded to median household incomes in the respective neighborhoods of approximately \$34,000 and \$92,000. We also examined women in middle-income census tracts with 5% to 19.9% of households below poverty.

We defined several other subgroups of interest: women living in non-metropolitan, metropolitan, predominantly non-white, and white areas; women switched to HDHPs with health savings accounts (HSA) or health reimbursement arrangements (HRA) for all follow-up months; and counterparts who did not have HSA/HRAs during all follow-up time. Details on subgroups are found in Appendix D.²⁰

Our final primary study groups included 54,403 low-income HDHP members and 76,776 high-income HDHP members with 534,735 and 869,433 matched controls, respectively (Appendix Exhibit A3). Sample sizes of secondary subgroups are included in Appendix Exhibit A6.

Outcome Measures.

Our 4 outcome measures were time to the first observed breast cancer diagnostic image, first breast biopsy,^{24,25} incident early stage breast cancer diagnosis,²⁴ and first breast cancer chemotherapy treatment. Appendix Exhibit A4 list the codes used to construct the measures and Appendix D explains how we constructed the measures and integrated them into analyses.²⁰

Appendix Exhibit A7²⁰ shows how we estimated baseline and follow-up delays for breast cancer services at the population level. The estimate provides an intuitive measure of delays that a woman with average characteristics in our HDHP group might experience after a mandated HDHP switch.

Covariates.

We used version 10 of the Johns Hopkins ACG® System²⁶ to calculate members' baseline period morbidity scores. Using 2008–2012 American Community Survey²⁷ census tract-level data and validated cut-points,²³ we created categories that defined residence in neighborhoods with below-poverty levels of <5%, 5%–9.9%, 10%–19.9%, and 20%. Similarly, we defined categories of residence in neighborhoods by high-school education levels.²³ We used geocoding to classify members as living in predominantly white and non-white neighborhoods for the purpose of stratified analyses. To create covariates for inclusion in matching and regression models, we used a similar approach to classify women as living in white, black, Hispanic, or mixed neighborhoods, and we used a superseding approach (the E-Tech system from Ethnic Technologies) to classify members as being Hispanic or Asian.²⁸ Details of this approach are included in Section E of the Appendix.²⁰ We defined women as from metropolitan or non-metropolitan counties based on the 2013 Rural-Metropolitan Continuum Codes classification.²⁹ Other covariates included age, age category (25–39 and 40–64 years), employer size used as either a continuous variable or with categories of 0–99, 100–999, or 1000 individuals US region (West, Midwest, South, Northeast), and calendar month of the index date.

Statistical analyses.

To measure delays in care, we used a parametric regression survival-time model with a Weibull distribution.³⁰ Appendix F describes our statistical analyses in detail and includes the model specification.²⁰ For the baseline period, we modeled the interval between time zero and a given woman's first study outcome (for each of the 4 outcomes separately). We adjusted for baseline age, ACG score, employer size category, US region, and index month. We used the same approach for the follow-up period to estimate the interval between the index date and a woman's first instance each of the four outcomes. The main variable of interest from the baseline and follow-up regression models was membership in the

intervention group. The coefficients were hazard ratios³⁰ that allowed estimation of baseline delays and follow-up delays, an approach that Appendix F explains in detail.²⁰

We performed analyses using SAS 9.4 (Cary, NC) and Stata 15.1 (College Station, Texas).

Study limitations.

We were unable to assess adverse clinical outcomes such as advanced cancer stage at diagnosis. The study was observational and therefore analyses are at risk for effects of unmeasured confounders such as the differential likelihood of breast cancer incidence, aggressiveness, or indications among women experiencing different treatment regimens. However, given the substantial balance on multiple measured characteristics (shown in Exhibit A8 of the Appendix²⁰), it seems unlikely that such risk factors would differ substantially between the study groups. Our estimates of delays could be biased if women in the study groups differentially dropped from our sample in anticipation of future events related to breast cancer. Such patterns could bias comparisons across income groups if such dropout also occurred differentially across income groups. Other benefit design changes at the time employers switched to HDHPs could also bias results. We were not able to determine if HDHP and control members were switched to narrow network plans at different rates. However, it seems unlikely that this played a role in our findings because employer uptake of narrow network plans was very limited during 2004–2013.³¹ Although we knew the exact deductible of most smaller employers, we had to impute deductible levels from claims for almost all large employers. However, we do not believe that the imputation significantly affected our results because of the high sensitivity and specificity of the imputation algorithm (shown in Appendix Exhibit A1).²⁰ We did not have access individuals' health insurance premiums or health savings account balances. Women in the income groups we created might be somewhat above the mean of their neighborhood's income distribution because they had commercial insurance, but these are the individuals to whom our results generalize. Our income categories are not intended to be proxy individual-level measures of socioeconomic status; rather, they are intended to capture a mix of both individual-level and neighborhood socioeconomic effects.²³ Our study findings are not generalizable to women with uncommonly high deductibles or those who are newly insured.

Results

Most characteristics of the HDHP and control groups were similar (Appendix Exhibits A8–A11).²⁰ Low-income and high-income HDHP members accounted for 17.2% and 24.3% of the overall HDHP cohort, respectively. The mean age of HDHP and controls was 44 years among high-income women and 45 years among low-income women. Only 25–26% of low-income women lived in high-education neighborhoods while almost all high-income women lived in such areas; 15% of the low-income groups and 5% of the high-income groups were of Hispanic ethnicity. The HDHP and control groups had similar morbidity scores at baseline. Employer size was somewhat less balanced, with fewer HDHP members enrolled through large employers (5%) than control group members (8%).

Low- and high-income HDHP members experienced increases in out-of-pocket medical expenditures ranging from 47% to 72% per follow-up year versus baseline relative to controls (Appendix Exhibits A12 and A13).²⁰

At baseline, the low-income and high-income intervention and control groups had no statistically significant differences in time to any measure (Exhibit 1). Among low-income women, those switched to HDHPs waited 1.6 months longer for breast diagnostic imaging (Exhibits 1 and Appendix Exhibit A14²⁰) compared to women with low deductibles and 2.7 months longer for breast biopsy (Exhibits 1 and 2). Among high-income women, those switched to HDHPs waited less than a month longer for breast diagnostic imaging than women with low deductibles and 1.9 months longer for biopsy (Exhibit 1 and Appendix Exhibit A14²⁰).

Among low-income women, time to incident early-stage breast cancer diagnosis was 6.6 months longer for HDHP members compared to women with low deductibles (Exhibits 1 and 3) and time to first chemotherapy was 8.7 months longer (Exhibits 1 and 4). Among high-income women, time to incident early stage breast cancer dx was 5.4 months longer among HDHP members compared to women with low deductibles and time to first chemotherapy was 5.7 months longer (Exhibit 1 and Appendix Exhibit A14²⁰).

We also detected delays in time to the 4 outcome measures among almost all other HDHP subgroups of interest (Appendix A15)²⁰, including women from predominantly non-white (1.0 to 6.0 months) and white (0.6 to 8.1 months) neighborhoods, women living in non-metropolitan (1.6 to 10.0 months) and metropolitan counties (0.7 to 8.1 months), and women without HSAs/HRAs in all follow-up years (0.8 to 8.3 months). The exception was women with HSAs/HRAs in all follow-up years. Delays in this group were of smaller magnitude (0.7 to 4.1 months) but only the delay in diagnostic imaging was statistically significant.

Discussion

This study found that both vulnerable and less vulnerable women experienced delays in breast cancer diagnostic testing, early-stage diagnosis, and chemotherapy initiation following an employer-mandated switch to HDHPs. Although magnitudes of delays among women in the 3 income categories were not statistically different at a 95% level of certainty, the graduated duration of the delays in the expected direction suggests true differences. For example, HDHP enrollment was associated with delays in chemotherapy initiation of 8.7 months among low-income women, 8.1 months among middle-income women, and 5.7 months among high-income women. We also detected delayed breast cancer care among HDHP members living in metropolitan, non-metropolitan, predominantly white, and predominantly non-white areas.

These results suggest that HDHP-associated delays for breast cancer care are only partially related to patient sociodemographic characteristics, and that women across the income spectrum might experience high out-of-pocket costs as a barrier to breast cancer care. The delay of approximately 7 months to early-stage breast cancer diagnosis among women across the sociodemographic spectrum could imply suboptimal breast cancer outcomes.

High-income women have greater ability to afford out-of-pocket expenses than low-income women, so our finding that high-income women experienced substantial delays in breast cancer care was unexpected. It was also seemingly inconsistent with an analysis that found that low-income but not high-income HDHP members delayed outpatient visits for acute diabetes complications.¹⁸ The different findings might be related to the greater familiarity of diabetes patients with health insurance and benefit designs. Patients with chronic medical conditions interact with their health insurance and the health system regularly, while the women in our study were generally healthy and initially breast cancer-free. Thus, the majority of HDHP members in this study might have had little experience navigating complex, high-cost health insurance designs.

Our study does not permit us to examine reasons behind the delays we observed. Women might have been apprehensive about taking on high out-of-pocket expenses and may have delayed care until their annual deductible level was exceeded. Such factors seemingly cut across the sociodemographic spectrum.

Previous studies have examined whether low-income members respond differently from higher income members to a HDHP switch. This research has generally found that when services are subject to the deductible, utilization decreases^{11,15,17,18,32} or adverse outcomes increase^{17,18} more among low-income than high-income members. When services are exempted from the deductible, multiple studies have found that low-income members generally do not change utilization levels.^{9,11,17,18,33}

Previous research has not examined how HDHPs affect cancer diagnosis and treatment by income level, race, or rural residence. An analysis that included women enrolled in HDHPs up to 2012 and that examined a similar population found delays that were close in magnitude to the current results, but that study was not powered to assess effects among low-income women.¹⁴ Our study adds a comprehensive assessment of the impact of high cost-sharing on key events along the pathway from breast cancer diagnostic testing to treatment, demonstrating delays at all stages of care and across the sociodemographic spectrum.

A large proportion of US women have HDHPs,³⁴ and enrollment is expected to continue to increase. The Affordable Care Act (ACA) modestly changed the makeup of HDHPs by requiring certain preventive services to have no out-of-pocket costs, mandating an annual out-of-pocket spending maximum, and changing several regulations governing HSAs.³⁵ Despite these changes, the trajectory of employer-sponsored HDHP uptake did not appear to change from before to after the ACA.³⁴ State-based health insurance exchanges set up under the ACA sell mostly HDHPs to individuals and small businesses.³⁶

Our findings raise concerns that in coming years a majority of commercially-insured women of all sociodemographic levels might experience delayed breast cancer care. In the short-term, clinicians and payers should emphasize the importance of presenting for symptoms of breast cancer and not delaying diagnostic testing. Interactions with women around the time of breast cancer screening might provide an opportunity to inquire about out-of-pocket cost barriers and to refer women for financial assistance if necessary. Financial discussions may

become essential in the care of women at high risk for breast cancer.³⁷ Employers could also include information about HDHPs and delayed cancer care in their workplace wellness and insurance benefits education programs.

In the longer term, policymakers, health insurers, and employers should design or incentivize health insurance benefits that facilitate transitions through key steps along the cancer care pathway. This could take the form of low or no out-of-pocket obligations for certain services such as diagnostic breast cancer testing, regardless of socioeconomic status.^{35,38} Value-based out-of-pocket exclusions for cancer screening have preserved rates among HDHP members,^{6–9,11,39} demonstrating that this approach might succeed for downstream cancer care. Our finding of shorter delays among women with HSA/HRA-HDHPs was not conclusive but suggests a potential protective effect of these savings mechanisms. Employers could increase HSA contributions for women with eligible HDHPs or add HRAs to their benefit offerings.

Future studies should assess HDHP impacts on cancer stage at diagnosis, survival, and breast cancer expenditures. Larger studies should also assess whether generously-funded HSAs prevent the delays we detected.

Conclusions

Both vulnerable and less vulnerable women who were switched to HDHPs experienced delays in breast cancer diagnostic testing, early-stage diagnosis, and chemotherapy initiation compared to women remaining in low-deductible health plans. Such delays might lead to adverse long-term breast cancer outcomes affecting a substantial proportion of commercially insured women who develop breast cancer. Policymakers, health insurers, and employers should consider implementing value-based features in HDHPs to encourage successful transitions through key stages of the cancer care pathway.⁴⁰ This could take the form of increased HSA contributions or “population-tailored” exclusions of essential care³⁵ so that women would pay minimal amounts for services such as breast diagnostic testing.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

REFERENCES

1. Martinez ME, Cohen RA, Zammitti EP. Health Insurance Coverage: Early Release of Estimates From the National Health Interview Survey, January–June 2018. 2018. Available from: <https://www.cdc.gov/nchs/data/nhis/earlyrelease/insur201811.pdf>.
2. Claxton GRM, Long M, Damico A, Sawyer B. 2017 Employer Health Benefits Survey [Internet]. Kaiser Family Foundation and Health Research & Education Trust; 2017.
3. Herzlinger RE. Let's put consumers in charge of health care. *Harvard Business Review*. 2002;80(7):44–50, 2–5, 123. [PubMed: 12140854]
4. Woolhandler S, Himmelstein DU. Consumer directed healthcare: except for the healthy and wealthy it's unwise. *Journal of general internal medicine*. 2007;22(6):879–81. [PubMed: 17394044]
5. Breast Cancer Facts & Figures 2015–2016: American Cancer Society; 2016 [Available from: <http://www.cancer.org/acs/groups/content/@research/documents/document/acspc-046381.pdf>].

6. Wharam JF, Galbraith AA, Kleinman KP, Soumerai SB, Ross-Degnan D, Landon BE. Cancer screening before and after switching to a high-deductible health plan. *Annals of internal medicine*. 2008;148(9):647–55. [PubMed: 18458277]
7. Beeuwkes Buntin M, Haviland AM, McDevitt R, Sood N. Healthcare spending and preventive care in high-deductible and consumer-directed health plans. *The American journal of managed care*. 2011;17(3):222–30. [PubMed: 21504258]
8. Rowe JW, Brown-Stevenson T, Downey RL, Newhouse JP. The effect of consumer-directed health plans on the use of preventive and chronic illness services. *Health affairs*. 2008;27(1):113–20. [PubMed: 18180485]
9. Wharam JF, Graves AJ, Zhang F, Soumerai SB, Ross-Degnan D, Landon BE. Two-year trends in cancer screening among low socioeconomic status women in an HMO-based high-deductible health plan. *Journal of general internal medicine*. 2012;27(9):1112–9. [PubMed: 22544705]
10. Haviland A, McDevitt R, Sood N, Marquis MS. How Do Consumer-Directed Health Plans Affect Vulnerable Populations? *Forum for Health Economics & Policy*. 2011;14(2).
11. Wharam JF, Zhang F, Landon BE, LeCates R, Soumerai S, Ross-Degnan D. Colorectal Cancer Screening in a Nationwide High-deductible Health Plan Before and After the Affordable Care Act. *Medical care*. 2016;54(5):466–73. [PubMed: 27078821]
12. NCCN. Breast Cancer Screening and Diagnosis 2015 [Available from: http://www.nccn.org/professionals/physician_gls/pdf/breast-screening.pdf.
13. NCCN. Breast Cancer 2015 [Available from: http://www.nccn.org/professionals/physician_gls/pdf/breast.pdf.
14. Wharam JF, Zhang F, Lu CY, Wagner AK, Nekhlyudov L, Earle CC, et al. Breast Cancer Diagnosis and Treatment After High-Deductible Insurance Enrollment. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2018;36(11):1121–7. [PubMed: 29489428]
15. Newhouse JP. *Free for all? Lessons from the RAND Health Insurance Experiment*. Cambridge: Harvard University Press; 1996.
16. Selby JV, Fireman BH, Swain BE. Effect of a copayment on use of the emergency department in a health maintenance organization. *New England Journal of Medicine*. 1996;334(10):635–41. [PubMed: 8592528]
17. Wharam JF, Zhang F, Eggleston EM, Lu CY, Soumerai SB, Ross-Degnan D. Effect of High-Deductible Insurance on High-Acuity Outcomes in Diabetes: A Natural Experiment for Translation in Diabetes (NEXT-D) Study. *Diabetes care*. 2018.
18. Wharam JF, Zhang F, Eggleston EM, Lu CY, Soumerai S, Ross-Degnan D. Diabetes Outpatient Care and Acute Complications Before and After High-Deductible Insurance Enrollment: A Natural Experiment for Translation in Diabetes (NEXT-D) Study. *JAMA Intern Med*. 2017;177(3):358–68. [PubMed: 28097328]
19. Kozhimannil KB, Law MR, Blauer-Peterson C, Zhang F, Wharam JF. The impact of high-deductible health plans on men and women: an analysis of emergency department care. *Medical care*. 2013;51(8):639–45. [PubMed: 23685403]
20. To access the Appendix, click on the Appendix link in the box to the right of the article online.
21. Coca-Perraillon M. Local and Global Optimal Propensity Score Matching 2007 [Available from: <http://www2.sas.com/proceedings/forum2007/185-2007.pdf>.
22. Iacus SM, King G, Porro G. Causal Inference Without Balance Checking: Coarsened Exact Matching. *Political Analysis*. 2012;20(1):1–24.
23. Krieger N, Chen JT, Waterman PD, Rehkopf DH, Subramanian SV. Race/ethnicity, gender, and monitoring socioeconomic gradients in health: a comparison of area-based socioeconomic measures--the public health disparities geocoding project. *American Journal of Public Health*. 2003;93(10):1655–71. [PubMed: 14534218]
24. Nattinger AB, Laud PW, Bajorunaite R, Sparapani RA, Freeman JL. An algorithm for the use of Medicare claims data to identify women with incident breast cancer. *Health services research*. 2004;39(6 Pt 1):1733–49. [PubMed: 1553184]
25. Fenton JJ, Onega T, Zhu W, Balch S, Smith-Bindman R, Henderson L, et al. Validation of a Medicare Claims-based Algorithm for Identifying Breast Cancers Detected at Screening Mammography. *Medical care*. 2013.

26. ACG. The Johns Hopkins ACG System [Available from: <https://www.hopkinsacg.org/advantage/>].
27. American Community Survey [Available from: <https://www.census.gov/programs-surveys/acs/>].
28. Ethnic Technologies. Frequently Asked Questions [Available from: www.ethnictechnologies.com/faq].
29. USDA. Rural-Urban Continuum Codes [Available from: <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/>].
30. Kalbfleisch JD, Prentice RL. The statistical analysis of failure time data Wiley series in probability and statistics. 2nd ed Hoboken, N.J.: J. Wiley; 2002 p. pages 33–4 and 41–2
31. Hall M, Fronstin P. Narrow Provider Networks for Employer Plans. EBRI Issue Brief [Internet]. 2016 13 12 2018 Available from: <https://ssrn.com/abstract=2888065>.
32. Wharam JF, Zhang F, Landon BE, Soumerai SB, Ross-Degnan D. Low-socioeconomic-status enrollees in high-deductible plans reduced high-severity emergency care. Health affairs. 2013;32(8):1398–406. [PubMed: 23918484]
33. Eisenberg MD, Haviland AM, Mehrotra A, Huckfeldt PJ, Sood N. The long term effects of “Consumer-Directed” health plans on preventive care use. J Health Econ. 2017;55:61–75. [PubMed: 28712437]
34. The Kaiser Family Foundation Employer Health Benefits 2018 Annual Survey. 2018 [Available from: <http://files.kff.org/attachment/Report-Employer-Health-Benefits-Annual-Survey-2018>].
35. Wharam JF, Ross-Degnan D, Rosenthal MB. The ACA and high-deductible insurance--strategies for sharpening a blunt instrument. New England Journal of Medicine. 2013;369(16):1481–4. [PubMed: 24088042]
36. Pearson CF, Carpenter E, Sloan C. Consumer Costs Continue to Increase in 2017 Exchanges2017 27 9 2018 Available from: <http://avalere.com/expertise/life-sciences/insights/consumer-costs-continue-to-increase-in-2017-exchanges>.
37. Jaggi R, Ward KC, Abrahamse PH, Wallner LP, Kurian AW, Hamilton AS, et al. Unmet Need for Clinician Engagement Regarding Financial Toxicity After Diagnosis of Breast Cancer. 0(0).
38. Fendrick AM, Chernew ME. Value-based insurance design: a “clinically sensitive” approach to preserve quality of care and contain costs. The American journal of managed care. 2006;12(1):18–20. [PubMed: 16402884]
39. 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 affairs. 2006;25(6):1529–36. [PubMed: 17102176]
40. Wharam JF, Daniels N. Toward evidence-based policy making and standardized assessment of health policy reform. Jama. 2007;298(6):676–9. [PubMed: 17684191]

b) Breast Biopsy

EXHIBIT 2.

Time to first breast biopsy in low-income women who were switched into high-deductible health plans, compared to matched women who remained in low-deductible plans, before and after switch

Authors' analysis of national claims data source, 2004–2014. Income data are from the 2008–2012 American Community Survey

Notes: HDHP is high-deductible health plan. Vertical blue line is centered at the index date when women were switched into high-deductible health plans. ^aLiving in census tracts with at least 20% of households below the Federal Poverty Level as captured in the 2008–2012 American Community Survey.

c) Early-stage Breast Cancer

EXHIBIT 3.

Time to incident early stage breast cancer diagnosis in low-income women who were switched into high-deductible health plans, compared to matched women who remained in low-deductible plans, before and after switch

Authors' analysis of national claims data source, 2004–2014. Income data are from the 2008–2012 American Community Survey

Notes: HDHP is high-deductible health plan. Vertical blue line is centered at the index date when women were switched into high-deductible health plans. ^aLiving in census tracts with at least 20% of households below the Federal Poverty Level as captured in the 2008–2012 American Community Survey.

d) Breast Cancer Chemotherapy

EXHIBIT 4.

Time to breast cancer chemotherapy initiation in low-income women who were switched into high-deductible health plans, compared to matched women who remained in low-deductible plans, before and after switch

Authors' analysis of national claims data source, 2004–2014. Income data are from the 2008–2012 American Community Survey

Notes: HDHP is high-deductible health plan. Vertical blue line is centered at the index date when women were switched into high-deductible health plans. ^aLiving in census tracts with at least 20% of households below the Federal Poverty Level as captured in the 2008–2012 American Community Survey.

Exhibit 1.

Delay in breast cancer diagnostic testing, diagnosis, and treatment for women in high deductible health plans and matched controls in low-deductible plans, by income level

Interval between index date and first:	Mean Interval, Months ^a		
	Baseline		Follow-up
	HDHP	Control	HDHP versus Control ^b
Low-income Women^c			
Diagnostic Breast Imaging	6.9	7.1	-0.1 1.6 ****
Breast Biopsy	7.4	7.7	-0.2 2.7 ****
Early-stage Breast Cancer	8.6	8.7	-0.1 6.6 **
Breast Cancer Chemotherapy	7.6	7.7	-0.1 8.7 **
Middle-income Women^d			
Diagnostic Breast Imaging	6.9	7.1	-0.1 23.3 22.7 0.6 ***
Breast Biopsy	7.2	7.4	-0.2 28.1 26.0 2.2 ****
Early-stage Breast Cancer	8.3	8.6	-0.3 35.6 28.6 7.0 ****
Breast Cancer Chemotherapy	7.3	7.6	-0.3 36.5 28.4 8.1 ****
High-income Women^e			
Diagnostic Breast Imaging	6.9	7.0	-0.1 23.2 22.5 0.7 ***
Breast Biopsy	7.0	7.2	-0.2 27.4 25.5 1.9 ***
Early-stage Breast Cancer	7.5	7.9	-0.4 34.1 28.7 5.4 ****
Breast Cancer Chemotherapy	7.6	7.9	-0.3 34.9 29.2 5.7 **

Authors' analysis of national claims data source, 2004–2014. Income data are from the 2008–2012 American Community Survey

NOTES: HDHP is high-deductible health plan.

^aIntervals in months during the follow-up period defined as the interval between the index date and reaching half the final baseline rate of controls, and estimated using a parametric regression survival-time model with a Weibull distribution and adjusted for baseline age, ACG score, employer size category, US region, and index month.

^bEstimate of interest, reflecting the delay in the high-deductible health plan group relative to the control group.

^cLiving in census tracts with at least 20% of households below the Federal Poverty Level.

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Living in census tracts with 5% to 19.9% of households below Federal Poverty Level.
p
Living in census tracts with fewer than 5% of households below Federal Poverty Level.
p

*
**

p < 0.10,
p < 0.05,

p < 0.01,

1000 > d