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Engaging in Cognitive Activities, Aging and Mild Cognitive Impairment: A Population-Based Study

Yonas E. Geda, MD, MSc, Hillary M. Topazian, Lewis A. Roberts, Rosebud O. Roberts, MB ChB, MS, David S. Knopman, MD, V. Shane Pankratz, PhD, Teresa J.H. Christianson, BSc, Bradley F. Boeve, MD, Eric G. Tangalos, MD, Robert J. Ivnik, PhD, and Ronald C. Petersen, MD, PhD

Department of Health Sciences Research, Divisions of Epidemiology (Drs. Geda, Petersen, and Roberts), Biomedical Statistics and Informatics (Ms. Christianson and Dr. Pankratz). Departments of Psychiatry and Psychology (Drs. Geda, Ivnik), Neurology (Drs. Boeve, Knopman, and Petersen), and Primary Care Internal Medicine (Dr. Tangalos), College of Medicine, Mayo Clinic, Rochester MN, USA. Wheaton University (Topazian), Chicago IL, Rice University, Houston, TX (LA Roberts) USA

Abstract

We investigated whether engaging in cognitive activities is associated with mild cognitive impairment (MCI) in a cross-sectional study derived from an ongoing population-based study of normal cognitive aging and MCI in Olmsted County, Minnesota. A random sample of 1321 nondemented study participants ages 70 to 89 ($n = 1124$ cognitively normal persons and $n = 197$ subjects with MCI) was interviewed about the frequency of cognitive activities carried out in late life (within one year of the date of interview). Computer activities [OR (95% CI) = 0.50 (0.36, 0.71); $p < .0001$], craft activities such as knitting, quilting, etc. [0.66 (0.47, 0.93); $p = 0.019$], playing games [0.65 (0.47, 0.90); $p = 0.010$], and reading books [0.67 (0.49, 0.94); $p = 0.019$] were associated with decreased odds of having MCI. Social activities such as traveling were marginally significant [0.71 (0.51, 1.00); $p = 0.050$]. Even though the point estimates for reading magazines, playing music, artistic activities, and group activities were associated with reduced odds of having MCI, none reached statistical significance. We could not expect to observe any difference between the two groups on the variable of reading newspapers since almost identical proportions of the two groups (97.4% of normals and 97.5% of the MCI group) were engaged in reading newspapers on a regular basis.

Keywords

cognitive activities; aging; mild cognitive impairment

Mild cognitive impairment (MCI) is the intermediate stage between the cognitive changes of normal aging and dementia¹. The reader is referred elsewhere for a detailed discussion of

Corresponding Author: Yonas E. Geda, MD, MSc. Associate Professor of Neurology and Psychiatry. College of Medicine, Mayo Clinic. 200 First Street SW, Rochester, MN 55905, USA. geda.yonas@mayo.edu.

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MCI^{2,3}. Subjects with MCI constitute a high risk group because they develop dementia at a rate of 10% to 15% per year compared with 1% to 2% per year in the general population⁴. In view of this, it is critical to identify potential protective factors against MCI. Previous studies have reported an association between cognitive activities and reduced risk of incident dementia⁵⁻⁷. However, little is known about the association between cognitive activities and the odds of having MCI. A convenience sample of a prospective cohort study involving community-dwelling elderly participants reported that baseline cognitive activities were associated with decreased risk of amnesic MCI⁸. There is a need to examine this question in a population-based setting using a larger sample.

We examined whether engaging in cognitive activities is associated with MCI in a cross-sectional study derived from an ongoing population-based study of normal cognitive aging and MCI in Olmsted County, Minnesota. Throughout this manuscript, one can interchangeably think of the phrase “cognitive activity” to be equivalent to “mental activity” or “intellectual activity”.

METHODS

SETTING

The detail of the design and conduct of the Mayo Clinic Study of Aging was reported elsewhere⁹. Briefly, it is an on-going population-based study of normal aging and MCI in Olmsted County, Minnesota. Elderly persons ages 70 to 89 on the prevalence date of October 1, 2004, were recruited by using a stratified random sampling from the target population of nearly 10,000 elderly individuals in Olmsted County, Minnesota. The sampling involved equal allocation of men and women in two age strata: 70 to 79 and 80 to 89 years old. During the first follow-up phase of the study, which took place between 2006 through 2008, we introduced a structured interview format to collect data on cognitive activities. 1,321 non-demented study participants completed the interview. At the time of the interview, neither the study participant nor the research personnel knew the case-control status of a participant. The classification of a study participant as having MCI or not was a downstream event to the collection of data on cognitive activities. The details of the classification process of MCI are discussed elsewhere in this paper. The study was approved by the institutional review boards of Mayo Clinic and the Olmsted Medical Center.

STUDY DESIGN

A population-based cross-sectional study involving 1,321 non-demented study participants (n = 197 subjects with MCI and n = 1,124 cognitively normal persons).

MEASUREMENT OF MCI

The association of interest in this study is between cognitive activities and the odds of having MCI. Each participant in the Mayo Clinic Study of Aging underwent the following three face-to-face evaluations: (1) neurological evaluation by a physician; (2) risk factor assessment by a nurse or study coordinator; and (3) neuropsychological testing that was interpreted by a neuropsychologist. The interview by the nurse or study coordinator included administration of the Clinical Dementia Rating Scale¹⁰ to the participant and to an informant. The neurological evaluation was performed by a physician and included administration of the Short Test of Mental Status¹¹, medical history review, and a complete neurological examination.

Neuropsychological testing was performed to assess four cognitive domains: (1) memory (Logical Memory-II [delayed recall] and Visual Reproduction-II [delayed recall] from Wechsler Memory Scale-Revised, and delayed recall from the Auditory Verbal Learning

Test)¹²⁻¹⁵; (2) executive function (Trail Making Test B¹⁶, and Digit Symbol Substitution from Wechsler Adult Intelligent Scale-Revised); (3) language (Boston Naming Test¹⁷, and category fluency)¹⁸; and (4) visuospatial skills (Picture Completion and Block Design from WAIS-R).

We considered as cases all the participants who met the revised Mayo Clinic criteria for MCI: (1) cognitive concern expressed by a physician, informant, participant, or nurse; (2) cognitive impairment in one or more domains (executive function, memory, language, or visuospatial); (3) normal functional activities; and (4) not demented^{2, 3}. Subjects with MCI could have a Clinical Dementia Rating Scale score of 0 or 0.5; however, the final diagnosis of MCI was not based exclusively on the clinical dementia rating, but rather on all available data. The diagnosis of normal cognition, MCI, dementia, or Alzheimer's disease was made by an expert consensus panel of physicians, psychologists, and nurses based on published criteria^{12, 13, 19-21}. The panel meets once per week and reviews three independent sources of data, i.e., the clinical data collected by behavioral neurologists and physicians of other specialties with expertise in dementia and MCI, neuropsychological data collected by psychometrists who are supervised by neuropsychologists, and nursing data gathered by research nurses⁹.

MEASUREMENT OF COGNITIVE ACTIVITIES

We defined the exposure of interest to be reading, craft activities, computer activities, playing games, playing music, group activities (e.g., book club), social activities (e.g., going out to movies and theaters), artistic activities, and watching television. We modified previously validated instruments to measure these activities^{6, 22, 23}. A research nurse or psychometrist interviewed each participant by using a structured survey with ordinal responses (e.g., reading books at a frequency of once per week, twice per week, etc.) The participants were asked to provide information about these activities within a year of the date of interview (late life cognitive activity). The measurement of cognitive activities was conducted along with neurological evaluation, neuropsychological assessment and risk factor ascertainment. Once these data were collected, then a consensus panel of experts classified the study participant to be cognitively normal or to have MCI.

MEASUREMENT OF COVARIATES

In addition to traditional confounders (age, sex, and education), we also defined medical comorbidity and depression to be covariates for the purpose of this study. We measured medical comorbidity by using the Charlson index, which is a widely used weighted index that takes into account the number and severity of diseases. Thus for each unit increase in Charlson index, there is a stepwise increase in the cumulative mortality attributable to the comorbid medical disease²⁴. We measured depression by using the Beck Depression Inventory-II²⁵. Additionally, we adjusted for physical exercise by assigning a numeric score to frequency of physical exercise and adding the scores across the light, moderate, and vigorous strata (equal weighting to all strata). The details of the physical exercise measurement were reported elsewhere²⁶.

STATISTICAL ANALYSIS

Multi-variable logistic regression analyses were conducted to examine the strength of association of cognitive activities with the odds of having MCI by computing odds ratios and corresponding 95% confidence intervals. The primary analysis was conducted by adjusting for traditional confounders (age [continuous variable], sex, and education [continuous variable]). We also conducted secondary analysis by adjusting for medical comorbidity (weighted Charlson index as a continuous variable), depressive symptoms (BDI-II score <13 versus ≥13), and physical exercise (continuous variable).²⁶

The frequency of each activity was dichotomized as none (once per month or less) versus any other frequency. We considered watching television to be hypothetically less beneficial, therefore watching TV was “reverse” scored, i.e., watching more television (>6 hours/day) versus watching less (\leq 6 hours/day).

Analyses were conducted for cognitive activity carried out in late life (within the past one year). Statistical testing was done at the conventional 2-tailed alpha level of 0.05. All analyses were performed by using SAS (Cary, NC).

RESULTS

Table 1 summarizes the demographic data. There were 1,321 non-demented study participants ($n = 1,124$ cognitively normal persons, $n = 197$ subjects with MCI). Among the cognitively normal group (normals), there were an equal number of males and females, whereas among the MCI group there were more males than females. On average, the MCI group was older than the normal group. The two groups also significantly differed in education, medical comorbidity, and depressive symptoms. Therefore, in the primary analysis the comparison of engaging in cognitive activities between the two groups was made after adjusting for age (continuous variable), sex, and education (continuous variable). In a secondary analysis, we also adjusted for depressive symptoms, medical comorbidity and physical exercise.

Table 2 displays the data comparing the two groups as measured by OR (95% CI). Reading books [0.67 (0.49, 0.94)], playing games [0.65 (0.47, 0.90)], craft activities (quilting, pottery, etc.) [0.66 (0.47, 0.93)], and computer activities [0.50 (0.36, 0.71)] were significantly associated with decreased odds of having MCI. The point estimate for social activity (e.g., going out with friends) was also associated with decreased odds of having MCI, but this association was marginally significant [0.71 (0.51, 1.00)].

The point estimates for reading magazines [0.81 (0.49, 1.32)], playing music [0.79 (0.50, 1.25)], artistic activities [0.81 (0.49, 1.32)], and group activities [0.88 (0.64, 1.22)] were associated with reduced odds of MCI; however, none reached statistical significance. The only exception to the overall trend was the cognitive activity of reading newspapers. The OR for reading newspapers [1.13 (0.43, 2.99)] was suggestive of increased odds of having MCI; however, close examination of the data indicates that almost identical proportions of the two groups engaged in regular newspaper reading (97.4% of the cognitively normal group vs 97.5% of the MCI group were reading newspapers on a regular basis).

We considered watching television to be a hypothetically less beneficial activity, therefore watching TV was “reverse” scored, i.e., watching more television (>6 hours/day) versus watching less (\leq 6 hours per day). We observed that watching less TV was associated with decreased odds of MCI [OR (95% CI) = 0.48 (0.27, 0.86); $p = 0.013$].

In the secondary analysis, additional adjustment for depressive symptoms, medical comorbidity and physical exercise did not affect the significance level observed in the primary analysis (data not shown).

DISCUSSION

In this population-based cross-sectional study we observed that cognitive activities such as computer use, playing games, reading books, craft activities (quilting, knitting, etc.) and watching less TV were associated with 30% to 50% reduced odds of having MCI. Social activities such as traveling were marginally significant. Even though the point estimates for reading magazines, playing music, artistic activities, and group activities were associated

with reduced odds of having MCI, none reached statistical significance. Almost identical proportions of the two groups were engaged in reading newspapers on a regular basis, therefore we could not observe a significant difference between the two groups.

Several studies have reported the association of cognitive/intellectual or ‘mental’ activities with decreased risk of incident dementia⁵⁻⁷. However, little is known about the association of cognitive activities with MCI. The Bronx Aging Study prospectively followed a convenience sample of 437 community-dwelling cognitively normal elderly persons ages 75 and older to the outcome of incident amnesic MCI⁸. During the median follow-up duration of 5.7 years, there were 58 subjects who developed incident amnesic MCI. The investigators noted that a unit increase in cognitive activity was associated with a 5% decreased risk of incident amnesic MCI. Even though the Bronx study was a convenience sample, the prospective study design would enable one to make some degree of etiologic inferences. The investigators retrofitted the MCI criteria; hence this might have potentially led to misclassification errors. Although our study is population-based, the cross-sectional design does not allow one to make etiologic inferences. Therefore, the observations made in our current study need to be tested on a larger sample in a prospective cohort design.

The findings of our study should be interpreted within the context of the following limitations. The first limitation pertains to study design. Since this was a cross-sectional study, we cannot determine the direction of causality between the hypothesized exposure of interest (i.e., cognitive activity) and the hypothesized outcome of interest (i.e., MCI). Second, like any survey based study, recall bias is a potential limitation. This is even more relevant to participants with MCI; however, at our center the data on cognitive activities are collected prior to determination of whether a person has MCI or not. Therefore, neither the participant nor the research personnel knew the case control status of the participant at the time of administration of the cognitive activities questionnaire. This likely minimized bias, but could not eliminate it. Additionally, in the past we had reported that the test-retest correlations were similar among subjects with normal cognition and MCI²⁶.

Our study did not address mechanism of action. However, the possible beneficial impact of cognitive activities as discussed in the literature is worth mentioning. Engaging in cognitive activities may be a marker for an overall healthy lifestyle, e.g., a person who likes to read books on a regular basis may also engage in an overall healthy lifestyle that includes exercise, diet, and stress management. Another possible explanation is related to the brain/cognitive reserve hypothesis^{27, 28}. Engaging in cognitive activity is more likely to reinforce and perhaps stimulate the formation of various neuronal networks in the brain²⁸ that can buffer against dementia and Alzheimer’s disease²⁹. This argument is supported by both basic science and clinical research. For instance, animals with enriched environments are protected against cognitive impairment^{28, 30}. Additionally in clinical settings it is also observed that clinical manifestations may not correlate with the neuropathological burden on postmortem examination^{6, 31-33}, implying that the cognitive reserve may serve as a buffer against the Alzheimer’s disease neuropathological burden. Since MCI is considered to be a prodromal state to Alzheimer’s disease, one can invoke the cognitive reserve theory to explain the inverse association between cognitive activities and the odds of having MCI. Yet, another potential mechanism pertains to the classic stress model proposed by Sapolsky and colleagues³⁴. According to this model, the hippocampus, which is the epicenter of the memory network³⁵, has a number of glucocorticoid receptors. These receptors are down regulated in excessively stressful situations. Thus, cognitive activities may serve as stress modifying agents, leading to decreased “neurotoxic” insult to the hippocampus and related structures pertinent to cognition and emotion.

In summary, our findings contribute to the growing body of literature that indicates that cognitive activities are associated with decreased odds of having MCI. A future prospective population-based cohort study needs to confirm whether cognitive activity is associated with a decreased risk of incident MCI. We are following a large cohort of cognitively normal persons to the outcome of incident MCI; thus we will be able to test the observation made from the current cross-sectional study. The population based setting will improve generalizability, and the prospective cohort will strengthen etiologic inferences.

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Table 1

Demographic Characteristics of Study Participants

| Variable | Normal (N = 1,124) | MCI (N = 197) | P-value |
|--|--------------------|---------------|---------|
| Men, n (%) | 564 (50.2) | 116 (58.9) | 0.024 |
| Age, years ^a | 80 (72-93) | 83 (72-93) | <0.001 |
| Education, years ^a | 13 (6-20) | 12 (6-20) | 0.001 |
| >12 years, n (%) | 651 (57.9) | 91 (46.2) | |
| BDI-II Depression (≥ 13) ^b | 62 (5.5) | 29 (14.8) | <0.001 |
| Charlson Index ^c | 2 (1-5) | 3 (2-6) | <0.001 |

^aMedian (range).

^b1 patient missing BDI (1 MCI).

^cMedian (interquartile range).

Table 2

Cognitive Activities Carried Out Within 1 year of the Date of Interview

| Activity | Normal (N=1124) N (%) | MCI (N=197) N (%) | OR (95% CI) ^a | P-value |
|---------------------|-----------------------|-------------------|--------------------------|---------|
| Reading newspapers | 1095 (97.4) | 192 (97.5) | 1.13 (0.43, 2.99) | 0.81 |
| Reading magazines | 1033 (91.9) | 174 (88.3) | 0.81 (0.49, 1.32) | 0.39 |
| Reading books | 776 (69.1) | 111 (56.3) | 0.67 (0.49, 0.94) | 0.019 |
| Play games | 795 (70.7) | 118 (59.9) | 0.65 (0.47, 0.90) | 0.010 |
| Play music | 203 (18.1) | 25 (12.7) | 0.79 (0.50, 1.25) | 0.31 |
| Artistic activities | 159 (14.1) | 21 (10.7) | 0.81 (0.49, 1.32) | 0.39 |
| Craft activities | 455 (40.5) | 57 (28.9) | 0.66 (0.47, 0.93) | 0.019 |
| Group activities | 456 (40.6) | 71 (36.0) | 0.88 (0.64, 1.22) | 0.45 |
| Social activities | 871 (77.5) | 134 (68.0) | 0.71 (0.51, 1.00) | 0.050 |
| Computer activities | 549 (48.8) | 58 (29.4) | 0.50 (0.36, 0.71) | <0.001 |

^aOR, odds ratios and CI, confidence intervals were computed by comparing frequencies of activities carried once a month or less (reference) versus any other frequency of activity. Findings are Adjusted for age, sex, and education. Secondary analysis also adjusted for, depression, medical comorbidity (Charlson index) and physical exercise. We did not observe any significant difference from the primary analysis (data not shown).