Journal of Aging and Physical Activity, 2021, 29, 455-465
https://doi.org/10.1123/japa.2020-0091

Human Kinetics
ORIGINAL RESEARCH

"It's Better Together": A Nested Longitudinal Study Examining the Benefits of Walking Regularly With Peers Versus Primarily Alone in Older Adults

Marlene Kritz, Cecilie Thøgersen-Ntoumani, Barbara Mullan, Afroditi Stathi, and Nikos Ntoumanis

The authors examined whether purposeful walking with peers at least once a week contributes to better behavioral and health outcomes in older adults than primarily walking alone. The authors used a longitudinal cohort design and recruited participants aged 60 years and older ($N = 136$) at the start of a 16-week walking intervention. Participants who walked on average at least once a week in the final 8 weeks of the intervention were included in the analysis ($N = 79$; 66 females, M_{age} [SD] = 77.73 [6.91]). The authors found that autonomous motivation, walking self-efficacy, functional capacity, body fat, and physical activity improved more in the walking with peers group compared with the walking alone group, after controlling for whether participants lived alone/with others and their health status. The results extend current literature by providing longitudinal evidence for the added benefits of regular peer-accompanied walking in older adults and highlight the importance of investing in peer-supported interventions.

Keywords: motivation, peer groups, retirement villages, walking self-efficacy

The number of older adults (aged 60 years and older) is rapidly growing and has been predicted to constitute 20% of the global population by the year 2050 (United Nations, 2019). Aging is associated with an increased risk of physical decline and chronic illness, but regular physical activity can alleviate such risks (Cunningham, Sullivan, Caserotti, & Tully, 2020; Holme & Anderssen, 2015; Windle, Dyfrig, Linck, Russell, & Woods, 2010). Walking is popular among older adults and is an effective and safe way to meet the recommended 150 min of moderate-intensity physical activity per week (Amireault, Baier, & Spencer, 2019). Older adults who engage in regular walking have a decreased risk of premature mortality (Kelly et al., 2014; Lee et al., 2019), have better physical health (Murphy, Nevill, Murtagh, & Holder, 2007; Murtagh et al., 2015), have better mental health (Diehr & Hirsch, 2010; Ji et al., 2017; Scherder et al., 2014), are more socially integrated (Bertera, 2003; Nathan, Wood, & Giles-Corti, 2014; Smith, Banting, Eime, Sullivan, & Uffelen, 2017), and have improved functional capacity (Parkatti, Perttunen, & Wacker, 2012; Tomas, Galan-Mercant, Carnero, & Fernandes, 2017) than their physically inactive peers. Reduced levels of functional capacity—the ability to master activities of daily life such as self-care and household activities—have been linked to mobility decline (Idland, Rydwik, Smastuen, & Bergland, 2013) and several comorbidities, such as cardiovascular disease, cognitive dysfunction, and depression (Enright et al., 2003). Despite known benefits of physical activity, the majority of older adults are insufficiently physically active and fail to meet recommended guidelines for health (Guthold, Stevens, Riley, & Bull, 2018; Kalisch, 2019).

Kritz, Thøgersen-Ntoumani, Mullan, and Ntoumanis are with the Health Psychology and Behavioral Medicine Research Group, School of Psychology, Curtin University, Perth, Western Australia, Australia. Kritz, Thøgersen-Ntoumani, and Ntoumanis are also with the Physical Activity and Well-Being Research Group, School of Psychology, Curtin University, Perth, Western Australia, Australia. Stathi is with the School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Birmingham, United Kingdom. Thøgersen-Ntoumani (c.thogersen@curtin.edu.au) is corresponding author.

Many older adults who are insufficiently physically active lack social support and self-efficacy to engage in physical activity (Kosteli, Williams, & Cumming, 2016; Stathi et al., 2012; Witvorapong, 2018). Research suggests that older adults prefer exercising with similar-aged peers (Beauchamp, Carron, McCutcheon, & Harper, 2007; Bennet et al., 2018). Peers (i.e., those of similar age, background, health, and life experience) can be an excellent source of social support and motivation for older adults (Burton et al., 2017; Kritz, Thøgersen-Ntoumani, Mullan, McVeigh, & Ntoumanis, 2020; Stathi et al., 2019). From the perspective of social cognitive theory (Bandura, 2004), peers can enhance self-efficacy through modeling (e.g., seeing others cope with barriers to physical activity) and verbal persuasion (Chaudhury, Campo, Michael, & Mahmood, 2016; Downward & Rasciute, 2016). However, empirical evidence shows that many older adults do not sustain participation in group walks (Jancey et al., 2007) or prefer to exercise alone (King, Castro, & Eyler, 1999; Wilcox, King, Brassington, & Ahn, 2000). Many seniors also find it hard to adapt to a walking group, worrying about not keeping up with a group (Jancey et al., 2007) or being discouraged by disabling peer behaviors, such as being told to slow down due to age (Nieboer & Cramm, 2019).

Hence, for group walks to result in positive outcomes, the quality of social support provided by peers may be important (Kazuhiro et al., 2020). Self-determination theory (Ryan & Deci, 2017) suggests that supportive social interactions can improve perceptions of competence and relatedness, which are associated with higher quality motivation and positive outcomes (Ng et al., 2012; Ntoumanis et al., 2020). For example, peers can reduce the perception of barriers (e.g., lack of confidence or fear of falling) and provide others with social support, verbal encouragement, and physical support during a walk (Devereux-Fitzgerald, Powell, Dewhurst, & French, 2016; Nieboer & Cramm, 2019; Thogersen-Ntoumani et al., 2019). Peer-accompanied walks can, therefore, provide older adults with a safe opportunity to be active and engage in meaningful peer interactions during or after walks (Morris, Guell, & Pollard, 2019; Thogersen-Ntoumani et al., 2017).

Evidence from a meta-analysis and a systematic review suggests that interventions that promote walking in groups are effective at increasing physical activity behavior, particularly in older adults (Kassavou, Turner, & French, 2013; Meads & Exley, 2018). In addition to increasing physical activity levels, walking programs have been successful at improving the overall health of a previously sedentary population (Bravata et al., 2007; Hanson & Jones, 2015; Murphy et al., 2007). A meta-analysis showed that pedometer interventions that promote individual walking were associated with significant reductions in body mass index, in addition to improving physical activity (Bravata et al., 2007). Hanson and Jones (2015) compared the effects of 42 group walking interventions, including 15 studies with older adults and found that, in a general adult population ($M_{\text{age}} = 58$ years), participation in outdoor walking groups led to psychological (i.e., quality of life, depression), functional (i.e., 6-min walk test distance, physical functioning), and cardiovascular risk improvements (i.e., blood pressure, total cholesterol, resting heart rate). Similarly, Thomas et al. (2012) found that Chinese older adults who received peer support (i.e., regular phone calls and monthly group walks) during a walking program showed greater improvements in physical activity levels and in functional capacity, and lost more fat (but were similar in body mass index) after 12 months, compared with controls who were inactive or only walked alone.

Current understanding of the benefits of peer-accompanied walking is primarily derived from cross-sectional research focusing on general exercise behavior (Seino et al., 2019) and experimental trials that compare group walkers to inactive controls, providing insufficient information about those who choose to regularly walk alone (Meads & Exley, 2018). Cross-sectional research has documented fewer falls (Hayashi, Kondo, Kanamori, & Taishi, 2018), higher levels of subjective health status (Kanamori et al., 2016), improved physical function (Seino et al., 2019), and better psychological well-being (Harada, Masumoto, & Kondo, 2019; Kanamori et al., 2018) among older adults who self-reported exercising as a group compared with exercising alone. However, given that a wide range of activities can be classified as "exercise behavior," it has remained unclear whether these effects apply when comparing those walking regularly with others versus primarily alone.

Study Rationale and Objectives

Researchers have noted a need for longitudinal studies identifying the unique effects of group-walking programs (Meads & Exley, 2018). We identified only one study with older adults that compared the effects of peer-supported walking with walking alone (Thomas et al., 2012). However, in that study, "peer support" was primarily provided in the form of encouraging telephone calls, and peer-accompanied walking was limited to monthly organized social walks. Most studies examining the effects of peer-supported walking have been conducted in controlled, group-based settings, providing little information on the experiences of older walkers who *naturally* choose to walk alone or with peers. It is also important to consider older adults who choose to walk with a partner and as part of a smaller group (Carr et al., 2019; Zubala et al., 2017). None of the reviewed studies examined motivation or self-efficacy for walking as outcomes. Finally, most studies examining the effects of walking have focused on heterogeneous groups of individuals, including clinical populations (Hanson & Jones, 2015). It has, therefore, remained unclear whether such improvements are generalizable to independent-living older adults who are sufficiently healthy to walk alone.

Given the overall benefits of walking (Lee et al., 2019), the effectiveness of interventions promoting individual walking (Bravata et al., 2007), and the potential of group-based approaches (Hanson & Jones, 2015; Meads & Exley, 2018; Seino et al., 2019), we were interested in understanding how *regularly* walking with peers (WP) compares to primarily walking alone (WA), among independent-living older adults. Our specific aim was to determine whether WP is associated with greater changes in self-efficacy, autonomous motivation, physical activity, body fat, and functional capacity than WA, among previously physically inactive older adults. Advancing past research, we examined a setting in which participants were encouraged to walk more but could decide for themselves whether they walked with others or only walked alone.

Building on research documenting higher physical activity levels in peer-supported walkers than inactive/solo walkers (Thomas et al., 2012), we expected the WP group to show greater improvements in physical activity than the WA group. In line with the evidence suggesting greater health benefits of group walking/exercising (Hanson & Jones, 2015), we expected the WP group to experience greater changes in fat loss (Thomas et al., 2012) and functional capacity (Seino et al., 2019) when compared with the WA group. Extending research that draws from social cognitive theory (Bandura, 2004; Ginis, Nigg, & Smith, 2013) and self-determination theory (Ng et al., 2012; Ryan & Deci, 2000), we expected the WP group to experience greater changes in self-efficacy and autonomous motivation, compared with the WA group.

Methods

Research Design

We conducted a longitudinal cohort study which was nested within the Residents for Action Trial (Thogersen-Ntoumani et al., 2017). The Residents in Action Trial examined the effectiveness of a 16-week peer-led walking intervention to promote walking behavior and wellbeing in physically inactive older adults living in retirement villages (Thogersen-Ntoumani et al., 2019). The intervention was motivationally embellished in that peer walk leaders received training on how to motivate group members, and walkers were taught how to overcome their own motivational barriers. The trial included, in both experimental arms, 10 weeks of program-initiated walks followed by 6 weeks of participant-initiated walks. The group-based components of the program offered triweekly walks with a peer-led group for the first 10 weeks of the program.

All participants who provided consent to take part in the walking intervention were invited to also take part in the present study. While the present study shared the participants and timeline of the main trial, it was conducted separately, examined different research questions, and collected additional data that were not examined as part of the larger trial. Further details on what data were shared with the main trial are provided in Figure S1 in the Supplementary Material (available online). To be included in the analysis, participants had to identify as a regular walker (i.e., on average, walk at least once a week during the preceding 8 weeks) at Week 16 of the intervention. Participants had to also complete at least one assessment at both time points. A detailed flow diagram illustrating the number of participants completing each measure at each time point within the nested longitudinal design is presented in Figure S2 in the Supplementary Material (available online).

The design of the intervention allowed us to explore outcomes based on the preferences of novice walkers. By focusing on the last 8 weeks of the program, we were provided with an ideal context to explore the walking preferences of participants, who followed the structured components of the program (for further details see Thogersen-Ntoumani et al., 2017).

Procedure

Ethical statement and eligibility criteria. We obtained ethical approval from an Australian university's Human Research Ethics Committee. To be eligible for the main trial (and the present study), all participants had to be living independently and be healthy enough that they could complete a questionnaire and go for a walk. Participants had to be at least 60 years old and be insufficiently active, which meant reporting that they engage in <150 min of moderate-intensity physical activity/week. Interested participants were informed about the study and asked to sign a written informed consent form.

Participants. Participants who met the eligibility criteria were asked to complete all assessments at baseline (T1) and postintervention, that is, at 16 weeks (T2). Of those completing baseline measures, participants were excluded from the analysis if they did not complete any measures postintervention ($n = 24$), acted as walk leaders ($n = 3$), or at week 16 reported having walked on average less than once per week over the previous 8 weeks ($n = 1$).

Measures

Demographic characteristics were determined at baseline. We determined height through verbal self-report. Weight, body-fat, and waist circumference were determined in the morning at both time points, prior to administering the walk test. Measurements were taken twice without delay, and the mean value of the two measurements was recorded.

Weight and body fat percentage. Weight and body fat percentage were measured with a Tanita Professional scale (model BC-551, Tanita Cooperation, Tokyo, Japan) and recorded to the nearest 0.1 kg. To determine body fat, the Tanita Professional scale uses bioelectrical impedance analysis. Participants were required to be barefoot and in a standing position, with thighs not touching each other. Previous research has provided supportive evidence of the reliability and validity of scores from this scale for measuring body fat in older adults (Kabiri, Hernandez, & Mitchell, 2015; Ritchie, Miller, & Smiciklas-Wright, 2005).

Waist circumference. Waist circumference was measured by a researcher using a measuring tape at the midpoint of the line between the coastal margin and the iliac crest in the midaxillary line (Howel, 2012).

Walking behavior. To measure walking behavior, we used the item "In the last eight weeks approximately, how many times did you go for a walk 1) alone; 2) with a partner or friend; or 3) as part of a group?" The question was asked via questionnaire at T2 (Week 16), and participants were asked to estimate the number of walks over the last 8 weeks. The total number of walks was then divided by the number of weeks to obtain a weekly estimate. Weekly estimates of walking behavior were then used to classify walkers as WP or WA. We defined WP as engaging on average at least once a week with others in a purposeful walk for any reason. WA was defined as walking at least once a week alone, *and* less than once a week with others. As part of the questionnaire, it was clarified that "walking" pertained to going on a "purposeful walk."

Physical activity. Overall physical activity was assessed using the Physical Activity Scale for the Elderly, a 12-item questionnaire requesting information about occupational, household, and leisure activities during the previous 7 days (Washburn, Smith, Jette, & Janney, 1993). Sample items include: "Over the past seven days, how often did you take a walk outside your home or yard for any reason?" (Washburn et al., 1993). A total physical activity score was determined by multiplying the time spent in each particular activity (hours per week) by validated weight scores (Washburn et al., 1993). The scale has been found to have excellent validity and test–retest reliability over a 7-week interval with older community-dwelling individuals (Ismail et al., 2015).

Motivation to walk. Motivation to walk was measured using the behavioral regulation for walking scale (Niven & Markland, 2016). The questionnaire contains 23 items that measure the level of self-determination for walking. We computed a score for autonomous regulation (Cronbach's alpha = .86) by averaging identified, integrated, and intrinsic items (Williams, Grow, Freedman, Ryan, & Deci, 1996) and a score for controlled regulation (Cronbach's alpha = .59) by averaging across external and introjected items. In the exercise literature, such composite scores are often used to provide an overall representation of the types of motivation driving behavior (Teixeira, Carraca, Markland, Silva, & Ryan, 2012).

Walking self-efficacy. An adapted version of the Exercise Self-Efficacy Scale (McAuley, 1993) was used to assess participants' beliefs in their ability to walk at a moderate pace without stopping for 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 min. The 10-item scale is scored on a 100-point percentage scale of 10-point increments, ranging from 0% (*not at all confident*) to 100% (*highly confident*). Scores from this measure have been found valid and reliable for use with older adults (McAuley, 1993; Wojcicki, White, & McAuley, 2009).

Functional capacity. The 6-min walk test measures the distance walked in 6 min and was used to quantify functional capacity (Enright et al., 2003; Middleton, Stacy, Lusardi, & Lusardi, 2020). The test was conducted at the retirement villages, indoors, or outdoors on a 30-m course, using previously published guidelines (Guyatt et al., 1985). During the test, participants were instructed to "walk as far as they can without jogging." Each lapsed minute was called out to help with pacing (American Thoracic Society, 2002). Assistive walking devices were permitted during the test. Participants who, at baseline, started the walk but stopped walking before the 6 min elapsed were included ($n = 3$). In line with past research, we classified those who walked <300 m in the allocated time as having low endurance (Bittner et al., 1993).

Analysis

All analyses were conducted using the Statistical Package for Social Sciences (SPSS for Mac, version 25, IBM Corp, Armonk, NY). Descriptive statistics were calculated for sociodemographic characteristics. A two-tailed independent-samples t test, the Mann–Whitney U test (for nonnormal data), and a chi-square test (for nominal data) were used to test for differences between the WP and WA groups in demographic and baseline characteristics that could affect outcomes. We then conducted mixed-design multivariate analyses of covariance (MANCOVA) and mixed analyses of covariance (ANCOVA) to determine the effect of time (T1, T2) and condition (WP vs. WA group) on outcomes. An ANCOVA was conducted when dependent variables could not be conceptually combined with other variables (e.g., physical activity scores). A MANCOVA was carried out for dependent variables, which could be combined. Specifically, overall fat in percentage and waist circumference were grouped together when conducting the MANCOVA, as they are both capturing fat levels. Walking self-efficacy and autonomous motivation were combined when conducting the MANCOVA, as self-efficacy/competence is an antecedent of autonomous motivation (Ryan & Deci, 2017).

Results

Participant Characteristics

We obtained consent for the present study and sociodemographic data from 136 participants, of whom 107 participants completed baseline measures. Of these, 79 participants met the inclusion criteria for further analysis. The excluded group ($n = 57$) contained a higher proportion of employed individuals (11% vs. 0%, $p = .003$) than the included group. T2 responders did not differ significantly (all $ps > .05$) in any other demographic or baseline measures from T1 responders. The majority of participants identified as healthy—mentioned health conditions were minor or included controlled chronic illnesses (e.g., diabetes). The sociodemographic and health characteristics of all study participants are presented in Table 1. At T2, the majority of participants reported engaging in walks that lasted at least 1 hr (72.2%). Further details on the duration of walks are provided in Table S1 in the Supplementary Material (available online).

WP and WA Group

About 54% ($n = 43$) of participants met the aforementioned inclusion criteria for the WP group. Members of the WP group reported walking with others on average 2.85 times/week and 2.51 times/week alone. The remaining participants (46%, $n = 36$) were classified as WA; members of that group walked on average 3.71/week alone. Further information on those who walked with a partner versus those who walked with a group is presented in the Supplementary Material (available online).

Demographic (see Table 2) and baseline characteristics (see Table 3) of the two groups were comparable except for a significant difference in health status and living status. The WA group contained a higher proportion of individuals suffering from a health condition (56% vs. 30%, $x^2 = 5.16$, $p = .023$) and more individuals living alone (67% vs. 42%, $x^2 = 4.84$, $p = .024$) than the WP group. We, therefore, controlled for these variables in all further analyses.

Comparison of Changes in Outcomes Between WP and WA Walkers

Descriptive statistics and changes in outcomes across time for both groups are presented in Table 4. The results of all MANCOVAs and ANCOVAs are presented in Table 5.

Table 1 Participant Characteristics of the Overall Sample

Characteristics	N[a]	% unless stated otherwise
Gender (female)	66	83.5
Age (years)	79	Mean = 77.7, SD = 6.9, range = 63–93
BMI (kg/m^2)	73	Median = 25.9, IQR = 5.5, range = 18.3–44.0
Ethnicity (White)	75	94.9
Australian born	55	69.6
Retired	79	100
Living alone	42	53.2
Number of years living in retirement village	79	Median = 5.8, IQR = 8, range = 0.1–18.2
Major life event, last 6 months	35	44.3
Marital status		
Married	33	41.8
Widowed/separated	40	50.6
Never married	6	7.60
Highest level of education		
Secondary education	37	48.8
Vocational training	17	21.5
College or university	25	31.6
Health		
Current health issue	33	41.8
Use of assistive device	19	24.1
Never smoked	64	81.0
BMI > 30 kg/m^2	13	17.8
Obesity based on total body fat percentage[b]	18/62	29.0
Central obesity[c]	19/65	24.0

Note. IQR = interquartile range; BMI = body mass index.
[a]N = 79 unless stated otherwise. [b]Obesity cutoff points, adjusted for older adults, for body fat percentage levels were ≥30% for men and ≥41.5% for women (Ritchie et al., 2005). [c]Central obesity: To determine the presence of central obesity, we used age-adjusted waist circumference cutoff points, for those aged 70 years and older (i.e., ≥107 cm for men and ≥100 cm for women; Heim et al., 2011). We used standard values for the remaining sample (i.e., cutoff ≥88 cm for females and ≥102 cm for males; Lean, Han, & Morrison, 1995).

Table 2 A Comparison of Demographic and Health Characteristics Between WA and WP

Characteristics	WP *N* = 43	WA *N* = 36	*p*
	% unless stated otherwise		
Age (years)	Mean = 77.8	Mean = 77.6	.953*
	SD = 6.72	*SD* = 7.24	
	Range = 65–90	Range = 63–93	
Gender (female)	81.4	86.1	.401**
Ethnicity (White)	97.7	91.7	.225**
Australian born	69.8	69.4	.975**
Living alone	41.9	66.7	**.024****
Number of years living in retirement village	Median = 5.80	Median = 8.40	.180***
	IQR = 7.80	IQR = 12.5	
Marital status			
Married	48.8	33.3	.183**
Widowed/separated	41.9	61.1	
Never married	9.30	5.60	
Highest level of education			
Secondary education	44.2	50.0	.954**
Vocational training	23.3	19.4	
College or university	32.6	30.6	
Health			
BMI (kg/m^2)	Median = 26.0	Median = 24.9	.099***
	IQR = 3.80	IQR = 7.20	
	Range = 19.6–40.8	Range = 18.3–44.0	
Use of an assistive device	20.9	27.8	.478**
Current health issue	30.2	55.6	**.023****
Major life event, last 6 months	44.2	44.4	.982**
Never smoked	81.4	80.6	.539**

Note. WA = those who primarily walked alone; WP = those who also walked with peers; BMI = body mass index; IQR = interquartile range. Significant values are indicated in bold ($p < .05$).
*p values determined using one-way analysis of variance. **p values were determined using chi-square tests. ***p values were determined using Mann–Whitney *U* tests, due to nonnormal data.

Table 3 A Comparison of Baseline Scores Between WA and WP

Variables	WP *n* = 43	WA *n* = 36	*p*
	Mean (*SD*) unless stated otherwise		
PASE[a]	114 (49.1)	109 (54.1)	.672*
6-Min walk test, distance walked (m)	374 (74.0)	365 (72.0)	.951*
Walking self-efficacy	54.1 (27.6)	52.3 (29.7)	.990*
Autonomous motivation	Median (IQR) = .3 (1.13)	Median (IQR) = 2.9 (1.21)	.278**
Controlled motivation	Median (IQR) = 0.95 (1.04)	Median (IQR) = 0.83 (1.35)	.362**
Overall fat (%)	36.8 (8.04)	33.7 (10.3)	.181*
Waist circumference (cm)	97.4 (10.3)	92.3 (14.7)	.115*

Note. WA = those who primarily walked alone; WP = those who also walked with peers; BMI = body mass index; IQR = interquartile range.
[a]PASE: Physical Activity Scale score for Elderly indicating self-reported physical activity levels in the preceding week.
*p value determined using one-way analysis of variance. **p value determined using a Mann–Whitney *U* test, due to nonnormal data.

Physical Activity

For physical activity, the interaction effect was significant, $F(1, 75) = 10.6$, $p < .01$, $\eta^2 = .124$, showing that over the 16 weeks, the WP group improved more in physical activity levels than the WA group. Bonferroni pairwise comparisons revealed that despite similar levels at T1, at T2 the WP group was significantly more physically active than the WA group, $F(1, 75) = 4.68$, $p = .034$, $\eta^2 = .059$.

Functional Capacity

For functional capacity, the condition by time interaction was significant, $F(1, 52) = 4.60$, $p = .037$, $\eta^2 = .08$. Further pairwise comparisons between T1 and T2 revealed that only WP participants improved over time, $F(1, 52) = 16.23$, $p < .01$, $\eta^2 = .239$.

Body Fat

There was a significant condition by time interaction for changes in body fat, $F(1, 45) = 6.76$, $p = .013$, $\eta^2 = .131$, indicating that the WP group experienced more significant improvements than the WA group. Follow-up pairwise comparisons revealed that only the WP group lost overall body fat and reduced their waist circumference.

Motivation and Walking Self-Efficacy

There was a significant condition by time interaction in autonomous motivation to walk, $F(1, 75) = 5.42$, $p = .23$, $\eta^2 = .067$, and self-efficacy to walk, $F(1, 75) = 7.21$, $p < .01$, $\eta^2 = .088$, indicating

Table 4 A Comparison of Changes in the Dependent Variables of WP and WA

Variables	Pre	Post	*p*
	Mean (*SE*) unless stated otherwise		
PASE ($n = 79$)			
WP	108 (7.89)	136 (9.38)	**.001**
WA	115 (8.68)	105 (10.3)	.205
6-Min walk test, distance walked (m) ($n = 56$)			
WP	379 (11.6)	423 (12.8)	**.000**
WA	409 (14.6)	414 (16.1)	.683
Walking self-efficacy ($n = 79$)			
WP	49.9 (4.33)	63.4 (4.77)	**.001**
WA	61.6 (4.13)	54.0 (4.54)	.635
Autonomous motivation ($n = 79$)			
WP	2.93 (0.118)	3.32 (0.159)	**.005**
WA	2.85 (0.130)	2.75 (0.174)	.513
Controlled motivation ($n = 79$)			
WP	1.08 (0.103)	1.19 (0.124)	.411
WA	0.903 (0.113)	0.786 (0.136)	.412
Overall fat in % ($n = 50$)			
WP	36.75 (1.61)	32.35 (1.58)	**.000**
WA	34.31 (2.23)	33.12 (2.18)	.233
Waist circumference (cm) ($n = 51$)			
WP	97.34 (2.00)	94.50 (1.91)	**.000**
WA	90.66 (2.77)	89.79 (2.64)	.336

Note. Significant values are indicated in bold ($p < .05$); means have been adjusted for living status and health condition. WA = those who primarily walked alone; WP = those who also walked with peers; PASE = Physical Activity Scale score for Elderly.

Table 5 Mixed-Effect ANCOVA and MANCOVA Comparing the Changes of Outcomes Over Time of WA Versus WP

Variables	Time (T1 vs. T2)		Group (WA vs. WP)		Time × Group	
	F (*df*)	*p*	*F* (*df*)	*p*	*F* (*df*)	*p*
PASE	1.03 (1, 75)	.314	0.157 (1, 75)	.693	10.6 (1, 75)	**.002**
6-Min walk test	1.11 (1, 52)	.298	0.355 (1, 52)	.554	4.60 (1, 52)	**.037**
Motivation	0.920 (3, 73)	.436	2.05 (3, 73)	.078	3.58 (3, 73)	**.018**
Walking self-efficacy	2.14 (1, 75)	.148	0.021 (1, 75)	.885	7.21 (1, 75)	**.009**
Autonomous motivation	1.36 (1, 75)	.247	3.00 (1, 75)	.088	5.42 (1, 75)	**.023**
Controlled motivation	0.063 (1, 75)	.803	3.97 (1, 75)	.050	1.27 (1, 75)	.263
Overall fat	1.63 (2, 44)	.207	1.88 (2, 44)	.164	3.31 (2,44)	**.046**
%Fat	2.79 (1, 45)	.102	0.097 (1, 45)	.757	6.76 (1, 45)	**.013**
Waist circumference	2.76 (1, 45)	.104	2.90 (1, 45)	.095	3.03 (1, 45)	.088

Note. Significant values are indicated in bold ($p < .05$). PASE = Physical Activity Scale for Elderly score indicating self-reported physical activity levels in the preceding week; WA = those who primarily walked alone; WP = those who also walked with peers; MANCOVA = multivariate analysis of covariance; ANCOVA = analysis of covariance.

that the WP group experienced greater improvements in these variables.

Discussion

We aimed to determine whether independent-living older adults who regularly walked with peers experience improved physical and psychological outcomes, compared with those who walked primarily alone. We found that the WP group experienced more positive changes in self-efficacy (small effect size), autonomous motivation (small effect size), physical activity (small effect size), fat loss (medium effect size), and functional capacity (medium effect size) than the WA group. The two groups did not differ at baseline on any of the outcomes.

The finding that at T2 (but not at T1), the WP group showed higher physical activity levels and functional capacity than the WA group aligns with past research highlighting the benefits of group-based walking programs in the general population (Hanson & Jones, 2015; Meads & Exley, 2018; Thomas et al., 2012), the importance of social support (Davis et al., 2019; Smith et al., 2017), and the effectiveness of dyadic physical activity interventions (Carr et al., 2019). In line with social cognitive theory, we found a positive link between regularly walking with peers and walking self-efficacy. Self-efficacy is an essential determinant of sustained physical activity behavior among older adults (Kosteli et al., 2016). A past study (Michael & Carlson, 2009) showed that participation in a volunteer-led group-walking intervention did not lead to higher levels of walking self-efficacy in seniors when compared with a control (only receiving health information). An explanation for this incongruence may be that in our study, participants could choose with whom they walked (i.e., with a peer or a group) and may have sought out peers who exhibited enabling and competence supportive behaviors or aligned with individual walking preferences (Nieboer & Cramm, 2019). In a setting (as in the study by Michael & Carlson, 2009) where participants are assigned to a group, the risk for discouraging behaviors (e.g., a group that walks too fast) may be higher. In line with this explanation is the finding that the WP group, but not the WA group, had higher levels of autonomous motivation and physical activity behavior at T2 when compared with T1. Supportive social interactions may have improved the quality of motivation and physical activity behavior among those who walked with peers (Arnautovska, Fleig, O'Callaghan, & Hamilton, 2019; Ryan & Deci, 2017).

At T2, the WP group (but not the WA group) had lower levels of fat compared with T1 (although the loss in abdominal fat did not reach significance) and higher functional capacity, which is consistent with past research documenting the beneficial health effects of group-based walking interventions in the general population (Hanson & Jones, 2015). These findings align with research indicating the physical benefits of exercise groups (Seino et al., 2019) and the benefits of peer support for promoting fat loss through walking (Thomas et al., 2012).

Strength and Limitations

The main strength of this study lies in its novelty of being the first to include functional capacity, self-efficacy for walking, and motivation as outcomes when comparing older adults who regularly walk with peers with those who walk primarily alone. Other strengths of the study include its longitudinal design, the inclusion of objective measures of body fat, and functional fitness, as well as the study of an under-researched cohort (84% of the oldest older than 70 years, including 15% over 85 years).

Our findings are limited by relying on some self-report measures (e.g., physical activity and walking behavior) and using a convenience sample that was predominantly female and White. However, given that we examined change, potential recall errors associated with self-reported measures should be of similar magnitude at both time points. We also cannot be sure whether weekly estimates represented an equal distribution of walks across the 8 weeks. However, all included participants were still actively walking postintervention. This was ensured by checking items that asked about walking behavior, such as the Physical Activity Scale for the Elderly, at postintervention.

The research team was not blinded to the intervention, which could have influenced some of the questionnaire responses. However, each of the groups in this manuscript included participants from both conditions, and the grouping for the present study was done after data collection. Furthermore, the WP group had higher compliance rates with program-initiated walks, which may have further confounded our findings. However, this difference was limited to noncomplying participants not engaging in group walks (i.e., not whether they walked with a partner). Further details are provided in the Supplementary Material (available online).

Finally, due to the nonexperimental observational design of our study, our findings do not imply causality. Future studies could use experimental designs to replicate the present results, use device-based measures of physical activity, and focus on other populations to determine the generalizability of findings to different groups of older adults. Future research can also assess the characteristics (i.e. duration and intensity) of individual walks when walking with peers or alone to further advance the present findings.

Implications

Our findings identify unique benefits experienced by older adults who choose to walk at least once a week with peers, advancing past research in the field (Kanamori, Takamiya, & Inoue, 2015; Seino et al., 2019). However, a better understanding of what makes a peer leader or a walking partner effective at increasing walking confidence, motivation, and behavior, particularly in physically inactive older adults, is needed. Future research can also explore the role of technology in providing peer support for older adults lacking social networks. Research suggests that online peer support for walking (e.g., interacting with other walkers through an online message board) does not achieve positive effects in older adults, indicating the importance of physical company while walking (Kullgren et al., 2014). Comparing our findings with other forms of peer support, such as the use of robots as a walking partner, can further advance understanding (Karunarathne, Morales, Nomura, Takayuki, & Hiroshi, 2019).

Conclusion

Overall, our findings highlight the potential of peer-accompanied walks for promoting physical activity and health in older adults. For individuals lacking confidence, walking in smaller groups or with a partner may be an attractive alternative (Carr et al., 2019; Jancey et al., 2007). Public health messages should encourage diversity in walking options for older adults as some people might prefer to walk with others and others on their own (Davis et al., 2019; Samra et al., 2019). However, peer-accompanied walks should be made attractive and accessible (Beauchamp et al., 2007), particularly for those with low confidence and motivation and at highest risk for physical inactivity (Chong et al., 2014; Perkins, Multhaup, Perkins, & Barton, 2008).

Acknowledgments

This work was supported by a Curtin University PhD Scholarship awarded to M. Kritz, and research project funding awarded by the Western Australian Health Promotion Foundation (Healthway) (grant number 24258) to the C. Thøgersen-Ntoumani and N. Ntoumanis. This study was approved by an Australian university's Human Research Ethics Committee. We have no conflicts of interest to declare.

References

American Thoracic Society. (2002). American thoracic society statement: Guidelines for the six-minute walk test. *American Journal Respiratory and Crititical Care Medicine, 166* (1):111–117. doi:10.1164/ajrccm.166.1.at1102

Amireault, S., Baier, J.M., & Spencer, J.R. (2019). Physical activity preferences among older adults: A systematic review. *Journal of Aging and Physical Activity, 27*(1), 128–139. doi:10.1123/japa.2017-0234

Arnautovska, U., Fleig, L., O'Callaghan, F., & Hamilton, K. (2019). Older adults' physical activity: The integration of autonomous motivation and theory of planned behaviour constructs. *Australian Psychologist, 54*(1), 46–54. doi:10.1111/ap.12346

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143–164. PubMed ID: 15090118 doi:10.1177/1090198104263660

Beauchamp, M.R., Carron, A.V., McCutcheon, S., & Harper, O. (2007). Older adults' preferences for exercising alone versus in groups: Considering contextual congruence. *Annals of Behavioral Medicine, 33*(2), 200–206. PubMed ID: 17447872 doi:10.1007/BF02879901

Bennet, E.V., Hurd Clarke, L., Wolf, S.A., Dunlop, W.L., Harden, S.M., Liu, Y., & Beauchamp, M.R. (2018). Older adults' experiences of group-based physical activity: A qualitative study from the 'GOAL' randomized controlled trial. *Psychology of Sport and Exercise, 39,* 184–192. doi:10.1016/j.psychsport.2018.08.017

Bertera, E.M. (2003). Physical activity and social network contacts in community dwelling older adults. *Adaption and Aging, 27*(3/4), 113–127. doi:10.1300/j016v27n03_08

Bittner, V., Weiner, D.H., Yusuf, S., Rogers, W.J., Mcintyre, K.M., Bangdiwala, S.I., . . . Bourassa, M.G. (1993). Prediction of mortality and morbidity with a 6-minute walk test in patients with left-ventricular dysfunction. *Journal of the American Medical Association, 270*(14), 1702–1707. PubMed ID: 8411500 doi:10.1001/jama.1993.03510140062030

Bravata, D.M., Smith-Spangler, C., Sundaram, V., Gienger, A.L., Lin, N., Lewis, R., . . . Sirard, J.R. (2007). Using pedometers to increase physical activity and improve health—A systematic review. *Journal of the American Medical Association, 298*(19), 2296–2304. PubMed ID: 18029834 doi:10.1001/jama.298.19.2296

Burton, E., Farrier, K., Hill, K.D., Codde, J., Airey, P., & Hill, A.M. (2017). Effectiveness of peers in delivering programs or motivating older people to increase their participation in physical activity: Systematic review and meta-analysis. *Journal of Sports Sciences, 36*(6), 666–678. PubMed ID: 28535358 doi:10.1080/02640414.2017.1329549

Carr, R.M., Prestwich, A., Kwasnicka, D., Thogersen-Ntoumani, C., Gucciardi, D.F., Quested, E., . . . Ntoumanis, N. (2019). Dyadic interventions to promote physical activity and reduce sedentary behaviour: Systematic review and meta-analysis. *Health Psychology Review, 13*(1), 91–109. PubMed ID: 30284501 doi:10.1080/17437199.2018.1532312

Chaudhury, H., Campo, M., Michael, Y., & Mahmood, A. (2016). Neighbourhood environment and physical activity in older adults. *Social Science & Medicine, 149,* 104–113. PubMed ID: 26708246 doi:10.1016/j.socscimed.2015.12.011

Chong, T.W.H., Doyle, C.J., Cyarto, E.V., Cox, K.L., Ellis, K.A., Ames, D., . . . Grp, A.R. (2014). Physical activity program preferences and perspectives of older adults with and without cognitive impairment. *Asia-Pacific Psychiatry, 6*(2), 179–190. PubMed ID: 23857923 doi:10.1111/appy.12015

Cunningham, C., O' Sullivan, R., Caserotti, P., & Tully, M.A. (2020). Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. *Scandinavian Journal of Medicine & Science in Sports, 30*(5), 816–827. PubMed ID: 32020713 doi:10.1111/sms.13616

Davis, C.A., Sentell, T.L., De Souza Barbosa, J.F., Ylili, A., Curcio, C., & Pirkle, C.M. (2019). Meeting physical activity guidelines by walking in older adults from three middle-income countries: A cross-sectional analysis from the international mobility in aging study. *Journal of Aging & Physical Activity, 28*(3), 333–342. doi:10.1123/japa.2018-0463

Devereux-Fitzgerald, A., Powell, R., Dewhurst, A., & French, D.P. (2016). The acceptability of physical activity interventions to older adults: A systematic review and meta-synthesis. *Social Science & Medicine, 158,* 14–23. PubMed ID: 27104307 doi:10.1016/j.socscimed.2016.04.006

Diehr, P., & Hirsch, C. (2010). Health benefits of increased walking for sedentary, generally healthy older adults: Using longitudinal data to approximate an intervention trial. *The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences, 65*(9), 982–989. doi:10.1093/gerona/glq070

Downward, P., & Rasciute, S. (2016). 'No man is an island entire of itself.' The hidden effect of peers on physical activity: John Donne, Meditation XVII. *Social Science & Medicine, 169,* 149–156. PubMed ID: 27721139 doi:10.1016/j.socscimed.2016.09.038

Enright, P.L., McBurnie, M.A., Bittner, V., Tracy, R.P., McNamara, R., Arnold, A., . . . Study, C.H. (2003). The 6-min walk test—A quick measure of functional status in elderly adults. *Chest, 123*(2), 387–398. PubMed ID: 12576356 doi:10.1378/chest.123.2.387

Ginis, K.A.M., Nigg, C.R., & Smith, A.L. (2013). Peer-delivered physical activity interventions: An overlooked opportunity for physical activity promotion. *Translational Behavioral Medicine, 3*(4), 434–443. PubMed ID: 24294332 doi:10.1007/s13142-013-0215-2

Guthold, R., Stevens, G.A., Riley, L.M., & Bull, F.C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1.9 million participants. *Lancet Global Health, 6*(10), E1077–E1086. PubMed ID: 30193830 doi:10.1016/S2214-109X(18)30357-7

Guyatt, G.H., Sullivan, M.J., Thompson, P.J., Fallen, E.L., Pugsley, S.O., Taylor, D.W., & Berman, L.B. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. *Canadian Medical Association Journal, 132*(8), 919–923. PubMed ID: 3978515

Hanson, S., & Jones, A. (2015). Is there evidence that walking groups have health benefits? A systematic review and meta-analysis. *British Journal of Sports Medicine, 49*(11), 710–715. PubMed ID: 25601182 doi:10.1136/bjsports-2014-094157

Harada, K., Masumoto, K., & Kondo, N. (2019). Exercising alone or exercising with others and mental health among middle-aged and older adults: Longitudinal analysis of cross-lagged and simultaneous effects. *Journal of Physical Activity & Health, 16*(7), 556–564. PubMed ID: 31195882 doi:10.1123/jpah.2018-0366

Hayashi, T., Kondo, K., Kanamori, S., & Taishi, T. (2018). Differences in falls between older adult participants in group exercise and those who exercise alone: A cross-sectional study using Japan Gerontological Evaluation Study (JAGES) data. *International Journal of Environmental Research and Public Health, 15*(7), 1413. doi:10.3390/ijerph15071413

Heim, N., Snijder, M.B., Heymans, M.W., Deeg, D.J., Seidell, J.C., & Visser, M. (2011). Optimal cutoff values for high-risk waist circumference in older adults based on related health outcomes. *American Journal of Epidemiology, 174*(4), 479–489. PubMed ID: 21673122 doi:10.1093/aje/kwr093

Holme, I., & Anderssen, S.A. (2015). Increases in physical activity is as important as smoking cessation for reduction in total mortality in elderly men: 12 years of follow-up of the Oslo II study. *British Journal of Sports Medicine, 49*(11), 743–748. PubMed ID: 25977572 doi:10.1136/bjsports-2014-094522

Howel, D. (2012). Waist circumference and abdominal obesity among older adults: Patterns, prevalence and trends. *PLoS One, 7*(10), e48528. PubMed ID: 23119047 doi:10.1371/journal.pone.0048528

Idland, G., Rydwik, E., Smastuen, M.C., & Bergland, A. (2013). Predictors of mobility in community-dwelling women aged 85 and older. *Disability and Rehabilitation, 35*(11), 881–887. PubMed ID: 22931434 doi:10.3109/09638288.2012.712195

Ismail, N., Hairi, F., Choo, W.Y., Hairi, N.N., Peramalah, D., & Bulgiba, A. (2015). The physical activity scale for the elderly (PASE): Validity and reliability among community-dwelling older adults in Malaysia. *Asia-Pacific Journal of Public Health, 27*(8), 62s–72s. doi:10.1177/1010539515590179

Jancey, J., Lee, A., Howat, P., Clarke, A., Wang, K., & Shilton, T. (2007). Reducing attrition in physical activity programs for older adults. *Journal of Aging and Physical Activity, 15*(2), 152–165. PubMed ID: 17556782 doi:10.1123/japa.15.2.152

Ji, Z., Li, A., Feng, T., Liu, X., You, Y., Meng, F., . . . Zhang, C. (2017). The benefits of Tai Chi and brisk walking for cognitive function and fitness in older adults. *PeerJ, 5,* e3943. PubMed ID: 29062610 doi:10.7717/peerj.3943

Kabiri, L.S., Hernandez, D.C., & Mitchell, K. (2015). Reliability, validity, and diagnostic value of a pediatric bioelectrical impedance analysis scale. *Childhood Obesity, 11*(5), 650–655. PubMed ID: 26332367 doi:10.1089/chi.2014.0156

Kalisch, W.D. (2019). National Health Survey, first results, Australia 2017–2018. Retrieved from https://www.ausstats.abs.gov.au/ausstats/

Kanamori, S., Takamiya, T., & Inoue, S. (2015). Group exercise for adults and elderly: Determinants of participation in group exercise and its associations with health outcome. *The Journal of Physical Fitness and Sports Medicine, 4*(4), 315–320. doi:10.7600/jpfsm.4.315

Kanamori, S., Takamiya, T., Inoue, S., Kai, Y., Kawachi, I., & Kondo, K. (2016). Exercising alone versus with others and associations with subjective health status in older Japanese: The JAGES Cohort Study. *Scientific Reports, 6*(1), 39151. PubMed ID: 27974855 doi:10.1038/srep39151

Kanamori, S., Takamiya, T., Inoue, S., Kai, Y., Tsuji, T., & Kondo, K. (2018). Frequency and pattern of exercise and depression after two years in older Japanese adults: The JAGES longitudinal study. *Scientific Reports, 8*(1), 11224. PubMed ID: 30046117 doi:10.1038/s41598-018-29053-x

Karunarathne, D., Morales, Y., Nomura, T., Takayuki, K., & Hiroshi, I. (2019). Will older adults accept a humanoid robot as a walking partner? *International Journal of Social Robotics, 11*(2), 343–358. doi:10.1007/s12369-018-0503-6

Kassavou, A., Turner, A., & French, D.P. (2013). Do interventions to promote walking in groups increase physical activity? A meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 18. PubMed ID: 23388115 doi:10.1186/1479-5868-10-18

Kazuhiro, H., Kouhei, M., Ai, F., Michiko, T., Koji, S., Narihiko, K., & Shuichi, O. (2020). Social interaction in walking groups and affective responses among Japanese older adults. *Journal of Aging and Physical Activity, 28*(2):287–293. doi:10.1123/japa.2018-0412

Kelly, P., Kahlmeier, S., Gotschi, T., Orsini, N., Richards, J., Roberts, N., . . . Foster, C. (2014). Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. *International Journal of Behavioral Nutrition and Physical Activity, 11*(1), 132. PubMed ID: 25344355 doi:10.1186/s12966-014-0132-x

King, A.C., Castro, C., & Eyler, A.A. (1999). Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women. *Health Psychology, 19*(4), 354–364. doi:10.1037/0278-6133.19.4.354

Kosteli, M.C., Williams, S.E., & Cumming, J. (2016). Investigating the psychosocial determinants of physical activity in older adults: A qualitative approach. *Psychology & Health, 31*(6), 730–749. PubMed ID: 26964473 doi:10.1080/08870446.2016.1143943

Kritz, M., Thøgersen-Ntoumani, C., Mullan, B., McVeigh, J., & Ntoumanis, N. (2020). Effective peer leader attributes for the promotion of walking in older adults. *Gerontologist, 60*(6), 1137–1148. doi:10.1093/geront/gnaa014

Kullgren, J.T., Harkins, K.A., Bellamy, S.L., Gonzales, A., Tao, Y., Zhu, J., . . . Karlawish, J. (2014). A mixed-methods randomized controlled trial of financial incentives and peer networks to promote walking among older adults. *Health Education & Behavior, 41*(1), 43S–50S. doi:10.1177/1090198114540464

Lean, M.E.J., Han, T.S., & Morrison, C.E. (1995). Waist circumference as a measure for indicating need for weight management. *BMJ, 311*(6998), 158–161. PubMed ID: 7613427 doi:10.1136/bmj.311.6998.158.

Lee, I.M., Shiroma, E.J., Kamada, M., Bassett, D.R., Matthews, C.E., & Buring, J.E. (2019). Association of step volume and intensity with all-cause mortality in older women. *JAMA Internal Medicine, 179*(8), 1105–1112. doi:10.1001/jamainternmed.2019.0899

McAuley, E. (1993). Self-efficacy and the maintenance of exercise participation in older adults. *Journal of Behavioral Medicine, 16*(1), 103–113. PubMed ID: 8433355 doi:10.1007/BF00844757

Meads, C., & Exley, J. (2018). A systematic review of group walking in physically healthy people to promote physical activity. *International Journal of Technology Assessment in Health Care, 34*(1), 27–37. PubMed ID: 29338794 doi:10.1017/S0266462317001088

Michael, Y.L., & Carlson, N.E. (2009). Analysis of individual social-ecological mediators and moderators and their ability to explain effect of a randomized neighborhood walking intervention. *International Journal of Behavioural Nutrition and Physical Activity, 6*, 49. doi:10.1186/1479-5868-6-49

Middleton, A., Stacy, L., Lusardi, F., & Lusardi, M. (2020). Walking speed: The functional vital sign. *Journal of Aging and Physical Activity, 23*(2), 314–322. doi:10.1123/japa.2013-0236

Morris, S., Guell, C., & Pollard, T.M. (2019). Group walking as a "lifeline": Understanding the place of outdoor walking groups in women's lives. *Social Science & Medicine, 238,* 112489. PubMed ID: 31437768 doi:10.1016/j.socscimed.2019.112489

Murphy, M.H., Nevill, A.M., Murtagh, E.M., & Holder, R.L. (2007). The effect of walking on fitness, fatness and resting blood pressure: A meta-analysis of randomised, controlled trials. *Preventive Medicine, 44*(5), 377–385. PubMed ID: 17275896 doi:10.1016/j.ypmed.2006.12.008

Murtagh, E.M., Nichols, L., Mohammed, M.A., Holder, R., Nevill, A.M., & Murphy, M.H. (2015). The effect of walking on risk factors for cardiovascular disease: An updated systematic review and meta-analysis of randomised control trials. *Preventive Medicine, 72,* 34–43. PubMed ID: 25579505 doi:10.1016/j.ypmed.2014.12.041

Nathan, A., Wood, L., & Giles-Corti, B. (2014). Exploring socioecological correlates of active living in retirement village residents. *Journal of Aging and Physical Activity, 22*(1), 1–15. PubMed ID: 23170755 doi:10.1123/japa.2012-0189

Ng, J.Y.Y., Ntoumanis, N., Thogersen-Ntoumani, C., Deci, E.L., Ryan, R.M., Duda, J.L., & Williams, G.C. (2012). Self-determination theory applied to health contexts: A meta-analysis. *Perspectives on Psychological Science, 7*(4), 325–340. PubMed ID: 26168470 doi:10.1177/1745691612447309

Nieboer, A.P., & Cramm, J.M. (2019). Enabling and disabling behaviors in the social environment are associated with physical activity of older people in the Netherlands. *BMC Public Health, 19*(1), 361. PubMed ID: 30935379 doi:10.1186/s12889-019-6670-z

Niven, A.G., & Markland, D. (2016). Using self-determination theory to understand motivation for walking: Instrument development and model testing using Bayesian structural equation modelling. *Psychology of Sport and Exercise, 23*(Suppl. C), 90–100. doi:10.1016/j.psychsport.2015.11.004

Ntoumanis, N., Ng, J., Prestwich, A., Quested, E., Hancox, J., Thogersen-Ntoumani, C., … Williams, G.C. (2020). A meta-analysis of self-determination theory-informed intervention studies in the health domain: Effects on motivation, health behaviour, physical, and psychological health. *Health Psychology Review*. Advance online publication. PubMed ID: 31983293 doi:10.1080/17437199.2020.1718529

Parkatti, T., Perttunen, J., & Wacker, P. (2012). Improvements in functional capacity from Nordic walking: A randomized-controlled trial among elderly people. *Journal of Aging and Physical Activity, 20*(1), 93–105. PubMed ID: 21949243 doi:10.1123/japa.20.1.93

Perkins, J.M., Multhaup, K.S., Perkins, H.W., & Barton, C. (2008). Self-efficacy and participation in physical and social activity among older adults in Spain and the United States. *Gerontologist, 48*(1), 51–58. PubMed ID: 18381832 doi:10.1093/geront/48.1.51

Ritchie, J.D., Miller, C.K., & Smiciklas-Wright, H. (2005). Tanita foot-to-foot bioelectrical impedance analysis system validated in older adults. *Journal of the American Dietetic Association, 105*(10), 1617–1619. PubMed ID: 16183365 doi:10.1016/j.jada.2005.07.011

Ryan, R.M., & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. PubMed ID: 11392867 doi:10.1037/0003-066X.55.1.68

Ryan, R.M., & Deci, E.L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. New York, NY: Guildford Press.

Samra, P.K., Rebar, A.L., Parkinson, L., van Uffelen, J.G.Z., Schoeppe, S., Power, D., … Alley, S. (2019). Physical activity attitudes, preferences, and experiences of regionally-based Australia adults aged 65 years and older. *Journal of Aging and Physical Activity, 27*(4), 446–451. PubMed ID: 30299206 doi:10.1123/japa.2017-0426

Scherder, E., Scherder, R., Verburgh, L., Königs, M., Blom, M., Kramer, A.F., & Eggermont, L. (2014). Executive functions of sedentary elderly may benefit from walking: A systematic review and meta-analysis. *American Journal of Geriatric Psychiatry, 22*(8), 782–791. PubMed ID: 23636004 doi:10.1016/j.jagp.2012.12.026

Seino, S., Kitamura, A., Tomine, Y., Tanaka, I., Nishi, M., Taniguchi, Y., … Shinkai, S. (2019). Exercise arrangement is associated with physical and mental health in older adults. *Medicine & Science in Sports & Exercise, 51*(6), 1146–1153. PubMed ID: 30694973 doi:10.1249/MSS.0000000000001884

Smith, G.L., Banting, L., Eime, R., Sullivan, G.O., & Uffelen, J.G.Z. (2017). The association between social support and physical activity in older adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 14*(56), 1–21. doi:10.1186/s12966-017-0509-8

Stathi, A., Gilbert, H., Fox, K.R., Coulson, J., Davis, M., & Thompson, J.L. (2012). Determinants of neighborhood activity of adults age 70 and over: A mixed-methods study. *Journal of Aging and Physical Activity, 20*(2), 148–170. PubMed ID: 22472577 doi:10.1123/japa.20.2.148

Stathi, A., Withall, J., Thompson, J.L., Davis, M.G., Gray, S., De Koning, J., … Fox, K.R. (2019). Feasibility trial evaluation of a peer volunteering active aging intervention: ACE (active, connected, engaged). *Gerontologist, 60*(3):571–582. doi:10.1093/geront/gnz003

Teixeira, P.J., Carraca, E.V., Markland, D., Silva, M.N., & Ryan, R.M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 9,*(1) 78. PubMed ID: 22726453 doi:10.1186/1479-5868-9-78

Thogersen-Ntoumani, C., Ntoumanis, N., Uren, H., Stathi, A., Wold, C., & Hill, K.D. (2017). Perceptions of group-based walks and strategies to inform the development of an intervention in retirement villages: Perspectives of residents and village managers. *Journal of Aging and Physical Activity, 25*(2), 261–268. PubMed ID: 27676271 doi:10.1123/japa.2015-0138

Thogersen-Ntoumani, C., Quested, E., Biddle, S.J.H., Kritz, M., Olson, J., Burton, E., … Ntoumanis, N. (2019). Trial feasibility and process evaluation of a motivationally-embellished group peer led walking intervention in retirement villages using the RE-AIM framework: The residents in action trial (RiAT). *Health Psychology and Behavioral Medicine, 7*(1), 202–233. doi:10.1080/21642850.2019.1629934

Thomas, G.N., Macfarlane, D.J., Guo, B., Cheung, B.M., McGhee, S.M., Chou, K.L., … Tomlinson, B. (2012). Health promotion in older Chinese: A 12-month cluster randomized controlled trial of pedometry and "peer support". *Medicine & Science in Sports & Exercise, 44*(6), 1157–1166. PubMed ID: 22143109 doi:10.1249/MSS.0b013e318244314a

Tomas, M.T., Galan-Mercant, A., Carnero, E.A., & Fernandes, B. (2017). Functional capacity and levels of physical activity in aging: A 3-year follow-up. *Frontiers in Medicine, 4,* 244. doi:10.3389/fmed.2017.00244

United Nations. (2019). 2019 revision of world population prospects. Retrieved from https://population.un.org/wpp/Download/Standard/Population.

Washburn, R.A., Smith, K.W., Jette, A.M., & Janney, C.A. (1993). The physical activity scale for the elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology, 46*(2), 153–162. PubMed ID: 8437031 doi:10.1016/0895-4356(93)90053-4

Wilcox, S., King, A.C., Brassington, G.S., & Ahn, D.K. (2000). Physical activity preferences of middle-aged and older adults: A community analysis. *Journal of Aging & Physical Activity, 7*(4), 386–399. doi:10.1123/japa.7.4.386

Williams, G.C., Grow, V.M., Freedman, Z.R., Ryan, R.M., & Deci, E.L. (1996). Motivational predictors of weight loss and weight-loss maintenance. *Journal of Personality and Social Psychology, 70*(1), 115–126. PubMed ID: 8558405 doi:10.1037/0022-3514.70.1.115

Windle, G., Dyfrig, H., Linck, P., Russell, I., & Woods, B. (2010). Is exercise effective in promoting mental well-being in older age? A systematic review. *Aging & Mental Health, 14*(6), 652–669. PubMed ID: 20686977 doi:10.1080/13607861003713232

Witvorapong, N. (2018). Healthy behaviours and productive activities among Thai older adults: A repeated cross-sectional analysis. *Social Science & Medicine, 213,* 12–19. PubMed ID: 30055421 doi:10.1016/j.socscimed.2018.07.031

Wojcicki, T.R., White, S.M., & McAuley, E. (2009). Assessing outcome expectations in older adults: The multidimensional outcome expectations for exercise scale. *The Journals of Gerontology, Series B: Psychological Sciences & Social Sciences, 64*(1), 33–40. doi:10.1093/geronb/gbn032

Zubala, A., MacGillivray, S., Frost, H., Kroll, T., Skelton, D.A., Gavine, A., . . . Morris, J. (2017). Promotion of physical activity interventions for community dwelling older adults: A systematic review of reviews. *PLoS One, 12*(7), e0180902. PubMed ID: 28700754 doi:10.1371/journal.pone.0180902