A Cross Sectional Analysis of Physical Activity Engagement in Adults with Mild Cognitive Impairment

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Abstract

Background

To address the paucity of literature regarding the relationship between mild cognitive impairment and physical activity engagement, this study aimed to understand the relative contribution of cognitive, demographic, physical and psychological variables related to physical activity engagement in individuals with mild cognitive impairment.

Method

This was a descriptive, cross – sectional study of secondary data from 62 participants with MCI (mean age 70.53, *SD* = 6.34), 53.2% female, median MoCA 23 (*IQR*: 20, 24)) from the NeuroExercise study, a 12 – month PA intervention on the outcome of cognitive function. The independent variable of interest was global cognitive function. Age, gender, years of education, number of medications, handgrip strength, depression, and quality of life were treated as covariates. The dependent variable was PA engagement in minutes per week, using the LAPAQ physical activity questionnaire and the Actigraph triaxial accelerometer device.

Results

Hierarchical regression analyses showed no significant effect of cognitive function on physical activity engagement after controlling for the effects of covariates. Physical activity engagement was low relative to global physical activity guidelines (($M = 111.38$, $SD = 94.29$) Actigraph ($t(51) = -2.95$, $p < .005$) and the LAPAQ ($M = 51.71$, $SD = 22.80$), $t(61) = -33.94$, $p = < .001$)). A Bland- Altman measure of agreement demonstrated that objective and subjective measures of physical activity were not equivalent.

Conclusions

This sample of adults with MCI were not sufficiently physically active. Further, there was substantial variability between objective and subjective measures of physical activity engagement. Objective measurement of PA data may be more reliable for adults with mild cognitive impairment.

Background

Physical activity (PA) in mid – late life may help to support brain health in adults with mild cognitive impairment (MCI), a risk state for dementia (Petersen et al., 2009; Sanford, 2017), (Gomes-Osman et al., 2018; Lautenschlager, Cox, & Ellis, 2019; Zheng, Xia, Zhou, Tao, & Chen, 2016). Increasing PA engagement in adults with MCI may reduce the risk of further impairment (Ahlskog, Geda, Graff-Radford, & Petersen, 2011; Geda et al., 2010), improve cognitive function in those already experiencing decline (Gallaway et al., 2017) and reduce rates of dementia in older adults (Gallaway et al., 2017; Stephen, Hongisto, Solomon, & Lonnroos, 2017). Thus, adults with MCI represent a key group for targeted interventions aimed at delaying or preventing dementia (Livingston et al., 2017).

According to global PA guidelines, adults aged 18 + should engage in at least 30 minutes of moderate intensity PA a day five days per week, or 150 minutes per week. The most recent guidelines have increased the minimum amount of recommended PA to 150–300 minutes of moderate or 75–150 minutes of vigorous intensity PA per week (Bull et al., 2020), however as this study was conducted prior to the release of these updated guidelines, this report will focus on recommended PA as per the previous guidelines. Previous research suggests that adults with subjective cognitive impairment (Miyawaki, Bouldin, Kumar, & McGuire, 2017), MCI {Vidoni, 2016 #12060) and dementia (van Alphen et al., 2016{Watts, 2013 #12059) are less physically active than non – impaired adults, but little evidence exists regarding the levels of PA engagement in a sample of Irish adults with MCI. Similarly, evidence regarding the factors related to PA in adults with MCI is sparse, with some cross- sectional correlational evidence which contrasts between studies, and a lack of data regarding the contribution of individual variables.

A small number of cross -sectional studies suggest that greater cognitive function (Kobayashi et al., 2016; Vancampfort et al., 2018) and earlier stage of MCI (early vs late stage) (Stuckenschneider et al., 2018) are positively correlated with PA engagement. However, Wettstein et al (2015) reported no correlation between cognitive function and PA engagement (Wettstein et al., 2015). Few studies have examined the demographic correlates of PA engagement in adults with MCI, with contradictory findings. Age was negatively significant in one study (Vancampfort et al., 2018) and non - significant in another (Rovner, Casten, & Leiby, 2016). In those studies, being male was positively (Rovner et al., 2016) and non - significantly (Vancampfort et al., 2018) associated with PA engagement. Similarly, level of education was non - significant but level of literacy was positively associated in one study (Rovner et al., 2016), whereas Vancampfort et al (2018) found level of education to be negatively related to PA engagement in Chinese adults but positively related in Ghanaian adults. Both studies reported negative correlations with PA engagement and depression. In addition, some evidence regarding domains relating to physical health and function suggests indicators of physical health such as measures of chronic conditions, injury and weak grip strength may be negatively correlated with PA engagement (Vancampfort et al., 2018), and mobility and instrumental activities of daily living (IADL`s) may positively correlated (Rovner et al., 2016). This evidence is suggestive of associations between cognitive, demographic, physical and psychosocial variables on the outcome of PA engagement in adults with MCI, but it is contradictory and does not provide evidence of the relative contributions of the variables to the outcome of interest.

Another limitation with the literature is that previous studies of PA in MCI and dementia populations have been limited by indirect measurement of PA (Gagliardi, Papa, Postacchini, & Giuli, 2016; van Alphen et al., 2016). The reliability of indirect measures such as self – report questionnaires, has been found to have low – moderate correlation with direct observation of PA in adults (Prince et al., 2008), and can be undermined by cognitive impairment (Cumming &

Klineberg, 1994; Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012) and prone to underestimation in cognitively impaired populations (Siebeling, Wiebers, Beem, Puhan, & Ter Riet, 2012). This highlights the need for studies to assess the reliability of self - reported PA data and its ability to accurately characterise PA engagement in a group of cognitively impaired adults.

This cross – sectional, descriptive study aimed to analyse secondary data from the NeuroExercise Study, a 12 – month PA intervention on the outcome of cognitive function (See Appendix 1 for NeuroExercise Study protocol summary (Devenney et al., 2017)) to quantify the association between PA engagement and demographic, cognitive, physical and psychological domains in adults with MCI, and to make two key comparisons: between levels of PA in an MCI population relative to global PA guidelines, and between the reliability and convergent validity of subjective and objective measures of PA engagement in this sample. It is necessary to better understand these issues to facilitate the use of PA as a risk factor treatment target for addressing early cognitive decline.

It was hypothesised that global cognitive function would be positively associated with PA engagement, after controlling for the effects of demographic, physical and psychological variables. Secondary hypotheses were that PA engagement would be below the global recommended PA guidelines of 150 minutes per week, and that objective and subjective measures of PA engagement in this cohort would not be convergently valid.

Objectives

1. To use hierarchical multiple regression to analyse the relationship between minutes of PA per week and global cognitive function (MoCA), controlling for age, and years of education, physical health (number of medications), physical frailty (handgrip strength),and psychosocial health (depression and quality of life) in 62 adults aged 50 + with MCI.
2. Use a one- sample t – test to compare levels of PA in MCI sample to global Physical Activity Guidelines.
3. Assess the relationship and level of agreement between subjective (LAPAQ physical activity questionnaire) and objective (Actigraph triaxial accelerometer) measures of PA engagement in individuals with MCI using a Bland – Altman scatterplot.

Methods

Design

This was a descriptive cross- sectional correlation study using secondary data. The independent variable of interest was level of global cognitive function. Ethical approval for this study was granted by SJH/AMNCH Research Ethics committee REC Ref 2015/09/04/ 2017- 05 List 17 (2), date granted 18/05/17. Data collection began on 21/06/17. The variables of age, gender and years of education (demographic), number of medications & handgrip strength (physical health), depression, and quality of life (psychosocial health) were treated as covariates in this analysis. The dependent variable was PA engagement in minutes per week, measured using the LAPAQ physical activity questionnaire and an Actigraph triaxial accelerometer device.

Participants & sampling

Sixty – two participants were recruited the community (n=26) and from memory clinics (n= 38) in Dublin, Ireland. Inclusion criteria were: i) a diagnosis of amnestic MCI due to AD based on the National Institute on Ageing and Alzheimer
$sAssociationcriteria, ii) aMontrealCognitiveAssessment(MoCA) sc \text{ or } eof18 - 26, \text{ and } iii) a \geq of50years + . Participantswereexcluded \text{ if } th$
s Hospital, Dublin, or by their primary physician at presentation to other community memory clinics. Community recruitment took place via newspaper advertisement and community group newsletters. Ethical approval for this study was granted by SJH/AMNCH Research Ethics committee REC Ref 2015/09/04/ 2017- 05 List 17 (2), date granted 18/05/17, and was carried out in accordance with institution guidelines and regulations. Participants were presented with a participant information leaflet for the NeuroExercise study and written informed consent was obtained. The participant information leaflet and consent form are presented in Appendix 2.

Measures

Physical activity engagement

Physical activity was measured using the self- report LASA Physical Activity Questionnaire (LAPAQ) (see Appendix 3.) and the Actigraph triaxial accelerometer device.

The LAPAQ is a researcher administered recall survey which records moderate to vigorous PA (MVPA) for the previous 14 days. Scoring is calculated by totalling minutes spent in each activity. Weekly totals were calculated to achieve minutes per seven days. The LAPAQ was designed for use in older populations and is valid and reliable in non – impaired older adults (Harris et al., 2009; Stel et al., 2004). In this sample Cronbach’s alpha coefficient was .44.

The Actigraph GT3X (Actigraph, Pensacola, Fl, USA), is a medical - grade triaxial accelerometer worn on the hip for seven consecutive days. It is valid and reliable for measuring PA in non – impaired adults (Aadland & Ylvisaker, 2015(Barrett, Dominick, & Winfree, 2017; Ozemek, Kirschner, Wilkerson, Byun, & Kaminsky, 2014). Freedson bouts (periods of MVPA for 10 minutes or longer) were taken as the objective measure of MVPA and are a valid, reliable method for estimating PA engagement (Leinonen et al., 2016). Data was extracted and analysed using Actilife software Version 6.13.3.

Cognitive Function

Cognitive function was measured using the Montreal Cognitive Assessment (MoCA, Appendix 4.) for global cognitive function and working memory, covering the domains of visuospatial and executive function, naming, verbal memory registration and learning, attention, abstraction, delayed verbal memory, and orientation. It is a 30- item researcher administered test, with scores ranging from 0 to 30. A score of 26 or higher is considered to show normal cognitive

functioning. It has been validated for use in the detection of MCI (Freitas, 2012; Nasreddine, Phillips, Bedirian, Charbonneau, Whitehead, Collin, Cummings & Chertow, 2005) in MCI and dementia in elderly populations (Abd Razak et al., 2019).

Psychological health

Quality of life

The Quality of life for Dementia questionnaire (DemQoL) version 4 has been validity, acceptability, and reliability in individuals with dementia (Smith, Lamping, Banerjee, Harwood, Foley, Smith, Cook, Murray, Prince & Levin, 2005) and MCI (Mhaolain, Gallagher, Crosby, Ryan, Lacey, Coen, Coakley, Walsh, Cunningham & Lawlor, 2012). It is a 28 – item, researcher administered questionnaire. In the current study, the Cronbach alpha coefficient was .89. Questions are scored on a 4 – point Likert scale. Higher scores indicating better health related quality of life (See Appendix 5).

Depression

Depression was measured using the Centre for Epidemiologic Studies Depression scales (CES- D, Appendix 6), a 20 - item researcher administered questionnaire measuring symptomatic depression (Radloff, 1977). It has been validated as a screening instrument in older adults (Irwin, Artin & Oxman, 1999) and is scored on a 4 – point Likert scale, with a score of 16 or over indicating presence of depression. In this current study, the Cronbach alpha coefficient was .79.

Physical health

Number of medications

Number of medications was used as a proxy measure of chronic illness. In the current study, all medications taken regularly were recorded by researchers and medication counts performed, excluding vitamin supplements, over the counter eye and nasal drops and herbal treatments as per previous studies (Agostini, Han, & Tinetti, 2004). This method has been previously used in adults with MCI to measure presence of chronic illness (Rovner et al., 2016).

Physical frailty

Measurement of handgrip strength is a reliable proxy measure for overall muscle strength (Bohannon, Magasi, Bubela, Wang, & Gershon, 2012). It has been shown to have predictive value as a measure of all – cause and disease specific mortality and future function and has utility as a means of identifying older adults at risk of poor health status (Bohannon, 2019). It was used here to indicate frailty status using a Jamar Digital Dynamometer and measured in kilograms.

Missing Data

Missing data was identified using the Frequencies option in SPSS. Missingness was low: Little's (1998) test of Missingness Completely at Random was not significant ($x2$ = 105.82 , *DF* = 101 , p = .352). Two participants failed to complete the CES- D, one was unable to complete the handgrip left measure, two were unable to complete the handgrip right measure and ten participants failed to supply Actigraph data. Table 1 provides an overview of all missing data.

Table 1.

Overview of Missing Data

Missing Data (Total number of cases: 62)	n (%)	%
CES- D	3	4.8
DemQol	0	0
MoCA	0	0
Age at screening	0	0
LAPAQ	0	0
Actigraph	10	16.1
Years of education	0	0
Handgrip	2	3.2
Number of medications	2	3.2

Statistical Analysis

Baseline participant data was analysed using Spss V.25. Descriptive statistics were used to describe the distribution of the data. Kolmogorov – Smirnov values were inspected to assess normality of the distribution of scores (Appendix 7, Table A1). Inspection of outliers showed some outliers which were not determined to be significant. The relevant boxplots for age, years of education, number of medications and the LAPAQ are presented in Appendices 8 - 11 (Figures A1 – A4). Scatterplot matrices were created to explore the linearity between each DV (LAPAQ (Appendix 12, Figure A5) and Actigraph (Appendix 13, Figure A6)) and the independent variables. Bar charts were used to inspect potential patterns in each IV across the categorical IVs (gender, recruitment source). Visual inspection of bar charts showed scores were similar when stratified (Appendix 14, Figure A7 and Appendix 15, Figure A8).

Hierarchical linear regression analyses were used to explore associations between the independent and dependent variables of the LAPAQ and the Actigraph data, controlling for covariates, to assess the individual contributions of these variables and the contributions of these variables as domain constructs. A one-sample t test was used to assess differences in means of PA minutes per week compared to recommended physical activity guidelines. A Bland -Altman plot was used to analyse level of agreement between objective and subjective measures of PA engagement. Alpha level was set at .005 following Bonferroni adjustment for multiple comparisons.

Results

Descriptive Statistics

Variables that were not normally distributed were number of medications, MoCA and Actigraph scores. The sample was 53.2% female (33 women), mean age of 70.53 (*SD* = 6.34). The mean minutes of PA engaged in per week were 51.72 (*SD* = 22.82) (LAPAQ) and 111 (*SD* = 94.30) (Actigraph data). Means, medians, standard deviations and interquartile ranges are presented in Table 2, with normative data where available. Frequencies for all variables are presented in Appendices 16–23 (Tables A2 – A9).

Table 2.

Means, Medians, Standard Deviations & Interquartile Ranges for all Study Variables.

Current study							**Normative values**			
Variable	*Md* (*IQR*)	*M* (*SD*)	Range					*M* (*SD*)		
			Min	Max						
Recruitment source										
Memory clinic	36									
Community	26									
Age in years	71 (IQR: 67, 75)	70.53 (6.339)	54	84						
Years of education	13 (IQR: 11, 15)	13.34 (3.188)	7	22						
MoCA	23 (IQR: 20, 24)	22.27 (2.504)	18	26				24.6 (3.2)****		
PA in minutes per week									%	
LAPAQ	47.25 (IQR: 35.88, 64.88)	51.72 (22.82)	14	111	0% ≥ 150 mins	100% <150 mins			28% ≥ 150 **	72% <150 mins**
Actigraph	75 (IQR: 23.25, 178.75)	111 (94.30)	0	353	34.62% ≥ 150 min	64.38% <150 min				
Handgrip males (in Kg)	34.80 (IQR: 29.6, 42.03)	35.36 (7.96)	20	48			Males < 173cm	31.8 (6.7)****		
							Males > 173cm	36.1 (7.1)****		
Handgrip females (in kg)	20.85 (IQR: 16.97, 25.28)	20.92 (5.62)	9	32			Females < 160cm	19.1 (3.9)****		
							Females > 160cm	21.6 (4.4)****		
Number of medications	3 (IQR; 2, 5)	3.61 (2.46)	0	12				2.35 (2.55)***		
CES- D Scores	11 (IQR: 6, 14)	10.14 (6.21)	0	26				9.35 (9.13)*****		
Dementia Related Quality of Life (DemQol)	94 (IQR: 86, 100)	92.48 (10.42)	65	110						
*Population norms for educational attainment of Irish adults derived from TILDA data (Kearney et al., 2011).										
** % of Irish adults aged 70–74 years achieving 150 minutes of PA per week derived from TILDA data recorded using the IPAQ physical activity questionnaire (Murtagh et al., 2015).										
*** Data cited by Peklar et al (Peklar et al., 2017) for Irish adults aged 50 years + obtained from TILDA.										
**** Normative muscle strength and MoCA values for adults 70 years + derived from TILDA data stratified by height (Kenny et al., 2013).										
***** Population norms for Australian adults aged 25–90 years (Crawford, Cayley, Lovibond, Wilson, & Hartley, 2011).										

Objective 1: Hierarchical regression for outcome 1 (LAPAQ scores).

Hierarchical multiple regression was used to analyse the relationship between the outcome measure of minutes of PA per week (LAPAQ) and cognitive function (MoCA) controlling for the variables of age, years of education (Block 1), number of medications and muscle strength (handgrip) (block 2), depression (CES – D) and quality of life (DemQoL) (Block 3). The MoCA was entered in Block 4. The model as a whole was not statistically significant *R2*

= .09, Adjusted R^2 = -. 03, *F change* (7, 49) = 2.16, *p* =. 661. No individual variables made a statistically significant contribution to the outcome of PA. Age (*Beta* = − .53, *p* = .276) and years of education (*Beta* = .760, *p* = .431) (model 1) explained 4 % of the variance in PA, R^2 = .04, Adjusted R^2 = − .00, *F* change (2, 54) =. 98, *p* =. 384. Number of medications (*Beta* = − .104, *p* = .939) and handgrip (*Beta* = − .112, *p* = .738) (model 2) explained 4% of the variance in the outcome, R^2 = .04, Adjusted R^2 = -. 04, *F change* (4, 52) = .07, *p* = .732. Model 3 which included quality of life (*Beta* = − .23, *p* = .571) and depression (*Beta* = − .63, *p* = .378) explained was 5%, R^2 = .05, Adjusted R^2 = -. 06, *F change* (6, 50) = .41, *p* = .675. When cognitive function was added to the model in Block 4 the total variance explained by the model was 9%, R^2 = .09, Adjusted R^2 = -. 04, *F change* (7, 49) = 2.16, *p* = .661. Regression coefficients are presented in Table 3.

Table 3. Hierarchical regression *with LAPAQ as outcome measure*

	Model 1					**Model 2**					**Model 3**					**Model 4**	
	B	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*	*β*	*t*	*p*	*B*	*SE B*
Age	− .53	.48	− .15	-1.10	.28	− .54	.52	− .15	-1.04	.30	− .45	.53	− .12	− .84	− .45	− .60	.54
Years education	.76	.96	.11	.79	.43	.85	1.01	.12	.84	.41	.65	1.05	.09	.62	.6	.93	1.06
Handgrip						− .11	.33	− .05	− .34	.74	− .12	.34	− .05	− .36	− .121	− .02	.34
Number of medications						− .10	1.34	− .01	− .08	.94	.11	1.39	.01	.08	.11	.54	1.41
Depression											− .63	.70	− .17	− .89	.38	− .79	.70
Quality of life											− .23	.39	− .10	− .57	− .23	− .22	.39
MoCA																-2.06	1.40
R2	.04					.04					.05					.09	
F for change in R2	.98					.07					.39					2.16	

**p* = < .05, ***p* = < .005

Hierarchical Regression for Outcome 2 (Actigraph scores).

A second hierarchical regression was conducted for outcome 2 (Actigraph scores of PA minutes) and global cognitive function (MoCA). The model as a whole was not statistically significant R^2 = .19, Adjusted R^2 = .05, *F change* (7, 41) = 2.50, *p* =. 24. No independent variables made a statistically significant contribution to the model. Model 1 (age (*Beta* = 1.27, *p* = .56) and years of education (*Beta*= -1.19, *p* = .79)) accounted for .9 % of the variance in physical activity R^2 = .01, Adjusted R^2 = − .03, *F* change (2, 46) = .21, *p* =. 81. Model 2 (number of medications (*Beta* =-12.62, *p* = .04) and handgrip (*Beta* = .24, *p* = .87)) accounted for 11%, R^2 = .11, Adjusted R^2 = .03, *F change* (4, 44) = 2.41, *p* = .28. Model 3 (quality of life (*Beta* = 1.66, *p* = .34) and depression (*Beta* = 3.90, *p* = .20)) explained 14%, R^2 = .14, Adjusted R^2 = .20, *F change* (6, 42) = .86, *p* = .34. After the entry of the MoCA in model 4 (*Beta* = -9.37, *p* = .13) the total variance explained by the model as a whole was 19%, R^2 = .19, Adjusted R^2 = .05, *F change* (7, 41) = 2.46, *p* = .24. Regression coefficients are presented in Table 4.

Table 4.

Hierarchical regression with Actigraph as outcome measure

	Model 1					Model 2					Model 3					M 4	
	B	*SE B*	β	*t*	*p*	*B*	*SE B*	β	*t*	*p*	*B*	*SE B*	β	*t*	*p*	*B*	*SE*
Age	1.27	2.19	.09	.58	.56	2.62	2.23	.18	1.14	.25	2.08	2.28	.14	.91	.37	1.37	2.
Years education	-1.19	4.35	− .04	− .27	.79	-1.28	4.36	− .04	− .30	.77	− .17	4.51	− .01	− .04	.97	1.12	4.
Handgrip						.23	1.44	.03	.16	.87	.33	1.46	.04	.23	.82	.79	1.
Number of medications						-12.62*	5.81	− .33	-2.17	.04	-13.78*	5.98	− .36	-2.31	.03	-11.84*	6.
Quality of life											1.66	1.70	.18	.98	.34	1.67	1.
Depression											3.90	3.01	.26	1.29	.20	3.15	2.
MoCA																-9.37	5.
R2	.01					.11					.14					.19	
F for change in R2	.22					2.42					.86					2.46	

**p* = < .05, ***p* = < .005

Objective 2:

The mean minutes of PA per week were 51. 72 (+/-*SD* = 22.82) for the LAPAQ and 111 (*SD* = 94.30). for the Actigraph. Frequency data shows that 29% of participants achieved 150 minutes or greater of PA engagement per week versus 0% of participants according to LAPAQ data. Frequencies for the LAPAQ and Actigraph data are presented in Table 5.

Table 5.

Frequencies of PA minutes per week from Actigraph and LAPAQ data

	Actigraph		LAPAQ	
Minutes per week	N	%	N	%
0 -37.5 mins	15	24.2	18	29.5
37.6–75 mins	12	19.4	35	57.4
75.6–112.5 mins	1	1.6	8	13.1
112.6–150 mins	6	9.7	0	0
150 + mins	18	29	0	0
Total	52	83.9	61	100
Missing	10	16.1	1	1.6
Total	**62**	**100**	**62**	**100**

A One – Sample t Test showed that levels of PA engagement differed significantly from the recommended guidelines of 150 minutes per week (*M* = 111.38, *SD* = 94.29) as recorded using the Actigraph (*t* (51) = -2.95, *p* = .005), and the LAPAQ questionnaire (*M* = 51.70, *SD* = 22.80), *t* (61) = -33.94, *p* = < .001). Table 6 presents descriptive statistics for participants who achieved recommended levels of PA per week versus those who did not as measured using Actigraph data.

Table 6.

Means for Independent variables stratified by activity level according to Actigraph data

		Inactive (< 150 mins)			Active (≥ 150 mins)	
Variable	N	Mean	SD	N	Mean	SD
MoCA	34	22.97	2.15	18	21.28	2.65
Age	34	70.32	6.42	18	71.72	6.04
Years education	34	13.56	3.21	18	13.5	2.81
Number of medications	33	4.27	2.52	18	2.83	2.20
Handgrip	33	28.3	11.22	18	26.62	8.59
CES - D	32	10.06	6.65	17	9.65	6.86
DemQol	34	92.35	10.97	18	94.83	8.63
*Active denotes activity levels of 150 minutes or greater of PA per week.						

Objective 3:

The Spearman rho correlation coefficient showed a medium positive correlation between variables ($r = .33$, $n = 52$, $p = .015$) indicating a moderate level of agreement between the LAPAQ questionnaire and the Actigraph. A Bland - Altman scatterplot {Bland, 1986) to further investigate the level of agreement between measures of PA engagement (Fig. 1.) showed that the limits of agreement expressed using 95% confidence intervals were wide (240.84, -118.98), indicating that measures were not equivalent. A simple linear regression showed the presence of proportional bias ($M = 1.68$, $SD = 35.97$), indicating a high level of disagreement between measures ($R2 = .85$, $p = < .001$). A one sample t- test was used to demonstrate the mean bias between measures, where 0 indicates an ideal level of agreement between measures. In this case the mean difference was $M = 60.93$ ($SD = 91.79$) indicating the presence of bias and demonstrating a large level of difference between measures.

Discussion

This study found no associations between cognitive function and PA engagement as measured using either the Actigraph or LAPAQ. However, beta coefficients suggest some level of variance, although non – significant, in the effect of cognitive function on the outcome in both regressions after controlling for covariates, albeit higher in regression two where the outcome was objectively measured. This is also true of number of medications where the beta value was high in models two, three and four using Actigraph data as the outcome measure. Previous studies have reported a positive association between cognitive function, stage of MCI and PA engagement in MCI populations (Kobayashi et al., 2016; Stuckenschneider et al., 2018; Vancampfort et al., 2018). In comparison to previous studies however, the sample used here was small and lack of statistical power may account for the non - significant association in this case. Further research in larger samples of Irish adults with MCI is needed to overcome this limitation of this study. Therefore, with regard to the primary research hypothesis, based on this analysis we fail to reject the null hypothesis but suggest that further exploration is needed here.

Both subjective and objective measures of PA demonstrate that participants did not achieve 150 minutes of PA per week. Twenty nine percent of participants as recorded objectively and 0% of participants as measured subjectively engaged in 150 minutes. This is in contrast with previous MCI studies, two of which reported low/ no physical activity (< 150 minutes per week) in between 20–27 % of adults (Rovner et al., 2016; Vancampfort et al., 2018), and another which reported mean PA levels of between 164–270 minutes of PA per day (Stuckenschneider et al., 2018). Our findings indicate that PA engagement in this sample of Irish adults with MCI is much lower than in previously sampled MCI cohorts in other countries. However, PA engagement in Irish adults in general has also been found to be low. Murtagh et al (Murtagh et al., 2015) report that 62% of cognitively healthy Irish adults did not engage in 150 minutes of PA per week and this is supported by a recent report stating 67% of Irish adults over 18 years were achieving < 150 minutes per week (Factsheets., 2018.). The low level of PA engagement seen here may be reflective of normative population values among Irish adults. Studies of global levels of PA confirm that Irish adults are less physically active than their European (35% inactive), American (43% inactive), African (28% inactive) and Southeast Asian (17% inactive) counterparts (Hallal et al., 2012). This suggests a potential area for improvement in public health initiatives designed to address and promote brain health in ageing through increasing physical activity.

Finally, correlational analysis showed a moderate positive association between objective and subjective PA engagement measures. However, further assessment showed a high level of bias and lack of agreement between the measures, suggesting an overall lack of convergent validity There was a trend toward the difference between measures decreasing as the mean values get higher, suggesting that at lower levels of PA engagement there is less disagreement between measures. The level of variability would also suggest this is the case. Based on these findings, we fail to accept the null hypothesis that measures will be convergently valid. This overall finding contrasts with validity testing in non- impaired samples which has demonstrated moderate reliability between objective and subjective measures of PA (Durante & Ainsworth, 1996; Helmerhorst et al., 2012; Kowalski, Rhodes, Naylor, Tuokko, & MacDonald, 2012; Prince et al., 2008; Skender et al., 2015)

These findings may be due to the fact that the maximum value of the LAPAQ recorded was far below that recorded objectively. It may also suggest that participants in this sample under – estimated the level of PA that they engaged in, in support of Siebelings` finding that self – reported PA is prone to under – estimation in cognitively impaired populations (Siebeling, 2012), or did not accurately recall past activity. Given that the internal reliability of the LAPAQ was shown to be low in this sample, and that previous studies of PA in Irish samples, in addition to previous reports of PA engagement in MCI cohorts, were concurrent with the findings of levels of PA engagement as recorded via Actigraph (29 %), it is likely that objective measures of PA engagement are more accurate in this case.

Limitations

The sample size of this study was small, and the decision to adjust the Alpha value for multiple comparisons may have inflated the risk of type II error. Examination of effect sizes suggests the possible presence of an effect between the independent and dependent variables of interest which studies using larger samples may be better placed to detect.

Conclusions

It is recommended that future studies gather data from larger samples with the possible inclusion of comparison groups to enable more in- depth analysis that can further elaborate on the relative contribution of various factors on physical activity engagement in MCI. As MCI is often a pre- cursor to dementia, people with MCI are ideally placed to use physical activity as a way of delaying the progression of cognitive decline and/ or managing symptoms of cognitive decline. Therefore, health policy should address the low levels of PA in the population in general, with an added focus on adults with MCI who are at a greater risk of progressing to dementia and who may particularly benefit from the protective effects of regular PA engagement on brain health. Finally, objective measurement of PA engagement may be a more reliable method of measurement in adults with MCI, and research requiring PA measurement in this cohort should incorporate its use.

Abbreviations

MCI: Mild cognitive impairment

PA: Physical activity

MoCA: Montreal Cognitive Assessment

IADL: Instrumental activities of daily living.

LAPAQ: LASA Physical Activity Questionnaire

MVPA: moderate to vigorous physical activity

CES- D: Centre for Epidemiological Studies Depression

DemQoL: Quality of life in dementia

Declarations

Ethics approval and consent to participate

Ethical approval for this study was granted by SJH/AMNCH Research Ethics committee REC Ref 2015/09/04/ 2017- 05 List 17 (2) and was carried out in accordance with institution guidelines. Ethics approval was granted on 18/05/17. Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The dataset used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

LC conducted data analysis and drafted the manuscript. BL and JMcHP oversaw and contributed comments to the writing of the manuscript.

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Figures

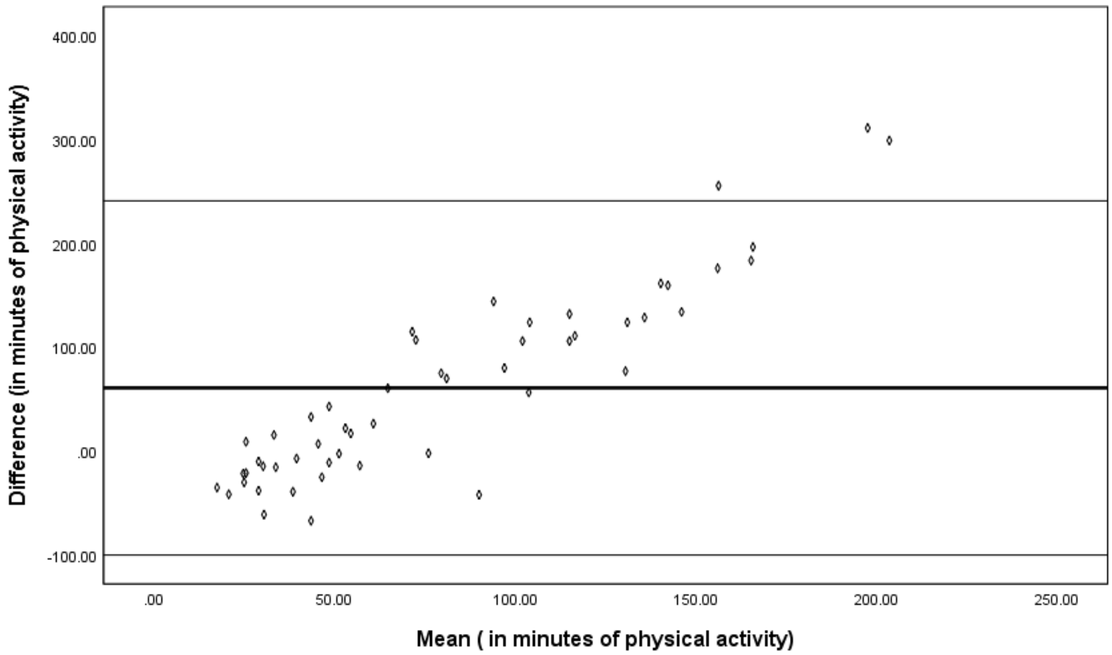

Figure 1

Bland – Altman scatterplot of agreement between Actigraph and LAPAQ measures

Supplementary Files

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