

Impact of the adolescent pertussis booster dose on the incidence of pertussis in British Columbia and Quebec, Canada

David Bellemare, **Nicholas Brousseau**, Rachid Amini, Yayuk Joffres, Quinten Clarke, Gaston De Serres, Vladimir Gilca, Caroline Quach, Fabien Rallu, Linda Hoang, Danuta M. Skowronski

5 December 2018

Disclosure Statement

Disclosure of Relationship	Company/Organization(s)	If you think this might be perceived as biasing your presentation or a conflict of interest, identify how you will address this in your presentation.
I have ownership interest or other financial interest in the company (i.e. stocks, stock options or other ownership interest, excluding diversified mutual funds)		
I am a member of an Advisory Board or similar committee		
I am a member of a Speaker's Bureau		
I am involved in research grants and funding from industry		
I am currently participating in or have participated in a clinical trial within the past two years	Sub-investigator, clinical trial on a CMV vaccine (Merck & Co.)	
I have received honorarium, consulting fees, salary, royalty, grant-in-aid or other monetary support received from or expected from the company		
I have ownership in a patent for a product referred to in the presentation or marketed by the company		
I am involved in the design of clinical studies concerning the use of products manufactured by the company		
My spouse or close family member(s) have commercial affiliation(s)		

Introduction

- 1981/85: Fluid wP vaccines replaced by a poorly-protective adsorbed wP formulation in Canada
 - Resurgence of pertussis and moving cohort effect
- 1997/8: aP vaccine replace wP vaccine
- 2004: Adolescent Tdap booster program
 - **National goal: ↓ pertussis incidence among 10-19-year-olds to at least the levels observed among 1-4-year-olds**

aP, acellular pertussis

Tdap: tetanus toxoid, reduced diphtheria toxoid, and aP vaccine

wP, whole-cell pertussis

Skowronski et al., 2002, The Journal of Infectious Diseases; Public Health Agency of Canada, 2007, CCDR

Introduction

- More recently...
 - Significant waning of aP-vaccine-induced protection
 - Impact of aP priming
 - Recent epidemics in Canada
 - Increased incidence amongst pre-teens 10-14-years-old primed with aP vaccine

Chit et al., 2018, PLoS ONE; Chambers et al., 2014, CCDR; Chief Medical Officer of Health, 2014, New Brunswick Department of Health

Objective

- Assess the population impact of the adolescent Tdap program in BC and Quebec:
 - Compare the incidence of pertussis notifications and hospitalizations among individuals 15-19-years-old during periods before and after introduction of the adolescent Tdap booster program

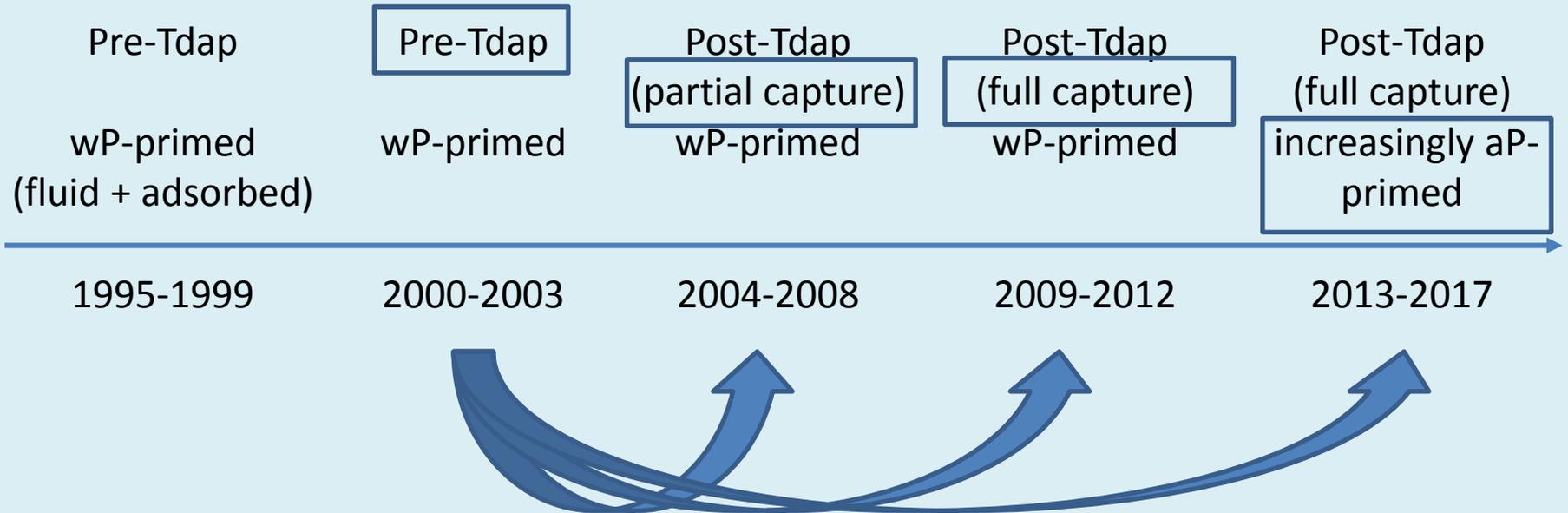
Methods

- Design
 - Time-series analysis of pertussis incidence (1995-2017)
- Study population
 - Cases meeting the national definition for **confirmed** pertussis
- Analysis
 - Incidence rates derived by age group and study period
 - Use of **incidence rate ratios** (IRR: incidence in 15-19-year-olds/incidence in <1-year-olds) to account for natural variation in pertussis cyclical peaks over time

* Rates of hospitalization assessed between 2000 and 2016 for the 15-19-year-old age group.

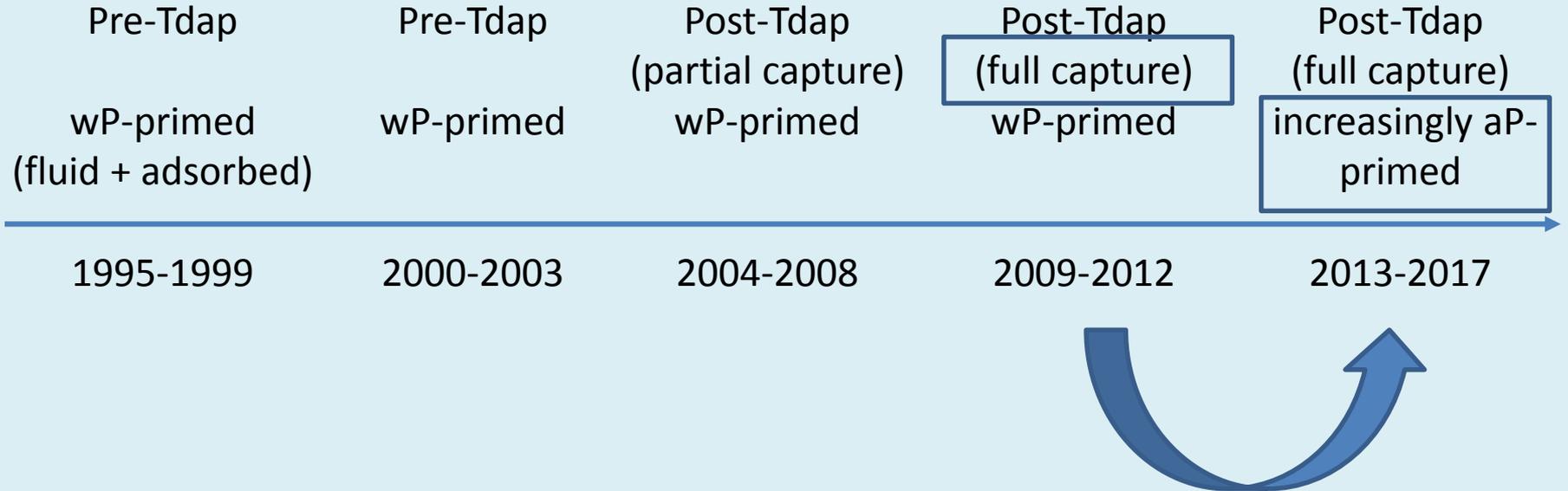
Methods

15-19-year-old cohort:



Methods

15-19-year-old cohort:



RESULTS

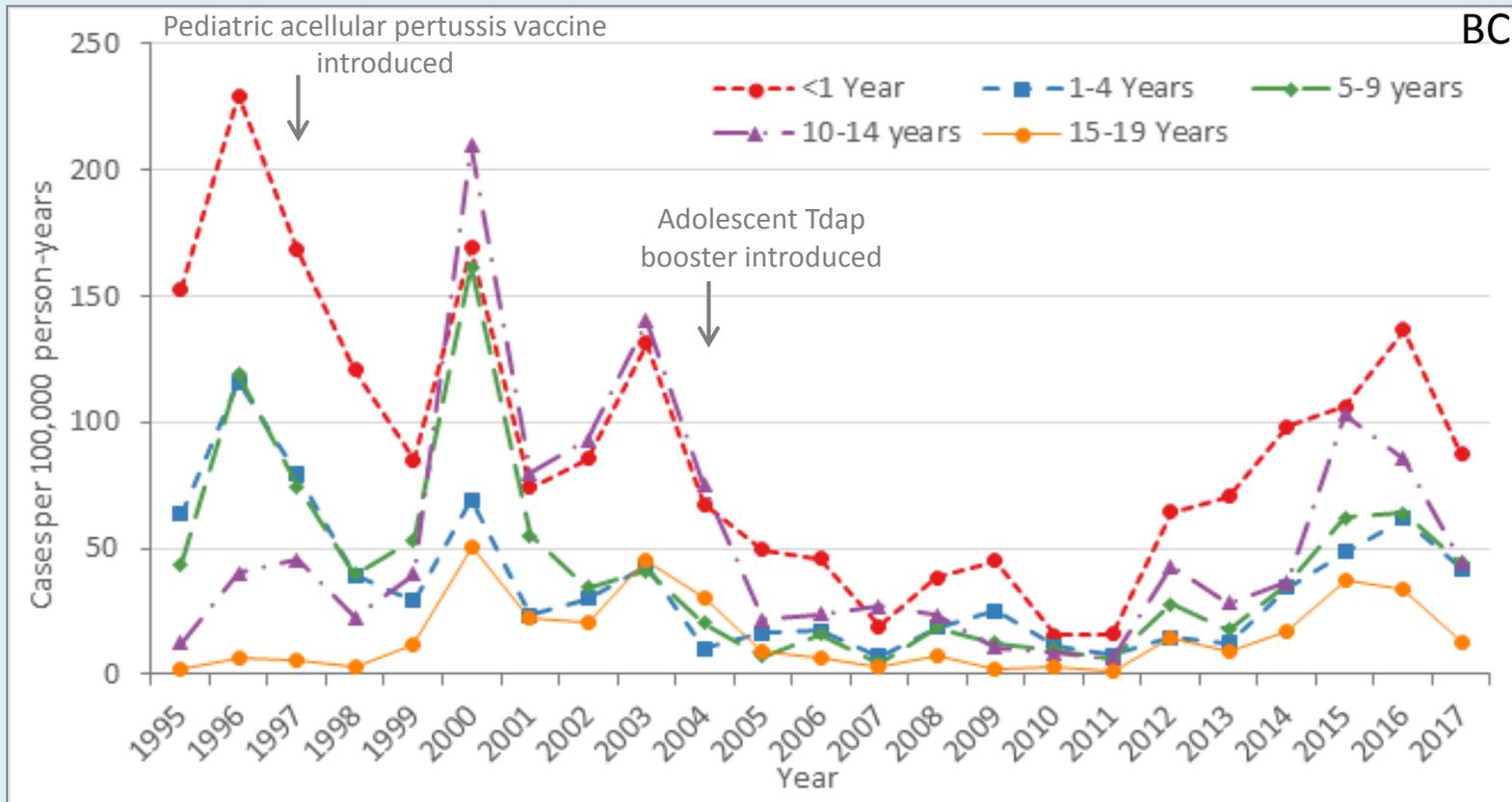


Figure. Pertussis incidence rates in British Columbia by age group, 1995-2017

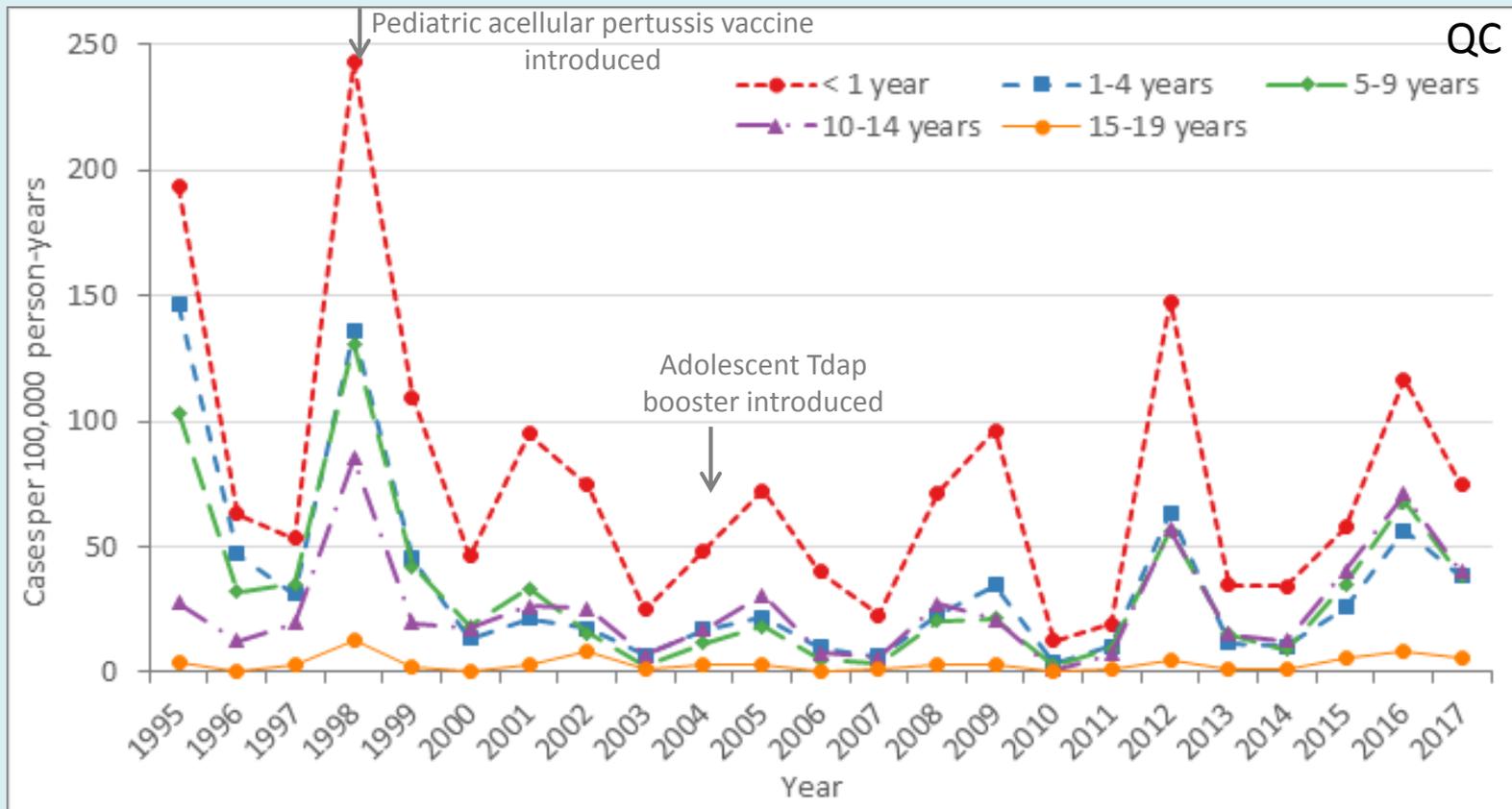


Figure. Pertussis incidence rates in Quebec by age group, 1995-2017

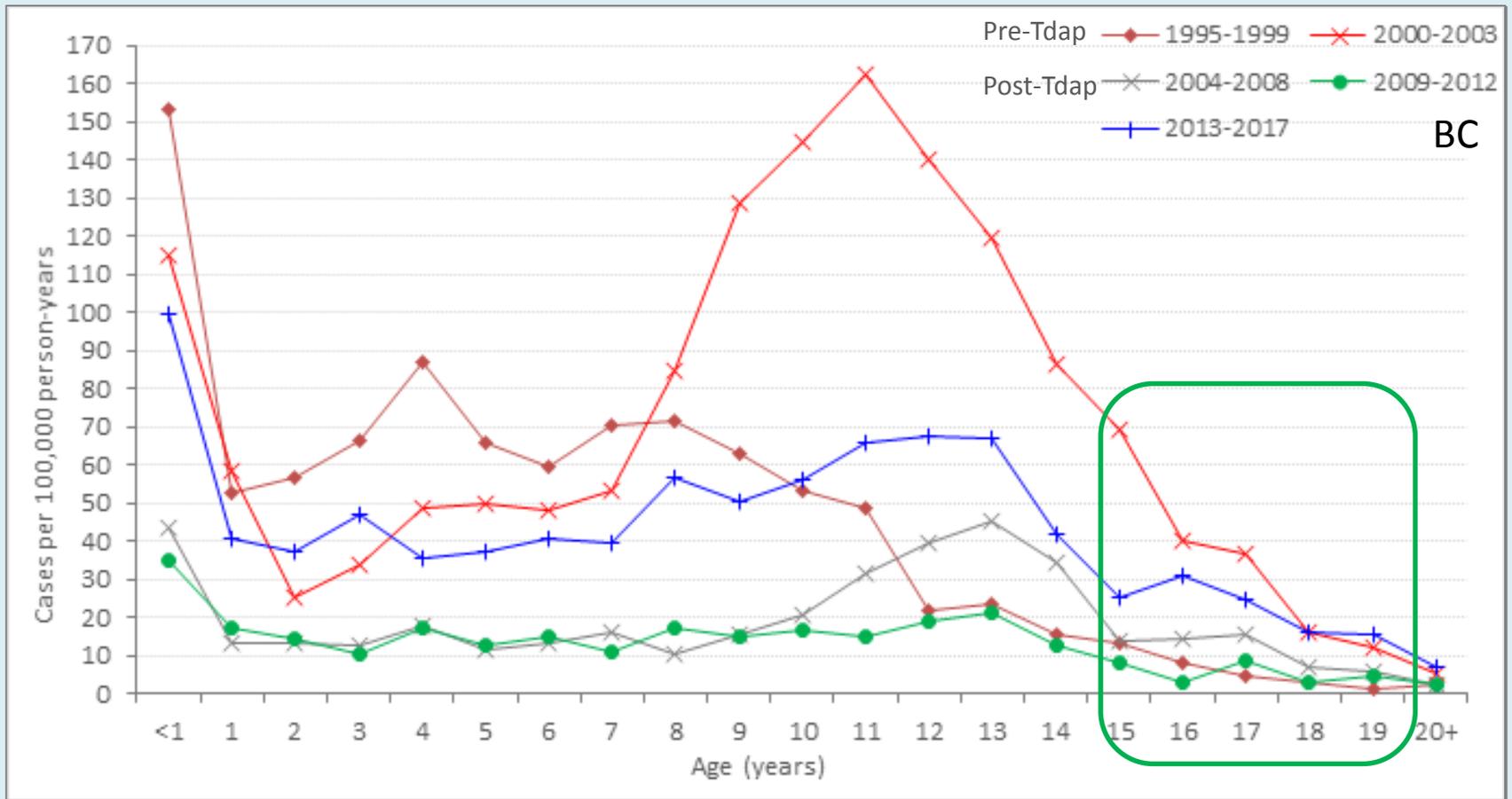


Figure. Pertussis incidence rates by age (single year) during pre- and post-Tdap periods in British Columbia

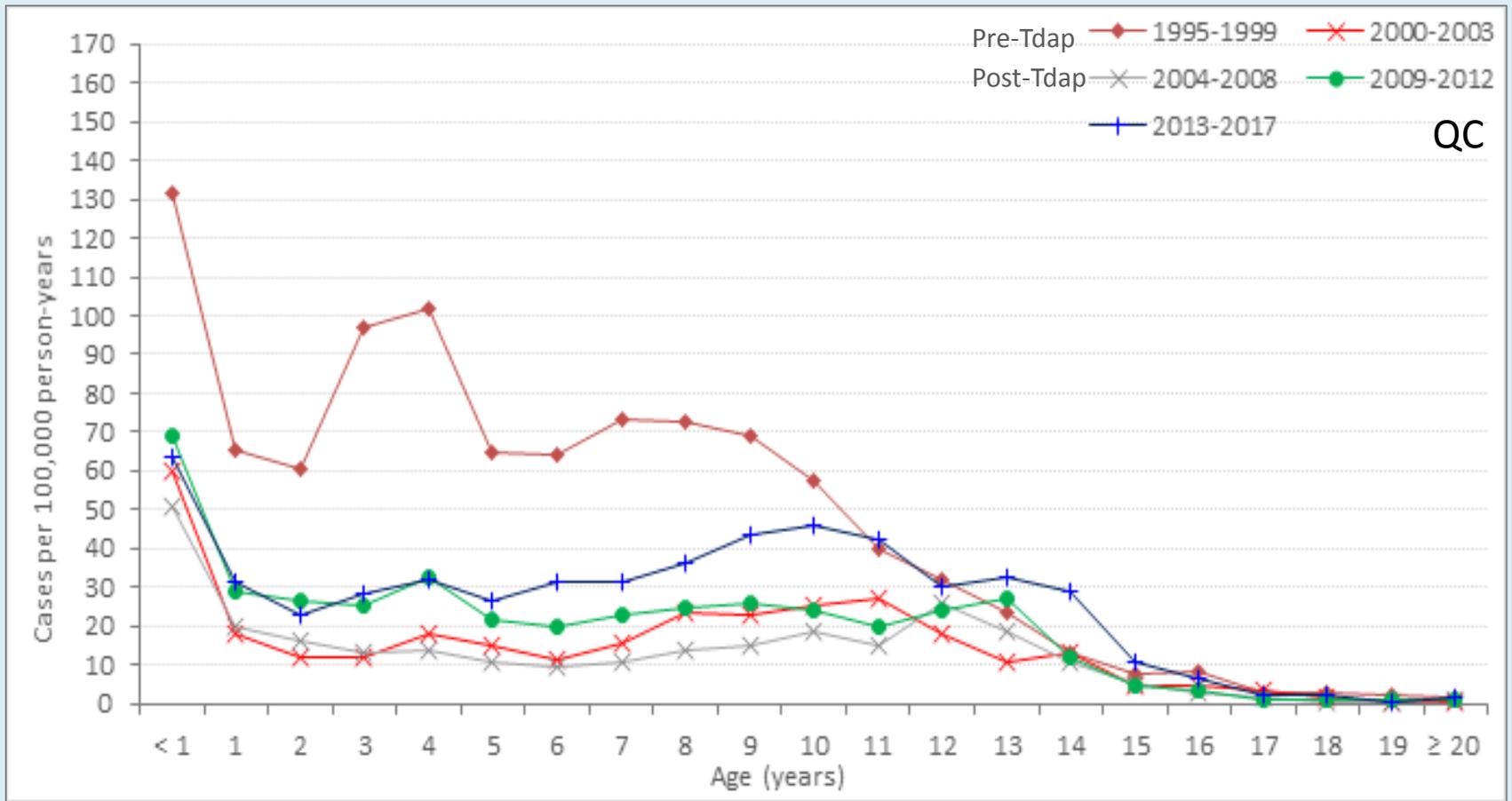


Figure. Pertussis incidence rates by age (single year) during pre- and post-Tdap periods in Quebec

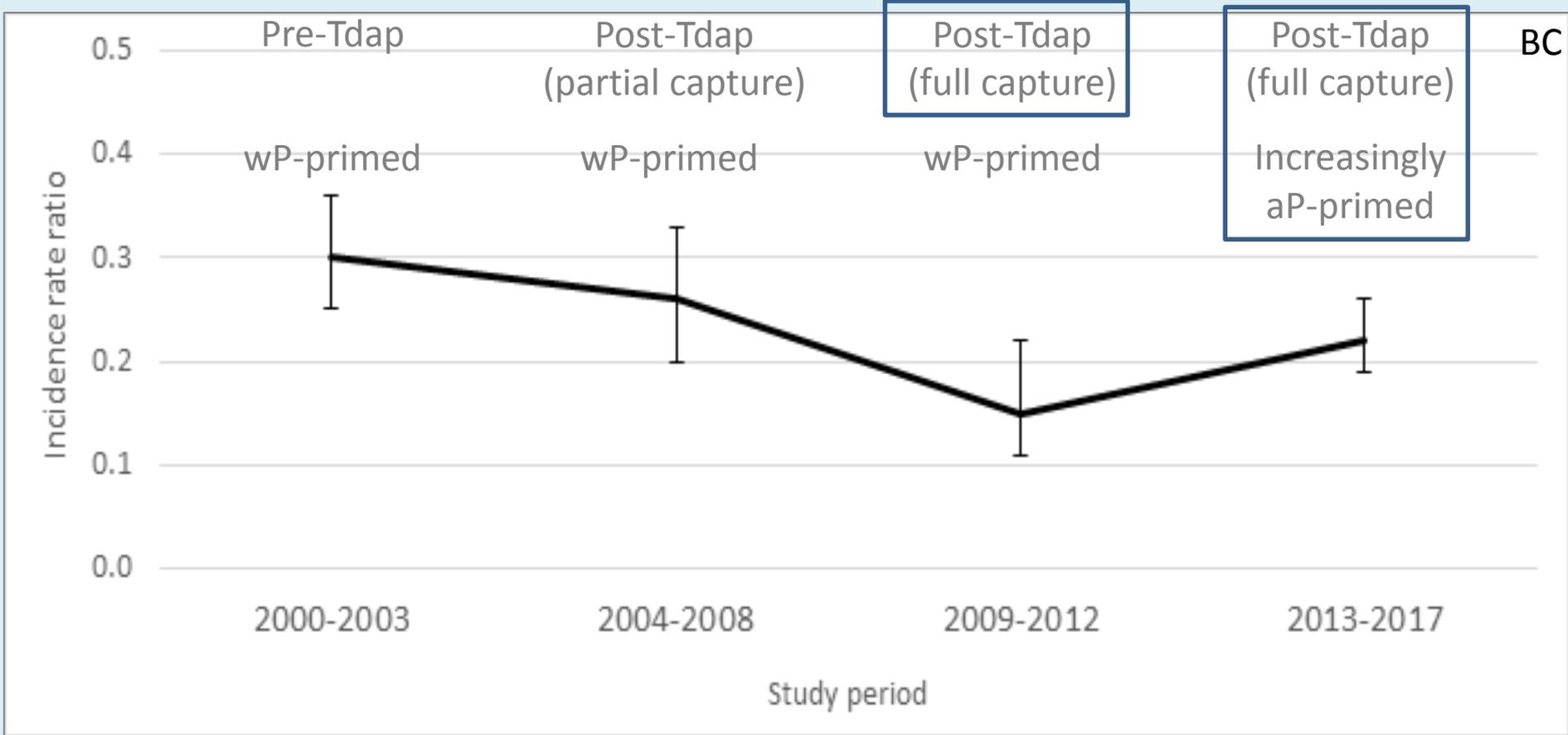


Figure. Pertussis **incidence rate ratios** for 15-19-year-olds vs <1-year-olds during pre- and post-Tdap periods in BC

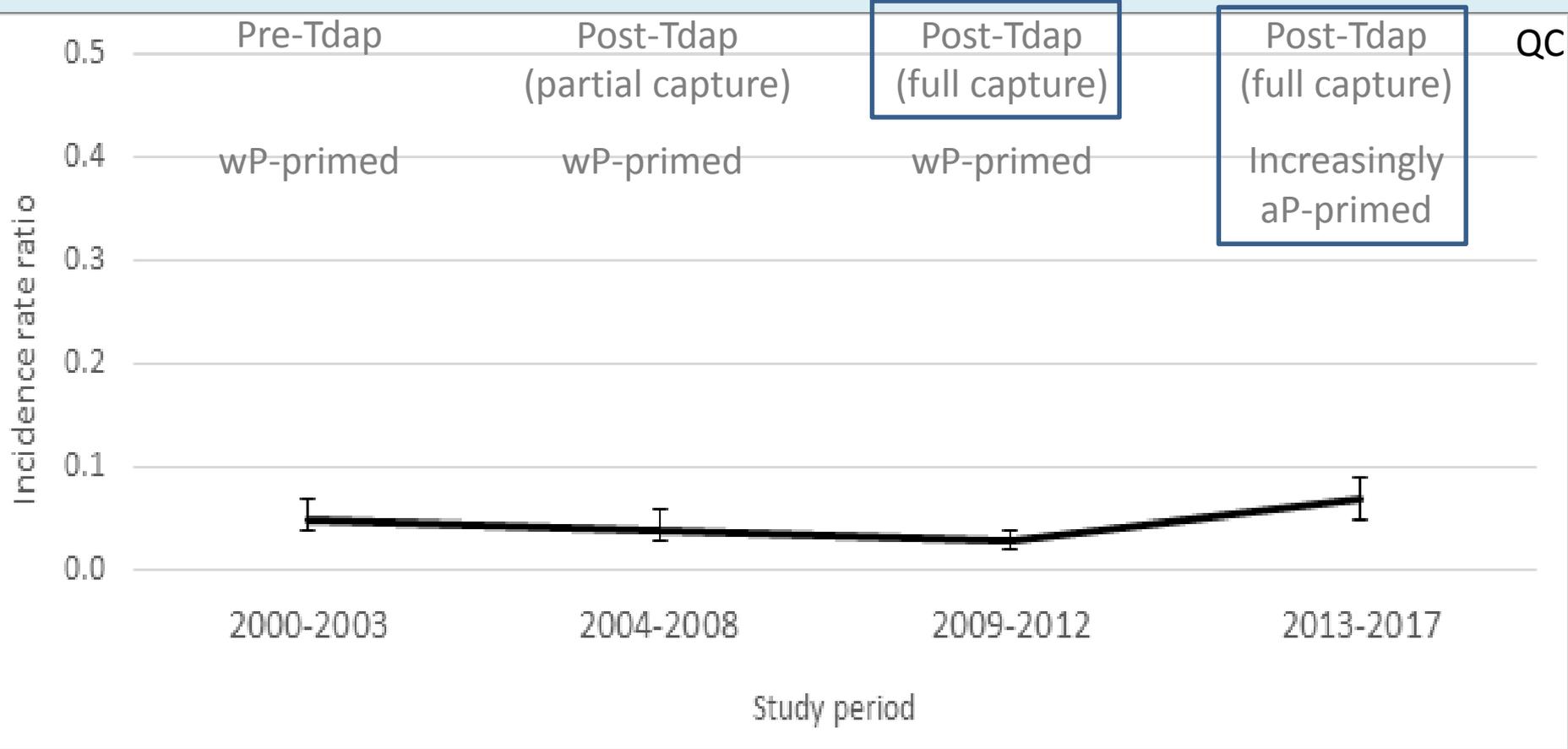


Figure. Pertussis **incidence rate ratios** for 15-19-year-olds vs <1-year-olds during pre- and post-Tdap periods in QC

Discussion

Adolescent Tdap booster program:

- IRRs significantly halved during the 2009-2012 post-Tdap period
- IRR increase during the 2013-2017 post-Tdap period among increasingly aP-primed 15-19-year-old adolescents
- Pertussis incidence among adolescents 15-19-years-old lower than other pediatric age groups (pre- and post-Tdap)
- Low risk of pertussis hospitalization among adolescents 15-19-years-old (<1/100,000 throughout the study period)*

Choi et al., 2016, BMC Medicine; Cherry, 2006, PIDJ; Amirthalingam, 2013, Arch Dis Child; Diavatopoulos and Edwards, 2017, Cold Spring Harb Perspect Biol; Skoff and Martin, 2016, JAMAPed)

* BC data source: Canadian Institute of Health Information [creator](2018): Discharge Abstract Database (Hospital Separations). British Columbia Ministry of Health [publisher]. Aggregate Data Report. MOH (2018). Quebec data source: Direction de la gestion des données et des outils de diffusion de l'information statistique (2018). Maintenance et exploitation des données pour l'étude de la clientèle hospitalière (MED-ÉCHO). Ministère de la Santé et des Services sociaux.

Conclusion

- Adolescent Tdap booster program in BC and Quebec
 - **Relative reduction of pertussis incidence among teens 15-19-years-old**
 - By about half in the post-Tdap full capture period compared to the pre-Tdap baseline period
 - **Absolute impact on pertussis disease burden likely minimal given lower pertussis incidence and risk of serious outcomes among 15-19-year-olds**
 - May have averted a moving cohort of increased susceptibility among individuals primed in the 1980s and 1990s with adsorbed wP vaccine, but this effect remains speculative
 - **Recent signal of diminished benefit among increasingly aP-primed 15-19-year-old individuals**
 - Warrants further monitoring and better understanding to inform potential program adjustments

Acknowledgements

- Danuta M. Skowronski
 - Yayuk Joffres
 - Quinten Clarke
 - Linda Hoang
- BC Centre for Disease Control
- Rachid Amini
 - David Bellemare
 - Gaston De Serres
 - Vladimir Gilca
 - Manale Ouakki
- Institut national de santé publique du Québec
- Caroline Quach
 - Fabien Rallu
- CHU Sainte-Justine

References

- Amirthalingam, G. 2013. « Strategies to Control Pertussis in Infants ». *Arch Dis Child* 98 (7): 552-5.
- Chambers, C, D M Skowronski, L Hoang, H Guiyun Li, C E Fritz, R Gustafson, M Murti, A Reid, R Parker, D Bowering. 2014. « Pertussis Surveillance Trends in British Columbia, Canada, over a 20-year Period: 1993-2013 ». *Can Commun Dis Rep* 40 (3): 31-41.
- Cherry, J D. 2006. « Epidemiology of Pertussis ». *The Pediatr Infect Dis J* 25 (4): 361-2.
- Chief Medical Officer of Health. 2014. « Pertussis Outbreak Investigation Report ». New Brunswick: Department of Health.
- Chit, A, H Zivaripiran, T Shin, J K H Lee, A Tomovici, D Macina, D R Johnson, M D Decker, J Wu. 2018. « Acellular Pertussis Vaccines Effectiveness over Time: A Systematic Review, Meta-Analysis and Modeling Study ». *PLoS One* 13 (6): e0197970.
- Choi, Y H, H Campbell, G Amirthalingam, A J van Hoek, E Miller. 2016. « Investigating the Pertussis Resurgence in England and Wales, and Options for Future Control ». *BMC Med* 14 (1): 121.
- Diavatopoulos, D A, K M Edwards. 2017. « What Is Wrong with Pertussis Vaccine Immunity? Why Immunological Memory to Pertussis Is Failing ». *Cold Spring Harb Perspect Biol* 9 (12): pii a029553.
- Public Health Agency of Canada. 2008. « Final Report of Outcomes from the National Consensus Conference for Vaccine-Preventable Diseases in Canada ». *CCDR* 34 Suppl 2:1-56.
- Skoff, T H, S W Martin. 2016. « Impact of Tetanus Toxoid, Reduced Diphtheria Toxoid, and Acellular Pertussis Vaccinations on Reported Pertussis Cases Among Those 11 to 18 Years of Age in an Era of Waning Pertussis Immunity: A Follow-up Analysis ». *JAMA Pediatr* 170 (5): 453-8.
- Skowronski, D M, N Z Janjua, E P Sonfack Tsafack, M Ouakki, L Hoang, G De Serres. 2012. « The Number Needed to Vaccinate to Prevent Infant Pertussis Hospitalization and Death Through Parent Cocoon Immunization ». *Clin Infect Dis* 54 (3): 318-27.
- Skowronski, D M, G De Serres, D MacDonald, W Wu, C Shaw, J Macnabb, S Champagne, D M Patrick, S A Halperin. 2002. « The Changing Age and Seasonal Profile of Pertussis in Canada ». *J Infect Dis* 185 (10): 1448-53.
- van Hoek, A J, N Andrews, H Campbell, G Amirthalingam, W J Edmunds, E Miller. 2013. « The Social Life of Infants in the Context of Infectious Disease Transmission; Social Contacts and Mixing Patterns of the Very Young ». *PLoS One* 8 (10): e76180.
- Warfel, J M, L I Zimmerman, T J Merkel. 2014. « Acellular Pertussis Vaccines Protect against Disease but Fail to Prevent Infection and Transmission in a Nonhuman Primate Model ». *Proc Natl Acad Sci U S A* 111 (2): 787-92.