RADAR-AD

Evaluating simple objective metrics for the remote measurement of physical activity: preliminary results from the RADAR-AD study

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BACKGROUND

- Higher physical activity is associated with better global cognition and a lower risk of dementia (Rojer et al, 2021).
- Using questionnaires to assess physical activity is difficult in an Alzheimer's disease (AD) population, since questionnaires rely on retrospective subjective recall.
- Wearables measure physical activity passively, objectively and continuously, and are therefore expected to measure changes in physical activity more sensitively.

AIMS OF THE STUDY

1. To compare simple activity metrics from two activity trackers monitoring physical activity between different stages of Alzheimer's disease.
2. To relate these simple metrics to standard clinical questionnaires.

STUDY DESIGN

- During 8-weeks, participants wore 2 activity trackers (Axivity AX3 and Fitbit Charge 3). Scan the QR code on the top right to learn more about the design of the study.
- The Axivity gives raw acceleration data, which can be processed according to Doherty et al., 2017 to the following outcomes: acceleration magnitude, time spent in sedentary, light, moderate-to-vigorous activity, and sleeping
- The Fitbit gives processed data: step count and heart rate
- Standard questionnaires:
  - Global cognition (Mini-mental state examination, MMSE)
  - Self-reported activity levels (Godin Leisure Time Questionnaire, GLTQ)
  - Depression (Geriatric Depression Scale, GDS)
  - Partner-reported function (ADCS-ADL)
  - Neuropsychiatric symptoms (Neuropsychiatric Inventory, NPI-Q)

DATA & RESULTS

GROUP DIFFERENCES

	Healthy control	Preclinical AD	Prodromal AD	Mild-to-moderate AD	P-value
n	44	17	23	17	
Age	67 (7)	69 (7)	71 (7)	67 (10)	0.16
Female, n(%)	24 (55%)	13 (77%)	10 (44%)	9 (53%)	0.22
Education, y	15 (3)	15 (3)	14 (4)	13 (4)	0.17
Season, n					0.18
• Spring	• 15	• 1	• 5	• 7	
• Summer	• 13	• 6	• 9	• 5	
• Autumn	• 9	• 9	• 5	• 3	
• Winter	• 7	• 1	• 4	• 2	
Standard questionnaires					
MMSE, total	29 (1)	29 (1)	27 (2)	23 (3)	<0.01[b,c,d,e,f]
GDS	1 (2)	2 (2)	3 (3)	3 (2)	<0.01[a,b,c]
GLTQ	34 (25)	41 (33)	27 (20)	32 (27)	0.40
ADCS-ADL	76 (3)	76 (3)	72 (5)	64 (9)	<0.01[b,c,d,e,f]
NPI-Q	1.2 (1)	1.9 (1.8)	2.6 (2.7)	9.5 (17)	<0.01[c,e,f]
Activity trackers					
Acc magnitude, mg	24 (5)	20 (6)	22 (9)	24 (9)	0.24*
Sedentary, h/day	7.4 (1.5)	8.2 (1.2)	8.5 (2.4)	7.9 (2.2)	0.12*
Light activity, h/day	7.2 (1.5)	6.3 (1.5)	6.2 (2.3)	6.0 (2.4)	0.048*[c]
MVPA, h/day	0.4 (0.3)	0.4 (0.3)	0.4 (0.4)	0.5 (0.4)	0.73*
Sleep, h/day	9.0 (1.2)	9.2 (1.1)	9.0 (1.2)	9.6 (1.3)	0.36*
Number of steps, n	7156 (3222)	6980 (3318)	6891 (4402)	7264 (4379)	0.99*
Mean heart rate, BPM	72 (7)	71 (8)	68 (6)	68 (6)	0.04*[b,c]

Table 1: Numbers show mean(SD), unless specified otherwise. The season variable shows the number of participants started at: March to May (spring), June to August (summer), September to November (autumn), December to February (winter). Acc = acceleration, BPM = beats per minute, mg = milligravity, MVPA = moderate-to-vigorous physical activity.

ASSOCIATIONS WITH STANDARD QUESTIONNAIRES

	Axivity					Fitbit	
	Acc magnitude	Sedentary h/day	Light activity h/day	MVPA h/day	Sleep h/day	Step count	Heart rate BPM
Age	-0.3(0.09) p<0.001	8.1(2.22) P<0.001	-5.52(2.35) p=0.02	-0.57(0.44) p=0.20	-2.01(1.54) p=0.19	-94.08(46.25) p=0.04	-0.11(0.09) p=0.23
MMSE	0.3(0.23) p=0.20	-5.84(6.05) p=0.34	18.06(5.95) p=0.003	-0.27(1.15) p=0.82	-11.96(3.8) p=0.002	208.27(119.52) p=0.08	0.48(0.22) p=0.03
GDS	-0.25(0.32) p=0.44	8.36(8.5) p=0.33	-13.77(8.25) p=0.10	-1.89(1.52) p=0.22	7.3(5.24) p=0.17	-184.19(166.5) p=0.27	-0.68(0.31) p=0.03
GLTQ	0.04(0.03) p=0.12	-1.06(0.72) p=0.14	1.21(0.73) p=0.10	0.31(0.13) p=0.02	-0.46(0.47) p=0.33	42.88(13.63) p=0.002	0(0.03) p=0.99
ADCS-ADL	0.09(0.11) p=0.42	-5.36(2.87) p=0.07	7.81(2.79) p=0.01	0.28(0.52) p=0.59	-2.74(1.81) p=0.13	111.6(56.19) p=0.05	0.11(0.11) p=0.30
NPI-Q total	0.07(0.09) p=0.47	-1.17(2.45) p=0.63	0.61(2.51) p=0.81	0.04(0.46) p=0.93	0.52(1.61) p=0.75	17.28(48.86) p=0.72	-0.14(0.09) p=0.12

Table 2: Numbers show beta (SE), p-value, uncorrected for age and sex. Acc = acceleration, MVPA = moderate-to-vigorous physical activity, BPM = beats per minute. See study design for other abbreviations.

* Linear models corrected for age and sex.

[a,b,c,d,e,f] Significant difference between a) healthy control and preclinical AD, b) healthy control and prodromal AD, c) healthy control and mild-to-moderate AD, d) preclinical AD and prodromal AD, e) preclinical AD and mild-to-moderate AD, f) prodromal AD and mild-to-moderate AD

CONCLUSION

- Group differences were found for time spent in light activity and heart rate, but these differences were very minimal.
- Higher physical activity as measured with wearables is associated with lower age and higher global cognition. Self-reported activity is associated with moderate-to-vigorous activity and step count.
- On-going research in the RADAR-AD study will focus on developing disease-specific methods of feature extraction based on raw movement data, and combining features from multiple devices, to explore this further.