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Prevalence and Risk Factors for Low Habitual Waling Speed in Nursing Home Residents: An Observational Study

Running Title: Gait speed in nursing home residents.

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Prevalence and Risk Factors for Low Habitual Walking Speed in Nursing Home Residents: An Observational Study

Abstract

Objective: The primary aims were to quantify habitual walking speed and estimate the prevalence of low habitual walking speed (< 0.8 m/s and < 0.5 m/s) in nursing home residents. A secondary aim was to gain some insight into whether demographic, health and functional outcomes could predict the nursing home residents' walking speed.

Design: Cross-sectional study.

Setting: 11 nursing homes.

Participants: One hundred and two nursing home residents (37%) consented to participate in this project from a total of 273 eligible, randomly selected residents from 11 nursing homes.

Interventions: Not applicable.

Main Outcome Measure(s): The primary outcome was habitual walking speed assessed over a distance of 2.4 m. Secondary outcomes including body composition, muscle strength, balance and physical performance as assessed via the Short Physical Performance Battery (SPPB), historical and current demographic and health measures were all assessed as potential predictors of walking speed.

Results: Mean walking speed was 0.37 ± 0.26 m/s, meaning that 97% and 75% had walking speeds < 0.8 m/s and < 0.5 m/s, respectively. Multivariable linear regression identified physical activity status prior to 50 years of age and daily sitting time as independent predictors of walking speed ($r^2 = 0.25$, $p < 0.05$), although this regression only accounted for 25% of the variance in walking speed.

Conclusions: Almost all participants in this study had below normal walking speed, a known clinical predictor of physical performance. As walking speed is a clinical marker of many age-related adverse outcomes in older age, efforts to increase or at least maintain walking speed in nursing home residents should be considered. Some evidence suggests that progressive resistance training may offset these declines in walking speed.

Key Words: aging; frail elderly; gait; independent living; nursing home; sarcopenia,

List of abbreviations:

ABC	Activity-Specific Balance Confidence
ACFI	Australian Aged Care Funding Instrument
GDS-15	Geriatric Depression Scale
IPAQ	International Physical Activity Questionnaire
MMSE	Mini-Mental State Examination questionnaire
MNA	Mini-Nutritional Assessment Instrument
SPPB	Short Physical Performance Battery

Prevalence and Risk Factors for Low Habitual Walking speed in Nursing Homes

Low habitual walking speed is an independent predictor of many adverse outcomes in older age including disability, cognitive impairment, institutionalisation, falls, and/or mortality.[1,2] Habitual walking speed is also a very simple, quick and easily obtained clinical measure that has similar predictive ability to larger composite tools including the Short Physical Performance Battery (SPPB).[1-3]

Older adults who transition into nursing homes (residential aged care) commonly do so due to a loss of physical and/or cognitive function that makes it increasingly difficult for them to live within the community.[4] Possible determinants of this physical decline include the age-related loss in muscle mass, muscle strength and physical performance, termed sarcopenia[5] and their very sedentary lifestyles.[6] The European Working Group on Sarcopenia in Older People recommend using habitual walking speed obtained over short distances (2.4-8 m) as the physical performance measure for diagnosing sarcopenia.[5] Habitual walking speeds < 0.8 m/s indicate reduced physical performance,[5] a value almost identical to the 0.82 m/s cut off identified by Stanaway et al.[7] as predictive of death within two years among men aged 70 or older. As older adults' physical performance decreases with age,[8-11] Weidung et al.[12] re-examined these walking speed thresholds for those over 80 years of age, an age group that is more similar to that of most nursing homes. Weidung et al.[12] identified 0.5 m/s as the threshold for increased adverse effects in this age group, suggesting that 0.5 m/s may be a more sensitive walking speed threshold for those in nursing homes.

Walking speed also declines with older adults' level of care.[2,13] Meta-analyses indicate mean walking speed declines from 0.74 m/s in ambulatory hospital patients (out-patients), to 0.53 m/s in sub-acute hospital patients, with acute hospital in-patients and ambulatory nursing homes residents having walking speeds of 0.46 and 0.48 m/s, respectively.[2,13] However, the authors of these meta-analyses acknowledged that many of the reviewed studies provided limited data on their sampling strategy or utilized non-randomly selected samples, meaning the participants in these studies may have had greater levels of physical and/or cognitive function than the non-consenters.[2,13] The results presented in these meta-analyses therefore may overestimate mean habitual walking speed and underestimate the true prevalence of reduced physical performance.

Several studies have sought to identify risk factors for low walking speed in older adults,[14-16] although most have assessed community-dwelling adults and only considered a small number of potential risk factors. Kim et al.[16] found that the time to complete a variety of balance and lower body strength tasks (tandem walk, alternate step and 5-time repeated chair stands) distinguished faster and slower walkers in community-dwelling adults. No such studies have directly assessed the ability of current and historical demographic, health and functional variables to predict the walking speed of nursing homes residents. McGough et al.[17] provides some insight, reporting that walking speed was significantly correlated to the SPPB summary score (r = 0.66) and the modified Berg balance test (r = 0.73) among 31 nursing homes residents with dementia. However, as walking speed is one of the three assessments comprising the SPPB, a positive relationship should exist between the summary score and walking speed.

The primary aims of this study were to access a randomly selected sample of residents living in nursing homes to: 1) quantify their habitual walking speed; and 2) estimate their prevalence of low habitual walking speed (assessed at thresholds of 0.8 m/s and 0.5 m/s).[5,12] A secondary aim was to gain some preliminary insight into whether demographic, health and functional outcomes were predictive of walking speed in this population.

Methods

Study design and recruitment

A cross-sectional study utilising stratified random sampling was performed to address the research aims. A full description of the study design including participant eligibility and recruitment is provided in the published study protocol.[18] In brief, 11 purposefully selected nursing homes within one care organisation in (Removed for blinding) were identified and invited to participate during late 2012 and early 2013.[18] Of the total population of 709 residents in these 11 nursing homes, 381 eligible residents were identified and 273 participants were randomly invited to participate. Random selection of eligible participants was undertaken using a random number generator (http://stattrek.com/statistics/random-number-generator.aspx). Resident inclusion criteria were: 1) 60 years or older; 2) residing in a nursing home; 3) able to self-ambulate 5m with or without a walking aid; and 4) able to provide informed consent, or if unable, proxy informed consent obtained from a substitute decision maker. Exclusion criteria included: 1) had a pacemaker due to reported contraindications to bioelectrical impedance analysis; 2) end-stage palliative; 3) behavioral issues that would affect data collection; or 4) any medical or other issue e.g. incommunicable deafness, significantly advanced dementia, two person transfer or a comatose status etc that would limit data collection.

Eligible participants were randomly selected within three strata of care (low care, high care or residing in a secure dementia ward). The definition of the classification of residents into low care or high care is based on the Australian Aged Care Funding Instrument (ACFI) score that comprises individual assessments for multiple activities of daily living, behavioural issues and complex health criteria items. The recommendation for particular residents to reside in in the dementia wards is independent of the ACFI score and reflects the assessment of the resident by nursing staff and discussions with the residents' family. The study was approved by the human ethics committees (institutional review boards) of the (Removed for blinding).

Data Collection

All measures used in the study have been validated for use among old and very old adults, with the study protocol and burden reported elsewhere.[18] All assessments were completed in a single session per participant. For low care participants, the research assistant conducted all data collection without assistance, whereas for high care and dementia participants, a member of the nursing home staff assisted the research assistant during the assessments. To reduce any potential burden during the assessments, participants were encouraged to rest as needed and given verbal support and encouragement. A brief overview of the methods described in full within the published study protocol is given below.[18]

Primary outcome: Habitual Walking speed

Habitual walking speed was measured by the SPPB's walk test.[19,20] Participants' habitual walking speed was assessed over 2.4 m with an additional 0.4 m at each end to allow for acceleration and deceleration.[19] Three trials were performed per participant, with the best time recorded for analysis.

Secondary outcomes

Additional Performance Measures

Isometric handgrip test and the 5-time repeated chair stand were used to assess upper- and lower-body strength, respectively. Participants performed the handgrip test seated, with their elbow flexed at 90^0 and were asked to squeeze the Jamar dynamometer (Sammons Preston Roylan, Bolingbrook, IL)[a] as hard as possible for several seconds.[21] Three trials were conducted using the dominant hand, with the best trial used in analysis. For the 5-time repeated chair stand task, the participants were asked to complete five sit to stands in a short as time as possible with their arms across the chest.[19] Only one trial of the chair stand was performed due to the fatigue associated with this task in this population.

Balance was assessed using the SPPB hierarchical test of standing balance.[19] This assessment requests the participant to stand unaided for a period of 10 seconds in three progressively more difficult stance positions (two feet side by side, semi-tandem and tandem stance).

Body Composition

Body composition (muscle and fat mass) was measured using Bioelectrical Impedance Analysis (BIA). A Maltron BF-906 (Maltron International Ltd, Rayleigh, UK)[b] was used with the participants lying supine during testing, electrodes attached to the top of the right wrist, distal end of the central metacarpal, and over the right foot talus and distal end of the central metatarsal. The skeletal muscle mass index was calculated from the equation of Janssen et al.[22]

Demographics and Health Status

The demographic and health status variables included in the study have been described in the protocol paper.[18] Many of these variables were based on those used by Landi et al.[23] who estimated the prevalence and risk factors of sarcopenia in 122 Italian nursing home residents. Height and bodyweight were measured on the assessment day using standard methods. Demographics and health status data obtained from self-report interview included gender, education level, occupation or spouse’s occupation if not the primary income earner as well as current and previous smoking habits.

In addition, women where asked about their age at menopause. The number and type of diseases and medications, date of birth and entry into the facility, marital status, language spoken, hospitalisation history, falls within the last six months, bone mineral density diagnosis (normal, osteopenic or osteoporotic) and the ACFI rating at entry and at present were obtained from facility records.

Mental Health

Potential levels of cognitive impairment and depression were assessed using the Mini-Mental State Examination questionnaire (MMSE) and the Geriatric Depression Scale (GDS-15), respectively.[24,25] The MMSE classifies participants as normal cognition (25-30) or mild (21-24), moderate (14-20) or severe (< 13) cognitive impairment.[26] The GDS summary scores classifies participants as no (0-4), mild (5-8), moderate (9-11) or severe (12-15) depression.[25]

Physical Activity

Physical activity levels over the last the last seven days were assessed by the International Physical Activity Questionnaire (IPAQ) Short Form.[27] Questions assessed the frequency and duration of vigorous and moderate physical activity as well as walking and sitting over the prior seven days. Additional questions were asked about levels of physical activity prior to the age of 50 years (Were you physically active prior to the age of 50 years?) and post-retirement (Were you physically active after retirement?) to gain a better understanding of historical physical activity patterns.

Nutritional Status

The Mini-Nutritional Assessment Instrument (MNA) was used to assess nutritional status. The MNA involves four main aspects (anthropometric, and a global, dietary, and subjective assessment), and is a recommended screening tool for all levels of aged care by the Dieticians Association of Australia.[28,29]

Falls History and Fear of Falling

The number of falls recorded for each participant in the last six months was obtained from facility records. A fall was defined as an event resulting in a person coming to rest unintentionally on the ground or lower level, not as a result of a major intrinsic event (such as a stroke) or an overwhelming hazard.[30] The Activity-Specific Balance Confidence (ABC) questionnaire was used to assess fear of falling during 16 activities.[31,32] The total ABC score ranged from 0-160 with a score of 160 indicating complete confidence in all activities.

Statistical Analysis

Descriptive statistics are presented as mean and SD for continuous variables, and counts and percentages for categorical variables. In cases where participants were unable to complete a physical measure, they were given the lowest possible score, generally zero. When participants were unable to complete self-report questions, the variable was left blank. The prevalence of low habitual walking speed was defined at two thresholds, these being: 0.8 m/s which is indicative of sarcopenia[5] and 0.5 m/s which is indicative of increased adverse health risks for those aged over 80 years.[12] Potential predictors of walking speed (treated as a continuous variable) were determined by the use of linear regression. Univariable analysis using all demographic variables and secondary outcomes (with the exception of the SPPB summary score) as potential predictors was used initially to identify possible predictors of walking speed. The SPPB summary score was not included as a potential predictor of walking speed, as walking speed is one of three tests comprising the SPPB summary score. Those factors that were significant at the 0.10 level in the univariable model were included in a multivariable model to determine which combination of factors best predicted walking speed. Backwards stepwise regression was used in the multivariable analysis, with a statistical significance level of $p<0.05$ for the final set of factors. All analyses were conducted using Stata 11.2 (StataCorp).[c]

Results

Participants

One hundred and two of the 273 invited, eligible residents participated in this study, giving a recruitment rate of 37%. Only 11 participants (~11%) were consented by proxy. A summary of selected demographic, cognitive, health and functional level outcomes of the sample including the number of participants who completed each assessment are described in Table 1. The majority of residents had below normal habitual walking speeds,[5,12] with 97% and 75% walking at < 0.8 m/s and

0.5 m/s, respectively. Low and high care residents did not significantly differ on gender, age, length of stay, skeletal muscle mass index, repeated chair stand or handgrip strength ($p > 0.05$). However, the low care group had significantly greater habitual walking speeds ($p = 0.021$), hierarchical balance score ($p = 0.010$) and SPPB summary score ($p = 0.016$) then the high care group.

Insert Table 1 about here

Results of the univariable linear regression analyses identified four factors (gender, physical activity status before 50 years, physical activity status after retirement and daily sitting time) that predicted walking speed (see Table 2). Of these, the strongest predictor was physical activity status prior to 50 years of age, with those active to 50 years walking on average 0.32 (95% CI 0.12 – 0.52) m/s faster than those inactive at that age.

Insert Table 2 about here

The multivariable linear regression involving all independent secondary outcomes identified two factors (physical activity status before 50 years and daily sitting time) that predicted walking speed with a r^2 of 0.25 (see Table 3). Physical activity prior to 50 years of age was the strongest predictor, with those active prior to 50 years walking at an average of 0.31 (0.12 – 0.49) m/s faster than those inactive at this age, after adjusting for other factors in the model. Every one hour increase in daily sitting time predicted an average 0.03 (0.02 - 0.04) m/s decrease in walking speed.

Insert Table 3 about here

Discussion

The residents' mean walking speed was of major concern as it was below the lower confidence limit reported in recent meta-analyses of 2888 nursing homes residents (0.48 m/s, 95% CI

0.40-0.55)[13] and just above the lower confidence limit for 7000 acute hospital in-patients (0.46 m/s, 0.34-0.57).[2] This meant that 97% walked at speeds < 0.8 m/s and 75% walked at speeds < 0.5 m/s. These values demonstrate the dangerously low physical capacity of the nursing home residents, given walking speeds < 0.8 m/s and 0.5 m/s are indicative of sarcopenia and associated with increased risk of mortality, dementia, disability, falls and hospitalisation including for those over 80 years.[1,5,7,12]

Multivariable regression analysis revealed that those physically active to 50 years walked on average 0.31 (0.12 – 0.49) m/s faster than those physically inactive to this age, and that an one hour increase in daily sitting time decreased walking speed by an average of 0.03 (0.02 - 0.04) m/s, although these two factors only accounted for 25% of the variance in walking speed. The importance of prior physical activity levels was consistent with previous community-dwelling older adult research, where physical activity levels in middle-age are established predictors of walking speed and overall health in later life.[33,34] Our results were however inconsistent with previous studies involving community dwelling older adults[14-16] and nursing home residents [17] where current physical activity levels, falls, strength and/or balance were predictors or significantly correlated to walking speed. The mechanisms underlying the contrasting results of our study to the community dwelling older adult literature and the relative lack of significant predictors may have reflected several between-study variations. Such variations may have existed in sample size and characteristics, the tendency for some of our assessments to exhibit floor effects more so than would be seen in community dwelling older adults or the probability that some nursing home residents were experiencing transient decreases in health and function at the time of their assessments. Our results therefore suggest that future research is required to better identify the risk factors and mechanisms underlying poor walking speed in nursing home residents.

Due to their high prevalence of low walking speed, we recommend that nursing homes strongly consider performing (at least) annual assessments of their residents' walking speed, with initial assessments conducted upon entry and used as the residents' reference value. For those identified as having low habitual walking speed (i.e. < 0.5m/s) on entry and/or for those experiencing a decline greater than the expected 0.03-0.05 m/s per year,[8,11] evidence-based interventions to minimize or reverse these losses are warranted. While relatively little research has been conducted on this topic, a systematic review reports data from several resistance training trials indicating that nursing home residents can increase their habitual walking speed by 0.04-0.12 m/s in 10-13 weeks,[35] with such effects likely mediated by their improved lower body strength and/or balance.

Study Limitations

By randomly selecting residents from 11 public nursing homes in low care, high care and dementia settings to obtain a representative sample, we were better able to quantify the true walking speed of nursing homes residents. However, we acknowledge that we only recruited 37% of the eligible participants, that the reliability of some of our measures may be affected by the inclusion of residents with dementia and that the predictors of walking speed may differ in residents with different care needs. The reliability issue may especially affect self-report measures such as physical activity status prior to 50 years of age, which was the strongest predictor of walking speed but was also answered positively by 91% of the sample. In support of our approach, recent studies of nursing home residents have used very similar physical performance and self-report data to predict similar outcomes to what we used.[17,23] Further, Fox et al.[36] reported adequate relative reliability of many of these measures in nursing homes residents with diagnosed dementia. We therefore feel our random selection of eligible residents including those with dementia is a valid approach that increases the generalizability of the data compared to other studies that excluded those with dementia and other advanced care needs.

Conclusion

Based on our results and a recent meta-analysis,[13] low habitual walking speed appears endemic in nursing homes residents internationally. Similar to studies involving community-dwelling older adults,[15,33] our multivariable regression analysis identified being physically active prior to 50 years of age and minimising daily sitting time as being protective of walking speed. As these two factors only accounted for 25% of the variance in walking speed, future studies in this population should examine whether other outcomes such as spatio-temporal gait parameters are better predictors. With habitual walking speed being a strong and independent predictor of many adverse effects in older age,[5,12] nursing home residents should have greater opportunities to improve (or at least offset the age-related decline in) their walking speed. While more research is required, preliminary evidence suggests that resistance training may produce clinically meaningful improvements in nursing home residents' walking speed,[35] although the translation of this evidence to practice is uncommon, perhaps due to the barriers encountered. If some of these barriers could be overcome, nursing home residents may use resistance training to improve their overall physical function (including walking speed), quality of life and health.

References

1. Abellan van Kan G, Rolland Y, Andrieu S et al. Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people an International Academy on Nutrition and Aging (IANA) Task Force. J Nutr Health Aging 2009;13:881-9.
2. Peel NM, Kuys SS, Klein K. Gait speed as a measure in geriatric assessment in clinical settings: a systematic review. J Gerontol A Biol Sci Med Sci 2013;68:39-46.
3. Thomas DR, Marren K, Banks W, Morley J. Do objective measurements of physical function in ambulatory nursing home women improve assessment of functional status? J Am Med Dir Assoc 2007;8:469-76.
4. Gaugler JE, Duval S, Anderson KA, Kane RL. Predicting nursing home admission in the U.S: a meta-analysis. BMC Geriatrics 2007;7:13.
5. Cruz-Jentoft AJ, Baeyens JP, Bauer JM et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing 2010;39:412-23.
6. Reid N, Eakin E, Henwood T et al. Objectively measured activity patterns among adults in residential aged care. Int J Environ Res Publ Health 2013;10:6783-98.
7. Stanaway FF, Gnjidic D, Blyth FM et al. How fast does the Grim Reaper walk? Receiver operating characteristics curve analysis in healthy men aged 70 and over. BMJ 2011;343.
8. Auyeung TW, Lee SWJ, Leung J, Kwok T, Woo J. Age-associated decline of muscle mass, grip strength and gait speed: A 4-year longitudinal study of 3018 community-dwelling older Chinese. Geriatr Gerontol Int 2014;14:76-84.
9. Yamada M, Nishiguchi S, Fukutani N et al. Prevalence of sarcopenia in community-dwelling Japanese older adults. J Am Med Dir Assoc 2013;14:911-5.
10. Lauretani F, Russo CR, Bandinelli S et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 2003;95:1851-60.

11. Onder G, Penninx BW, Lapuerta P et al. Change in physical performance over time in older women: the Women's Health and Aging Study. J Gerontol A Biol Sci Med Sci 2002;57:M289-93.

12. Weidung B, Boström G, Toots A et al. Blood pressure, gait speed, and mortality in very old individuals: a population-based cohort study. J Am Med Dir Assoc 2015;16:208-14.

13. Kuys SS, Peel NM, Klein K, Slater A, Hubbard RE. Gait speed in ambulant older people in long term care: a systematic review and meta-analysis. J Am Med Dir Assoc 2014;15:194-200.

14. Schulz BW, Ashton-Miller JA, Alexander NB. Maximum step length: relationships to age and knee and hip extensor capacities. Clin Biomech 2007;22:689-96.

15. Ruggero CR, Bilton TL, Teixeira LF et al. Gait speed correlates in a multiracial population of community-dwelling older adults living in Brazil: a cross-sectional population-based study. BMC Public Health 2013;13:182.

16. Kim MJ, Yabushita N, Tanaka K. Exploring effective items of physical function in slow walking speed and self-reported mobility limitation in community-dwelling older adults. Geriatr Gerontol Int 2012;12:50-8.

17. McGough EL, Logsdon RG, Kelly VE, Teri L. Functional mobility limitations and falls in assisted living residents with dementia: physical performance assessment and quantitative gait analysis. J Geriatr Phys Ther 2013;36:78-86.

18. Henwood T, Keogh JW, Reid N, Jordan W, Senior H. Assessing sarcopenic prevalence and risk factors in residential aged care: methodology and feasibility J Cachexia Sarcopenia Muscle 2014;5:229-36.

19. Guralnik JM, Simonsick EM, Ferrucci L et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994;49:M85-94.

20. Studenski S, Perera S, Patel K et al. Gait speed and survival in older adults. JAMA 2011;305:50-8.

21. Lauretani F, Russo CR, Bandinelli S et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 2003;95:1851-60.

22. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. J Appl Physiol 2000;89:465-71.

23. Landi F, Liperoti R, Fusco D et al. Prevalence and risk factors of sarcopenia among nursing home older residents. J Gerontol A Biol Sci Med Sci 2012;67A:48-55.

24. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.

25. Kurlowicz L. The Geriatric Depression Scale (GDS). Geriatr Nurs 1999;20:212-3.

26. Woodford HJ, George J. Cognitive assessment in the elderly: a review of clinical methods. QJM 2007;100:469-84.

27. Cerin E, Barnett A, Man-chin C et al. Reliability and Validity of the IPAQ-L in a Sample of Hong Kong Urban Older Adults: Does Neighborhood of Residence Matter? J Aging Phys Act 2012;20:402-20.

28. Saka B, Kaya O, Ozturk GB, Erten N, Karan MA. Malnutrition in the elderly and its relationship with other geriatric syndromes. Clin Nutr 2010;29:745-8.

29. Guigoz Y. The Mini Nutritional Assessment (MNA) review of the literature--What does it tell us? J Nutr Health Aging 2006;10:466-87.

30. Lamb SE, Jorstad-Stein EC, Hauer K, Becker C. Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. J Am Geriatr Soc 2005;53:1618-22.

31. Holbein-Jenny MA, Billek-Sawhney B, Beckman E, Smith T. Balance in personal care home residents: a comparison of the Berg Balance Scale, the Multi-Directional Reach Test, and the Activities-Specific Balance Confidence Scale. J Geriatr Phys Ther 2005;28:48-53.

32. Steffen T, Seney M. Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the Unified Parkinson Disease Rating Scale in people with Parkinsonism. Phys Ther 2008;88:733-46.

33. Akune T, Muraki S, Oka H et al. Exercise habits during middle age are associated with lower prevalence of sarcopenia: the ROAD study. Osteoporos Int 2014;25:1081-8.

34. Woolf K, Reese CE, Mason MP et al. Physical activity is associated with risk factors for chronic disease across adult women's life cycle. J Am Diet Assoc 2008;108:948-59.

35. Valenzuela T. Efficacy of progressive resistance training interventions in older adults in nursing homes: a systematic review. J Am Med Dir Assoc 2012;13:418-28.

36. Fox B, Henwood T, Neville C, Keogh J. Relative and absolute reliability of functional performance measures for adults with dementia living in residential aged care. Int Psychogeriatr 2014;26:1659-67.

Suppliers

[a] Jamar handgrip dynamometer (Sammons Preston Roylan, Bolingbrook, IL, USA)

[b] Maltron BF-906 Bioelectrical Impedance Analysis (Maltron International Ltd, Rayleigh, UK)

[c] Stata 11.2 (StataCorp, College Station, Texas, USA).

Table 1: Characteristics of the sample of 31 males and 71 females. Portions of this data have been previously published in the study protocol and burden paper.[18]

Parameter	Males	Females	Whole Sample	Total sample size per outcome
Age (yrs)	82.1 ± 8.3	85.8 ± 8.0	84.5 ± 8.2	102
Height (cm)	170 ± 7.6	157 ± 8.0	161 ± 10.1	102
Weight (kg)	76 ± 16.3	69 ± 17.4	71 ± 16.3	102
BMI (kg/m^2)	26 ± 4.4	28 ± 6.1	27 ± 5.7	102
Fat Mass (%)	28 ± 10.4	38 ± 10.8	36 ± 11.7	102
Skeletal muscle mass index (kg/m^2)	11.1 ± 11.8	7.2 ± 2.2	8.4 ± 7.0	102
Hand grip strength (kg)	20.7 ± 8.9	14.7 ± 6.5	16.5 ± 7.7	102
Five time repeated chair stands	9 (29%)	18 (25%)	27 (26%)	102
Gait speed (m/s)	0.31 ± 0.21	0.39 ± 0.23	0.37 ± 0.23	102
Hierarchial balance score				102
1	12 (38.7%)	13 (18.3%)	25 (24.5%)	
2	8 (25.8%)	17 (23.9%)	25 (24.5%)	
3	10 (32.3%)	29 (40.1%)	39 (38.2%)	
4	1 (3.2%)	12 (16.9%)	13 (12.7%)	
SPPB summary score	2.7 ± 1.9	3.8 ± 2.6	3.5 ± 2.4	102
Physically active < 50 years age	29 (93.5%)	64 (90.1%)	93 (91.2%)	98
Physically active post retirement	23 (74.2%)	55 (77.5%)	78 (76.5%)	98
IPAQ daily sitting time (hours)	13.3 ± 2.3	12.7 ± 3.3	12.9 ± 3.0	98
MMSE	20.2 ± 5.9	21.3 ± 6.6	20.9 ± 6.4	96
GDS	6.6 ± 4.3	4.6 ± 3.4	5.2 ± 3.8	96

ABC	61.0 ± 24.0	69.7 ± 34.7	67.0 ± 32.2	96
ACFI	2.7 ± 1.7	2.6 ± 1.8	2.6 ± 1.7	102
Hospital admissions in past year	2.3 ± 1.3	1.5 ± 1.1	1.7 ± 1.2	102
Number of medications	11.4 ± 4.3	11.9 ± 5.3	11.8 ± 4.9	102
Education Level				102
None	2 (6.5%)	0 (0%)	2 (2.0%)	
Primary School	13 (4.2%)	31 (43.7%)	44 (43.1%)	
High School	8 (25.8%)	28 (39.4%)	36 (35.3%)	
TAFE/Trade	2 (6.5%)	4 (5.6%)	6 (5.9%)	
University Undergraduate	4 (12.9%)	3 (4.2%)	7 (6.9%)	
University Postgraduate	1 (3.2%)	1 (1.4%)	2 (2.0%)	
Unknown	1 (3.2%)	4 (5.6%)	5 (4.9%)	

All results are expressed as either mean ± standard deviations for continuous variables or the count (proportion) for categorical variables. The values reported for the five time repeated chair stands include the number of participants and in parentheses the proportion of the group who could complete this test. BMI = body mass index; SPPB = Short Physical Performance Battery; IPAQ = International Physical Activity Questionnaire; MMSE = Mini-Mental State Examination questionnaire; GDS = Geriatric Depression Scale; ABC = Activity-Specific Balance Confidence scale; ACFI = Australian Aged Care Funding Instrument score.

Table 2: Univariable linear regression models of the risk factors for low habitual gait speed in 102 older adults living in nursing homes.

Factor	**Beta Coefficient (95% CI)**	**P-value**
Male gender	-0.08 (-0.18 – 0.01)	0.09
Physically active < 50 years age	0.32 (0.12 – 0.52)	0.002
Physically active post retirement	0.12 (0.01 – 0.24)	0.03
IPAQ daily sitting time (hours)	-0.03 (-0.01 – -0.04)	<0.001

IPAQ = International Physical Activity Questionnaire. All results significant at $p < 0.10$.

Table 3: Multivariable linear regression model (excluding SPPB summary score) of the risk factors for preferred gait speed in 102 older adults living in nursing home.

Factor	**Beta Coefficient (95% CI)**	**P-value**
Physically active < 50 years age	0.31 (0.12 – 0.49)	0.001
IPAQ daily sitting time (hours)	-0.03 (-0.02 to -0.04)	<0.001

IPAQ = International Physical Activity Questionnaire. All results significant at $p < 0.05$.