Preventing Patient Falls Through Physical Design

Debajyoti Pati, PhD, FIIA, IDEC, LEED AP
Professor
Department of Design
Texas Tech University

Acknowledgments

Funding

- Agency for Healthcare Research & Quality (Study 2)
- National Patient Safety Foundation (Study 1)

Team

- TTU
  - Debajyoti Pati
  - James Yang
  - Jae-hoon Lee
  - Shabboo Valipoor
  - Aimee Cloutier
- HKS Architects – Thomas E. Harvey, Jr.
- Covenant Health – Patricia Freier

Core Issue

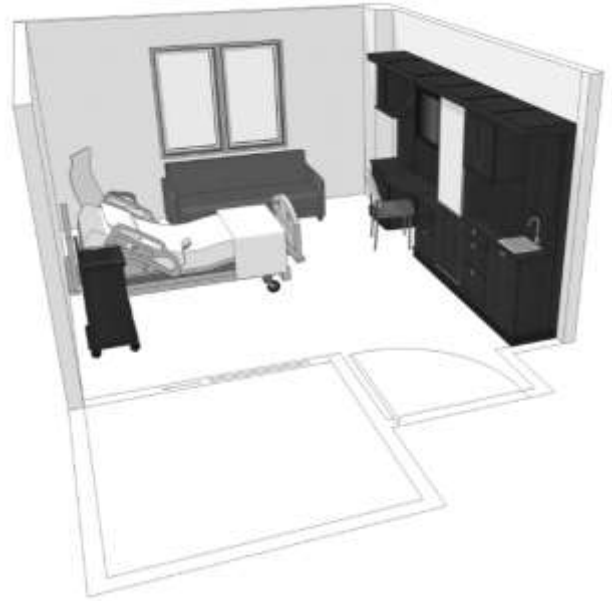
- How changes in physical design may decrease the number of falls in hospitals?

What we knew

- Falls are one of the major sources of injury in hospitals
  - $34 billion annually in direct medical cost
  - Non-reimbursed hospital-acquired condition since 2005
- Intrinsic & extrinsic risk factors
- Assisted & unassisted falls

Research Questions Study 1

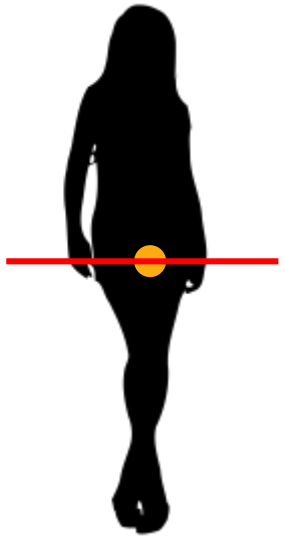
1. From a physical design perspective, what are the specific decisions pertaining to patient room design that may contribute to fall events?



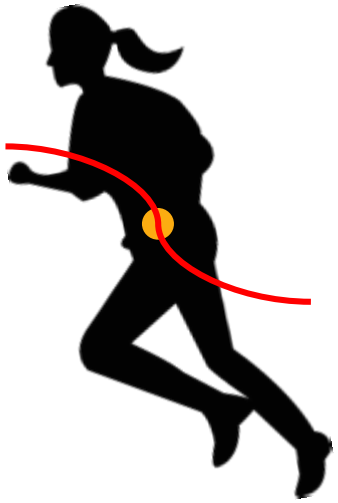
Research Design

- Ideal scenario: monitoring real patients in actual hospital rooms/bathrooms and analyze their falls

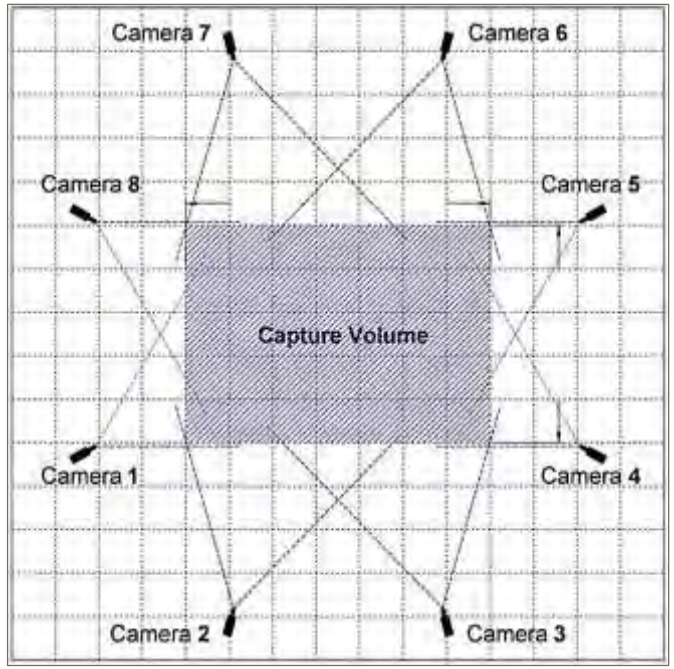
Potential Fall



Stable Acceleration



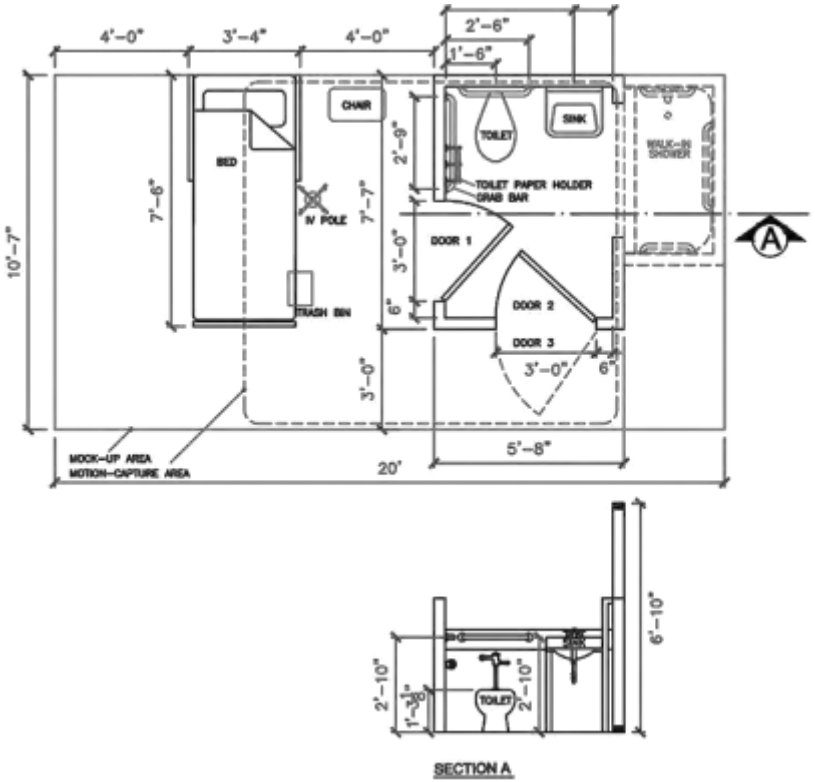
Jerk in Acceleration



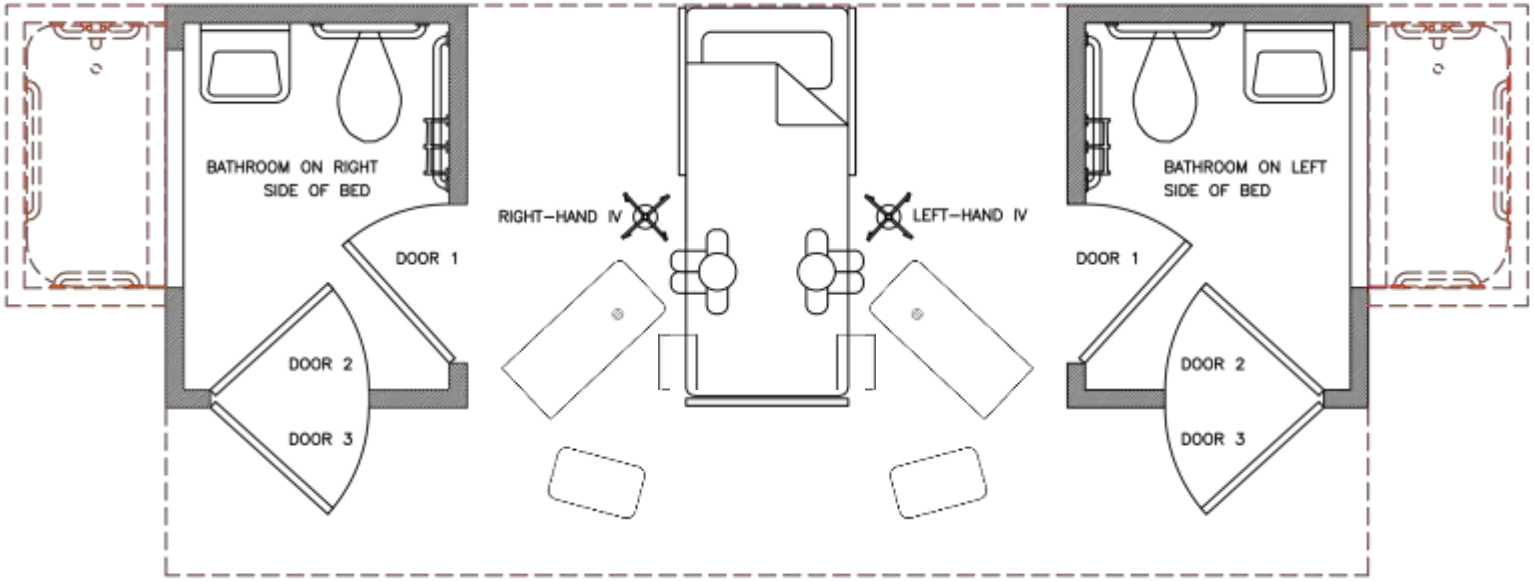
Simulation

Human-Centric Design Research (HCDR) Lab

Department of Mechanical Engineering, TTU



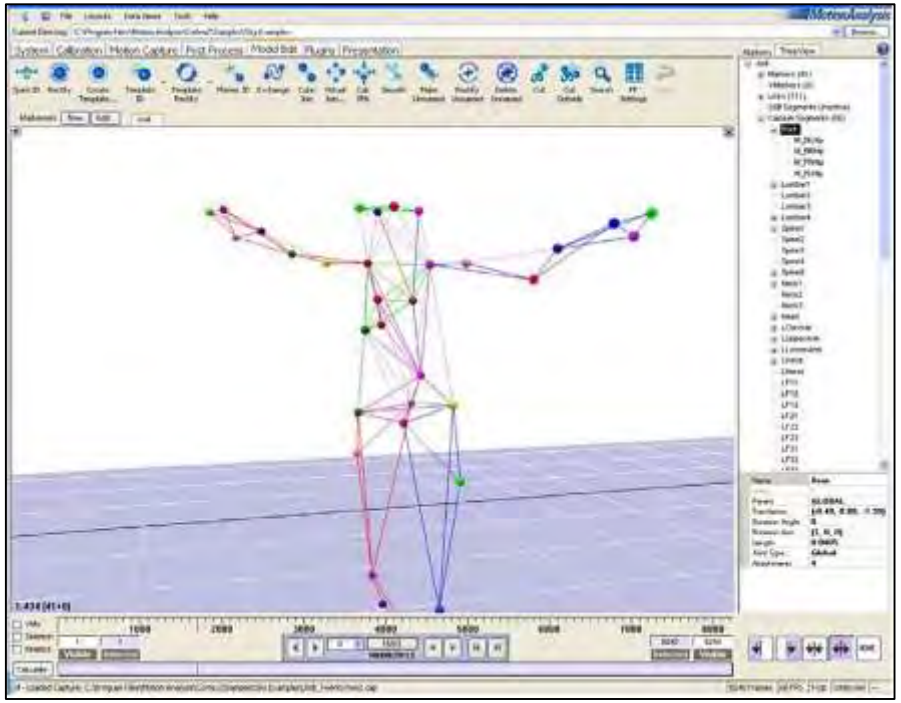
Experiments

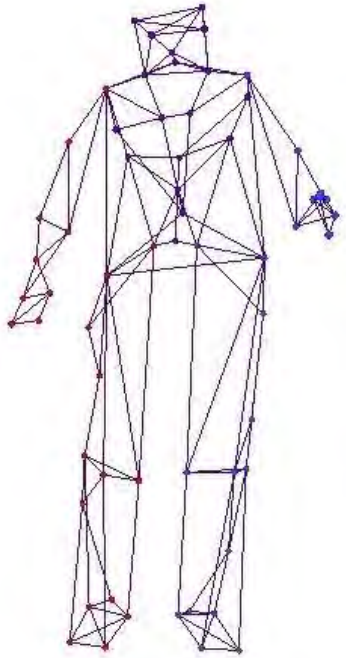


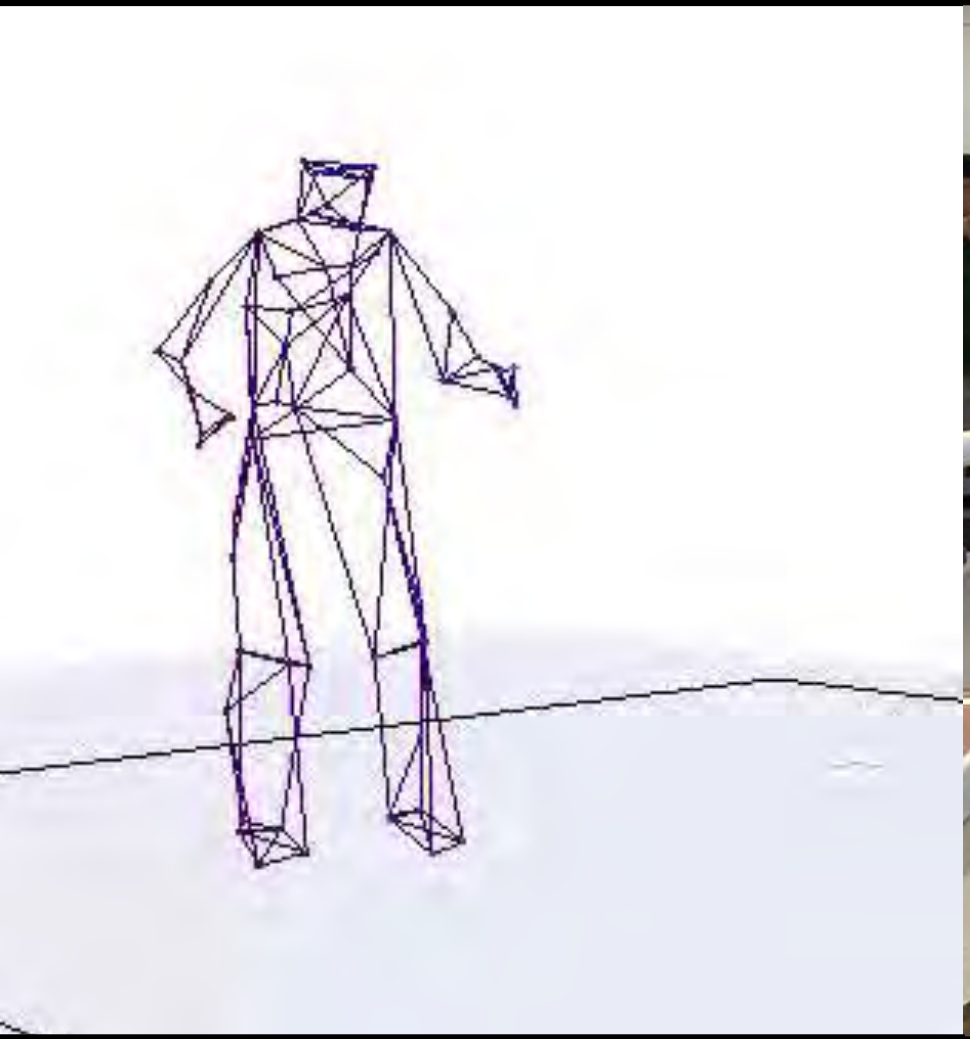
- Subjects:
  - 30 elderly individuals
  - 70 to 87 years (mean 78)
  - Female (17), Male (13)
- Environmental variables:
  - Bathroom location
  - Bathroom door location
  - Bathroom door swing
  - IV on arm
- Experimental trials:
  - 200 x 3 = **600 runs**
  - Best 200 used for analysis
  - Each run: 2 to 4 minutes

Motion Capture

Data processing

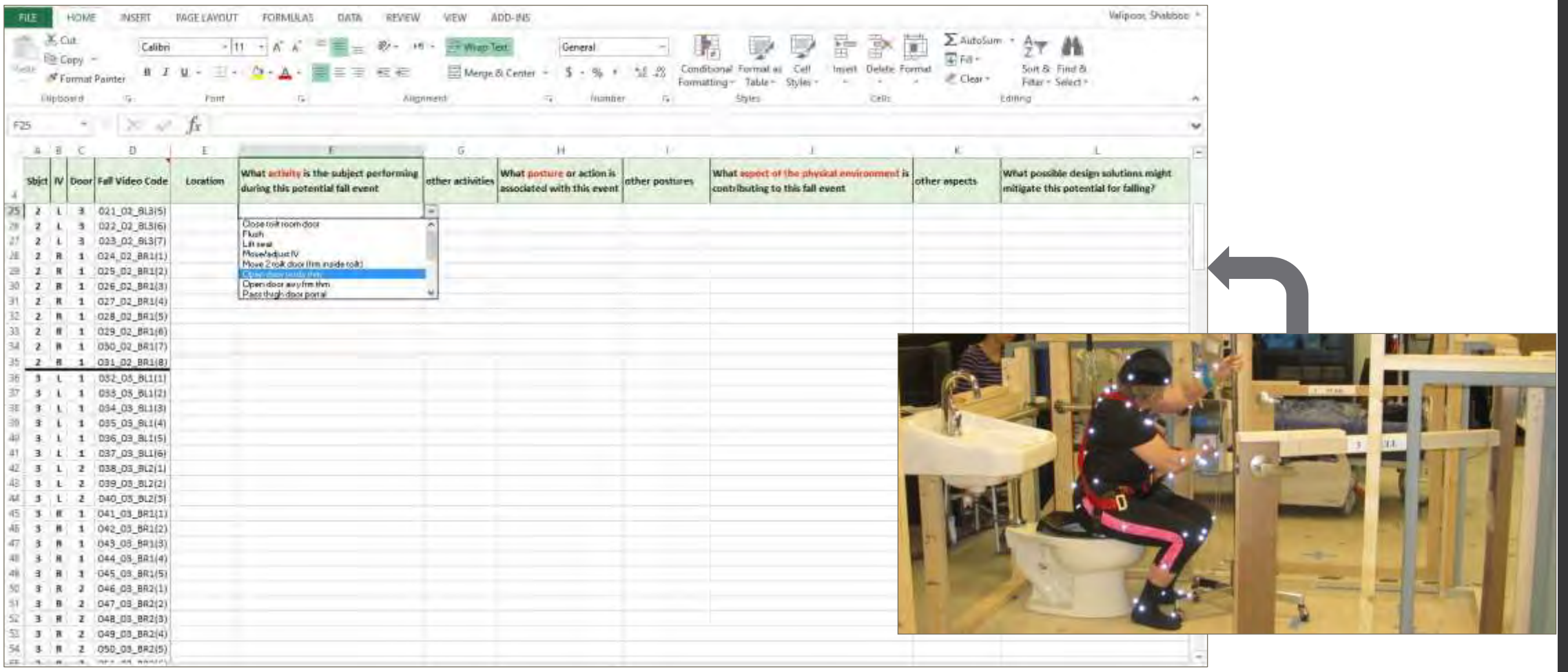






730 potential fall moments

Analyses


FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
ADD-INS
Valipoor, Shabboo
Cut
Copy
Format Painter
Calibri
11
Wrap Text
General
Merge & Center
Conditional Formatting
Format as Table
Cell Styles
Insert
Delete
Format
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Clipboard
Font
Alignment
Number
Styles
Cells
Editing
F25
Sbjct
IV
Door
Fall Video Code
Location
What activity is the subject performing during this potential fall event
other activities
What posture or action is associated with this event
other postures
What aspect of the physical environment is contributing to this fall event
other aspects
What possible design solutions might mitigate this potential for falling?
Close toilet room door
Flush
Lift seat
Move/adjust IV
Move 2 walk door (frm inside toilt)
Open door awy frm thm
Pass thugh door portal

Highlighted Findings (Study 1)

Interaction between offending postures and physical environment
(TOTAL 16 ELEMENTS/ ATTRIBUTES)

- In <u>bathrooms</u> :
  - Offending postures: **turning, grabbing, pushing, & pulling**
- Around the <u>bed</u>:
  - Offending postures: **push or pull**
- The physical elements associated with offending postures:

  bathroom configuration, intravenous pole, door, toilet seat height, flush, grab bars, over-bed table, patient chair

Research Question Study 2

- What are the odds of observing different postures?
- What physical design elements or attributes are associated with the postures exhibiting the highest and statistically significant odds of occurring?

Best-Subsets Analysis Results on 11 Predictors in the Bathroom Data

Parameter	Estimate	SE	z	p	OR
Intercept	0.40	0.13	3.10	.002	
Pushing	0.48	0.23	2.09	.036*	1.62
Pulling	0.51	0.19	2.62	.009*	1.66
Bending forward	0.42	0.18	2.40	.017*	1.52
Walking	0.33	0.19	1.68	.093	1.39
Making turns	0.88	0.36	2.46	.014*	2.41

Follow-up Analysis Results on Four Predictors in the Bathroom Data

Parameter	Estimate	SE	z	p	OR
Intercept	0.90	0.09	10.36	.000	
Making a turn up to 90°	1.07	0.14	7.58	.000*	2.92
Making a 120° turn	0.00	0.37	–0.01	.993	1.00
Making a 150° turn	–0.03	0.30	–0.09	.931	0.97
Making a 180° turn	0.74	0.26	2.82	.005*	2.09

Best-Subsets Analysis Results on 11 Predictors in the Bedroom Data

Parameter	Estimate	SE	z	p	OR
Intercept	0.38	0.17	2.20	.0280	
Pushing	0.92	0.26	3.59	.0003*	2.52
Grabbing	1.81	0.44	4.12	.0000*	6.10
Sitting	0.67	0.23	2.96	.0031*	1.95
Walking	0.34	0.23	1.47	.1429	1.40

Associated Environmental Factors

Architecture/ Interior Design

- Bathroom Door
- Bathroom Configuration
- Bathroom Hardware – Door, Toilet
- Bedroom - Spatial Constraints
- Bedroom Configuration

Medical Equipment and Furniture

- IV Pole
- Patient Bed
- Patient Chair
- Over-bed Table

Thank You!