From Research to Clinical Practice: Utilizing Structural Equation Modeling to Identify Factors in Fall Incidency Among Community-Dwelling Older Women

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Article

Investigating Fall-Related Factors in Community-Dwelling Older Women Through Structural Equation Modeling Analysis

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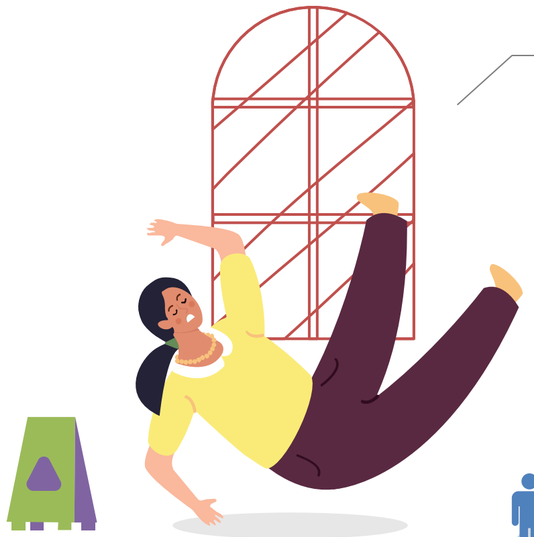
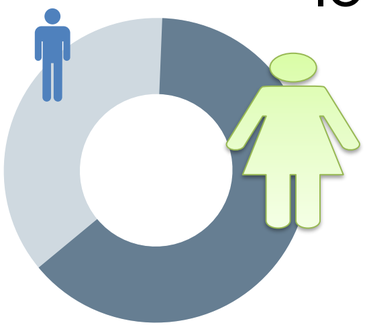
Why this topic matters?



- Falls in community-dwelling older adults represent a major public health concern.
  ✓ 1 in 3 older adults experience a fall each year.

- Falls were affected by loss of balance, poor gait, low physical activity, fear of falling, and low self-efficacy.



- The prevalence of falls in older women is higher compared to older men.

(Sebastiani et al., 2024; Suh et al., 2023; Bally et al., 2023)

Why Older Women?

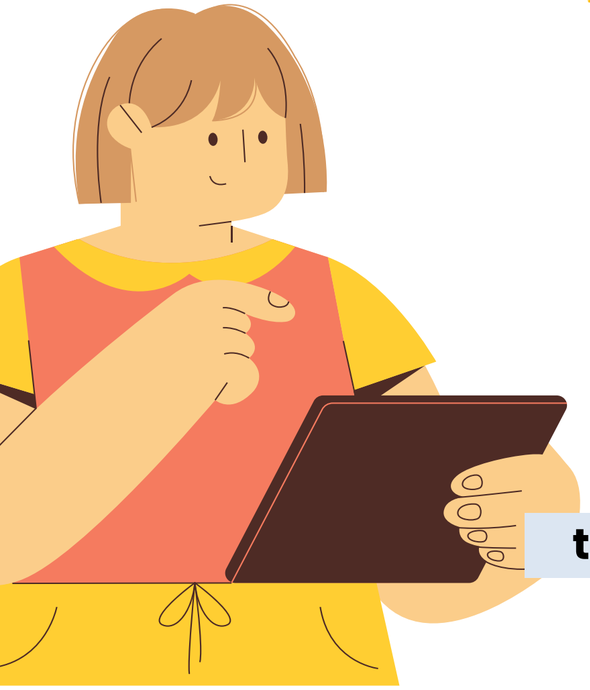
- Women has unique Risk Profile

- ☑ ↓ Muscle mass post-menopause
- ☑ ↓ Physical activity (caregiving roles)
- ☑ ↑ Fear of falling

What's missing ??

Most of studies:

- ☑ Physical factors only
- ☑ Psychological factors only



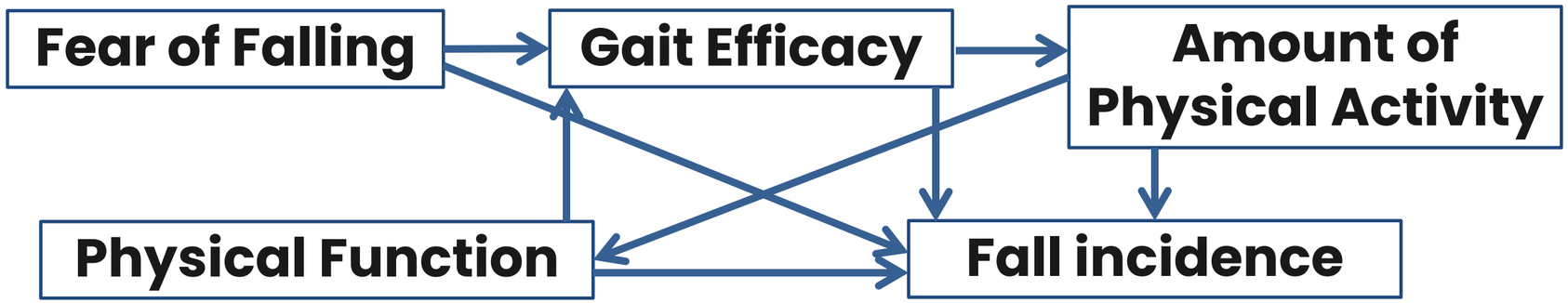
the interplay among these factors in influencing fall incidence is not yet fully understood.

(Gale et al., 2016; Halter et al., 2017; Patton et al., 2022)

Aim

To investigate the factors associated with fall incidence in community-dwelling older women by using structural equation modeling analysis (SEM)

Hypothesis Model



1. Physical function, fear of falling, gait efficacy, and the amount of physical activity are directly associated with fall incidence among community-dwelling older women.

2. Fear of falling and physical function are indirectly associated with fall incidence through the mediation of gait efficacy & the amount of physical activity.

3. The amount of physical activity is directly associated with physical function.

Study Design & Participants

Study Design

- Cross-sectional study was performed on 90 community-dwelling older women in Indonesia from August to September 2023.

Inclusion Criteria

- Age ≥ 60 years old
- Able to walk independently

Exclusion Criteria

Older adults with:

- Cognitive impairment or dementia.
- Hearing, vision impairment, or depression.
- Acute neurological disease, cardiovascular disease, or arthroplasty.

Measurements

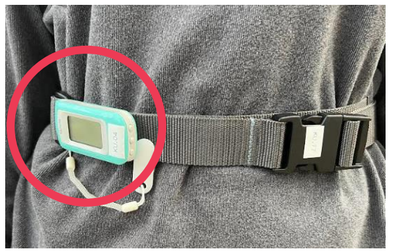
Fall incidence

Yes/no question about "Have you ever fallen in the past year?"

- Yes: Fallers
- No: Non-fallers

Amount of physical activity

Count the number of steps for 7 days (The average of 5 days steps was included in the analysis).



Activity Meter EZ-064 (Tanita Co, Japan)

Sociodemographic variables

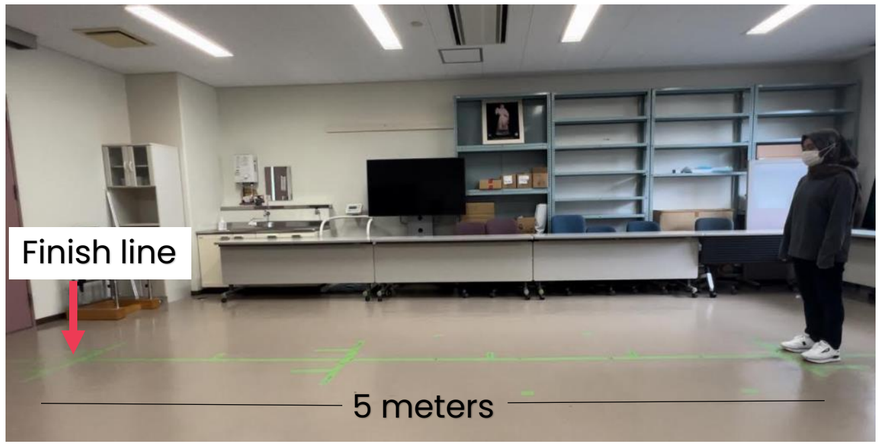
- Age
- Education
- Living status
- Toilet status
- Stairs
- Working status
- Health status

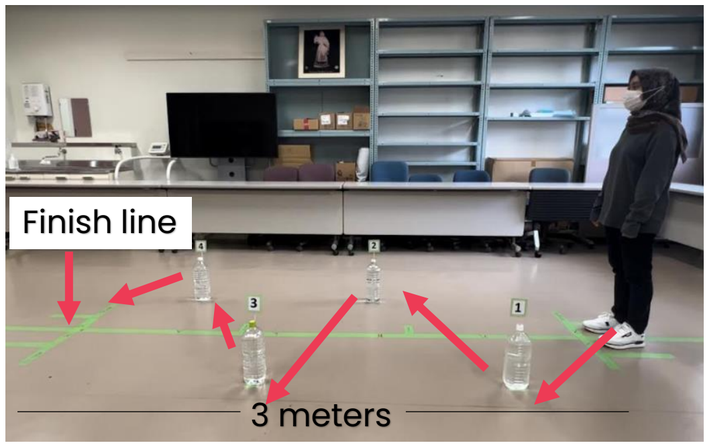
Psychological Factors

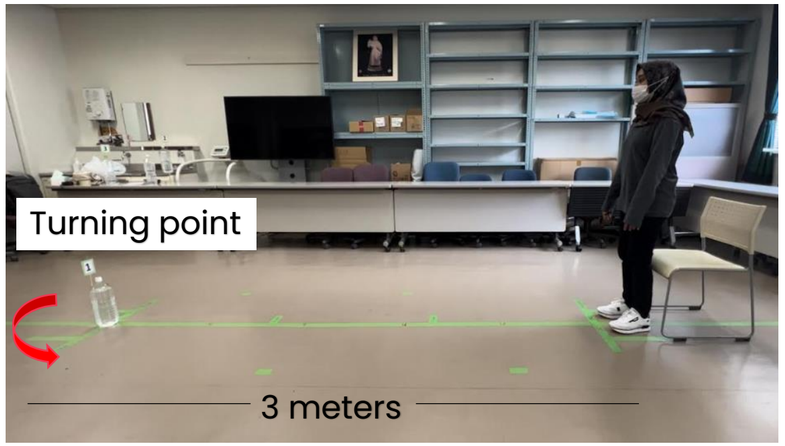
- Fear of falling: The Short Fall Efficacy Scale International (SEF-I) questionnaire
- Gait efficacy: The Modified Gate Efficacy Scale (mGES) questionnaire

Physical function

Physical function measurements







The Five Meter Walking Test (5MWT)

5MWT measures straight-line walking speed, which reflects lower-limb strength and general mobility (Salbach, 2001).

Zig-zag Walking Test (ZWT)

ZWT represents indoor walking situations that require frequent changes of direction (Suganuma, 2013). In older women, many falls occur during activities that involve directional changes within the home.

Timed Up and Go Test (TUGT)

TUGT involves standing, walking, turning, and sitting, which together reflect dynamic balance, coordination, and fall risk (Shumway-Cook, 2000).

All tests were measured twice and the average was used in the analysis.

Statistical Analysis

Data analysis was conducted using SPSS version 29 and AMOS version 29.

Descriptive statistics were presented as :

- Means with standard deviations, or
- Frequencies with percentages.

- Bivariate associations between variables were tested by:
  - Independent samples t-test,
  - Chi-square test, or
  - Fisher's exact test.
- *p*-values <0.05 were considered statistically significant.

- Multicollinearity test were performed.
- Variables with Variance inflation factors values < 10 and Tolerance values > 0.10 were included in the SEM analysis

SEM was conducted in 2 steps:

- Confirmatory factor analysis (CFA) for verification of latent construct of physical function.
- Complete SEM analysis of all variables.

Results

Demographic characteristics

Characteristics		Total (N=90) Mean ± SD / Number (%)	Fallers (N =19) Mean ± SD / Number (%)	Non-Fallers (N =71) Mean ± SD / Number (%)	*p*-value
Age (years)		68.0± 6.4	67.6± 5.1	68.2±6.7	0.730a
Educational Background	Less than middle school	71(78.9)	16(84.2)	55(77.5)	0.753b
	Middle and high school	19(21.1)	3(15.8)	16(22.5)	
Living Status	Living alone	10(11.1)	3(15.8)	7(9.9)	0.435b
	Living with spouse/children, relatives	80(88.9)	16(84.2)	64(90.1)	
Toilet use	Sit	24(26.7)	6(31.6)	18(25.4)	0.586c
	Squat	66(73.3)	13(68.4)	53(74.6)	
Stair use	Yes	30(33.3)	6(31.6)	24(33.8)	0.855c
	No	60(66.7)	13(68.4)	47(66.2)	
Working Status	Yes	22(24.4)	5(26.3)	17(23.9)	1.000b
	No	68(75.6)	14(73.7)	54(76.1)	
Health Status	Good	65(72.2)	13(68.4)	52(73.2)	0.677c
	Not good	25(27.8)	6(31.6)	19(26.8)	

SD, Standard deviation; a, Independent sample t-test; b, Fisher exact test; c, Chi-square test.

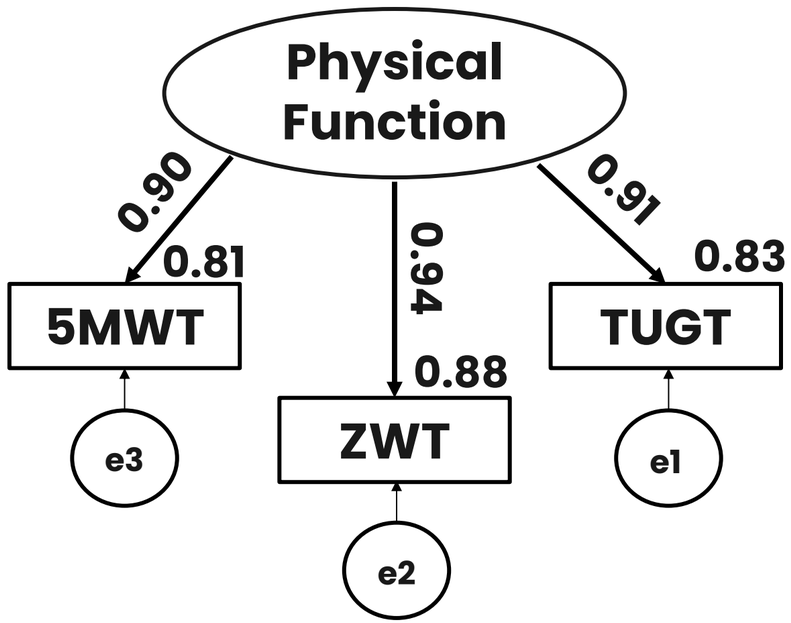
There is no difference in sociodemographic variables between the fallers and non-fallers group.

Fall related factors between fallers and non-fallers

Characteristics		Total (N=90) Mean ± SD / Number (%)	Fallers (n=19) Mean ± SD / Number (%)	Non-Fallers (n=71) Mean ± SD / Number (%)	*p*-value
Physical Function	5MWT time (sec)	8.2 ± 2.4	10.2 ± 3.3	7.7 ± 1.8	<0.001
	ZWT time (sec)	13.3 ± 4.7	17.1 ± 6.9	12.3 ± 3.3	<0.001
	TUGT time (sec)	13.7 ± 4.2	17.1 ± 5.9	12.8 ± 3.1	<0.001
Fear of Falling	Short FES-I (score)	11.4 ± 4.3	12.0 ± 4.8	11.3 ± 4.1	0.517
Gait Efficacy	mGES (score)	84.7 ± 15.6	69.4 ± 21.3	88.9 ± 10.6	<0.001
Amount of Physical Activity	Number of steps (step)	3560.2 ± 3022.9	1029.2 ± 782.1	4237.5 ± 3042.5	<0.001

Note: 5MWT, Five Meter Walking Test; ZWT, Zig-zag walking test; TUGT, Timed Up and Go Test; mGES, modified gait efficacy scale; Short FES-I, Short Fall Efficacy Scale International; SD, Standard deviation ; *p*-value of Independent sample t-test.

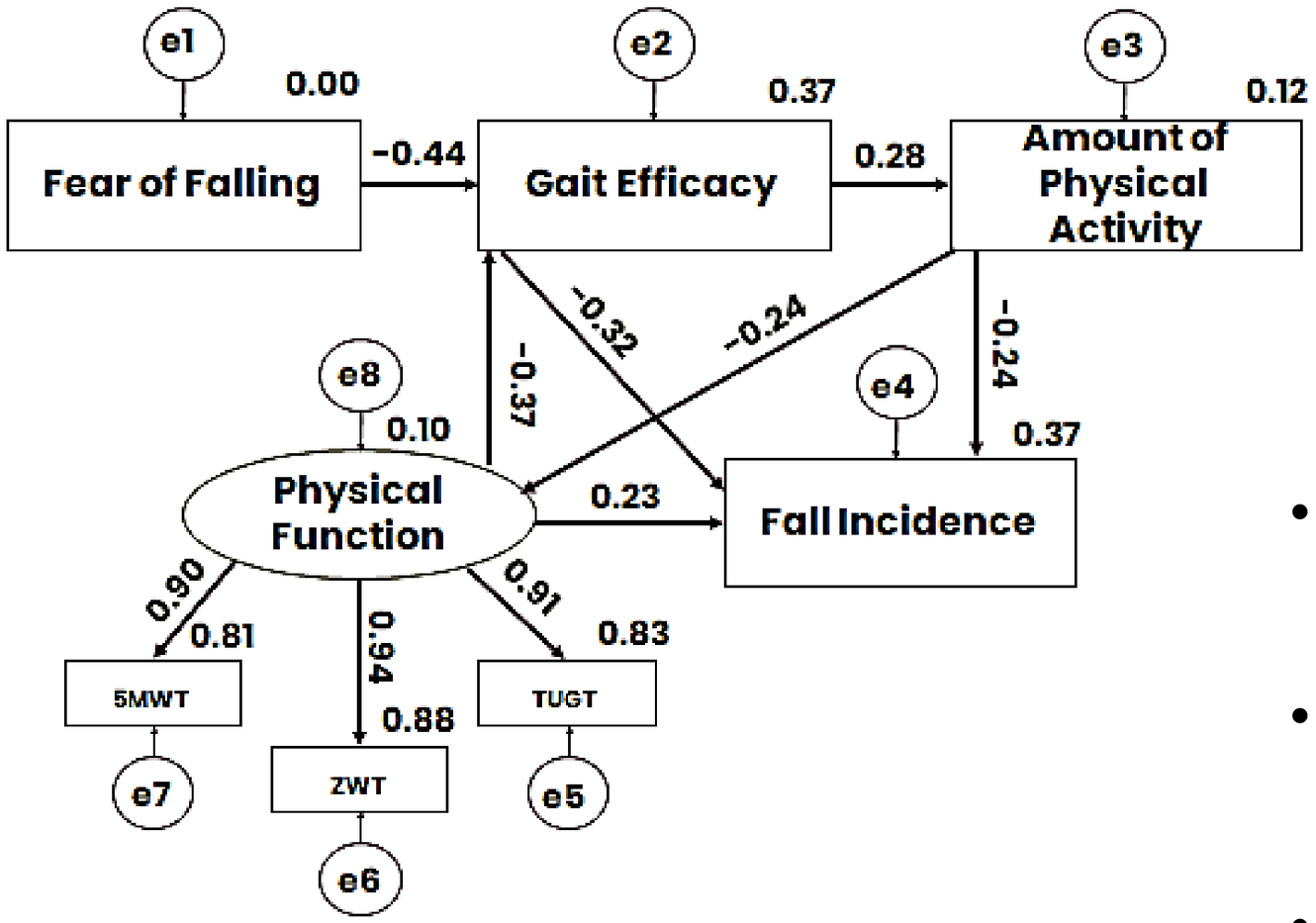
CFA for the latent variable



- Excellent model fit:
  - Comparative fit index (CFI) = 1.000,
  - Goodness of fit index (GFI) = 1.000,
  - Normed fit index (NFI) = 1.000
- Factor loadings: 5MWT = 0.901, ZWT = 0.942, TUGT = 0.910
- The CFA confirmed that the indicators (5MWT, ZWT, and TUGT) appropriately represent the latent construct of physical function.

Note: 5MWT, Five Meter Walking Test; ZWT, zig-zag walking test; TUGT, Timed Up and Go Test.

SEM Analysis



Note: 5MWT, Five Meter Walking Test; ZWT, zig-zag walking test;
TUGT, Timed Up and Go Test; β = Standardized regression coefficient.

Goodness of fit:

- Chi-square (χ^2) = 6.187
- df = 11; χ^2/df= 0.562
- Probability = 0.861
- Goodness of fit index (GFI) = 0.981
- Comparative fit index (CFI)= 1.000
- Normed fit index (NFI)= 0.982
- Root mean square error of approximation (RMSEA)= 0.000

- Physical function (β = 0.233, *p* = 0.02), gait efficacy (β = -0.318, *p* = 0.001), and the amount of physical activity (β = -0.243, *p* = 0.009) directly associated with fall incidence.
- Fear of falling (β = 0.183) and physical function (β = 0.152) had an indirect association with fall incidence through the mediation of gait efficacy & the amount of physical activity.
- The amount of physical activity (β = -0.236, *p* = 0.038) had direct association with physical function.

What Does This Mean for Health Care Providers ?

Don’t only strengthen muscles → strengthen confidence.

Gait training + balance training + reassurance =
- ✨ higher gait efficacy
- ✨ more physical activity
- ✨ fewer falls

Encourage daily movement — not only exercise sessions.

- ✨ Activity done at home > exercise done once a week

Family plays a huge role.

Encourage :
- ✨ Share chores
- ✨ support for walking
- ✨ community activities

Practical example

Imagine two 70-year-old women:

Ibu A: confident, walks 4,000 steps/day, helps with housework

Ibu B: scared to walk alone, sits most of the day, only 1,000 steps/day

This model shows exactly why Ibu B is more likely to fall — not because of age, but because of reduced confidence and inactivity.

Conclusions

- Falls are not caused by one factor.

  They are the result of an interaction between physical, psychological, and daily movement.
- To prevent falls in older women, it is necessary :
  - ✓ Improve physical function
  - ✓ Strengthen walking confidence
  - ✓ Increase physical activity
  - ✓ Engage families and communities
- This study provides a integrated way to understand fall risk in older women and gives healthcare providers a clearer roadmap for fall prevention.

Ethics & Funding

Ethics

This study was approved by the Medical Ethics Review Committee of Kanazawa University (number: 111094-1).

Funding

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Conflict of Interest

There is no conflict of interest in this study

Thank You

Any question?