Prevalence and characteristics of compensatory stepping responses during real-life falls in older adults

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BACKGROUND

In laboratory studies, older adults commonly rely on stepping to prevent falling when their balance is perturbed (Jensen et al., 2001). We extended the literature by characterizing the stepping responses of older adults during real-life falls, captured on video in long-term care (LTC).

METHODS

We analyzed videos of 1516 falls by 515 LTC residents. We used Generalized Estimated Equations to test whether step characteristics (prevalence, direction, and length) associated with initial fall direction, activity at the time of the fall, held weight-bearing objects, attempts to recover balance by grasping, sex, and age.

RESULTS

Attempts to recover balance by stepping were observed in 76% of falls. For these cases, 64% involved small steps (less than one-half foot length), 80% involved multiple steps, and 81% involved steps that aligned with the initial fall direction. Forward falls elicited larger steps that were more aligned with the fall direction. The oldest residents took smaller steps, but their steps were more aligned with the fall direction. Falling while walking (versus standing) led to more frequent steps. Holding a weight-bearing object led to smaller and less frequent steps. Attempts to recover balance by reaching to grasp a nearby object elicited steps that were more often misaligned with the fall direction.

DISCUSSION

Most falls by older adults in LTC were accompanied by attempts to recover balance by stepping. Further research is required on strategies to enhance compensatory stepping through exercise or perturbation training (Mansfield et al., 2010).

Older adults in long-term care responded to falls with attempts to recover balance by stepping. Most falls elicited **multiple, small steps that aligned with the fall direction.**
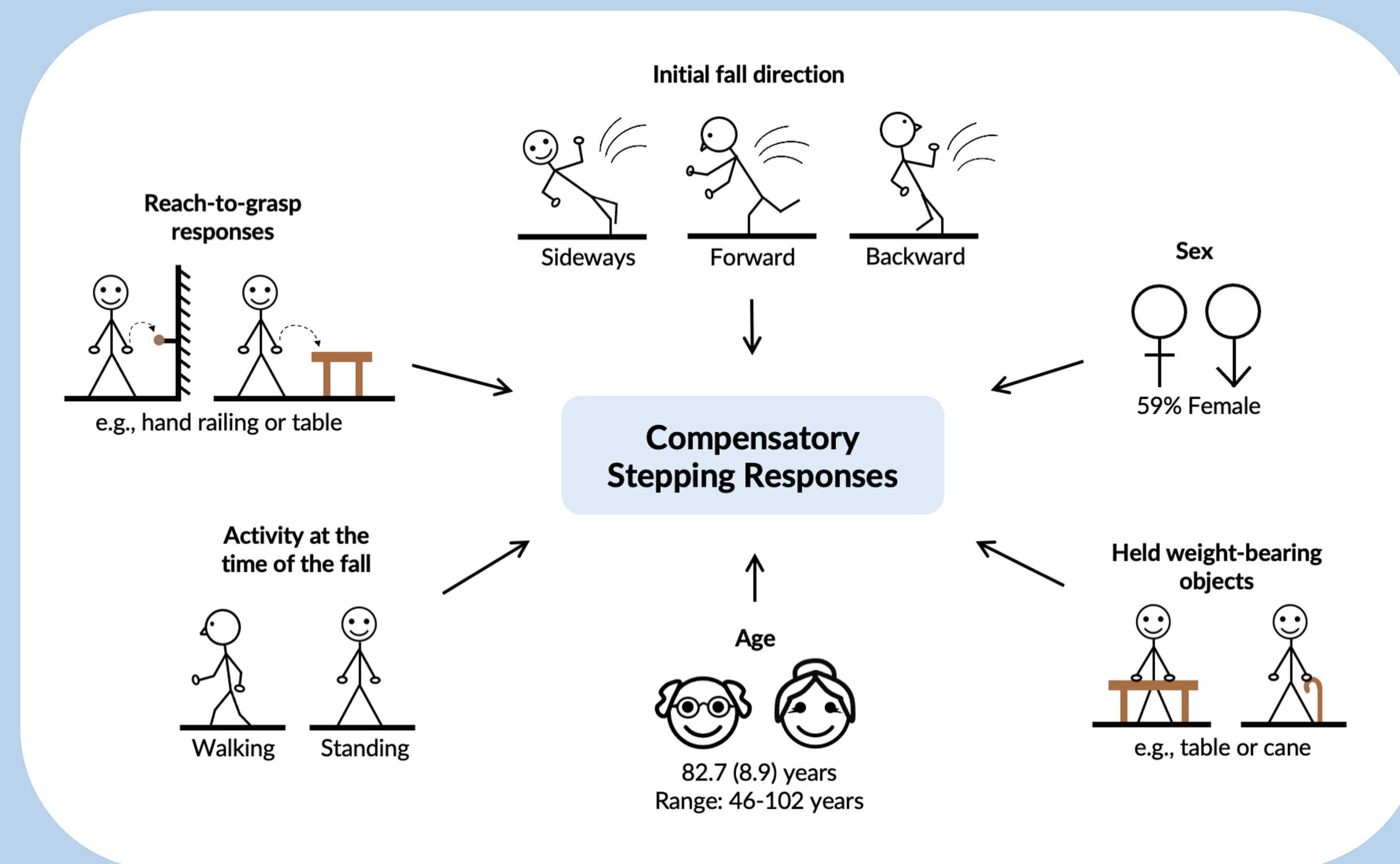

Figure 1. Screen captures of falls in the forward (A), backward (B), and sideways (C) directions

Table 1. Effect of fall and resident characteristics on stepping responses (n=1516 falls)

	Number of Falls (%)		Univariate Analysis	
	Steps Taken	No Steps	Odds Ratio (95% CI)	p
Falls by men versus:	477 (76.9)	143 (23.1)	1	
Falls by women	679 (75.8)	217 (24.2)	0.897 (0.680-1.184)	0.444
Falls in younger participants versus:	580 (75.5)	188 (24.5)	1	
Falls in older participants	576 (77.0)	172 (23.0)	1.070 (0.809-1.415)	0.636
Falling forward versus:	294 (72.8)	110 (27.2)	1	
Falling sideways	480 (82.2)	104 (17.8)	1.694 (1.172-2.449)	0.005
Falling backward	382 (72.3)	146 (27.7)	0.995 (0.709-1.398)	0.979
Hands-free falls versus:	522 (79.9)	131 (20.1)	1	
Falls while holding WB objects	483 (69.4)	213 (30.6)	0.564 (0.432-0.736)	< 0.0001
Falls without holding WB objects and successful RTG	151 (90.4)	16 (9.6)	2.283 (1.218-4.279)	0.010
Falls while standing versus:	415 (67.8)	197 (32.2)	1	
Falls while walking	741 (82.0)	163 (18.0)	2.136 (1.620-2.817)	< 0.0001

Table 2. Effect of fall and resident characteristics on step direction (n=1156 falls)

	Number of Falls (%)		Univariate Analysis	
	Aligned Direction	Different Direction	Odds Ratio (95% CI)	p
Falls by men versus:	398 (83.4)	79 (16.6)	1	
Falls by women	549 (80.9)	130 (19.1)	0.838 (0.624-1.123)	0.237
Falls in younger participants versus:	461 (79.5)	119 (20.5)	1	
Falls in older participants	486 (84.4)	90 (15.6)	1.395 (1.045-1.861)	0.024
Falling forward versus:	259 (88.1)	35 (11.9)	1	
Falling sideways	375 (78.1)	105 (21.9)	0.483 (0.322-0.723)	< 0.0001
Falling backward	313 (81.9)	69 (18.1)	0.613 (0.409-0.920)	0.018
Hands-free falls versus:	437 (83.7)	85 (16.3)	1	
Falls while holding WB objects	399 (82.6)	84 (17.4)	0.924 (0.668-1.279)	0.635
Falls without holding WB objects and successful RTG	111 (73.5)	40 (26.5)	0.539 (0.352-0.828)	0.005
Falls while standing versus:	341 (82.2)	74 (17.8)	1	
Falls while walking	606 (81.8)	135 (18.2)	0.973 (0.713-1.328)	0.865

Table 3. Effect of fall and resident characteristics on step length (n=1156 falls)

	Number of Falls (%)		Univariate Analysis	
	Small Step	Medium/Large Step	Odds Ratio (95% CI)	p
Falls by men versus:	311 (65.2)	166 (34.8)	1	
Falls by women	432 (63.6)	247 (36.4)	0.998 (0.746-1.335)	0.990
Falls in younger participants versus:	337 (58.1)	243 (41.9)	1	
Falls in older participants	406 (70.5)	170 (29.5)	1.546 (1.170-2.042)	0.002
Falling forward versus:	176 (59.9)	118 (40.1)	1	
Falling sideways	292 (60.8)	188 (39.2)	1.105 (0.781-1.563)	0.572
Falling backward	275 (72.0)	107 (28.0)	1.904 (1.351-2.684)	< 0.0001
Hands-free falls versus:	300 (57.5)	222 (42.5)	1	
Falls while holding WB objects	349 (72.3)	134 (27.7)	1.794 (1.386-2.322)	< 0.0001
Falls without holding WB objects and successful RTG	94 (62.3)	57 (37.7)	1.241 (0.861-1.788)	0.247
Falls while standing versus:	305 (73.5)	110 (26.5)	1	
Falls while walking	438 (59.1)	303 (40.9)	0.535 (0.412-0.694)	< 0.0001

Initial fall direction

Sideways   Forward   Backward

Reach-to-grasp responses

e.g., hand railing or table

Sex

59% Female

Compensatory Stepping Responses

Activity at the time of the fall

Walking   Standing

Age

82.7 (8.9) years
Range: 46-102 years

Held weight-bearing objects

e.g., table or cane