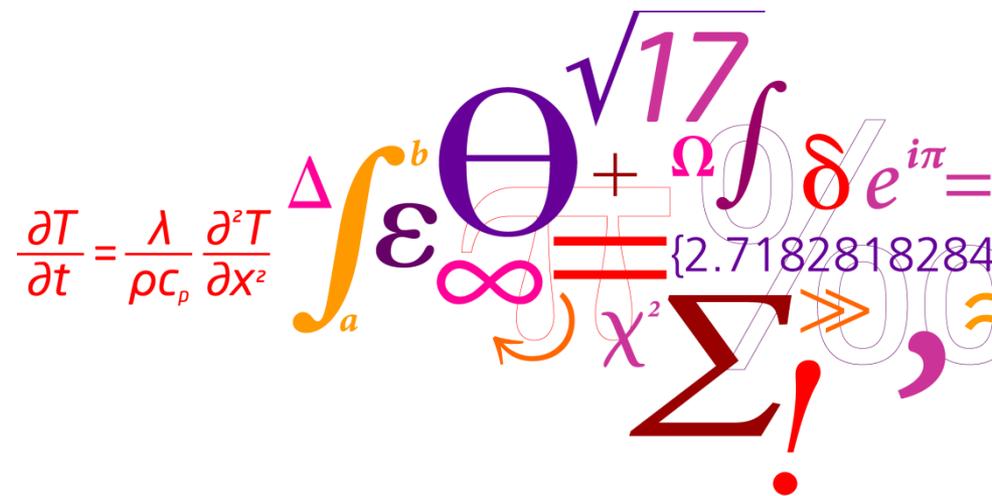


Evacuation Dynamics of Children

-Walking speeds, flow through doors in daycare centers

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Agenda

- Introduction
- Method
- Results
- Conclusion
- Questions and Comments

Introduction

- Motivation
 - Performance based fire codes.
 - Evacuation models.
 - Mainly data on healthy adults.
 - More focus coming on vulnerable groups.
 - Very limited data on children.
- Aim of the study.
 - Collect data on children's evacuation.
 - Compare to existing fire evacuation theory.
 - Bring focus to the subject.

Method

- Daycare centers in Denmark.
 - Younger children, 0-2 years.
 - Older children, 3-6 years.
- 16 full scale evacuation experiments.
 - Fire alarm.
 - Verbal warning.
- Data collection.
 - Filming
 - Measurements
 - Interviews
 - Observations

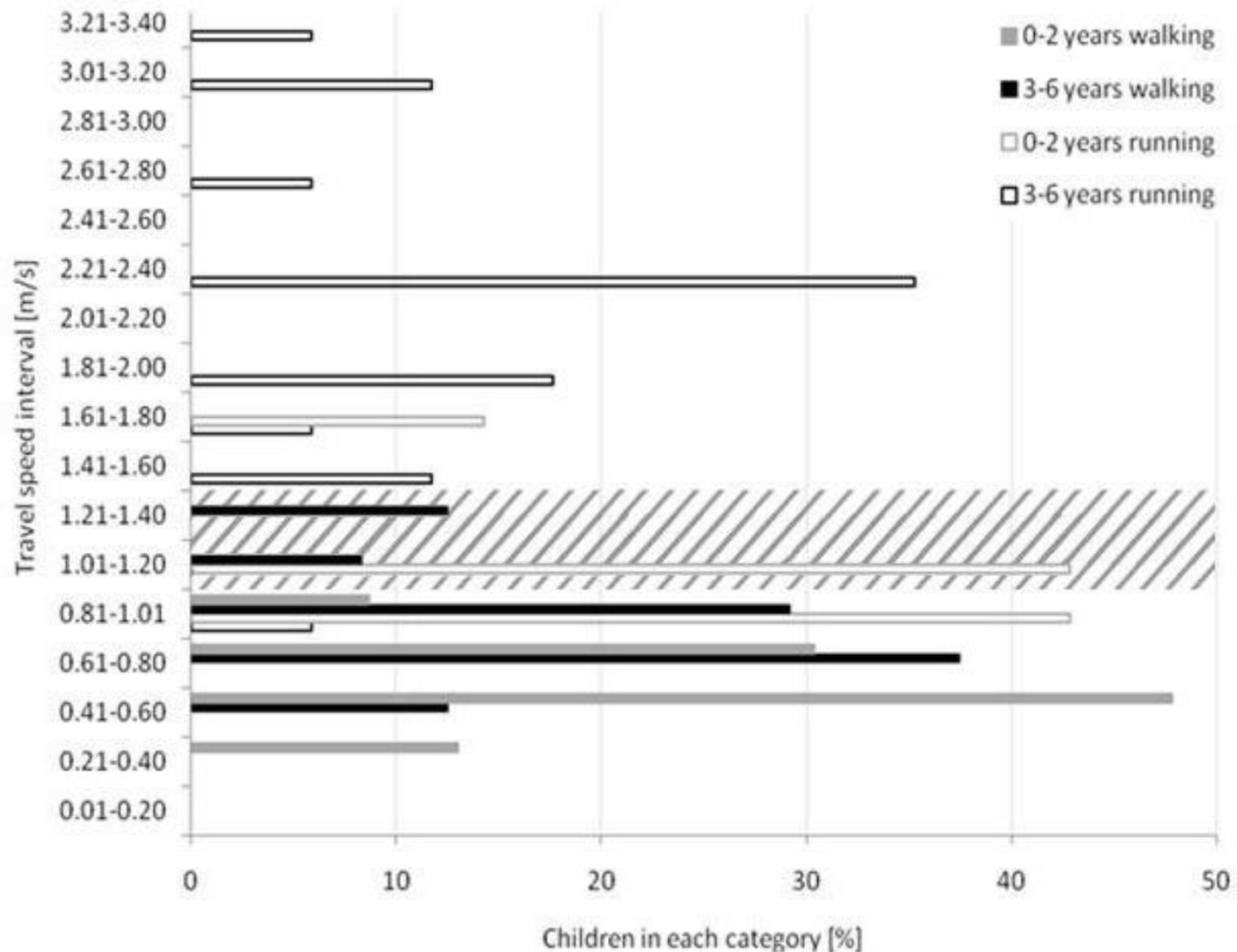
Results

- Walking speed.
 - In horizontal plane.
 - In stairs.
- Flow through doors.
- Other interesting findings.

Walking speed – horizontal plane

- Measured at low person densities.
- Average walking speed.
 - 0.52 m/s for 0-2 year olds.
 - 0.84 m/s for 3-6 year olds.
- Running towards exits.
 - 40% of older children.
 - 5% of younger children.

Walking speed – horizontal plane (continue)



Walking speed - stairs

- Three spiral stairs.
- Used by 3-6 year old children and their teachers.
- Similar dimensions.
- Different design.



Stair 1



Stair 2

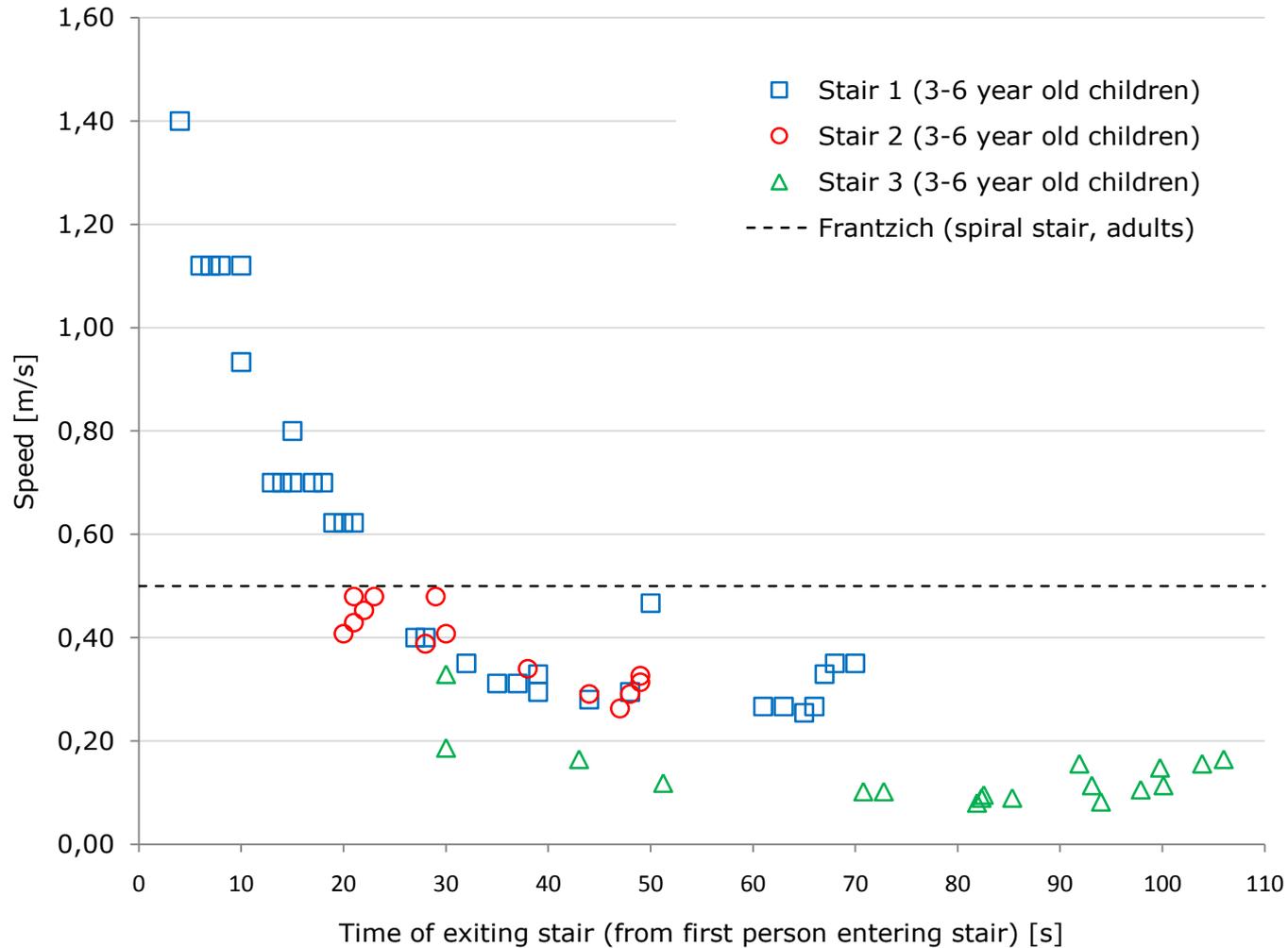


Stair 3

Data on three spiral stairs.

| Stair | Width (m) | Slope (°) | Average speed (m/s) | Standard deviation (m/s) |
|--------------|------------------|------------------|----------------------------|---------------------------------|
| Stair 1 | 0.80 | 33 | 0.58 | 0.31 |
| Stair 2 | 0.87 | 33 | 0.38 | 0.07 |
| Stair 3 | 0.91 | 30 | 0.13 | 0.06 |

Walking speed – stairs (continue)



Stair 1



Stair 2

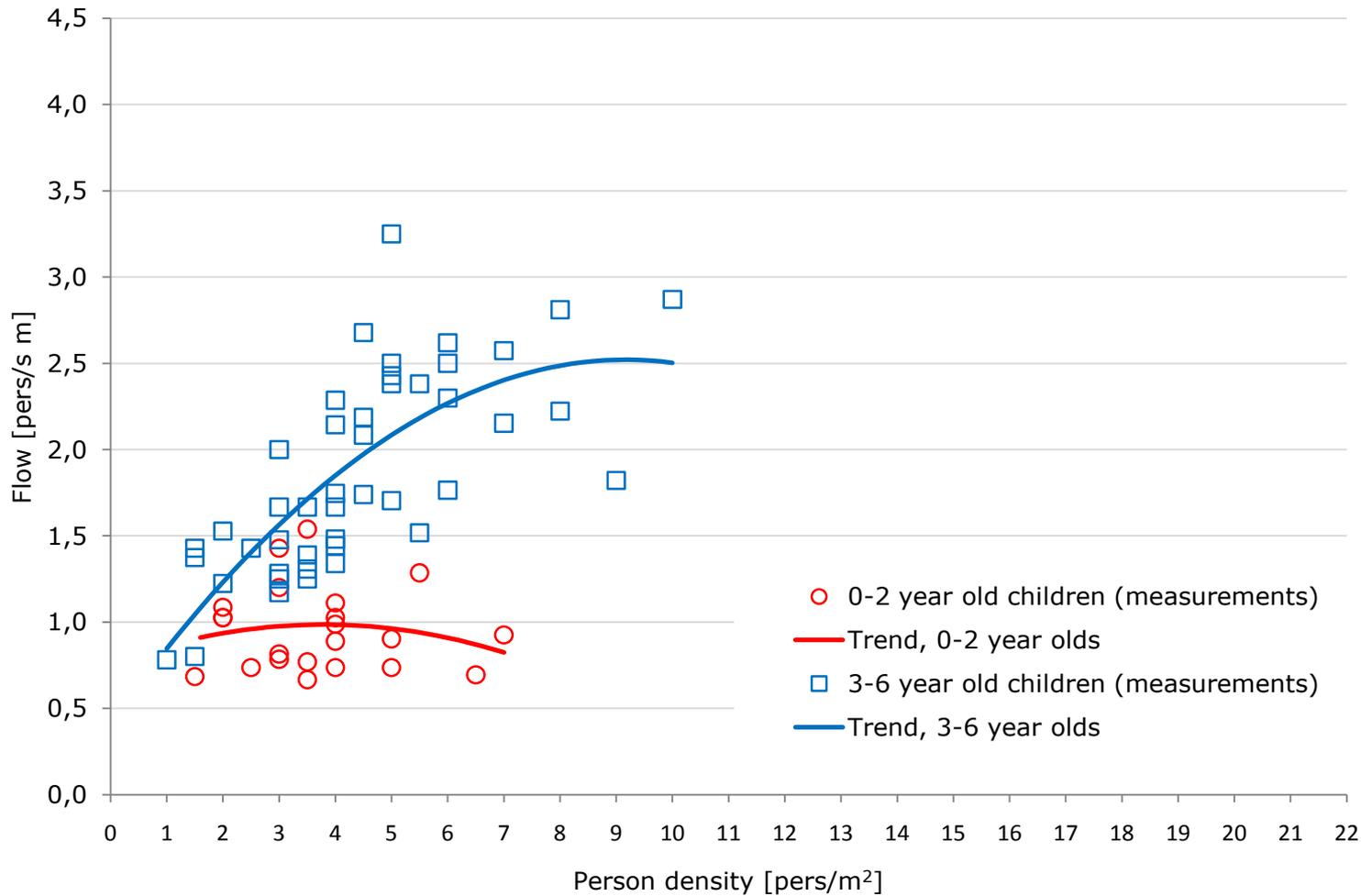


Stair 3

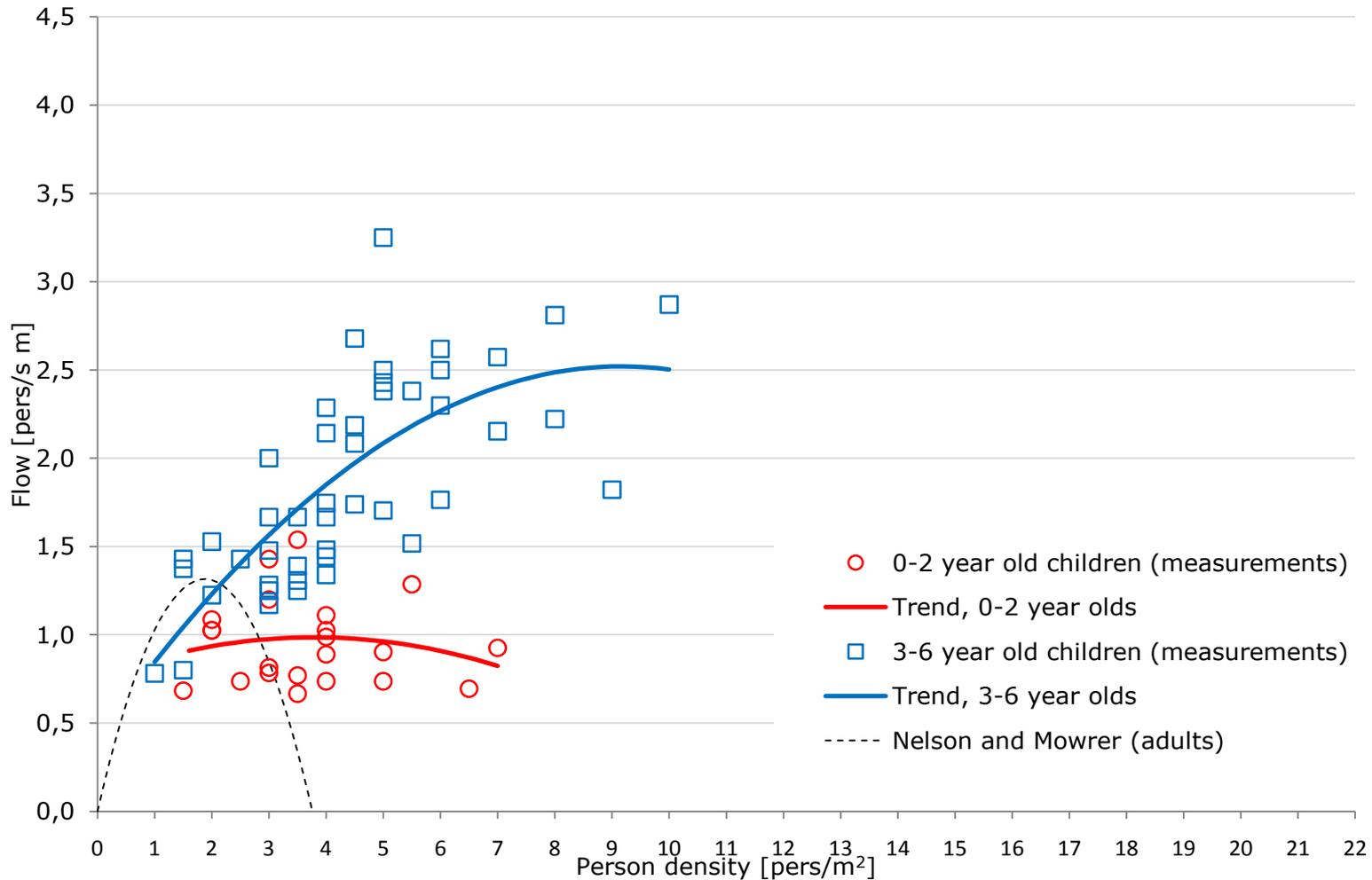
Flow through doors

- Flow unit: person/s m.
 - Effective width of door = width of door opening
- Density unit: person/m².
 - Densities up to 6 pers/m² obtained naturally.
 - Extra experiments to obtain higher densities.

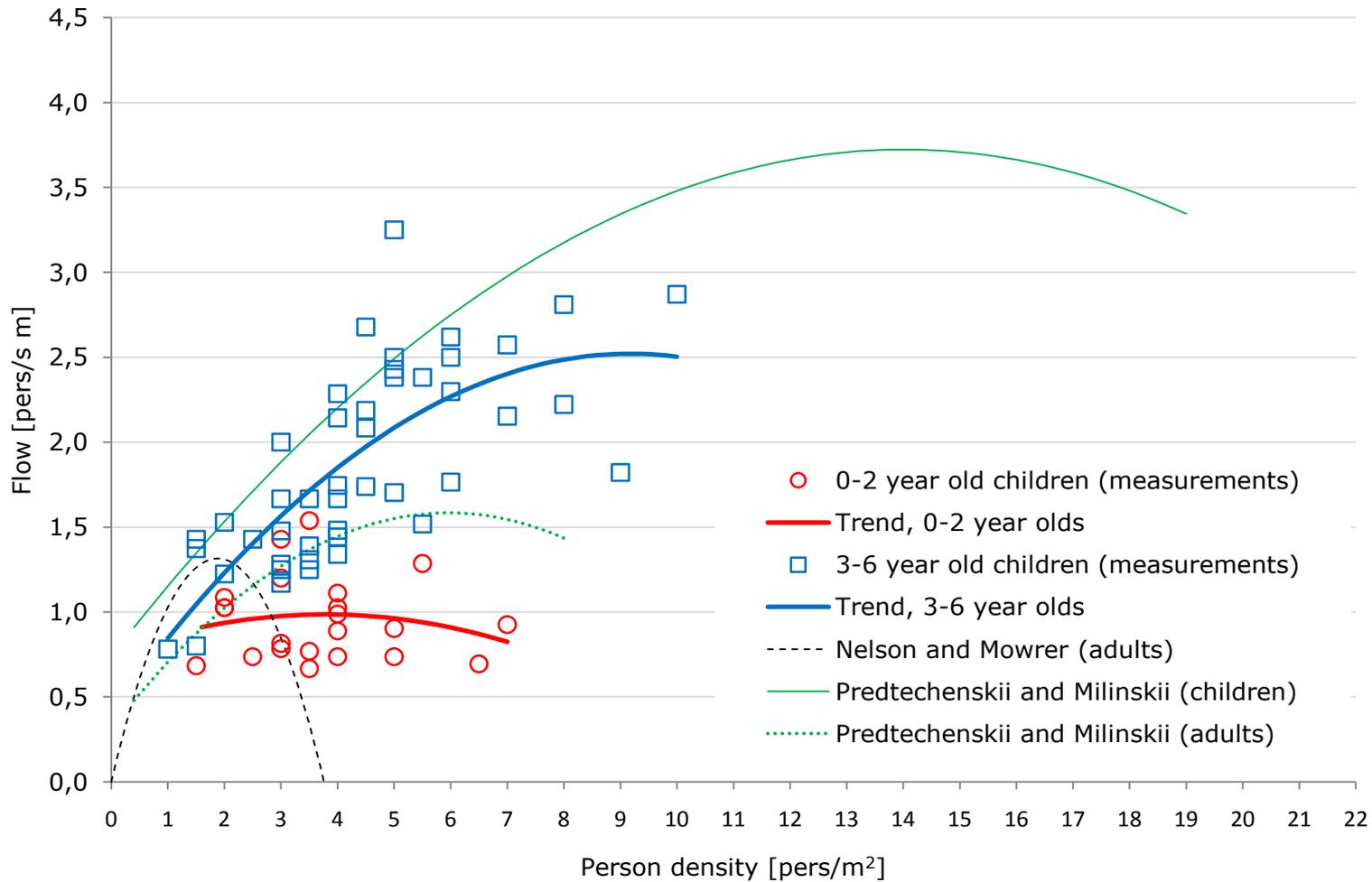
Flow through doors (continue)



Flow through doors (continue)



Flow through doors (continue)



Other interesting findings

- The children were good at following instructions.
- Used to rules and routines.
- Majority of the older children evacuated on verbal command.
- Most of the younger children needed some physical assistance.

Conclusions

- Walking speed in horizontal plane was slower than for adults.
- More of the older children ran during the evacuation.
- Walking speed on spiral stairs varied greatly between the stairs.
- Important factors affecting evacuation time.
 - Familiarity with evacuation route.
 - Design of route.
- Today's evacuation models do not present children.

Questions and Comments