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Prevalence of Dementia and Its Subtypes in the Japanese American Population of King County, Washington State

The *Kame* Project

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Studies of Asian populations generally have reported prevalence rates for dementia similar to those of predominantly Caucasian populations, but relative prevalence rates of Alzheimer's disease and vascular dementia have differed. Between May 1, 1992 and May 1, 1994, the prevalence rates of dementia, Alzheimer's disease, and vascular dementia were examined in the Japanese American population aged over 65 years in King County, Washington State. A total of 3,045 eligible individuals were identified in a census of persons who were of at least 50% Japanese heritage. Of 1,985 persons who participated in the baseline examination, 382 individuals of 450 sampled from all cognitive performance strata received a diagnostic evaluation. A total of 107 cases with a Clinical Dementia Rating (CDR) of ≥1 met criteria for dementia according to the *Diagnostic and Statistical Manual*, 3rd edition, revised (DSM-III-R); 58 of these cases were diagnosed with Alzheimer's disease and 24 with multi-infarct dementia. The estimated prevalence rate for all dementias was 6.3% (95% confidence interval 5.9–6.8). Prevalence rates for dementia increased continuously with age and were 30%, 50%, and 74% for participants aged 85–89, 90–94, and ≥95 years, respectively; for Alzheimer's disease, prevalence rates were 14%, 36%, and 58% for these three age groups. Rates for Alzheimer's disease were generally higher among women; for multi-infarct dementia, rates for men and women were similar. In the institutional population, the prevalence rate was 66%, and in the community, 2.9%. Persons with lower education had higher overall rates of dementia than those with higher education, but this tendency became weak and inconsistent when rates were age-stratified. The prevalence of dementia in this geographically defined population of Japanese Americans was somewhat higher than prevalence rates reported from Japan, and the distribution of dementia subtypes more closely resembled that found in Caucasian populations in North America and Europe than previously reported in Asian populations. *Am J Epidemiol* 1996;144:760–71.

Alzheimer's disease; cross-cultural comparison; dementia; dementia, multi-infarct; prevalence

Despite similar overall prevalence rates for dementia in North American, European, and Asian populations (1–8), the relative proportions attributed to Alzheimer's disease and vascular causes differ markedly. In most Asian studies, between 30 to 60 percent of dementia cases have been ascribed to vascular causes (6, 9–11) and approximately half as many to Alzheimer's disease (12, 13). In most Western studies of predominantly Caucasian populations, the reverse is true, with at least 50–70 percent of the total dementia rate attributed to Alzheimer's disease and only 12–20 percent to vascular causes. Exceptions to this general

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Abbreviations: CASI, Cognitive Abilities Screening Instrument; CDR, Clinical Dementia Rating; CERAD, Consortium to Establish a Registry for Alzheimer's disease; CI, confidence interval; DSM-III-R, *Diagnostic and Statistical Manual*, 3rd edition, revised; IQCODE, Informant Questionnaire on Cognitive Decline in the Elderly; NART, New Adult Reading Test; OR, odds ratio; SD, standard deviation.

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trend have been reported. For example, Skoog et al. (14) reported a higher rate of vascular dementia than Alzheimer's disease in a very old Caucasian population. Also, some recent studies conducted in Asia have reported higher rates of Alzheimer's disease than vascular dementia (10, 15, 16).

This study reports the prevalence of dementia and its subtypes in the *Kame* Project, a study of the Japanese American community aged 65 years and over in King County, Washington State. Both institutionalized and non-institutionalized individuals were studied. The relatively large number of very elderly participants permitted reliable estimates of dementia rates above age 90 years. Because previous studies have indicated exponential increases in prevalence with age, higher prevalence rates of Alzheimer's disease in women, and higher prevalence rates in lower educated populations, we also were interested in describing these characteristics in this cohort.

MATERIALS AND METHODS

Study population

The target population was all persons aged 65 years or older of at least 50 percent Japanese heritage living within King County, Washington, which includes the city of Seattle. To identify these individuals, we conducted a census using King County telephone directories, Health Care Financing Administration (Medicare-recipient) lists, Japanese American organizational lists, and word-of-mouth. On November 1, 1991, 7,720 letters were sent to the households of persons thought to be of Japanese heritage, primarily identified from the King County telephone directories and the Japanese American Citizen's League. The household survey requested the names of persons who had been living in King County, Washington for at least 6 months during 1991, who were 55 years old or older, and of at least 50 percent Japanese heritage. Intensive follow-up mailings and telephone call-back efforts were undertaken to obtain information from persons who did not return the initial survey.

Of the 7,720 households contacted, 1,973 households (25.6 percent) were enumerated with one or more members who were at least 55 years old. We were unable to reach 1,316 households (17 percent), which either had wrong or disconnected numbers or did not answer. Another 50 households (0.7 percent) were reached but no information could be obtained. The census enumerated 4,047 persons aged 55 years and over. The enumeration of the population was terminated on May 1, 1994, the end of the prevalence cycle, at which time 3,196 persons aged ≥65 years had been found. The majority of the 3,196 persons were identified from the King County telephone directories (n = 2,084, 65.2 percent). An additional 379 (11.9 percent) were identified through Japanese American organizations and 292 (9.1 percent) from a Medicare beneficiary list obtained from the Health Care Financing Administration. The remainder were identified from a variety of other sources, including 3 percent through Japanese services and 5 percent through referrals.

Figure 1 shows the disposition of the 3,196 persons enumerated in the census, and table 1 shows the participation status of the eligible and screened population by age and sex.

Because the major goals of the *Kame* Project concern memory and aging, only persons who were at least 65 years old by May 1, 1994 (n = 3,045) were invited to participate. These constitute 90 percent of the approximately 3,400 persons of Japanese ancestry who would have been 65 years or older by May 1, 1994 according to calculations based on the 1990 US Census (17). However, the definition of Japanese heritage used by the US Census (self-proclaimed) varies somewhat from our definition (at least 50 percent Japanese). Ninety-six percent of our participants were 100 percent Japanese.

Eligible individuals, both community- and institution-dwelling (in nursing or care homes), were invited to participate in the baseline examination (Phase I). An attempt was made to invite persons aged ≥85 years first to minimize attrition due to death. A total of 1,985 persons participated in the baseline examination (65.2 percent). To screen for prevalent cognitive impairment in the cohort, we used the Cognitive Abilities Screening Instrument (CASI) (18), which has a score range from 0 to 100. Figure 1 shows the proportions of the cohort scoring in three performance groups of the CASI: low (<81), intermediate (81–86.9), and high (≥87).

In order to compare Phase I participants with nonparticipants, a short telephone refusal questionnaire was administered that asked demographic questions as well as questions about the presence of chronic diseases, family history of memory problems, and smoking habits. Data were obtained for 676 of 979 refusals (69 percent). Persons without refusal questionnaires were significantly younger (mean = 71.0, standard deviation (SD) = 5.2) than either those with refusal questionnaires (mean = 72.9, SD = 6.5, $p < 0.05$) or participants (mean = 73.0, SD = 7.2, $p < 0.05$). There were no differences in gender between the three groups. Among the 676 individuals with refusal questionnaires, refusers were more likely than participants to be women living in the community (odds ratio (OR) predicting refusal = 5.1, 95 percent confidence inter-

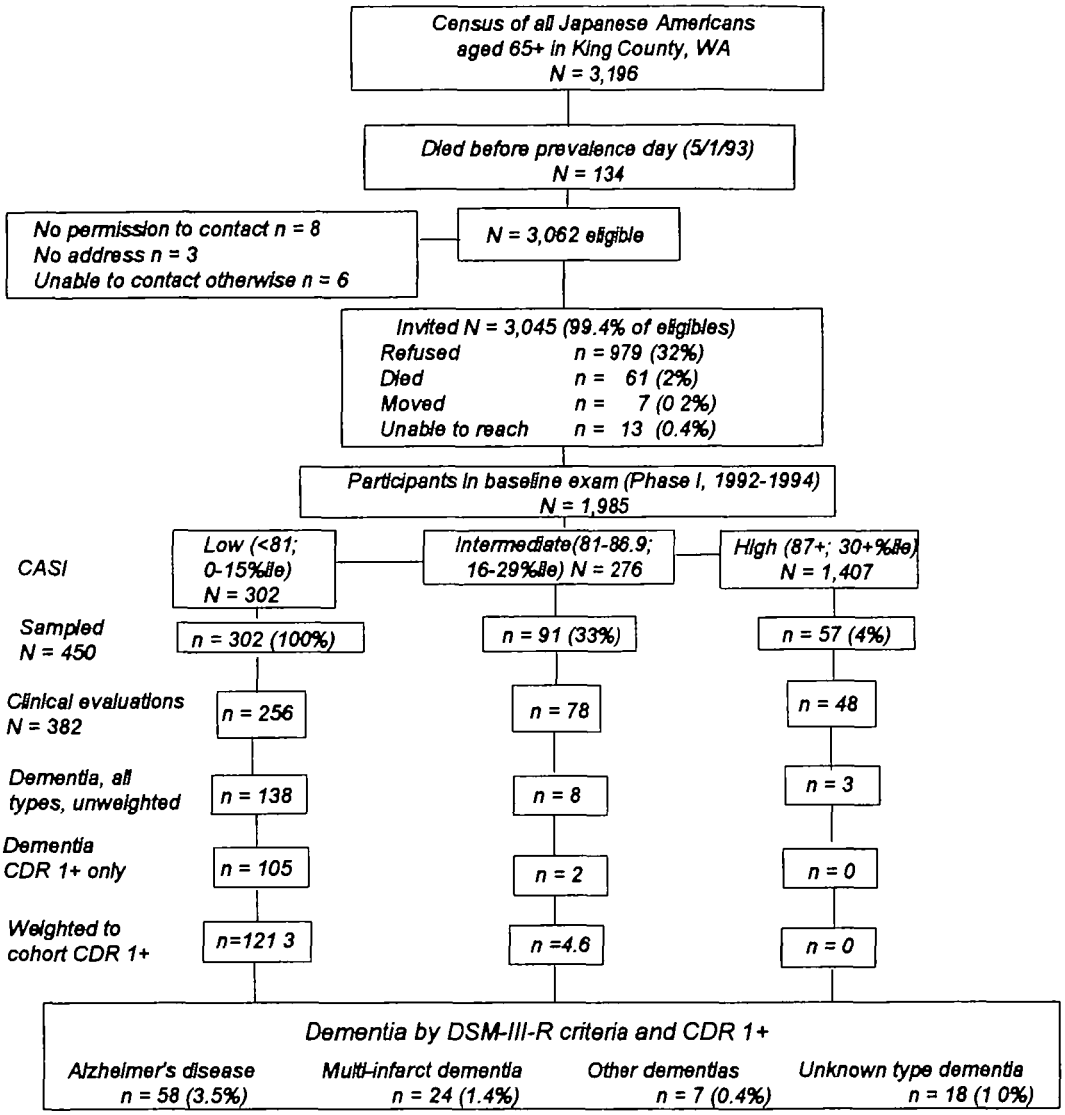

FIGURE 1. Flowchart of prevalence cycle of the *Kame* Project, 1992–1994.

val (CI) 1.3–20.1). This was adjusted for in a secondary analysis of overall prevalence rates (see Discussion). Variables that did not predict refusal included age at Phase I, low education (0–7 years vs. ≥8 years), and place of birth (United States vs. Japan).

In order to be able to estimate prevalence rates for dementia for the entire population, 450 participants were sampled by age and CASI group for diagnostic evaluation (Phases II/III) (figure 1). All persons aged ≥85 years or scoring <81 on the CASI were sampled. For persons aged 65–84 years who scored in the intermediate or high ranges on the CASI, sampling probabilities were calculated based on estimates of the expected prevalence of cognitive impairment in each of eight age-cognitive performance strata. This was done to ensure that higher and lower performing subjects who were sampled were similar in age. In figure 1, these sampling probabilities were collapsed for the intermediate and high performance groups, such that overall, 33 percent of the intermediate CASI group and 4 percent of the high CASI group were sampled.

Of those sampled, 382 completed clinical evaluations (figure 1). Refusal rates between the screen and clinical evaluation phases of the study were similar by CASI group: 13.2 percent (low), 11 percent (intermediate), and 14 percent (high). Among 109 institutionalized persons sampled, 95.4 percent completed the clinical evaluation compared with 81.5 percent of the 341 community-dwelling persons sampled. Female sex and residence independently predicted refusal between the baseline and clinical examinations (OR for women = 2.8, 95 percent CI 1.5–5.3; for community

TABLE 1. Age and sex distribution of 3,045 eligible and 1,985 persons screened in the baseline examination of the *Kame* Project, King County, Washington State, 1992–1994

Sex and age (years)	Eligible population	Refused		Died		Moved		Unable to reach		Screened population	
		No.	%*	No.	%	No.	%	No.	%	No	%
Men											
65–69	489	151	31	4	1			5	1	329	65.8
70–74	459	158	34	13	3	1	0.2	2	0.4	285	62.4
75–79	232	73	32	4	2					155	68.6
80–84	80	25	31	3	4			1	1	51	68.0
85–89	30	9	30	2	7					19	63.3
90–94	18	5	28			1	6			12	66.7
≥95	9			2	22					7	77.8
Missing	1	1	100								
All	1,318	422	32	28	2	2	0.2	8	1	858	65.1
Women											
65–69	676	250	37	10	2	2	0.3	3	0.4	411	60.8
70–74	526	163	31	4	1	2	0.4	2	0.4	355	67.5
75–79	243	78	32	4	2					161	66.3
80–84	120	34	28	3	3					83	69.2
85–89	61	13	21	2	3					46	75.4
90–94	54	13	24	4	7					37	68.5
≥95	46	5	11	6	13	1	2			34	73.9
Missing	1	1	100								
All	1,727	557	32	33	2	5	0.3	5	0.3	1,127	65.3
Total	3,045	979	32	61	2	7	0.2	13	0.4	1,985	65.2

* Percent of eligible population.

residence, OR = 5.7, 95 percent CI 2.2–14.6) while age, education, CASI score (<81 vs. ≥81), and place of birth (Japan vs. the United States) did not. All individuals sampled were seen for the clinical evaluation between 2 and 12 weeks following the baseline examination.

Procedures

Phase I: baseline evaluation. The baseline examination was administered by trained interviewers at a clinic (75.4 percent), in the participant's or a relative's home (18.8 percent), in a nursing or care home (5.1 percent), or at another location (0.7 percent). Because many of the participants preferred to have the interviews in Japanese (21.6 percent), all study instruments were translated into Japanese by bilingual interviewers and back-translated by a professional translator. The baseline evaluation consisted of a broad range of tests and interviews. The first part included tests of hearing, vision, olfaction, the CASI, a short neurologic examination administered by lay interviewers, and the New Adult Reading Test (NART) (19), which was performed only in participants whose preferred language was English. The second part consisted of highly structured interviews of the participant's medical history, assessment of physical and psychosocial functioning, and risk factor, acculturation, dietary, and family histories of various neurologic conditions. Data from all or parts of Phase I were available from 1,985 individuals.

Phase II: proxy interview. For 382 participants who received further diagnostic evaluation, proxy informants were sought to answer the same basic set of questions about the participant as in Phase I, with the exception of the NART and the dietary questionnaire. In addition, during this interview, the Blessed Dementia Rating Scale (20) and the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) (21) were administered, as were a series of questions on abilities related to thinking and memory. When analyses included a variable that might not have been collected during Phase I due to cognitive impairment of the participant, these data were substituted from the proxy informant interview.

Phase III: neuropsychological and clinical evaluation. All sampled participants received a standardized neuropsychological screening battery administered by a trained psychometrician and interpreted by a geriatric neuropsychologist. The Consortium to Establish a Registry for Alzheimer's Disease (CERAD) neuropsychological battery (22, 23) was used, excluding the Mini-Mental State Examination, since this test is embedded in the CASI. Additional tests administered included: the Shipley Vocabulary Scale (24), Wechsler Memory Scale—Revised, Paired Associates, and Recall of Paired Associates (25), Trails A and B (26), Digit Span and Digit Symbol from the Wechsler

Adult Intelligence Scale—Revised (27), the CES-D (28), modified Calculations (29), Comprehension (29), Similarities (29), Clock Drawing (30), the Purdue Pegboard Test (31), and Finger Tapping (26).

Sampled participants also received a standardized physical and neurologic exam conducted by a neurologist or a geriatrician. The Clinical Dementia Rating Scale (CDR) (32) was used to assess severity of the dementia and was completed by the examining physician. Participants suspected of having dementia underwent laboratory evaluations including non-contrast CT scans of the brain, complete blood counts, erythrocyte sedimentation rates, blood chemistries, thyroid function tests, vitamin B_{12} levels, and FTA-ABS syphilis serologies.

The presence of dementia was determined by consensus committee (33), including two neurologists, a geriatrician, a neuropsychologist, an epidemiologist, and a research nurse. The diagnosis of dementia was made using *Diagnostic and Statistical Manual*, 3rd edition, revised (DSM-III-R) criteria (34). The consensus committee was blinded to scores on the CASI. The DSM-III-R criterion specifying a loss of intellectual abilities that "significantly interferes with work or usual social activities or relationships with others" was based on changes in job performance, household responsibilities (cooking, cleaning, yard work, family finances), hobbies, community affairs (church and social activities), and driving ability or personal activities (appointments, hygiene).

To further classify dementia subtypes, criteria from the work group of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) (35) were used for the diagnosis of probable and possible Alzheimer's disease. DSM-III-R criteria for multi-infarct dementia were used for the rates reported in this report, although participants also were classified using several additional criteria for vascular dementia (36–38). The DSM-III-R criteria for multi-infarct dementia require a stepwise course, focal neurologic signs, focal neurologic symptoms, and evidence of significant cerebrovascular disease that is judged to be etiologically related to the disturbance. Patients with computerized tomographic evidence of cerebrovascular disease but with nonfocal examinations or without a history of stroke were not classified as vascular dementia.

Statistical analysis

For prevalence estimates, cases had to fulfill DSM-III-R criteria (primary degenerative dementia of the Alzheimer type, multi-infarct dementia, alcohol-related, mixed, other, and type unknown) and to have a CDR of ≥ 1. Prevalence rates were estimated by the standard design-based algorithm for stratified simple random sampling (39). With this algorithm, the population prevalence is estimated as the weighted average of observed stratum-specific prevalence rates with weights equal to the proportion of the population represented by each stratum. Standard 95 percent confidence intervals were computed (39), with the modification that for strata in which no prevalent cases were observed (occurring only in young age strata) the stratum-specific proportion estimates were adjusted from zero to one percent in the confidence interval calculations. This is a conservative adjustment to ensure that the confidence intervals achieve 95 percent coverage.

The design-based estimator is unbiased and is the standard method of analysis for stratified sample designs (39). However, for subgroup-specific prevalence estimation, small within-stratum sample sizes render the design-based estimator unstable. For this reason, logistic model-based point estimation and confidence interval calculation (40) were used for sex-age-education- and residence-specific prevalence estimates. This second set of analyses was based on Phase III sample data using a parsimonious set of predictor variables. Outcomes of any dementia and Alzheimer's disease were modeled as a function of sex, age, and CASI score; for multi-infarct dementia, a history of stroke diagnosed by a physician was added to the model. These variables were not studied as predictors of the outcomes; rather, they were used to model the fit for estimating stratum-specific prevalence rates.

RESULTS

Demographic features

Demographic features of the population are shown in table 2. The mean age at Phase I interview was 73.0 (SD = 7.1). Men comprised 43 percent of the population. There were a larger number of people aged ≥ 85 years than those aged 80–84 years, reflecting migration patterns in the early 20th century. Of the 1,985 participants, 17.2 percent were born in Japan ("Issei"), and most of these were women (271/342). The majority of the population consisted of American-born "Nisei." The population was generally well educated (mean completed years of education = 12.7, SD = 3.0, median = 12).

Dementia outcomes

Figure 1 depicts dementia outcomes in the cohort. Of 107 participants who met the DSM-III-R criteria for dementia with a CDR of ≥ 1, 105 were in the low CASI performance group, and two participants were in

TABLE 2. Demographic characteristics of 1,985 participants in the baseline examination of the *Kame* Project, King County, Washington State, 1992–1994

Age (years)	Men, by education (years)						Women, by education (years)						Both Sexes
	0–8	9–11	12	≥13	Missing	All men	0–8	9–11	12	≥13	Missing	All women	
65–69	8	19	115	187		329	22	56	186	145	2	411	740
70–74	12	16	126	129	2	285	16	48	186	101	4	355	640
75–79	11	30	57	56	1	155	15	17	89	36	4	161	316
80–84	7	6	21	16	1	51	21	15	27	19	1	83	134
85–89	11	2	1	3	2	19	18	8	12	4	4	46	65
90–94	6	1	2	2	1	12	17	5	6	1	8	37	49
≥95	1	2		3	3	7	13	2	4	4	11	34	41
Total	56	76	322	394	10	858	123	151	510	309	34	1,127	1,985

the intermediate performance group. The overall estimated prevalence rate of dementia weighted to the target population was 6.3 percent (95 percent CI 5.9–6.8). Among the cases, 23 percent had a CDR of 1 (mild severity), 33 percent had a CDR of 2 (moderate), and 44 percent had a CDR of ≥3 (severe).

Table 3 shows estimated prevalence rates by dementia subtype and age. For all dementias, rates increased steadily until age ≥95 years, where the estimated prevalence was 74 percent. Most of this precipitous increase with age could be accounted for by Alzheimer's disease; in the oldest age group, over half the population was affected with Alzheimer's disease. For multi-infarct dementia, rates increased with age until age 90–94 years, where there was a leveling off or decline, but for those aged ≥95 years, the rate again increased. For other dementias, the rate for persons aged 65–69 years was higher than for persons aged 70–74 years; thereafter, there was a slight increase in rates with increasing age, although the numbers of cases were small. Rates for dementia of unknown type generally increased with age, with a leveling off or decline in the oldest age group.

Table 4 shows the modeled prevalence rates by age, sex, and education for all dementias, Alzheimer's disease, and multi-infarct dementia. Rates for all dementias and Alzheimer's disease increased with age when the sexes were combined, but for all dementias in men, there was a plateau between ages 85–89 and 90–94 years. Rates increased continuously with age for both men and women with Alzheimer's disease, but education-specific rates were less consistent among men with low education. This is likely due to small numbers in these strata, and conclusions for this group of individuals must be made with caution. For multi-infarct dementia, the modeled rates again showed a decline in rates between ages 85–89 and 90–94 years in men and women, but these rates may be unstable due to the small numbers of cases in these age groups (3 and 2, respectively). Although rates for all dementia were generally higher among women aged 65–84 years, rates in the oldest old were more similar and differences between men and women were not significant ($p < 0.10$). Rates for multi-infarct dementia tended to be similar between men and women. Overall sex-specific rates differed markedly for those with 0–8 years of formal schooling compared with those with ≥9 years for all diagnostic categories. However, the age-specific rates showed much less consistency, and the trend of a greater prevalence of disease in lower educated strata was no longer evident in the oldest age groups.

In order to examine the burden of dementia in institutionalized (nursing/care home) versus community-

TABLE 3. Prevalence rates (percent) (design-based method) for all types of dementia and its subtypes by age, in the *Kame* Project, King County, Washington State, 1992–1994

Age (years)	All types			Alzheimer's disease			Multi-infarct dementia			Other dementias			Dementia, unknown type		
	Rate	95% CI*	No	Rate	95% CI	No.	Rate	95% CI	No.	Rate	95% CI	No.	Rate	95% CI	No
65–69	0.76	0.57–1.09	4	0.19	0–0.37	1	0 19	0–0.38	1	0.38	0.11–0.63	2			0
70–74	1.35	0.94–1.77	7	0.39	0.15–0.62	2	0.39	0.15–0.63	2	0.19	0.02–0 36	1	0.39	0.15–0.62	2
75–79	6.26	4.29–8.36	15	2.20	0.34–4.08	4	2.95	2.18–3.72	8			0	1.11	0.62–1.62	3
80–84	12.67	10.91–14.42	15	5.07	3.76–6.37	6	4.22	3.01–5 44	5	1.69	0.89–2.49	2	1.69	0.89–2.49	2
85–89	29.69	25.99–33.39	17	13.97	10.92–17.03	8	5.24	3.21–7.26	3	3.49	1.82–5.17	2	6.99	4.68–9.29	4
90–94	50.20	44.84–55.57	21	35.68	30.44–44.28	15	4.78	2.24–7.32	2			0	9.56	6.04–13.05	4
≥95	74.28	70.83–77.73	28	58.32	54.00–62.20	22	7.98	5.41–10.56	3			0	7.98	5.41–10.56	3
Total	6.32	5.90–6.78	107	3.46	3.08–3.84	58	1.41	1.20–1.62	24	0.43	0.29–0 56	7	1.04	0.87–1.22	18

* CI, confidence interval.

TABLE 4. Prevalence rates (based on logistic modeling) of dementia, all types, Alzheimer's disease and multi-infarct dementia, by age, sex, and education*, *Kame* Project, Washington State, 1992–1994

Type of dementia and age (years)	Men, by education (years)				Women, by education (years)				Both Sexes
	0–8	≥9	All	No.†	0–8	≥9	All	No.†	
All dementias									
65–69	13.0	0.8	1.1	2	1.7	1.3	1.6	2	1.3
70–74	1.8	1.4	1.4	2	7.0	2.4	2.9	5	2.2
75–79	10.6	4.7	5.1	6	13.1	6.6	7.1	9	6.1
80–84	6.2	5.6	7.3	4	17.6	12.7	13.8	11	11.3
85–89	27.9	20.3	33.0	6	26.6	28.2	30.2	11	31.0
90–94	10.0	39.8	29.4	4	57.6	56.9	60.6	17	52.9
≥95	75.6	48.6	74.3	5	68.3	63.9	70.4	23	71 1
All	13 0	2.5	4.0	29	25.1	5.2	8.9	78	6.8
Alzheimer's disease									
65–69	1.0	0 3	0.4	–	0.7	0.7	0.7	1	0.5
70–74	0.8	0 6	0.7	1	1.8	1.2	1.3	1	1.0
75–79	3.5	1.8	2.0	1	4.1	3.5	3.5	3	2.8
80–84	2.9	2.8	3.1	1	7.0	8.0	7.7	5	5.9
85–89	10.9	8.7	14.5	3	13.2	18.6	17.1	5	16.4
90–94	8.8	24.0	17.9	1	37.2	42.0	41.0	14	35.4
≥95	34.5	33.0	52.7	5	57.7	46.6	56.0	17	55.4
All	5.1	1.2	1.9	12	15.4	3.2	5.5	46	3.9
Multi-infarct dementia									
65–69	1.8	0.5	0.5	1	1.0	0.4	0.5	–	0.5
70–74	1.2	1 0	1.0	–	4.3	0.8	1.0	2	1.0
75–79	0.7	2 8	2.7	4	3.2	1.8	1.9	4	2.2
80–84	0.2	1.6	2.6	2	1.6	3.1	2.7	3	2.7
85–89	9.2	3.0	6.8	1	2.4	4.9	6.0	2	6.3
90–94	4.7	1 3	3.0	–	5.6	3.6	4.0	2	3.8
≥95	0.7	0 4	1.8	–	19.5	0.5	14.2	3	12.1
All	3.0	1.2	1.4	8	4.6	1.0	1.7	16	1 6

* Education missing for 46 of 1,985 participants.
† Number of observed cases in each sex-age stratum. Data for other and unknown type dementia not shown.

dwelling populations, prevalence rates were stratified by residence at the time the baseline examination was performed (table 5). Prevalent cases in this population resided predominantly in institutions (weighted *n* from logistic model = 79/133). Among observed cases in the institutionalized population, 49 had Alzheimer's disease (58 percent), 21 (25 percent) had multi-infarct dementia, 5 (6 percent) had other dementia, and 9 (11 percent) had a dementia of unknown type. In the community, of 23 demented cases observed, 9 (39 percent) had Alzheimer's disease, 3 (13 percent) had multi-infarct dementia, 2 (9 percent) had other dementia, and 9 (39 percent) had a dementia of unknown cause. Overall, 66 percent of the institutionalized population were demented compared with only 2.9 percent of the community-dwelling population. In the community, almost twice as many women were demented as men (3.7 percent vs. 2.0 percent), but this difference was not statistically significant after age adjustment.

There was a sharp increase with age in the prevalence of all dementias, Alzheimer's disease, and multi-infarct dementia in the community. For all dementias and multi-infarct dementia, the ratio of prevalence rates in institutions to those in the community decreased with increasing age. For Alzheimer's disease, these ratios were similar for cases aged 65–74 and 75–84 years, but were only one-third in cases aged ≥85 years, which perhaps indicates a reluctance to institutionalize the very old (table 5).

DISCUSSION

Figure 2 compares age-specific prevalence curves for all-cause dementia in the present study with two studies each from North America (3, 41), Europe (4, 42), and Japan (6, 7). In the younger age intervals (ages 65–74 years), the rates in the current study were lower than all of the other studies depicted. Between ages 75 and 84 years, the *Kame* Study rates fell between the Japanese rates (higher) and the North American and European rates (lower). In the oldest age group (≥85 years), the rates from the present study increased steeply, with 48 percent of the oldest old being affected.

Table 6 summarizes the results of 23 prevalence surveys from North America, Europe, and Asia. Although the prevalence rates are not age-, sex-, or education-standardized to one another, the relative prevalence of vascular dementia to Alzheimer's dis-

TABLE 5. Prevalence rates (based on logistic modeling) for all dementias, Alzheimer's disease, and multi-infarct dementia by age, sex, and residence, *Kame* Project, Washington State, 1992–1994

Type of dementia	No. of Cases	Institutional residence (rate)	95% CI*	Community-dwelling (rate)	95% CI	Ratio†
All dementias						
All	107	66.0	62.5–69.5	2.9	1.9–4 0	22.8
Men	29	69.9	66.9–72.9	2.0	0.9–3.2	35.0
Women	78	65.0	60.9–69.1	3.7	2.2–5.1	17.5
Age (years)						
65–74	11	36.5	31.9–41 1	1.3	0.4–2.2	28.1
75–84	30	57 3	54.3–60.4	4.0	2.4–5.6	14.3
≥85	66	77.9	73.1–82.7	24.4	18.9–29.8	3.2
Alzheimer's disease						
All	58	37.5	31.1–43.9	1.8	0.8–2.7	20.8
Men	12	29.9	18.3–41.6	1.1	0.2–1.9	27.2
Women	46	39.5	32.5–46.5	2.3	1.1–3.6	17.4
Age (years)						
65–74	3	6.4	1.5–11.4	0.7	0–1.4	9.1
75–84	10	22.1	13.8–30.3	2.3	0.8–3.9	9.6
≥85	45	52.7	41.4–61.4	16.2	11.1–21.4	3.3
Multi-infarct dementia						
All	24	15.0	11.3–18.8	0.7	0.2–1.2	21.4
Men	8	19.6	12.6–26.6	0.8	0–1.6	24.5
Women	16	13.8	9.7–18.0	0.6	0.1–1.1	23.0
Age (years)						
65–74	3	15.4	8.1–22.6	0.5	0–1.0	30.8
75–84	13	20.5	15.9–25.0	1.0	0.4–1.7	20.5
≥85	8	12.5	8.0–17.0	2.5	1.0–3.9	5.0

* CI, confidence interval.
† Ratio of institutional residence rate to community-dwelling rate.

ease is notable for the following trends. First, when the relative prevalence ratios were listed in decreasing order of magnitude, Asian studies clearly clustered in the top half of the table, while studies conducted in North America and Europe assembled in the lower part. Notable exceptions were two studies conducted in China (10, 15) and one from Korea (16). The study of Zhang et al. (15) was done in close collaboration with investigators in San Diego, California, and therefore adopted similar methodology to that of studies conducted in the United States. This was true also of the study of Liu et al. (10), which followed the methodology protocol outlined by the Ni-Hon-Sea Dementia Project, of which the current study is a part (10, 50, 51). The study of Park et al. (16) also sought to utilize "methods similar to those used in Western countries." Therefore, one must consider case-finding, diagnostic methodology, and interpretation of clinical criteria as important variables in contributing to differences in the relative prevalence of vascular dementia and Alzheimer's disease across studies. However, the findings in the current study suggest that Japanese Americans in King County, Washington have rates of dementia, Alzheimer's disease, and multi-infarct dementia that more closely resemble their Caucasian counterparts than Japanese natives. While this implies that environmental risk factors may contribute significantly to the pathogenesis or clinical expression of dementia and its subcomponents, it will be important to compare prevalence rates among methodologically standardized studies conducted in Japan and Japanese Americans in Honolulu, Hawaii and Seattle, Washington (the Ni-Hon-Sea Dementia Project currently in progress).

Of the studies listed in table 6, only 12 included institutionalized subjects. The mean overall rate from the four Japanese studies was 6 percent with a mean ratio of vascular dementia to Alzheimer's disease of 1.7. For the studies done in Europe, the mean vascular dementia to Alzheimer's disease prevalence ratio was 0.6. The two studies done in North America (1, 3) had a mean overall prevalence rate of 6 percent with a mean relative vascular dementia to Alzheimer's disease prevalence ratio of 0.3. This compares closely with our overall prevalence rate of 6.3 percent and relative prevalence ratio of 0.4.

Prevalence rates in the oldest age groups

The prevalence rate in the ≥85 years age group in our study (48.2 percent) is among the highest reported in the literature, even higher than that in the study by Evans et al. in East Boston (41). In that study, which used a similar sampling technique, the prevalence rate of probable Alzheimer's disease alone was 47.2

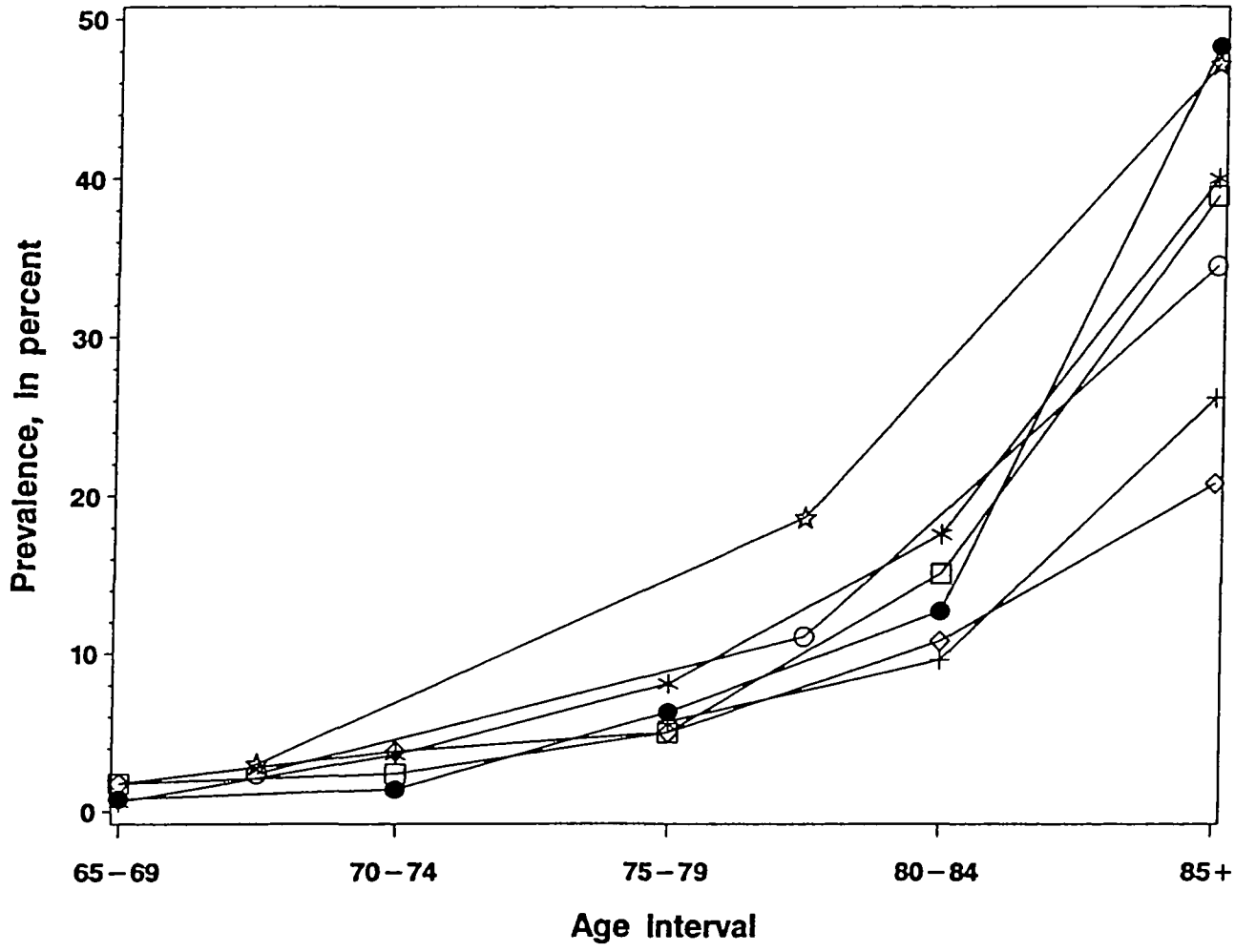

FIGURE 2. Comparison of age-specific prevalence rates for all types of dementia from the *Kame* Project, 1992–1994 (current study, shown as closed circles), with studies from North America, Europe, and Japan. *North America*: open circles = CSHA, 1994 (3) (community and institutional population), open stars = Evans et al., 1989 (41) (community population only). *Europe*. plus signs = Fratiglioni et al., 1991 (42) (community and institutional populations); asterisks = Rocca et al., 1990 (4) (community and institutional populations). *Japan*: open diamonds = Hasegawa, 1990 (7) (community population only); open squares = Kawano et al., 1990 (6) (community population only)

percent (95 percent CI 37.0–63.2) among non-institutionalized persons aged ≥85 years. Evans et al. observed that if institutionalized persons had been included in their study, their prevalence rates would likely have been higher. Another possible difference between our study and that of Evans et al. is the distribution of our population aged ≥85 years, which includes a large number of very old high-risk subjects (mean for 38 men aged ≥85 years was 90.8 (SD = 5.1) and mean for 117 women aged ≥85 years was 91.5 (SD = 4.5)).

Previous studies that have included substantial numbers of very old individuals have reported somewhat lower rates of dementia among persons aged ≥95 years (52–54). Among the 41 persons in our study aged ≥95 years, 73 percent lived in institutions, and 89.5 percent of these were cases. It is possible that response bias could account in part for the high prevalence rates among the oldest old: 6 percent of the Phase I population lived in institutions compared with 2.4 percent of the refusing population. To test the potential extent of this bias, we calculated prevalence rates for all dementias standardized to the age and residence distribution of the total census population, assuming that the prevalence rate of dementia was the same among the 979 refusals as in the 1,985 participants. The overall standardized prevalence rate was 0.4 percent less than the uncorrected rate and was within its confidence interval. Age-specific rates (by percent) standardized to the age and residence distribution of the eligible population of 3,045 individuals were: 65–69 years, 1.3; 70–74, 1.7; 75–79, 5.4; 80–84, 10.0; 85–89, 30.5; 90–94, 49.2; and ≥95 years, 65.8. The corrected rate, although still high among

TABLE 6. Overall rate of dementia of all types, Alzheimer's disease, vascular dementia, and other etiologies (in percent) and ratio of vascular dementia to Alzheimer's disease (in decreasing order) in studies from North America, Europe, and Asia

Author and year (reference no.)	Country	Overall rate (age ≥65 years)	Alzheimer's disease	Vascular dementia	Other causes of dementia	Ratio of vascular dementia to Alzheimer's disease
Karasawa et al., 1982* (43)	Japan	4.5	0.6	1.6	2.4	2.7
Ichinowatari et al., 1987* (44)	Japan	5.4	1.4	3.8	0.2	2.7
Li et al., 1989* (11)	China	1.8	0.4	1.0	0.4	2.5
Ueda et al., 1992*,†,‡ (45)	Japan	6.7	1.7	3.8	1.2	2.2
Kawano et al., 1990*,† (6)	Japan	5.8	1.2	2.1	2.5	1.8
Kiyohara et al., 1994*,† (46)	Japan	6.5	1.3	2.3	2.9	1.8
Hasegawa, 1990* (7)	Japan	4.8	1.2	2.0	1.6	1.7
Shibayama et al., 1986* (8)	Japan	5.8	2.4	2.8	0.6	1.2
Fukunishi et al., 1991* (47)	Japan	4.1	1.6	1.6	0.9	1.0
Folstein et al., 1991* (2)	United States	4 5	2.0	2.0	0.5	1 0
Kiyohara et al., 1994*,† (46)	Japan	4.8	1.5	1.5	1.8	1.0
Rocca et al., 1990*,† (4)	Italy	7.9	3.3	3.1	1.5	0.9
Ichinowatari et al., 1987* (44)	Japan	2.4	1.4	1.0	Not stated	0 7
Brayne and Calloway, 1989*,† (5)	Great Britain	6.2	3.2	1.9	1.1	0.6
Fratiglioni et al., 1991*,† (42)	Sweden	11.9§	6.0	3.0	2.9	0.5
Zhang et al., 1990*,† (15)	China	4.6	3.0	1.2	0.4	0.4
Present study*,†	United States	6.3	3.5	1.4	1.4	0.4
CSHA, 1994*,† (3)	Canada	8.0	5.1	1.5	1.4	0.3
O'Connor et al., 1989*,† (48)	Great Britain	10.5	7.9	2.1	0.5	0.3
Park et al., 1994* (16)	Korea	10.8	6.5	1.3	3.0	0.2
Bachman et al., 1992*,† (1)	United States	4.1	2.3	0.4	1.4	0.2
Dartigues et al., 1991* (49)	France	3.6	2.6	0.2	0.8	0.08
Liu et al., 1994* (10)	China	3.5	2.8	0.2	0.5	0.07
Evans et al., 1989* (41)	United States	10.3	8.7	0.3	1.3	0.03

* Community-based.
† Institution-based.
‡ Rates based on autopsy diagnoses.
§ Age ≥75 years.

those aged ≥95 years, is closer to the upper confidence limits of the studies conducted by Ebly et al. (52) and Wernicke and Reischies (54).

It is also possible that our study census missed very old persons in the community. However, a comparison of our census with the 1990 US Census (17) showed that our census identified approximately 97 percent of those aged ≥85 years. Given that participants aged ≥85 years were sampled with 100 percent probability for diagnostic evaluation and that refusal rates did not decrease with age overall (table 1), our prevalence estimates for the oldest old are likely representative of the Japanese American population living in King County.

Education and the prevalence of dementia and its subtypes

Much attention has been focused recently on the association observed in many population-based studies that persons with lower education are more likely to have or to develop dementia and Alzheimer's disease (15, 49, 55–57). Because there is also an effect of lower education on cognitive test-taking ability, there has been debate regarding the etiologic significance of the education effect (58), whether it is desirable to use different cutoff scores for persons with differing educational attainment (59), and whether it is possible to differentiate the two effects (60, 61). In our study, there was a strong relation between lower education and greater prevalence rates for all dementias, Alzheimer's disease, multi-infarct dementia, other, and unknown dementias when age was not taken into account. When these data were stratified by age, the association was much weaker and was no longer present in the older age groups. The lack of association between age-adjusted educational attainment and dementia may be due to a correlation between age and education in the oldest old in our sample that may not apply to other populations; it is in this group that we found a large number of cases, especially women. Nevertheless, the comparison of crude rates to age-stratified rates by education illustrates that age should be properly controlled in future studies that seek to examine education as a risk factor for dementia or Alzheimer's disease.

Institutional and community residence

In the present study, 59 percent of the cases lived in institutions. This proportion is similar to that reported

in other studies. For example, in the Canadian study (3), approximately half of the cases resided in institutions and half resided in the community. In a study done in Sweden (62), the proportion was comparable, with 55 percent of cases in institutions. Schoenberg et al. (63) found that among 80 cases of severe dementia in Mississippi, 44 percent lived in institutions. We suggest that the somewhat higher proportion in our study is due to the existence of a nursing home in Seattle that is targeted to the Japanese American population, and that this nursing home is inherently appealing to the community because of the integral role it plays in the community's support of its elderly. The decreasing ratio with age of institutionalized cases to community-dwelling cases (table 6) may suggest that, while use of the Japanese American nursing home provides an acceptable alternative to maintaining dementia patients in the community, families of the oldest patients continue to retain cultural values about care in the home while families of younger cases find nursing home care more acceptable or necessary.

The findings reported show that overall prevalence rates of dementia in a Japanese American community are similar to those of Caucasian populations in North America, and that the relative prevalence of vascular dementia to Alzheimer's disease also more closely resembles Caucasian than native Japanese populations. This implies that there may be environmental determinants that influence the risk of these diseases in Japanese populations as they migrate to the West. Our study also found very high prevalence rates of dementia in the oldest old. This may reflect an older age distribution in our population relative to that in other studies, which may result from greater longevity and/or a longer survival period following disease onset. Finally, in our population, lower education was not associated with dementia prevalence after adjusting for age.

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