The effect of comorbidity on primary care use during breast cancer chemotherapy

A population-based retrospective cohort study using CanIMPACT data

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Competing Interests:

No competing interests to declare.

Abstract:

BACKGROUND: Breast cancer patients visit their primary care physicians (PCPs) more often during chemotherapy compared to before their breast cancer diagnosis. However, It is unclear why PCP visits increase and what the role of PCPs is during chemotherapy. We assessed the association between physical comorbidities and/or mental health history (MHH) and the change in PCP use during adjuvant breast cancer chemotherapy.

METHODS: We conducted a population-based, retrospective cohort study of women diagnosed with stage I-III breast cancer in Ontario during 2007-2011 who received surgery and adjuvant chemotherapy. The primary outcome was the difference in the 6-month rate of PCP visits at baseline and during treatment.

RESULTS: Six-month PCP visit rate increased during chemotherapy (mean 2.3 visits at baseline, 3.4 visits during chemotherapy). During treatment, the adjusted 6-month rate of PCP visits more than doubled in the lowest physical comorbidity/no MHH group compared to the baseline rate (Rate Ratio (RR) 2.52, 95%CI 2.43-2.61). This increase was lower in those with MHH (RR 1.81, 95%CI 1.68-1.96) and in the highest physical comorbidity group (RR 1.16, 95%CI 1.07-1.28).

INTERPRETATION: Breast cancer patients with more physical comorbidities and/or MHH have a higher frequency of PCP visits during adjuvant chemotherapy but lower absolute and relative increases in visits compared to baseline. This could be due to a ceiling effect. Primary care providers can expect to see their patients with fewer physical comorbidities and/or no MHH more often during chemotherapy. It is therefore important for PCPs to be prepared to provide breast cancer-related care during chemotherapy.

Keywords: breast neoplasms, primary health care, population health

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Introduction:

Breast cancer is the most commonly diagnosed cancer among women worldwide and the second most common cause of cancer death for women in developed regions of the world,(1) including Canada.(2) In 2018, just under 12,000 women were diagnosed with breast cancer in Ontario alone.(3) Treatment for breast cancer often involves surgery and sometimes includes adjuvant chemotherapy (given after surgery) in order to reduce the risk of recurrence. In 2007 to 2012, 76% of Canadian women with stages I-III breast cancer received surgical treatment, and in Ontario, 43.4% of these women also received adjuvant chemotherapy.(4)

Breast cancer patients frequently visit their primary care physicians (PCPs) during the course of their cancer journey.(5) A PCP can expect to see an average of one new case of breast cancer in their practice in any given year.(6) While the role of PCPs during prevention, screening, diagnosis, survivorship and end-of-life care has been relatively well-established, the role of PCPs during breast cancer treatment is less clear.(6)

Despite the lack of a clear role for PCPs during breast cancer treatment, breast cancer patients have been shown to visit their PCPs more often when they are receiving adjuvant chemotherapy compared to before their breast cancer diagnosis.(7-9)The reasons for this remain unclear. Previous qualitative work with providers suggests that PCPs' main roles in caring for cancer patients are not to manage urgent issues during chemotherapy, but rather to coordinate care, manage comorbidities and provide psychosocial care.(10) It is possible, then, that breast cancer patients see their PCPs more often

while they are undergoing chemotherapy due to increased concerns related to management of the patients' physical and/or mental comorbidities during this time.

In our study, we aimed to determine how physical and/or mental comorbidity affect the increase in PCP use during adjuvant breast cancer chemotherapy. We hypothesized that patients with high levels of physical and/or mental comorbidity would show the greatest increases in PCP use during adjuvant chemotherapy.

Methods:

Study design

We performed a population-based, retrospective cohort study using linked provincial-level administrative health databases housed at ICES.(11) This study was performed on the Ontario cohort of a larger, nationwide cohort study (the Canadian Team to Improve Community-Based Cancer Care along the Continuum – CanIMPACT).(12) Approval was received from the University of Toronto research ethics board.

Study population

We included women over 18 years of age diagnosed with stage I-III breast cancer from Jan 1, 2007 to Dec 31, 2011 (to allow for at least 5 full years of follow-up data used in other CanIMPACT studies (13,14)) who underwent potentially curative surgery and adjuvant chemotherapy. We excluded patients who had a previous history of cancer, were diagnosed with a new primary cancer within 14 months of breast cancer diagnosis, had received neoadjuvant chemotherapy, had received radiation therapy prior to adjuvant chemotherapy, or were living in a long-term care (LTC) facility at diagnosis.

Variables and data sources

For our main outcome variable, we examined the difference in the 6-month rate of PCP visits during a 24-month baseline period (the 6 to 30 months before diagnosis) and the 6-month treatment period (6 months from the start of adjuvant chemotherapy). Visits that took place in emergency department or inpatient locations were excluded. Diagnostic codes were noted. Visits were considered cancer-related if the diagnostic code was listed as female or male breast neoplasm, other malignant neoplasm, breast carcinoma in situ, or adverse drug effect.

Our main predictor variables were physical comorbidity and/or mental health history (MHH). We determined physical comorbidity level using the Johns Hopkins Aggregated Diagnosis Groups (ADGs)(15) and excluding psychosocial ADGs. ADGs are groups of similar conditions based on characteristics such as condition duration, severity, and specialty care involvement.(16) We categorized physical comorbidity into low (0-5 ADGs), medium (6-9 ADGs), and high (10+ ADGs) levels, similar to a previous CanIMPACT study.(17) We determined MHH by whether a patient had any PCP visits during the baseline period associated with previously-validated mental health diagnostic codes.(18)

Variables considered potential confounders in our study included age at diagnosis, immigration status (non-immigrants were classified as long-term residents who are Canadian-born citizens or immigrants arriving to Canada prior to 1985), income quintile based on neighbourhood income, rurality, regional health district (one of fourteen Local Health Integration Networks (LHINs) in Ontario), primary care continuity, and primary care practice type. Primary care continuity was measured using the Usual Provider of Care (UPC) index:(19) the proportion of visits to the most-often-visited PCP during the 2-year baseline interval, for patients with at least 3 visits to any PCP during that interval. As such, continuity of primary care was divided into the following categories: 0 PCP visits, 1-2 PCP visits, low continuity (UPC ≤0.75) and high continuity (UPC >0.75). Primary care practice type was determined by enrollment in a particular funding model at the time of diagnosis ('team-based capitation' for inter-professional teams

with physicians paid primarily by capitation, 'enhanced fee-for-service (FFS)' paid primarily by FFS with some capitation, 'capitation', 'straight FFS' for those not enrolled in a primary care model, and 'other'). Databases used to obtain data elements are shown in Appendix A.

Statistical analysis

We used Wilcoxon rank sum tests and Kruskall-Wallis analysis of variance to compare mean ranks of PCP visit rates across patient characteristics. We used difference-in-difference methodology (20) to examine the difference in the change of PCP visit rates between baseline and treatment periods across physical comorbidity and MHH groups. We included potential confounders in a multivariable negative binomial regression analysis using generalized estimating equations (GEE) with unstructured covariance to account for repeated measures. We included an offset term in our negative binomial model to account for differences in the exposure time of the baseline and treatment periods. All analyses were performed using SAS software, version 9.4.(21) A p-value of less than 0.05 was considered statistically significant.

Results:

Our cohort consisted of 12,781 women (Table 1). Those in the higher physical comorbidity groups were more likely to be older, live in urban areas, be immigrants, have low continuity of care, be in an enhanced FFS model, and have a MHH. Those with a MHH were more likely to be younger, live in urban areas, be non-immigrants, be in an enhanced FFS model, and have a higher number of physical comorbidities. There were 42 participants (0.3%) with missing values for at least one demographic characteristics. These were treated as missing completely at random.

The mean number of PCP visits at baseline was 0.39 visits per month (2.34 visits over 6 months) (figure 1). The mean number of PCP visits during treatment was 0.56 visits per month (3.36 visits over 6 months).

Approximately 6% of patients did not see any PCP at baseline. During treatment, this proportion increased to 15%. There were 247 (1.9%) patients who had no PCP visits at baseline or during treatment. Despite this, overall PCP visit rates increased from baseline to treatment periods across all groups of baseline characteristics (mean 6-month PCP visit increase of 1.0) (table 2). The greatest increases in PCP visit rates from baseline to treatment occurred in those with <3 PCP visits at baseline, and those living in remote or very remote rural locations (mean 6-month visit increase of 1.8-2.9).

Those with higher physical comorbidity level/MHH had higher PCP visit rates during both baseline and treatment compared to low physical comorbidity/no MHH groups (6-month PCP visit rates higher by 4.2/1.7 at baseline and 2.5/1.1 during treatment); however, the absolute increases in PCP visit rates in the high physical comorbidity/MHH groups were less than those with low physical comorbidity/no MHH (mean increases lower by 1.6/0.6 PCP visits per 6 months) (table 2).

In our multivariable model (figure 2, detailed results in appendix B), we found that, during treatment, the adjusted 6-month PCP visit rate more than doubled in the lowest physical comorbidity and no MHH group compared to the baseline rate (RR 2.52, 95% CI 2.43-2.61). Having a MHH was associated with a lower increase in PCP visits during the treatment period (RR 1.81, 95% CI 1.68-1.96). Those in the highest physical comorbidity group demonstrated an even lower increase in PCP visits (RR 1.16, 95% CI 1.07-1.28).

Patients were seen by their PCPs during the baseline and treatment periods for various reasons (table 4). Prior to their breast cancer diagnosis, patients most often saw their PCP for hypertension, anxiety, annual health examinations, upper respiratory tract infections and diabetes. During adjuvant

chemotherapy, patients most often saw their PCP for breast cancer-related concerns, with other reasons remaining similar to their pre-diagnosis visits. Breast cancer-related concerns made up 39.6% of PCP visits during treatment (28.8% in the high physical comorbidity group, and 45.9% in the low physical comorbidity group). Adding anxiety as a breast cancer-related concern increased this proportion to 45.9% (35.7% in the high physical comorbidity group, and 51.6% in the low comorbidity group).

Interpretation:

Our study is the first to examine the effect of physical comorbidity and MHH on the change in PCP visits during breast cancer treatment. Similar to previous studies,(7-9) in this population-based cohort of women in Ontario with breast cancer, we found that the absolute number of PCP visits over 6 months increased from 2.3 at baseline to 3.4 during adjuvant chemotherapy. In our adjusted analyses, we found that, while women with high physical comorbidity and/or MHH had more visits during baseline and treatment periods, the increase in PCP visits from baseline to treatment periods was lower than those with low physical comorbidity and/or no MHH.

Our findings could be due to a "ceiling effect" – where those with high physical comorbidity and/or MHH already had a relatively saturated number of PCP visits at baseline with little room for increasing visits during the treatment period. Alternatively, those with a low number of PCP visits at baseline, who are more likely to be those with low comorbidity levels, may be less familiar with the healthcare system and require more PCP visits during treatment for care coordination and navigation. Several studies have shown that physical and mental comorbidities increase after breast cancer diagnosis.(22-26) Therefore, another reason for this association could be that those with low physical comorbidity and/or no MHH at baseline develop more comorbidities and/or mental health issues, or have more of these issues identified, during chemotherapy, which would require additional primary care

management. Future research should examine how increasing comorbidity after breast cancer diagnosis might influence PCP visits during treatment.

However, our results need to be interpreted in light of several possible limitations. First, physician billings data do not provide detailed clinical information for PCP visits. While we identified the number of visits with a breast cancer diagnostic code, future research should examine the details of these visits in order to identify the specific issues during chemotherapy that are being addressed by PCPs. Second, the CanIMPACT cohort used in this study involved patients diagnosed from 2007 to 2011. While the principles of breast cancer treatment have not dramatically changed since 2011,(27) and no major primary care reform has occurred in Ontario since then,(28) we need to consider that trends in PCP visits during chemotherapy may have shifted since these patients were treated.

Overall, PCPs can expect breast cancer patients to have one additional visit over six months after starting adjuvant chemotherapy compared to their baseline rate. PCPs can plan for their patients with high physical comorbidity and/or MHH to continue having appointments at a high rate while they undergo chemotherapy and they can expect their patients with low physical comorbidity and/or no MHH to increase the frequency of their visits during chemotherapy, with forty percent of these visits being related to their breast cancer diagnosis. It is therefore important for PCPs to be aware of, and be able to provide management strategies for, issues that may arise during chemotherapy.

One way to help PCPs in managing issues during chemotherapy is to implement shared care initiatives between PCPs and oncologists. For example, faxing chemotherapy information to PCPs can increase PCP confidence in managing chemotherapy effects.(29) Additionally, CanIMPACT has launched a trial of eOncoNote, an asynchronous communications tool imbedded within the larger eConsult platform,(30) aimed at improving communication between PCPs and oncologists.(31) Incorporating

these or other interventions to improve shared care during chemotherapy can assist PCPs in managing the increased visits during this time.

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Table 1. Physical and mental comorbidity levels stratified by cohort characteristics

	Total N= 12,781	Physical Co-morbidity Level			P value	Mental Comorbidity		P value
		0-5 ADGs (low) N= 7,287	6-9 ADGs (medium) N= 4,425	10+ ADGs (high) N= 1,069		Yes N=4,127	No N=8,654	
Age at diagnosis (years)								
<40	1,102 (8.6%)	639 (8.8%)	374 (8.5%)	89 (8.3%)	<0.001	349 (8.5%)	753 (8.7%)	0.008
40-49	3,481 (27.2%)	2,177 (29.9%)	1,092 (24.7%)	212 (19.8%)		1,134 (27.5%)	2,347 (27.1%)	
50-59	4,225 (33.1%)	2,500 (34.3%)	1,417 (32.0%)	308 (28.8%)		1,404 (34.0%)	2,821 (32.6%)	
60-69	3,045 (23.8%)	1,581 (21.7%)	1,155 (26.1%)	309 (28.9%)		985 (23.9%)	2,060 (23.8%)	
70-74	607 (4.7%)	262 (3.6%)	239 (5.4%)	106 (9.9%)		180 (4.4%)	427 (4.9%)	
>74	321 (2.5%)	128 (1.8%)	148 (3.3%)	45 (4.2%)		75 (1.8%)	246 (2.8%)	
Urban/rural Residence								
Urban	11,189 (87.5%)	6,254 (85.8%)	3,957 (89.4%)	978 (91.5%)	<0.001	3,677 (89.1%)	7,512 (86.8%)	0.06
Rural	699 (5.5%)	450 (6.2%)	213 (4.8%)	36 (3.4%)		199 (4.8%)	500 (5.8%)	
Rural-remote	596 (4.7%)	392 (5.4%)	168 (3.8%)	36 (3.4%)		170 (4.1%)	426 (4.9%)	
Rural-very remote	292-297 (2.3%)	187-192 (2.6%)	85-90 (1.9-2.0%)	15-20 (1.4-1.9%)		80-85 (1.9-2.1%)	210-215 (2.4-2.5%)	
Rural-unknown	*	*	*	*		*	*	
Unknown	*	*	*	*		*	*	
Immigration Status								
Long-term residents	11,075 (86.7%)	6,384 (87.6%)	3,775 (85.3%)	916 (85.7%)	0.001	3,636 (88.1%)	7,439 (86.0%)	<0.001
Immigrants	1,706 (13.3%)	903 (12.4%)	650 (14.7%)	153 (14.3%)		491 (11.9%)	1,215 (14.0%)	
Neighbourhood Income Quintile					0.073			0.09
1 (lowest)	2,020 (15.8%)	1,121 (15.4%)	705 (15.9%)	194 (18.1%)		685 (16.6%)	1,335 (15.4%)	
2	2,384 (18.7%)	1,376 (18.9%)	792 (17.9%)	216 (20.2%)		786 (19.0%)	1,598 (18.5%)	

	Total N= 12,781	Physical Co-morbidity Level			P value	Mental Comorbidity		P value
		0-5 ADGs (low) N= 7,287	**6-9 ADGs (medium)** N= 4,425	**10+ ADGs (high)** N= 1,069		**Yes** N=4,127	**No** N=8,654	
3	2,523 (19.7%)	1,433 (19.7%)	879-883 (20.0%)	207-211 (19.4-19.7%)		839 (20.3%)	1,684 (19.5%)	
4	2,819 (22.1%)	1,598 (21.9%)	980 (22.1%)	241 (22.5%)		867 (21.0%)	1,952 (22.6%)	
5 (highest)	2,994 (23.4%)	1,733 (23.8%)	1,051 (23.8%)	210 (19.6%)		934 (22.6%)	2,060 (23.8%)	
Unknown	41 (0.3%)	26 (0.4%)	10-15 (0.2-0.3%)	*		16 (0.4%)	25 (0.3%)	
Baseline Continuity of Care								
0 visit	800 (6.3%)	788 (10.8%)	7-12 (0.2-0.3%)	*	<0.001	18 (0.4%)	782 (9.0%)	<0.001
1-2 visits	1,536 (12.0%)	1,472 (20.2%)	59-64 (1.3-1.4%)	*		149 (3.6%)	1,387 (16.0%)	
UPC<=0.75 (low)	3,914 (30.6%)	1,773 (24.3%)	1,661 (37.5%)	480 (44.9%)		1,486 (36.0%)	2,428 (28.1%)	
UPC>0.75 (high)	6,531 (51.1%)	3,254 (44.7%)	2,695 (60.9%)	582 (54.4%)		2,474 (59.9%)	4,057 (46.9%)	
Primary Care Practice Model								
Straight FFS	1,887 (14.8%)	1,193 (16.4%)	568 (12.8%)	126 (11.8%)	<0.001	562 (13.6%)	1,325 (15.3%)	<0.001
Enhanced FFS	6,281 (49.1%)	3,212 (44.1%)	2,394 (54.1%)	675 (63.1%)		2,213 (53.6%)	4,068 (47.0%)	
Capitation	2,235 (17.5%)	1,326 (18.2%)	763 (17.2%)	146 (13.7%)		714 (17.3%)	1,521 (17.6%)	
Team-based capitation	2,206 (17.3%)	1,434 (19.7%)	658 (14.9%)	114 (10.7%)		608 (14.7%)	1,598 (18.5%)	
Other	172 (1.3%)	122 (1.7%)	42 (0.9%)	8 (0.7%)		30 (0.7%)	142 (1.6%)	
Regional health district (LHIN)					<0.001			<0.001
Erie St. Clair	713 (5.6%)	396 (5.4%)	256 (5.8%)	61 (5.7%)		259 (6.3%)	454 (5.2%)	
South West	992 (7.8%)	623 (8.5%)	302 (6.8%)	67 (6.3%)		312 (7.6%)	680 (7.9%)	
Waterloo Wellington	654 (5.1%)	436 (6.0%)	188 (4.2%)	30 (2.8%)		180 (4.4%)	474 (5.5%)	

	Total N= 12,781	Physical Co-morbidity Level			P value	Mental Comorbidity		P value
		0-5 ADGs (low) N= 7,287	**6-9 ADGs (medium)** N= 4,425	**10+ ADGs (high)** N= 1,069		**Yes** N=4,127	**No** N=8,654	
Hamilton Niagara Haldimand Brant	1,468 (11.5%)	906 (12.4%)	471 (10.6%)	91 (8.5%)		454 (11.0%)	1,014 (11.7%)	
Central West	543 (4.2%)	248 (3.4%)	226 (5.1%)	69 (6.5%)		180 (4.4%)	363 (4.2%)	
Mississauga Halton	750 (5.9%)	393 (5.4%)	273 (6.2%)	84 (7.9%)		226 (5.5%)	524 (6.1%)	
Toronto Central	1,061 (8.3%)	554 (7.6%)	405 (9.2%)	102 (9.5%)		398 (9.6%)	663 (7.7%)	
Central	1,784 (14.0%)	886 (12.2%)	712 (16.1%)	186 (17.4%)		550 (13.3%)	1,234 (14.3%)	
Central East	1,710 (13.4%)	923 (12.7%)	615 (13.9%)	172 (16.1%)		570 (13.8%)	1,140 (13.2%)	
South East	520 (4.1%)	349 (4.8%)	137 (3.1%)	34 (3.2%)		139 (3.4%)	381 (4.4%)	
Champlain	1,335 (10.4%)	784 (10.8%)	453 (10.2%)	98 (9.2%)		460 (11.1%)	875 (10.1%)	
North Simcoe Muskoka	518-522 (4.1%)	325-329 (4.5%)	170-174 (3.8-3.9%)	14-18 (1.3-1.7%)		177-181 (4.3-4.4%)	338-342 (3.9-4.0%)	
North East	478 (3.7%)	301 (4.1%)	146 (3.3%)	31 (2.9%)		157 (3.8%)	321 (3.7%)	
North West	252 (2.0%)	157 (2.2%)	69 (1.6%)	26 (2.4%)		62 (1.5%)	190 (2.2%)	
Unknown	*	*	*	*		*	*	
Mental comorbidity	4,127 (32.3%)	1,730 (23.7%)	1,810 (40.9%)	587 (54.9%)	<0.001			
Physical ADGs								
0-5	7,287 (57.01%)					1,730 (41.9%)	5,557 (64.2%)	<0.001
6-9	4,425 (34.62%)					1,810 (43.9%)	2,615 (30.2%)	
10+	1,069 (8.36%)					587 (14.2%)	482 (5.6%)	

* denotes too few cases to report. Ranges provided in associated rows/columns in order to prevent re-identification of small cells as per ICES policy.
UPC: usual provider of care index
LHIN: Local Health Integration Network

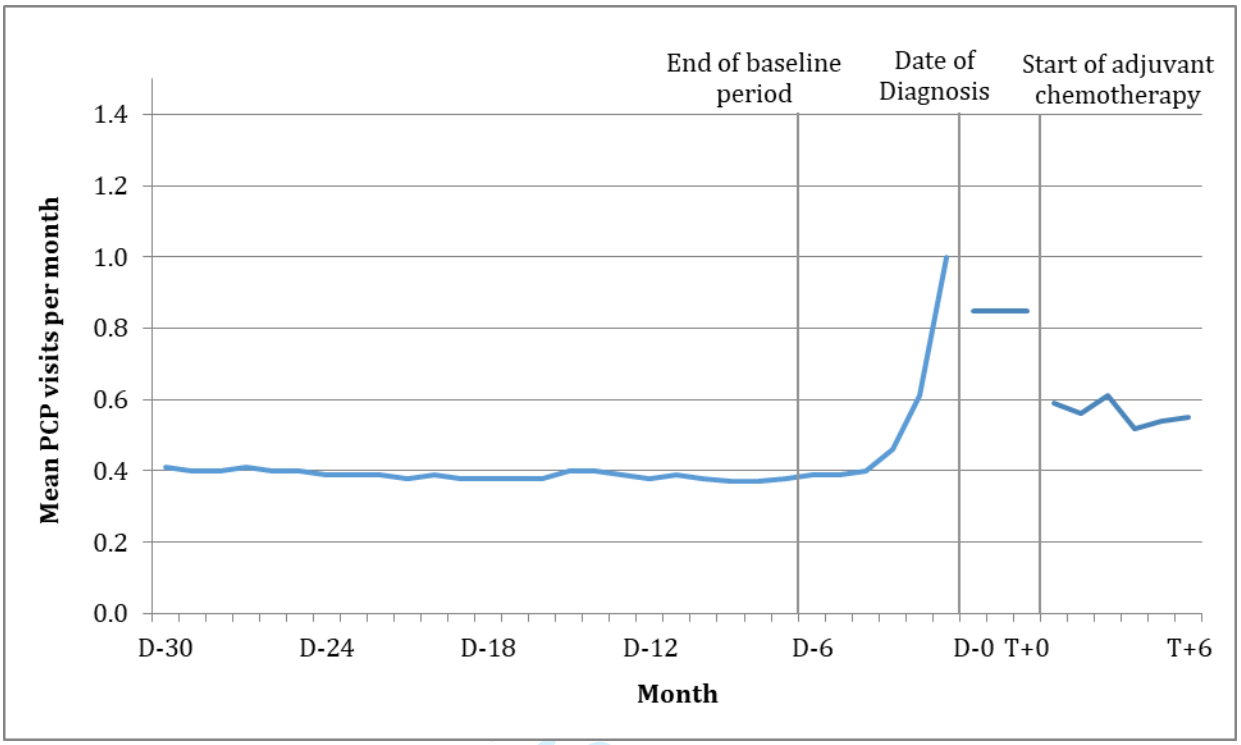

Figure 1. Mean PCP visits per month prior to diagnosis and during adjuvant chemotherapy
D[n]=number of months prior to diagnosis date
T[n]=number of months from start of adjuvant chemotherapy
Median number of days between date of diagnosis and start of adjuvant chemotherapy=91 days.

Table 2. Mean PCP visits (per 6 months) during baseline and treatment periods stratified by cohort characteristics

	Total N= 12,781	Mean (SD)/4* baseline PCP visits	P value	Mean (SD) treatment PCP visits	P value	Difference (treatment – baseline) Mean (SD)	P value
Total		2.3 (2.5)		3.4 (3.4)		1 (3.3)	
Age at diagnosis (years)			<0.0001		<0.0001		0.3662
<40	1,102 (8.6%)	2.2 (2.2)		3 (3.7)		0.87 (3.6)	
40-49	3,481 (27.2%)	2.1 (2.3)		3.1 (3.1)		1 (3.1)	
50-59	4,225 (33.1%)	2.3 (2.6)		3.3 (3.1)		1 (3.2)	
60-69	3,045 (23.8%)	2.5 (2.5)		3.6 (3.4)		1 (3.4)	
70-74	607 (4.7%)	3.1 (2.6)		4.2 (3.8)		1 (3.3)	
>74	321 (2.5%)	3 (2.7)		4.4 (4.9)		1.3 (4.8)	
Urban/rural Residence			<0.0001		<0.0001		<0.0001

	Total N= 12,781	Mean (SD)/4* baseline PCP visits	P value	Mean (SD) treatment PCP visits	P value	Difference (treatment – baseline) Mean (SD)	P value
Urban	11,189 (87.5%)	2.4 (2.5)		3.3 (3.3)		0.89 (3.2)	
Rural	699 (5.5%)	2 (2.2)		3.5 (3.6)		1.5 (3.7)	
Rural-remote	596 (4.7%)	1.7 (1.7)		3.5 (3.8)		1.8 (3.8)	
Rural-very remote	292-297 (2.3%)	1.7 (1.9)		4.7 (4.2)		2.9 (4.3)	
Rural-unknown	<=5	**		**		**	
Unknown	<=5	**		**		**	
Immigration Status			0.0439		0.2578		0.0079
Long-term residents	11,075 (86.7%)	2.3 (2.5)		3.4 (3.4)		1 (3.3)	
Immigrants	1,706 (13.3%)	2.5 (2.2)		3.3 (3.1)		0.82 (3.1)	
Neighbourhood Income Quintile			0.0028		<0.0001		0.2246
1 (lowest)	2,020 (15.8%)	2.4 (2.3)		3.5 (3.6)		1.1 (3.5)	
2	2,384 (18.7%)	2.3 (2.4)		3.5 (3.4)		1.1 (3.3)	
3	2,523 (19.7%)	2.4 (2.5)		3.5 (3.3)		1 (3.2)	
4	2,819 (22.1%)	2.3 (2.4)		3.4 (3.3)		1 (3.3)	
5 (highest)	2,994 (23.4%)	2.2 (2.7)		3.1 (3.3)		0.91 (3.3)	
Unknown	41 (0.3%)	2.2 (1.5)		3.9 (3.5)		1.7 (3.2)	
Stage			0.7891		0.8486		0.5796
Stage I	2,839 (22.2%)	2.3 (2.2)		3.4 (3.2)		1.1 (3.2)	
Stage II	7,311 (57.2%)	2.4 (2.4)		3.3 (3.3)		0.99 (3.2)	
Stage III	2,631 (20.6%)	2.3 (2.9)		3.4 (3.7)		1 (3.7)	
Baseline Continuity of Care			<0.0001		<0.0001		<0.0001
0 visit	800 (6.3%)	0 (0)		2.1 (2.7)		2.1 (2.7)	
1-2 visits	1,536 (12.0%)	0.39 (0.12)		2.1 (2.4)		1.8 (2.4)	
UPC<=0.75 (low)	3,914 (30.6%)	2.8 (2.5)		3.6 (3.5)		0.74 (3.6)	

	Total N= 12,781	Mean (SD)/4* baseline PCP visits	P value	Mean (SD) treatment PCP visits	P value	Difference (treatment – baseline) Mean (SD)	P value
UPC>0.75 (high)	6,531 (51.1%)	2.8 (2.5)		3.7 (3.4)		0.88 (3.3)	
Primary Care Practice Model			<0.0001		<0.0001		<0.0001
Straight FFS	1,887 (14.8%)	2.1 (2.7)		3.2 (3.4)		1.1 (3.4)	
Enhanced FFS	6,281 (49.1%)	2.7 (2.7)		3.6 (3.4)		0.88 (3.3)	
Capitation	2,235 (17.5%)	2.1 (2.1)		3 (3.1)		0.85 (3.1)	
Team-based capitation	2,206 (17.3%)	1.7 (1.9)		3.2 (3.3)		1.5 (3.4)	
Other	172 (1.3%)	1.3 (1.6)		2.4 (3.2)		1.1 (3)	
Regional health district (LHIN)			<0.0001		<0.0001		<0.0001
Erie St. Clair	713 (5.6%)	2.4 (2.5)		3.4 (3.7)		1.1 (3.5)	
South West	992 (7.8%)	2.1 (2)		3.8 (3.2)		1.8 (3.2)	
Waterloo Wellington	654 (5.1%)	1.7 (1.8)		2.7 (3)		1 (2.7)	
Hamilton Niagara Haldimand Brant	1,468 (11.5%)	2.1 (2.2)		3.5 (3.1)		1.4 (3)	
Central West	543 (4.2%)	3 (2.4)		3.5 (3.1)		0.46 (3.1)	
Mississauga Halton	750 (5.9%)	2.6 (2.4)		2.8 (3.1)		0.21 (3)	
Toronto Central	1,061 (8.3%)	2.5 (3.2)		3 (3.3)		0.47 (3.2)	
Central	1,784 (14.0%)	2.7 (2.7)		3.2 (3)		0.52 (3.3)	
Central East	1,710 (13.4%)	2.6 (2.4)		3.4 (3.5)		0.85 (3.4)	
South East	520 (4.1%)	2 (2.1)		3.1 (3.5)		1.2 (3.5)	
Champlain	1,335 (10.4%)	2.1 (2.6)		3.9 (3.3)		1.8 (2.9)	
North Simcoe Muskoka	518-522 (4.1%)	2.3 (2.9)		3 (2.7)		0.7 (3.5)	
North East	478 (3.7%)	2 (1.9)		3.1 (3.9)		1.1 (3.6)	
North West	252 (2.0%)	1.9 (1.8)		4.4 (5.6)		2.5 (5.6)	
Unknown	<=5	**		**		**	
Physical comorbidities			<0.0001		<0.0001		<0.0001
0-5 physical ADGs (low)	7,287 (57.1%)	1.4 (1.7)		2.8 (3)		1.4 (3)	
6-9 physical ADGs (medium)	4,425 (34.6%)	3.2 (2.3)		3.8 (3.4)		0.66 (3.4)	

	Total N= 12,781	Mean (SD)/4* baseline PCP visits	P value	Mean (SD) treatment PCP visits	P value	Difference (treatment – baseline) Mean (SD)	P value
10+ physical ADGs (high)	1,069 (8.4%)	5.6 (3.4)		5.3 (4.2)		-0.2 (4)	
Mental health history			<0.0001		<0.0001		<0.0001
Yes	4,127 (32.3%)	3.5 (3.1)		4.1 (3.8)		0.58 (3.7)	
No	8,654 (67.7%)	1.8 (1.9)		3 (3.1)		1.2 (3.1)	

* mean baseline PCP visits divided by 4 in order to obtain 6-month visit rate
** denotes too few cases to report
UPC: usual provider of care index
LHIN: Local Health Integration Network

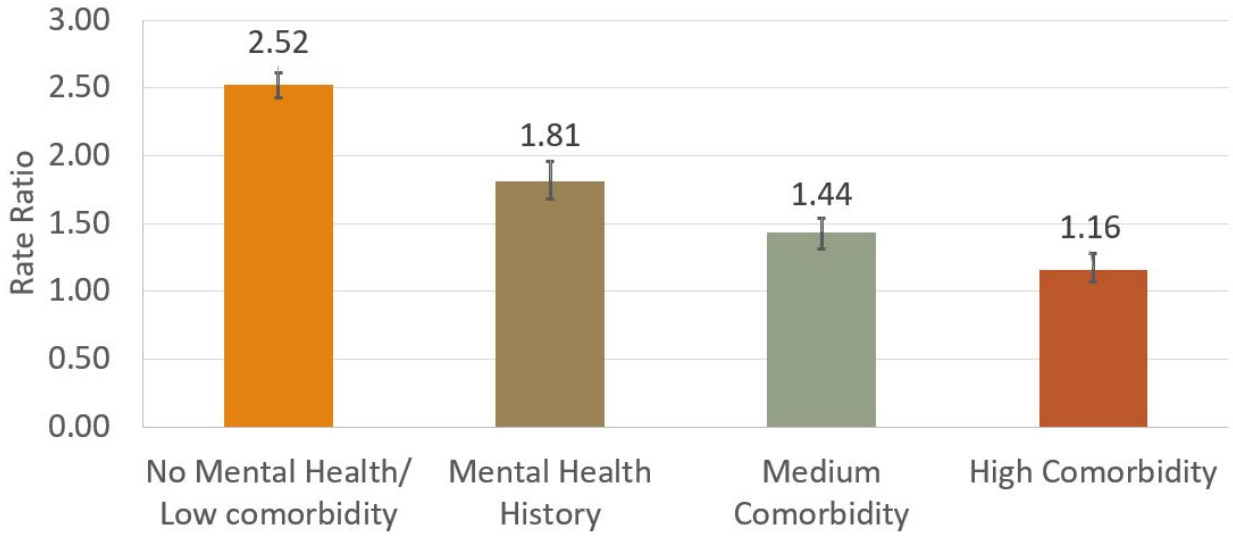

Figure 2. Relative increase in PCP visit rates from baseline to treatment periods (rate ratio) by mental health and physical comorbidity groups – adjusted for: age, immigration status, income, rurality, regional health district (LHIN), continuity of primary care, primary care enrollment model

Table 3. Top 5 diagnostic codes for PCP visits during baseline and treatment periods

Rank	PCP Visits (Baseline period)		PCP Visits (Treatment period)	
	Dx code	N (%)	Dx code	N (%)
Total		119294		42748
1	Hypertension	10951 (9.18%)	Breast cancer (Female)	14097 (32.98%)
2	Anxiety	8533 (7.15%)	Anxiety	2686 (6.28%)

3	Annual health examination	5606 (4.70%)	Hypertension	1757 (4.11%)
4	Common cold	4844 (4.06%)	Other ill-defined conditions, general symptoms	1429 (3.34%)
5	Diabetes	4696 (3.94%)	Common cold	1301 (3.04%)

Appendix A. Data sources used to obtain data elements for variable creation

Data Source	Data Elements
Ontario Cancer Registry (OCR)	Date of breast cancer diagnosis, age at diagnosis, sex, other cancer diagnoses, cancer stage
Registered Persons Database (RPDB)	Postal code at time of diagnosis, LHIN
2006 Statistics Canada Census & Postal code conversion file plus, version 5C	Rurality, Neighborhood income quintile
Immigration Refugee and Citizenship Canada (IRCC) database	Immigration status
Ontario Health Insurance Plan (OHIP)	Number of PCP visits (billed encounters) total and per provider, reasons for visits, diagnostic codes, chemotherapy receipt, start of adjuvant chemotherapy
ICES Physician Database	Physician specialty
Client Agency Program Enrollment database (CAPE) & Corporate Provider Database	Primary care enrollment model
Canadian Institute for Health Information: Discharge Abstract Database (DAD) & Same Day Surgery (SDS) database	Diagnosis codes, surgery receipt
Cancer Activity Level Reporting (ALR) database	Date of radiotherapy receipt

Appendix B. Relative differences in PCP visit rates– adjusted difference-in-difference model estimates.

	Exponentiated estimate (95% CI)
Intercept	0.01 (0.01-0.01)
Treatment period	2.52 (2.43-2.61)
Mental Health History	1.49 (1.44-1.54)
No Mental Health History	reference
Period*Mental Health History	0.72 (0.69-0.75)
0-5 ADGs	reference
6-9 ADGs	1.82 (1.76-1.88)
10+ ADGs	2.97 (2.83-3.12)
Period*(6-9 ADGs)	0.57 (0.54-0.59)
Period*(10+ ADGs)	0.46 (0.44-0.49)
Age <40 years	0.94 (0.90-0.99)

Age 40-49 years	0.94 (0.91-0.98)
Age 50-59 years	Reference
Age 60-69 years	1.04 (1.01-1.08)
Age 70-74 years	1.13 (1.07-1.18)
Age >74 years	1.20 (1.11-1.29)
Non-immigrant	Reference
Immigrant	1.03 (1.00-1.07)
Income quintile 1	Reference
Income quintile 2	0.99 (0.95-1.03)
Income quintile 3	0.99 (0.95-1.03)
Income quintile 4	0.97 (0.93-1.01)
Income quintile 5	0.93 (0.89-0.97)
Urban	Reference
Rural	0.99 (0.94-1.05)
Rural-remote	0.96 (0.90-1.03)
Rural-very remote	1.20 (1.10-1.31)
LHIN 1 Erie St. Clair	1.06 (0.98-1.14)
LHIN 2 South West	1.11 (1.03-1.19)
LHIN 3 Waterloo Wellington	0.97 (0.90-1.05)
LHIN 4 Hamilton Niagara Haldimand Brant	1.09 (1.02-1.17)
LHIN 5 Central West	1.10 (1.02-1.19)
LHIN 6 Mississauga Halton	1.05 (0.97-1.13)
LHIN 7 Toronto Central	reference
LHIN 8 Central	1.05 (0.98-1.12)
LHIN 9 Central East	1.06 (0.99-1.14)
LHIN 10 South East	1.10 (1.01-1.20)
LHIN 11 Champlain	1.12 (1.04-1.21)
LHIN 12 North Simcoe Muskoka	1.08 (0.98-1.19)
LHIN 13 North East	1.03 (0.94-1.13)
LHIN 14 North West	1.14 (1.00-1.30)
Continuity 0 visits	0.25 (0.23-0.28)
Continuity 1-2 visits	0.39 (0.38-0.41)
Continuity UPC <=0.75	0.95 (0.93-0.98)
Continuity UPC >0.75	Reference
PC model capitation	0.89 (0.85-0.93)
PC model enhanced FFS	1.00 (0.96-1.04)
PC model team-based capitation	0.87 (0.83-0.92)
PC model other	0.74 (0.65-0.83)
PC model straight FFS	reference

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Introduction section page 3-4
Objectives	3	State specific objectives, including any prespecified hypotheses End of Introduction Section page 4
Methods		
Study design	4	Present key elements of study design early in the paper Study Design page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Methods page 4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Methods page 4-5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Variable and data sources page 5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Variable and data sources page 5-6; Appendix A
Bias	9	Describe any efforts to address potential sources of bias Methods page 5-6
Study size	10	Explain how the study size was arrived at N/A population-based cohort
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Methods page 5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 6
		(*b*) Describe any methods used to examine subgroups and interactions Page 6
		(*c*) Explain how missing data were addressed Page 6 Results
		(*d*) If applicable, explain how loss to follow-up was addressed N/A
		(*e*) Describe any sensitivity analyses N/A
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Results page 6
		(b) Give reasons for non-participation at each stage N/A
		(c) Consider use of a flow diagram Considered
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Results page 6, table 1
		(b) Indicate number of participants with missing data for each variable of interest Results page 6, table 1
		(c) Summarise follow-up time (eg, average and total amount) Methods page 5
Outcome data	15*	Report numbers of outcome events or summary measures over time Figure 1, Table 2

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Results page 7-8, Figure 2
		(*b*) Report category boundaries when continuous variables were categorized Methods page 5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Considered
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives Interpretation page 8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Interpretation page 9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Interpretation page 8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results Interpretation page 9
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Funding statement page 1.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.