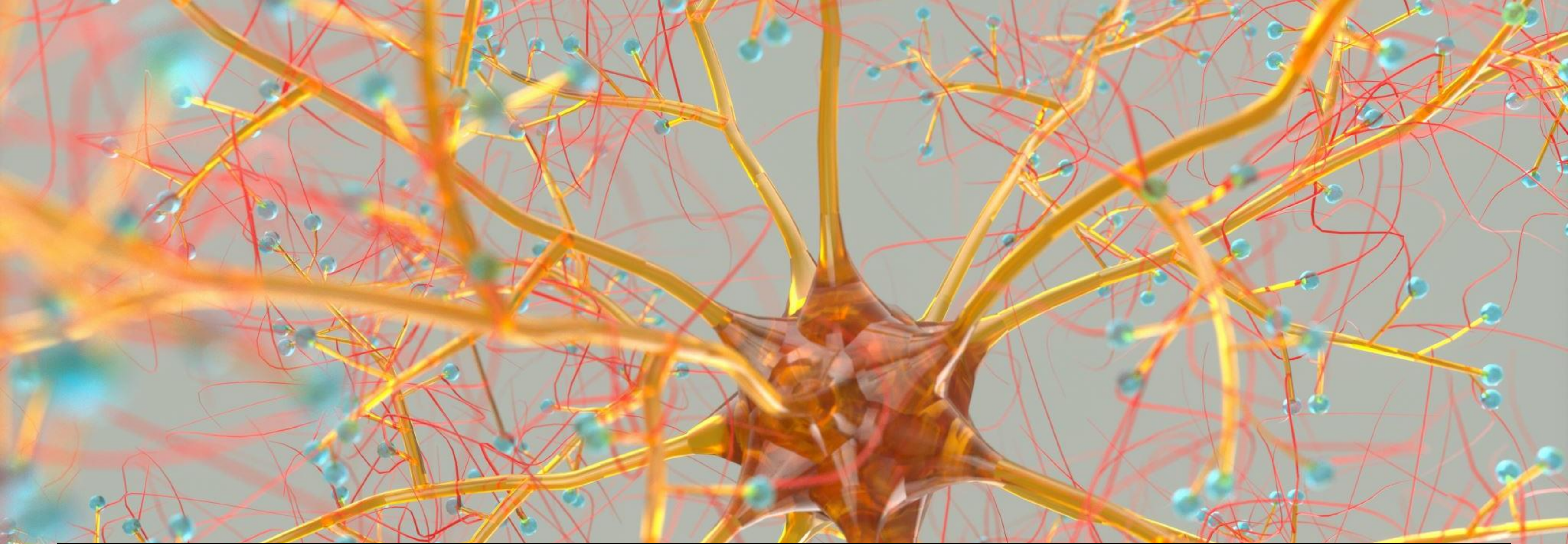


ASSESSMENT OF DELAY IN AGE-APPROPRIATE VACCINATION USING SURVIVAL ANALYSIS

STAT 2261 FINAL PROJECT

APRIL 2021

ORLY OLBUM

THE MOTIVATION

- Study:
  - How well are vaccines performing in terms of arming a population against a disease?
  - What factors might affect whether children receive vaccines on time (age-appropriate)?
  - How can health policy makers and healthcare officials determine how well they are taking care of the community?
- Personal:
  - Vaccines are a hot topic nowadays
  - Interest in general vaccine research to understand vaccine studies surrounding COVID-19

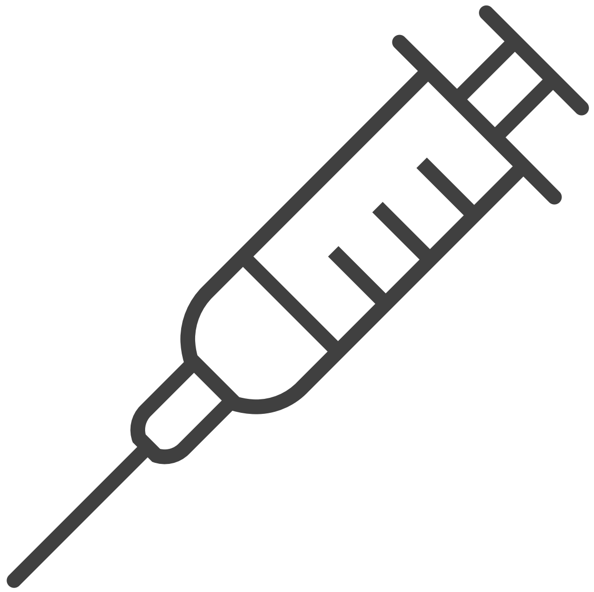
THE OVERVIEW

- Use vaccination coverage as an indicator of vaccination program performance
- Want children to receive vaccinations as early as possible, on schedule
  - US target: 80% for children 19-35 months
  - US reality: 18% of children receive vaccines by recommended ages
- If children aren't vaccinated on time/age-appropriately, disease risk for the general population increases
  - Common measure: up-to-date vaccination
  - Desired measure: age-appropriate vaccination
- How can we describe this data?
  - Use Kaplan-Meier method to describe time-to-event data
  - Consider outside characteristics that may be associated with delay in vaccination

THE SURVEY

- Buenos Aires, March 8, 2002 – April 20, 2002
- Survey of 13-59-month-old children
- Consider 3 different vaccines recommended to children between birth and 59 months old
- Objectives
  1. Estimate vaccination uptake
  2. Identify sociodemographic factors associated with delayed vaccination
- Data collected through face-to-face interviews
  - Child: d.o.b., sex, country of birth, ethnicity, number and age of siblings, child-care attendance, health insurance, type of immunization provider (public, private, both)
  - Caregiver: age, marital status, work, education

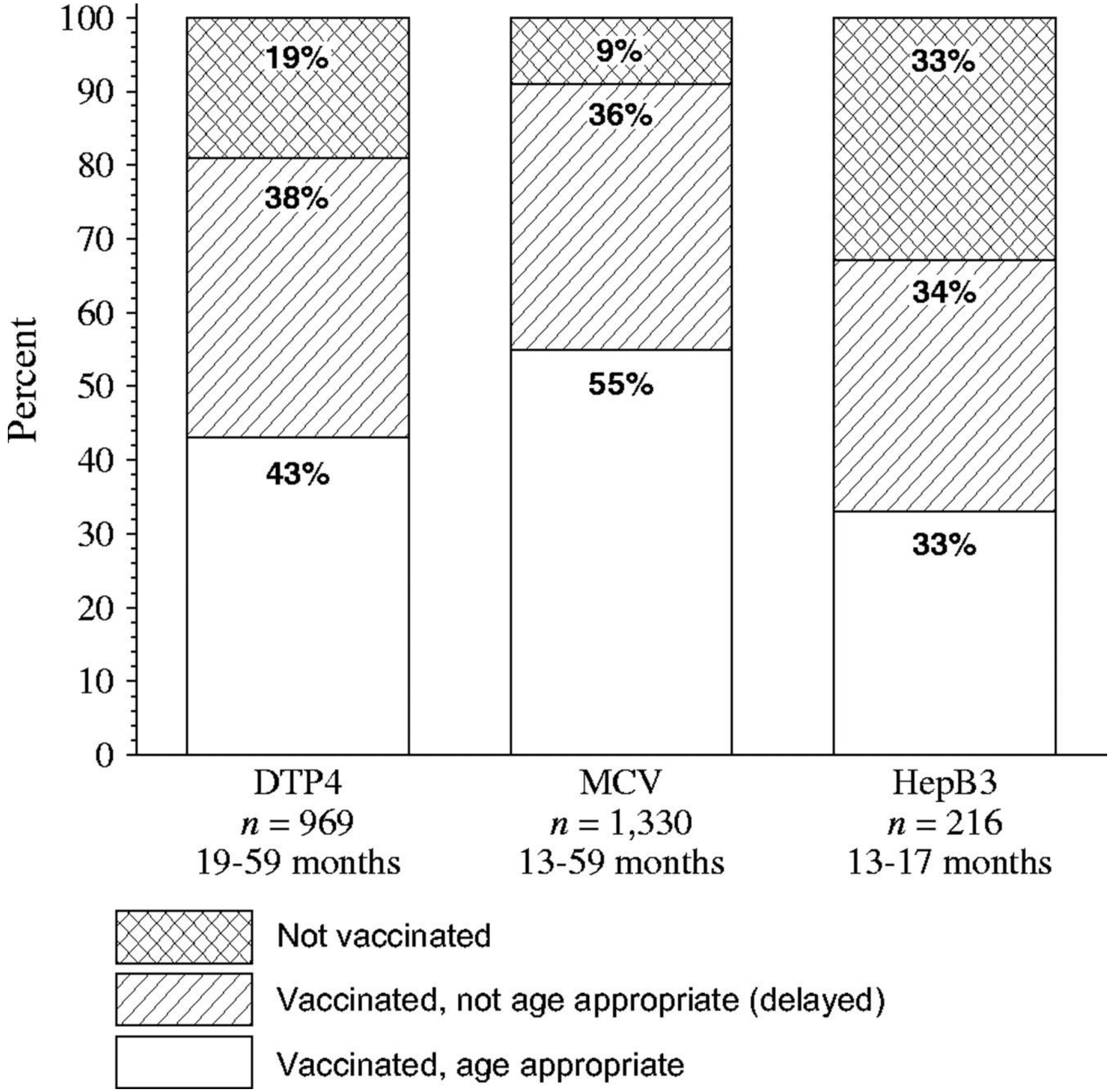
THE VACCINES



- Diphtheria, Tetanus, and Pertussis (DTP)
  - Long-established
  - Several doses scheduled for first 2 years of life
- Measles-containing Vaccine (MCV)
  - Long-established
  - One dose at 1 year
- Hepatitis B (HepB)
  - Recently introduced
  - Several doses scheduled for first year of life

THE DATA

- Measure: months (30.5 days)
- Restrictions:
  - DTP4: children at least 580 days by start of study
  - MCV: children at least 397 days by start of study
  - HepB3: children born after Nov 1, 2000
- Final sample sizes:
  - DTP4: 969 children aged 19-59 months
  - MCV: 1,330 children aged 13-59 months
  - HepB3: 216 aged 13-16 months



THE ANALYSIS: KM CURVES

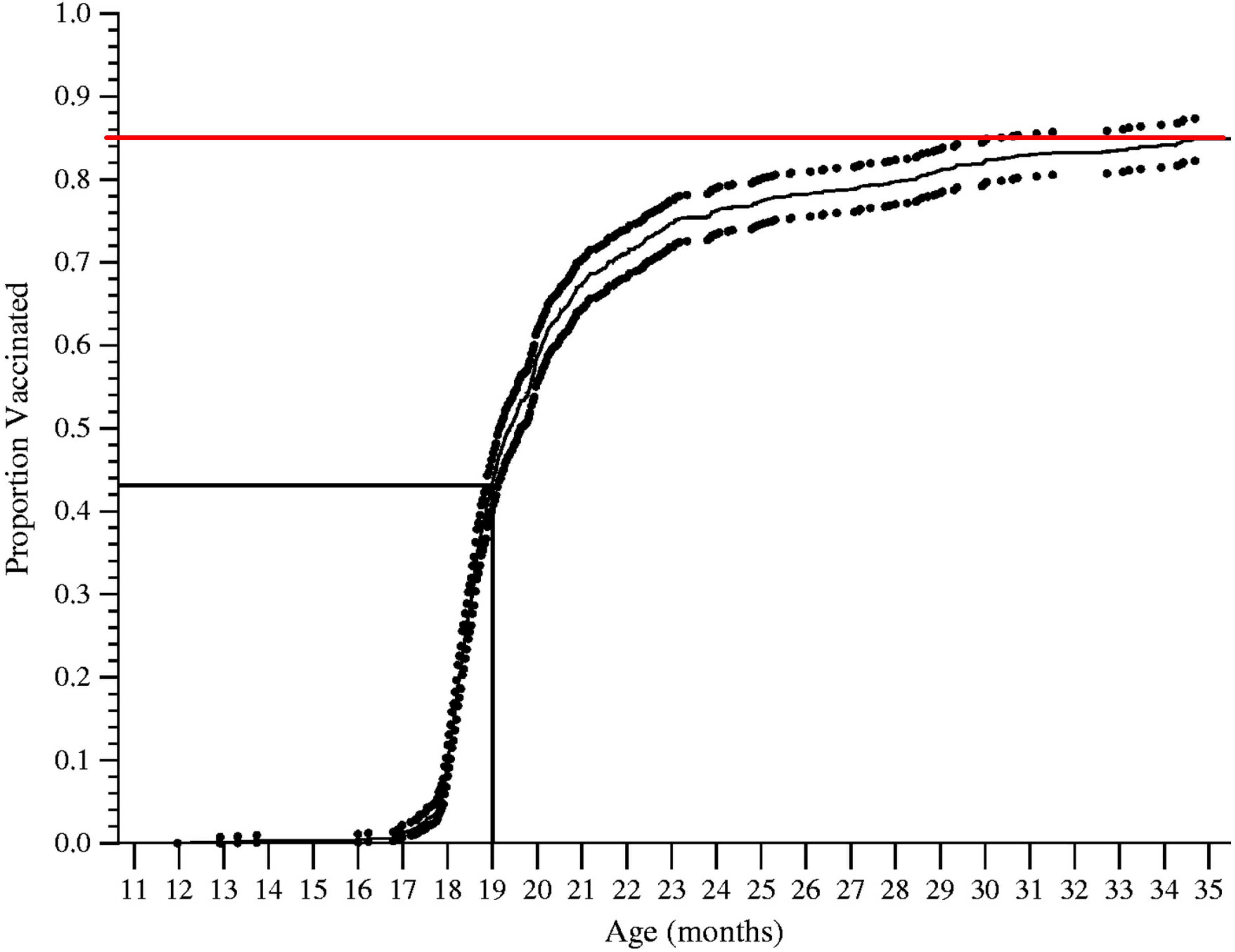
- Coverage by age estimated using Kaplan-Meier

$$1 - S_{KM}(t)$$

  - At age t (in months)
  - Formula above is cumulative probability of being vaccinated by age t
- KM curves with 95% CIs on following tabs
- Log-binomial regression analysis used to determine associated between characteristics and delayed vaccination
  - Analysis done in SAS
  - GENMOD procedure

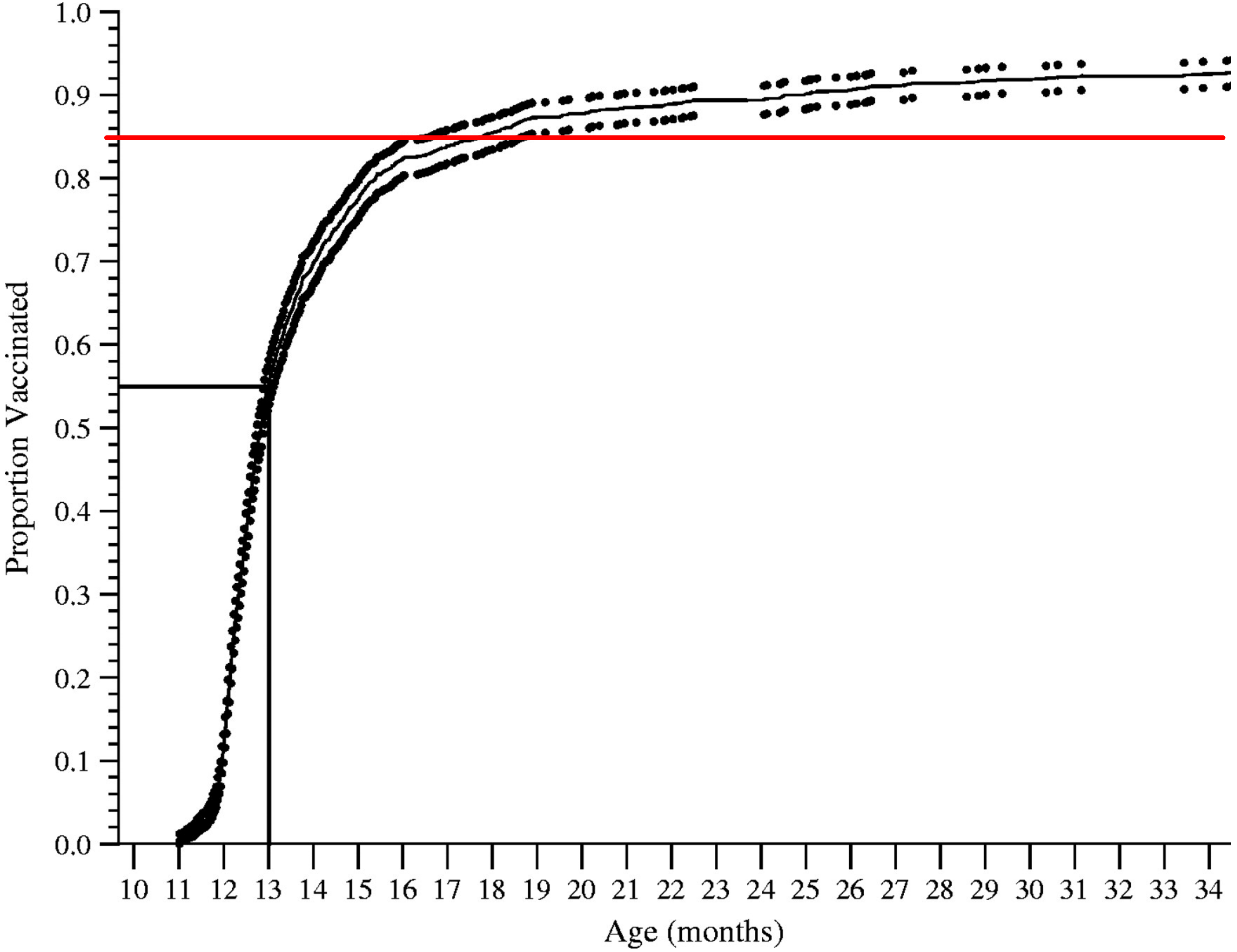
KM CURVE: DTP4

- Max age of DTP4 recommended: 19 months
- 81% up-do-date vaccinated
- 43% age-appropriately vaccinated (reference line)



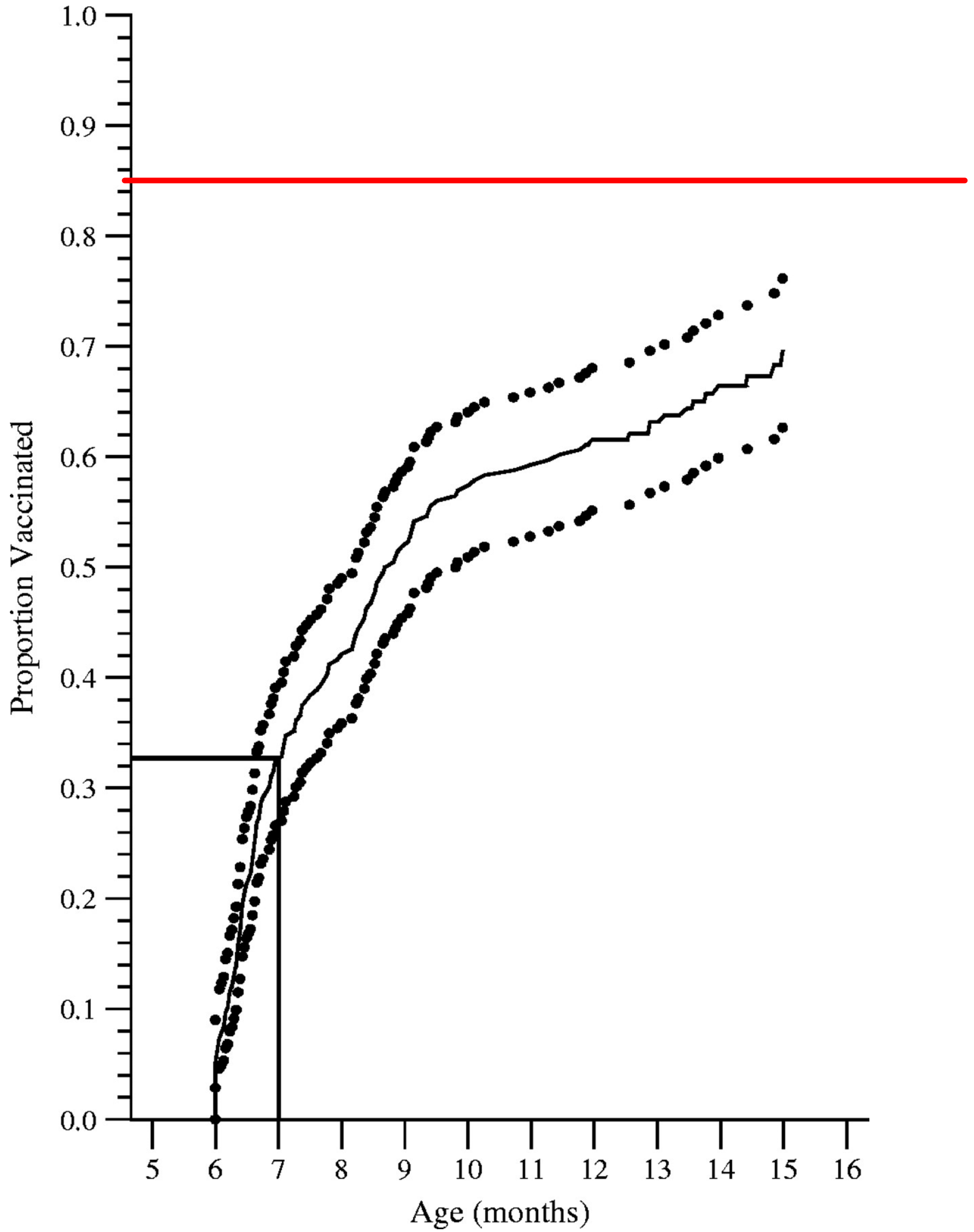
KM CURVE: MCV

- Max age of MCV recommended: 13 months
- 91% up-do-date vaccinated
- 55% age-appropriately vaccinated (reference line)



KM CURVE: HEPB3

- Max age of HepB3 recommended: 7 months
- 67% up-to-date vaccinated
- 33% age-appropriately vaccinated (reference line)



THE ANALYSIS: KM CURVE INTERPRETATION

- Interested in the delay vaccination uptake
  - I.e., how long does it take past the recommended line (reference lines on KM graphs) for a certain proportion of children to be vaccinated?
  - Desired proportion: 85% (red lines)
- DTP4: 18-month delay
- MCV: 6-month delay
- HepB3: curve does not reach 85% coverage by 16 months
  - 9-month delay for 70% coverage

THE ANALYSIS: CHARACTERISTICS (BIVARIATE ANALYSIS)

Vaccine	Significant Characteristic
DTP4	Position in family
	Provider of vaccine
	Health insurance
	Education
MCV	Position in family
	Health insurance
	Education
HepB3	Position in family
	Zone

THE ANALYSIS: CHARACTERISTICS (MULTIVARIABLE ANALYSIS)

Characteristic	DTP4		MCV		HepB3	
	RR	95% CI	RR	95% CI	RR	95% CI
Position in the family						
First child	1	Referent	1	Referent	1	Referent
Second child	1.32	1.15, 1.51	1.40	1.20, 1.62	1.34	1.08, 1.65
Third child	1.41	1.22, 1.62	1.54	1.32, 1.78	1.31	1.03, 1.67
Unknown	1.49	1.17, 1.90	1.30	0.97, 1.74	1.29	0.95, 1.75
Provider of vaccine						
Public only	1	Referent				
Private only	0.94	0.79, 1.12				
Both public and private	0.90	0.75, 1.07				
Unknown	0.70	0.33, 1.49				
Health insurance						
No health insurance	1	Referent	1	Referent		
Union insurance	0.86	0.75, 0.97	0.82	0.72, 0.93		
Private prepaid medicine	0.86	0.70, 1.06	0.91	0.75, 1.09		
Unknown	0.86	0.46, 1.59	0.72	0.48, 1.08		
Education						
No education/incomplete primary	1	Referent	1	Referent		
Primary complete	0.74	0.57, 0.96	1.13	0.77, 1.66		
Secondary complete	0.68	0.52, 0.90	1.18	0.81, 1.73		
Tertiary/university complete	0.81	0.60, 1.08	0.95	0.63, 1.43		
Unknown	0.78	0.57, 1.07	1.4	0.93, 2.11		
Zone						
Northern					1	Referent
Central					0.71	0.56, 0.90
Southern					0.96	0.78, 1.17

THE ANALYSIS: RELATIVE RISK

Non-first child

Union health insurance

Secondary/Tertiary education

Central Zone

Variable	DTP4	MCV	HepB3
Second Child	RR: 1.32 CI: (1.15, 1.51)	RR: 1.40 CI: (1.20, 1.54)	RR: 1.34 CI: (1.08, 1.67)
Third Child	RR: 1.41 CI: (1.22, 1.62)	RR: 1.54 CI: (1.32, 1.78)	RR: 1.31 CI: (1.03, 1.67)
Union Health Insurance	RR: 0.86 CI: (0.75, 0.97)	RR: 0.82 CI: (0.72, 0.93)	-
Secondary Ed.	RR: 0.68 CI: (0.52, 0.90)	-	-
Tertiary Ed.	RR: 0.81 CI: (0.60, 1.08)	-	
Central Zone	-	-	RR: 0.71 CI: (0.56, 0.90)

THE LIMITATIONS

- Only children with valid vaccination records were accepted for the survey
  - Other studies of the same nature show that most children with such vaccine records are generally white, from families not in poverty, with two parents, and covered by health insurance
  - These same traits are generally associated with less delay in vaccination, which leads to underestimates of delays
- Children who moved or died were not included
  - Might lead to some bias in estimating the curve
  - However, study was focused just on children living in the area

THE TAKEAWAYS

- How does this information help?
  - Health policy makers
  - Healthcare providers
  - Estimate protection of adult population from disease
- Missing information
  - Children with invalid doses were not included
  - Censored data may provide a different picture
  - Difference between up-to-date and age-appropriate vaccinations
- Answer questions
  - At what age is a certain vaccination coverage achieved?
  - Assess performance of a program in reaching target coverage rates

THE NEXT STEPS

- How can we apply this to other countries?
- What characteristics might be missing from this analysis?
- How can the survival curve be applied to other vaccination studies?
- Which questions from policy makers and health insurance companies can be answered using this type of analysis?

THANK YOU!
QUESTIONS?

SOURCES

- Gustavo H. Dayan, Kate M. Shaw, Andrew L. Baughman, Liliana C. Orellana, Raúl Forlenza, Alejandro Ellis, Jorge Chaui, Silvia Kaplan, Peter Strebel, Assessment of Delay in Age-appropriate Vaccination Using Survival Analysis, *American Journal of Epidemiology*, Volume 163, Issue 6, 15 March 2006, Pages 561–570, https://doi.org/10.1093/aje/kwj074