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Exploring Path Models of Disablement in Residential Care and Assisted Living Residents

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Abstract

This study examined the relationships between individual and environmental factors and physical activity, and between physical activity and functional limitations and disability in residential care/assisted living (RC/AL) residents. Participants completed questionnaires and physical performance tests, and wore the Fitbit Motion Tracker® to capture physical activity. Model fit was analyzed using 2-level path models with residents nested within RC/AL settings. Model parameters were estimated using the MPlus robust maximum likelihood method. A multilevel model with good fit (Root Mean Square Error of Approximation = 0.07, Comparative Fit Index = 0.91) showed that persons with greater exercise self-efficacy were more physically active, and persons who were more physically active had better physical function and less disability. Setting-level factors did not significantly correlate with physical activity or disability. Although environmental factors may influence physical activity behavior, only individual factors were associated with physical activity in this sample of RC/AL residents.

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Keywords

Disability; functional limitations; physical activity; self-efficacy; hierarchical linear modeling

In 2014, on any given day, 835,200 U.S. older adults lived in residential care/assisted living (RC/AL) communities (Caffrey, Harris-Kojetin, & Sengupta, 2015). RC/AL communities are licensed by the state at a non-nursing home level of care and provide housing, 24-hour staffing, and supportive services such as assistance with activities of daily living (ADLs) and medication administration. The typical RC/AL resident is over age 85, has at least two chronic health conditions, and needs assistance with one or more ADLs (Caffrey et al., 2012). RC/AL communities are more appealing than traditional nursing homes because they strive to be less institutional, offer greater independence and privacy, and are roughly half as costly (Genworth, 2016). Given the projected growth in the number of persons age 65 and over, aging-in-place in RC/AL settings will be in greater demand. Regrettably, progressive mobility and ADL decline threaten elders' plans to age in place and eventually prompts nursing home admission for many RC/AL residents (Aud & Rantz, 2005; National Center for Assisted Living, 2010).

Fortunately, physical activity is a means to slow the progression of disability (Chal-Rush et al., 2010; Pahor et al., 2014; Phillips, 2015). According to the disablement process model, regular physical activity can boost mobility and strength, which in turn decreases the risk of ADL decline as well as falls and nursing home transfer (Giuliani et al., 2008; Hatch & Lusardi, 2010; Motl & McAuley, 2010; Verbrugge & Jette, 1994). Unfortunately, evidence suggests that RC/AL residents are relatively inactive (Hall & McAuley, 2011; Resnick, Galik, Gruber-Baldini, & Zimmerman, 2010). Although exercise interventions in RC/AL have yielded improved functional outcomes, this research has rarely examined factors that sustain long-term physical activity independent of investigator-supervised intervention (Baum, Jarjoura, Polen, Faur, & Rutecki, 2003; Cadore et al., 2014; Marshall & Berg, 2010). Because the cessation of regular exercise - even for as little as 12 weeks - may precipitate irreversible functional decline in frail older adults, identifying correlates of physical activity is important in this population (Marshall & Berg, 2010).

Prior research suggests that other individual factors, such as exercise self-efficacy, outcome expectancies, social support, and positive self-perceptions of aging, are associated with physical activity participation among older adults (Levy & Myers, 2004; Morris, McAuley, & Motl, 2008; Park, Elavsky, & Koo, 2014; Resnick & D'Adamo, 2011). Conversely, negative beliefs or experiences surrounding physical activity, lack of interest, poor health, and symptoms such as joint pain, fatigue, and depression, are noted deterrents to exercise (Crombie et al., 2004; Rasinaho, Hirvensalo, Leinonen, Lintunen, & Rantanen, 2007; Resnick & D'Adamo, 2011; Rosenberg, Bombardier, Artherholt, Jensen, & Motl, 2013). Understanding the effects of negative thinking and symptoms of impairment on physical activity is important to identify targets for interventions.

The disablement model also recognizes the contribution of factors outside the individual, such as the social and built environment (e.g., medical care, recreational therapy, and adaptive equipment) imposed on or available to the individual (Jette, 2006). Environmental

factors, such as walking path availability, weather, and neighborhood safety, may impact older adults' physical activity behavior (Rosenberg, Bombardier, Hoffman, & Belza, 2011). Fiscal, structural, and staffing constraints may limit the availability of exercise space and programs in many RC/AL communities, resulting in fewer physical activity opportunities for residents (Benjamin, Edwards, & Caswell, 2009; Harris-Kojetin, Kiefer, Joseph, Arch, & Zimring, 2005; Phillips & Flesner, 2013). That being said, access to professionally-supervised exercise space and programs may not ensure exercise participation (Hatch & Lusardi, 2010). In addition, state-level licensing and regulatory differences in services, admission and retention policies, staffing requirements, and staff training requirements may affect the availability and diversity of physical activity programs (Carder, O'Keefe, & O'Keefe, 2015). Finally, RC/AL staff may promote inactivity by tolerating dependent behavior and offering assistance with self-care activities rather than encouraging activity (Mihalko & Wickley, 2003; Resnick, Galik, Gruber-Baldini, & Zimmerman, 2009).

Better understanding and eventually curbing ADL disability in RC/AL could likely help prevent or delay unwelcome and costly nursing home relocation. Guided by the disablement model and Pender's model of health promotion (Pender, Murdaugh, & Parsons, 2006), this study explored the relationships between individual and environmental factors and physical activity in RC/AL residents and between physical activity and functional limitations and disability. By identifying correlates of physical activity, findings suggest targets to increase physical activity participation in RC/AL residents.

Method

Design and Sample

This study used cross-sectional data from older adults (age 65 and over) enrolled in the Physical Activity and Disability in Residential Care/Assisted Living Residents study. The Institutional Review Board of the University of Missouri approved the study. A two-stage nonprobability sampling approach was used to recruit RC/AL communities and residents within communities. Recruitment letters were sent to administrators of 72 licensed RC/AL communities across 15 Missouri counties, and of those, 34 communities enrolled. In Missouri, RC and AL communities offer similar services although in cases of emergency egress, state regulations require RC residents to be able to follow a path to safety unassisted, but allow AL residents to receive help to safely evacuate. Communities primarily serving individuals with mental retardation and/or developmental disabilities were excluded.

Information recruitment meetings were held at participating communities; persons expressing interest in the study were screened for eligibility. Inclusion criteria included a score on the Mini Mental State Examination-2 Standard Version of 17, corrected for age and education (Folstein, Folstein, White, & Messer, 2010; Mungas, Marshall, Weldon, Haan, & Reed, 1996), age 65 or older, the ability to understand and speak English, and the ability to give consent or assent. Residents with (1) an unstable medical or psychiatric illness (e.g., heart failure exacerbation, suicidal ideation), (2) a terminal illness, (3) severe hearing and vision impairment, and (4) short-stay admission in the RC/AL (e.g., rehabilitation, respite, or terminal care) were excluded.

A total of 272 RC/AL residents enrolled between 2011 and 2013, representing 62% of the persons approached to participate. Of those who did not enroll, most declined participation, but approximately 50 individuals did not meet eligibility criteria. Written consent was obtained from participants after successful completion of the Evaluation to Sign and Informed Consent Document for Research (University of Iowa, n.d.). Caregivers (responsible parties or legal guardians) provided consent on behalf of four participants. Data were obtained using observational measures and interviews.

Measures

Instruments assessed the following domains of the disablement process: Demographic risk factors, pathology, impairments, functional limitations, disability, other individual factors, and setting-level factors. Of particular interest in this study were relationships among the main pathway variables and individual and setting factors; the research model depicting these relationships is displayed in Figure 1. Physical activity antecedents (exercise self-efficacy, outcome expectations, perceived barriers, and perceptions of aging) were hypothesized to affect physical activity directly and affect disablement indirectly through physical activity. The mediating effect of physical activity on the impairment/functional limitation relationship was also tested. In addition, features specific to RC/AL settings that affected physical activity directly or moderated the relationship between functional limitations and disability were explored.

Demographic Risk Factors—Age, gender, height and weight as well as other demographic characteristics including ethnicity, educational status, and marital status were recorded. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

Pathology—The Comorbidity Questionnaire, modeled after the Charlson Index (Charlson, Pompei, Ales, & MacKenzie, 1987), was used to measure pathology (Katz, Chang, Sangha, Fossel, & Bates, 1996); it included the same 19 conditions as the Charlson Index as well as participant report to capture data missing in the medical record. Scores on the Comorbidity Questionnaire range from 0 – 32.

Impairments—Pain was measured with the Iowa Pain thermometer, a single-item pain scale that contains seven descriptors of pain intensity from no pain to the most intense pain imaginable, plus numerical response options between words (Herr, Spratt, Garand, & Li, 2007). Pain scores range from 0 to 12; higher scores indicate more pain. The Fatigue Assessment Scale was used to measure usual fatigue symptoms (Michielsen, De Vries, & Van Heck, 2003). Respondents rated 10 items on a 5-point Likert scale; scores range from 10 to 50, with higher scores reflecting greater fatigue. Depressive symptoms were measured with the Geriatric Depression Scale-15 (Sheikh & Yesavage, 1982), a self-report scale that solicits yes/no responses to simple questions about the respondent's feelings during the past week. Scores range from 0 to 15, with higher scores indicating greater symptoms.

Functional Limitations—Tests of upper and lower extremity performance included the Short Physical Performance Battery (SPPB), overhead lifting, shoulder range of motion, and

grip strength (Ferrucci et al., 1995; Guralnik et al., 1994). The SPPB includes timed tests of standing balance, gait speed over 4 meters (m), and repeated chair rise, each scored on a 0 to 4 scale and summed to yield a total performance score ranging from 0 to 12. Internal and external shoulder rotation were rated on a 1 to 3 point scale and overhead lifting on a 1 to 4 point scale, with the summed score of all three tests ranging from 3 to 10. In addition, using the Jamar Hydraulic Hand Dynamometer, grip strength was measured three times in each hand according to the American Society of Hand Therapists procedures (Shechtman, Mann, Justiss, & Tomita, 2004). The greater value of the right or left mean hand strength in kilograms was used for data analysis.

Disability—Direct care staff completed the Modified Barthel Index, a 10-item scale for rating resident's level of independence in ADLs (Mahoney & Barthel, 1965; Shah, Vancley, & Cooper, 1989). Item scores were summed for a total score ranging from 0 (total dependence) to 100 (total independence). In the present study, staff were unable to rate stair climbing ability for 19 subjects, therefore the stair climbing item was removed from the total score calculation. Consequently, Barthel Index scores could range from 0 to 90, with 90 representing total independence.

Other Individual Factors—Other factors included exercise self-efficacy, outcome expectations, perceived barriers, and perceptions of aging. The Self-efficacy to Exercise Regularly Scale is a 3-item scale in which respondents rated their confidence for gentle exercise, aerobic exercise, and exercise without making symptoms worse, scored from 1 (not at all confident) to 10 (totally confident), and averaged (Lorig et al., 1996). The Outcome Expectations for Exercise Scale (OEE) (Resnick, Zimmerman, Orwig, Furstenberg, & Magaziner, 2000) assesses perceived benefits of exercise on a 1 – 5 point scale; respondents rate the extent to which they agree or disagree with nine statements about the physical and mental health outcomes of exercise. Higher mean scores reflect more positive outcome expectations. The Barriers to Physical Activity Subscale of the San Diego Health and Exercise Questionnaire – 2-year follow-up version (Sallis, 2010) contains 16 items, rated on a 0 – 4 scale, describing various problems that keep people from exercising. Higher summed scores indicate greater perceived barriers. Perceptions of aging were measured with the five-item Attitude Toward Own Aging subscale of the Philadelphia Geriatric Center Morale Scale (Lawton, 2003). Using yes/no or better/worse formats, respondents answered questions concerning changes in their lives as a result of aging; higher scores reflect more positive perceptions of aging.

In accordance with the exercise science literature, physical activity was operationalized as daily walking and measured with an accelerometer (Hansen, Kolle, Dyrstad, Holme, & Anderssen, 2012; Rowe, Kemble, Robinson, & Mahar, 2007). Participants wore the Fitbit® Tracker (Fitbit Inc., San Francisco, CA) (hereinafter called Fitbit) at the lateral waist for three consecutive days from morning to retiring to bed at night. As a triaxial accelerometer, the Fitbit uses three dimensional motion sensing technology similar to the technology of the Nintendo Wii (Montgomery-Downs, Insana, & Bond, 2012). Activity was recorded in 60 s epochs and displayed on a web-based server in the form of steps taken in five-minute intervals. Prior to distribution, research staff used the Fitbit visual display to verify that steps

recorded on the Fitbit matched the verbal count of test steps. Participants and RC/AL staff received written and verbal wear instructions and staff received second- and third-day reminder calls. Interruptions in wear that participants or staff reported were noted for data cleaning and analysis purposes. Twenty-four of the 272 participants did not receive Fitbits because staff predicted poor compliance for 10 individuals and another 14 participants ambulated with wheelchairs. Prior research has demonstrated high between-day reliability for accelerometer steps ($ICC = 0.87$) over as few as two days of monitoring in older adult samples (Rowe, Kemble, Robinson, & Mahar, 2007).

Setting Factors—Administrators completed Part III of the Multiphasic Environmental Assessment Procedure (MEAP) Policy and Program Information Form, Expectations for Functioning, which addresses the community's intolerance for residents who are unable to, for example, dress themselves or make their own beds (Moos & Lemke, 1996). Raw scores were converted to percentages, with higher percentages indicating greater expectations for functioning.

Activity staff or administrators provided information on the frequency and type of physical activity programs per week. A tool developed for the present study listed the following physical activity categories: chair exercises, structured walking, strength training, stretching, balance, dance, and water exercise (Mihalko & Wickley, 2003; Wasner & Rimmer, 1997).

RC/AL administrators also provided descriptive information on RC/AL size, type, occupancy rate, profit status, urban/rural location, affiliation with other long-term care communities, and services provided. By regulation, Missouri RC communities may admit only persons able to independently get to an area of refuge in an emergency whereas AL communities may admit and retain residents who require more than minimal assistance. However, AL regulations dictate a higher staff-to-resident ratio, a licensed administrator, an individualized service plan for each resident, and recreational activities.

Data Analysis

All data were double-entered in Excel and checked for accuracy, missing data, and outliers. Internal consistency reliability was calculated as appropriate. Descriptive statistics were calculated to describe the demographic characteristics of RC/AL residents and communities. Physical activity was recorded in steps per hour to account for the observed variation in wear duration. Because 16 of the 248 participants to which a Fitbit was distributed did not have any days of wear, usable data were available for 232 participants. The average of three largest non-zero hourly counts over the 3-day wear period was used to estimate their *capacity* for physical activity. The distribution of raw *capacity* was skewed because a few participants had very large maximal hourly count values (e.g., 3000 - 4000 steps/hour). To meet modeling assumptions, the natural logarithm of *capacity* was used but is referred to as “capacity” from here on. Although a log transformation of physical activity was used in subsequent analyses, as a linear transformation, a change in the log of a measure would be directionally congruent with a change in the original raw value of that measure.

MPlus (Muthén & Muthén, 2004) was used to operationalize and test the path model displayed in Figure 1. The intra-class correlation coefficient (ICC) was derived for each

dependent variable to determine the proportion of the total variance accounted for by the nesting of subjects within RC/AL communities. The ICC estimates were nearly zero (0.001) for all variables except disability (Barthel Index). The ICC for the Barthel Index score was 0.73 which supported the use of a multilevel model. Model testing proceeded in several phases.

For a multilevel path model to be estimable the number of estimated parameters must be fewer than the number of clusters. The full model as depicted in Figure 1 implies too many parameters to be estimable. Thus to simplify the path model, principal components factor analysis was used to form composite scores for physical activity antecedents, impairments, and functional limitations. For all three composites a single component was retained according to the eigenvalue greater than 1.0 rule of thumb (Kaiser, 1961). The derived composite variables were expressed as z-scores with a mean of zero and a standard deviation of one.

The first step of path modeling was to refine a resident-level model by excluding from the full model (Figure 1) statistically non-significant ($p > 0.05$) relationships, which was done in the context of a random intercept model for disability. Once the resident-level model was specified, the setting-level factors were added to test for a potentially direct effect of resident physical activity and for a moderating effect on the relationship between functional limitations and disability. The multilevel portion of the model was expressed using the slopes-as-outcomes format for computing but these equations can also be combined into the traditional linear model format (as shown below) which clearly illustrates that the multilevel model offers a test of cross-level moderation.

$$Disability_{ij} = \gamma_{00} + \gamma_{01}^{EF} j + \gamma_{02}^{PAP} j + \gamma_{10}^{FL} i_j + \gamma_{11}^{EF} j * FL_i + \gamma_{12}^{PAP} j * FL_i + u_{1j} * FL_{ij} + \varepsilon_{ij} + u_{0j}$$

Model parameters were estimated using the robust maximum likelihood method available in MPlus. Model goodness-of-fit for the resident-level model was assessed using Comparative Fit Index (CFI; Bentler, 1990) and Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1993). CFI and RMSEA for the full multilevel context have not yet been developed.

Results

Descriptive Statistics

Resident ($N = 232$) and RC/AL community characteristics are provided in Table 1. Participants' mean age was 85 ± 7.8 and mean length of stay was 26.3 ± 27.9 months. Most residents were White (98.7%), female (82.8%), and widowed (71.1%). Frequencies of health conditions affecting 20% of participants are also listed in Table 1. The majority of the communities were for-profit (77%) and two-thirds were part of long-term care chains (68%). Using the National Survey of Residential Care Facilities' definition, most communities (71%) were categorized as large, having 26-100 beds. The majority of communities offered chair exercise (91%) and many offered other types of physical activity programs, although

AL communities offered more programs (8.3 ± 4.0) than did RC communities (4.2 ± 3.6). With respect to exercise space and equipment, seven of the 34 communities had dedicated exercise rooms; the most common types of exercise equipment were the NuStep machine ($n = 13$) and free weights ($n = 10$). Descriptive statistics, factor loadings, and reliabilities for variables included in the model analysis are presented in Table 2.

Model Testing Results

The initial model, the reification of Figure 1 using composite scores, exhibited poor fit to the data ($RMSEA = 0.22$, $CFI = 0.24$) and included a number of non-significant paths. It was found that pathology was predicted by age but not by the other presumed risk factors of BMI and gender, and that pathology was not predictive of impairment. It was also observed that age and pathology had a strong association with resident physical activity and so the model was revised to reflect this. The regression of physical activity and functional limitations on the impairment score was not statistically significant. Thus we did not find evidence that physical activity mediated the relationship between functional limitations and impairments. The full regression results for the initial model are given in Table 3.

The physical activity antecedents composite score was predictive of physical activity and so to further elucidate the role of each variable comprising the physical activity antecedent score the composite score was replaced with its constituent variables. Only exercise self-efficacy demonstrated a statistically significant relationship with physical activity ($p < .001$). Overall fit of the final resident-level model was acceptable: $RMSEA = 0.11$, $CFI = 0.88$.

Figure 2 displays the resulting resident-level model, to which the setting-level variables were added to explore whether the number of RC/AL physical activity programs and RC/AL expectations for functioning moderated the functional limitations/disability relationship, and that these setting-level factors were associated with residents' level of physical activity. It was also noted that RC and AL settings differ somewhat with respect to their physical activity programs and expectations so the type of setting was added as a covariate (i.e., relative to AL, RC communities offer an average of four fewer physical activity programs per week ($p = 0.001$) and have higher expectations for resident functioning ($p = 0.006$)). Setting-level factors do not appear to moderate the relationship between functional limitations and disability. That being said, the Mann Whitney U test yielded a significant difference ($p < 0.001$) in Barthel Index scores for RC residents (mean 87.1, SD 7.1) compared to AL residents (mean 82.8, SD 14.1) even though the latter setting offered more physical activity programs.

Also, Figure 2 indicates that physical activity declines with age ($b = -.047$, $p < 0.01$) and pathology ($b = -.085$, $p < 0.01$), while exercise self-efficacy ($b = .173$, $p < 0.01$) has a strong positive relationship with physical activity. Physical activity has a positive relationship with functional limitations ($b = 0.437$, $p < 0.01$) which are in turn are associated with disability ($b = 1.71$, $p < 0.01$). Because the functional limitations composite is expressed as a "z-score," one interpretation of these results is that a one SD change in the functional limitations composite score has approximately 1.7 points of change in disability (Barthel Index). Fixed effects estimates for the final two-level model are given in Table 4. For the disability outcome the results are given in the traditional linear model form.

Discussion

Participants in the present study had similar demographic and health characteristics as RC/AL residents represented in national surveys (Caffrey et al., 2012). However, the more frequent diagnosis of cerebrovascular accident in our sample than in national samples, of which 11% had a stroke diagnosis, may be explained by the Comorbidity Questionnaire's definition of cerebrovascular accident that encompassed transient ischemic attack. Compared to RC/AL residents in the Collaborative Studies of Long-Term Care, participants in the present study had slightly better grip strength and gait speed (Giuliani et al., 2008), a finding that may reflect participation of more physically active RC/AL residents and/or different type of RC/AL settings.

In this cross-sectional analysis, we tested a path model in which presumed physical activity antecedents, physical activity, and impairments were hypothesized to influence ADL disability through their relationships with functional limitations. Additionally, setting-level variables added to the resident-level model were tested for an association with physical activity and as a moderator of the functional limitations/disability relationship. We found that persons with greater exercise self-efficacy were more physically active, and persons who were more physically active performed better on tests of physical function and had better ADL function. Among setting-level variables, RC/AL type significantly related to expectations for resident's functioning. That AL residents, compared to RC residents, had poorer ADL function is in accordance with Missouri regulations governing staffing, service provision, and scope of care in AL. Finally, the frequency of physical activity programs was not a significant predictor or moderator variable in the model.

Contrary to our hypothesized model, the paths between pathology and impairments and between impairments and functional limitations were not statistically significant and therefore the composite impairments variable was eliminated from the model. Impairments, conceptualized as dysfunctions and abnormalities in bodily systems that may affect functioning, were operationalized as a report of symptoms (i.e., fatigue, depressive symptoms, and pain) that are known deterrents to physical activity and predictors of functional decline (Bennett, Stewart, Kayser-Jones, & Glaser, 2002; Crombie et al., 2004; Dalle Carbonare et al., 2009; Resnick & D'Adamo, 2011; Rosenberg et al., 2013). Although factor loadings for the Impairment composite variable indicated constituent variables represented a shared construct, that the path coefficients from pathology to impairments and impairment to functional limitations were not statistically significant may suggest that the observed variables were an imprecise representation of impairments. Had impairments been examined individually or measured by clinical examination of bodily systems linked to performance on tests of functional limitations, the path coefficient may have been of sufficient magnitude to be retained in the model.

That physical activity was associated with disablement aligns with conclusions of prior reviews (Keysor, 2003; Paterson & Warburton, 2010; Tak, Kuiper, Chorus, Hopman-Rock, 2013). Keysor's (2003) narrative review that encompassed prior meta-analyses and systematic reviews, randomized clinical trials, and observational studies found compelling evidence for protective effects of exercise on functional limitations but limited evidence for

similar effects on disability. However, more recent systematic reviews and meta-analyses concluded that physical activity of moderate or greater intensity conferred a reduced risk for incidence and progression of ADL disability (Paterson & Warburton, 2010; Tak et al., 2013). Specifically, Tak and colleagues' (2013) meta-analysis of ADL disability incidence yielded substantial heterogeneity that subsequent subgroup analyses with functional limitations and health factors as moderator variables did not explain. Thus, identifying alternative pathways of the effect of physical activity on disability beyond the chronological disablement process model is important for targeting upstream determinants of disability.

In contrast to the strong association between tests of upper and lower extremity performance and ADL disability commonly reported (Giuliani et al., 2008; Stenholm, Guralnik, Bandinelli, & Ferrucci, 2014), we found the relationship between these variables to be modest. Regression parameters may be underestimated when scale range is attenuated and in the present study the Barthel Index demonstrated a pronounced ceiling effect with over 60% of subjects having a score of 89 or 90 (maximum Barthel Index score was 90 in the present study). Other researchers have reported similar psychometric issues with the Barthel Index (Poulsen, Hesselbo, Pietersen, & Schroll, 2005). Additionally, a recent psychometric study determined that none of the six instruments tested, of which the Barthel Index was one, were adequate for measuring functional status in the assisted living population (Bowen, Rowe, Hart-Hughes, Barnett, & Ji, 2015). Because existing functional status or ADL instruments were not originally developed for the RC/AL population, many include items that may be irrelevant to RC/AL environments, such as stair climbing in the Barthel Index or carrying groceries 70 meters in another established tool, the Continuous Scale Physical Functional Performance test (Cress et al., 1996). Maryland's Assisted Living Resident Assessment Tool (Maryland Department of Health and Mental Hygiene, 2006), which guides facilities in developing residents' service plans, includes a 9-item ADL assessment similar to the Barthel Index but with clearly defined response options for rating the level of assistance needed to perform each activity (e.g., 0 - Independently; 1 - With supervision, or stand-by or set-up, or cuing and coaching; 2 - One-person physical assistance; or 3 - Two-person physical assistance, needs complete assistance). Given the current deficit of ADL measures specific to RC/AL residents, research and practice knowledge could be advanced by testing the ADL section of the Maryland's Assisted Living Resident Assessment Tool in future studies.

There is a well-established link between self-efficacy for exercise and physical activity behavior (Hall & McAuley, 2011; Morris et al., 2008; Mullen, McAuley, Satariano, Kealey, & Prohaska, 2012; Park et al., 2014; Resnick & D'Adamo, 2011). Our hypothesis that greater self-efficacy for exercise would be associated with greater physical activity was supported in the path analysis and concurs with Bandura's (2004) causal model of social cognitive theory wherein efficacy beliefs impact behavior directly and also indirectly through their influence on goals, outcome expectancies, and perceived facilitators and barriers. However, it is plausible that physical activity is a source of efficacy information as McAuley and colleagues' studies have repeatedly demonstrated (Hall & McAuley, 2011; McAuley et al., 2007; Mullen et al., 2012). Among older adults in a 6-month trial comparing two forms of group exercise (walking versus stretching), those who exercised more frequently reported greater social support, more positive experiences, and higher self-efficacy at the end of the trial (McAuley, Jerome, Marquez, Elavsky, & Blissmer, 2003).

Eliciting social support for physical activity is one of several self-regulatory strategies that have been shown to influence exercise self-efficacy and subsequently exercise adherence (McAuley et al., 2011). Therefore, providing older adults with frequent opportunities to successfully engage in socially-oriented physical activity programs could enhance exercise self-efficacy, reciprocally increase physical activity levels, and eventually yield improvements in their physical function performance. Regularly-scheduled group physical activity programs are important to maintain exercise behavior and exercise self-efficacy among RC/AL residents that may have perceptual and other barriers to physical activity. Additionally, incorporating program attendance logs and self-report measures of physical activity in future studies will better quantify older adults' physical activity adherence.

Our study results are consistent with prior research suggesting that wide variation in physical activity programming exists across RC/AL communities. Larger communities offered a greater number of physical activity programs, but a few communities lacked physical activity programs entirely. Group-based chair exercises remain the most commonly offered type of physical activity, evidence that physical activity programming has changed little over the past 10-15 years (Mihalko & Wickley, 2003; Wasner & Rimmer, 1997). Typical chair exercises do not target the declines in walking, strength, and balance associated with institutional living and the progression of ADL disability, however an evaluation of the intensity and dose of individual exercise programs was beyond the scope of this study. As a researcher-developed measure, exercise program availability may simply reflect resources and values within different communities.

Unfortunately, RC/AL activity directors typically lack training specific to the physical activity needs and capacities of older adults, yet are charged with organizing exercise as well as other types of activities. Many exercise programs designed for older adults use a train-the-trainer model in which activity directors could be certified. With additional training, RC/AL activity directors would gain the necessary skills to safely deliver exercise programs such as A Matter of Balance and Tai Chi for Arthritis (MaineHealth Partnership for Healthy Aging, n.d.; Tai Chi for Health Institute, n.d.). In addition, the American College of Sports Medicine (ACSM) recommends and provides ACSM Certified Personal Trainer certification as preparation to train seniors (ACSM, 2014). If RC/AL communities were to consistently provide nationally recognized exercise programs, prospective studies examining the effects of exercise on a variety of proximal and distal functional outcomes would be feasible.

In the context of relatively low expectations for residents' functioning, that less emphasis is placed on exercises to improve mobility is not surprising. Conversely, more negative expectancies of administrators and staff may develop as residents experience progressive functional decline. Prior research has demonstrated that even informal caregivers, trained in a home-based exercise program for persons with dementia, are able to affect and sustain improvement in physical activity and physical functioning for as long as 2 years (Teri et al., 2003). Given that the average length of stay in RC/AL is only 22 months, training RC/AL staff to promote rather than limit activity may yield both quality of life benefits for residents and occupancy benefits for communities (Caffrey et al., 2012).

The present study has several notable limitations. First, given this study's emphasis on physical disablement, operations of the main pathway constructs could have better captured associated physical qualities. Operationalizing impairments as symptoms of pain, fatigue, and depression did not optimize congruence with the operations of pathology and functional limitations, and therefore impairments were not retained in the final path model. Second, although participants and staff were instructed to wear the Fitbit during waking hours for three consecutive days, we found this frequently did not happen. Therefore, we defined physical activity in terms of *capacity*, or their capability for walking. Potential approaches to improve compliance with wear, and therefore more accurately capture daily walking, include daily telephone calls to participants instead of staff, daily site visits by research staff, and use of water-proof devices that could stay in place for the full schedule of wear. Attending to Kowalski and colleagues (2012) recommendation to report compliance levels with physical activity measurement in older adults, the real world problems we encountered with collecting physical activity data in the RC/AL population are described in this report. Third, the Fitbit measures ambulation but does not record activity expended on stationary exercise equipment, such as a bicycle or a NuStep machine, or activities with upper body or arm movements involved in performing functional activities. Collecting both activity monitor data and physical activity questionnaire data could capture the frequency and types of physical activity in which RC/AL residents engage and assess the agreement and association between indirect and direct measures (Kowalski, Rhodes, Naylor, Tuokko, & MacDonald, 2012). Lacking data on the frequency and duration our participants engaged in group or individual physical activity programs, we were unable to determine the association between overall physical activity participation and disablement outcomes. Fourth, we encountered missing data for the Barthel Index stair-climbing item because staff were not able to rate resident's stair-climbing ability in communities without stairs. Our solution was to eliminate this item from the total Barthel Index score, which further restricted the range of scores. Finally, our sampling methods and recruitment success may have introduced bias. Because only one-half (47%) of solicited RC/AL communities participated and participating communities were limited to certain counties in Missouri, these results may not be generalizable to other settings and locations. Also our inclusion and exclusion criteria were designed to enroll persons in stable physical and mental health, with minimal cognitive impairment, and able to reliably wear an activity monitor, the combination of which may not reflect the variability of residents served in different RC/AL types (Zimmerman et al., 2003).

In conclusion, our path model provided evidence for exogenous correlates of physical activity (i.e., exercise self-efficacy, age, and comorbidities) and downstream associations between physical activity and functional limitations and between functional limitations and ADL disability in RC/AL residents. We did not find a significant association between physical activity and the availability of physical activity programs or expectations for functioning. Although environmental factors may influence physical activity behavior, only individual factors were associated with physical activity in this sample of RC/AL residents.

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Figure 1.

Hypothesized Path Model of the Relationships between Individual and Setting Factors and Disablement.

Note: Dotted lines indicate hypothesized relationships.

BMI = Body Mass Index; ADL = Activity of Daily Living; RC/AL = Residential Care/Assisted Living.

Figure 2.

Regression Estimates for the Final Multilevel Model.

Note: Solid lines reflect all paths tested in the final model. Path coefficients with an asterisk are statistically significant, all at $p < .01$. Fit indices for the final model: RMSEA = 0.11, CFI = 0.88. *Higher* scores on the functional limitations and disability measures reflect *fewer* limitations and disability. RC/AL = Residential Care/ Assisted Living.

Table 1Participating Residents ($N = 232$) and Residential Care/Assisted Living Communities ($N = 34$)

Variable	Percent or M (SD)
Residents	
Distribution by type of setting (%)	
AL community	63
RC community	37
Age (years)	85.0 (7.8)
Gender (female; %)	82.8
Race (White; %)	98.7
Marital status (widowed; %)	71.1
Education (years)	13.1 (3.1)
Length of stay in facility (months)	26.3 (27.9)
Mini Mental State Examination ^a	
Raw score corrected for age and education	25.6 (3.9)
Raw score, uncorrected	24.3 (3.9)
Co-Morbidity Questionnaire	2.7 (2.2)
Cerebrovascular accident without hemiplegia (%)	31.9
Congestive heart failure (%)	30.2
Dementia (%)	25.0
Myocardial infarction	20.7
Chronic obstructive pulmonary disease	20.7
Walking aid use (%)	
None	63.8
Cane	5.2
Walker	31.0
Gait speed (m/s)	0.60 (0.2)
Community	
Community location (%)	
Rural	47
Urban	53
Community type (%)	
Assisted living	53
Residential care	47
Administration	

Variable	Percent or <i>M</i> (<i>SD</i>)
For-profit ownership (%)	76.5
Chain (%)	67.6
Bed capacity	48.6 (33.5)
Occupancy (mean %)	73.8 (20.1)
Years in business	20.4 (19.2)
Community size (%)	
Medium (11 - 25 beds)	23.5
Large (26 - 100 beds)	70.6
Extra large (> 100 beds)	5.9
Number of beds	48.6 (33.5)
Number of physical activity programs per week, RC/AL combined	6.4 (4.3)
RC community	4.2 (3.6)
AL community	8.3 (4.0)
Program availability across all RC/AL communities (%)	
Chair exercise	91.2
Flexibility exercise	70.6
Walking	61.8
Balance training	58.8
Strengthening exercise	55.9
Dance	47.1
Water exercise	2.9
Expectations for Functioning ^b , RC/AL combined, (mean %)	28.4 (16.2)
AL Expectations for Functioning (mean %)	21.8 (12.0)
RC Expectations for Functioning (mean %)	35.7 (17.4)

Notes: M = mean; SD = standard deviation; RC/AL = Residential Care/Assisted Living.

^aCorrection based on education greater or less than 12 years and age greater or less than 70 years.

^bScore reflects the percentage of the minimum number of standards for self-care accepted in the facility.

Table 2

Psychometric Properties for Path Model Variables

Variables and Measures	<i>M</i> (<i>SD</i>)	Composite Variable Factor Loadings	α
<u>Risk Factors</u>			
Age	85.0 (7.6)		
Gender (percent female)	82.8%		
Body Mass Index (kg/m ²)	28 (5.8)		
<u>Pathology</u>			
Comorbidity Questionnaire	2.7 (2.2)		
<u>Impairments</u>			
Iowa Pain Thermometer	1.7 (2.6)	0.63	
Fatigue Assessment Scale	20.1 (6.5)	0.82	0.81
Geriatric Depression Scale-15	2.5 (2.5)	0.76	0.75
<u>Functional Limitations</u>			
Short Physical Performance Battery	6.7 (2.5)	0.72	0.62
Upper Extremity Performance	9.2 (1.4)	0.76	0.78
Grip Strength (kg)	17.4 (6.0)	0.74	
<u>Disability</u>			
Barthel Index	84.4 (12.2)		0.89
<u>Physical Activity Antecedents</u>			
Self-efficacy to Exercise Regularly	7.6 (2.4)	0.75	0.67
Outcome Expectations for Exercise	3.9 (0.8)	0.75	0.93
Barriers to Physical Activity	11.7 (9.6)	0.78	0.84
Attitude Towards Own Aging	2.4 (1.6)	0.63	0.65
<u>Physical Activity</u>			
Capacity (average of three maxima steps/hour)	513 (615)		
Capacity (natural log)	5.6 (1.2)		
<u>Setting Factors</u>			
RC/AL Type (percent assisted living)	53%		
RC/AL Physical Activity Programs (number per week)	6.4 (4.3)		
Expectations for Functioning ^a (mean %)	28.4 (16.2)		0.80

Notes: M = mean; SD = standard deviation; RC/AL = Residential Care/ Assisted Living.

^aScore reflects the percentage of the minimum number of standards for self-care accepted in the facility.

Table 3

Regression Results for the Initial Resident-level Model.

Dependent Variable (R^2)	Independent Variable	Regression Estimate	z	p	Standardized Estimate
Pathology (0.028)	Age	-0.039	-2.03	.042	-0.135
	BMI	0.014	0.62	.533	0.038
	Female	-0.332	-0.80	.422	-0.058
	Intercept	2.938			
Impairment Score (0.01)	Pathology	0.026	0.87	.383	0.391
	Intercept	-0.072			
Physical Activity (0.06)	Impairments Score	-0.024	-0.24	.811	-0.020
	Physical Activity Antecedents Score	0.296	3.46	.001	0.248
	Intercept	5.642			
	Impairments Score	-0.117	-1.61	.108	-0.118
Functional Limitations (0.21)	Physical Activity Capacity (natural log)	0.419	8.20	< .001	0.498
	Intercept	-2.363			
	Functional Limitations	1.605	3.29	.001	0.237
Disability (0.04)	Intercept	84.866			

Note: BMI = Body Mass Index.

Table 4

Regression Results for the Final Multilevel Model.

Dependent Variable	Independent Variable	Estimate	Standard Error	z	p
Within Level					
Physical Activity Capacity (natural log)	Age	-0.047	0.006	-8.00	< .001
	Pathology	-0.085	0.023	-3.72	< .001
	Exercise Self-Efficacy	0.173	0.021	8.38	< .001
	Intercept	5.642			
Functional Limitations	Physical Activity	0.437	0.048	9.11	< .001
	Intercept	0.001			
Between Level					
RC/AL Expectations for Functioning	RC vs. AL	13.85	5.031	2.75	.006
	RC vs. AL	-4.083	1.281	-3.19	.001
Physical Activity Capacity (natural log)	RC/AL Expectations for Functioning	0.003	0.004	0.76	0.447
	RC/AL Physical Activity Programs	-0.004	0.016	-0.23	0.820
	Functional Limitations	1.709	0.480	3.56	< .001
	RC/AL Expectations for Functioning	0.006	0.480	0.11	.910
Disability	RC/AL Physical Activity Programs	-0.315	0.193	-1.63	.102
	RC/AL Expectations for Functioning * Functional Limitations	0.029	0.002	1.30	.193
	RC/AL Physical Activity Programs * Functional Limitations	0.031	0.113	0.28	.782
	Constant (γ_{00})	84.560			

Note: RC/AL = Residential Care/Assisted Living.