ORIGINAL ARTICLE

Relationship between Physical Activity and Cognitive Function in Older Population at High Risk of Dementia

HAFIZ MUHAMMAD WAQAS SIDDQUE[1], ISHFAQ QASIM[2], MUHAMMAD FARHAN AKHTAR[3], *MUHAMMAD ALI AZIZ[4]*
[1]Clinical Intern (Internal Medicine), King Edward Medical University/Mayo Hospital Lahore.
[2]MD, Clinical Intern, King Edward Medical University/Mayo Hospital Lahore.
[3]MD, Clinical Intern King Edward Medical University/Mayo Hospital Lahore.
[4]MD.
Correspondence to: Dr. Hafiz Muhammad Waqas Siddque, Email: wsmalghani@gmail.com, Cell: +923461292727

ABSTRACT

Dementia, a condition associated with multiple symptoms of mental deficit including personality changes, impaired reasoning and memory disorders (1). It is a grave concern in aging individuals. Multiple factors influence the onset and progression of this disease. Among those modifiable risk factors, physical activity has a significant role.

Objective: To determine whether physical activity has any effect on the mental health of elderly people prone to dementia.

Methodology: A cross-sectional type of study was performed in order to know the relationship between physical activity and cognitive function in older individuals of Lahore from April 2017 to June 2017. The study included about 85 participants, all of which were above 50 years of age. The measurement of physical activity was done with a standard questionnaire and Mini-Mental State Examination was used to assess the cognition. We analyzed the final data with help of SPSS version 23 and descriptive statistics e.g. percentage and frequencies were achieved and used to obtain the results.

Results: Out of 85 participants between 50 to 85 years of age, cognitive function was found to be influenced by the level of physical activities performed by them. Those who scored higher in Mini-Mental Stated Examination were physically more active than those who scored less. Participants who used walking as a mean of transportation were better oriented in time and place ($p=0.05$). They also had good memory and recall ($p<0.05$). People who walked more often responded better to the complex commands of Mini-Mental State Examination ($p=0.004$). Similarly exercise was associated with well orientation of participants who performed exercise 4 times a week ($p<0.05$).

Conclusion: It was found that regular physical activity had a protective effect on cognitive impairment and dementia in elderly persons. Moreover, the reduction in the physical activity level is associated with cognitive impairment.

Key words: Physical activity, Cognitive function, dementia.

INTRODUCTION

Dementia, a condition associated with multiple symptoms of mental deficit including personality changes, impaired reasoning and memory disorders (1). It is a grave concern in aging individuals. Multiple factors influence the onset and progression of this disease. Among those modifiable risk factors, physical activity has a significant role. Physical activity has overwhelming impact on the brains of people with forgetfulness (2). Besides improving psychological symptoms, physical activity provides nourishment to the brain cells by increasing blood perfusion.

A research conducted in 2014 developed concepts of impacts of functional tasks and activity on older individuals at high risk of Alzheimer's dementia. It was a Randomized Control Trial and showed that in older people exercise program is helpful in improving cognitive function. This program may act as highly effective intervention for group of people with mild cognitive dysfunction (3). In 2012, the research on the effects of exercise on signs and symptoms of dementia showed remarkable effect of exercise, a non-pharmacological intervention, on the brains of people with dementia by affecting their ill-temper and nervous excitement. It has been found that daily exercise for about half an hour has note-worthy effect on daunting symptoms of dementia. It could be a milestone in better prognosis of dementia (4).

A cross sectional study on physical activity & neurocognitive functioning concluded that physical activity not only enhances physical fitness but also cognitive fitness. It improved higher-level functions more than lower-level functions of brain (5). Micheal Valenzuela conducted a meta-analytic study in 2009 and showed that mental activity may be beneficial in preventing early appearance of symptoms of dementia and can lead to good brain health (6). Daniele, Kathrin Macpherson and Rockwood in 2001 studied that physical activity plays significant role in protection of older adults from cognitive impairment and dementia (7).

A randomized trial in 2004-2007 indicated improvement in cognition after a period of 6 months of physical exertion[2]. A research conducted in 2001 on relationship between physical activity (jogging) and cognition in older women showed that regular physical activity for a long period was associated with risk reduction of dementia and significantly improve the cognitive function (8). Similarly another study found that physical exertion prevents age related cognitive decline and neurodegenerative diseases (9). Another study in European Union and Israel, with almost 80,000 participants aged 50 years or older concluded that a decrease in BMI and a low body weight, both are associated with increase cognitive functions in this age group (10). Robert M. Pastula, Christine

B. Stopka, Anthony T. Delisle and Chris J. Hass conducted a study to see the effect of intense exercise on IQ of participants and found that an average of 8 IQ point improvement was seen after 2 months session of physical activity (strenuous exercise)[11].

This research aims at observing the effects of physical activity on cognition and finding out most probable factors resulting in debilitation of mental health. It also aims to find the most effective physical activity which can ameliorate the intellectual state. As a result, efforts can be made to maintain optimal brain health by improving physical exertion.

METHODOLOGY

We conducted a cross-sectional type of study of 3 months duration April 2017 to June 2017. For this study, 85 participants from Mayo Hospital Lahore who fulfilled the inclusion criteria were recruited by simple random sampling. Patients having risk factors of dementia i.e. hypertension, diabetes etc were preferred. For assessing physical activity, a questionnaire about work related, household and leisure time activities was formulated. Cognitive function was evaluated with the help of Mini-Mental State Examination (maximum score of 30 points). Participants were explained the benefits and possible risks and ensured that their personal information would be kept confidential. The response rate by the participants was 100%. Data was analyzed using SPSS (software package for statistical analysis) version 23. Descriptive analysis and cross tabs were used to obtain the result.

Study Design: Cross sectional study.
Study Duration: 3 months (April 2017 to June 2017).
Study Settings: Mayo Hospital Lahore
Sample Selection:

Inclusion Criteria:

- Both males and females are included in order to determine the sex distribution.
- Participants 50 years or older are included in the study.
- Those who can perform physical activity are included.

Exclusion Criteria:

- Those having chronic mental disorders like schizophrenia are excluded.
- Chronic alcoholics are not included in the study.
- Individual who are unable to perform physical activity due to some severe illness e.g. cardiac failure and metastatic cancer, are excluded.

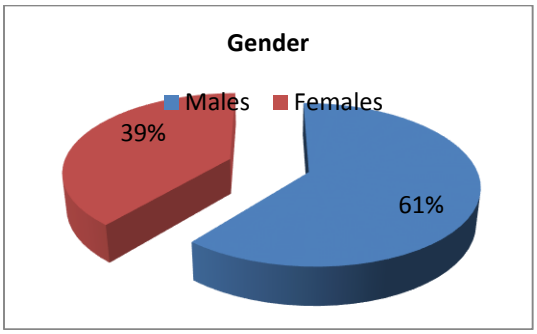
Sampling Technique: Simple Random Sampling Technique
Data Collection Tool: Questionnaire based

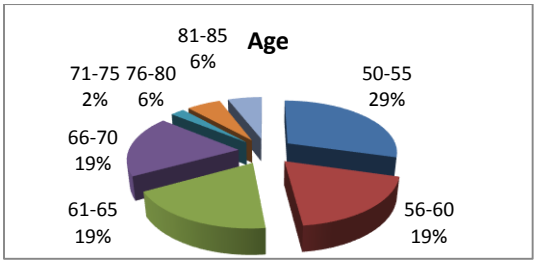
RESULTS

The gender ratio was 1.6 (52 males) to 1 (33 females).

Among 7 categories of age, 29.4% participants were between 51 to 55 years, 18.8% between 56 to 70 years, 18.8% between 61 to 65 years, 18.8% between 66 to 70 years, 2.4% between 71 to 75 years, 5.9% between 76 to 80 years and 5.9% between 81 to 85 years.

For the whole study group, 17.6% participants were educated up to primary level, 20% up to secondary level, 21.2% up to the higher level and 41.2% were uneducated.





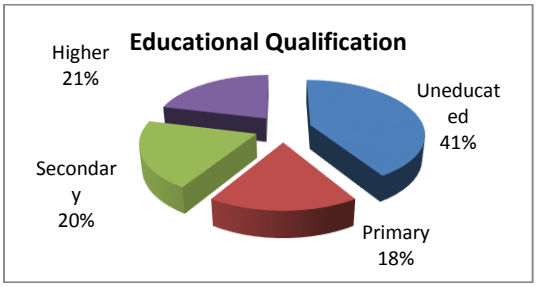


Table 1:

		Frequency	Percentage
1.	Gender		
	Male	52	61.19
	Female	33	38.79
2.	Age		
	51-55	25	29.4
	56-60	16	18.8
	61-65	16	18.8
	66-70	16	18.8
	71-75	2	2.4
	76-80	5	5.9
	81-85	5	5.9
3.	Education		
	Primary	15	17.6
	Secondary	17	20.0
	Higher	18	21.2
	Not educated	35	41.2

Table 2: Stairs Climbing per day

	Frequency	Percentage
None	28	32.9
1 to 5 times a day	40	47.1
6 to 10 times a day	13	15.3
11 to 15 times a day	4	4.7

Among the participants, 18.8% used car as a mode of transport while going to work, 23.5% used public transport, 18.8% used bike, 10.6% used cycle and 28.2 % walked to their work place. In case of stair climbing, 47.1% participants did it 1 to 5 times a day.

Table 3: Household activities

	None		1 to 3 hours a week		3 to 6 hours a week		6 to 10 hours a week		10 to 15 hours a week	
	f	%	f	%	f	%	f	%	f	%
Cooking	59	69.4	10	11.8	5	5.9	6	7.1	5	5.9
Shopping	26	30.6	23	27.1	23	27.1	11	12.9	2	2.4
Cleaning	63	72.9	13	15.3	5	5.9	3	3.5	2	2.4
Washing	67	78.8	8	9.4	9	10.6	0	0	1	1.2
Nursing	43	50.6	15	17.6	12	14.1	13	15.3	2	2.4
Caring	61	71.8	5	5.9	1	1.2	16	18.8	2	2.4

Table 4: Leisure time activities

		Frequency	Percentage
1.	Walking for pleasure		
	None	22	25.9
	Once a week	18	21.2
	2 times a week	21	24.7
	3 times a week	11	12.9
	4 times a week	13	15.3
2.	Racing or jogging		
	None	73	85.9
	Once a week	5	5.9
	2 times a week	4	4.7
	3 times a week	0	0
	4 times a week	13	15.3
3.	Gardening		
	None	47	55.3
	Once a week	13	15.3
	2 times a week	16	18.8
	3 times a week	3	3.5
	4 times a week	6	7.1
4.	DIY		
	None	52	61.2
	Once a week	22	25.9
	2 times a week	8	9.4
	3 times a week	3	3.5
	4 times a week	0	0
5.	Exercise		
	None	32	37.6
	Once a week	15	17.6
	2 times a week	20	23.5
	3 times a week	11	12.9
	4 times a week	7	8.2
6.	Any sport		
	None	83	97.6
	Once a week	1	1.2
	2 times a week	1	1.2
	3 times a week	0	0
	4 times a week	0	0

Mini Mental State Examination shows the cognitive function of participants as follows:

Table 5: Mini Mental State Examination

		Frequency	Percentage
1.	Time Orientation		
	0	2	2.4
	1	3	3.5
	2	16	18.8
	3	12	14.1
	4	14	16.5
	5	38	44.7
2.	Place Orientation		
	0	1	1.2
	1	2	2.4
	2	6	7.1
	3	7	8.2
	4	16	18.8
	5	53	62.4
3.	Registration		
	0	1	1.2
	1	7	8.2
	2	24	28.2
	3	53	62.4
4.	Calculation		
	0	11	12.9
	1	7	8.2
	2	3	3.5
	3	22	25.9
	4	7	8.2
	5	35	41.2
5.	Recall		
	0	8	9.4
	1	11	12.9
	2	24	28.2
	3	42	49.9
6.	Language		
	1	6	7.1
	2	79	92.9
7.	Repetition		
	0	5	5.9
	1	80	94.1
8.	Holding		
	0	2	2.4
	1	2	2.4
	2	11	12.9
	3	70	82.4
9.	Reading		
	0	22	25.90
	1	63	74.1
10.	Writing		
	0	33	38.8
	1	52	61.2
11.	Copying		
	0	54	63.5
	1	31	36.5

Among household activities, 11.8% participants do cooking almost 1 to 3 hours a week and 7.1% do 6 to 10 hours a week. 27.1% participants spend 1 to 6 hours a week in shopping. 15.3% people spend1 to 3 hours per week in cleaning while 10.6% 3 to 6 hours in washing. In case of nursing and caring the handicapped, 17.6% participants spend 1 to 3 hours a week and 18.8% spend 6 to 10 hours a week respectively.

Among leisure time activities, 24.7% participants do walk twice a week. 5.9% do jogging once a week. 18.8% people do gardening twice a week. DIY activities are done once a week by 25.9%. Exercise is practiced by 23.5% people twice a week. Whereas majority of participant don't do any kind of sports.

• Chi-square test to check the association between mode of transport and memory of respondents

i. Hypothesis

H_1: Mode of transport of respondents does affect their memory.

H_0: Mode of transport of respondents doesn't affect their memory.

ii. Level of Significance .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p-value is greater than 0.05.

iv. Computation

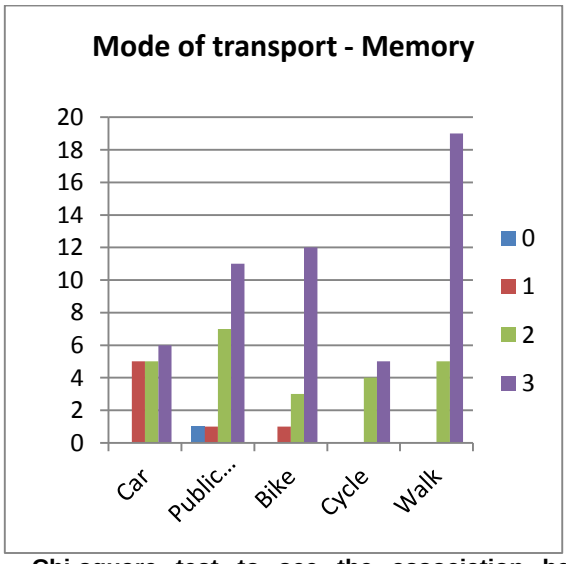
Table 6: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi Square Test	20.794[a]	12	0.053
Likelihood Ratio	18.994	12	0.089
Linear-by-Linear Association	10.379	1	0.001
Total Cases	85		

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is 0.09.

v. Decision

The calculated p-value of 0.053 is equal to 0.05 so null hypothesis is rejected meaning thereby mode of transport of respondents does affect their memory.



• Chi-square test to see the association between walking and time orientation of respondents

i. Hypothesis

H_1: Walking influences the time orientation of respondents.

H_0: Walking doesn't influence the time orientation of respondents.

ii. **Level of Significance** .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p-value is greater than 0.05.

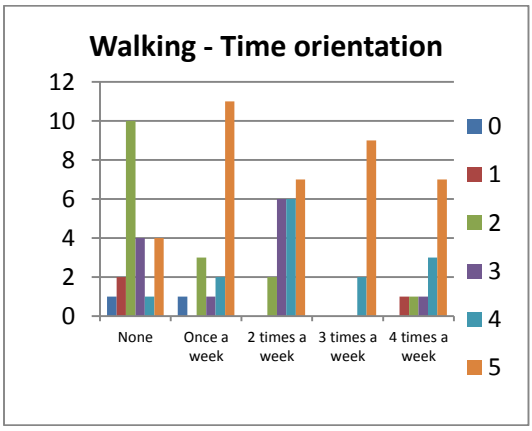
iv. Computation

Table 7: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.311[a]	20	0.008
Likelihood Ratio	42.102	20	0.003
Linear-by-Linear Association	12.857	1	0.000
Total Cases	85		

b. 26 cells (86.7%) have expected count less than 5. The minimum expected count is .26.

v. Decision The calculated p-value 0.008 is < 0.05 so null hypothesis is rejected meaning thereby walking influences the time orientation of respondents.



• Chi-square test to see the association between exercise and place orientation of respondents

i. Hypothesis

H_1: Exercise influences the place orientation of respondents.

H_0: Exercise doesn't influence the place orientation of respondents.

ii. **Level of Significance** .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p-value is greater than 0.05.

iv. Computation

Table 8: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.880[a]	20	0.05
Likelihood Ratio	31.204	20	0.053
Linear-by-Linear Association	.611	1	0.434
Total Cases	85		

c. 25 cells (83.3%) have expected count less than 5. The minimum expected count is .16.

v. Decision

The calculated p-value 0.05 so null hypothesis is rejected meaning thereby exercise influences the place orientation of respondents.

• Chi-square test to see the association between walking and reading ability of respondents

i. Hypothesis

H_1: Walking affects the reading ability of respondents.

H_0: Walking doesn't affect the reading ability of respondents.

ii. Level of Significance .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p. value is greater than 0.05.

iv. Computation

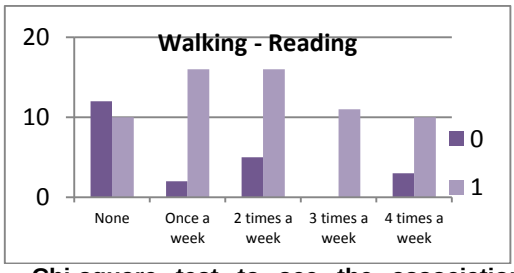
Table 9: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.411[a]	4	0.004
Likelihood Ratio	17.237	4	0.002
Linear-by-Linear Association	5.833	1	0.016
Total Cases	85		

d. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 2.85.

v. Decision

The calculated p-value 0.004 is < 0.05 so null hypothesis is rejected meaning thereby exercise affects the reading ability of respondents.



• Chi-square test to see the association between Shopping and recall of respondents

i. Hypothesis

H_1: Shopping affects the recall of respondents

H_0: Shopping doesn't affect the recall of respondents

ii. **Level of Significance** .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p-value is greater than 0.05.

iv. Computation

Table 10: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.404[a]	12	0.830
Likelihood Ratio	8.838	12	0.717
Linear-by-Linear Association	.905	1	0.342
Total Cases	85		

e. 13 cells (65.0%) have expected count less than 5. The minimum expected count is .19.

v. Decision

The calculated p-value 0.830 is > 0.05 so null hypothesis is not rejected meaning thereby shopping doesn't affect the recall of respondents.

• Chi-square test to see the association between DIY and calculation of respondents

i. Hypothesis

H_1: Calculation of respondents is influenced by DIY activities.

H_0: Calculation of respondents isn't influenced by DIY activities.

ii. **Level of Significance** .05

iii. Critical Region

The null hypothesis will be rejected if the calculated p-value is < 0.05 and fail to reject null hypothesis when p-value is greater than 0.05.

iv. Computation

Table 11: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.536[a]	15	0.007
Likelihood Ratio	37.428	15	0.001
Linear-by-Linear Association	12.604	1	0.000
Total Cases	85		

f. 19 cells (79.2%) have expected count less than 5. The minimum expected count is .11.

v. Decision

The calculated p. value 0.007 is less than 0.05 so null hypothesis is rejected meaning thereby Calculation of respondents is influenced by DIY activities.

Table 12: Caring of Pre-school children and Place orientation:

	Where are we now? State? Country? Town/City? Floor?						
Caring for pre-school children at home	**0**	**1**	**2**	**3**	**4**	**5**	**Total**
None	1	1	5	1	8	27	43
1 to 3 hours a week	0	1	1	1	3	9	15
3 to 6 hours a week	0	0	0	2	1	9	12
6 to 10 hours a week	0	0	0	1	4	8	13
10 to 15 hours a week	0	0	0	2	0	0	2
	1	2	6	7	16	53	85

P value = 0.03 which proves that there is a significant relation between caring of pre-school children and orientation in place.

DISCUSSION

Age brings with it a decline in physical activities which subsequently affect the performance in a multitude of cognitive tasks. These deficits have been found to be associated with reduced work-related activation in cerebral cortex of older population [9]. In our study, age related differences in cognitive function were observed in aged population in relation to the physical activity performed by them. This effect of physical activity on cognitive function in older population is supported by results of interventional studies that shows that elder people who have undergone a physical activity program often show enhanced cognitive performance [9]. Small sample size as a whole means that gender cannot be termed as significant predictor for cognitive decline.

In our study, people who used walking as a mean of transportation while going to work were mostly between 50 to 65 years of age while with increasing age people opted for car and public transport. This significantly affected their memory, with improved memory performances in those who walked to their work place. This finding is supported by Kramer et al.'s study that older adults after completing aerobic exercise program (walking) explained a significant improvement in cognition [12]. Walking for pleasure is another important factor which has pronounced effect on the cognition of older adults. In our study, it was found that people who did regular walk for almost 4 times a week had a better memory and recall. They also responded well to the complex commands of Mini Mental State Examination. A randomized control trial done in Netherland showed that walking program was efficacious in improving cognition and concentration [13]. Similarly a research by Jennifer also concluded that higher level of walking was associated with better cognitive function [14].

Exercise was performed by very few participants in our study as aging leads to narrowing of physical activities. So it did not have a statistically significant effect on the memory, recall, and concentration, reading and writing abilities of participants. Similar result was found in a research done in 2012 on the effect of activity on quality of life of older individuals [15]. Though a number of studies have concluded that exercise can enhance the cognitive performance by improving the health conditions [16, 17]. One statistically significant relation in our study was found between exercise and place orientation ($p < 0.05$). A cross-sectional study also found that the regular exercise is associated with psychological well-being of individuals [18].

Among the leisure time activities being asked from respondents, gardening, care of pre-school children and Do It Yourself (DIY) activities significantly affected the reading ability ($p= 0.01$) ,orientation in place ($p= 0.03$) and calculation skills ($p= 0.007$) respectively. A research done on retired people in 2009 also states that leisure time activities improve the cognitive function [19]. Another study states that an activity based and socially connected lifestyle in later life protects against the cognitive decline [20].However household activities were not found to have any effect on the mental functioning ($p >0.05$) of participants. Among the daily life activities, it was found that stairs climbing daily for more than 5 times is associated with better orientation in time. A study done in Canada also correlates to this finding [9].

There are few limitations that may have affected the results of our study. As we have approached a random sample of older individuals at Mayo hospital, 41% of them were uneducated. This might have influenced Mini-Mental State Score as many of them couldn't respond to the complex commands of Mini Mental State Examination like reading or writing. It is supported by the hypothesis that education is an important determinant of diversity in cognitive function in older individuals [21]. A study also correlates to this fact that higher education level correlates with the better scores to all cognitive tests. But these differences are particularly important in the case of numeracy and don't seem to be much important in the case of orientation in time [19].

Lastly, as questionnaire was the mode employed in our study, the bias related with the researches where questionnaires are the mode of data collection cannot be discounted.

CONCLUSION

Physical activity is related to non-specific or specific brain changes that are accompanied by improved cognitive function. Even in older age, participation in regular physical activity may postpone cognitive decline. Regular activities like walking not only enhance the physical fitness but also provide the maximum benefit to save or even improve the mental health level in older age. Those who have a sedentary lifestyle are at risk of developing degenerative disorders such as dementia. Our study suggests physical activity a potent protective factor for cognitive impairment in elderly population.

Recommendation: The findings of the current study are important for prevention against dementia. It is proposed that people should endorse different physical activities as a part of their life style to lessen the negative effect of aging on mind. A regular exercise per week should be performed to improve the cognition.

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