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Assessment of trends in cervical cancer screening rates using healthcare claims data: United States, 2003–2014

Meg Watson[a,*], Vicki Benard[a], Elaine W. Flagg[b]

[a] Division of Cancer Prevention and Control, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA, United States

[b] Division of Sexually Transmitted Disease Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention, Atlanta, GA, United States

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ABSTRACT

Improved understanding of the natural history of cervical cancer has led to changes in screening recommendations, including the addition of the human papillomavirus (HPV) testing as an option in routine screening. Most studies of screening trends have used national self-reported survey data. To better understand recent trends in cervical cancer screening, including cytology (Papanicolaou, or Pap, tests) and human papillomavirus co-tests (HPV + Pap test), we used healthcare claims data to examine screening practices and trends. We analyzed screening among commercially-insured females ages 18–65 during 2005–2014 who were continuously enrolled during three or more contiguous calendar years, to identify those who received cervical cancer screening with a Pap test or co-test. We examined screening prevalence by age group and year. During the latter years of our study period, screening prevalence (regardless of screening method) declined significantly for women in all age groups examined. Despite declines in overall screening, the prevalence of co-testing increased in all age groups except those aged 18–20. In 2014, women aged 30–39 had the highest overall screening uptake (77.5%) and the highest use of co-testing (44.4%); this group also had the lowest overall declines in screening over the time period (−4.5%). These screening measures from healthcare claims were lower than self-reported screening from national surveys of the general population. More research to explore the reasons for these differences is needed to ensure that women are receiving appropriate screening, and to better understand why screening prevalence is declining among this population of commercially insured women.

1. Introduction

Over the past twenty years, the availability of human papillomavirus (HPV) tests and improved understanding of the natural history of cervical cancer has led to changes in screening recommendations. Since 2003, the United States (US) Preventive Services Task Force has recommended cytology (Papanicolaou, or Pap, tests) every three years for most women (U.S. Preventive Services Task Force, 2003). In 2012, all three major organizations that issue cervical screening guidelines adopted consistent recommendations: cytology screening every three years for women aged 21–65, with the option for women aged 30–65 to add the HPV test with the Pap test (co-test) and extend screening intervals to every five years (American College of Obstetricians and Gynecologists Committee on Practice Bulletins–Gynecology, 2016).

In the US, the National Health Interview Survey (NHIS) is used to monitor public health efforts toward achieving national health objectives (Centers for Disease Control and Prevention, 2017; Healthy People 2020, 2016). The NHIS is a population-based sample survey which collects data via in-person interviews. A recent analysis using 2015 NHIS data showed that no group of US women had attained the Healthy People 2020 objective of 93% of eligible women (aged 21–65) receiving cervical cancer screening in accordance with current recommendations (Watson et al., 2017). Screening percentages were particularly low among uninsured women (Watson et al., 2017). Questions about HPV testing were only added to the NHIS beginning in 2015, so the survey cannot yet be used to examine trends in the use of co-tests for recommended screening.

Validation of self-reported cervical cancer screening data has documented frequent overreporting of cervical screening, and women frequently confuse Pap testing with pelvic exams for other reasons (Rauscher et al., 2008). Cervical cancer screening rates have also been examined using data from additional sources such as programs and

* Corresponding author at: Division of HIV/AID Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD & TB Prevention, Centers for Disease Control and Prevention, MS-E47, 1600 Clifton Rd. NE, Atlanta, GA 30329, United States.
E-mail address: eze5@cdc.gov (M. Watson).

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healthcare claims (Watson et al., 2015; Tangka et al., 2015; Abdullah et al., 2016). Claims data have been used to assess the impact of screening recommendation updates on mammography rates (Qin et al., 2017), and the potential impact of HPV vaccination on the prevalence of anogenital warts (Flagg et al., 2013; Flagg and Torrone, 2018).

To better understand recent trends in cervical cancer screening (including co-testing) among women with access to private insurance, and to understand how claims data might differ from self-report survey data, we examined cervical cancer screening during 2005–2014 among privately insured women ages 18–65.

2. Methods

2.1. Study cohort

We used data from the *MarketScan® Commercial Claims and Encounters Database*, constructed by Truven Health Analytics (a subsidiary of IBM Watson) (Truven Health Analytics, Ann Arbor MI). Truven collects service-level claims for inpatient and outpatient services from employers and commercially-available private health plans, in exchange for healthcare benchmark reports. The claims and encounters records represent medical experiences of insured employees and their dependents throughout the US. Claims from all primary- and specialty-care providers who submit claims for reimbursement are included. Data are linked at the patient level by a unique encrypted identifier that is consistent across services, health plans, and time; data from individual patients can be linked across multiple years, even if patients change health plans, as long as the employer still reports claims to Truven. All claims have been paid and adjudicated. Healthcare for individuals in the *MarketScan* database is provided by a variety of fee-for-service, fully capitated, and partially capitated health plans, including preferred and exclusive provider organizations (PPOs and EPOs), point of service plans, indemnity plans, health maintenance organizations (HMOs), and consumer-directed health plans.

The number of all *MarketScan* enrollees increased annually from 17.5 million in 2003 to 49.3 million in 2008; the number of enrollees was reasonably stable from 2008 through 2014, ranging from 45.2 to 53.1 million. Approximately 30% of the US populations with employer-provided private health insurance were enrolled in plans contributing data to *MarketScan* as of 2013–2014 (Truven Health Analytics, 2015 and Kaiser Family Foundation, 2017).

We used records for inpatient admissions and outpatient (ambulatory) visits from January 2003 through December 2014 from approximately 150 self-insured employers; these employers participated in 200 national and local health insurance plans and 20 additional regional health insurance plans. We restricted records to those from females aged 16–65 years at the beginning of a calendar year, who were continuously enrolled during three or more contiguous calendar years (e.g., continuously enrolled from January 1, 2005 through December 31, 2007). We aggregated all claims records from providers within each year so that individual females were used as the units of analysis. Each individual could contribute one or more person-years to the analysis, based on having at least three years of continuous enrollment. For example, a woman who was continuously enrolled during 2003–2005 would contribute one person-year of data for 2005 (being considered adequately screened if there were any claims during the three-year window). If this same woman were not enrolled during 2006–2007, and then continuously enrolled again during 2008–2014, she would then contribute six person-years of data: one person-year each for calendar years 2005, and 2010–2014. Results are presented for women aged 18–65 years during 2005–2014.

Females who received cervical cancer screening within a given three year period were identified from claims records within that period containing any one of (a) three *International Classification of Disease, 9th Revision, Clinical Modification* (*ICD-9-CM*) encounter codes or two *Healthcare Financing Association Common Procedural Coding System* (HCPCS) procedure codes indicating a screening Pap test, or (b) 15 *Current Procedural Terminology*, *4th Edition* (CPT-4) or 10 HCPCS codes indicating cervical or vaginal cytopathology, or (c) three CPT-4 codes indicating HPV nucleic acid detection testing (Supplemental Table) (Centers for Medicare and Medicaid Services, n.d.; International Classification of Diseases, 2015; American Medical Association, 2014). Those having records in a given three-year period with none of the above codes, or with only ICD-9-CM codes indicating an encounter for a gynecologic exam without additional evidence of cervical cancer screening, were classified as having no evidence of screening. For women with claims records indicating receipt of an HPV test in January or December of a given year, but with no claims for a Pap test in the same year, we examined records in December of the previous year or January of the following year, respectively, when available (regardless of continuous annual enrollment) to ascertain whether they also received a Pap test within 1–2 months of their HPV test. No information was available on hysterectomy status.

We examined receipt of cervical cancer screening within the past three years using two outcomes of interest:

- Pap test (cytology)
- Co-test (cytology + HPV test; a subset of women having had Pap tests).

A very small percentage of women had records indicating an HPV test without a Pap test (ranging from 0.04% in 2003 to 0.14% in 2014). Because this number was so small, and because we were unable to verify that these women had not had a cytology screening elsewhere, we included these women in the co-test outcome for our analyses. We stratified our analysis by age group (18–20, 21–29, 30–39, 40–49, and 50–65).

2.2. Statistical analysis

We considered the number of females who received cervical cancer screening at least once in a three-year period, with at least two prior years of continuous enrollment, to be adequately screened. We calculated percent prevalence by dividing this number by the total number of screening-eligible females continuously enrolled during the same three-year period. The percentage of women who received a co-test and were screened again in less than five years was estimated using the contiguous four-year period following the year in which co-testing occurred, and was restricted to women who were co-tested in 2003–2010. Confidence intervals (CI) were estimated using log binomial modelling conducted with SAS version 9.3 (SAS Institute, Cary NC). Percent change in prevalence over the entire time period was calculated as the difference between the average rate of the first 2 years and the average rate of the last 2 years, divided by the average rate of the first 2 years (National Cancer Institute, n.d.). Annual percent change (APC) in prevalence was estimated using Joinpoint software version 4.2.0 (National Cancer Institute, Bethesda MD), which fits trend data to identify the log-linear model with the fewest number of inflection points (joinpoints); APC was based on the log-linear slope of the trend segment between joinpoints (Kim et al., 2000).

3. Results

The *MarketScan* 2003–2014 data contained 213 million person-years of data from 76 million individual females. Sixty million (79%) of these individuals were aged 16–65 during this time period, and of these, 42 million (70%) were continuously enrolled during three or more contiguous calendar years, contributing almost 89 million person-years of data to the analysis (Table 1). Overall, 5% of person-years were contributed by women aged 18–20 years, while 11%, 20%, 26%, and 38% of person-years were contributed by women aged 21–29, 30–39, 40–49, and 50–65, respectively. Most observations were from enrollees

Table 1
Demographic characteristics of privately insured females aged 18–65 years who were continuously enrolled for at least three years, by year, United States, 2005–2014.

Characteristics	2005 (n = 3,332,163)	2006 (n = 3,049,012)	2007 (n = 3,961,273)	2008 (n = 4,895,522)	2009 (n = 6,473,392)	2010 (n = 7,116,087)	2011 (n = 7,680,896)	2012 (n = 8,688,960)	2013 (n = 7,284,863)	2014 (n = 6,362,249)	Total (n = 58,844,417 PY)
	%	%	%	%	%	%	%	%	%	%	%
Age, years											
18–20	4.5	4.6	4.2	4.3	4.8	4.6	5.1	5.7	6.0	6.4	5.2
21–29	9.7	9.7	10.5	10.9	10.9	11.3	11.9	12.1	12.5	12.1	11.4
30–39	19.5	19.6	20.4	20.6	20.1	20.5	20.1	19.3	18.3	17.5	19.5
40–49	28.2	28.0	27.9	27.3	26.6	26.4	26.0	25.4	24.7	24.2	26.1
50–65	38.1	38.1	37.0	36.9	37.7	37.2	37.0	37.5	38.6	39.8	37.8
Residence in Metropolitan Statistical Area (MSA) or non-MSA											
MSA	81.6	81.4	82.5	83.2	83.8	85.0	84.7	84.3	84.6	85.2	84.0
Non-MSA	17.9	18.0	17.3	16.6	16.1	14.9	13.4	13.3	12.8	12.3	14.7
Missing/unknown	0.5	0.6	0.2	0.2	0.2	0.1	1.8	2.4	2.7	2.5	1.3
Residence: US census region											
North East	6.7	8.9	8.5	8.7	10.4	12.8	15.2	15.2	16.0	17.2	12.9
North Central	25.2	26.6	27.4	27.1	26.3	25.1	24.6	23.8	22.4	23.4	24.8
South	42.8	44.8	46.4	45.9	46.0	43.5	39.1	37.1	35.4	36.8	41.0
West	24.9	19.0	17.4	18.0	17.1	18.4	19.2	22.6	23.5	20.1	19.9
Missing/unknown	0.5	0.7	0.3	0.3	0.2	0.2	1.9	2.4	2.7	2.5	1.4
Capitated or non-capitated health plan											
Capitated	27.4	22.6	19.3	18.2	15.5	14.5	15.4	14.4	15.7	10.7	16.2
Non-capitated	71.6	74.7	79.1	79.7	82.2	83.1	82.9	84.1	83.2	88.4	82.1
Missing/unknown	1.1	2.7	1.7	2.2	2.3	2.4	1.7	1.5	1.1	1.0	1.7

Table 2
Trends n three year cervical cancer screening by age group among female privately insured continuous enrollees aged 18–65 years, United States, 2005–2014.

Age group, years	Cervical cancer screening	Percent change in prevalence[a]	Inflection year	Trend segment	Annual percent change in prevalence[b] (95% confidence interval)	p-Value, annual percent change in prevalence
18–20 years	Pap test	−54.3	2010	2005–2010	0.9 (−5.7, 8.0)	0.751
				2010–2014	−22.5 (−30.5, −13.6)	0.002
	Co-test	−15.6	2008	2005–2008	36.6 (−0.7, 87.8)	0.053
				2008–2014	−14.2 (−19.9, −8.0)	0.002
21–29 years	Pap test	−12.2	2008	2005–2008	4.6 (−3.1, 13.0)	0.192
				2008–2014	−3.8 (−5.8, −1.8)	0.005
	Co-test	101.7	2008	2005–2008	31.7 (12.8, 53.8)	0.006
				2008–2014	1.0 (−1.5, 3.6)	0.360
30–39 years	Pap test	−4.5	2008	2005–2008	3.4 (−1.5, 8.6)	0.139
				2008–2014	−2.3 (−3.6, −0.9)	0.007
	Co-test	327.4	2009	2005–2009	34.5 (24.0, 45.9)	< 0.001
				2009–2014	8.1 (5.8, 10.4)	< 0.001
40–49 years	Pap test	−5.5	2007	2005–2007	8.2 (−6.6, 25.4)	0.225
				2007–2014	−2.4 (−3.8, −1.0)	0.007
	Co-test	343.7	2009	2005–2009	35.7 (24.2, 48.3)	< 0.001
				2009–2014	8.1 (5.5, 10.8)	< 0.001
50–65 years	Pap test	−9.3	2008	2005–2008	4.9 (−3.5, 14.0)	0.204
				2008–2014	−3.9 (−6.1, −1.6)	0.007
	Co-test	369.2	2009	2005–2009	37.7 (25.6, 50.9)	< 0.001
				2009–2014	8.5 (5.8, 11.2)	< 0.001

[a] Percent change in prevalence over the entire time period, calculated as the difference between the average rate of 2013–2014 and the average rate of 2005–2006, divided by the average rate of 2005–2006.
[b] Estimated using the log-linear slope of the trend segment.

residing in a metropolitan statistical area (MSA) (84%), and more were from residents in the South (41%) than other regions; only 13% of person-years were contributed by women residing in the Northeast. Overall, 82% of observations were from non-capitated (i.e., fee-for-service) health plans.

3.1. Cervical cancer screening

During 2005–2014, the lowest prevalence of three-year cervical cancer screening, and the greatest declines in screening, were observed among women aged 18–20; the overall percent change from 2003 to 2014 was −54.3% (Table 2). In this age group, prevalence decreased significantly during 2010–2014 (APC = −22.5, P = 0.002), from 55.8% (95% CI: 55.7, 56.0) to 20.4% (95% CI: 20.3, 20.5) (Fig. 1). For women aged 21–29 and 30–39, screening prevalence was similar early in the study period. During 2008–2014, prevalence declined significantly for women in their 20s and 30s (APC = −3.8, P = 0.005 for women aged 21–29; APC = −2.3, P = 0.007 for women aged 31–39). In 2014, screening prevalence was 69.4% (95% CI: 69.3, 69.5) in women aged 21–29 and 77.5% (95% CI: 77.4, 77.6) in those aged 30–39. Trends in screening prevalence for women aged 40–49 and 50–65 years were similar to those observed for women aged 30–39, although rates were lower for older women throughout the study period.

3.2. Cervical cancer screening with co-testing

Prevalence of co-testing in women aged 18–20 declined significantly from 2005 to 2015. (Table 2). In women aged 21–29, co-testing prevalence increased during 2005–2008, from 6.7% (95% CI: 6.7, 6.8) to 14.9% (95% CI: 14.8, 15.0) (APC = 31.7, P = 0.006), then stabilized during 2008–2014. Prevalence of co-testing was highest

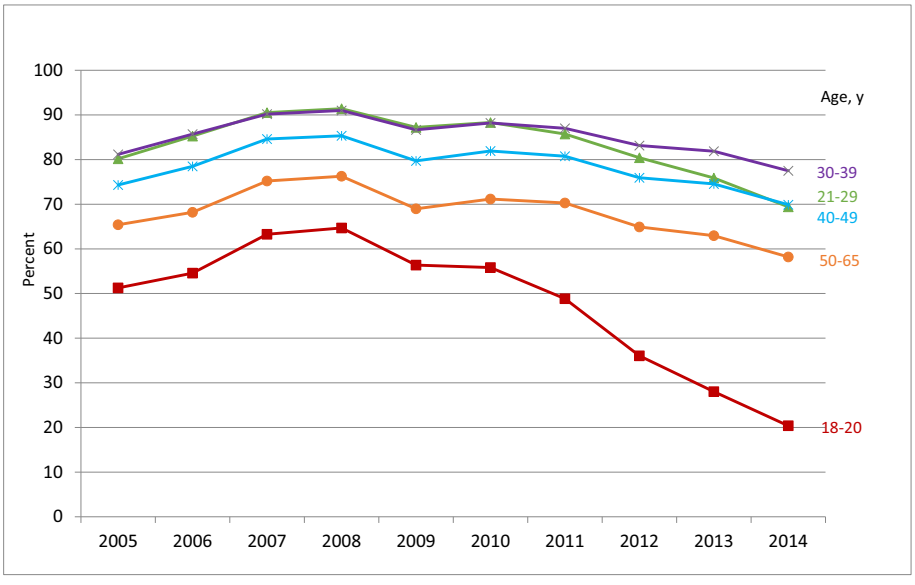

Fig. 1. Trends in three-year cervical cancer screening status by age group among privately insured continuous enrollees aged 18–65 years, 2005–2014.
Analysis restricted to women who were continuously enrolled for at least 3 years.

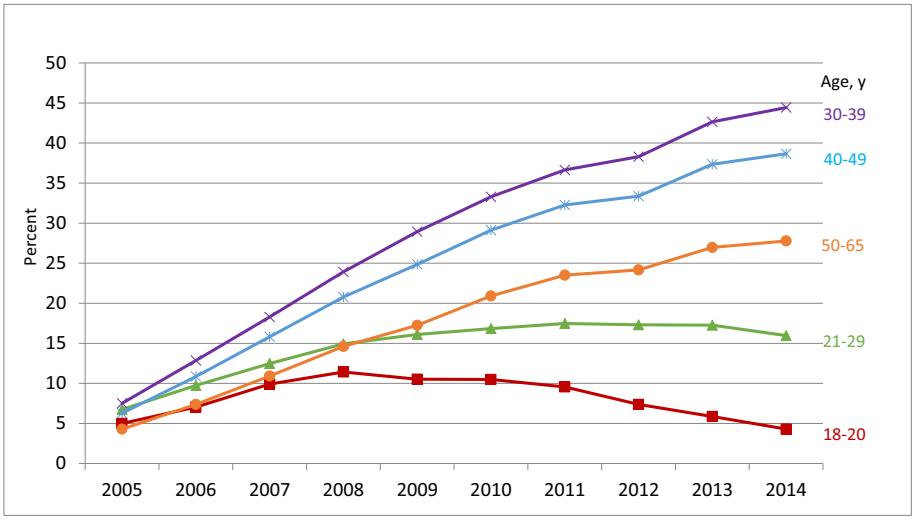

Fig. 2. Trends in cervical cancer screening with HPV co-testing by age group among privately insured continuous enrollees aged 18–65 years, 2005–2014.
Analysis restricted to women who were continuously enrolled for at least 3 years.

throughout the entire period for women aged 30–39 (Fig. 2), ranging from 7.5% (95% CI: 7.5, 7.6) in 2005 to 44.4% (95% CI: 44.3, 44.5) in 2014. Trends in co-testing prevalence for women aged 40–49 and 50–65 years were similar to those in women aged 30–39, although prevalence of co-testing was lower in the two older age groups.

4. Discussion

This study provides important information on cervical cancer screening trends among 42 million women with private insurance during 2005–2014. We found declining screening rates over time, and lower overall prevalence of cervical cancer screening than self-reported data suggest (Watson et al., 2017; Gamble et al., 2017).

In 2012 the three major organizations that issue cervical cancer screening recommendations all issued consistent recommendations against screening women younger than age 21 (American College of Obstetricians and Gynecologists Committee on Practice Bulletins–Gynecology, 2016; ACOG Committee on Practice Bulletins–Gynecology, 2009). Thus, the observed declines in screening among women aged 18–20 were to be expected. We also observed declines in screening among women aged 21–65. Other analyses have described declining percentages of eligible women meeting screening recommendations (White et al., 2017; Watson et al., 2017). However, previously documented declines were largest among uninsured and lower-income women (Watson et al., 2017). Our analysis focuses solely on women with private, employer-provided insurance. As expected, co-testing increased over the time period. In 2014, the FDA approved use of some HPV tests as primary screening for women aged 25 and older; several organizations have issued interim guidance for clinicians wishing to use the HPV test as primary screening (American College of Obstetricians and Gynecologists Committee on Practice Bulletins–Gynecology, 2016). During our study period, very few HPV tests were conducted without corresponding cytology tests, so it appears that primary screening via HPV testing was not commonly being used prior to FDA approval and issuance of interim guidelines.

Our analysis suggests that some women may be inaccurately reporting screening when responding to surveys. Aside from previously documented over-reporting of cervical cancer screening in self-report surveys (Lofters et al., 2013), we were unable to identify reasons for the lower prevalence of screening documented in claims data compared to national survey data. Self-reported three-year screening percentages were higher for each age group than those found in the current analysis (Watson et al., 2017), and differences increased with age, with the largest differences among women aged 50–65; 58.2% of these women had claims-documented screening within a three-year time period in 2014, compared to 79.8% of women in the same age group and without hysterectomy reporting being screened within three years in the 2015 NHIS (Watson et al., 2017).

We also observed differences in co-testing rates from claims data compared with self-report. The *MarketScan* healthcare claims data showed that 16.0% of privately insured women aged 21–29 had a co-test in the previous three years as of 2014, while 38.2% of women in the same age group self-reported co-testing in the 2015 NHIS (Healthy People 2020, 2016). Our current analysis only includes women with employer-provided private health insurance, who are presumably more likely to be screened than uninsured or publicly-insured women; therefore, these discrepancies may be related to previously-documented overreporting of cervical screening (Rauscher et al., 2008). Co-testing among women aged 30–39 was roughly similar in 2014 healthcare claims and 2015 NHIS data, with slight under-reporting from self-report (44.4% vs. 41.0%, respectively).

5. Strengths and limitations

Our study provides a unique look at cervical cancer screening in the United States among privately insured women. Healthcare claims data can provide important information to supplement national self-report surveys. The *MarketScan* database tracks enrollees when they change insurance plans, unless the employer discontinues contributing data or the employee changes employers. By limiting our analysis only to women with available records for at least three contiguous years, we have ensured that all women in our study were counted for at least one screening interval. Although it is possible that some women could have received screening from sources outside of their health plan (e.g. a screening event or campus clinic), it is unlikely that women enrolled in private, employer-provided insurance plans would seek cervical cancer screening from providers who would not submit claims for reimbursement for this routine, recommended procedure that is covered by insurance at little to no out-of-pocket cost to the patient. For the current analysis we were also unable to examine screening trends in the context of HPV vaccination, because although the *MarketScan* data do contain claims for HPV vaccination, a different study design that includes only those continuously enrolled since HPV vaccine was first licensed in the US would be required to ascertain each enrollee's vaccination status with reasonable certainty. However, research to date suggests that vaccinated women are more likely to receive timely screening than unvaccinated women (Watson et al., 2017; Guo et al., 2017), so we do not expect that HPV vaccination was a reason for declining screening rates.

This analysis had several limitations. The *MarketScan* data were not

sampled from a well-defined population, and therefore may not be generalizable to the US population or to all privately-insured females. In addition, the data do not contain information on demographic factors beyond age, sex, and geographic area of residence. In our preliminary analysis we examined age group-specific trends by geographical region, residence in a MSA, and insurance plan, but examination of these trends showed no meaningful differences across any of these factors, compared with overall trends by age group (data not shown).

We did not have complete information on hysterectomy status, so we do not know which women were not screened because they do not have an intact cervix. The prevalence of hysterectomy increases with age and is highest (about 40%) among women older than age 65, who were not included in our analysis (Beavis et al., 2017). Because we did not examine the use of HPV tests as primary tests (i.e., separate from co-testing), we cannot be sure whether HPV tests were conducted as a follow up to abnormal cytology, for primary screening, or as part of a co-test. However, in every year the percentage of women with records indicating an HPV test without a corresponding Pap test within 1–2 months was very small ($< 0.15\%$). We did not have complete date of birth information, and age of enrollees at the beginning of the calendar year was used in all analyses, so the age categories we used may contain some women who were actually 1 year older or younger than the age range in which they were classified. We also did not have sociodemographic information on the women included in the study, precluding any type of analysis of these data; however, all of the women were privately insured.

In addition, our data did not include complete information on reason for the Pap or co-testing procedure, so a small number of encounters may have been for follow-up of previous abnormal results rather than initial screening. Thus, we did not examine screening more frequently than recommended, because more frequent screening may have been conducted as a follow-up to abnormal results. Finally, we did not examine screening interval timing overall (e.g. comparing annual to 3-year screening, or 5-year screening among those with co-tests). Few (approximately 10%) of women who had co-tests were screened at 5-year intervals; approximately 20% or less of women in any age category were co-tested in a given calendar year, so it is unlikely that this would have affected our conclusions.

6. Conclusion

This large study of cervical cancer screening shows that while screening percentages overall declined among privately insured women in our claims-based data, screening via co-tests increased. While general patterns in screening mirrored those found in self-reported national surveys, many women appeared to be receiving less screening documented by healthcare claims data compared to self-report, while older women appeared to be receiving more co-tests than self-report data would indicate. More research to explore the reasons for these differences is needed to ensure that women are receiving appropriate screening, and to understand why screening prevalence is declining even among this population of commercially insured women.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Conflict of interest disclosures

None.

Capsule summary

We used healthcare claims data to examine cervical cancer screening practices during 2005–2014, including Papanicolaou, or Pap, tests and human papillomavirus co-tests. Screening percentages from healthcare claims among a commercially-insured population were lower than self-reported screening percentages from national surveys of the general population, and declined during recent years.

Human participant protection

Institutional review board approval was not needed because only secondary, de-identified data were used for this analysis.

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The authors have no conflicts of interest to report.

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Contributor statement

M. Watson assisted with the study design and led the writing. E. W. Flagg designed the study and analyzed the data, and assisted in the writing. V. Benard contributed to the study design, supervised the study, and assisted with analyses and writing.

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