Influence of Age, Sex, and Generation on Physician Payments and Clinical Activity in Ontario, Canada: An Age-Period-Cohort Analysis

YVONNE M. BUYS, MAYILEE CANIZARES, TINA FELFELI, AND YAPING JIN

• PURPOSE: To compare the effect of age, sex and generation on physician practice patterns in Ontario, Canada.
• DESIGN: Retrospective cohort study.
• METHODS: Physician and patient data from 1992 to 2013 were used to calculate yearly number of physicians, distinct patients seen, patient visits, government payments, physician age, sex, specialty, and year of birth. Age-period-cohort models were used for analysis.
• RESULTS: There was a negligible change in the number of distinct patients for all physicians and family physicians and a 20.6% decrease for ophthalmologists. There were small declines in yearly visits for all physicians (14.2%) and family physicians (17.3%) and a 10.0% increase for ophthalmologists. There was a lower number of visits (and patients for ophthalmologists) in each succeeding recent birth cohort. For all groups and birth cohorts, male physicians had significantly greater number of visits and patients. Median payments increased over time in all groups and were less for women with an average women-to-men ratio of 0.64 for all physicians, 0.75 for family physicians, and 0.59 for ophthalmologists. After adjusting for the number of visits and patients, sex differences in payments remained significant for all physicians and ophthalmologists but were no longer significant for family physicians.
• CONCLUSION: Younger cohorts of Ontario physicians have greater yearly payments compared to older cohorts at the same age despite similar or slightly fewer numbers of visits and patients. The sex gap of payments was mostly explained by differences in the number of patients and visits for family physicians, but remained significant for all physicians and ophthalmologists. (Am J Ophthalmol 2019;197:23–35. © 2018 Elsevier Inc. All rights reserved.)

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From the Department of Ophthalmology and Visual Sciences, University of Toronto, Toronto, Ontario, Canada (Y.M.B., T.F., Y.J.); The Arthritis Program, Krembil Research Institute, Toronto Western Hospital, University Health Network, Toronto, Ontario, Canada (M.C.); and Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada (Y.J.).

Inquiries to Yvonne M. Buys, Toronto Western Hospital, 399 Bathurst St, EW6-405, Toronto, Ontario, Canada M5T 2S8; e-mail: y.buys@utoronto.ca

WE HAVE PREVIOUSLY SHOWN THAT THE MEAN age and proportion of women in the Canadian physician workforce are increasing.[1] For example, in 1970 the mean age of Canadian physicians was 44.8 years and this increased to 50.4 years in 2011. In comparison, for ophthalmologists the mean age increased from 44.7 to 53.1 years in the same timeframe. In 1970, 5.2% of physicians were ≥65 years of age, with this proportion increasing to 13.2% in 2011, whereas for ophthalmologists there was a 7-fold increase over this same time period from 3.1% in 1970 to 21.4% of ophthalmologists in 2011 aged ≥65 years. The proportion of female physicians in Canada has also increased, from 7.8% in 1970 to 36.8% in 2011. These shifting trends have also been noted in ophthalmology, although with a much slower progression, with women making up 3.1% of the workforce in 1970 and 20.5% of the workforce in 2011, an average yearly increase of 0.43%.[1]

It has been argued that the aging and feminization of the physician workforce may affect delivery of care, as age and sex are known to influence work productivity.[1–5] For example, a study from 2007-08 found that physician income, a surrogate for productivity, peaked around age 41-45 years, with the average full-time equivalent value (calculated by using age- and sex-specific fee-for-service billings) for men being 1.34 but only 0.78 for women in this age group.[6] More recent evidence suggests that the productivity of female physicians has increased over time.[7–11] Nevertheless, it has been suggested that measures of clinical and academic productivity alone provide only a partial understanding of the differences in practice patterns of male and female physicians.[12,13]

In addition to the influence of age and sex, there is also growing evidence of generational differences in practice patterns of physicians. The Baby Boomer generation (born between 1945 and 1964) of physicians are most commonly viewed as a group that work long hours and see the practice of medicine as a tireless vocation.[2] Conversely, the newer-generation doctors are reported to have fewer working hours per week and an expectation to work for more years compared to the older generations.[2] Recent generations are reported to be more savvy with technology, more independent, less loyal to the institution, and more concerned with work-life balance.[14,15] However,

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self-reported work hours and billing dollars suggest that in fact there are very few differences in the practice patterns of generations of physicians.[16]

Comparing birth cohorts is complex because cohort differences are closely linked to age and period effects. Age effects are the consequences of growing older irrespective of the year of birth; while period effects are the consequences of external factors that affect all age groups. They can be the result of an event that happened at a particular point in time or they could arise from the long-term effects of changes in society, such as innovations in health care or changes in policies. Birth cohort effects arise from the accumulation of unique life experiences and different opportunities available to those born in different time periods.

To understand how aging, sex, and generational influences impact physician productivity and to provide guidance for workforce planning, we analyzed physician and billing data including year of physician's birth, physician sex, government payments, number of distinct patients seen, and number of patient visits of the entire physician workforce in Ontario, Canada. We paid special attention to family physicians and ophthalmologists, as the former are general practitioners and the latter are specialist practitioners.

METHODS

THIS RETROSPECTIVE POPULATION-BASED STUDY WAS CONducted by compiling de-identified physician and patient data from Ontario, Canada housed at the Institute for Clinical Evaluative Sciences (ICES). Access to the data was granted by the ICES Data and Analytic Services (DAS) from the Ontario Ministry of Health and Long-Term Care and the Ministry of Research and Innovation. This study was approved by the University Health Network Research Ethics Review Board.

In Canada, medically necessary health care costs are universally covered for all citizens by publicly funded health insurance plans that are administered at the provincial level. Physicians are not permitted to bill insured health services outside of the provincial health insurance plans. As physician remuneration requires submission of complete data, these databases have excellent reliability.[17] In Ontario, the largest province in Canada by population (over 13.5 million in 2013), the Ontario Health Insurance Plan (OHIP) is used by physicians for submitting claims for payment of insured services. Physician remuneration through OHIP represents 95% of total Ministry of Health (MOH) physician expenditures in Ontario.[18] It is important to note that the database does not include Alternate Funding Plans (AFP), which account for the remaining 5% of expenditures made under the MOH, third-party payers, payments made by patients for uninsured services, and Worker's Compensation.

Physician and patient data from ICES for the years 1992-2013 was used to calculate physician age, sex, year of birth, specialty, year of payment, yearly number of physicians, median OHIP payments, number of distinct patients seen, and number of patient visits. We defined the generations by birth year as follows: Younger Generation X (1975-1984), Older Generation X (1965-1974), Younger Baby Boomers (1955-1964), Older Baby Boomers (1945-1954), World War II (1935-1944), Pre-World War II (1925-1934), and World War I (≤1925). Reported data regarding payments were converted to 2013 Canadian dollars using the consumer price index published by Statistics Canada.[19]

• **STATISTICAL ANALYSIS:** We used hierarchical age-period-cohort (APC) models to examine age, period, and cohort effects on physician billings (a surrogate for physician productivity), number of visits, and number of distinct patients.[20] Disentangling age, period and cohort effects is complicated because these 3 effects are linearly related, which produce unreliable results. Therefore, assumptions have to be made about the period and/or cohort effects in order to obtain robust estimates.[21] As we were interested in directly comparing birth cohorts, we made assumptions about the period effects. We conceptualized period as a contextual unit; hence we estimated period indirectly as a random effect. Analyses were conducted in 3 separate groups: all Ontario physicians, family physicians, and ophthalmologists. Family physicians are general practitioners. Ophthalmologists were chosen as a representative of specialist practitioners who have a mixed medical and surgical practice. Models were fitted using PROC GLIMMIX from SAS 9.4 and the significance of variables was assessed by Wald tests.

RESULTS

• **DEMOGRAPHICS:** A total of 19 323 physicians (22.8% female), including 10 229 family physicians (27.0% female) and 388 ophthalmologists (11.3% female), were practicing in Ontario in 1992 and 27 489 physicians (37.3% female), including 12 875 family physicians (42.8% female) and 457 ophthalmologists (19.9% female), in 2013 (Figures 1-3, Top left, respectively).

• **PRACTICE VOLUME BY VISITS AND DISTINCT PATIENTS:** Figures 1-3 illustrate the period and sex trends for the mean number of distinct patients seen and the mean number of total visits for all physicians (Figure 1, Top right and Bottom left, respectively), family physicians (Figure 2, Top right and Bottom left, respectively), and ophthalmologists (Figure 3, Top right and Bottom left, respectively). The number of distinct patients seen was relatively unchanged for all physicians and family physicians but decreased for ophthalmologists, from 3278 patients per ophthalmologist in 1992 to 2604 patients in 2013, a 20.6% decrease (18.7% decrease for men and 21.5%

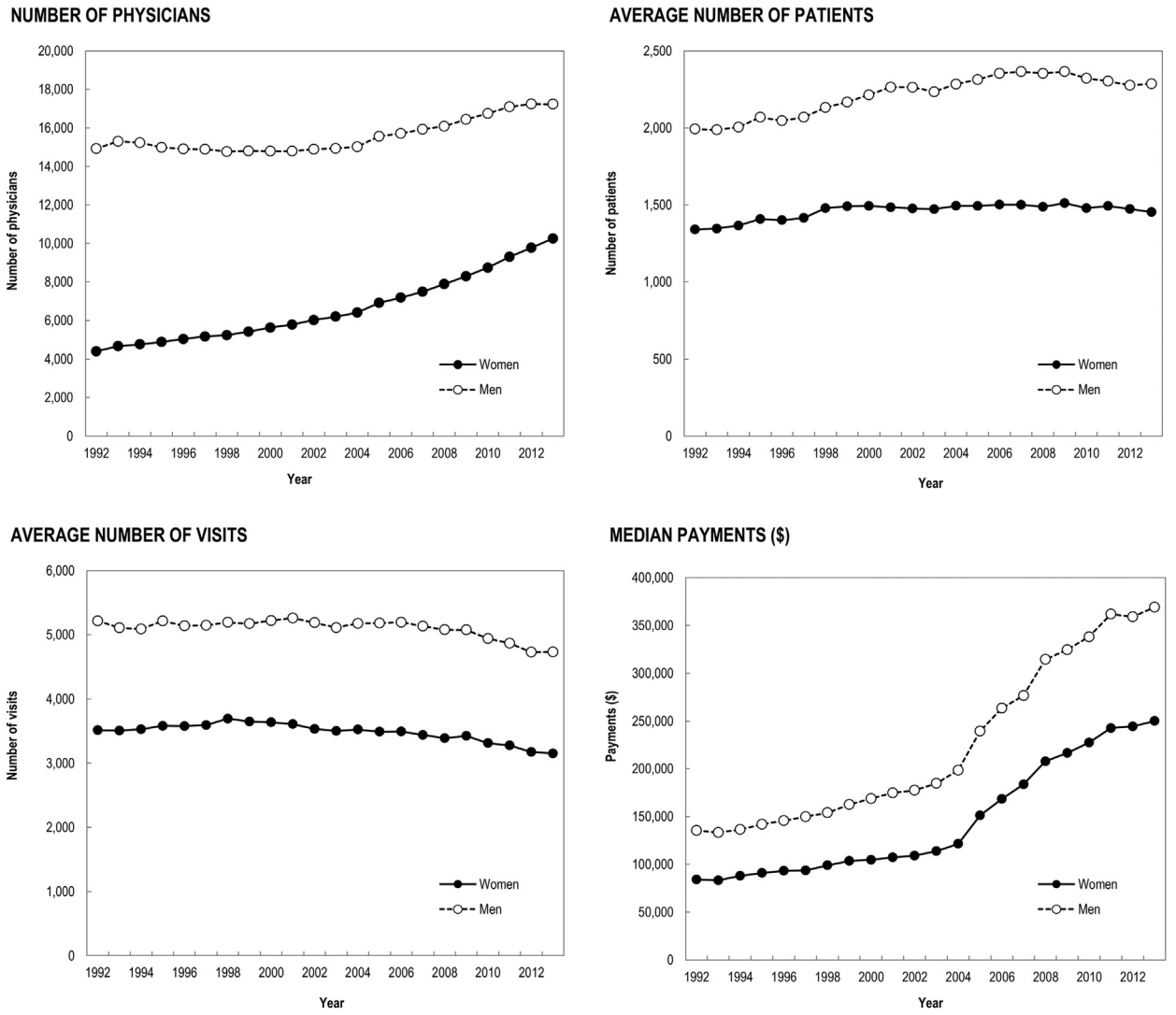

FIGURE 1. Number of all physicians (Top left), mean number of patients per physician per year (Top right), mean number of visits per year (Bottom left), and median payments* (Bottom right) by sex and year in Ontario. Ontario Health Insurance Plan Data from 1992 to 2013. *Adjusted to 2013 dollars.

decrease for women, Figure 3, Top right). Additionally, between 1992 and 2013, there were small declines in the mean number of yearly total visits for all physicians (14.2%, Figure 1, Bottom left) and family physicians (17.3%, Figure 2, Bottom left), while the number of visits slightly increased for ophthalmologists (10%, Figure 3, Bottom left). Noticeably, this increase was mainly seen among male ophthalmologists. Results of the estimated number of patients and number of visits from the APC model for all physicians, family physicians, and ophthalmologists are illustrated in Figures 4–6, respectively. For all physicians and ophthalmologists differences in the number of visits by different birth cohorts were very small (albeit significant; Figure 4, Top left, and Figure 6, Top left), while birth cohort differences for family physicians were significant and large (Figure 5, Top left). Likewise, model results for the number of patients indicate that cohort differences were not significant for all physicians and family physicians (Figure 4, Top right and Figure 5, Top right), while they were significant for ophthalmologists (Figure 6, Top right). In all cases, when comparing birth cohorts at the same age, there was a trend of lower number of visits (and patients for ophthalmologists) in each succeeding recent cohort (eg, members of Generation X had fewer visits and/or patients than Baby Boomers and other older generations). Furthermore, for the 3 groups, sex differences were large and significant, with greater number of visits and patients for male physicians in all birth cohorts.

• **BILLING DATA:** Figures 1-3 (Bottom right) show the observed yearly median payments for all physicians, family physicians, and ophthalmologists by sex from 1992

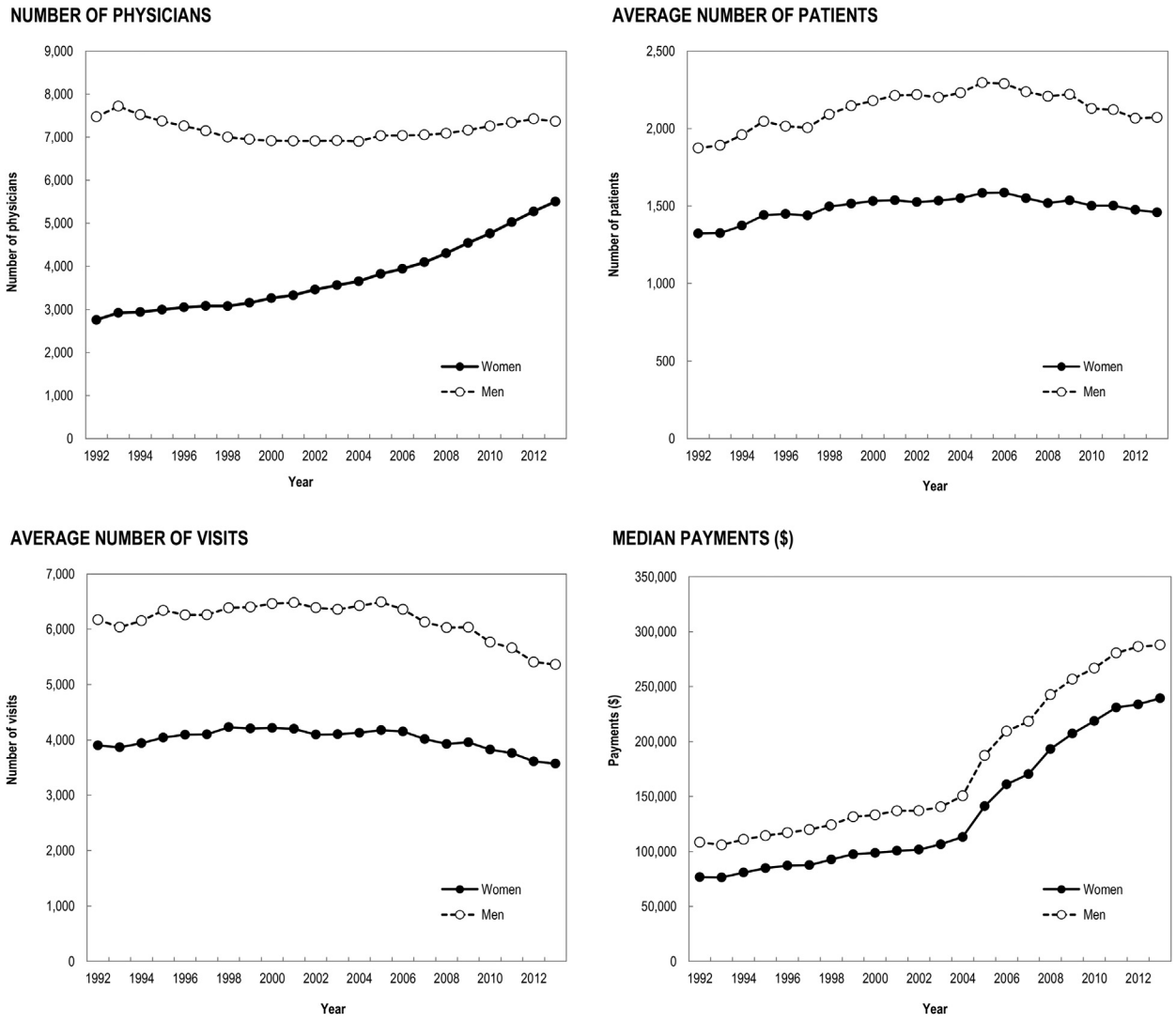

FIGURE 2. Number of family practitioners (Top left), mean number of patients per physician per year (Top right), mean number of visits per year (Bottom left), and median payments* (Bottom right) by sex and year in Ontario. Ontario Health Insurance Plan Data from 1992 to 2013. *Adjusted to 2013 dollars.

to 2013. Payments increased over time with a greater increase after 2004 in all 3 groups. The median payments for women were less than for men, with an average female-to-male ratio of 0.64 for all physicians, 0.75 for family physicians, and 0.59 for ophthalmologists. The ratio of payment gap by sex seems to be slightly narrowing in more recent years: all physicians (0.62 in 1992 to 0.68 in 2013), family physicians (0.71 in 1992 to 0.83 in 2013), and ophthalmologists (0.56 in 1992 to 0.70 in 2013).

Figures 4-6, Bottom left and Bottom right, illustrate the results of model estimated payments by, respectively, age and birth cohort for all physicians (Figure 4), family physicians (Figure 5), and ophthalmologists (Figure 6). Findings from the unadjusted model for all physicians (Figure 4, Bottom left) indicate significant overall sex gap (female-to-male ratio 0.65, $P < .0001$) in payments. There were also significant age effects ($P < .0001$) with the overall age trajectory of payments increasing from age 30, peaking in middle age, and showing a decline in older ages. In addition to the age effects, cohort effects were significant for both men and women ($P < .001$), with a general trend of higher payments in each succeeding recent cohort. When comparing birth cohorts at the same age, there was a trend of greater yearly payments in each succeeding recent cohort (eg, Younger Generation X greater than Older Generation X). After adjusting for the volume of visits and patients seen in practice (Figure 4, Bottom right), sex differences in payments remained statistically significant, although they were largely reduced (female-to-male ratio 0.77, $P < .0001$).

Figure 5 shows the modeling results for family physicians. The age and cohort patterns (Figure 5, Bottom left) were

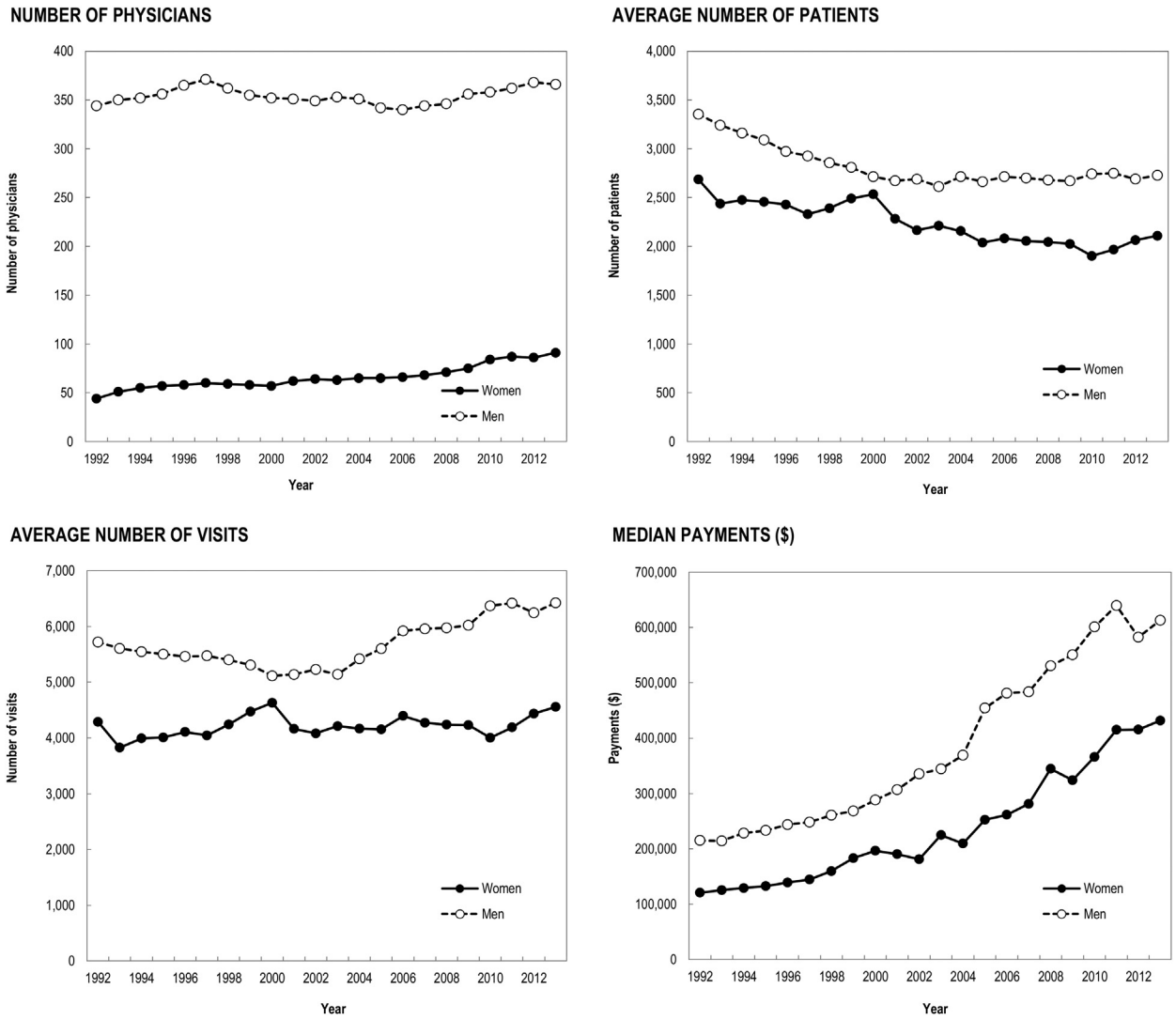

FIGURE 3. Number of ophthalmologists (Top left), mean number of patients per physician per year (Top right), mean number of visits per year (Bottom left), and median payments* (Bottom right) by sex and year in Ontario. Ontario Health Insurance Plan Data from 1992 to 2013. *Adjusted to 2013 dollars.

similar to those for all physicians (Figure 4, Bottom left). However, after accounting for the volume of visits and patients seen in practice, the previously seen sex gap (female-to-male ratio 0.70, $P < .0001$) was no longer significant (0.98, $P = .75$, Figure 5, Bottom right).

Lastly, Figure 6 shows the modeling results for ophthalmologists, with findings similar to those for all physicians. Of note, there were significant interactions between sex and birth cohort ($P = .048$) and sex and age ($P = .015$) from the adjusted payment model. Taking together the trend information from Figure 6, Bottom right, a wider sex gap in payments in more recent cohorts (eg, Generation X and Baby Boomers) is suggested.

Figures 7-9 show the model estimated payments by period effects for all physicians, family physicians, and ophthalmologists, respectively. The overall unadjusted sex gap for all physicians was 0.60 for female-to-male ratio (Figure 7, Top left). Adjusting for the effect of age (Figure 7, Top right) and the effects of age and birth cohort (Figure 7, Bottom left) did not substantially impact the sex gap. Further adjusting for the number of patients seen and the number of visits (Figure 7, Bottom right), the sex gap in payment was still significant ($P < .0001$), although somewhat reduced (0.77). Results for family physicians are shown in Figure 8. The sex gap was not affected by age and cohort adjustments (Figure 8, Top left, Top right, and Bottom left); however, after accounting for the volume of visits and patients the sex gap was no longer significant ($P = .752$, Figure 8, Bottom right).

Lastly, results of the modeling for ophthalmologists are shown in Figure 9. When adjusted for the effect of age (Figure 9, Top right), the average sex gap increased, with

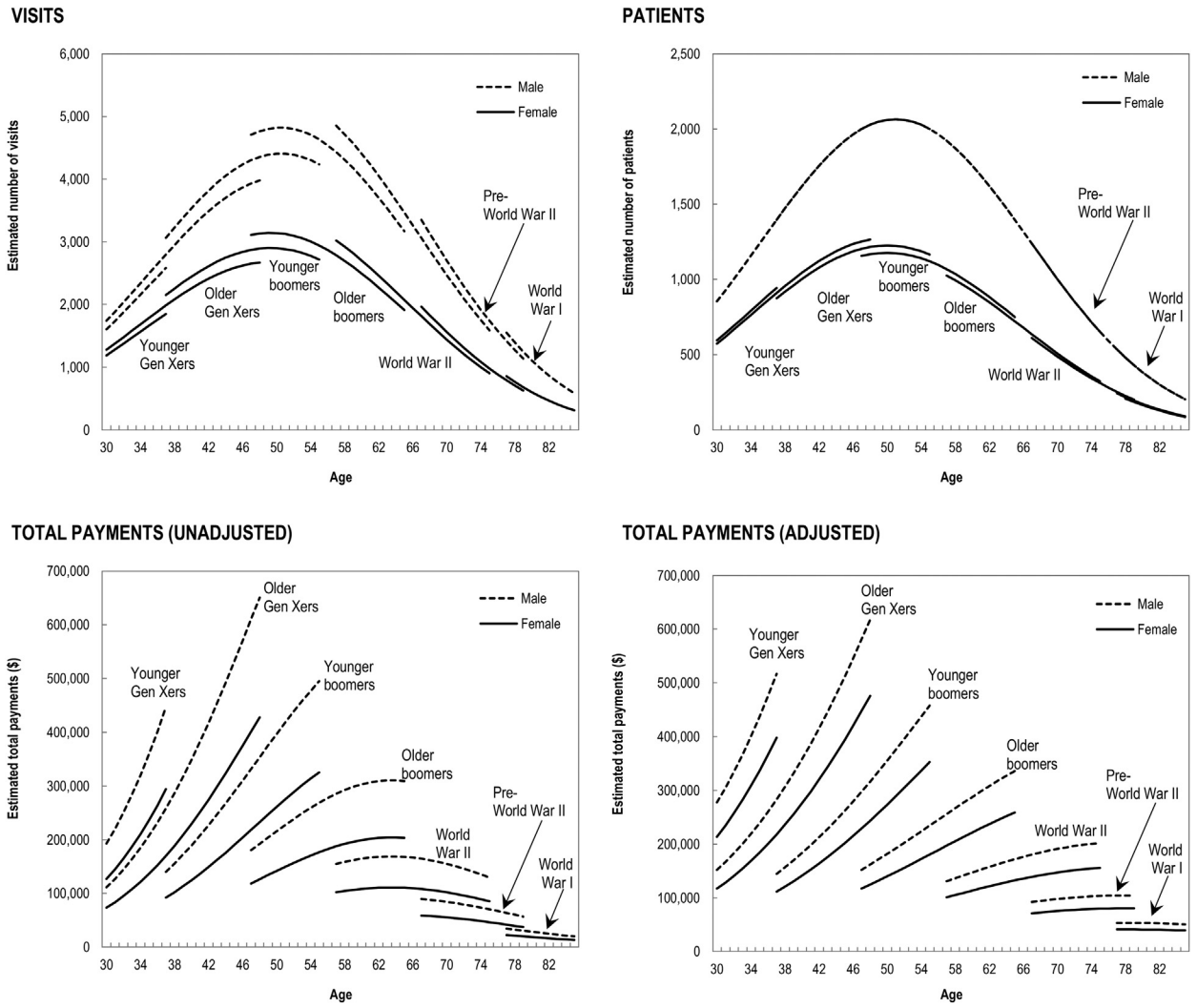

FIGURE 4. Age and birth cohort differences* in the number of visits (Top left), the number of patients (Top right), and payments (Bottom left and Bottom right) by sex for all physicians. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in number of visits, patients, and payments (Bottom left) are unadjusted. Estimates in payments (Bottom right) are from a model that adjusted for the number of patients and the number of visits per patient.

female ophthalmologists billing $0.55 for every dollar a male ophthalmologist billed (compared to $0.62 in the unadjusted model), suggesting that age differences between male and female ophthalmologists may be partially explaining the narrowing of the sex gap in payment in the unadjusted analysis (Figure 9, Top left and right). The time trends in payments with age and cohort adjusted revealed an average sex gap of 0.52 (Figure 9, Bottom left). The larger sex gap, which is evident after adjustments have been made, indicates that cohort replacement had an impact in reducing the sex gap found in the unadjusted analysis. The period effect was still significant but substantially reduced. When adjusting time trends in total payments by age, cohort, and number of visits and patients, both the sex gap and period effect were substantially reduced (Figure 9, Bottom right).

DISCUSSION

THE FINDINGS OF THIS INVESTIGATION OF BILLING TRENDS, with consideration of the number of patient visits and number of distinct patients seen, and of the sex and year of birth of physicians, have shed light on differences in sex and generational practice patterns over time. Overall, we illustrated considerable differences in payments among different birth cohorts, with more recent cohorts having greater payments than the preceding cohort at the same age. These differences remained true even after accounting for cohort differences in the number of patients and the number of visits. We also found a significant sex gap in payments across all birth cohorts for all physicians, family physicians, and ophthalmologists. Of note was that sex

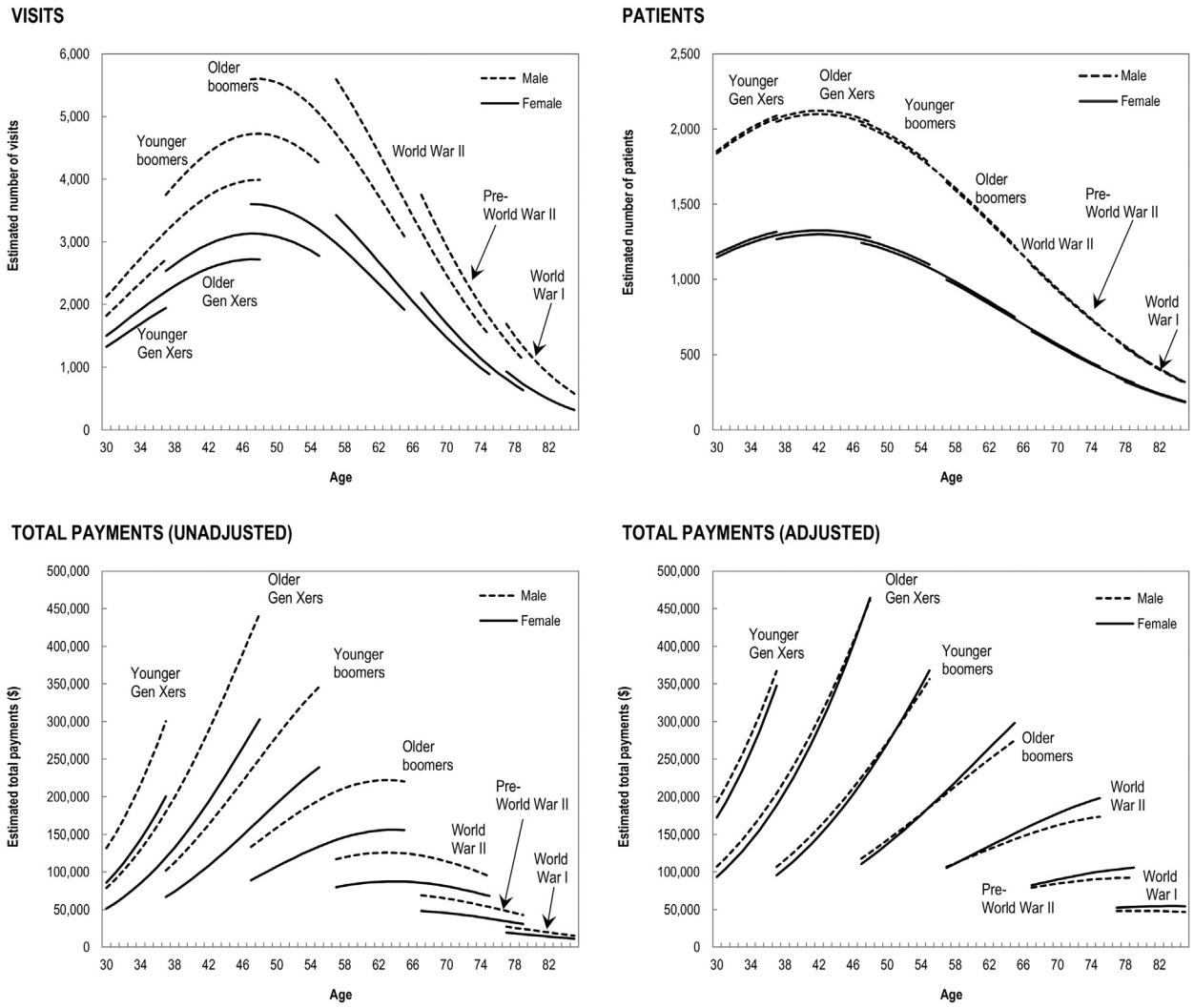

FIGURE 5. Age and birth cohort differences* in the number of visits (Top left), the number of patients (Top right), and payments (Bottom left and Bottom right) by sex for family practitioners. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in number of visits, patients, and payments (Bottom left) are unadjusted. Estimates in payments (Bottom right) are from a model that adjusted for the number of patients and the number of visits per patient.

differences in payments for family physicians were explained by sex differences in the number of visits and the number of patients. However, sex differences for all physicians and ophthalmologists remained unexplained (although reduced) after accounting for differences in the number of patients and visits.

Overall, we found that yearly median payments to Ontario's physicians from 1992 to 2013 increased over time. In an attempt to address the effect of inflation, we used the consumer price index for health and personal care[19] to convert all payment data to 2013 Canadian dollars. Despite this adjustment, the period effect of payments is evident from Figures 1-3 (Bottom right), where median payments have increased 160%, 166%, and 93% from 1992 to 2013 for all physicians, family physicians, and ophthalmologists, respectively.

The cause of payment increases unrelated to inflation are multifactorial and include innovations in health care, resulting in either improved efficiencies requiring less time for a procedure (for example, phacoemulsification) or changes in practice (for example, intravitreal injections for macular degeneration) or the introduction of a new billing code (for example, ocular coherence tomography). In addition, the government can make changes to the fee schedule, as illustrated by a tipping point in increased billings around 2004 in all groups, which coincided with the elimination of claims threshold levels, which was a government program introduced in June 1996 as an attempt to

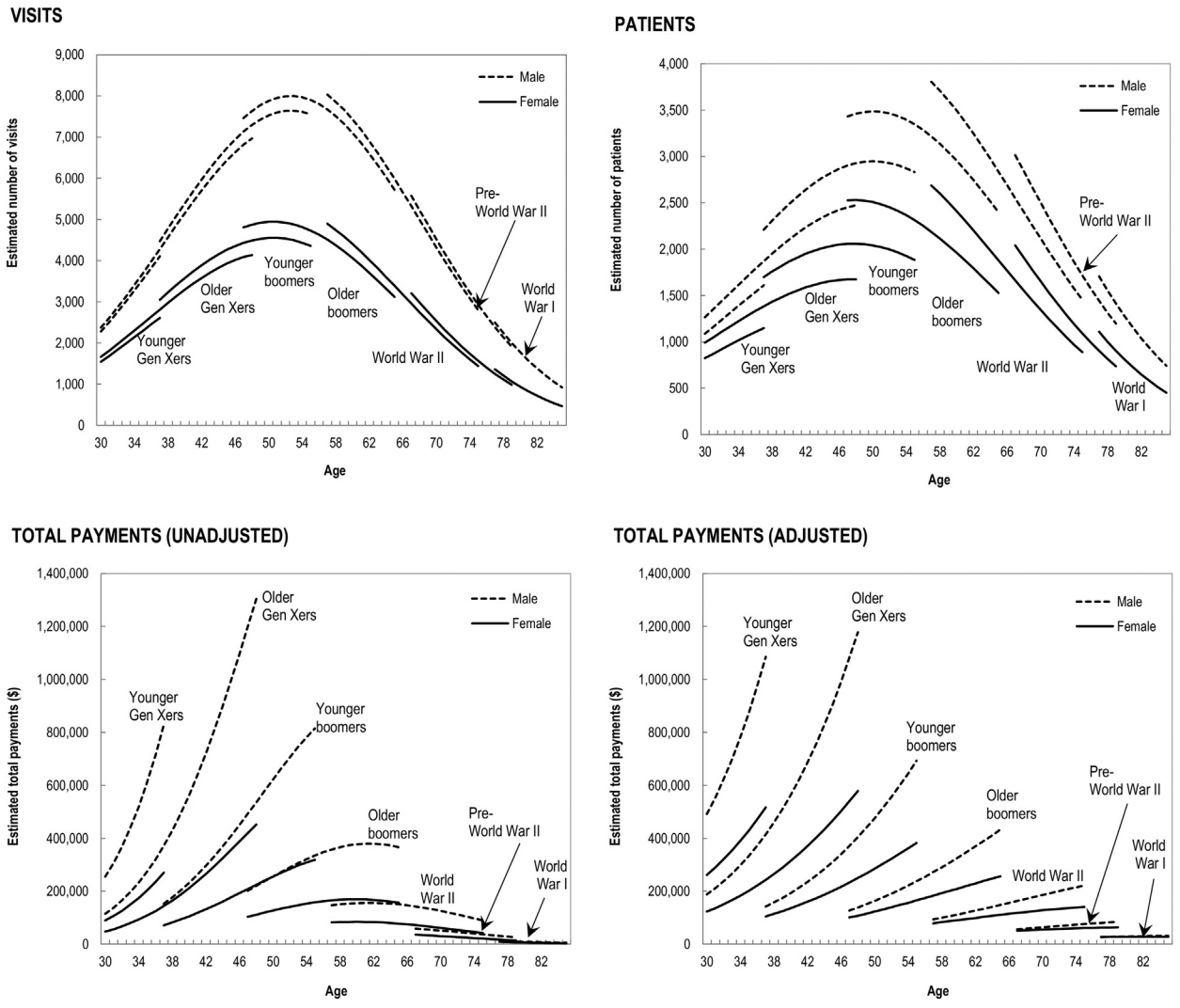

FIGURE 6. Age and birth cohort differences* in the number of visits (Top left), the number of patients (Top right), and payments (Bottom left and Bottom right) by sex for ophthalmologists. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in number of visits, patients, and payments (Bottom left) are unadjusted. Estimates in payments (Bottom right) are from a model that adjusted for the number of patients and the number of visits per patient.

manage OHIP payments. This program introduced tiered thresholds on physician billings where payments would be reduced by a percentage (33.3%, 66.7%, and 75%) when a given threshold was reached (in 1998 these were $300 000, $325 000, and $350 000 for family physicians and $380 000, $405 000, and $430 000 for specialists, respectively). Exemptions existed for those working in under-serviced populations or in a unique sub-specialty. This would negatively impact the physicians' payment and be a disincentive for productivity for those affected. These external factors will affect all age groups in the year in which the change took place.

Throughout the study period there was a significant sex gap with a ratio of female-to-male median payments of 0.64, 0.75, and 0.59 for all physicians, family physicians, and ophthalmologists, respectively; however, this gap decreased from 1992 to 2013. The APC model found that the sex gap for payments increased in the more recent cohorts for ophthalmologists but not for all physicians or family physicians. After adjustment for number of visits and distinct patients, this sex gap in payments no longer existed for family physicians. This suggests that differences in the way female and male family physicians practice underpin the sex gap in payments observed. In contrast, the sex gap for all physicians and ophthalmologists was still significant, albeit slightly reduced. This is somewhat surprising, given the fee-for-service environment, suggesting that male physicians are billing more per patient than

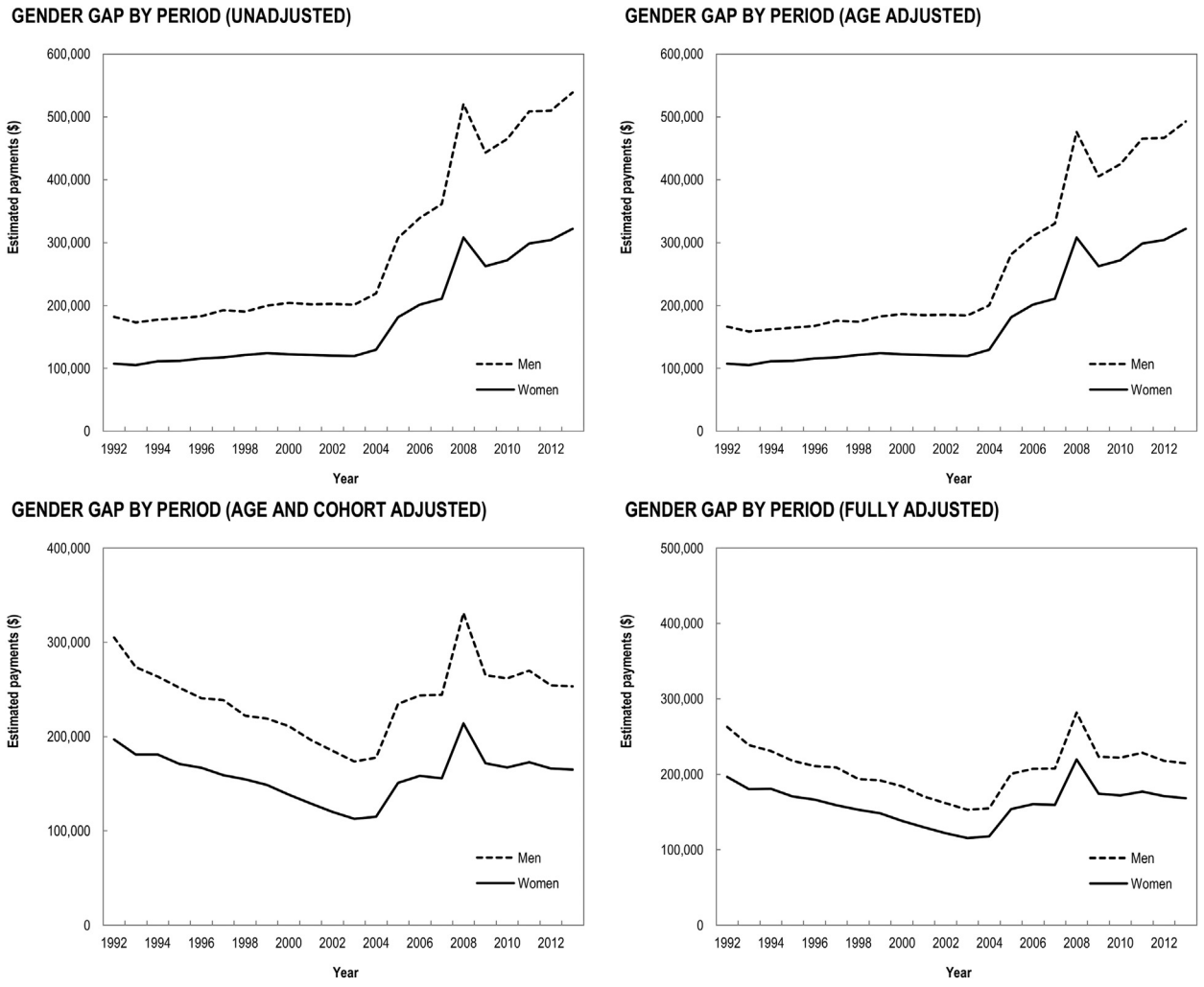

FIGURE 7. Period effects* in the payments by sex for all physicians. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in Top left are unadjusted, in Top right are age-adjusted, in Bottom left are age-cohort adjusted, and in Bottom right are from a model that adjusted for the number of patients and the number of visits per patient.

female physicians. This is likely explained by male and female differences in proclivity to surgery, including surgical access. In a study of Ontario ophthalmologists using billing data from 1999 to 2013, 69.5% of ophthalmologists had a surgical practice while 30.5% had a medical-only practice.[22] For those with a surgical practice the proportion of men performing surgery was significantly greater than for women, with 68.6% of male physicians performing surgery during this time period compared to 57.9% of female physicians in 2000, increasing to 61.3% of female physicians in 2013.[22] This sex difference was also found in a study looking specifically at cataract surgery in Ontario, with only 55.1% of female ophthalmologists performing cataract surgery in 2000 compared to 69.9% of male ophthalmologists.[23] Furthermore, male ophthalmologists performing cataract surgery had 1.4 times the volume of cataract procedures compared to female ophthalmologists in 2000, increasing to 1.7 times in 2013.[23] These findings are also supported by a survey of Canadian ophthalmologists in 2012, which reported significantly less operating room time for female compared to male ophthalmologists.[11]

Sex differences in compensation of physicians have previously been reported; however, most studies are based on surveys that are limited by selection and recall bias.[24–26] A database study of 10 241 (34.7% female) salaried physicians representing a variety of specialties from 24 public medical schools in the United States reported that female physicians earned 0.80 compared to male physicians. After adjusting for age, specialty, and research productivity, this gap decreased to 0.92. Surgical specialties were specifically noted to have the largest absolute sex difference.[27] Reddy and associates, in a study of 16 111 ophthalmologists (19.8% female) in the United States using the Centers for Medicare and Medicaid

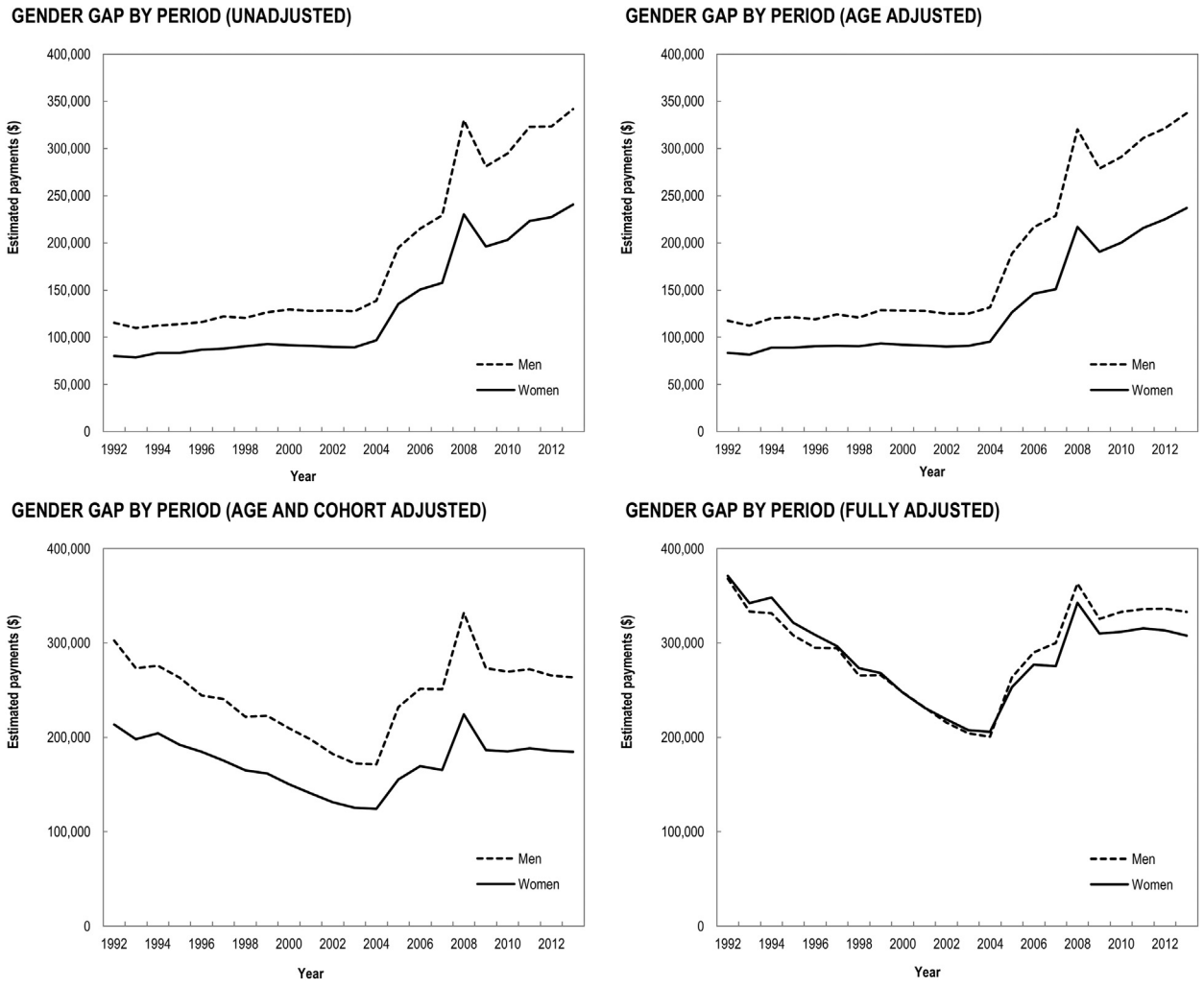

FIGURE 8. Period effects* in the payments by sex for family practitioners. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in Top left are unadjusted, in Top right are age-adjusted, in Bottom left are age-cohort adjusted, and in Bottom right are from a model that adjusted for the number of patients and the number of visits per patient.

Services database from January 2012 to December 2013, reported a median female-to-male ratio of 0.56 for payments; however, in contrast to our findings, this was proportionate to the volume of clinical activity.[28]

In terms of age effects, payment data from all groups had a bell-shaped curve with peak payments around ages 48-52. Disparity by sex was noted in all age groups, with women billing less than men and the maximum gap coinciding with peak billings. It is interesting, however, that the timing of peak billing by age was similar for men and women, which was unexpected, since it is often suggested that childcare responsibilities delay women's careers, leading to a later peak in productivity compared to men.[29,30] It has been previously reported that being married reduces work hours of female physicians, with a peak in productivity at age 55-59 years, in contrast to male physicians, who experience an increase in work hours following marriage, with a peak in productivity at age 45-49 years.[30,31]

Overall there was little change in the yearly mean number of visits and number of distinct patients, with the exception of ophthalmology, where there was little change in the number of visits but a 20% decrease in the number of distinct patients. We found negligible cohort differences in the number of patients for all physicians and family physicians; however, for ophthalmologists, more recent cohorts had fewer patients than the preceding cohort at the same age. For all groups, more recent cohorts had lower numbers of visits than their predecessors. This difference may be partly explained by surgical compared to medical practice patterns. In a study comparing medical to surgical ophthalmologists in Ontario, surgical ophthalmologists had 1.6 times the number of patient visits compared to their medical peers.[22] In addition, female ophthalmologists[22,23]

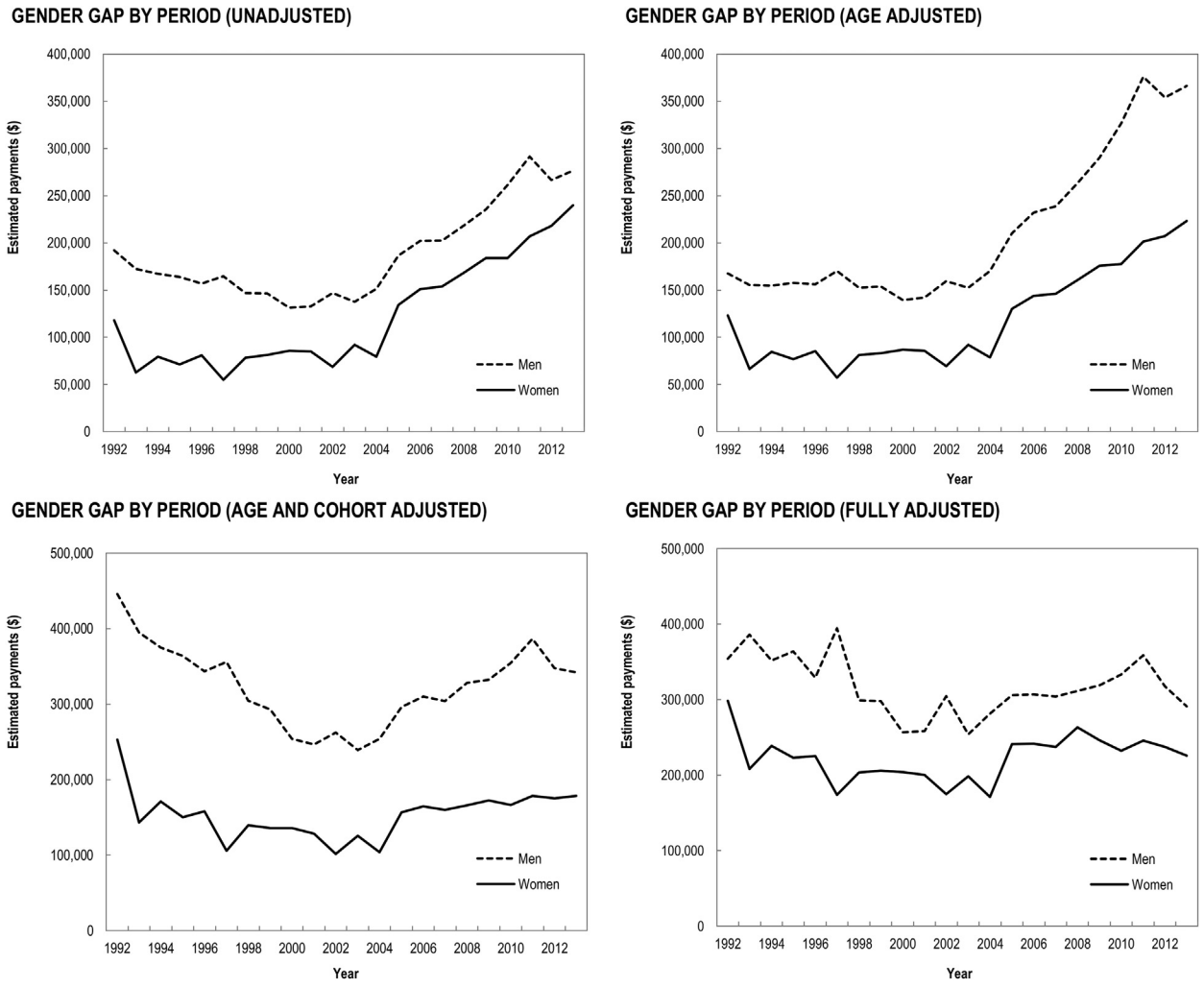

FIGURE 9. Period effects* in the payments by sex for ophthalmologists. Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in Top left are unadjusted, in Top right are age-adjusted, in Bottom left are age-cohort adjusted, and in Bottom right are from a model that adjusted for the number of patients and the number of visits per patient.

and earlier career ophthalmologists of both sexes[22] were less likely to perform surgery, which likely impacts the number of visits for more recent cohorts.

• **STRENGTHS AND LIMITATIONS:** Ontario has a single-payer universal health care system, which provides an objective, robust, and reliable source of billing information; however, non–medically necessary procedures, which are uninsured, are not included in this database. This study was undertaken in part to examine birth cohort effects. The ICES database was limited to a 20-year period, which, although valuable for assessing trends, provided little overlap by age for the birth cohorts. Sex differences in payments after adjusting for number of visits and distinct patients in a fee-for-service environment suggest men are billing more per patient. Since remuneration for procedural services is higher than for office visits, this difference found for ophthalmologists likely represents men performing more procedures. In this database we did not have access to unique billing codes, prohibiting exploration of this hypothesis.

In conclusion, physician billings have been commonly used as a surrogate of work productivity. This analysis shows that billings may be a poor surrogate, since despite an increase in yearly billings, productivity as measured by number of visits declined slightly for all physicians and family physicians and number of distinct patients seen showed either little change over time or, in the case of ophthalmology, a 20% decrease. Cohort effects varied, with more recent cohorts having higher payments despite fewer numbers of visits, and either similar numbers of distinct patients for all physicians and family physicians and fewer distinct patients for ophthalmology. Sex differences, men having higher payments than women, were

noted throughout the study period, albeit decreasing slightly over time. The differential was greatest for ophthalmologists, compared to all physicians and family physicians, and greater for more recent cohorts. After adjusting for the number of visits and distinct patients, the sex payment difference no longer existed for family physicians; however, the sex difference in payments remained significant for all physicians and ophthalmologists, although it was reduced. This difference may be related to sex differences in specialty practice, specifically as it relates to surgical procedures, volumes, and access.

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