

# How physical activity influences cognitive function in population with cognitive impairment?



V. Cipollini, L. Narda, A. De Carolis, F. Giubilei, F. Troili

SETTE SANITARIO REGIONALE  
AZIENDA OSPEDALIERO-UNIVERSITARIA  
SANT'ANDREA

SAPIENZA  
UNIVERSITÀ DI ROMA

NESMOS Department, Faculty of Medicine and Psychology, Sapienza University of Rome, Rome, Italy

## Background/Aims

The effects of physical activity on various domains of cognitive function is an actively researched topic and several studies have shown that physical activity can have a role in both prevention and slowing down of disease progression in age-related diseases, including dementia and Alzheimer's disease (1,2).

The aim of our study was to identify the relationship between physical activity and cognitive functioning in a sample of non-selected outpatient subjects with cognitive impairment, representative of the real world. Moreover, we wanted to analyze the effect of other variables, such as social activity, working cognitive activity and education in cognitive performances of subject with cognitive impairment.

## Materials and Methods

## Results

### Subjects

One hundred and seventeen subjects with cognitive impairment were consecutively recruited. The demographic and clinical data of the subjects enrolled in the study are summarized in Table 1. The inclusion criteria were a diagnosis of cognitive impairment with mild to moderate severity (Mini Mental State Evaluation (MMSE) major than 14), a level of education major than three years, an age between 65 to 90 years old, Italian as mother tongue and the absence of other psychiatric and behavioral disorders.

### Neuropsychological assessment

All the subjects underwent a standard neuropsychological evaluation using a battery of tests to investigate global cognitive level, general intelligence, memory, executive functions, selective attention, language and constructive apraxia. The distribution of the performance above and below the cut-off was verified on the basis of the equivalent scores. For this purpose, all the raw scores of the NPS tests were first transformed into z-scores, based on the averages of the scores of the entire sample; subsequently an average performance value was obtained for each cognitive domain (Figure 2).

### Physical assessment

To quantify the level, duration and frequency of physical activity, we used the Physical Activity Scale for the Elderly (PASE) (Figure 1) (3). Moreover, other measures regarding the physical state of the subjects were collected including MUAC (mid upper arm circumference), waist circumference, calf circumference, height, weight and BMI (Body Mass Index) (Table 1). Finally, lifestyle measures such as the Florida Cognitive Activity Scale (FCAS) and the Lubben Social Network Scale (LSNS-6) were completed by patients and informants.

Partial correlation analysis showed that several cognitive domains correlate positively and significantly ( $p < 0.001$ ) with the level of habitual physical activity, especially intelligence ( $r=0.339$ ), selective attention ( $r=0.432$ ) and executive functions ( $r=0.507$ ), despite adjusting for potentially interfering variables such as age, education, level of cognitive activity and level of social relations (Table 2). Moreover, dependent variables analysis demonstrated that the level of habitual physical activity is a significant predictor of cognitive performance in all investigated cognitive domains, in particular general intelligence (18.3% of variance), speed of processing (15.5% of the variance), selective attention (25.7% of variance) and executive functions (33.3% of variance) (Table 3). Finally, according to the PASE score and considering the median value, we identified 2 groups of patients: "high physical activity" group (Group 0, 45 patients) and "low physical activity" group (Group 1, 72 patients). Group 1 compared to group 0 presented significantly better performance in different neuropsychological tests, including Raven's coloured progressive matrices (RCPM) test ( $p < 0.05$ ), Visual search test ( $p < 0.001$ ), Trial Making A ( $p < 0.001$ ), Trial Making BA ( $p < 0.001$ ), phonological fluency test ( $p < 0.05$ ), semantic fluency test ( $p < 0.033$ ), copy of Rey-Osterrieth complex figure (ROCF) test ( $p < 0.05$ ), immediate recall and delayed recall of Rey-Osterrieth complex figure test ( $p < 0.05$ ;  $p < 0.05$ ), BADA denomination test ( $p < 0.05$ ) and MMSE test ( $p < 0.05$ ) (Table 4).

Subjects with cognitive impairment (n=117)	
Sex (male/female)	66/52
Age (years)	75.3 ± 4.84
Education time (years)	9.77 ± 4.54
MMSE	25.76 ± 3.25
PASE	119.17 ± 55.35
Height	165.81 ± 9.1
Weight	71.74 ± 11.46
BMI	25.94 ± 3.52
Waist circumference	99.18 ± 11.3
MUAC	28.63 ± 3.05
Calf circumference (mean ± SD)	34.5 ± 3.31

DOMINIO	FUNZIONE	TEST
Cognitivo Globale		MMSE (Mini Mental Status Evaluation)
Intelligenza Generale		Matrici Progressive Colore di Raven
Funzioni esecutive	Flessibilità cognitiva/Working Memory	Test di Corsi + Digit Span (WAIS) + Fluente fonetica (F-P-L) - Trail Making B-A** - Falsi riconoscimenti /5 ***
Attenzione selettiva	Attenzione selettiva	Visual search - Test di cancellazione di cifre
Memoria a lungo termine (MLT)	Memoria verbale/episodica LT	Memoria di Prosa + Lista di parole di Rey rievocazione differita/2
	Memoria visuo-spaziale LT	Figura di Rey rievocazione differita
Memoria a breve termine (MBT)	MBT verbale	Lista di parole di Rey rievocazione immediata
	MBT visuo-spaziale	Figura di Rey rievocazione immediata
Speed processing	velocità di elaborazione	Trail making A
Prassia	abilità costruttive	Figura di Rey Copia
Linguaggio	sistema semantico-lessicale	Denominazione (BADA) Fluency semantica

Dependent Variables	Adjusted R <sup>2</sup>	F	P	B	β	t	P
General Intelligence	.183	26.978	<.001	.008	.436	5.194	<.001
Speed of Processing	.155	22.206	<.001	-.007	-.402	-4.172	<.001
Selective Attention	.257	41.097	<.001	.009	.513	6.411	<.001
Constructional Praxis	.120	16.885	<.001	.007	.358	4.109	<.001
Spatial STM	.052	7.341	<.05	.004	.245	2.709	<.05
Verbal STM	.098	13.627	<.001	.005	.325	3.692	<.001
Spatial LTM	.091	12.609	<.05	.005	.314	3.551	<.05
Verbal LTM	.076	10.522	<.05	.004	.290	3.244	<.05
Executive Functions	.333	58.916	<.001	.007	.582	7.676	<.001
Semantic Lexical system	.125	17.556	<.001	.004	.364	4.190	<.001

Table 1

Figure 1

Table 3

Cognitive Domains		PASE	Muscle Mass	Body Fat
General Intelligence	Correlation	.339	.019	-.074
	P	.000	.844	.436
	Df	111	111	111
Speed of Processing	Correlation	-.323	.006	-.007
	P	.000	.946	.941
	Df	111	111	111
Selective Attention	Correlation	.432	.023	-.094
	P	.000	.807	.323
	Df	111	111	111
Executive Functions	Correlation	.507	-.002	-.044
	P	.000	.984	.641
	Df	111	111	111
Spatial STM	Correlation	.207	.163	.123
	P	.028	.084	.194
	Df	111	111	111
Verbal STM	Correlation	.250	.053	-.012
	P	.008	.577	.896
	Df	111	111	111
Spatial LTM	Correlation	.246	.163	.115
	P	.009	.085	.226
	Df	111	111	111
Verbal LTM	Correlation	.206	.125	.055
	P	.029	.186	.562
	Df	111	111	111
Constructional Praxis	Correlation	.250	-.031	-.046
	P	.008	.747	.627
	Df	111	111	111
Semantic Lexical system	Correlation	.256	-.023	-.052
	P	.006	.747	.737
	Df	111	111	111
PASE	Correlation	1.00	.070	-.032
	P		.464	.737
	Df	0	111	111
Body Fat	Correlation	-.032	.581	1.00
	P	.737	.000	
	Df	111	111	0
Muscle Mass	Correlation	.070	1.00	.581
	P	.464	.000	
	Df	111	0	111

Table 2

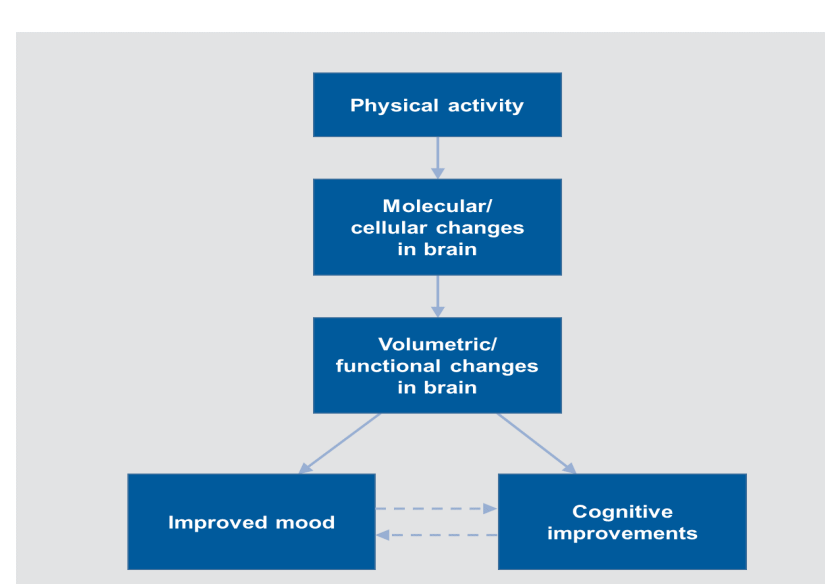
### References:

- Rathore A, Lom B. The effects of chronic and acute physical activity on working memory performance in healthy participants: a systematic review with meta-analysis of randomized controlled trials. Syst Rev. 2017;6(1):124.
- Farina, N., Rusted, J., & Tabet, N. The effect of exercise interventions on cognitive outcome in Alzheimer's disease: A systematic review. International. Psychogeriatrics, 2014; 26(1), 9-18.
- Washburn R. A., Smith K. W., Jette A. M., Janney C. A. The physical activity scale for the elderly (PASE): Development and evaluation. Journal of Clinical Epidemiology. 1993;46(2):153-162.

		Peso delle attività	Esempio
SVAGO	4.7	2	2 - Passeggiare, portare il cane a spasso, andare in bicicletta
	4.7	21	3 - Praticare attività fisica leggera come ginnastica dolce, pesca, ballo, caccia, ecc.
	4.7	23	4 - Praticare attività fisica moderata come ballo, caccia, ecc.
	4.7	23	5 - Praticare attività fisica pesante come tennis, calcio, ginnastica aerobica
	4.7	30	6 - Praticare ginnastica con attrezzi, fitness
ATTIVITA' DOMESTICA	4.8	25	1 - Praticare attività domestiche leggere come spolverare, lavare i piatti
	4.8	25	2 - Praticare attività domestiche pesanti come lavare pavimenti, spostare mobili
	4.8	30	3 - Eseguire piccole riparazioni
	4.8	36	4 - Eseguire lavori nell'orto come zappare o vangare
LAVORO	4.8	20	5 - Fare giardinaggio, curare i fiori
	4.8	35	6 - Prendersi cura di una persona
	4.9	21	Attività lavorative pagate o di volontariato, in cui cammina o fa lavori che richiedono uno sforzo fisico

## Conclusions

Our results support the hypothesis that a healthy and active lifestyle can make the brain of older people more plastic and more functional in different cognitive domains. Possible explanations for these results are that exercise has a nutritive influence on neuronal function and that "high physical activity" subjects may compensate better for cognitive deficits caused by the presence of neurodegenerative pathology.



Erickson et al. Dialogues Clin Neurosci, 2013

Neuropsychological test	Group	Mean ± SD	t	df	P
RCPM	Group 1	28.82 ± 5.93	3.261	115	.001
	Group 0	24.66 ± 7.16			
Visual Search test	Group 1	43.40 ± 10.42	4.214	115	.000
	Group 0	34.73 ± 11.08			
Trial Making test A	Group 1	63.09 ± 47	-4.751	89.7	.000
	Group 0	157.44 ± 157.67			
Trial Making test BA	Group 1	161.69 ± 178.66	-8.368	100.2	.000
	Group 0	466.58 ± 196.53			
Digit Span test	Group 1	5.17 ± 0.87	1.180	115	.240
	Group 0	4.92 ± 1.24			
Corsi Block test	Group 1	4.28 ± 0.69	1.761	115	.081
	Group 0	3.97 ± 1.05			
Prosa test	Group 1	9.57 ± 5.61	1.737	114	.085
	Group 0	7.91 ± 4.55			
Semantic Verbal Fluency test	Group 1	28.27 ± 9.51	2.163	115	.033
	Group 0	22.47 ± 7.51			
Phonological Verbal Fluency test	Group 1	26.82 ± 7.7	2.704	115	.008
	Group 0	22.78 ± 7.97			
ROCF Test (copy)	Group 1	31.62 ± 6.84	3.462	114	.001
	Group 0	25.86 ± 11.07			
ROCF Test (immediate recall)	Group 1	9.12 ± 6.73	.954	115	.342
	Group 0	7.84 ± 7.28			
ROCF Test (delayed recall)	Group 1	9.37 ± 7.02	2.137	115	.035
	Group 0	6.63 ± 6.56			
Verbal Rey Auditory Verbal Learning Test (immediate recall)	Group 1	32.3 ± 10.18	2.481	87.2	.015
	Group 0	27.65 ± 9.3			
Verbal Rey Auditory Verbal Learning Test (delayed recall)	Group 1	5.19 ± 3.92	1.298	115	.197
	Group 0	4.29 ± 3.42			
BADA denomination test	Group 1	27.91 ± 3.75	2.131	115	.035
	Group 0	26.4 ± 3.7			
MMSE	Group 1	26.19 ± 3.1	3.51	115	.001
	Group 0	24 ± 3.22			
Weight	Group 1	73.22 ± 12.87	1.105	115	.272
	Group 0	70.82 ± 10.47			
BMI	Group 1	26.08 ± 3.17	.325	115	.746
	Group 0	25.86 ± 3.73			
Body Fat Index	Group 1	124.5 ± 15.72	-.389	115	.698
	Group 0	125.52 ± 12.29			
Muscle Mass Index	Group 1	63.49 ± 5.39	.560	155	.577
	Group 0	62.9 ± 5.59			

Table 4