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Inter-Step Height Variation and Observations of Fall-Related Events During Stairway Negotiation

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Inter-step height variation and observations of fall-related events during stairway negotiation

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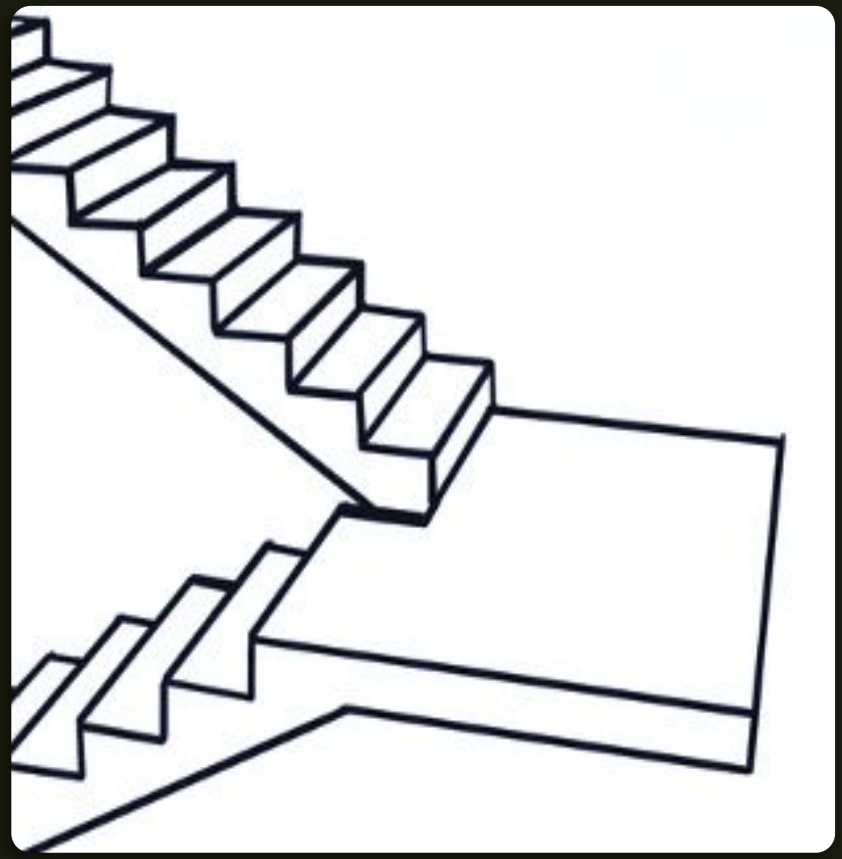
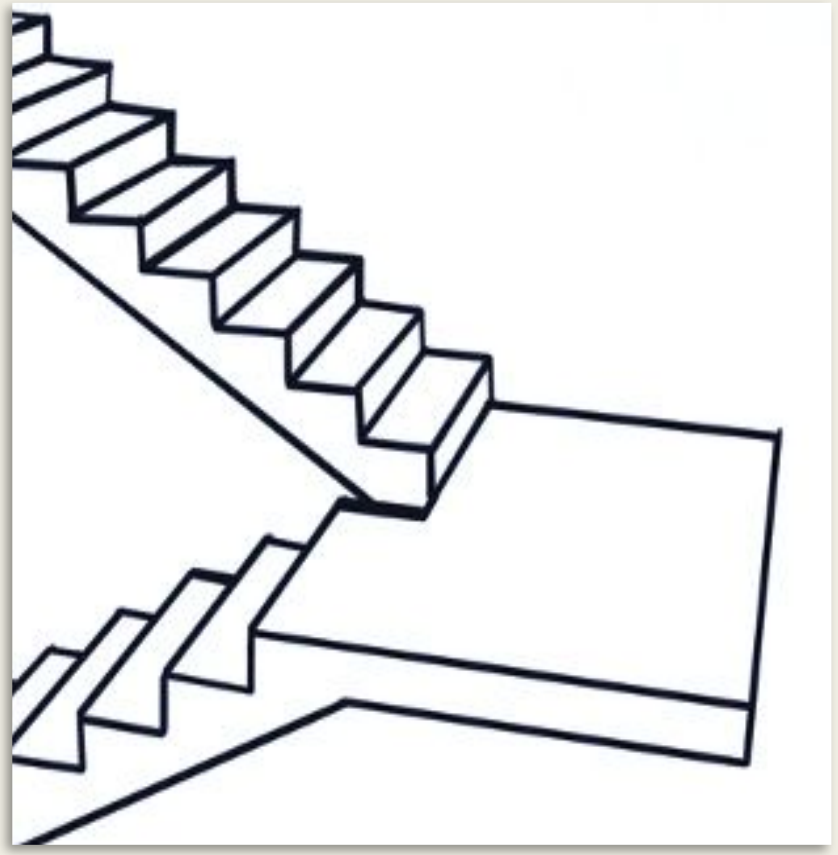


The New York Stairway

Inter-step height variations

- Variations of **6.35 mm (about 1/4 inch)** may cause more falls
- Variations **greater than 9.525 mm (3/8 inch)** related to 60% of falls on stairs**.**



(Cohen et al., 2009 & Templer, 1992)

OVERVIEW

Why research falls?

How can we reduce falls on stairs?

A possible solution

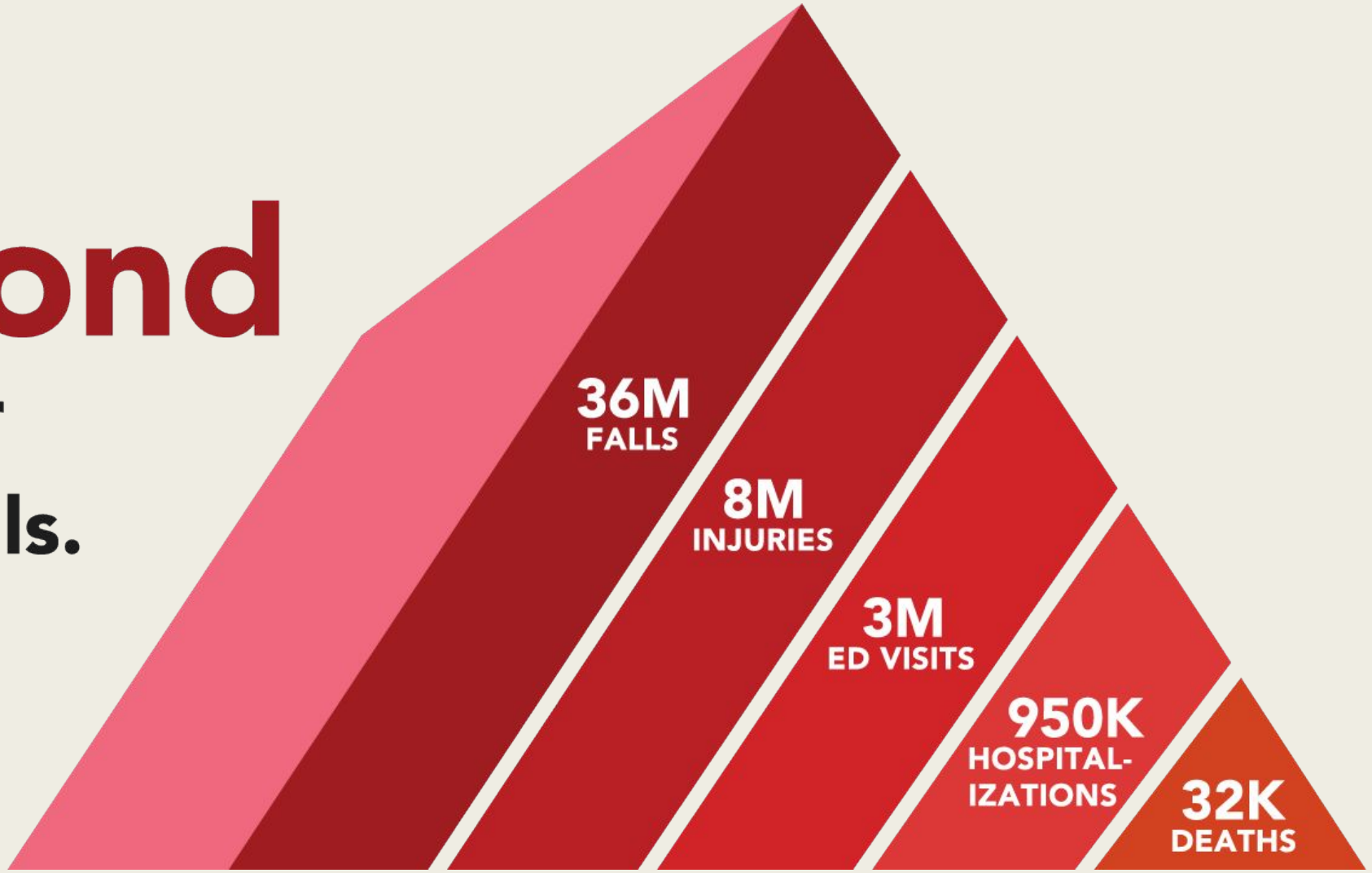
Why research falls?

Every

second

an older

adult falls.



How can we reduce falls on stairs?

The simple answer:

The simple answer:

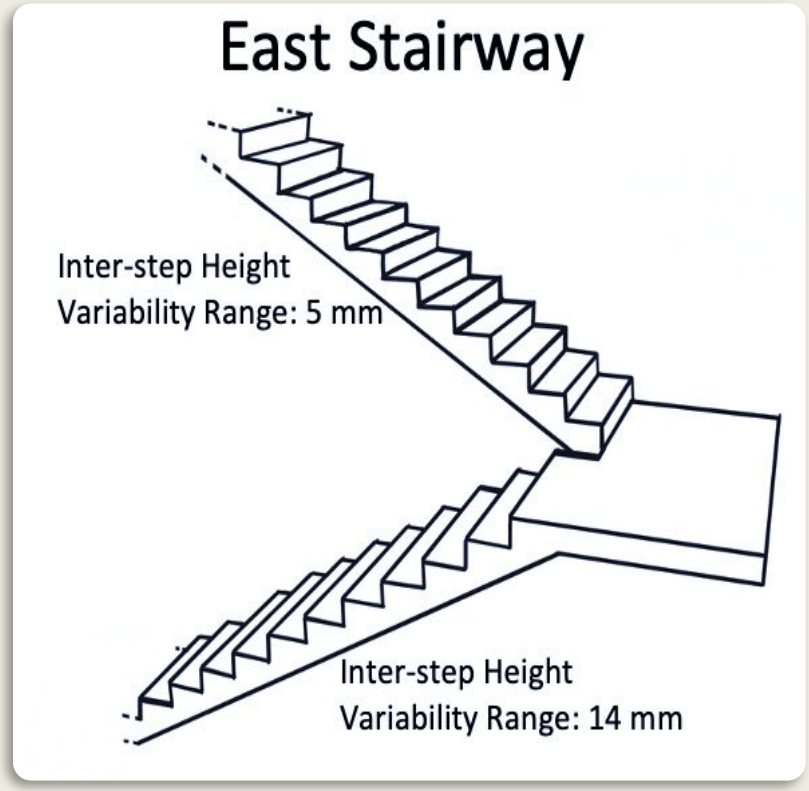
Build better stairs.

Occupational Safety and Health Administration (OSHA)

Height Variations

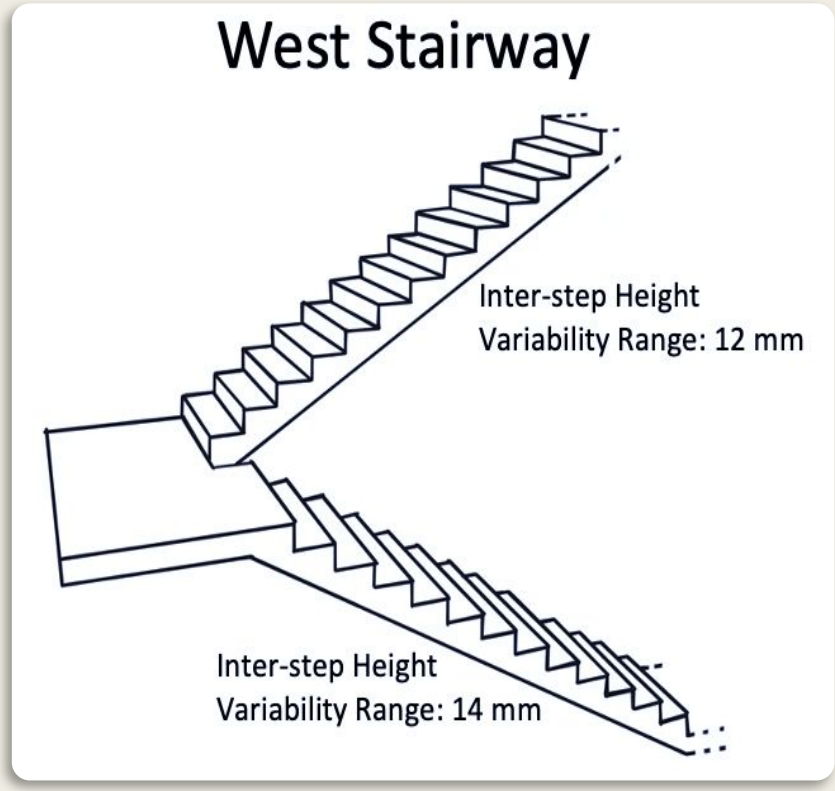
East Stairway

- Upper – 5 mm
- Lower – 14 mm



West Stairway

- Upper – 12 mm
- Lower – 14 mm



Question #1

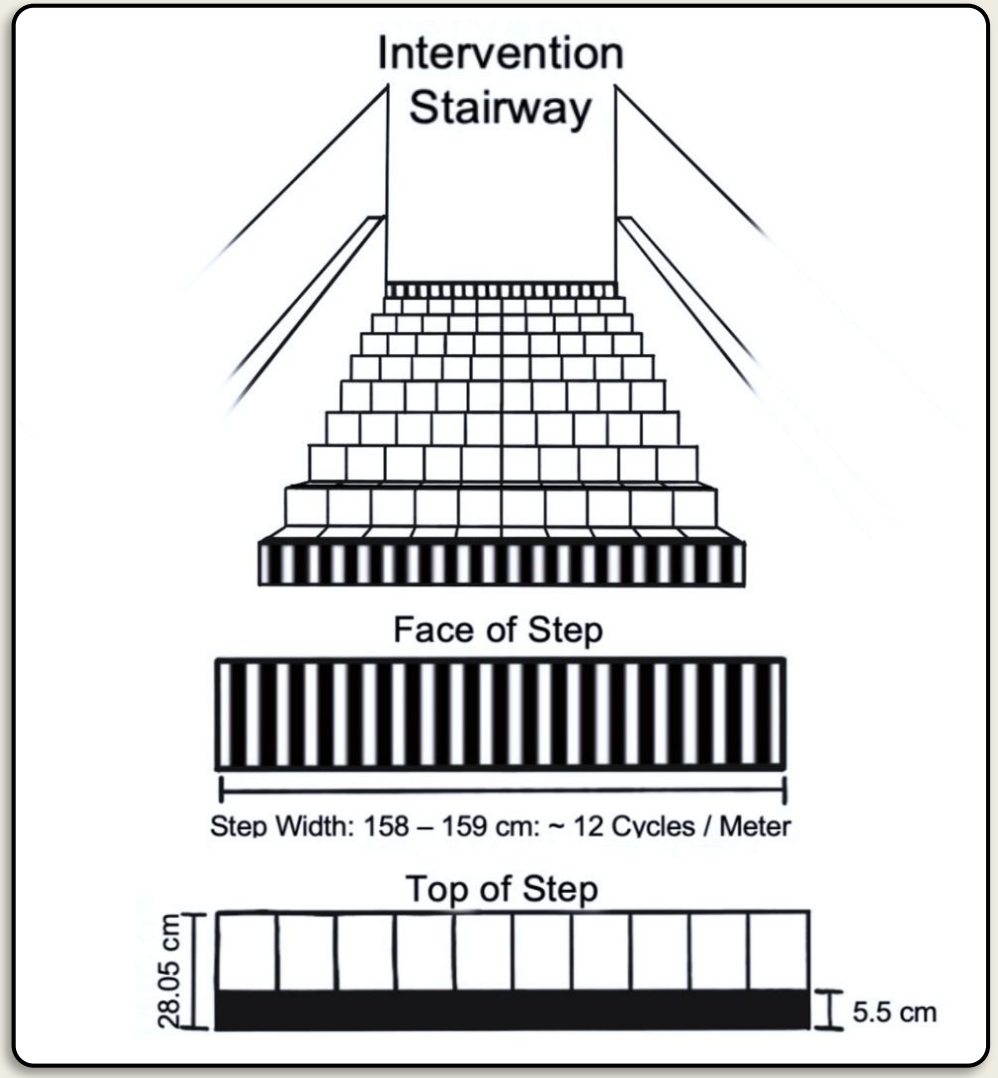
- Are falls associated with greater step height variations?

- Prediction
  - ***More falls*** *on flights with* ***greater variation***
    - Possible mechanisms: Assumptions of uniformity or lack of attention

A Possible Solution

Basis of intervention: Striping

- Step edge striping **5.5 cm wide**
- Vertical Striping on **first and last stair faces**



(Elliot et al., 2015)

Question #2

- Where there is greater height variation, do more falls occur on an unaltered or striped (intervention) stairway?

- Prediction
  - ***More falls*** *will occur on the* ***unaltered stairway*** *on flights with* ***greater variation***

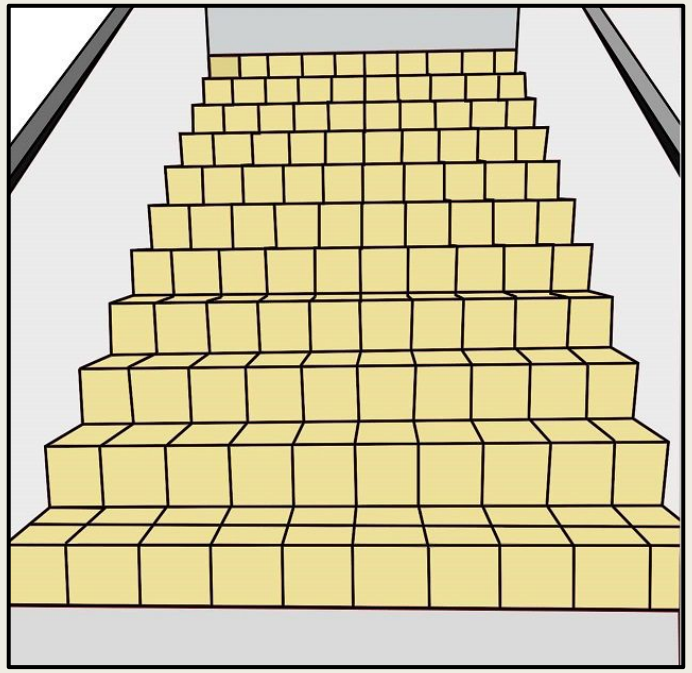
The Questions:

- Are falls associated with greater step height variations?
- Where there is greater height variation, do more falls occur on an unaltered or striped (intervention) stairway?

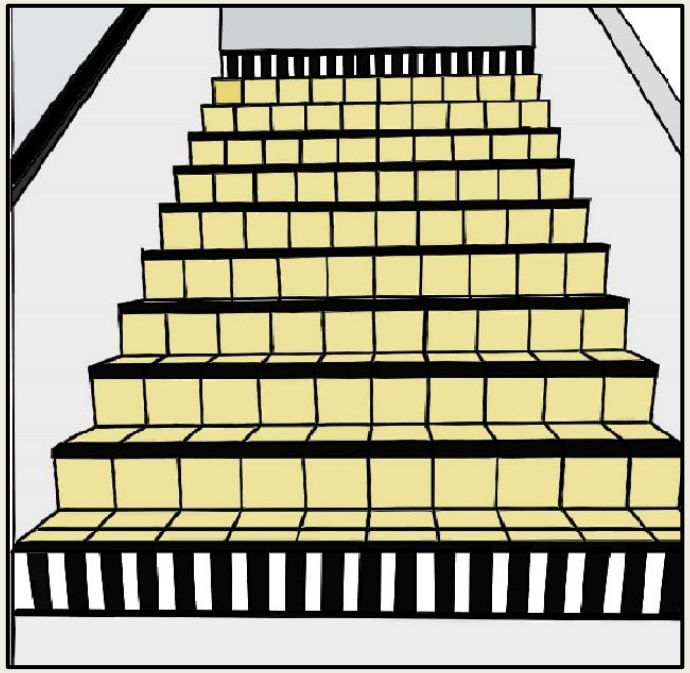
How did we go about testing this?

Methods

- Primarily college-aged adults
- Security cameras
- Fall events were recorded by flight and stairway condition



Control

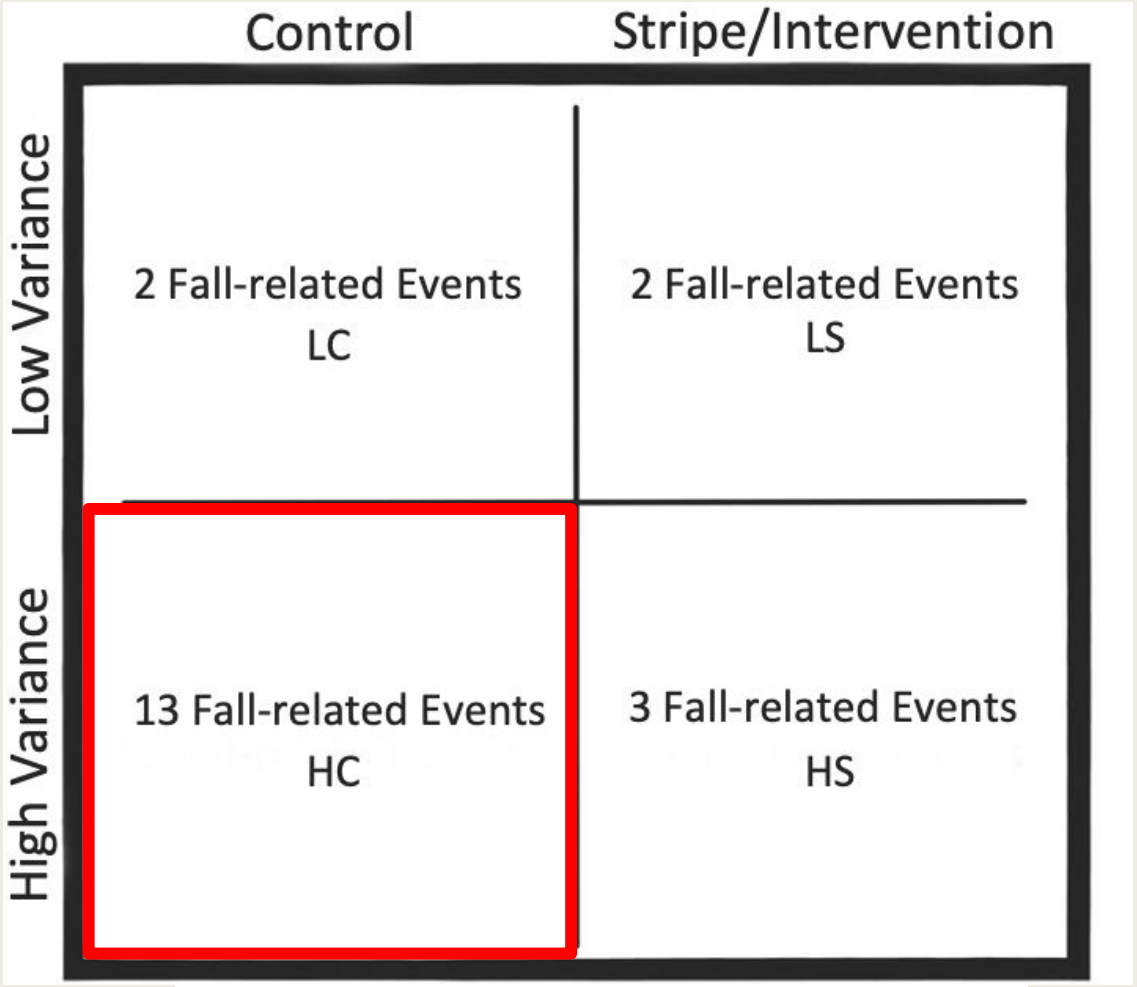


Intervention

Results

- Question #1: More falls on flights with greater variation?
  - **Yes!**
    - 16 of 20 observed falls

- Question #2: Were there more falls on the control stairway with greater variation?
  - **Yes!**
    - 13 of 16 observed falls



Monte Carlo Simulation (P = 0.0358)

Discussion

- Striping, a simple, vision-based strategy, may reduce fall risk
- If a primarily young, healthy population benefits from striping, what about those who could benefit the most?

Future work

- Apply the intervention to high-risk populations
  - Older adults
  - Those with visual impairment

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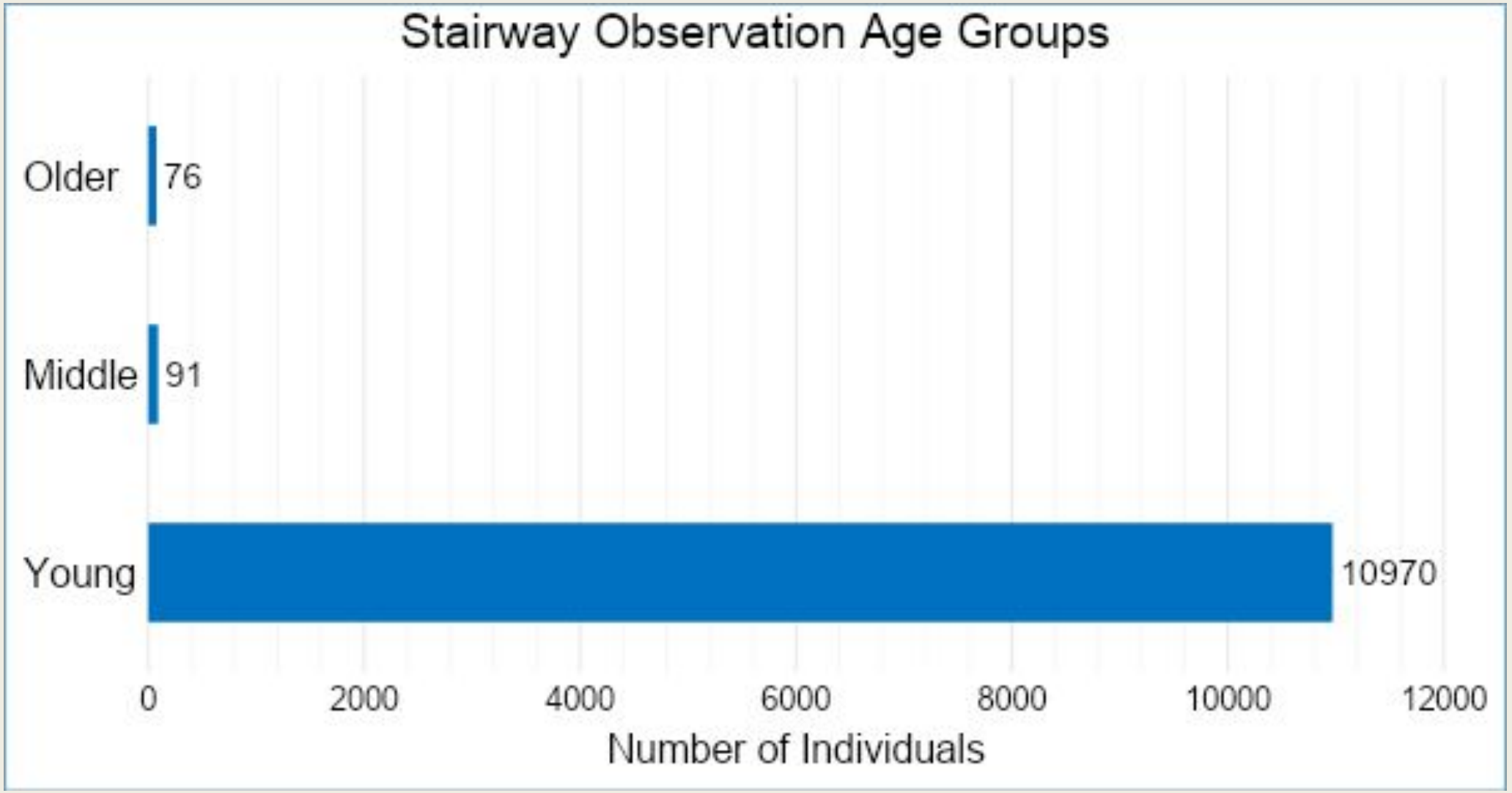
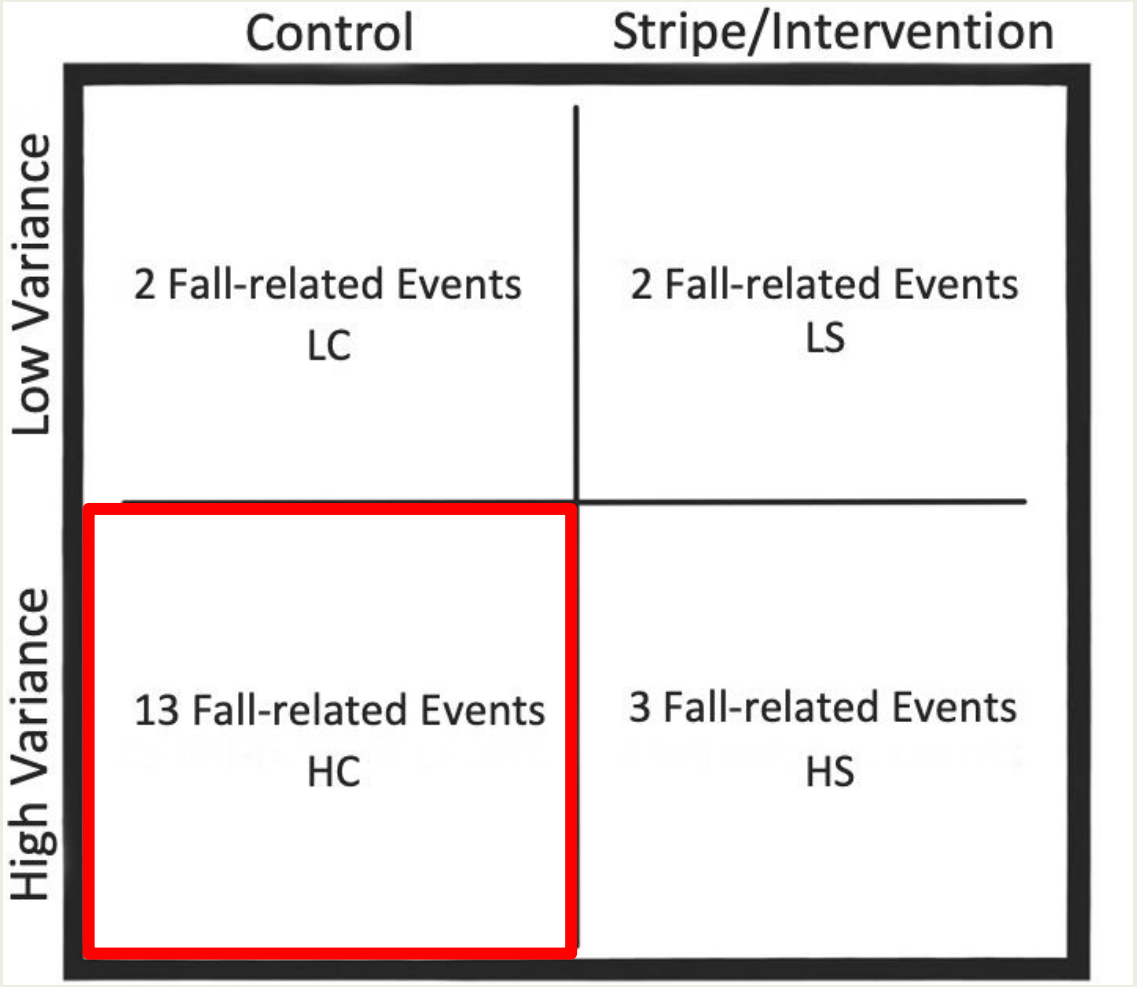
Observations and age groups



Monte-Carlo Simulation

- Four assumptions were used to code our hypotheses for the total number of falls observed (n=20):
  (1) Falls in HC > falls in LC
  (2) Difference between LS and LC < 2 falls
  (3) Number of falls in HC will be ≥ two times of HS
  (4) Difference between LC and HC > the difference between LS and HS

- Probability of a distribution meeting these assumptions occurring by chance is P=0.0358



Occupational Safety and Health Administration (OSHA)

- 1910.25(b)(3) – Stairs should have **uniform riser heights and tread depths** between landings

- 1926.1052(a)(3) – **Variations** in riser height or tread depth **shall not be over ¼ in (0.635 cm)** in any stairway system
  - Last amended FR 68795, Dec. 17, 2019.

Tread depth

Tread depth ranges (cm)			
West upper	0.6	East upper	0.4
West lower	3.8	East lower	3.8

At a glance

- Why
  - Falls present a health and financial burden
- How
  - Step edge and face striping may reduce fall risk on stairs
- Further work
  - High-risk populations (i.e., older adults)