Adherence to cervical cancer screening guidelines by family physicians in Calgary: cross-sectional analysis using demographic characteristics and lab data

Sayeeda Amber Sayed (sayeeda.sayed@ucalgary.ca)
University of Calgary
Christopher Naugler
University of Calgary
Guanmin Chen
University of Calgary
Dickinson James
University of Calgary

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Abstract

Background: The effectiveness of cervical cancer screening programs is well recognized; however, inappropriate screening practices result in either a woman being tested too often or not tested at the recommended intervals. The objectives of the study were to identify the characteristics of family physicians associated with over- and underscreening for eligible women aged 25-69 in Calgary, Alberta.

Methods: We performed a population-based retrospective observational study linking the Calgary Laboratory Services database from 2014-2016 to the College of Physicians and Surgeons of Alberta database of family physicians practicing in Calgary. We matched physicians' characteristics with their cervical screening practices. Panel size data was not directly available, so we used their laboratory test orders in 2016 as a proxy measure to estimate physician practice size. For the underscreening analysis, we excluded those physicians whose estimated practice size was lower than the number of screening tests ordered. Logistic regression models were applied to analyze the overscreening and underscreening patterns.

Results: Among 807 physicians included in the overscreening analysis, 43% of physicians had over-screened their screen-eligible patients. Physician characteristics significantly associated with overscreening included more years of practice and having more female patients in the practice. Among the 317 physicians included in the underscreening analysis, 42% had under-screened during the three-year study period. Female physicians were less likely to underscreen their eligible female patients. Physicians practicing in the Northeast quadrant of the city also had higher odds of underscreening.

Conclusions: Screening patterns of family physicians indicate both overuse and underuse, which indicates inconsistency in adherence to screening guideline recommendations. Addressing disparities and identifying strategies to improve guideline adherence among different physician demographic groups is critical for the success of screening programs.

Background

A key risk factor for developing cervical cancer is not getting cervical screening at the recommended time intervals or having an extended interval between screening tests [1]. Cancer screening literature focuses mostly on strategies to promote testing, providing an environment that is more conducive to overscreening than a less frequent schedule that balances the benefits and risks of cervical screening [2]. Overscreening comprises being tested too often or when it is inappropriate [3]. Adherence to evidence-based cervical screening guidelines is important, given potential harms associated with overscreening women, including false-positive results and invasive diagnostic procedures [3–5].

Cervical cancer screening guidelines have evolved substantially over the past decade to increase screening appropriateness and reduce harms [6]. In Alberta, screening guidelines were changed in 2009 from annual to screening every three years. In 2013, the Canadian Task Force on Preventive Health Care (CTFPHC) strongly recommended screening for women aged 30-69 at three-year intervals and discontinuing for women aged 70 years and older after three successive negative Pap test results. For women aged 25–29 years, CTFPHC made a weak recommendation for routine screening for cervical cancer every three years [2].-A weak recommendation implies that the evidence shows uncertainty in the balance between desirable and undesirable consequences [7]. Therefore, there is a need to consider more carefully than usual, individual patient's circumstances, preferences, and values [7]. In 2016, Alberta revised its cervical screening guidelines in agreement with the CTFPHC recommendations and recommended to start screening at age 25 with a three-year interval [6]. Despite these recommendations, many women continue to receive annual screenings and begin testing at a younger age. [6].

In Canada, nearly all cervical screening is performed by family physicians (FPs). Therefore, a major predictor of cervical cancer screening uptake is receiving a recommendation from the FP; correspondingly, lack of recommendation is a recognized barrier [8]. Physician-level barriers to cervical screening include limited interaction with patients to discuss the importance of screening and the test procedure, failure to communicate in a culturally appropriate manner, and physician noncompliance with screening guidelines [1, 8, 9], resulting in some women being underscreened or not tested at all [4, 10].

Understanding factors that influence cervical cancer screening utilization is crucial for the success of cancer screening programs [2]. While many studies explored patient-level sociodemographic factors influencing screening [11, 12], few have examined the screening patterns of physicians [13]. Evidence from a retrospective cohort study from Ontario suggests that international medical graduates (IMGs) are about 4% to 39% less likely to screen their patients for cancer than US- or Canadian-trained physicians [14]. Physicians from Muslim majority countries and developing countries may order less cervical screening due to their cultural and religious beliefs [15, 16]. Women physicians are more likely to order cancer screening compared to male physicians and women FPs are more likely to offer screening to their patients if they were trained in the North American health care system [14].

Screening practices can be improved by identifying physician-level factors that contribute to guideline non-adherence. Therefore, we aimed to identify FP characteristics associated with over- and underscreening of 25-69-year-old women in Calgary, Alberta, during 2014-2016.

Methods

Study Setting and Design

A population-based retrospective cross-sectional study was conducted from January 1, 2014, to December 31, 2016, in Calgary, a Canadian city with a population of 1.3 million [17] and a single pathology laboratory, where medical care, including pathology, is free to users.

Ethics approval for the study was obtained from the Conjoint Health Research Ethics Board at the University of Calgary (IRISS No. REB13-0376).

Data Sources

We used data from the Calgary Laboratory Services Laboratory Information System (LIS) of about 2800 physicians practicing in Calgary and surrounding catchment areas. We identified FPs through linkage with the publicly available College of Physicians and Surgeons of Alberta (CPSA) physician database. Family physicians' sex, country, and year of medical school graduation, years since medical school graduation, the number of years of independent practice in Alberta, and their clinic address were extracted. Countries of medical school graduation were further categorized into Muslim and non-Muslim majority countries [18] and developing and developed countries based on the countries' economic development status provided by the World Bank [19].

Physicians' clinic address was used to report the city quadrant in Calgary where the physicians practice [20]. Calgary city is divided into four quadrants: Northeast (NE), Northwest (NW), Southeast (SE) and Southwest (SW). The dividing line between east and west is Centre Street in the north and roughly Macleod Trail in the south. The dividing line between north and south is generally the Bow River in the west and Centre Avenue and Memorial Drive in the east [20]. (Additional file 1). There were differences in the physician-to-female 25-69 patient ratios in the different quadrants of Calgary (Additional file 2), which indicates that access to FPs in different quadrants of the city differ. Moreover, the Northeast quadrant of the city includes a higher proportion of recent immigrants and visible minorities, while the Southwest and Northwest include more populations with higher socio-economic status [21].

We limited the study to FPs who were active and independently practicing in Calgary for the entire study period, i.e., from January 1, 2014, to December 31, 2016. We used de-identified data for the analysis to avoid ethical concerns about identifying specific doctor's performance.

Eligible female patients for cervical cancer screening were 25 to 69 years of age between January 1, 2014, to December 31, 2016, with a valid Alberta health number and a residential address in Calgary. To focus only on screening, we excluded 32,588 tests from women who had a previous abnormal Pap test within the 2014-2016 study period.

Measurement of outcomes

Definition of over, appropriate, and underscreening women

Screening patterns of women were classified into three categories:

(1) Overscreening, comprising women who had received two or more normal cervical cytology tests during the study period.

(2) Appropriate screening, comprising those women who had received one cytology test during the study period 2014-2016.

(3) Underscreening, defined as women with no screening performed during the 3 years [6].

Overscreening versus appropriate screening

We calculated the number of appropriately screened and over-screened patients for each FP. Using total women screened as the denominator, we then calculated the percentages of appropriately screened and over-screened patients for the physician. We counted a FP as screening appropriately if 80% or more of their patients were screened once during the three-year study period. (Additional file 3). The choice of 80% cut-off for appropriate screening was arbitrary but does conform with the Canadian national target rates for cervical screening programs [22]. Figure 1 shows the study flow process for the study population.

Underscreening versus appropriate/ over screening

To estimate the number of women in individual practices who were underscreened, we first had to estimate the practice size of screen-eligible women for that individual physician. These data were not directly available. Therefore, we calculated a proxy measure of screen-eligible women for each individual FP by recording the total number of patients who received a laboratory test of any type in 2016. To provide a better estimate of the female population 25–69-year-old eligible for cervical cancer screening, we also adjusted for hysterectomy rates. Since women who do not have a cervix do not require a pap test, we calculated an age-weighted average hysterectomy rate of 5.71% for this spread of ages (25-69 years) and adjusted the denominator for the underscreening analysis. (Additional file 4). We then estimated the number of women in the practice who received no Pap tests during the study period by subtracting total number of women who received at least one Pap test from the estimated number of screen-eligible women for that physician.

For this analysis, we excluded (489, 61%) physicians who ordered cervical screening tests on more women than their estimated practice size. We then divided the remaining physicians into under-screeners and appropriate/over screeners based on their screening rates. The use of a 50% screening cut-off for this analysis was arbitrary and was based on the data distribution. (Additional file 3). Figure 2 shows the study flow process for the study population.

Data Analysis

Descriptive statistics were used to describe the characteristics of the physicians ordering cervical screening. In each case, the data was dichotomised. Those definitely over-screening were compared to the ones screening appropriately; and those underscreening were compared to the rest, both appropriately screened and over-screened. The analyses allocated each physician to be an appropriate/over screener, or not, or an under-screener or not. We have not analyzed patients, except as they contributed to the physician score.

The distribution of continuous variables showed positive skewness. Therefore, the Mann-Whitney Wilcoxon test for the continuous variables and chi-square tests for the categorical variables were used for between-group and within-group comparisons. Two separate multivariable binary logistic regression models were run to study physician characteristics associated with each of the comparisons (overscreening versus appropriate screening and underscreening versus appropriate/over screening). For all analyses, unadjusted and adjusted odds ratios (OR), 95% confidence intervals (CI), and two-sided p values of < .05 are reported. The Statistical Package for the Social Sciences (SPSS) version 26 was used for all analyses [23].

Results

Physician and practice characteristics

A total of 806 physicians met the study inclusion criteria. There were 58% female physicians and 27% IMGs included in the overscreening vs appropriate screening analysis. (Additional file 5) Overall, 33% of the IMGs were from Muslim majority countries, and 79% of IMGs were from developing countries. The median years since medical school graduation were 21 (interquartile range [IQR] 13-28 years), and the median years of practice in Alberta were 13 (IQR 7-22 years). We found that 25–69-year-old females-to-physician ratios in the Northeast (637:1) and Southeast (515:1) city quadrants were larger compared to the Southwest (317:1) and Northwest (402:1) (Additional file 4). In total, 59% of physicians had been in independent practice for 10 or more years. Male physicians had markedly more patients in their practice (median 651, IQR 275-940) than female physicians (median 432, IQR 234-701). However, the number of female patients (median 322, IQR 159-509) and eligible female patients for cervical screening (median 209, IQR 104-351) were quite similar among the male and female physicians.

A total of 317 physicians included in the underscreening analysis. (Additional file 6) There were 42% female physicians and 36% IMGs included. Overall, 36% of the IMGs were from Muslim majority countries, and 81% of IMGs were from developing countries. The median years since medical school graduation were 20 (interquartile range [IQR] 13-27 years), and the median years of practice in Alberta were 11 (IQR 6-20 years). Physicians included in the underscreening analysis has at least 2 years less practice experience than the physicians included in the appropriate/over screening analysis.

Male physicians had markedly more patients in their practice (median 831, IQR 574-1120) than female physicians (median 476, IQR 329-815). However, the number of female patients (median 410, IQR 264-572) and eligible female patients for cervical screening (median 278, IQR 166-394) were quite similar among the male and female physicians included in the underscreening analysis.

Overscreening versus appropriate screening

Table 1 shows that 43% (n = 350) of physicians had over-screened most of their patients. Overscreening physicians comparatively had more years of independent practice (median 22 years) than the appropriately screening physicians (median 19 years, $p = 0.01$). Overscreening physicians had more patients under their care (median 562) than appropriately screening physicians (median 437, $p < 0.001$). The number of eligible female patients aged 25-69 were also significantly higher for physicians who over-screened (median 239, $p < 0.001$).

Table 2 displays univariate and multivariable binary logistic regression modeling results for the overscreening versus appropriate screening analysis. We found that physicians with more years of practice were 1.32 times more likely to over-screen than the physicians with fewer years of practice (odds ratio [OR] 1.32, $p = 0.002$). A higher number of eligible female patients in a physician's practice was also associated with higher odds of overscreening (OR 1.22, $p = 0.04$).

Underscreening versus appropriate/over screening

There were 317 physicians included in the underscreening study; 58% were male physicians and 42% were IMGs. The median years since medical school graduation were 20 (IQR 13-27 years), and the median years of practice in Alberta were 11 (IQR 6-20 years).

Table 3 displays that underscreening physicians had fewer years of independent practice (median 11 years) than physicians who performed appropriate/over screening (median 14 years, $p = 0.03$). Underscreening physicians also had comparatively more patients under their care (median 754) than appropriate/over screening physicians (median 614, $p < 0.04$). Similarly, the number of eligible female patients aged 25-69 among underscreening physicians was significantly higher (median 289) than appropriate/over screening physicians (median 251, $p = 0.04$).

Multivariable regression showed that female physicians were less likely to under-screen their eligible patients (OR 0.68, $p = 0.04$) of. Physicians practicing in the Northeast quadrant of the city were more likely to under-screen their patients compared to other quadrants of the city (OR 3.55, $p = 0.03$). See Table 4.

Sensitivity analysis

Sensitivity analyses [24] were performed for the full regression model assessing appropriate versus overscreening, using cut-offs of 70%, 75% and 85%. Results proved comparable to those presented in Table 3. We also performed sensitivity analyses for the full regression model assessing appropriate versus underscreening, where the cut-offs used were 40% and 45%. Results proved comparable to those presented in Table 6.

Discussion

Physicians with more years of practice (OR 1.32 p value < 0.05) and those with greater number of eligible female patients are more likely to over-screen (OR 1.22 p value < 0.05). Female physicians and physicians practicing in the northeast quadrant of the city were more likely to under-screen (OR 0.68 p value < 0.05). While the number of FPs in our study who over- and underscreened was different, a variety of factors were found to be associated with both over- and underscreening, including years of practice, sex, location of practice and patient panel size. Other areas we felt warranted further discussion regarding screening include IMG country of medical school and factors that might affect screening patterns, including physician beliefs, patient preferences, and performance measures.

Years in practice

We found that physicians who over-screened (median 22, IQR 14-29) had more years of practice than those who underscreened (median 11, IQR 6-19). FPs with more years of experience began practice when annual screening was the rule. [25]. Therefore, they may not follow the most current recommendations and continue their learned habits [25]. A qualitative study of 30 Dutch primary care physicians reported that FPs are confronted with too many guidelines, as each year at least eight to ten new or updated guidelines are produced. [26] In Canada, there are more than 1,700 evidence-based clinical practice guidelines (CPGs) and approx. 900 Choosing Wisely Canada recommendations; therefore, it may be useful to regularly conduct mandatory sessions for FPs for guideline education and implementation. However, it must be done in an acceptable way [27]. The effectiveness of interactive education with active involvement and participation has been demonstrated in other studies as well. [28–30].

Sex

We also found that female physicians were less likely to under-screen their eligible female patients. Our results partially align with other Canadian and North American studies. Female physicians follow cancer screening guidelines more frequently than male physicians. In 2015, Lofters *et al.* conducted an Ontario based retrospective cohort study of 6303 FPs in Ontario using multiple datasets including the Ontario Physicians claims (billing) database, and found that female physicians were (OR = 1.80) more likely to conduct cervical cancer screening [14]. In a survey of 2000 US physicians from Texas, female physicians reported that they are more likely to discuss general health and cancer-specific prevention activities than male physicians [31]. A 2018 claim database analysis and cross-sectional study of 347 general practitioners (GPs) and 90,094 screen eligible females patients from France also reported that patients of female GPs have higher cervical cancer screening participation rates [32]. This may be explained by the fact that female primary care physicians engage in more patient-centered communication and have longer visits than their male colleagues [33].

The benefits of having a female provider for preventive healthcare, including cervical cancer screening, are well recognized [34]. Many females, especially from specific cultural and religious backgrounds (e.g., Asians and/or Muslims) are more comfortable with having a female physician perform the test due to the intimate nature of the procedure [15]. Likewise, female physicians may be more comfortable performing the test than male physicians [35].

Location of practice

There were differences in the physician-to-female 25-69 patient ratios in the different quadrants of Calgary (Additional file 2), with FPs in the Northeast having higher ratios than others, which indicates that access to FPs in different quadrants of the city differs. The Northeast quadrant of the city is comprised of a more recent immigrant population and visible minorities, while the Southwest and Northwest have populations with higher socio-economic status [21]. Variations in practice patterns based on quadrants reflect physician and population-level characteristics. Understanding the role of these geographic characteristics on screening is an area for additional research [36, 37].

Patient panel size

Both over- and underscreening physicians had a significantly higher number of eligible female patients and more female patients in their practice in general compared to appropriate screeners. Increasing panel size has been thought to have an influence on the quality of care. [38]. A cross-sectional study of 4195 FPs in Ontario reported a small association between cervical screening rates with increasing physician panel size. Practices with 3900 patients per family physician had 7.9% lower cervical screening rates than practices with 1200 patients ($p < .001$) [39]. The similar study also assessed cancer screening, chronic disease management, admissions for ambulatory care, emergency department visits and found that all measures had a lesser quality with increasing panel sizes. [39]

Discussing the pros and cons of screening and completing the cervical screening procedure by the FP is time-consuming [38]. Reducing excessive screening also requires that physicians spend more time with their patients to mitigate overuse of cervical cancer screening [16]. Family physicians who build trust and mutual respect with their patients help in reducing their patients’ misconceptions and fears and consequentially reduce the number of missed opportunities for screening and follow-up [40].

IMG country of medical school

Previous studies in Canada have reported that IMGs from Muslim countries are less likely to perform cervical cancer screening [15]. There are reported regional and cultural differences in medical school programs, where some medical schools place less emphasis on prevention [41]. Muslim priorities on privacy and modesty may make it more difficult for physicians to undertake genital examinations or for women to receive them [42]; however, we did not find such an association. This may be because most of the IMGs who began practice in Alberta in the past 20 years have either completed a residency program in Canada or had British, Irish, Australian, South African, or US postgraduate training prior to being permitted to practice in Alberta. Family physicians practicing in Alberta might thus differ from other Canadian provinces by adapting their practices to Western guidelines during their Western post-graduate medical training.

Factors affecting screening patterns

Physicians may overscreen because of strong patient demand or due to their belief that annual screening represents a standard of practice [12, 43, 44]. Physicians, particularly those with many years in practice, are less likely to change because of their comfort with the previous guidelines, hence retaining the practice of overscreening [3, 45]. Over-screening produces unnecessary follow-up and increased risk of complications [46, 47]. Alternatively, physicians who believe in low cancer risk for their patients may choose to under-screen or not screen in their practices [28]. Under-screening results in fewer earlier stage or pre-invasive cancers being detected [46].

Another factor that could affect screening patterns includes patient preferences either for frequent or infrequent screening [10, 48]. A 2018 systematic scoping review of 28 studies including 13 from Ontario and 6 from British Columbia, women's preferences were reported to be based on their perceived cervical cancer risk and the perceived benefits and barriers to screening [49]. Women with a history of sexual trauma and those with modesty issues prefer less frequent pelvic examinations and are underscreened [14, 50]. Another 2018 systematic review of 25 studies including 20 observational and 5 interventional studies (16 were conducted in the U.S) reported that women who believe that annual testing increases early detection of cervical cancer demand frequent screening, which often results in overscreening, with its consequent overdiagnosis and unnecessary procedures [46].

The screening literature has mostly concentrated on the causes of under screening. The cervical screening performance indicators and incentives also focus on under screening and increasing screening. However, screening performance measures that classify overscreening as appropriate are detrimental to the women involved and to the health care system in general. Women who are over screened, are thereby subjected to an increased risk of harm and get screened more frequently than is necessary. [16]. Monitoring cervical cancer screening performance can help in reducing the frequency of unnecessary procedures and the consequent harms of overscreening. This idea also echoes with the Choosing Wisely campaign to reduce unnecessary procedures [51].

Strengths of the study

The strength of the current study is that we used city-wide laboratory data and analyzed testing that actually had been performed and hence avoided the recall bias that occurs in self-report studies [52]. Furthermore, we used linked physicians' data from the CPSA database and the cervical screening data from the CLS database for a three-year period. We also accounted for hysterectomy rates by adjusting the denominator of the eligible female population in a physician's practice, although the effect was small.

The geographical location of the physicians is classified based on the city quadrant of practice. Using a classification based on sociodemographic distribution may be more informative. Nevertheless, using established boundaries provides the added benefit of linking this study conclusions to other studies and plan interventions to improve screening accordingly.

Limitations

Limitations of underscreening analysis versus appropriate/over screening

Our analyses would have gained in precision with more precise information on FPs' panel sizes. Since patients in Calgary do not enroll in a family practice, measuring practice size of an FP is an unclear concept and difficult to calculate. We therefore used FP laboratory test orders in 2016 to estimate physician's practice size and number of women aged 25-69 for the underscreening analysis [53].

Past studies have also used laboratory based measures to provide conservative estimates of testing and screening patterns. [54, 55] A 2019 report by the Health Quality Council of Alberta (HQCA) on FP practice sizes used the number of laboratory tests (complete blood count, thyroid-stimulating hormone, lipid profile, hemoglobin $A1_C$, and urinalysis) ordered by the physician as a measure to determine physician panel sizes [53]. It is also likely that our calculation of estimated practice size through laboratory tests is an underestimate because not all patients in an FP practice would receive a laboratory test every year.

The best approach for such studies would be to use individual physician billing data from Alberta Health; however, its access is restricted, and we were unable to obtain it. An alternate approach to estimating the total practice size for future studies would be to include all radiology and prescription data of an individual physician. This would still underestimate the practice size, given that some patients will still have no laboratory tests, radiology procedures, or prescriptions each year. A three-year period might better address this issue.

We used administrative data, so it is not possible to know why patients were or were not screened. Screening may not have been recommended for some eligible female patients, while others may have refused an offer to screen. Past studies have also used retrospective and secondary data to analyze screening uptake. [56, 57] Female patients may also go to a different physician for their cervical screening. Our data cannot measure such effects.

Data comparisons

Our analysis of overscreening versus appropriately screening physicians and underscreening versus appropriate/over screening physicians cannot be directly compared. Some physicians may have appropriately screened patients on whom we have cervical screening data but also have underscreened other patients (for whom there is no data). Likewise, individual physicians may have overscreened some of the patients and at the same time underscreened their practice population as a whole.

Generalizability

Our study included FPs from diverse geographic, sex, ethnic, and racial backgrounds, suggesting it is representative of the general population of Canadian FPs. Factors that contribute to a physician's adherence to screening guidelines are also related to the healthcare system context in which they operate. In Canada, there are no cost barriers to screening so the study results are not generalizable to other contexts where screening is not part of a universal health care plan, that have differing guidelines, and/or a different healthcare provider performing the screening. While details may differ according to the specific history of cervical screening in each country, it is likely that similar variations will occur. International comparative studies may be informative to determine the generalizability of our findings.

Conclusion

Cervical screening must be done adequately with appropriate follow-up. Ensuring that physicians recommend screening for eligible women is equally important. Improving practices using innovations in electronic records and decision aids help to change practice [58]. Various effective approaches are used to change practice: audit and feedback [58], educational outreach visits and separate staff allocated to the task of prevention guides for patients.

Continuing Medical Education (CME) improves physician performance and patient health and delivered usually through lecture and small group discussions. However, acceptability and therefore effectiveness is greater for topics the physician considers to be important; how best to proceed when physicians do not think a topic is important is unclear.

Most practice improvement efforts in Alberta, as elsewhere, focus on volunteer physicians who wish to participate, largely the ones who adopt changes early [58]. These people are already keen to follow approved practice guidelines, so efforts to improve practice may only impact them marginally except perhaps to reduce over-screening [58]. Screening guidelines are developed to help physicians make appropriate decisions for their patients. The successful implementation of these guidelines allows for the provision of appropriate screening, hence improving the quality of health care, and decreasing inappropriate care variation. Future studies can target an in-depth qualitative review of physician level barriers to inform the development of effective interventions that can change FPs practice.

Canadian national guidance are expected to be revised in 2022 and will replace Pap test by human papillomavirus DNA PCR testing for primary cervical cancer screening. [59] FPs screening behaviours identified in this paper will continue to affect uptake of screening regardless of the type of test used for cervical screening. Consistent efforts and public health education are required to overcome natural resistance to change while addressing the concerns of both providers and patients.

List Of Abbreviations

CI: confidence interval; CIHI: Canadian Institute for Health Information; CME, Continuing Medical Education; CPSA: College of Physicians and Surgeons of Alberta; CTFPHC: Canadian Task Force on Preventive Health Care; FP: family physicians; HQCA: Health Quality Council of Alberta; IMG: International Medical Graduate; IQR: interquartile range; LIS: Laboratory Information System; NE: Northeast; NW: Northwest; OR: odds ratios; SE: Southeast; SPSS: Statistical Package for the Social Sciences; SW: Southwest; US: United States

Declarations

Ethics approval and consent to participate

Ethics approval for the study was obtained from the Conjoint Health Research Ethics Board at the University of Calgary (IRISS No. REB13-0376).

Consent for publication

Not applicable.

Availability of data and materials

There are ethical restrictions on publicly sharing the data of this study. The study received exemption from informed consent, based on keeping the participants anonymity. The dataset is de-identified, but not anonymized, meaning that given the combination of some variables (demographics of the physician) individuals may identify themselves or others. Data are available upon request for researchers who meet the criteria for access to confidential de-identified information.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

SA cleaned, analyzed, and interpreted the data and wrote the initial draft of the manuscript. Authors CN, GC and JAD provided guidance in the analysis and improving the writeup of the manuscript. All authors have read and approved the final manuscript.

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Tables

Table 1: Descriptive Characteristics of over-screening and appropriate screening family physicians during 2014-2016

Variables	Categories	Over-screening vs appropriate screening N=806		
		Over n=350 (43%)	Appropriate n=456 (57%)	P value*
Sex	Female	221 (63%)	248 (54%)	0.01
	Male	129 (37%)	208 (46%)	
Type of medical graduate	Canadian	246 (70%)	342 (75%)	0.14
	IMG	104 (30%)	114 (25%)	
IMG country of medical school ^	Non-Muslim Majority	76 (73%)	70 (61%)	0.07
	Muslim Majority	28 (27%)	44 (39%)	
IMG country of medical school ^	Developed	23 (61%)	22 (61%)	0.61
	Developing	81 (61%)	92 (61%)	
City quadrant of practice	Northeast	51 (15%)	60 (13%)	0.80
	Northwest	111 (31%)	138 (31%)	
	Southeast	66 (19%)	97 (21%)	
	Southwest	122 (35%)	161 (35%)	
Years since medical school graduation	Median (IQR)	22(14-29)	19 (11-28)	0.01
Years in independent practice in Alberta	Median (IQR)	14 (8-22)	12 (6-22)	0.07
Patient panel size ^	Median (IQR)	562 (291-849)	437 (221-756)	0.00
Number of female patients ^	Median (IQR)	359 (205-561)	281 (138-475)	0.00
Number of eligible female patients for screening (25-69-year-old) ^	Median (IQR)	239 (128-381)	180 (94-329)	0.00

^ Internationally trained medical graduates (IMGs)

Total number of IMGs were used to calculate percentages of Muslim vs non-Muslim-majority countries and developed vs developing countries.

^^ estimated by total number of laboratory tests ordered by the FP in 2016

** Chi square test used for categorical variables and Mann Whitney Wilcoxon Test for continuous variables for comparisons between over screening and appropriately screening physicians*

***Over screening** comprising women who had received two or more normal cervical cytology tests during the study period 2014-2016.*

***Appropriate screening**, comprising those women who had received one cytology test during the study period 2014-2016.*

Table 2: Logistic regression analyses for over-screening versus appropriate screening by family physicians during 2014-2016

Physician Characteristics	Over screening	
	n=806	
	Unadjusted [a] OR	Adjusted [b] OR
	(95% CI)	
Female physician [1]	0.44 (0.08, 1.91)	0.80 (0.23, 1.94)
Canadian Graduates [2]	0.93 (0.27, 1.73)	0.69 (0.35, 1.34)
Medical degree from Muslim Majority Countries [3]	0.81 (0.49,1.34)	0.74 (0.36,1.92)
Medical degree from Developing Countries [4]	1.12 (0.85, 1.68)	1.03 (0.49, 2.12)
City quadrant of practice [5]		
Northeast	1.12 (0.72, 1.74)	0.98 (0.63, 1.59)
Northwest	1.06 (0.75, 1.50)	0.97 (0.67, 1.40)
Southeast	0.90 (0.61, 1.33)	0.87 (0.59, 1.29)
Years since medical school graduation	1.22* (1.10, 1.36)	1.32* (1.08, 1.97)
Years in independent practice in Alberta	1.01 (1.00, 1.03)	1.01 (0.98, 1.05)
Patient panel size	1.01 (1.00, 1.02)	1.02 (1.00, 1.02)
Number of female patients	1.02* (1.01, 1.03)	1.22* (1.08, 1.78)
Number of female patients 25-69 years	1.00 (1.00, 1.04)	0.99 (0.99, 1.07)

For the univariate and multivariable regression analysis, appropriate screening was used as the reference category.

** OR are statistically significant. CI= Confidence Interval.*

[a] Unadjusted models include only the single variable of physician characteristics studied

[b] Adjusted models include all physician characteristics described in Table 4.1

Reference categories in the model include 1 Male physician, 2 IMGs, 3 Non-Muslim majority countries, 4 Developed countries,

5 Southwest

***Over screening** comprising women who had received two or more normal cervical cytology tests during the study period 2014-2016.*

***Appropriate screening**, comprising those women who had received one cytology test during the study period 2014-2016.*

Table 3: Descriptive Characteristics of underscreening and appropriate/over screening family physicians during 2014-2016

Variables	Categories	Underscreening vs appropriate/over screening		
		N=317		
		Under	Appropriate/over	P value*
		n=133 (42%)	n=184 (58%)	
Sex	Female	98 (74%)	126 (68%)	0.03
	Male	35 (26%)	58 (32%)	
Type of medical graduate	Canadian	54 (41%)	150 (82%)	0.83
	IMG*	79 (59%)	34 (18%)	
IMG country of medical school ^	Non-Muslim Majority	53 (67%)	19 (56%)	0.26
	Muslim Majority	26 (33%)	15 (44%)	
IMG country of medical school ^	Developed	17 (22%)	4 (12%)	0.22
	Developing	62 (78%)	30 (88%)	
City quadrant of practice	Northeast	31 (23%)	25 (14%)	0.02
	Northwest	34 (26%)	52 (28%)	
	Southeast	26 (19%)	44 (24%)	
	Southwest	42 (32%)	63 (34%)	
Years since medical school graduation	Median (IQR)	19 (11-26)	21 (13-31)	0.04
Years in independent practice in Alberta	Median (IQR)	11 (6-19)	14 (6-21)	0.03
Patient panel size ^	Median (IQR)	754 (459-1029)	614 (381-969)	0.04
Number of female patients ^	Median (IQR)	432 (270-624)	361(252-525)	0.05
Number of eligible female patients for screening (25-69-year-old) ^	Median (IQR)	289 (170-423)	251 (161-371)	0.04

- Internationally trained medical graduates (IMGs)

^Total number of IMGs were used to calculate percentages of Muslim vs non-Muslim-majority countries and developed vs developing countries.

^^ estimated by total number of laboratory tests ordered by the FP in 2016

**Chi square test used for categorical variables and Mann Whitney Wilcoxon Test for continuous variables for comparisons between over screening and appropriately screening physicians; and underscreening and appropriately screening physicians.*

***Overscreening** comprising women who had received two or more normal cervical cytology tests during the study period 2014-2016.*

***Appropriate screening**, comprising those women who had received one cytology test during the study period 2014-2016.*

***Underscreening**, defined as women with no screening performed during the 3 years*

Table 4: Logistic regression analyses for underscreening versus appropriate/over screening family physicians during 2014-2016

Physician Characteristics (n=317)	Underscreening n=317	
	Unadjusted [a] OR (95% CI)	Adjusted [b] OR
Female physician [1]	0.78* (0.48, 0.97)	0.68 * (0.35, 1.38)
Canadian Graduates [2]	1.01 (0.99, 1.03)	1.90 (0.85, 4.19)
Medical degree from Muslim Majority Countries [3]	1.38 (0.58, 3.32)	1.57 (0.57, 3.78)
Medical degree from Developing Countries [4]	1.07 (0.55, 2.09)	1.32 (0.35, 4.96)
City quadrant of practice [5]		
Northeast	2.18* (1.07, 4.17)	3.55* (1.22, 5.31)
Northwest	1.07 (0.57, 2.02)	1.06 (0.54, 2.08)
Southeast	0.66 (0.32, 1.35)	0.68 (0.32, 1.44)
Years since medical school graduation	1.02* (1.02, 1.05)	1.06 (1.00, 1.11)
Years in independent practice in Alberta	1.01 (0.99, 1.03)	0.97 (0.92, 1.02)
Patient panel size	1.00 (1.00, 1.00)	0.99 (1.00, 1.00)
Number of female patients	1.00 (1.00, 1.00)	0.98 (0.98, 1.00)
Number of female patients 25-69 years	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)

For the univariate and multivariate regression analysis, appropriate/over screening was used as the reference category.

** OR are statistically significant. CI= Confidence Interval.*

[a] *Unadjusted models include only the single variable of physician characteristics studied*

[b] *Adjusted models include all physician characteristics described in Table 4.4*

Reference categories in the model include [1] Male physician, [2] IMGs, [3] Non-Muslim majority countries, [4] Developed countries, [5] Southwest

***Overscreening** comprising women who had received two or more normal cervical cytology tests during the study period 2014-2016.*

***Appropriate screening**, comprising those women who had received one cytology test during the study period 2014-2016.*

***Underscreening**, defined as women with no screening performed during the 3 years*

Figures

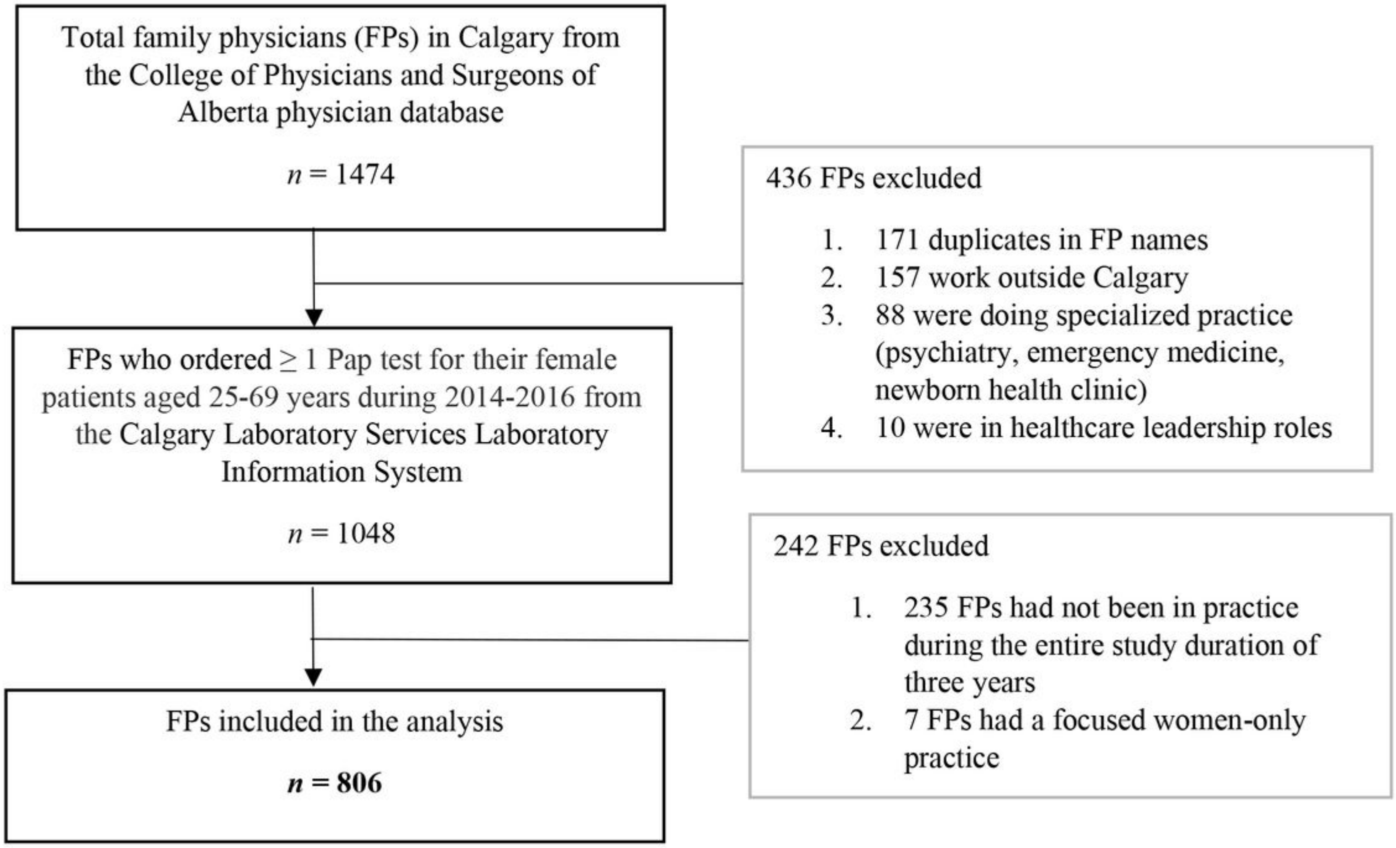

Figure 1

Study Flow Diagram for over screening versus appropriate screening analysis

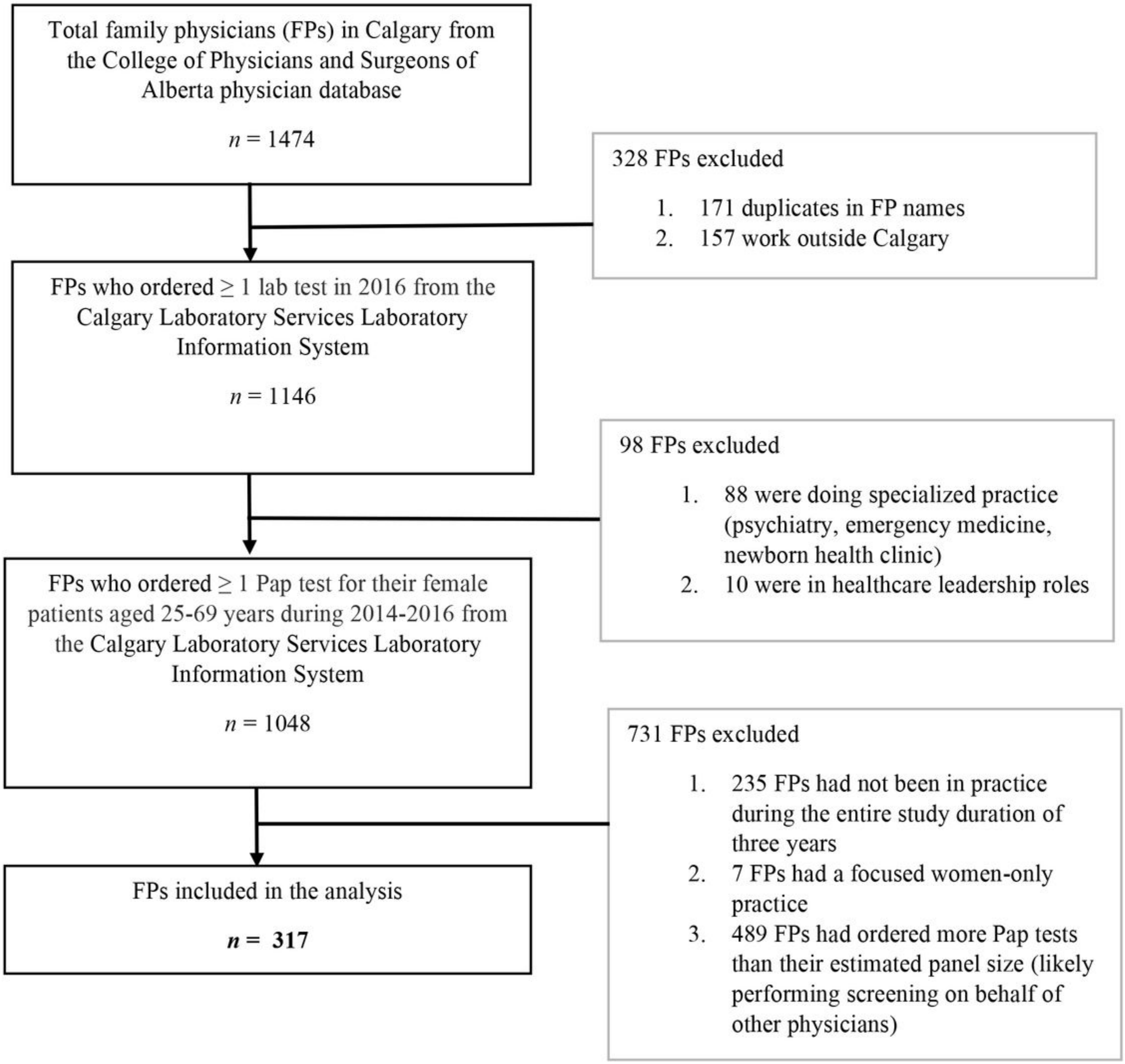

Figure 2

Study Flow Diagram for Underscreening versus appropriate/over screening analysis

Supplementary Files

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