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Physical Activity and Function in Assisted Living Residents

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Abstract

The purpose of this study was to consider the feasibility, reliability and validity of MotionWatch 8. A total of 249 residents were recruited from 26 assisted living. Data collection included demographics, comorbidities, function (Barthel Index), physical activity (MotionWatch 8), and falls. The mean age of participants was 86.86 (SD=7.0), the majority were women 179 (74%) and white (N=232, 96%). A total of 86% of participants wore the MotionWatch 8. There were no significant differences in physical activity over three days of testing. The MotionWatch 8 findings were significantly associated with ADL function. There were no significant differences in ADL function or physical activity between those who did and did not fall. The study provides additional support for the feasibility, reliability and validity of the MotionWatch 8 and confirms that older adults living in assisted living settings spend the majority of their time in sedentary activity.

Repeatedly it has been shown that older adults in assisted living settings engage in very limited amounts of overall physical activity and particularly limited amounts of exercise (Hanson et al., 2014; Phillips & Flesner, 2013; Regan et al., 2016; Resnick, Galik, Gruber-Baldini, & Zimmerman, 2010). Physical activity is defined as behavior that involves movement of the body resulting in the expenditure of energy. Exercise is a subset of physical activity defined as moderate intensity physical activity or activity that is planned, structured,

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and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness (Centers for Disease Control, 2017; World Health Organization, 2010). Current guidelines for older adults recommend at least 150 minutes weekly of moderate intensity physical activity, preferably in bouts of 10 minutes or more at any time during the day. Moderate intensity activity burns 3.5 to 7 kilocalories (kcals)/ minute and includes such things as walking briskly (three to four miles per hour), climbing up the stairs, heavy housework (vacuuming, cleaning widows or floors), swimming or dancing. Alternatively, the guidelines recommend 75 minutes weekly of vigorous intensity activity. Vigorous activity burns more than 7 kcal/min and includes such things as running (6–8 miles per hour) or cycling (12–14 miles per hour) (Centers for Disease Control, 2017). It is important to focus on increasing time spent in physical activity for older adults in assisted living settings as there are numerous health related benefits associated with physical activity. Specifically these include maintaining or improving function, balance, gait speed, and walking endurance and decreasing fear of and risk of falling (Fahlman et al., 2011; Hatch & Lusardi, 2011; Resnick et al., 2010; Chao, Scherer, Wu, Lucke, & Montgomery, 2013).

There is evidence that engaging in physical activity, particularly physical activity that addresses muscle strength and balance, will decrease the risk of falling and the number of falls that occur among older adults (Bauman, Merom, Bull, Buchner, & Singh, 2016; Gawler et al., 2016; Halvarsson, Oddsson, Franzén, & Ståhle, 2016; Lee et al., 2017; McMahon et al., 2016). Beneficial physical activity can include group exercise, home based programs and moderate or lower intensity activity. For example, an exercise intervention referred to as Ready-Steady which included leg-strengthening, balance and flexibility activity along with walking and a group based intensive exercise program that increased time spent in moderate to vigorous physical activity both decreased fall risk and/or injurious falls among participants (Gawler et al., 2016; McMahon et al., 2016). A primary role of physical activity in the prevention of falls is to avert the onset of disease, which may result in disability. In addition, by improving muscle strength and balance through exercise the older adult will be more likely to resist gravity and regain his or her balance when balance is challenged or a near fall occurs (Moreira, Bilton, Dias, Ferriolli, & Perracini, 2017). Conversely, physical inactivity is a behavior-related risk factor for falls (Boelens, Hekman, & Verkerke, 2013). Unfortunately the majority of older adults do not believe that engaging in physical activity is a useful strategy to prevent falls (Hill et al., 2011; Johnson, Martin, Anens, Jahansson, & Hellstrom, 2018) and only about 50% of older adults engage in regular physical activity (Centers for Disease Control, 2017; World Health Organization, 2010).

Approximately 40% of residents in assisted living required assistance with three or more ADLs and the majority need help with bathing, meal preparation, and medication management (The National Center for Health Statistics Data Brief No. 223, 2015; Resnick & Galik, 2015). The majority of the physical activity performed by residents in assisted living is related to basic activities of daily living such as bathing and dressing (Resnick & Galik, 2015).

In the research to date, measurement of physical activity among residents in assisted living has not been consistently obtained. Many studies use survey reports of physical activity as

they are easy to administer and low in cost. There are advantages to survey input as they provide the participant's or caregiver's perspective on the amount of activity currently being done by the older individual. Unfortunately, survey reports of physical activity tend to overestimate the amount of activity that is actually performed (Chao et al., 2013; Fjeldsoe, Winkler, Marshall, Eakin, & Reeves, 2013; Gennuso, Matthews, & Colbert, 2015; Resnick, Galik, Gruber-Baldini & Zimmerman, 2009; Resnick et al., 2010).

Alternatively, some studies of assisted living residents have used objective monitoring of physical activity with pedometers or actigraphy. Objective measures of physical activity tend to be less biased. Disadvantages of objective measures when used with older adults in assisted living include a reliance on preset algorithms for estimates of intensity of physical activity that were developed for younger individuals such as the Freedson calculation (Freedson, Melanson, & Sirard, 1998). Preset algorithms for physical activity can result in biased findings as energy expenditure in older adults is not equivalent to that of young adult men and women (Ainsworth, 2009). The most commonly used algorithm is the Freedson calculation (Freedson et al., 1998) which estimates moderate physical activity to be 1,964 counts per minute and may underestimate the amount of energy expended by older individuals (Pruitt et al., 2008). Other measurement challenges include a lack of sensitivity with regard to light intensity activities, and the inability to detect non-ambulatory activities (e.g. cycling, weight lifting) or to differentiate activities (e.g., transfers, toileting, resistance exercise versus ambulation) (Resnick et al., 2010). In addition, there are some individuals who refuse to wear these devices, particularly those worn around the waist such as the Actigraph, and thus the results may be biased due to participant selectivity.

The MotionWatch 8, developed in 2012, is a newer type of accelerometer and is referred to as the next generation of actigraphy from CamNtech (MotionWatch 8 Overview - CamNtech. (n.d.). The MotionWatch 8 uses a tri-axial accelerometer, has a built in ambient light sensor and event marker and provides an option for long-term recording with no interruptions for battery charging. The device is worn on the wrist of the older individual and is lightweight (9.1 gm's). A major advantage of the MotionWatch 8 over the Actigraph is that individual set-points for intensity of physical activity can be established. The analysis function uses a calibration to derive reference levels for vigorous, moderate, and sedentary activity based on individual gait speed. To establish these individual reference levels, the participant is asked to perform a brisk walk (3–4 mph) for at least five minutes as soon as the device is initiated. An average of the activity counts found within this five- minute period is used to produce the moderate threshold level. Prior testing with a sample of 23 community dwelling older adults led to the development of set activity levels for older individuals (Landry, Falck, Beets, & Liu-Ambrose, 2015); sedentary behavior was set at less than or equal to 178.50 counts per minute; moderate level physical activity was set at greater than or equal to 562.50 counts per minute and vigorous activity was set at ≥ 1020 counts per minute. Counts are the unit of measurement used to evaluate activity when calculated by any type of actigraph. The device counts the number of times the waveform crosses zero for each time-period being evaluated.

The purpose of this study was to: (1) describe physical activity among a group of assisted living residents using the MotionWatch 8; (2) consider the feasibility and reliability and

validity of the MotionWatch 8 when used with assisted living residents; and (3) evaluate if time in physical activity (sedentary or moderate activity) was associated with falls among a group of assisted living residents.

Methods

Design

This study used baseline data from the first cohort of a study entitled, Dissemination and Implementation of Function Focused Care for Assisted Living Using the Evidence Integration Triangle (FFC-AL-EIT). The FFC-AL-EIT is a dissemination and implementation study focused on helping assisted living settings integrate Function Focused Care into routine care (Resnick et al., in press). Function Focused Care is a philosophy of care in which older adults are encouraged to engage in physical activity at their highest level during all care interactions. Participants were recruited from 26 assisted living settings in Maryland, Pennsylvania and Massachusetts. Settings were invited to participate if they: (1) had at least 25 beds; and (2) identified a nurse (a direct care worker, licensed practical nurse or registered nurse) to be the champion and work with the study team in the implementation of FFC-AL-EIT; and (3) were able to access email and websites via a phone, tablet or computer. The study was approved by a University based ethics Institutional Review Board. The consent form was consistent with recommendations in the Declaration of Helsinki.

Study Participants

Residents were eligible to participate in this study if they were 65 years of age or older, able to speak English, lived in a participating assisted living setting at the time of recruitment, and were able to recall at least one out of three words as per the Minicog (Borson, Scanlan, Chen & Ganguli, 2003). Residents were excluded from the study if they were enrolled in hospice. All participants were given the Evaluation to Sign Consent, a five item questionnaire evaluating the individual's understanding of participation in the research project (Resnick et al., 2007). Potentially eligible participants were identified by the staff in the assisted living facility and were randomly approached until ten residents per setting were recruited. A total of 381 residents were approached; 110 (29%) refused to participate (6 of these were refusals from the legally authorized representative), 7 (2%) individuals were excluded/ineligible as they were either too young or enrolled in Hospice and 15 (4%) were unable to assent or the evaluator was unable to reach the legally authorized representative to obtain consent. A total of 249 individuals consented, five of whom were ineligible due to cognitive status, leaving a baseline enrolled sample of 244 residents. Of the 244 residents, one individual withdrew prior to baseline data and there was missing baseline data on one enrolled resident. Data analysis was therefore done on 242 enrolled participants with data.

Procedures

Following consent, demographic and descriptive information was obtained from resident charts to include: age, gender, race, ethnicity, marital status, and education as well as number of falls that occurred in the prior 4 months. Comorbidities were calculated based on the Cumulative Illness Rating Scale for Geriatrics (Linn, Linn, & Gurel, 1968; Miller et al., 1992). The Cumulative Illness Rating Scale for Geriatrics was designed for use with frail

nursing facility residents and contains ratings of both illness severity and comorbidity. Participants are evaluated based on 13 organs or systems and a psychiatric/behavioral rating. In prior studies the scores on the Cumulative Illness Rating Scale were correlated with medication use and predicted mortality, hospitalization and disability (Linn et al., 1968; Miller et al., 1992).

The Barthel Index (Mahoney & Barthel, 1965) was completed on each participant by asking the direct care worker providing care for the resident on the day of testing how the resident performed with regard to activities of daily living. The Barthel Index is a 10-item measure of activities of daily living (e.g., bathing, dressing). Items are weighted to account for the amount of assistance required. A score of 100 indicates complete independence. Based on prior testing of the Barthel Index (Mahoney & Barthel, 1965), estimates of internal consistency ranged from alpha coefficients of 0.62 to 0.80, inter-rater reliability was supported based on an intra-class correlation of 0.89 between two observers; and validity was based on correlations with the Functional Inventory Measure ($r=0.97$, $p<.05$).

Baseline falls included those that occurred within the 4 months prior to baseline. Assisted living settings in all three states are required to gather this data on individual residents and the falls data was obtained based on chart review or from the appropriate designated individual within settings. Lastly, the MotionWatch 8 was placed on each participant for a five- day period. Prior research has shown that daily activity for older adults in this type of setting is consistent on a day to day basis (Chakravarthy & Resnick, 2017). Therefore, we used the three full days of data obtained on days 2, 3, and 4 for analysis. Participants were instructed to wear the MotionWatch 8 at all times during the 5 day period including showering, bathing, swimming and when sleeping.

As described above, the MotionWatch 8 is a compact, lightweight, water resistant, body-worn activity monitoring device that is used to measure physical movement. The device is intended to monitor limb or body movements during daily living and sleep. The MotionWatch 8 contains a miniature accelerometer to allow measurement and recording of physical movement of the wrist which provides a close correlation to whole body movement. The data are sampled at 50Hz and processed into ‘epochs’ of user selectable length (e.g., every minute). These data are stored in an internal non-volatile memory and then downloaded for analysis at the end of the study period. The majority of participants in our study were either physically unable to walk at a moderate level of activity for five minutes or cognitively unable to follow those directions so individual reference levels could not be accurately calculated. Consequently, we used the previously established reference levels for the MotionWatch 8 when worn by older adults as described above (Landry et al., 2015). Prior evidence of reliability of the MotionWatch 8 was based on consistency between recordings across three days of wear and evidence of validity was based on a consistent match between activity counts and recorded activity performed and a statistically significant difference in Borg Rating of Perceived Exercise Scale (RPE) between the sedentary group (Borg RPE = 8.6, SD=3.0) and those with some level of activity (Borg RPE = 9.9, SD= 2.3; $F=5.72$, $p=.02$) (Chakravarthy & Resnick, 2017).

Data Analysis and Reliability and Validity Testing

The aims of this study were to describe physical activity among a group of assisted living residents using the MotionWatch 8, test the feasibility and reliability and validity of the MotionWatch 8, and consider the association between physical activity and falls. For Aim I, descriptive statistics were done using SPSS 23 to describe physical activity among the residents. Aim II feasibility of the MotionWatch 8 was based on participant willingness to wear the watch over at least three full days of data collection. Reliability was based on evidence of consistency across the three days of testing. A repeated measure analysis of covariance was done to test the hypothesis that, controlling for function, there would not be a statistically significant difference across the three days of testing with regard to counts of activity and time spent in sedentary, moderate or vigorous physical activity. Validity of the MotionWatch 8 was based on demonstrating that there was a statistically significant relationship between the MotionWatch 8 outcomes (counts of activity and time in sedentary and moderate activity) and function based on the Barthel Index. The Barthel Index was selected as the comparative measure as the majority of physical activity done by older adults in assisted living settings is done during activities of daily living such as bathing, dressing and walking. Three linear regression models were tested: controlling for age, gender, race and comorbidities, MotionWatch 8 outcomes (counts of activity, time in moderate activity, time in sedentary activity) were each regressed onto the dependent variable function measured using the Barthel Index. Lastly, to evaluate if counts of activity, time spent in sedentary, or moderate level activity was different between those who did or did not experience a fall in the prior four months a Multivariate Analysis of Covariance was performed. Specifically we hypothesized that, controlling for age, gender, race, comorbidities, and function, those who engaged in more activity would be less likely to have experienced a fall.

Results

As shown in Table 1, the cohort one sample included 242 residents with a mean age of 86.86 (SD=7.0), the majority of whom were women 179(74%), white (N=232, 96%) and currently either widowed, divorced or never married (N=197, 82%). These individuals had a mean score of 8.06 (SD=4.89) on the Cumulative Index Rating and a mean score of 2.44 (SD=.78) on the 3 out of 3 recall question from the MiniCog. The participants needed help with some activities of daily living as noted by a mean Barthel Index score of 63.06 (SD=20.20). Overall they engaged in 1,236 (SD=498) minutes (or 20.6 hours ±8.3 hours) of sedentary activity daily, 42 (SD=63) minutes of moderate level activity daily and 6.9 (SD=14.7) minutes of vigorous activity with 47% of individuals engaging in 0 minutes of vigorous activity.

With regard to the feasibility and reliability and validity of the MotionWatch 8, a total of 207 individuals out of the 242 participants included in this analysis (86%) wore the MotionWatch 8 for the 5 days as requested. In 18 cases there was a technical problem downloading the data due to problems with the laptop being used in the field and so baseline data was lost on those individuals. One individual cut the band on the watch, one individual

broke the band and two MotionWatches were removed by residents and lost within the settings. The remaining 13 individuals refused to wear the MotionWatches.

There was evidence, as hypothesized, for consistency of activity measurements based on the MotionWatch 8. As shown in Table 2 there was no difference in counts of activity (F= 1.28, p=.22), time spent in sedentary activity (F=.71, p=.49) or time spent in moderate level activity (F=.26, p=.77) or vigorous activity (F=.29, p=.75). across the three days?

With regard to validity testing, the linear regression analysis demonstrated that counts of activity were significantly associated with function based on the Barthel Index and accounted for 4% of the variance in that outcome (F=8.57, p=.004). Time in moderate activity was also significantly associated with function based on the Barthel Index and accounted for 2% of the variance (F=4.52, p=.04). Time in sedentary activity did not enter the regression model and was not significantly associated with function based on the Barthel Index.

Approximately a quarter of the residents sustained a fall in the four months prior to baseline data collection (N=58, 24%). Thirty-eight of those who fell had one fall (66%), 10 individuals (17%) had two falls, 7 individuals (12%) had three falls, 1 individual had four falls (2%), 1 individual had five falls (2%), and 1 individual had seven falls (2%). Controlling for age, gender, race, comorbidities and function there was no difference between individuals who did or did not sustain a fall with regard to counts of activity, time spent in sedentary, moderate or vigorous level activity (overall Wilks' Lambda = 1.20, p=. 31).

Discussion

The findings from this study support prior findings that older adults in assisted living settings spend the majority of their time daily in sedentary activity (86%) and that the MotionWatch 8 is feasible, reliable and valid and can be considered as an option when evaluating physical activity among older adults in assisted living settings. The mean amount of time spent in sedentary activity in this sample was consistent with that reported on two samples of older adults living in continuing care retirement communities (CCRC) (Chakravarthy & Resnick, 2017; Regan et al., 2016). Study participants in our study, as well as the CCRC samples, spent the majority of the day in sedentary activity but exceeded the daily recommendations for time in moderate level activity. Both our assisted living sample and the samples of older adults living in a CCRC engaged in 40 to 50 minutes per day of moderate level activity (Chakravarthy & Resnick, 2017; Regan et al., 2016). In both of the CCRC setting studies the actigraphy data (one study used the MotionWatch 8 and one used the ActiGraph) was collected on devices that were recalibrated for activity levels anticipated among older adults. Conversely, in prior research using the Actigraph with similar samples of older adults in long-term care settings in which the Freedson equation was used to calibrate moderate level activity only .5 to 2.75 minutes of moderate level activity were noted (Galik, Resnick, Lerner, Hammersla & Gruber-Baldini, 2015; Resnick, Galik, Gruber-Baldini & Zimmerman, 2011).

Long periods of sedentary activity are common among older adults and have a negative impact on both physical and mental health (Diaz et al., 2017; Dunstan, Thorp, & Healy, 2011; Hamer & Stamatakis, 2014). This is true even for those who meet the guidelines for time spent in moderate level activity. It is anticipated that the environments in institutional settings may facilitate increased opportunities to walk longer hallway distances and thus achieve the goal of 30 minutes per day of moderate level activity at least 5 days per week. Conversely, however, there tends to be a subsequent decrease in overall activity as many opportunities for non-sedentary activity done in routine daily life are taken over by staff (e.g., laundry, cooking, setting the table). Ongoing work needs to continue to focus on ways to engage residents in all types of physical activity during the day and thereby decrease the time in sedentary activity. In addition, future consideration should be given to comparing the impact of the number and length of breaks from sedentary activity among older adults versus considering only the total amount of time spent in sedentary activity as was done in this study.

As noted the MotionWatch 8 was generally well tolerated by participants and the majority (86%) were willing to wear the device. The percentage of individuals willing to wear the MotionWatch 8 was greater than the approximately 75% of participants willing to wear the Actigraph in prior studies in assisted living settings (Galik et al., 2015 ; Resnick et al., 2011). Participants preferred the MotionWatch as it was worn on the wrist and did not interfere with clothing as did the Actigraph which was worn around the waist. The findings from this study provided additional support that the MotionWatch 8 was reliable based on consistency of measurement of physical activity across three days of testing (Chakravarthy & Resnick, 2017). For additional evidence of reliability future research should test the device using short episodes of walking multiple times. For example having the participant walk 100 feet, rest for several minutes and walk 100 feet again.

There was partial support for the validity of the MotionWatch 8 as, controlling for age, gender, cognition, and comorbidities, there was a statistically significant relationship between activity counts and moderate level activity and the Barthel Index, or the functional level of the individual. Consideration of a relationship between the MotionWatch 8 findings and function is particularly relevant as the majority of the activity that participants engage in is related to functional tasks such as bathing, dressing and ambulation. The amount of variance explained by the MotionWatch 8 data, however, was very small. Ongoing use and testing of this device should consider comparisons with directly observed activity, an activity diary, and other actigraphy monitors.

The participants in this study had a rate of falls that was relatively consistent with what has been reported in other studies of residents in assisted living settings. Specifically, fall rates were noted to range from 30 to 50% of older adults living in assisted living settings experiencing a fall over a 6–12 month period (Eriksson, Gustafson, & Lundin-Olsson, 2007; Resnick, Galik, Gruber-Baldini & Zimmerman, 2012; Sharaf & Ibrahim, 2008). Close to 25% of residents in our sample sustained a fall over a 4- month period. We did not support our hypothesis that physical activity would be protective of falling. Rather there was no difference noted between fallers and nonfallers on any of our descriptive data. The lack of differences in any of the outcomes between fallers and nonfallers may be due to the fact that

falls data were collected retrospectively and activity was measured in a single point in time at baseline recruitment. It is also possible that the lack of support for the protective nature of physical activity on falls is due to the *type* of activity (e.g., balance exercise; resistance exercise) performed and not time spent in activity (Moreira, Bilton et al., 2017). Moreover, some of the physical activity recorded as moderate level activity based on the MotionWatch 8 involved upper extremity movement versus ambulation or balance related activities and thus was unlikely to have influenced falls or falls prevention.

The strength of this study was that it involved multiple assisted living settings across three states and included objective data (i.e., the Barthel Index and actigraphy data from the MotionWatch 8). The sample, however, was relatively small and homogeneous with the majority being female, white and sedentary. We did not gather subjective data regarding the type of activity being done to consider this against the findings from the MotionWatch 8 and data was gathered only at a single point in time. Data related to function were based on reports from the direct care workers providing care to the resident on the day of testing. It was possible, however, that some of the direct care workers were more familiar with the resident than others and thus may have been able to provide a more accurate and comprehensive review of the resident. Despite these limitations, the study provides some additional support for the feasibility, reliability, and validity of the MotionWatch 8 when used with older adults and confirms that older adults living in these settings continue to spend the majority of their time in sedentary activity. To improve our understanding and ability to collect activity data among older adults in assisted living, ongoing testing of the MotionWatch 8 is needed with a particular focus on comparing the findings from the MotionWatch 8 with other actigraphs. Ongoing research is also needed to test approaches that effectively increase the time spent in physical activity among older adults in assisted living and decrease the long periods of time in sedentary activity. In particular consideration should be given to the type of activities done with a focus on incorporating the type of activity that will be most likely to prevent falls and on shortening time spent in sedentary activity. This can be done by encouraging walking to meals, incorporating physical activity into recreational activities such as having residents walk to get prizes after winning BINGO or utilizing a BINGO game that incorporates physical activity, a balloon toss activity, balloon badminton, or dancing. Accurate measurement of physical activity and focusing on increasing physical activity among older adults in assisted living has the potential to have a significant impact on clinical outcomes and thereby quality of life among these individuals.

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Table 1

Descriptive Findings

	Measure Range	Sample range	Mean	Std. Deviation
Age	-	67–103	86.85	7.00
Total Minutes in Sedentary Activity	-	660–1440	1233	156
Total Minutes in Moderate Activity	-	0–327	43.76	64.31
Total Minutes in Vigorous Activity	-	0–221	20.72	44.00
Total Counts	-	50–451690	111353	87262
Barthel Index	0–100	3–80	63.06	20.20
Cumulative Rating Index	0–56	1–26	8.05	4.89
3/3 Word Recall Question	1–3	1–3	2.44	.77

Table 2

MotionWatch 8 Reliability Findings Based on Three Full Days of Wear*

Motionwatch 8 Outcomes	Mean (SD)	F	p
Counts of Activity		1.28	.22
Full day one	116697 (93725)		
Full day two	109537 (86606)		
Full day three	106556 (90541)		
Time (minutes) in Sedentary Activity		.71	.49
Full day one	1234 (165)		
Full day two	1244 (156)		
Full day three	1225 (199)		
Time (minutes) in Moderate Activity		.26	.77
Full day one	46.44 (70.39)		
Full day two	42.99 (62.84)		
Full day three	41.59 (66.22)		
Time (minutes) in Vigorous Activity		.29	.75
Full day one	7.98 (16.84)		
Full day two	6.57 (14.35)		
Full day three	6.17 (14.74)		

*significant at $p<.05$