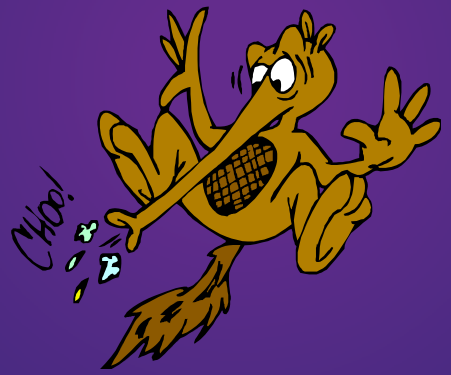
The Burden of Influenza in New Zealand:

Statistical Modelling of Influenza-Associated Mortality, 1994 – 2008



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Dr. James Stanley, Biostatistician and Research Fellow, University of Otago
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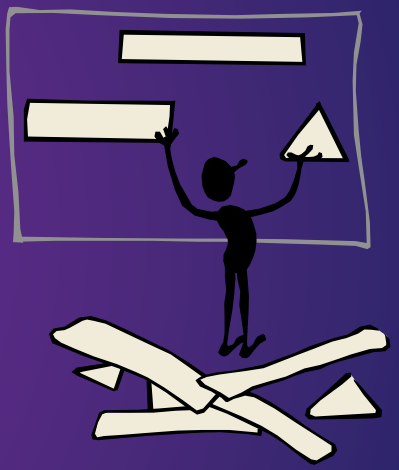
The modeling for this research was programmed by Dr. James Stanley

Outline

- **Rationale**
- **Methods**
    - **Poisson Regression**
- **Results**
- **Limitations**
- **Future Research and Action**



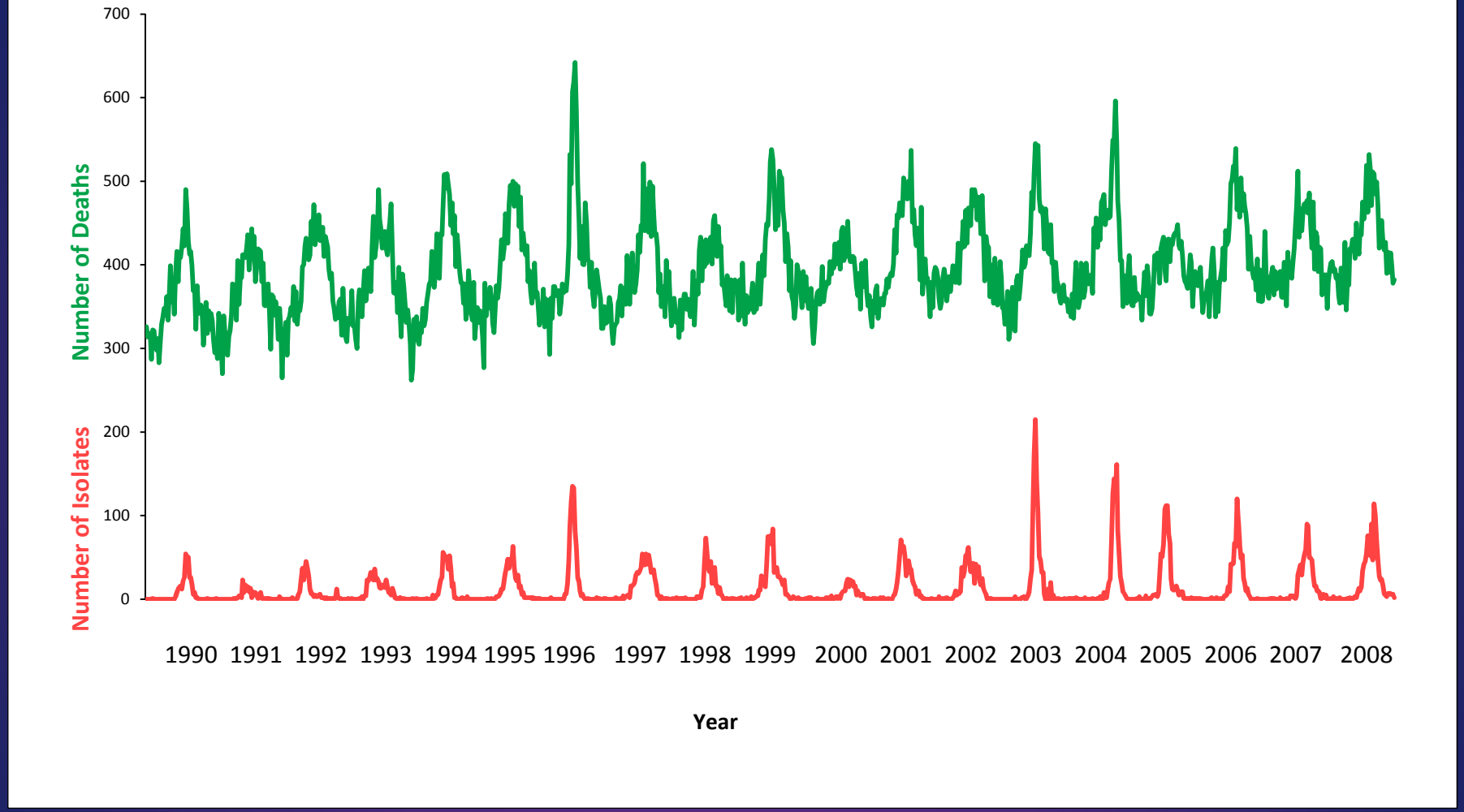
Rationale

Sequelae from influenza infection - respiratory, neurological, and especially cardiovascular events.

Influenza may not be suspected or diagnosed.

Role of influenza is under stated in the Mortality Collection.

The rise in mortality in influenza periods has long since been recognised.



Observed weekly number of deaths due to all causes in those ≥65 years and influenza isolates in New Zealand from 1990 to 2008. Data sources: Ministry of Health Mortality Collection, ESR Weekly Virology Reports.

Methods

4 Ways to Model

Rate Difference Model

ARIMA Model
(Autoregressive Integrated Moving Averages)

Serfling Model/Cyclical Regression Model

Poisson Regression Model

Poisson Regression

- Changes in the population size using census data
- Changes in the trend in mortality over time
- Seasonality of deaths
- Respiratory Syncytial Virus isolate counts
- Influenza A and influenza B isolate counts
  (Hospital and sentinel surveillance combined)

Mortality Collection

- Respiratory and Circulatory
- All causes
- <65, ≥65, all ages

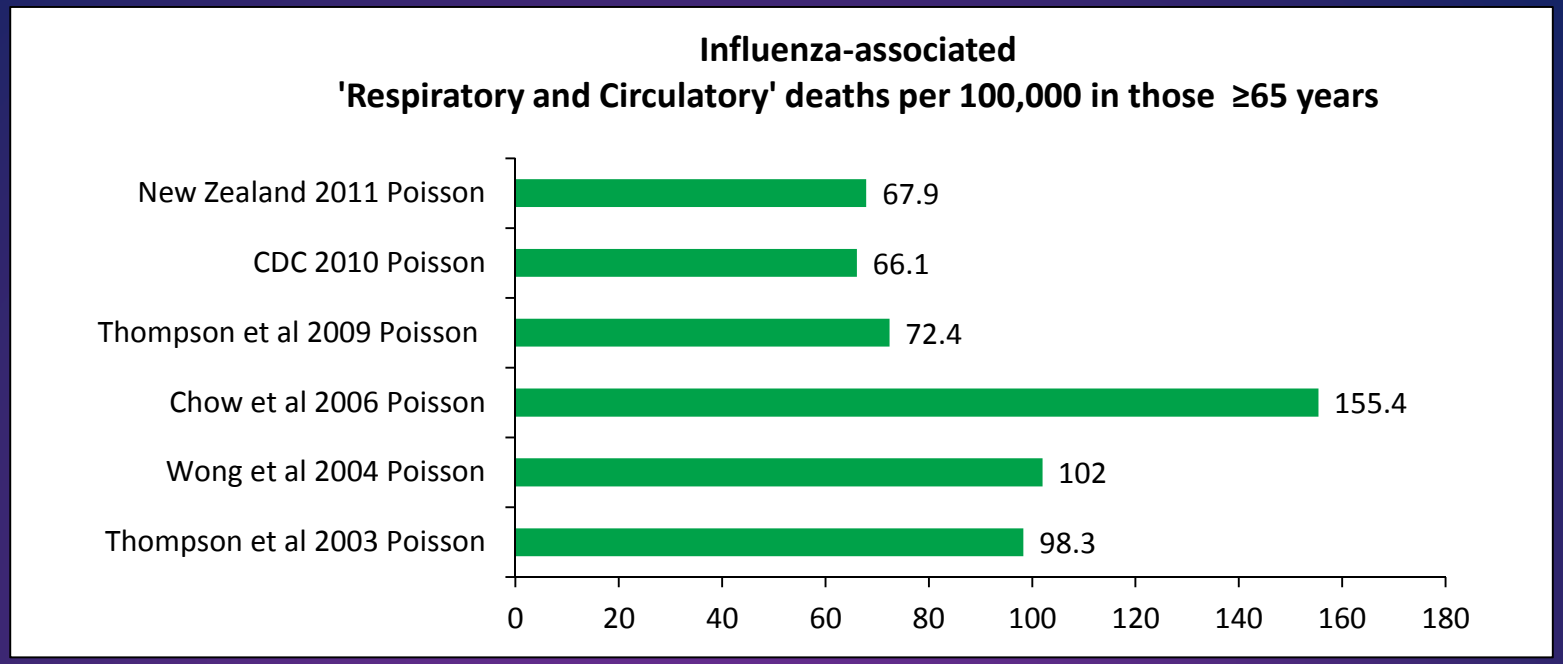
$$Y_i = \alpha \exp\{\beta_0 + \beta_1(t_i) + \beta_2(t_i^2) + \beta_3[\sin(2t_i\pi/52)] + \beta_4[\cos(2t_i\pi/52)] + \beta_5[A] + \beta_6[B] + \beta_7[RSV]\}$$

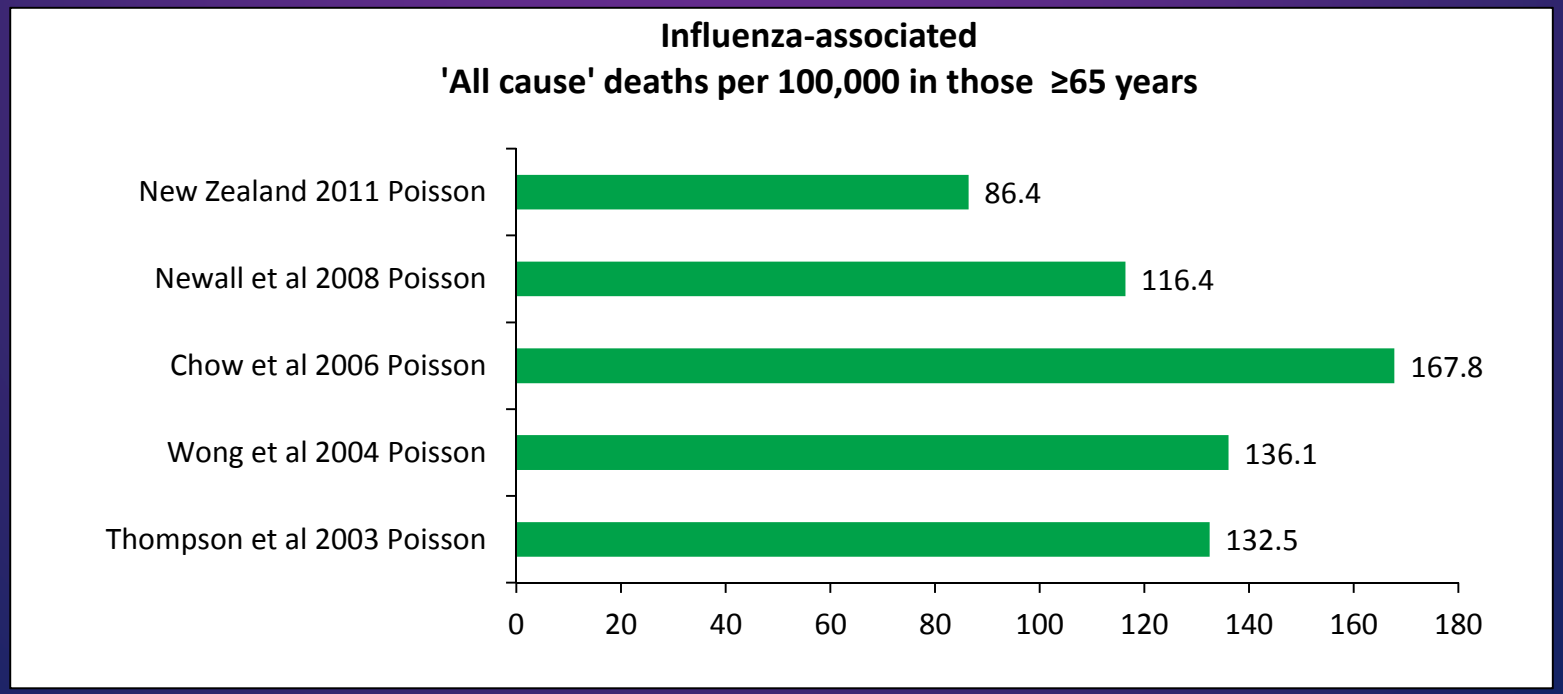
Previous New Zealand Study (1980-1992) –

Average 484 all-cause deaths per year

Results

	Respiratory and Circulatory			All Cause		
	<65	*≥65*	*All Ages*	*<65*	*≥65*	*All Ages*
Average number of deaths (1994-2008)	34.5	310.4	**345.9**	59.8	396.1	**457.9**
Lower 95% CI	29.7	246.1	277.8	50.5	299.7	353.2
Upper 95% CI	39.3	374.7	413.9	69.2	492.5	562.5
Average mortality rate per 100,000 (1994-2008)	1.03	67.89	**9.09**	1.78	86.40	**12.01**
Lower 95% CI	0.89	54.14	7.33	1.52	66.03	9.33
Upper 95% CI	1.17	81.64	10.85	2.05	106.76	14.70


Influenza-associated
'Respiratory and Circulatory' deaths per 100,000 in those ≥65 years
New Zealand 2011 Poisson
67.9
CDC 2010 Poisson
66.1
Thompson et al 2009 Poisson
72.4
Chow et al 2006 Poisson
155.4
Wong et al 2004 Poisson
102
Thompson et al 2003 Poisson
98.3
0
20
40
60
80
100
120
140
160
180


Influenza-associated
'All cause' deaths per 100,000 in those ≥65 years
New Zealand 2011 Poisson
86.4
Newall et al 2008 Poisson
116.4
Chow et al 2006 Poisson
167.8
Wong et al 2004 Poisson
136.1
Thompson et al 2003 Poisson
132.5
0
20
40
60
80
100
120
140
160
180

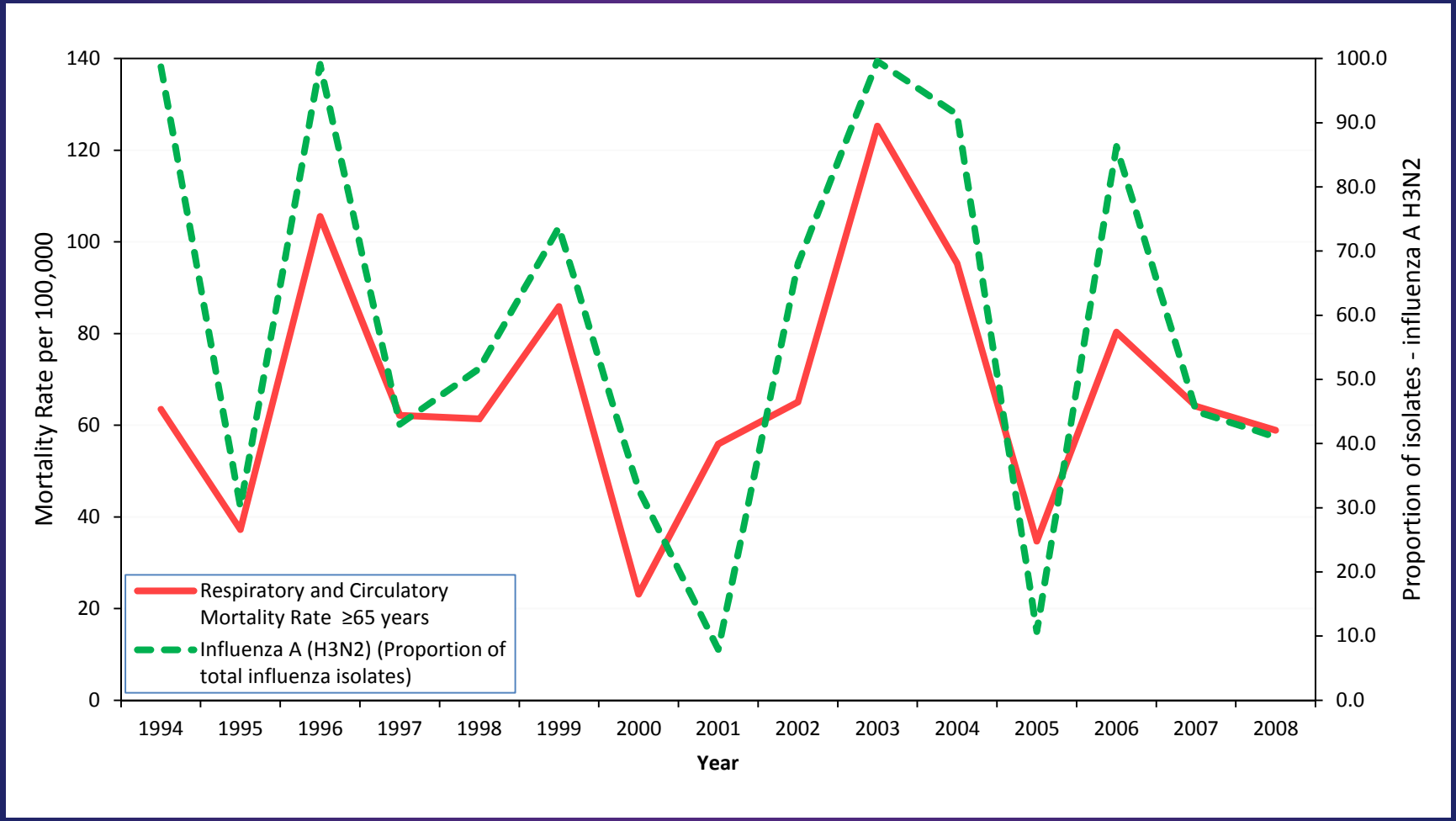
Modelling versus the Mortality Collection

	Observed Influenza-Coded Deaths	Poisson Model Estimates of Deaths Respiratory and Circulatory	Modelled Deaths/Observed Deaths
1994-1998	38.0	312.2	**8.2**
1999-2003	11.8	357.1	30.3
2004-2008	15.6	368.3	23.6

	Observed Influenza-Coded Deaths	Poisson Modelled Estimates of Deaths All Causes	Modelled Deaths/Observed Deaths
1994-1998	38.0	389.0	10.2
1999-2003	11.8	483.0	**40.9**
2004-2008	15.6	501.6	32.2

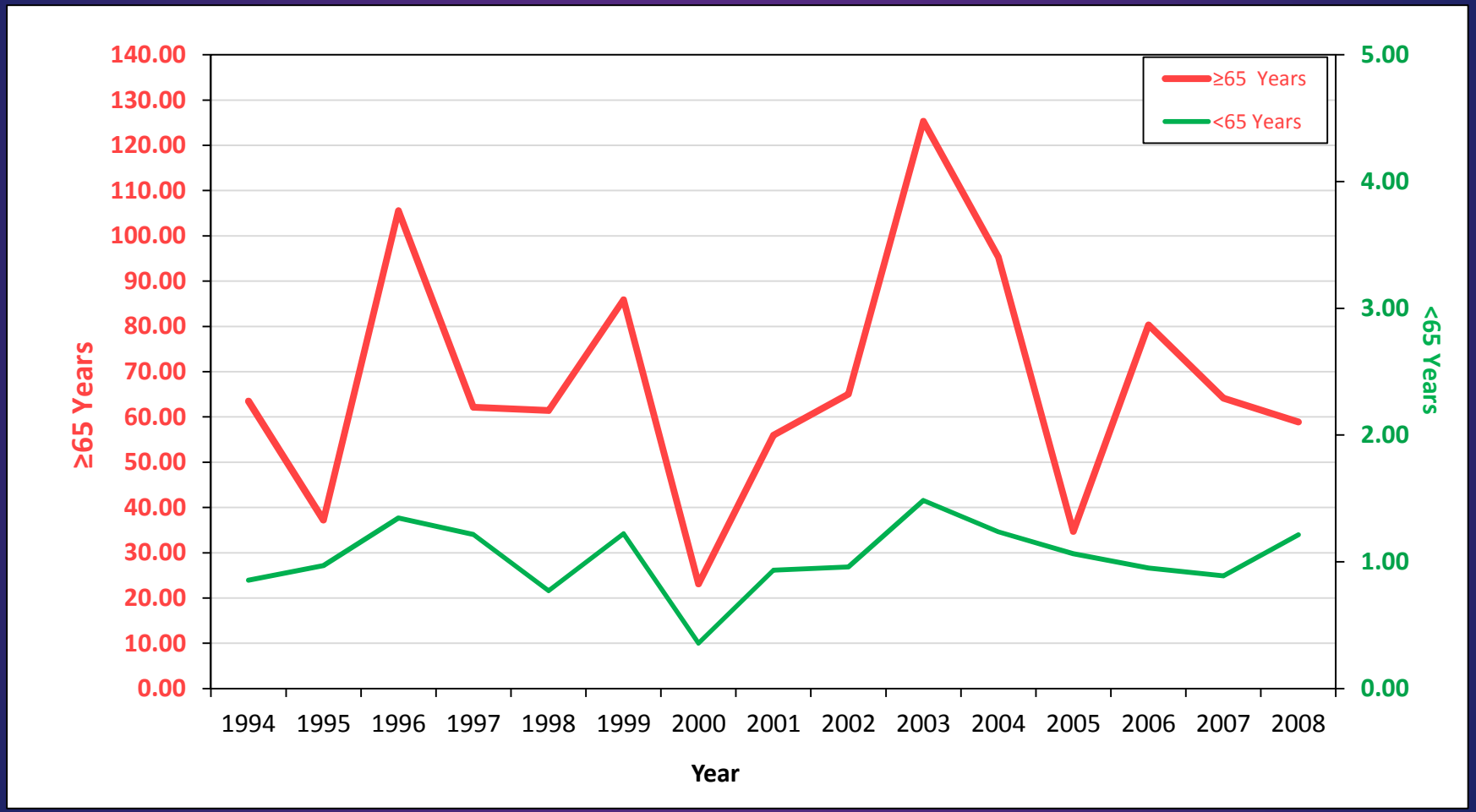
Average annual number of observed influenza-coded deaths (ICD-9: 487.0, 487.1; ICD-10: J10.0, J10.1, J10.8, J11.0 J11.1, J11.8) in the Mortality Collection compared with average annual estimates of the number of influenza-associated deaths (Poisson model) for all ages, based on respiratory and circulatory, and all cause data for the periods 1994-1998, 1999-2003, and 2004-2008.

Influenza subtype



Influenza-associated mortality rates per 100,000 persons (respiratory and circulatory data, Poisson model) in those ≥65 years; yearly percentage of influenza isolates that were influenza A (H3N2), 1994 to 2008. Source: ESR

Trends over time



Influenza-associated mortality rates per 100,000 persons (respiratory and circulatory data, Poisson model) in those <65 years and ≥65 years between 1994 and 2008.

Trends over time

	≥65 Years		All Ages	
Respiratory and Circulatory	Observed Mortality Rate	Modelled influenza-associated mortality rate	Observed Mortality Rate	Modelled influenza-associated mortality rate
1994-1998	2943.11	**65.94**	397.42	8.66
1999-2003	2644.84	**71.06**	364.13	9.46
2004-2008	2318.56	**66.66**	324.36	9.16
	≥65 Years		**All Ages**	
All causes	Observed Mortality Rate	Modelled influenza-associated mortality rate	Observed mortality rate	Modelled influenza-associated mortality rate
1994-1998	4833.20	**78.99**	706.63	10.78
1999-2003	4637.68	**92.71**	689.48	12.78
2004-2008	4311.44	**87.50**	650.46	12.47

Average observed mortality rates per 100,000 persons (Mortality Collection) and average influenza-associated mortality rates (Poisson model) in those ≥65 years and in all ages based on respiratory and circulatory, and all cause data, for the periods 1994-1998, 1999-2003, and 2004-2008.

Where to now?

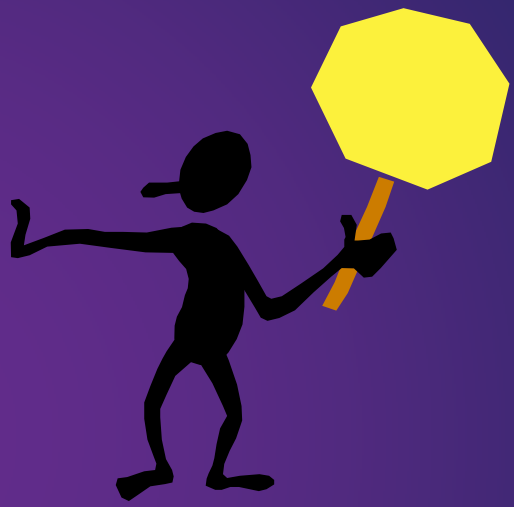
Limitations

- **Variables**

- **Age groups**

- **Disparities**

- ***Could these deaths really be prevented?***



Future Research and Action

- Burden of disease

Years of life lost, Hospitalisations

- Validation

- Vaccine effectiveness

The evidence is "slim and not particularly encouraging with regard to the degree to which influenza vaccination protects elderly people against severe influenza outcomes"

-Simonsen L, Taylor RJ, Viboud C, Miller MA, Jackson LA. Mortality benefits of influenza vaccination in elderly people: an ongoing controversy. Lancet Infectious Diseases.2007;7(10):658-66.

- Public health measures

Thank-you

And with many thanks to Associate Professor Michael Baker and Dr. James Stanley

Questions