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ORIGINAL CONTRIBUTIONS

Late-Life Engagement in Social and Leisure Activities Is Associated with a Decreased Risk of Dementia: A Longitudinal Study from the Kungsholmen Project

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Recent findings suggest that a rich social network may decrease the risk of developing dementia. The authors hypothesized that such a protective effect may be due to social interaction and intellectual stimulation. To test this hypothesis, data from the 1987–1996 Kungsholmen Project, a longitudinal population-based study carried out in a central area of Stockholm, Sweden, were used to examine whether engagement in different activities 6.4 years before dementia diagnosis was related to a decreased incidence of dementia. Dementia cases were diagnosed by specialists according to *Diagnostic and Statistical Manual of Mental Disorders,* Third Edition, Revised, criteria. After adjustment for age, sex, education, cognitive functioning, comorbidity, depressive symptoms, and physical functioning at the first examination, frequent (daily-weekly) engagement in mental, social, or productive activities was inversely related to dementia incidence. Adjusted relative risks for mental, social, and productive activities were 0.54 (95% confidence interval (CI): 0.34, 0.87), 0.58 (95% CI: 0.37, 0.91), and 0.58 (95% CI: 0.38, 0.91), respectively. Similar results were found when these three factors were analyzed together in the same model. Results suggest that stimulating activity, either mentally or socially oriented, may protect against dementia, indicating that both social interaction and intellectual stimulation may be relevant to preserving mental functioning in the elderly. *Am J Epidemiol* 2002;155:1081–7.

aged; dementia; incidence; leisure activities; risk factors

A positive effect of physical activities on survival has long been recognized (1–4); more recently, a similar effect was also reported for social and productive activities (5). Social disengagement has been suggested as a possible risk factor for cognitive decline in elderly persons (6–9). In a Swedish community-based study, the Kungsholmen Project, a rich social network showed a protective effect against dementia (10).

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Abbreviations: *APOE*, apolipoprotein E (genotype); CI, confidence interval; ICD-8, *International Classification of Diseases,* Eighth Revision; ICD-9, *International Classification of Diseases,* Ninth Revision; MMSE, Mini-Mental State Examination; RR, relative risk.

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The specific effects of social and leisure activities on dementia have been investigated in only two known case-control (11, 12) and two follow-up studies (13, 14). These studies found that an inactive life was related to a higher risk of dementia. However, case-control studies have been criticized because of the presence of selection and recall biases. Follow-up studies have been hampered by the fact that subjects in the early phases of dementia could reduce their activities because of initial cognitive impairment, depressive symptoms, or other dementia-related disorders.

The present study aimed to further explore the relation between social and leisure activities and the development of dementia and to verify whether the suggested protective effect of a rich social network might be due to social interaction or intellectual stimulation. The Kungsholmen Project's database gathered information on mental, physical, social, productive, and recreational activities, collected at baseline on average 6 years before dementia diagnosis. Engagement in these activities was related to the incident dementia occurring between the first and second follow-up examinations of

subjects cognitively intact at baseline and still nondemented 3 years later (first follow-up). Cognitive functioning, depressive symptoms, physical functioning, and comorbidity of the subjects when their engagement in social and leisure activities was assessed were taken into account. To explore the mechanisms underlying the reported association between social network and dementia (10), the leisure activities were divided into predominately intellectual, physical, social, productive, and recreational categories.

MATERIALS AND METHODS

Study population

All inhabitants of the Kungsholmen district of Stockholm, Sweden, aged 75 years or more in October 1987 were asked to participate in the initial examination of the Kungsholmen Project. Participants were interviewed by nurses, examined by physicians, and tested by psychologists during the baseline (1987–1989), first follow-up (1991–1993), and second follow-up (1994–1996) examinations.

Figure 1 illustrates the study population, time of detection of dementia cases, and assessment of engagement in social and leisure activities. Of the 1,810 eligible participants who underwent the baseline examination, 1,473 were diagnosed as nondemented. The detailed procedure has been described elsewhere (15, 16). Because impaired cognition or institutionalization may limit subjects' activity (8), 98 subjects whose Mini-Mental State Examination (MMSE) scores were less than 23 or who were living in an institution were excluded from the present study; 1,375 persons remained for analysis. Of these subjects, 269 died, 172 refused participation, and 934 participated in the first follow-up examination. Of these 934 subjects, 158 were diagnosed as demented. The population for the present study was composed of those 776 subjects still nondemented at the first follow-up examination. Because 44 refused to participate, a cohort of 732 nondemented subjects was followed for another 3 years (second follow-up) to detect incident dementia cases.

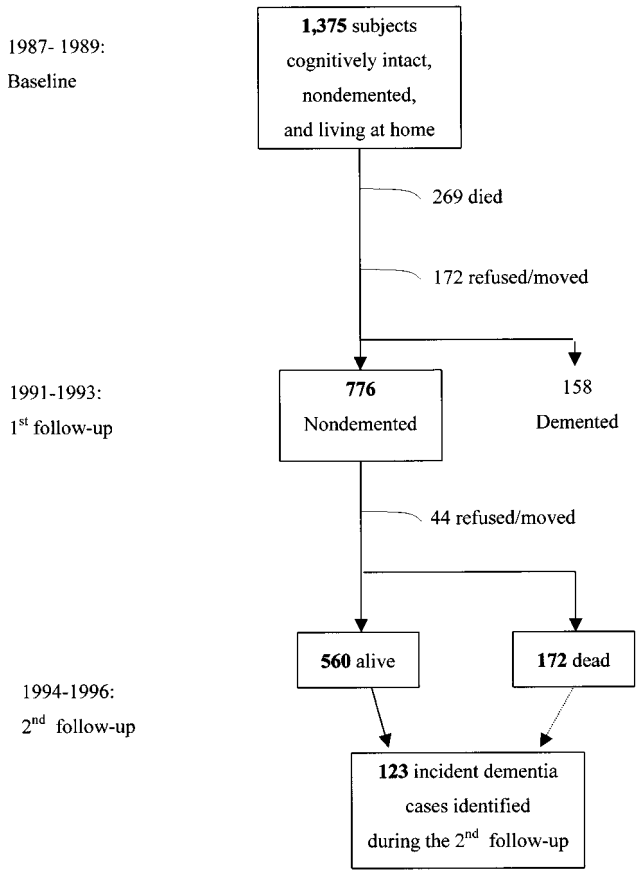

FIGURE 1. Study population, the Kungsholmen Project, Stockholm, Sweden, 1987–1996. During the baseline phase of the study, current engagement in different activities was assessed. Incident dementia cases were identified by clinical examination of the survivors and, for deceased subjects, by using clinical records and death certificates.

Incident dementia cases

The incident dementia cases examined in this study were those subjects who developed dementia during the second follow-up period. Time of dementia onset was assumed to be the midpoint between the first and second follow-up examinations or the time of death. At each examination, all cohort subjects were clinically examined following a standardized protocol, which included family and personal history collected by nurses, clinical examination conducted by physicians, and psychological tests administered by trained personnel. If a subject was unable to answer, an informant, usually the subject's next of kin, was interviewed. Details on the study design are available elsewhere (15, 16).

The diagnosis of dementia was made according to criteria specified in the *Diagnostic and Statistical Manual of Mental Disorders*, Third Edition, Revised (17) following the same three-step diagnostic procedure used during the baseline examination (18). Two physicians made the preliminary diagnoses independently. Concordant diagnoses were accepted as final diagnoses, and a third opinion was requested in case of disagreement.

If the subject had moved, he or she was traced and asked to participate in the follow-up examination. For those subjects who had died before the follow-up examination (172 died between the first and second follow-up examinations), information regarding their health status was obtained from the computerized inpatient register system, a registry of discharge diagnoses from all hospitals in Stockholm since 1969. Individual hospital records and discharge diagnoses, as well as death certificates, were collected and examined.

Assessment of social and leisure activities

Information on social and leisure activities was obtained from subjects by means of a personal interview carried out by trained nurses during the first examination. Subjects were asked 1) whether they regularly engaged in any particular activities or participated in any organizations, 2) to specify the types of activities or organizations, and 3) to report the frequency of participation.

Social and leisure activities were grouped following the classification adopted in previous studies (5, 6, 8). Mental activity includes reading books/newspapers, writing, studying, working crossword puzzles, painting, or drawing. Physical activity encompasses swimming, walking, or gymnastics. Social activity consists of attending the theater, concerts, or art exhibitions; traveling; playing cards/games; or participating in social groups or a pension organization. Productive activity is composed of gardening, housekeeping, cooking, working for pay after retirement, doing volunteer work, or sewing, knitting, crocheting, or weaving. Recreational activity includes watching television or listening to the radio.

A subject belonged to a group if he or she participated in at least one of the group's listed activities. A person was considered to be in different groups if he or she participated in two or more groups of activities. Frequency of participation was recorded as daily, weekly, monthly, or annually.

Potential confounders

Age, sex, education, cognitive functioning, comorbidity, depressive symptoms, and physical functioning at the baseline examination were taken into account as potential confounders in the present study. Information on age and sex was obtained from the Kungsholmen Municipality. Education was assessed according to the highest level of schooling reported by the subject. Cognitive functioning was evaluated by using the MMSE (19). Depressive symptoms were assessed by using self-reported symptoms such as often feeling lonely and being in a low mood. Physical functional dependence was defined as disability regarding at least one of the basic activities of daily living: bathing, dressing, toileting, continence, feeding, or walking (20).

Previous diseases were ascertained by reviewing the hospital discharge diagnoses using the Stockholm computerized inpatient register system. Disease diagnoses were based on the *International Classification of Diseases,* Eighth Revision (ICD-8) (21), as follows: coronary heart disease (ICD-8 codes 410–414), cerebrovascular disease (ICD-8 codes 430–438), diabetes mellitus (ICD-8 code 250), malignancy (ICD-8 codes 140–208 and 230–239), and hip fracture (ICD-8 code 820). Comorbidity was considered the presence of any of these disease categories. Because this comorbidity variable took into account only those diseases that resulted in hospitalization, we repeated all analyses by using a new "comorbidity variable" derived from the data collected by the physician during the second clinical examination. The physician diagnosed diseases according to the *International Classification of Diseases,* Ninth Revision (ICD-9) (22), as follows: cardiovascular diseases (ICD-9 codes 390–398, 401–429, and 440–459), cerebrovascular diseases (ICD-9 codes 430–438), diabetes mellitus (ICD-9 code 250), malignancy (ICD-9 codes 140–208), and hip fracture (ICD-9 code 820). The new comorbidity variable was defined as the presence of any of these disease categories. Because results were similar, we used only baseline, hospital-based comorbidity data.

Social network included marital status, living arrangements, parenthood, and close social ties that defined the structure of social connections. Frequency of and satisfaction with these connections represented the perceived adequacy of the social network. Both the structure and perceived adequacy of the social network were integrated in a single index that consisted of the following four categories (10):

1. Extensive social network: a) being married and living with someone, b) having children and having daily to weekly satisfying contacts with them, and c) having relatives and/or friends and having daily to weekly satisfying contacts with them
2. Moderate social network: having any two of these three conditions
3. Limited social network: having any one of these three conditions
4. Poor social network: being single and living alone; no children and no close social ties

Statistical analysis

Logistic regression analysis was used to examine differences between participants and study dropouts. To take into account the different follow-up times, Cox proportional hazards models were used to estimate the relative risks and corresponding 95 percent confidence intervals for the social and leisure activities associated with development of dementia. All analyses were performed by using SPSS software (Statistical Package for Social Sciences; SPSS, Inc., Chicago, Illinois).

First, engagement in each type of activity was analyzed in relation to the incidence of dementia by examining participation versus no participation. Second, engagement in each type of activity was introduced into the models as a five-grade indicator variable, with no participation as the reference group and daily, weekly, monthly, and annual participation as the other categories. Finally, a reduced three-grade variable for each activity was derived from the original five-grade variable and was entered into the models as an indicator variable.

All of the associations studied were first assessed with univariate Cox proportional hazards models and then with multivariate models adjusted for all potential confounders. Age and cognitive functioning (MMSE score) were entered in the models as continuous variables (1 year/point increment). Education was entered as a categorical variable (>12 years, 8–12 years, and <8 years of schooling) (23). Sex (female vs. male), comorbidity (the presence of coronary heart disease, cerebrovascular disease, diabetes mellitus, malignancy, or hip fracture vs. the presence of none of them), depressive symptoms (yes vs. no), and physical functioning (dependent vs. independent) were entered as dichotomous variables.

An alternative grouping of some of the covariates was also used to assess the associations studied. For example, education was grouped according to the number of years of schooling, physical functioning was classified into seven categories—1 as most independent (requiring no personal assistance with any of the six activities of daily living) and 7 as most dependent (requiring assistance with all six of these activities)—and comorbidity was categorized as no disease, one disease, or two or more diseases.

RESULTS

The study population was composed of 776 subjects (figure 1). The mean age of participants was 81.1 (standard deviation, 4.9) years, and the mean MMSE score at baseline was 27.3 (standard deviation, 1.5). In comparison with those subjects who participated in the study, the 44 nonparticipants (4.7 percent) had less comorbidity and participated less often in mental activity and more often in social activity (odds ratios = 0.4 and 1.9, respectively; $p < 0.05$). The distributions of age, sex, education, cognitive functioning, depressive symptoms, physical functioning, and other types of activities were similar.

During the second follow-up, 123 incident cases of dementia were identified. Of these cases, one (0.8 percent) was due to Parkinson's disease and one (0.8 percent) to alcoholism. Table 1 shows the baseline characteristics of the 732 cohort subjects and the distribution of the 123 incident dementia cases. Demented subjects were older, had lower MMSE scores, had more comorbidity, had more depressive symptoms, and were more physical-functioning dependent compared with the corresponding reference group for each variable.

The adjusted relative risks of dementia associated with participation versus no participation in the following activities were 0.67 (95 percent confidence interval (CI): 0.45, 1.01) for mental activity, 0.70 (95 percent CI: 0.49, 1.01) for social activity, 0.67 (95 percent CI: 0.34, 1.33) for physical activity, 0.61 (95 percent CI: 0.40, 0.93) for productive activity, and 0.97 (95 percent CI: 0.61, 1.57) for recreational activity. Table 2 shows the adjusted relative risks of dementia in relation to social and leisure activities when frequency of participation was taken into account. Compared with those who did not, elderly subjects who participated in mental, social, or productive activity had a lower incidence of dementia. Dementia incidence decreased with increasing frequency of participation in the three types of activities. Furthermore, these associations were independent of the effects of age, sex, education, cognitive functioning, comorbidity, depressive symptoms, and physical functioning. The observed associations between frequent engagement in

TABLE 2. Adjusted* relative risks of dementia in relation to social and leisure activities engaged in 6.4 years prior to diagnosis, the Kungsholmen Project, Stockholm, Sweden, 1987–1996

	No. of dementia cases	RR†	95% CI†
Mental activity			
No	34	1	
Less than daily	40	0.81	0.52, 1.26
Daily	49	0.54	0.34, 0.87
Physical activity			
No	114	1	
Less than daily	6	0.97	0.42, 2.22
Daily	3	0.41	0.13, 1.31
Social activity			
No	72	1	
Less than weekly	27	0.92	0.57, 1.47
Daily-weekly	24	0.58	0.37, 0.91
Productive activity			
No	94	1	
Less than weekly	3	0.95	0.30, 3.00
Daily-weekly	26	0.58	0.38, 0.91
Recreational activity			
No	102	1	
Less than daily	6	1.06	0.46, 2.45
Daily	15	0.95	0.55, 1.63

* Adjusted for age, sex, education, baseline Mini-Mental State Examination score, comorbidity, depressive symptoms, and physical functioning.
† RR, relative risk; CI, confidence interval.

TABLE 1. Baseline (1987–1989) characteristics of the cohort subjects and distribution of the incident dementia cases occurring during the second follow-up (1994–1996), the Kungsholmen Project, Stockholm, Sweden, 1987–1996

Baseline characteristics	Participants (n = 732)		Incident dementia cases (n = 123)	
	No.	%	No.	%
Age (years)				
75–79	364	49.7	36	29.3
80–84	232	31.7	55	44.7
≥85	136	18.6	32	26.1
Sex: female	543	74.2	93	75.6
Education*: >7 years	343	47.1	53	43.1
MMSE† score				
24–26	178	24.3	38	30.9
27–30	554	75.7	85	69.1
Comorbidity*	179	24.6	46	37.4
Depressive symptoms*	201	27.6	53	43.1
Physical dependence‡	132	18.2	30	24.4

* For three subjects, information was missing.
† MMSE, Mini-Mental State Examination.
‡ For eight subjects, information was missing.

activities and incidence of dementia persisted even when the effect of social network was taken into account (relative risk (RR) = 0.60, 95 percent CI: 0.37, 0.98 for mental activities; RR = 0.60, 95 percent CI: 0.38, 0.94 for social activities; and RR = 0.61, 95 percent CI: 0.39, 0.96 for productive activities).

In addition, the observed associations were independent of each other. When the three types of activities were introduced into the multivariate models simultaneously, the adjusted relative risks of dementia were 0.7 (95 percent CI: 0.5, 1.3) for mental activity, 0.7 (95 percent CI: 0.5, 1.0) for social activity, and 0.6 (95 percent CI: 0.4, 0.9) for productive activity. Table 3 shows that daily/daily-weekly participation in each activity was independently associated with a lower risk of dementia. Entering the alternative grouping of potential confounders as covariates in the models did not change the observed results substantially.

The following statistical analyses were performed to verify the results:

- Although we included only those subjects whose baseline MMSE scores were more than 23, weaker cognitive functioning (MMSE score, 24–26) may have had an impact on the studied relation. Therefore, we repeated all analyses for subjects whose MMSE scores were more than 26 at the first examination. Similar results were observed.
- To avoid biases introduced by underdiagnosis of dementia cases among deceased subjects during follow-up, further analyses were conducted for a subgroup of subjects who were survivors at the second follow-up examination. The results did not change.
- To eliminate the possibility that depression may be the cause of inactivity in elderly people, all analyses were repeated for subjects who did not have any depressive symptoms. The observed associations remained unchanged.
- We also examined the genetic influence by both introducing the apolipoprotein E (*APOE*) genotypes into the models as covariates and conducting stratified analyses for subjects with and without the *APOE**ε4 allele. No substantial variations were observed.

TABLE 3. Independent effect of mental, social, and productive activities on dementia occurrence derived from the same Cox regression model, contrasting different frequencies of participation with nonparticipation in the activities, the Kungsholmen Project, Stockholm, Sweden, 1987–1996*

	RR	95% CI
Mental activity		
No	1	
Less than daily	0.83	0.54, 1.30
Daily	0.59	0.37, 0.96
Social activity		
No	1	
Less than weekly	0.88	0.54, 1.41
Daily-weekly	0.60	0.38, 0.94
Productive activity		
No	1	
Less than weekly	0.81	0.25, 2.58
Daily-weekly	0.61	0.39, 0.95

* Relative risks (RR) and 95% confidence intervals (CI) were derived from multiple Cox regression models and were adjusted for age, sex, education, baseline Mini-Mental State Examination score, comorbidity, depressive symptoms, physical functioning, and mental, social, or productive activities.

DISCUSSION

We examined the influence of engagement in mental, physical, social, productive, and recreational activities on dementia incidence in a community-based cohort of nondemented subjects living at home, whose initial cognition level was good. Participation in these activities was assessed on average 6 years before dementia diagnosis. Our results suggest that frequent participation in mental, social, or productive activity is associated with a lower risk of dementia in the elderly. These associations are independent of the influence of age, sex, education, cognitive functioning, presence of other chronic diseases and depressive symptoms, and physical functioning.

Some possible mechanisms may be hypothesized:

- The process of mental stimulation may play a role in preserving cognition. It has been reported that continuing to engage in intellectually challenging activity may promote stability of or enhance cognitive performance (8). Mental activity involves thinking and attention control processes, which might increase or maintain brain reserve even in old age (8, 24).
- Psychosocial pathways may be involved in the beneficial effect on dementia. Participation in productive or social activities fulfills a meaningful social or economic role, which could potentially sustain a person's self-concept of usefulness and competence (25). A sense of self-efficacy has been linked to several important health outcomes in middle-aged or elderly adults (26, 27). In addition, experimental studies have shown that an enriched environment improves the plasticity and thickness of the cerebral cortex of old rats (28). Maintenance of many social connections and a high level of participation in social activities have been found to be related to a high memory performance score or to prevent cognitive decline in community-dwelling elderly persons (6, 8).

Yoshitake et al. reported that regular, moderate physical activity may preserve cognitive function (14), but we were unable to identify a significant beneficial effect of physical activity. However, only a few elderly people engaged in this type of activity, leading to limited power to detect a moderate effect.

The present findings are in line with our previous report concerning a decreased dementia risk for subjects who have a rich social network (10). The fact that a rich social network could reduce the incidence of dementia might be explained by factors other than social and emotional stimulation. For example, such subjects could have received more

help with their daily needs, such as with nutrition or health care. In this study, we excluded the possible effect of social support by introducing the social network index into the models; the protective effects of mentally and socially stimulating activities were still present. The findings from our previous and present studies, taken together, suggest that a stimulating life, which includes participating in creative, educational, or interactive activities, may produce beneficial effects on dementia development.

Our findings confirmed the beneficial effect of an active life on dementia in the elderly, findings that have cautiously been suggested by a few previous reports (11–14). The caution was due to methodological limitations highlighted by the authors themselves. In our study, we overcame most of these limitations. Information on activities was collected directly from the subjects several years before dementia diagnosis. We controlled for the effects of the most relevant confounders. The possibility that depressive mood might have caused subjects' inactivity was ruled out by finding similar results for subjects without any depressive symptoms. Initial cognitive functioning was controlled for in the analysis, and similar associations were found for subjects whose cognition level was initially good. The influence of genetic variability was excluded by conducting additional stratified analyses of subjects with and without the *APOE**ε4* allele. Possible confounding due to the presence of other chronic diseases common in old age, as well as physical disability, was also eliminated. Finally, the effect of social support likely to be associated with an active lifestyle was excluded by adjusting for the social network index (10).

Four limitations of our study need to be discussed. First, an open question was used to obtain information on social and leisure activities; subjects were asked whether they regularly participated in any activities. Although we ascertained information regarding the frequency of participation, we do not know the extent to which subjects participated in these activities, for example, how strenuous the activity was and how long it lasted. Furthermore, because of the small number of elderly participants, we could not determine the effect of any one particular activity on dementia development.

Second, recent reports on the preclinical stages of Alzheimer's disease have shown deficits in specific cognitive domains in subjects who developed dementia 7 (29, 30) and 10 (31) years later. Although time of engagement in the activities referred to a period of life preceding by 6 years the onset of dementia, some cognitive disturbances might be present in those subjects who will later develop dementia. However, the impairment found during the preclinical phase was limited to episodic memory and clearly did not affect daily life. In addition, we found similar results when we analyzed a subgroup of subjects whose MMSE scores were high, and all of our results were adjusted for initial cognitive functioning.

Third, Berger et al. (32) reported that depressive symptoms might be part of the preclinical phase of Alzheimer's disease. In our study, the possibility that depressive symptoms might have biased the associations between these activities and dementia was ruled out because similar findings were observed for subjects without any depressive symptoms.

Finally, although we controlled for many potential confounders such as age, sex, education, cognitive functioning, chronic diseases, depressive symptoms, social network, physical functioning, and genetic variability, latent and unmeasured differences might have determined the associations between mental, physical, social, productive, and recreational activities and the incidence of dementia. Premorbid personality is one possible factor that may represent such differences. Associations between dementia and specific personality traits have been suggested by two case-control studies (33, 34). Evidence on this topic is limited by two factors. First, only two known studies have focused on this subject. Second, there are difficulties in studying this topic, which result from the retrospective assessment of personality and the presence of personality changes during the early phase of Alzheimer's disease.

In conclusion, stimulating activities that involve either mental or psychosocial components may act as stimuli to preserve cognition or hinder cognitive decline, therefore preventing elderly persons from developing dementia. We could not demonstrate a causal relation and rule out all possible confounding effects. However, because of their potential value, these results deserve to be explored further.

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REFERENCES

1. Paffenbarger RS Jr, Hyde RT, Wing AL, et al. The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. N Engl J Med 1993;328:538–45.
2. Blair SN, Kampert JB, Kohl HW 3rd, et al. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. JAMA 1996;276:205–10.
3. Kaplan GA, Strawbridge WJ, Cohen RD, et al. Natural history of leisure-time physical activity and its correlates: associations with mortality from all causes and cardiovascular disease over 28 years. Am J Epidemiol 1996;144:793–7.
4. Kujala UM, Kaprio J, Sarna S, et al. Relationship of leisure-time physical activity and mortality: the Finnish twin cohort. JAMA 1998;279:440–4.
5. Glass TA, de Leon CM, Marottoli RA, et al. Population based study of social and productive activities as predictors of survival among elderly Americans. BMJ 1999;319:478–83.
6. Bassuk SS, Glass TA, Berkman LF. Social disengagement and incident cognitive decline in community-dwelling elderly persons. Ann Intern Med 1999;131:165–73.
7. Rogers RL, Meyer JS, Mortel KF. After reaching retirement

age physical activity sustains cerebral perfusion and cognition. J Am Geriatr Soc 1990;38:123–8.
8. Hultsch DF, Hammer M, Small BJ. Age differences in cognitive performance in later life: relationships to self-reported health and activity life style. J Gerontol 1993;48:P1–11.
9. Freidl W, Schmidt R, Stronegger WJ, et al. Mini-Mental State Examination: influence of sociodemographic, environmental and behavioral factors and vascular risk factors. J Clin Epidemiol 1996;49:73–8.
10. Fratiglioni L, Wang HX, Ericsson K, et al. The influence of social network on the occurrence of dementia: a community-based longitudinal study. Lancet 2000;355:1315–19.
11. Broe GA, Henderson AS, Creasey H, et al. A case-control study of Alzheimer's disease in Australia. Neurology 1990;40: 1698–707.
12. Kondo K, Niino M, Shido K. A case-control study of Alzheimer's disease in Japan—significance of life-styles. Dementia 1994;5:314–26.
13. Fabrigoule C, Letenneur L, Dartigues JF, et al. Social and leisure activities and risk of dementia: a prospective longitudinal study. J Am Geriatr Soc 1995;43:485–90.
14. Yoshitake T, Kiyohara Y, Kato I, et al. Incidence and risk factors of vascular dementia and Alzheimer's disease in a defined elderly Japanese population: the Hisayama Study. Neurology 1995;45:1161–8.
15. Fratiglioni L, Grut M, Forsell Y, et al. Prevalence of Alzheimer's disease and other dementias in an elderly urban population: relationship with age, sex, and education. Neurology 1991;41:1886–92.
16. Fratiglioni L, Viitanen M, von Strauss E, et al. Very old women at highest risk of dementia and Alzheimer's disease: incidence data from the Kungsholmen Project, Stockholm. Neurology 1997;48:132–8.
17. American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-III-R. 3rd ed, rev. Washington, DC: American Psychiatric Association, 1987: 97–163.
18. Fratiglioni L, Grut M, Forsell Y, et al. Clinical diagnosis of Alzheimer's disease and other dementias in a population survey. Agreement and causes of disagreement in applying DSM-III-R criteria. Arch Neurol 1992;49:927–32.
19. Folstein MF, Folstein SE, McHugh PR. "Mini-Mental State": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–98.
20. Katz S, Ford AB, Moskowitz RW, et al. The index of ADL: a standardized measure of biological and psychosocial function. JAMA 1963;185:914–19.
21. World Health Organization. International classification of diseases. Manual of the international statistical classification of diseases, injuries, and causes of death. Eighth Revision. Vol 1. Geneva, Switzerland: World Health Organization, 1967.
22. World Health Organization. International classification of diseases. Manual of the international statistical classification of diseases, injuries, and causes of death. Ninth Revision. Geneva, Switzerland: World Health Organization, 1979.
23. Qiu C, Bäckman L, Winblad B, et al. The influence of education on clinically diagnosed dementia: incidence and mortality data from the Kungsholmen Project. Arch Neurol 2001;58:2034–9.
24. Schooler C. Psychological effects of complex environments during the life span: a review and theory. Intelligence 1984;8: 259–81.
25. Herzog AR, Franks MM, Markus HR, et al. Activities and well-being in older age: effects of self-concept and educational attainment. Psychol Aging 1998;13:179–85.
26. Mendes de Leon CF, Seeman TE, Baker DI, et al. Self-efficacy, physical decline, and change in functioning in community-living elders: a prospective study. J Gerontol 1996;51: S183–90.
27. Orth-Gomér K, Rosengren A, Wilhelmsen L. Lack of social support and incidence of coronary heart disease in middle-aged Swedish men. Psychosom Med 1993;55:37–43.
28. Powell D. Profiles in cognitive aging. Cambridge, MA: Harvard University Press, 1994.
29. Bäckman L, Small BJ, Fratiglioni L. Stability of the preclinical episodic memory deficit in Alzheimer's disease. Brain 2001;124:96–102.
30. Small BJ, Fratiglioni L, Viitanen M, et al. The course of cognitive impairment in preclinical Alzheimer's disease: three- and 6-year follow-up of a population-based sample. Arch Neurol 2000;57:839–44.
31. Elias MF, Beiser A, Wolf PA, et al. The preclinical phase of Alzheimer's disease: a 22-year prospective study of the Framingham Cohort. Arch Neurol 2000;57:808–13.
32. Berger AK, Fratiglioni L, Forsell Y, et al. The occurrence of depressive symptoms in the preclinical phase of AD: a population-based study. Neurology 1999;53:1998–2002.
33. Malinchoc M, Rocca WA, Colligan RC, et al. Premorbid personality characteristics in Alzheimer's disease: an exploratory case-control study. Eur J Neurol 1997;4:227–30.
34. Meins W, Dammast J. Do personality traits predict the occurrence of Alzheimer's disease? Int J Geriatr Psychiatry 2000; 15:120–4.