

Babies with older siblings face higher infection risk, but are less protected through maternal immunisation

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IDI disclaimer

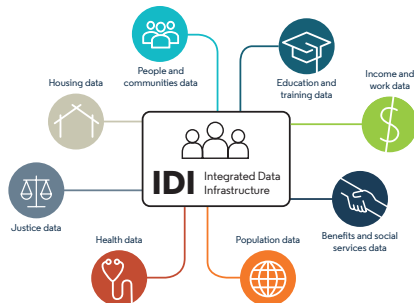
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Introduction

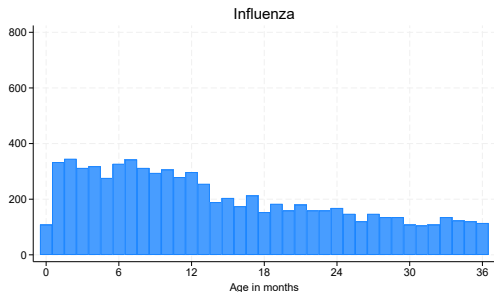
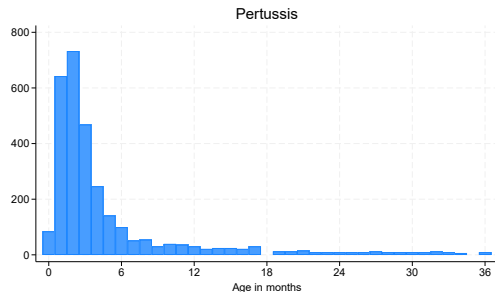
- ▶ pregnancy and infancy are periods of increased vulnerability to infections
- ▶ maternal immunisations: protect pregnant women and their infants
 - ▶  how does uptake of maternal immunisation against pertussis and influenza vary by birth order?
 - ▶  how is the relationship between birth order and childhood hospitalisation due to these diseases?
- ▶ growing evidence that birth order affects childhood health and parental behaviour
- ▶ parental behavior
 - ▶  mothers are less likely to attend pre-natal care and breastfeed later-born children (Buckles and Kolka, [2014](#); Brenøe and Molitor, [2018](#); Lehmann et al., [2018](#))
 - ▶  later-born children are less likely to participate in preventive medical health checks and have lower childhood immunisation uptake (Pruckner et al., [2021](#); Lin et al., [2022](#))
- ▶ family environment: older siblings can 'bring home' common viruses or bacteria
 - ▶  younger siblings have higher rates respiratory/infectious conditions in early life (Pruckner et al., [2021](#); Daysal et al., [2021](#))

Integrated Data Infrastructure (IDI)

- ▶ population-wide research database managed by StatsNZ
- ▶ linked micro-data from government agencies, NGOs, surveys
 - ▶ births from Department of Internal Affairs (DIA)
 - ▶ vaccine type and date from Aotearoa Immunisation Register (AIR) (*replaced the National Immunisation Register*)
 - ▶ hospital discharge records from Ministry of Health (MoH) with diagnostic information
 - ▶ National Maternity Collection: visits to lead maternity carer

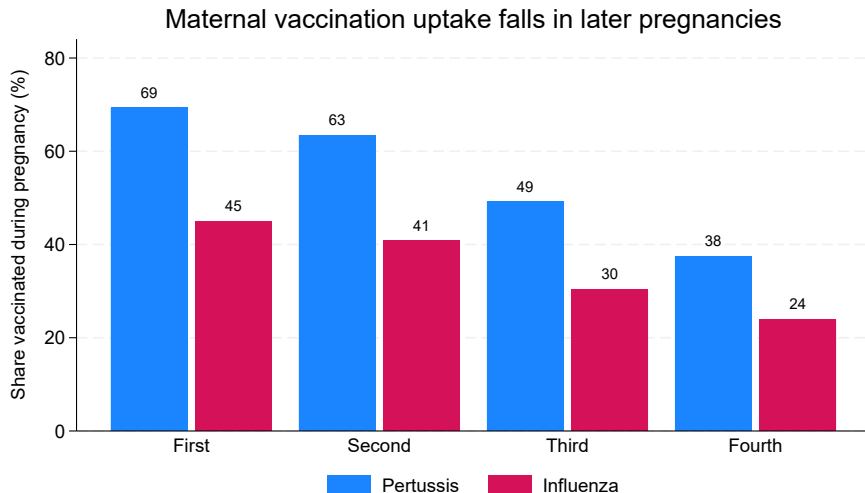


Pertussis and influenza hospitalisations in NZ



- ▶ repeated **pertussis** (= whooping cough) outbreaks in NZ
 - ▶ young infants face a higher risk of hospitalisation and death (Kandeil et al., 2020)
- ▶ annual **influenza** seasons
 - ▶ approximately 1 in 5 unvaccinated children and 1 in 10 unvaccinated adults infected by seasonal influenza annually (Somes et al., 2018)
- ▶ potential long-term effects: brain development (Al-Haddad et al., 2019), socio-economic outcomes (Almond, 2006)

Maternal vaccination in NZ



Share of mothers receiving pertussis or influenza vaccination during pregnancy, by birth order. Data cover pregnancies resulting in births in New Zealand from July 2024 to June 2025.

Empirical strategy

$$Y_{im} = \alpha + \sum_j \beta_j I(BO_{im} = j) + \gamma X_i + \delta_m + \epsilon_{im},$$

Y_{im}	outcome of pregnancy/child i of mother m
$BO_{im} = j$	birth order indicators ($j = 2, 3, 4$)
X_i	sex, year-by-month of birth
δ_m	mother fixed effects

- ▶ exploit within-family variation in birth order to account for time-constant unobserved factors at the family level (e. g., genetic endowment, SES)
- ▶ main sample: children born between 2015-2023 for maternal immunisations
 -  mother with at least 2 live births
 -  excluding mothers with multiple births

Effects of birth order on immunisations

	(1) Maternal Tdap	(2) Maternal Influenza	(3) All infant immunisations
Birth order 2	-0.070*** (0.004)	-0.014*** (0.004)	-0.018*** (0.001)
Birth order 3	-0.114*** (0.007)	-0.044*** (0.007)	-0.036*** (0.002)
Birth order 4	-0.160*** (0.012)	-0.096*** (0.011)	-0.061*** (0.004)
N	208,632	208,632	486,825
Mean	0.427	0.323	0.917

Notes: Births between 2015 and 2023 in columns 1-2, and births between July 2007 and June 2022 in column 3. Regressions include mother fixed effects, year by month of birth fixed effects, and a female indicator. The mean of the dependent variable is displayed at the bottom of the table. Standard errors in parentheses are clustered at the mother level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Why do maternal immunisations decrease with birth order?

- ▶ mothers may believe immunisation during an earlier pregnancy provides sufficient protection
 -  test: use a sample of mothers who received maternal immunisation during their first pregnancy and had at least two subsequent pregnancies
 -  would expect a higher vaccine uptake for the third pregnancy compared to the second
 -  finding: lower uptake of maternal immunisation for third than second pregnancy
- ▶ adverse effects of immunisation at earlier pregnancies?
 -  medical literature suggests severe side-effects are rare
 -  controlling for hospitalisations during previous pregnancy does not affect results
- ▶ significant birth order effects also number of visits to LMC and ultrasounds during pregnancy
 -  less recommendations/opportunities for vaccinations
 -  generally lower uptake of services during pregnancy → parental behaviour and resources (time constraints)
 -  parents become more experienced, changing how they approach pregnancy and infant care

Effects of birth order on infant hospitalisations for infectious diseases

	(1) Pertussis	(2) Influenza	(3) RSV
Birth order 2	46.3*** (13.3)	58.6*** (17.7)	1252.4*** (44.6)
Birth order 3	92.3*** (26.9)	121.4*** (35.9)	1857.9*** (86.6)
Birth order 4	109.4* (43.8)	220.5*** (60.3)	2486.5*** (141.4)
N	875,100	875,100	875,100
Mean	124.1	236.2	1612.3

Notes: Coefficients and Standard errors scaled to per 100,000 children. Births between 2000 and 2023. Regressions include mother fixed effects, year by month of birth fixed effects, and a female indicator. The mean of the dependent variable is displayed at the bottom of the table. Standard errors in parentheses are clustered at the mother level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Summary & discussion

- ▶ decrease of maternal immunisation uptake with each subsequent pregnancy
- ▶ pertussis and influenza hospitalisations increase with birth order
 -  *because* of lower maternal immunisations? not sole explanation: birth order effects for infant hospitalisations due to RSV
 -  *contagion effect*: having older siblings increases exposure
- ▶ double disadvantage for later-born children
 -  lower uptake of maternal immunisation + increased exposure to infectious diseases
 -  infants who would benefit the most from protection tend to miss out most often
- ▶ policy implications
 -  access barriers such as gaps in awareness, time constraints and difficulty accessing services may be particularly relevant for later pregnancies
 -  policy initiatives may be particularly effective if they target later pregnancies
 -  current expansion of where immunisations are delivered may help reduce birth-order differences

Thank you!

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Further reading:

- ▶ **Academic paper:** Schober, T. (2026). *Birth order and infant health: Evidence from maternal immunisation in New Zealand*. [Social Science & Medicine, 401, 119352](#)
- ▶ **Conversation article:** Schober, T. (2026). *Babies with older siblings have a higher infection risk, but are less protected through vaccination*. [The Conversation](#).

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- ▶ Somes, Mitchell P, Robin M Turner, Liam J Dwyer, and Anthony T Newall (2018). "Estimating the annual attack rate of seasonal influenza among unvaccinated individuals: a systematic review and meta-analysis". In: *Vaccine* 36.23, pp. 3199–3207.