The Impact of School Opening on Hospital Admissions for Asthma in New York State

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Background

- Asthma is one of the most common chronic diseases among children in New York State (NYS).

- Asthma morbidity is normally believed to increase beginning in autumn, but seasonal variation in asthma peak may occur by age group.

- The impact of returning to school on asthma admissions in children has not been well explored.

Study Objectives

- Identify seasonal variation in hospital admissions for asthma by different age groups.

- Determine how the return to school affects hospital admissions for asthma.

- Assess the timing and magnitude of asthma admissions following school vacations among different age groups.

Study Design & Population

- **Design**: Time-series Study

- **Study population**: Hospital admissions due to asthma occurring during 1991-2001 for all ages.

- **Asthma definition**: Principal diagnosis of ICD-9 493
- **Age groups**:
  Pre-school children (2-4 years)
  Elementary school children (5-11years)
  Middle school children (12-17 years)
  College students (18-22 years)
  Adults (23-65 years) --comparison group
 Elders(>65 years) --comparison group

Data Sources

- **Admissions data:** Asthma hospital admissions were obtained from the NYSDOH Statewide Planning and Research Cooperative System (SPARCS).

- **Ambient air and Meteorological data:** Ambient ozone, temperature and humidity data were obtained from NYS Department of Environmental Conservation.

Time Periods

- 4 school vacation periods:
  - Summer (June-August)
  - Holiday (December): commonly recognized as the Christmas and Jewish holiday break
  - Winter (Feb): President's Day
  - Spring (April): Easter holiday

Exposure Definition

- **Exposure period**: the school session following four school breaks (summer, holiday, winter, and spring)

- **Definition**: Set the first day of the school as 0, count the days back from the first day of the school and assign negative values to school vacation days, then count the days forward to the end of the school and give positive values to school sessions.

-2 -1 0 1 2 3

The start of vacation

The first day of school

The end of school
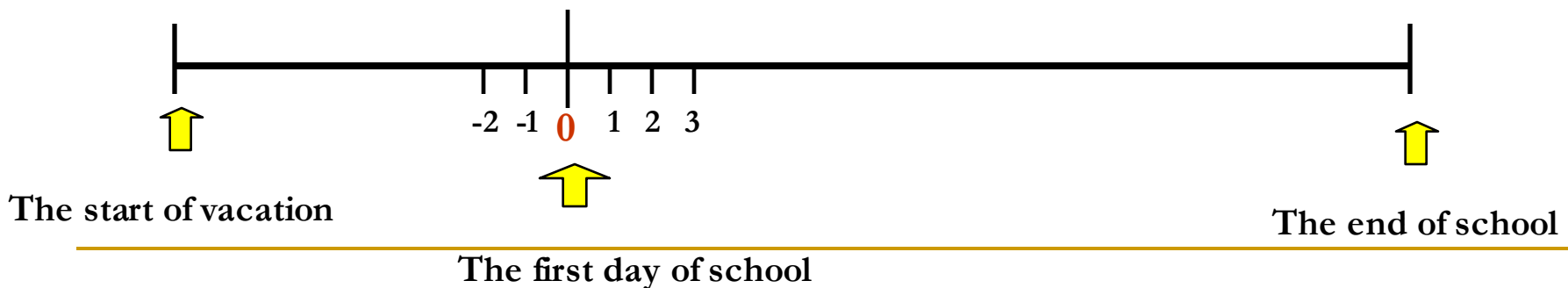
Statistical Analysis

- **Method**: Generalized additive model (GAM) was used with a log link function to assess the risk associated with the return to school.

- **Confounders included**: long term trends, holidays, day-of-the-week, daily ambient ozone level, temperature, humidity, and SES

Daily asthma admissions by age group

Proportion of daily asthma admissions in all admissions by age, 1991—2001
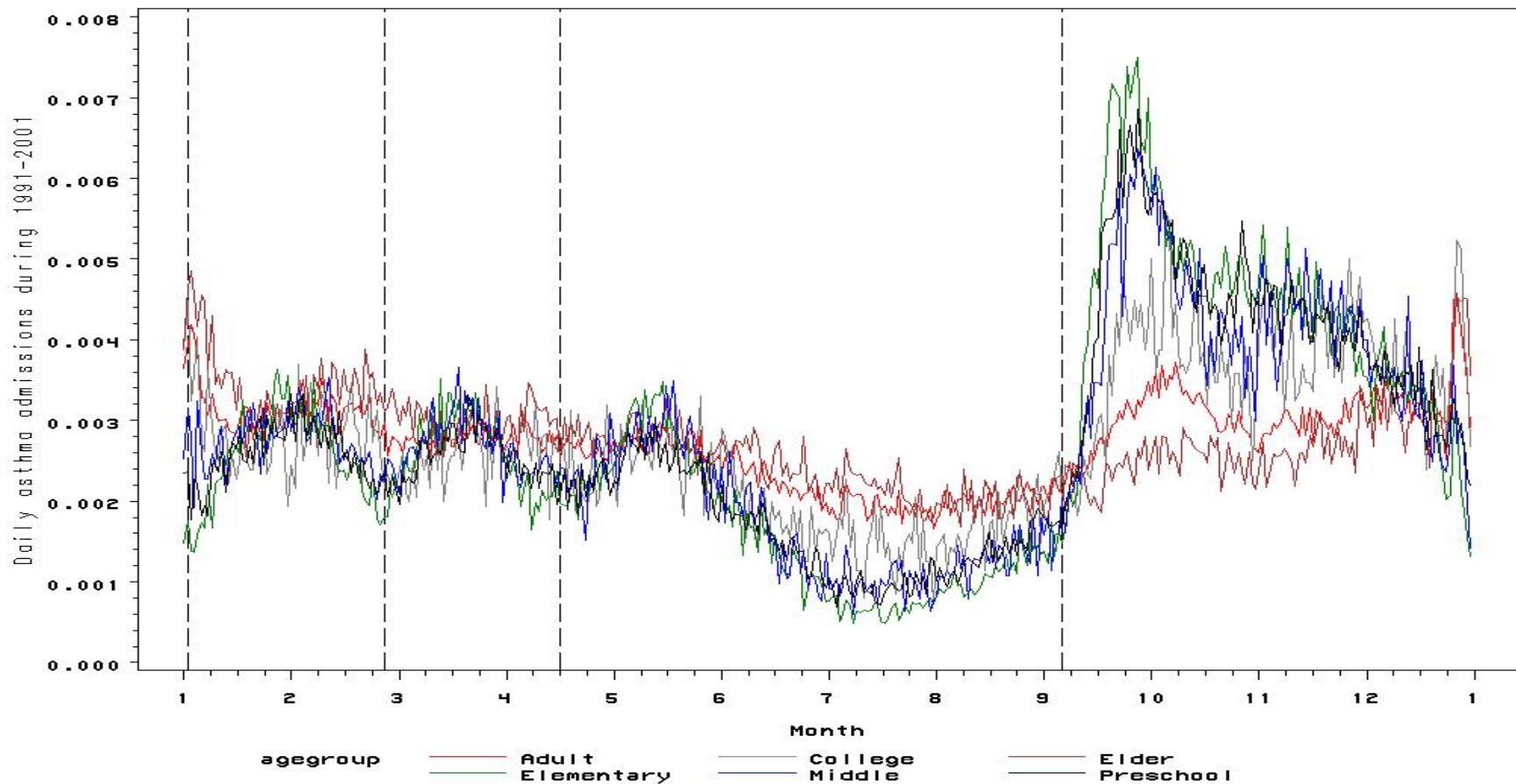

* Vertical lines indicated the rough start date after each school break (holiday, winter, spring, and summer).

Summary: Significant increase in early fall after summer vacation, and 3 small increases following holiday, winter and spring vacations for children. For adults and elders, the trends are more stable and flat.

Seasonal variation of asthma admissions by age group

The cycle of weekly asthma admissions of children 5 — 11 years
Use Cubic Spline method
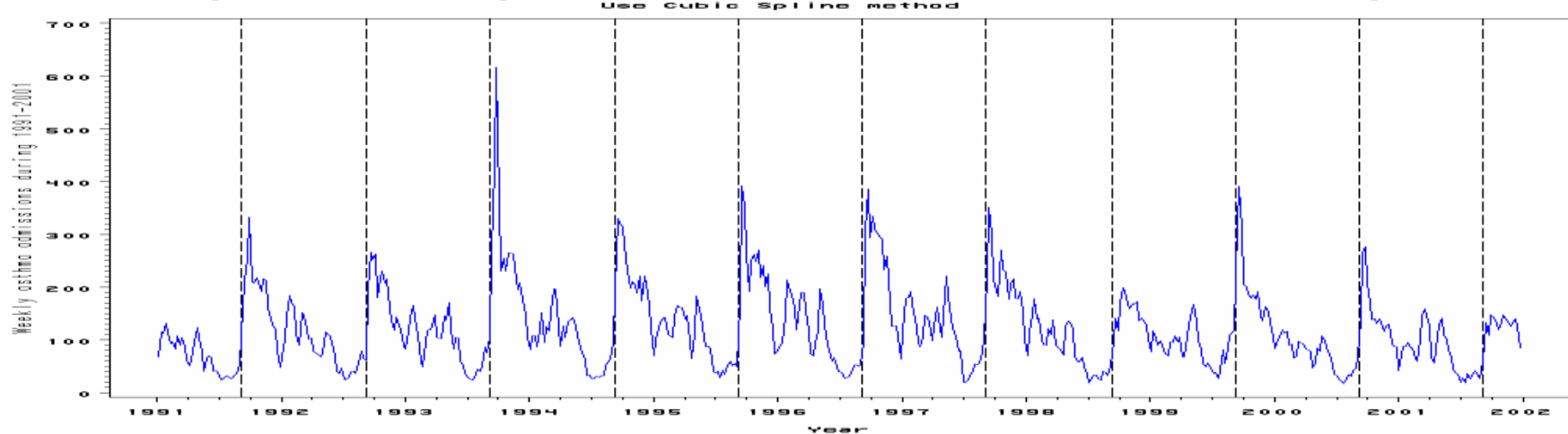
The cycle of weekly asthma admissions of adults over 65 years
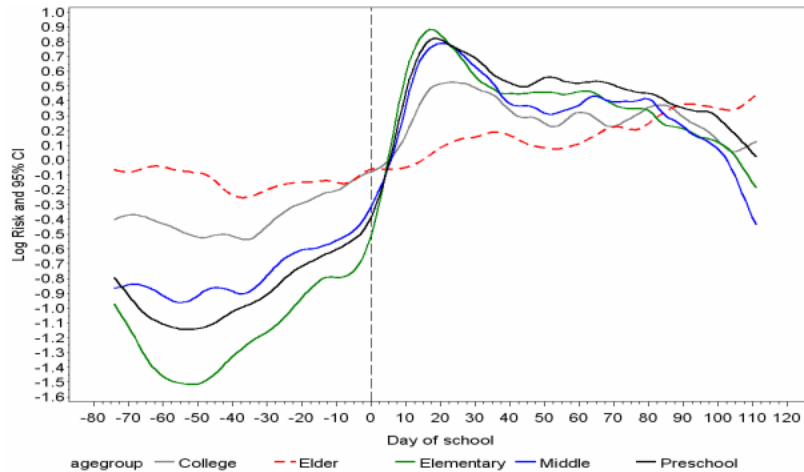Use Cubic Spline method
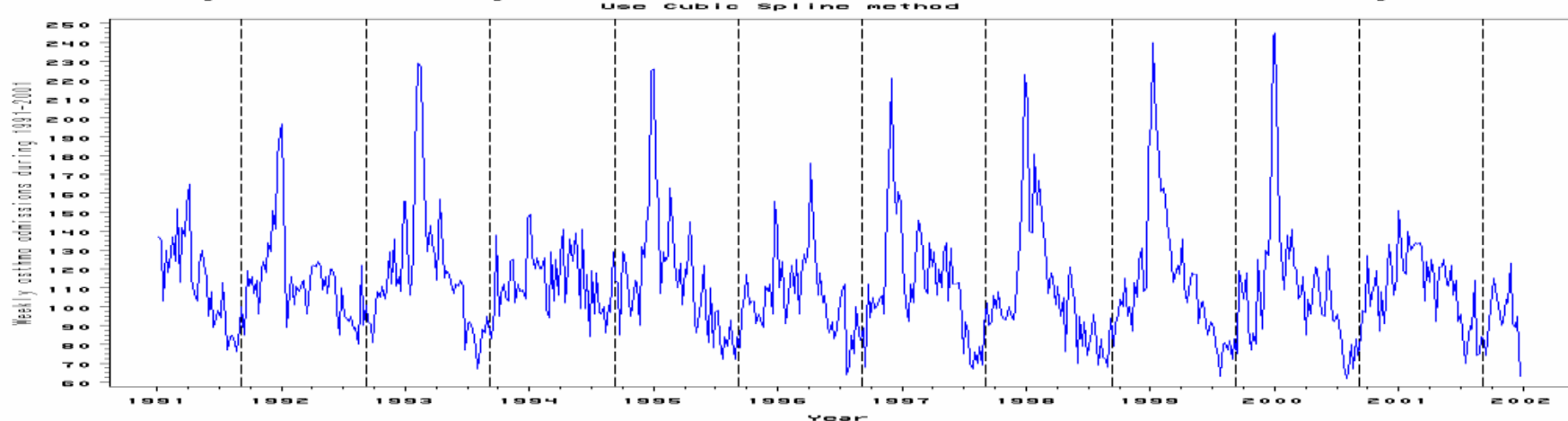
* Vertical lines are the first day of school after summer vacation from 1991 to 2001.

Summary: Annual patterns are similar over 11 years for both age groups. Asthma admissions peaked in early fall for children, but peaked in winter for adults.

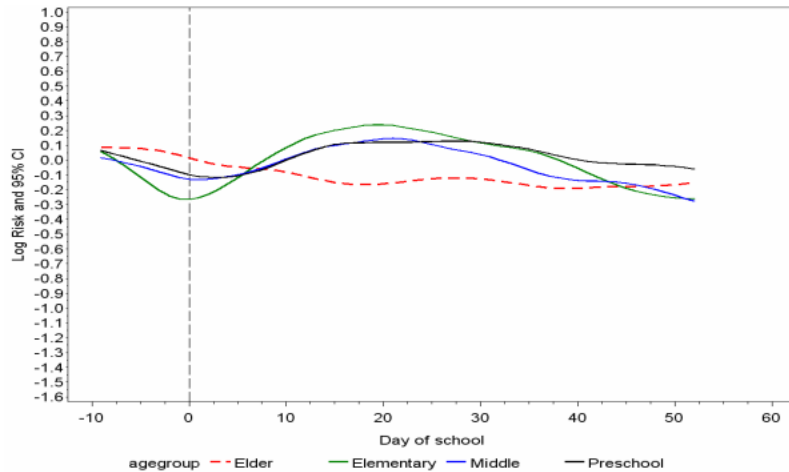# Adjusted log risk[a] of asthma admissions by age group

School session after summer vacation

School session after Christmas vacation
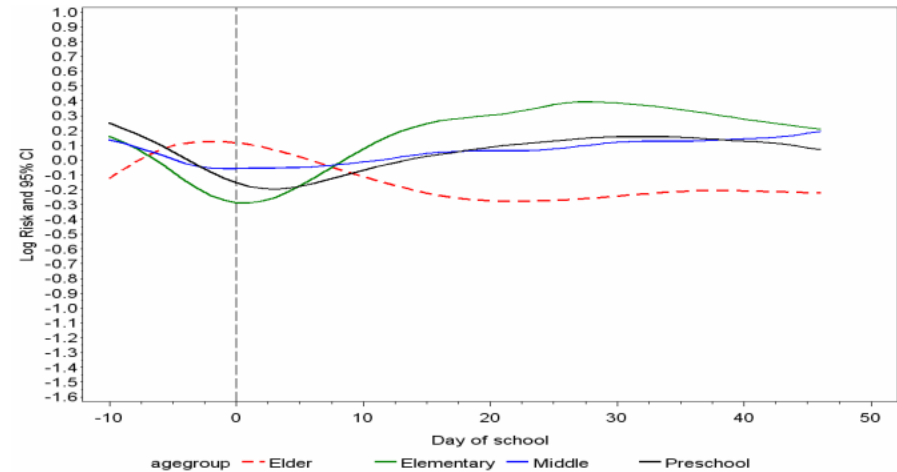
School session after winter vacation

School session after spring vacation
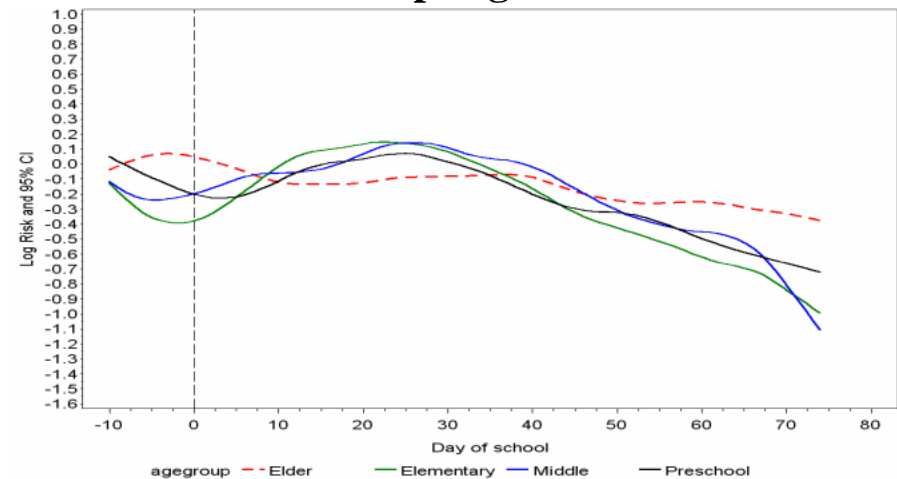
[a]: Adjusted for long term trends, holidays, day-of-the-week, daily ambient ozone level, temperature, and humidity.

* Red line is the reference: elder group.

Summary: For children, we observed a decrease in admissions during vacations and an increase after vacations for each school period. The strongest increase was found following summer vacation for all age groups.

Risk[a] of admissions & 95% CI associated with the return to school

Break Period	2-4 years		5-11 years		12-17 years		18-22 years	
	RR[b]	95% CI	RR[b]	95% CI	RR[b]	95% CI	RR[b]	95% CI
Summer	3.34	3.11-3.60	4.00	3.73-4.29	3.01	2.71-3.34	1.83	1.59-2.11
Christmas	1.37	1.27-1.48	1.98	1.83-2.14	1.20	1.08-1.34	N/A	
Winter	1.25	1.16-1.36	1.66	1.53-1.79	1.32	1.18-1.47	N/A	
Spring	1.31	1.20-1.43	1.69	1.56-1.84	1.40	1.25-1.58	N/A	

[a]: Adjusted for long term trends, holidays, day-of-the-week, daily ambient ozone level, temperature, and humidity.

[b]: RR: Probability of admission during peak/probability of admission on the first day of school.

Summary: Increased risk of hospital admissions associated with each return to school. For children (2-17 years), peak asthma admissions occurred from 17 to 21 days after the summer vacation (data not shown).

Exceedance percent[a] of asthma admissions associated with being at school after summer vacation

	Average cases during Sept-Nov[b] (Annual %[c])	Exceedance %[a] (Sept-Nov)	Exceedance cases [d] during Sept-Nov (Annual %[e])
Preschool Children	2324 (40.01)	32.9	764 (13.15)
Elementary school children	2657 (42.09)	36.2	962 (15.24)
Middle school children	1096 (37.98)	29.3	321 (11.12)
College students	528 (33.02)	18.7	99 (6.19)
23-65 years (Ref)		0	

[a] exceedance %=(daily proportion-reference daily proportion)/daily proportion. [c] %= (cases in 3 months / cases in 1 year)*100%

[b] The calculation was restricted to fall (September 1 to November 30). [e] %=(exceedance cases in 3 months / cases in 1 year)*100%

[a] & [d] & [e] Controlled for reference.

Exceedance hospital stay and hospital cost[a] associated with being at school after summer vacation

	Exceedance cases (Sept-Nov)	Average LOS[b] (days) (Sept-Nov)	Exceedance LOS (days) (Annual %[c])	Average daily hospital cost ($) (Sept-Nov)	Exceedance hospital cost ($) (Annual %[d])
Preschool children	764	2.65	2027 (13.17)	1580	3,202,660 (13.67)
Elementary school children	962	2.82	2712 (15.13)	1572	4,263,264 (15.19)
Middle school children	321	3.14	1008 (10.97)	1507	1,519,056 (11.10)
College students	99	3.24	320 (6.13)	1595	510,400 (6.47)
Total			6067 (12.71)		9,495,380 (13.00)

[a] The calculation was restricted to fall (September 1 to November 30).

[b] Length of stay

[c] %= (exceedance LOS in 3 months / total LOS in 1 year)*100%

[d] %=(exceedance cost in 3 months / total cost in 1 year)*100%

Preliminary Findings

- **Seasonal trends:**
  - The annual peak of asthma admissions was observed in early fall for children (2-17 years) and for college students, and in winter for adults and elders.

- **Associations with the return to school:**

  - Significant increase in admissions related to the return to school after each break for children aged 2-17 years; for college students, significant increases observed in the fall only.

  - Peak asthma hospitalizations occurred from 17 to 21 days after the summer break for children, especially among children aged 5-11 years

  - Fewer or no significant increases were seen in adults or elders.

Strengths and Limitations

- **Strengths:**
  - ❑ The school calendar in NYS is fairly stable
  - ❑ Large, susceptible population over a long period of time
- **Limitations:**
  - ❑ We did not assess readmissions and therefore cannot separate incidence from prevalence.
  - ❑ Hospital admissions typically capture only the most severe disease, thus we may be underestimating effects.

Conclusions and Next Steps

- There were substantial increases in asthma admissions after returning to school from vacations, especially among elementary school children. This finding is consistent with a limited number of studies.

- Next steps: identify readmissions to separate incident from exacerbation events, which may have a different etiology.

- Future studies needed to identify the factors associated with the peak in admissions after the return from school breaks in order to guide appropriate intervention efforts.