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

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• 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 1992–2013 were used to calculate the 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 were a lower number of visits (and patients for ophthalmologists) in each succeeding recent birth cohort. For all groups and birth cohorts, male physicians had a 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 with older cohorts at the same age despite similar or a slightly lower number 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.

NOTE: Publication of this article is sponsored by the American Ophthalmological Society. (Am J Ophthalmol 2019;205:184–196. © 2019 Elsevier Inc. All rights reserved.)

WE HAVE PREVIOUSLY SHOWN THAT THE MEAN age and proportion of women in the Canadian physician workforce are increasing.[1] In 1970, for example, the mean age of Canadian physicians was 44.8 years, and this increased to 50.4 years in 2011. In comparison with ophthalmologists, the mean age increased from 44.7 to 53.1 years in the same time frame. In 1970, 5.2% of physicians were ≥65 years of age, with this proportion increasing to 13.2% in 2011; for ophthalmologists, there was a 7-fold increase over this same period from 3.1% in 1970 to 21.4% of ophthalmologists in 2011 who were ≥65 years of age. The proportion of female physicians in Canada also increased from 7.8% in 1970 to 36.8% in 2011. These shifting trends have been noted in ophthalmology, although with a much slower progression, with females 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 affects the delivery of care because age and sex are known to influence work productivity.[1–5] For example, a study from 2007–2008 found that physician income, a surrogate for productivity, peaked around 41–45 years of age, with the average full-time equivalent value (calculated by using age- and sex-specific fee-for-service billings) for males being 1.34 but only 0.78 for females 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 1945–1964) of physicians are most commonly viewed as a group that work long hours and

Accepted for publication Apr 4, 2019.

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0002-9394/$36.00
https://doi.org/10.1016/j.ajo.2019.04.006

see the practice of medicine as a tireless vocation.[2] Conversely, newer-generation doctors are reported to have fewer working hours per week with an expectation to work for more years compared with 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, self-reported work hours and billing dollars suggest that there are 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; 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 the year of a 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 because the former are general practitioners and the latter are specialist practitioners.

METHODS

THIS RETROSPECTIVE POPULATION-BASED STUDY WAS CONducted by compiling deidentified 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 (>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 physician expenditures in Ontario.[18] It is important to note that the database does not include Alternate Funding Plans, which account for the remaining 5% of expenditures made under the Ministry of Health, 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 and produce unreliable results. Therefore, assumptions must be made about the period and/or cohort effects to obtain robust estimates.[21] We were interested in directly comparing birth cohorts and we made assumptions about the period effects. We conceptualized period as a contextual unit; therefore, we estimated period indirectly as a random effect. Contextual unit is a technical term used in multilevel/hierarchical analysis. In traditional methods of analysis, there is only 1 level of analysis—that is, the unit of analysis is the individual. In contrast, in multilevel/hierarchical analysis there is more than 1 level of analysis. The units of analysis are usually individuals (at a lower level) nested within contextual/aggregate units (at a higher level). In our case, the contextual unit is the period. The underlying hypothesis is that the context (in our case, the period) influences individual physician billings. To uncover these contextual effects in our analyses, we examined the variation in billings occurring within (between physicians in each period) and between groups (time periods). 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 the PROC GLIMMIX function in SAS software (version 9.4; SAS Inc, Cary, North Carolina, USA) and the significance of variables was assessed with Wald tests.

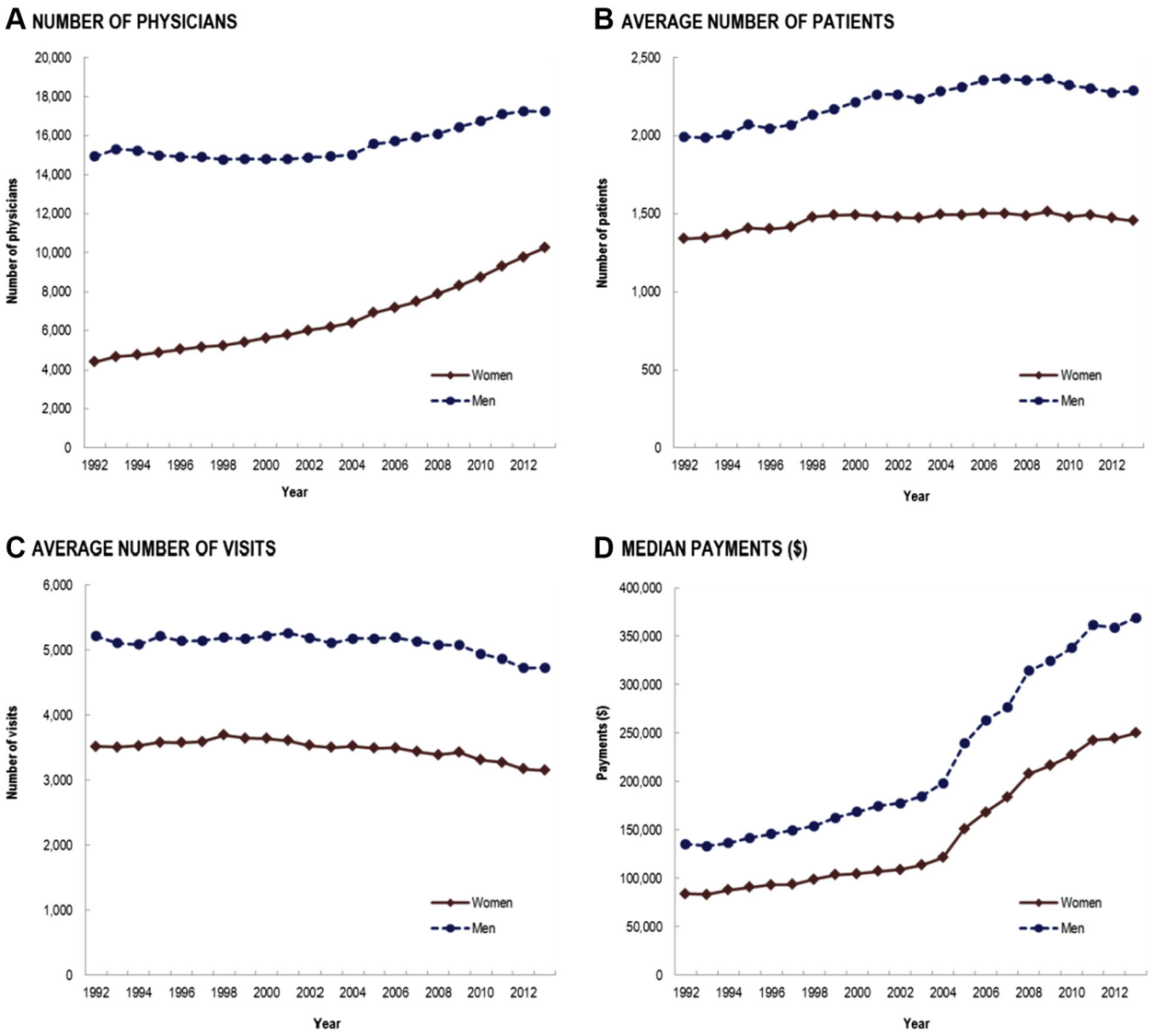

FIGURE 1. (A) Number of all physicians. (B) Mean number of patients per physician per year. (C) Mean number of visits per year. (D) Median payments (adjusted to 2013 dollars) by sex and year in Ontario. Data from the Ontario Health Insurance Plan Data from 1992 to 2013.

RESULTS

• **DEMOGRAPHICS:** A total of 19,323 physicians (22.8% female) including 10,229 family physicians (27.0% female) and 388 (11.3% female) ophthalmologists were practicing in Ontario in 1992, and 27,489 physicians (37.3% female) including 12,875 family physicians (42.8% female) and 457 (19.9% female) ophthalmologists were practicing in 2013 (Figures 1A, 2A, and 3A, 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 (Figures 1B and 1C, respectively), family physicians (Figure 2B and 2C, respectively), and ophthalmologists (Figure 3B and 3C, respectively). The number of distinct patients seen was relatively unchanged for all physicians and family physicians; however, the number of patients decreased for ophthalmologists from 3278 patients per ophthalmologist in 1992 to 2604 patients in 2013, a 20.6% decrease (an 18.7% decrease for males and a 21.5% decrease for females; Figure 3B). In addition, between 1992 and 2013 there were small declines in the mean number of yearly total visits for all physicians (14.2%; Figure 1C) and family physicians (17.3%; Figure 2C), while the number of visits slightly increased for ophthalmologists (10%; Figure 3C). 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,

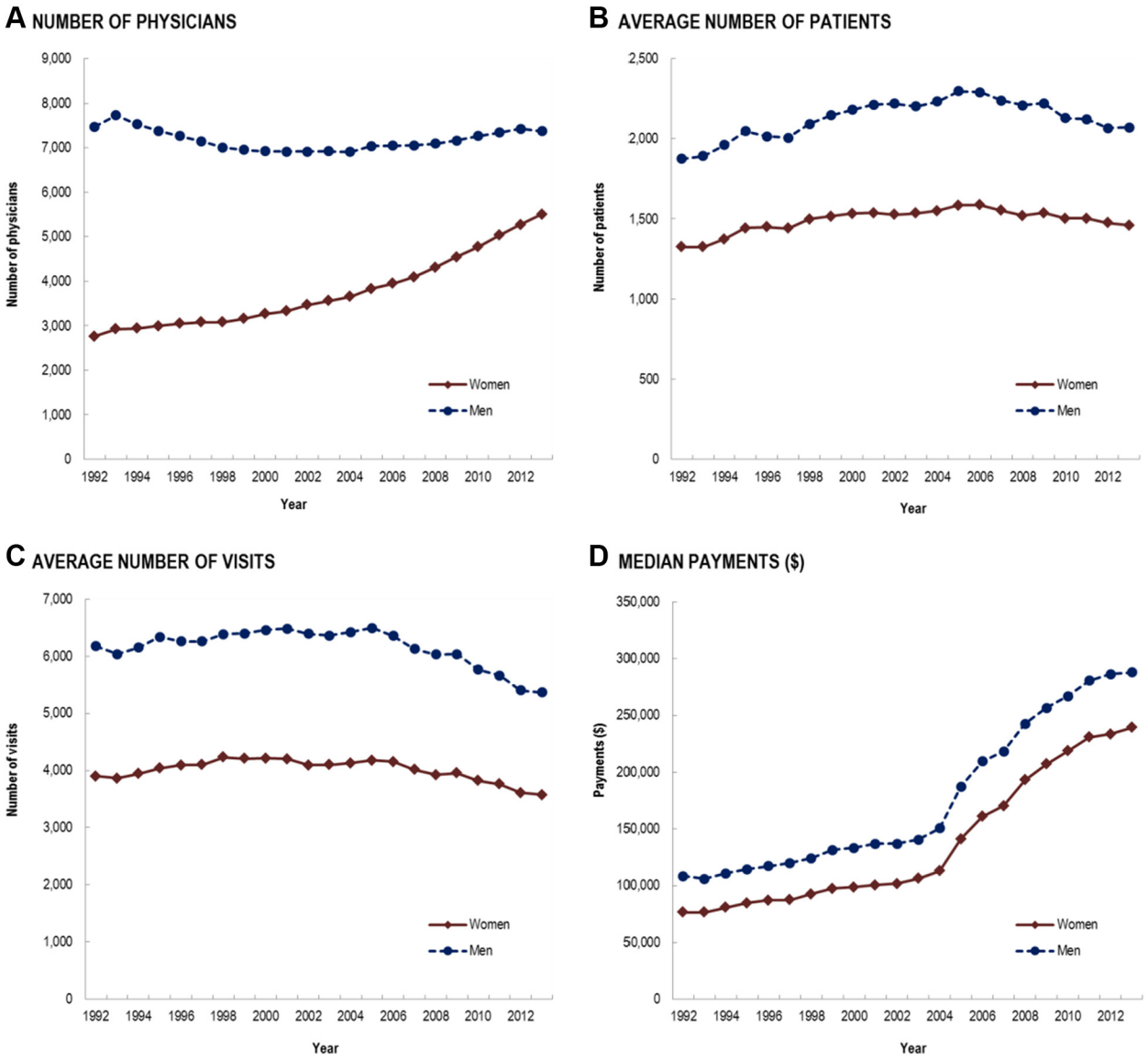

FIGURE 2. (A) Number of family practitioners. (B) Mean number of patients per physician per year. (C) Mean number of visits per year. (D) Median payments (adjusted to 2013 dollars) by sex and year in Ontario. Data from the Ontario Health Insurance Plan Data from 1992 to 2013.

family physicians, and ophthalmologists are shown in Figures 4, 5, and 6, respectively. For all physicians and ophthalmologists, differences in the number of visits by different birth cohorts were small (albeit significant; Figure 4A and 6A) while birth cohort differences for family physicians were significant and large (Figure 5A). Likewise, model results for the number of patients indicate that cohort differences were not significant for all physicians and family physicians (Figures 4B and 5B), while they were significant for ophthalmologists (Figure 6B). 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, Generation Xers 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 1D, 2D, and 3D show the observed yearly median payments for all physicians, family physicians, and ophthalmologists by sex from 1992 to 2013. Payments increased over time with a greater increase after 2004 in all 3 groups. The median payments for women were less than men with an average ratio of women to men 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 in

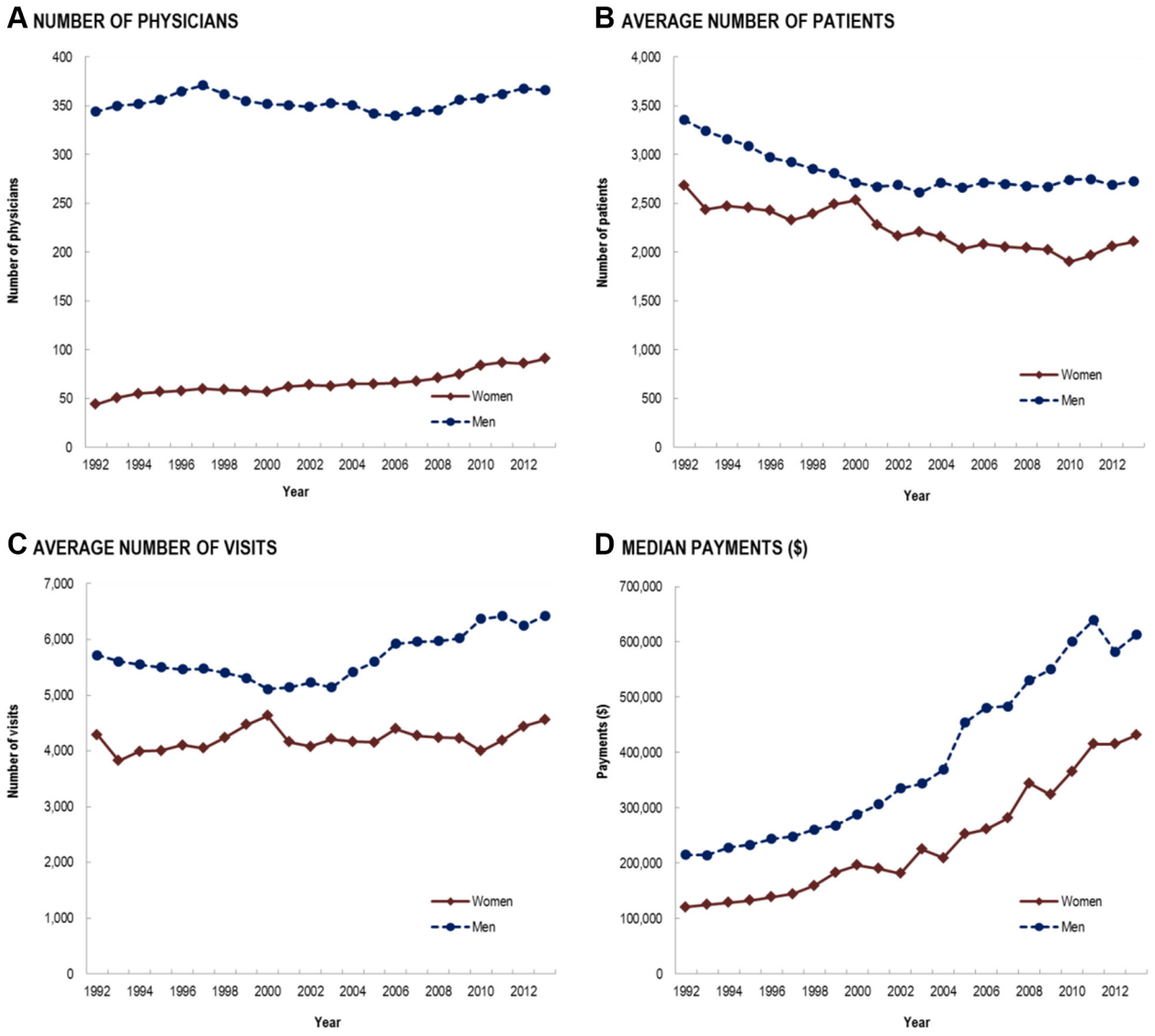

FIGURE 3. (A) Number of ophthalmologists. (B) Mean number of patients per physician per year. (C) Mean number of visits per year. (D) Median payments (adjusted to 2013 dollars) by sex and year in Ontario. Data from the Ontario Health Insurance Plan Data from 1992 to 2013.

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 4C, 4D, 5C, 5D, 6C, and 6D show the results of model-estimated payments by age and birth cohort for all physicians, family physicians, and ophthalmologists, respectively. Findings from the unadjusted model for all physicians (Figure 4C) indicate significant overall sex gap (women-to-men ratio 0.65, $P < .0001$) in payments. There were also significant age affects ($P < .0001$) with the overall age trajectory of payments increasing from 30 years of age, peaking in middle age, and declining 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 Xers greater than Older Generation Xers). After adjusting for the volume of visits and patients seen in practice (Figure 4D), sex differences in payments remained statistically significant although were largely reduced (women-to-men ratio 0.77, $P < .0001$).

Figure 5 shows the modeling results for family physicians. The age and cohort patterns (Figure 5C) were similar to those for all physicians (Figure 4C). However, after accounting for the volume of visits and patients seen in practice the previously seen sex gap (women-to-men ratio 0.70, $P < .0001$) was no longer significant (0.98, $P = .75$; Figure 5D).

Lastly, Figure 6 shows the modeling results for ophthalmologists with findings similar to those for all physicians. Of note,

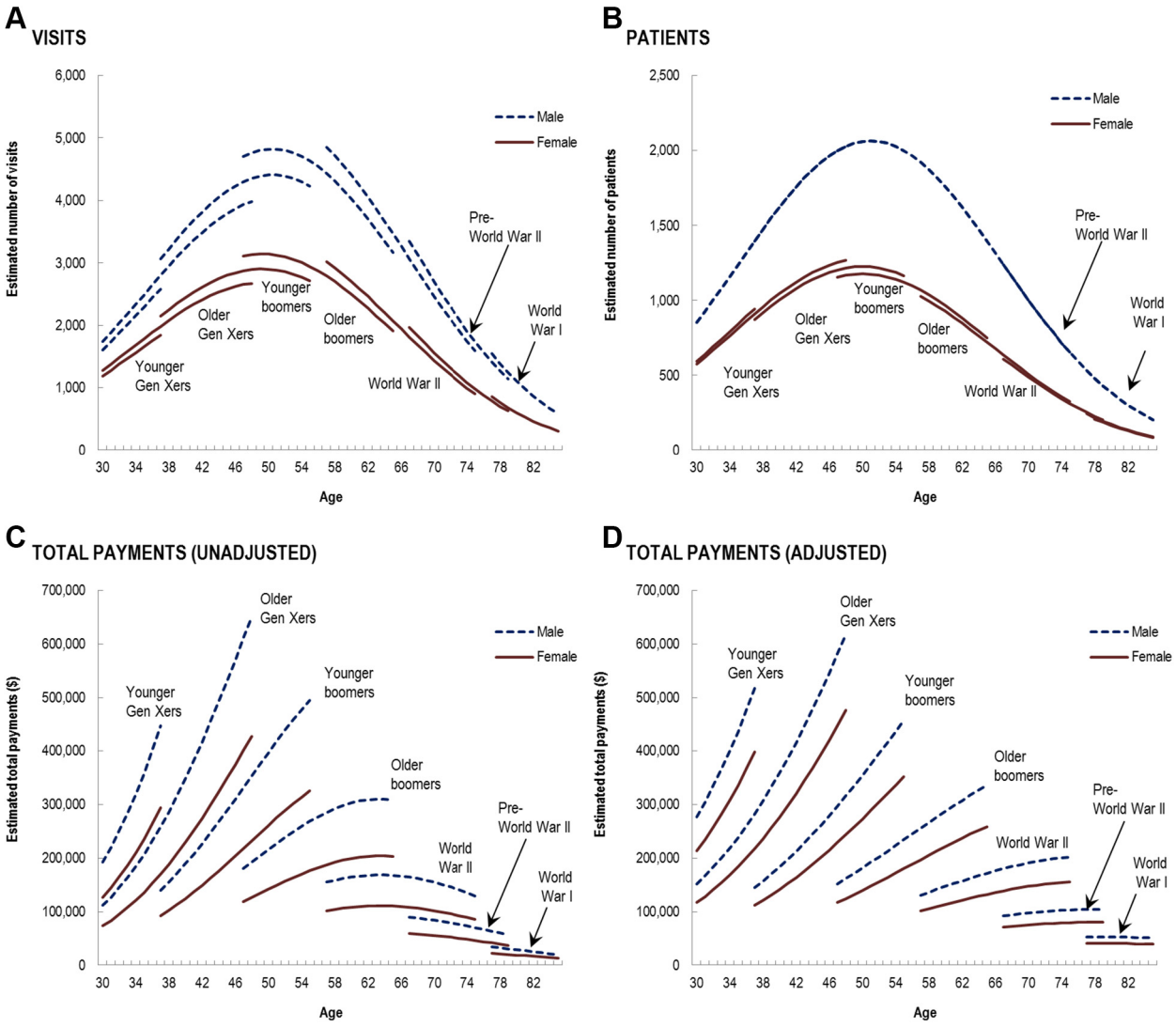

FIGURE 4. (A) Age and birth cohort differences* in the number of visits. (B) The number of patients, and (C and D) payments by sex for all physicians. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in number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

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 6D, 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 women-to-men (Figure 7A). Adjusting for the effect of age (Figure 7B) and the effects of age and birth cohort (Figure 7C) did not substantially impact the sex gap. Further adjusting for the number of patients seen and the number of visits (Figure 7D), 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 8A–C); however, after accounting for the volume of visits and patients, the sex gap was no longer significant ($P = .752$, Figure 8D).

Lastly, results of the modeling for ophthalmologists are shown in Figure 9. When adjusted for the effect of age (Figure 9B), the average sex gap increased, with 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 9A and B). The time trends in payments with age and cohort adjusted revealed an average sex gap of 0.52

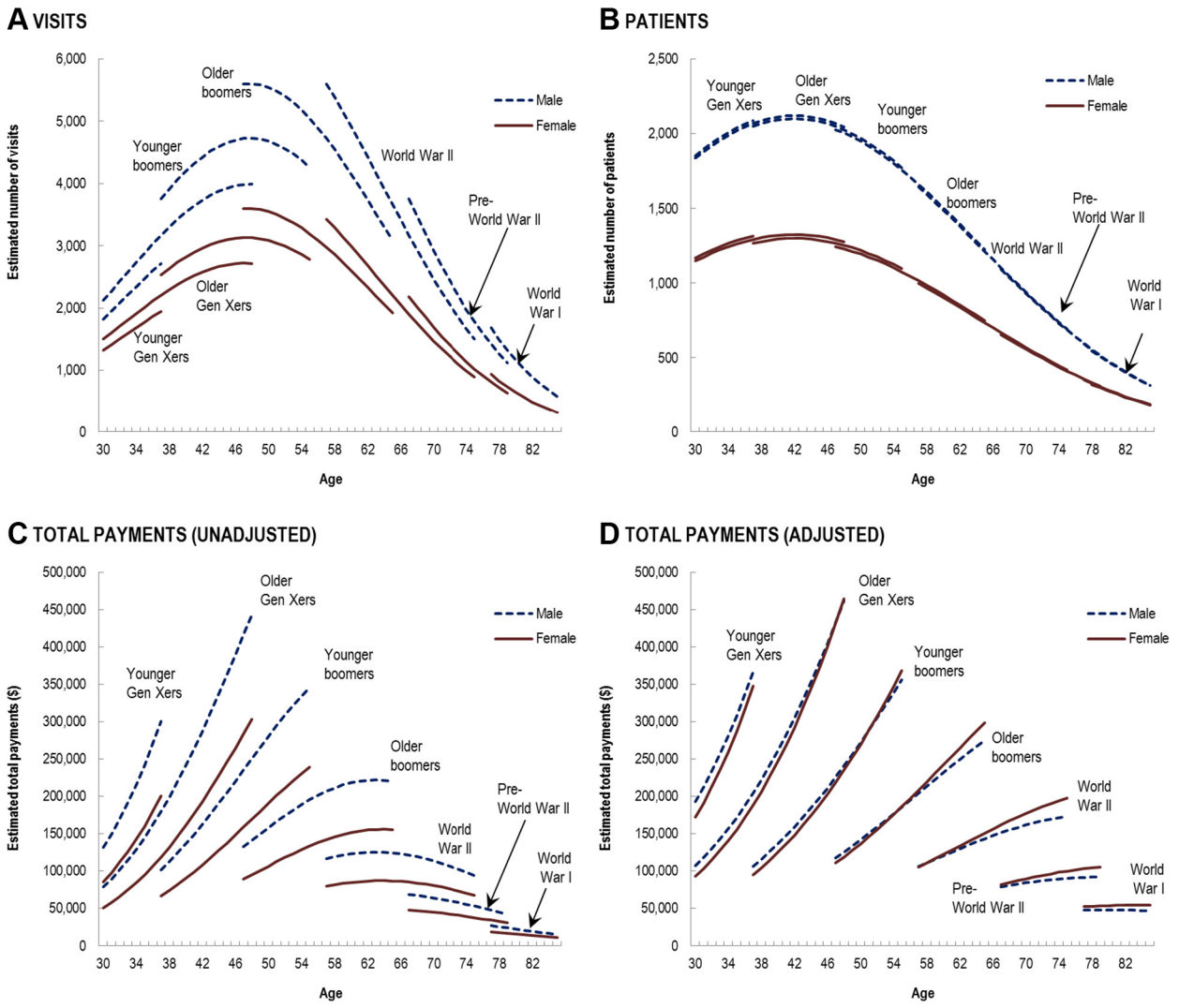

FIGURE 5. (A) Age and birth cohort differences* in the number of visits. (B) The number of patients, and (C and D) payments by sex for family practitioners. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in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

(Figure 9C). 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 9D).

DISCUSSION

THE FINDINGS OF THIS INVESTIGATION OF BILLING TRENDS, with consideration of the number of patient visits and number of distinct patients seen, 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 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

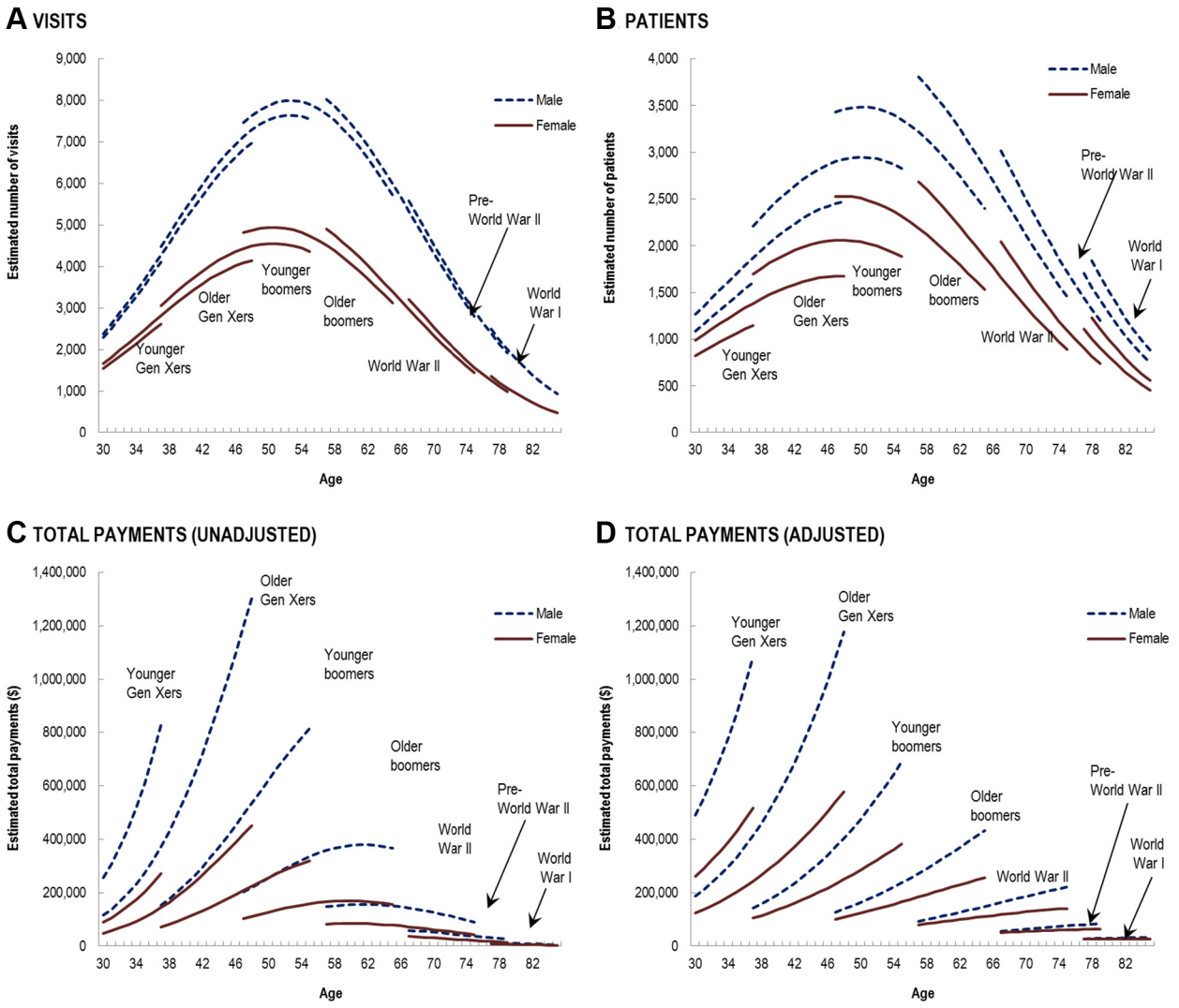

FIGURE 6. (A) Age and birth cohort differences* in the number of visits. (B) The number of patients, and (C and D) payments by sex for ophthalmologists. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. Estimates in number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

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 1D, 2D, and 3D 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 (eg, phacoemulsification) or changes in practice (eg, intravitreal injections for macular degeneration) or the introduction of a new billing code (eg, 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 that coincided with the elimination of claims threshold levels, which was a government program introduced in June 1996 as an attempt to 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 underserviced populations or in a unique subspecialty. 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 that the change took place.

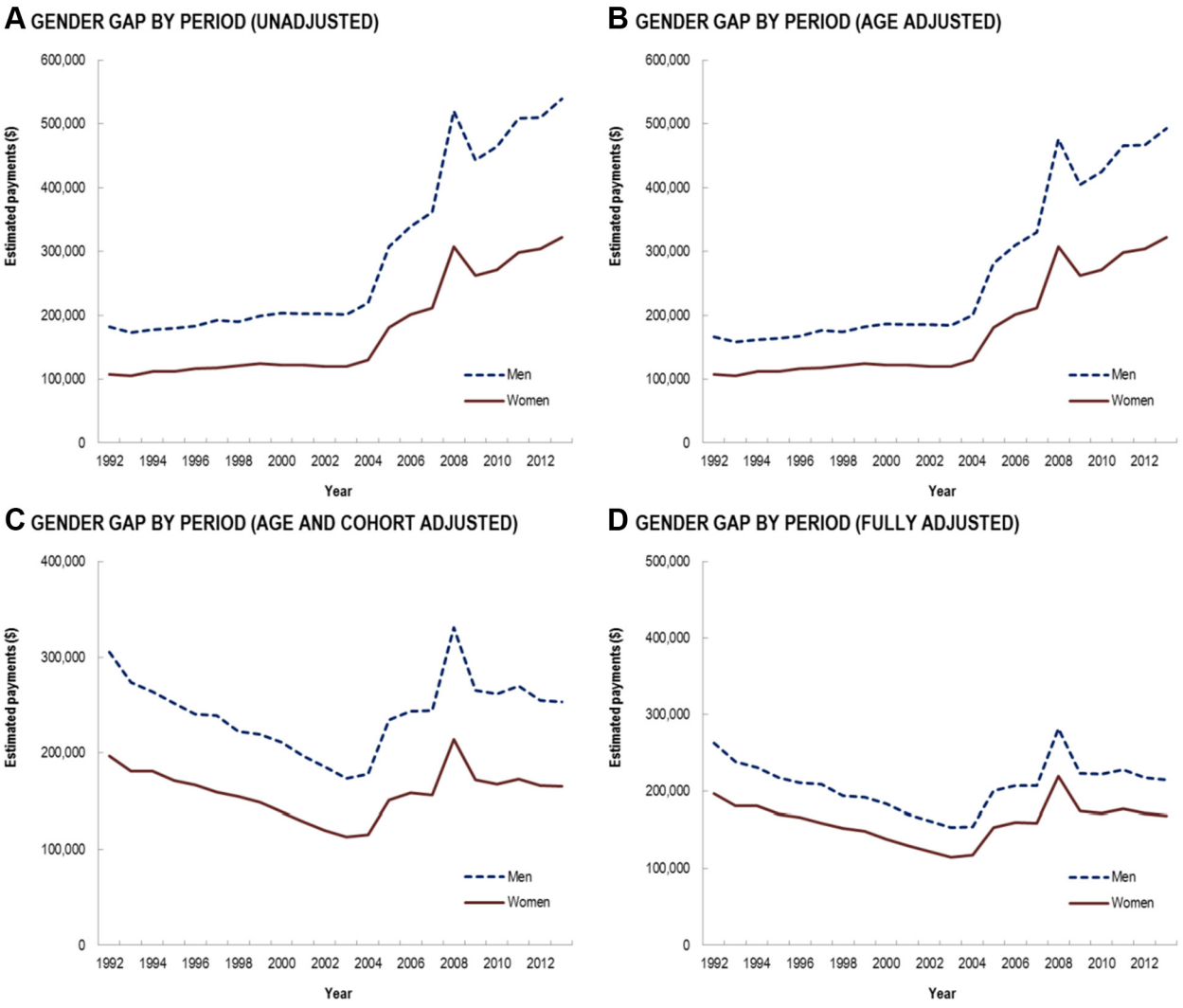

FIGURE 7. Period effects* in the payments by sex for all physicians. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. (A) Unadjusted estimates; (B) age-adjusted estimates; (C) age-cohort-adjusted estimates; (D) estimates from a model that adjusted for the number of patients and the number of visits per patient.

Throughout the study period there was a significant sex gap with a ratio of women-to-men 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 adjusting 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 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 1999–2013, 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 males performing surgery was significantly greater than females, with 68.6% of males performing surgery during this time period compared with 57.9% of females in 2000 increasing to 61.3% of females in 2013.[22] This sex difference was also found in a study specifically examining cataract surgery in Ontario, with only 55.1% of female ophthalmologists performing cataract surgery in 2000 compared with 69.9% of male ophthalmologists.[23] In addition, male ophthalmologists performing cataract surgery had 1.4 times the volume of cataract procedures compared with female ophthalmologists in 2000 and increased to 1.7 times the

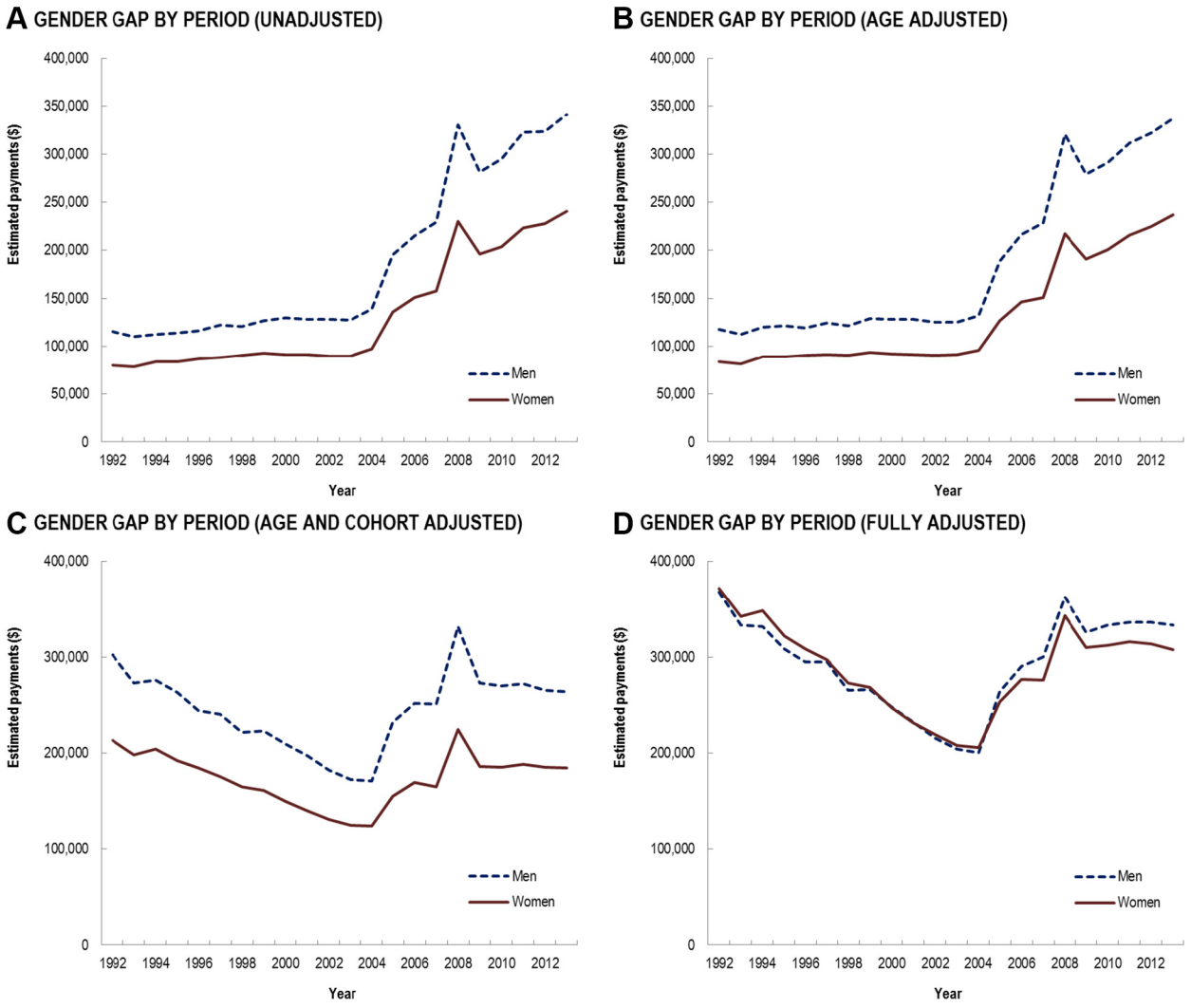

FIGURE 8. Period effects* in the payments by sex for family practitioners. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. (A) Unadjusted estimates; (B) age-adjusted estimates; (C) age-cohort-adjusted estimates; (D) estimates from a model that adjusted for the number of patients and the number of visits per patient.

volume in 2013.[23] These findings are also supported by a survey of Canadian ophthalmologists in 2012 that reported significantly less operating room time for female compared with 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 10241 (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 with 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] In a study of 16,111 ophthalmologists (19.8% female) in the United States using the Centers for Medicare and Medicaid Services database from January 2012 to December 2013, Reddy and associates[28] reported a median female-to-male ratio of 0.56 for payments; in contrast to our findings, this was proportionate to the volume of clinical activity.

In terms of age effects, payment data from all groups had a bell-shaped curve, with peak payments around 48–52 years of age. 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—this was unexpected because it is often suggested that childcare responsibilities delay women's careers, leading to a later peak in productivity compared with men.[29,30] It has been reported that being married reduces the work hours of female physicians, with a peak in productivity at 55–59 years of age, in contrast to males who experience an increase in work hours after

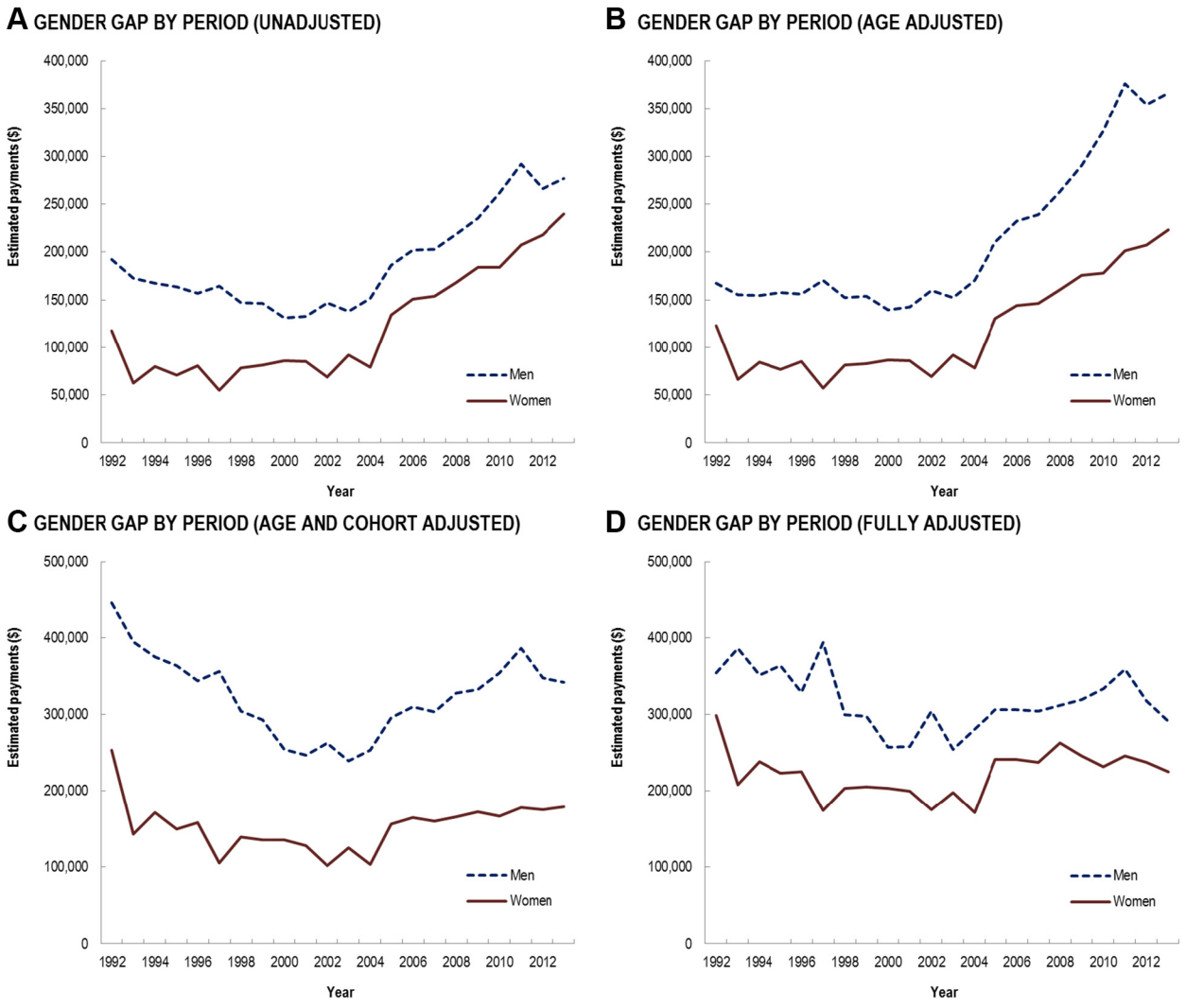

FIGURE 9. Period effects* in the payments by sex for ophthalmologists. Data from the Ontario Health Insurance Plan Data from 1992 to 2013. *Predictions derived from hierarchical age-period-cohort models. (A) Unadjusted estimates; (B) age-adjusted estimates; (C) age-cohort-adjusted estimates; (D) estimates from a model that adjusted for the number of patients and the number of visits per patient.

marriage, with a peak in productivity at 45–49 years of age.[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 number of visits than their predecessors. This difference may be partly explained by surgical compared with medical practice patterns. In a study comparing medical with surgical ophthalmologists in Ontario, surgical ophthalmologists had 1.6 times the number of patient visits compared with their medical peers.[22] In addition, female ophthalmologists[22,23] 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 that provides an objective, robust, and reliable source of billing information; however, non–medically necessary procedures that 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 that provided little overlap by age for the birth cohorts—although it was valuable for assessing trends. Sex differences in

payments after adjusting for number of visits and distinct patients in a fee-for-service environment suggest that men are billing more per patient. Remuneration for procedural services are higher than office visits, and therefore 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 because despite an increase in yearly billings, productivity as measured by number of visits declined slightly for all physicians and family physicians and the 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 a similar number of distinct patients for all physicians and family physicians and fewer distinct patients for ophthalmology. Sex differences—ie, men having higher payments than females—were noted throughout the study period—albeit decreasing slightly over time. The differential was greatest for ophthalmologists compared with 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.

ALL AUTHORS HAVE COMPLETED AND SUBMITTED THE ICMJE FORM FOR DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST. Funding/Support: Supported by the Canadian Institutes of Health Research and the Department of Ophthalmology and Vision Sciences, Toronto Western Hospital, Toronto, Ontario, Canada. Financial Disclosures: Yvonne M. Buys has provided expert testimony for Argentum Pharmaceuticals. The remaining authors indicate no financial support or financial conflict of interest. All authors attest that they meet the current ICMJE criteria for authorship.

Other Acknowledgments: This study made use of deidentified data from the Institute for Clinical Evaluative Sciences Data Repository, which is managed by the Institute for Clinical Evaluative Sciences with support from its funders and partners: Canada's Strategy for Patient-Oriented Research, the Ontario Strategy for Patient-Oriented Research Support Unit, the Canadian Institutes of Health Research, and the Government of Ontario. The opinions, results, and conclusions reported are those of the authors. No endorsement by the Institute for Clinical Evaluative Sciences or any of its funders or partners is intended or should be inferred.

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