

## Research Article

# Impairments in Activities of Daily Living in Older Japanese Men in Hawaii and Japan

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**Introduction.** Hypertension and cigarette smoking are dominant risk factors for cardiovascular disease in Japan while in westernized countries, broader effects encompass obesity, diabetes, and hypercholesterolemia. This paper examines whether different associations also appear important in the manifestation of activities of daily living (ADL) in older Japanese men in Hawaii and Japan. **Methods.** Measures of ADL (feeding, toileting, dressing, bathing, and walking around the house) were assessed from 1995 to 1999 in 1,893 men in Hawaii and 543 men in Japan. Concomitant risk factors were measured from 1990 to 1993. **Results.** In Hawaii, diabetes increased the odds of  $\geq 1$  ADL impairment nearly 1.5-fold ( $P = .020$ ). A similar association was absent in Japan. In contrast, the odds of an ADL impairment in Japan was increased more than 5-fold in the presence of stroke ( $P < .001$ ). The association in Hawaii was significantly weaker ( $P = .007$ ). In both cohorts, past alcohol use was associated with a greater likelihood of ADL impairment. **Conclusion.** In this comparison of genetically similar samples, findings suggest that different strengths in risk factor associations with cardiovascular disease in Japan and westernized countries may also include different strengths in associations with impaired ADL.

## 1. Introduction

Hypertension and cigarette smoking are often considered the most important risk factors for total mortality and morbidity from cardiovascular disease in Japan while in more westernized countries, broader effects encompass obesity, diabetes, and hypercholesterolemia [1]. Although in need of further study, differences in these risk factor associations could also have similar effects on declines in late-life physical function and activities of daily living (ADL), including difficulties in feeding, toileting, dressing, bathing, and walking around the house. A demonstration that this is the case would suggest

that ADL is not an inevitable consequence of aging but is culturally or environmentally determined, and prevention or delays in onset are possible. It might further imply that the most effective countermeasures or campaigns to prevent declines in ADL should include a greater emphasis on culturally dominant risk factors (e.g., hypertension and smoking in Japan versus obesity and diet in more westernized countries).

Implications are important since chronic disability and impairments in ADL will have an increasingly high impact on long-term care and public health resources as populations rapidly age [2, 3]. Social and economic support will need to be broad and comprehensive as they address a variety

of adverse consequences that are associated with ADL impairments that include affects on mobility, personal care, and nutrition [4–8].

The purpose of this report is to describe impairments in ADL that were observed in Japanese men in two samples that are genetically similar but with different risk factor and lifestyle exposures [9, 10]. The comparison will include a cohort of men enrolled in the Honolulu-Asia Aging Study (HAAS), and in Japan, a cohort enrolled in the National Integrated Project for Prospective Observation of Non-Communicable Disease and its Trends in the Aged (NIPPON DATA). Both are population-based longitudinal studies with similar periods of execution and methods of risk factor and physical function assessment. The key feature to be addressed is whether there are risk factor associations that emerge as being more important in one cohort versus another.

## 2. Methods

**2.1. Study Samples.** From 1965 to 1968, a long-term follow-up study of 8,006 Japanese-American men was launched on the island of Oahu, Hawaii (the Honolulu Heart Program) for the study of cardiovascular disease [9, 11]. Beginning with examinations that were given from 1991 to 1993, the Honolulu-Asia Aging Study (HAAS) was created as an expansion of the Honolulu Heart Program with a dedicated focus on neurodegenerative disease, cognitive function, and other diseases of aging [12].

The NIPPON DATA includes two cohorts of Japanese men who were enrolled in the 1980 and 1990 Japan National Survey on Circulatory Disorders [13–16]. Participants were randomly selected from regions in Japan that were considered to be representative of the general Japanese population. To better correspond with the timing of examinations that were given in the HAAS, only data for men enrolled in the 1990 sample were used. Among this group, participants were screened for ADL 5 years later (1995) and compared to similar assessments that were made in the HAAS from 1997 to 1999. The age range at the time of ADL assessment in the NIPPON DATA was further limited to 70–98 years to better match the 77–98-year age range at the time of ADL assessment in the HAAS. Because of the one-time measurement of concomitant risk factors in 1990 from the NIPPON DATA, comparisons were made to similar data collected at the initiation of the HAAS (1991–1993).

Among the regions sampled for the NIPPON DATA, there were 545 men aged 70 years and older who participated in the 1995 ADL survey (approximately 90% of the surviving participants who received examinations 5 years earlier). In the HAAS, 1,867 received an ADL assessment from 1997 to 1999 (nearly 80% of surviving participants who received examinations from 1991 to 1993). Two men in the NIPPON DATA and 3 men in the HAAS were excluded because of missing data for at least one ADL assessment. The remaining samples comprised 543 men from the NIPPON DATA and 1,863 men from the HAAS. For both cohorts, all subjects were sufficiently ambulatory to appear for a clinic evaluation for ADL assessment and measurement of concomitant risk

factors. Procedures were in accordance with institutional guidelines and approved by an institutional review board. Written informed consent was obtained from the study participants.

**2.2. Concomitant Risk Factors.** Concomitant risk factors that were measured from 1991 to 1993 in the HAAS and in 1990 in the NIPPON DATA included systolic blood pressure, hypertension, treatment for hypertension, diabetes, body mass index, total cholesterol, history of myocardial infarction and stroke, and cigarette smoking and alcohol drinking status. Age of the study participants corresponds with the age at ADL assessment.

For this report, a diagnosis of hypertension was made when a systolic or diastolic blood pressure was  $\geq 160$  and 95 mm Hg, respectively, or when subjects were receiving antihypertensive medication. Diabetes was defined based on a physician diagnosis, medical history, or the use of medications to treat diabetes. A diagnosis of diabetes was also made when a fasting blood glucose exceeded 125 mg/dL in the HAAS and when a nonfasting blood glucose exceeded 200 mg/dL in the NIPPON DATA. A history of myocardial infarction and stroke was based on a physician diagnosis or a self-report of either event. Further description of the remaining risk factors is provided elsewhere [9, 17–19].

**2.3. Activities of Daily Living.** The term ADL generally refers to features of an active life-style related to independence, mobility, and personal care [2, 3]. Impairments in ADL have been significantly related to chronic diseases [2]. During the ADL surveys that were given from 1997 to 1999 in the HAAS and in 1995 in the NIPPON DATA, impaired ADL was assessed through questions that were asked about difficulties in feeding, toileting, dressing, bathing, and walking around the house. In Hawaii, specific questions included “Because of health or physical problems, do you have difficulty (1) feeding yourself (like holding a fork, cutting food, or drinking from a glass), (2) getting to or using the toilet, (3) dressing yourself (like putting on a shirt, buttoning and zipping, or putting on/tying shoes), and (4) bathing or taking a shower.” Participants were also asked (5) “Do you have difficulty walking around your house.” Answers to each of the five questions included “no” and “yes.” “Yes” answers were coded as impaired ADL for the corresponding activity while “no” answers were coded as not impaired. In Japan, similar questions were asked with answers that included “independent,” “need partial assistance,” and “need full assistance.” Subjects who responded that they “need partial or full assistance” were defined as having impaired ADL for the corresponding activity while those who responded that they were “independent” in performing the activity were defined as not impaired.

**2.4. Statistical Analysis.** Crude and adjusted estimates of the percent prevalence of each ADL impairment were calculated between cohorts following standard analysis of covariance techniques and binary logistic regression models [20]. The prevalence of having  $\geq 1$  ADL impairment was also derived.

TABLE 1: Percent of elderly men with an impairment in activities of daily living (ADL) in Hawaii and Japan.

ADL impairment	Percent prevalence of an ADL impairment		Relative odds <sup>†</sup>
	Hawaii (1863)*	Japan (543)	
Feeding difficulty	4.7 (87) <sup>‡</sup>	2.2 (12)	2.17 <sup>  </sup> (1.18,3.99) <sup>§</sup>
Difficulty in using the toilet	6.0 (111)	3.3 (18)	1.85 <sup>¶</sup> (1.11,3.07)
Dressing difficulty	8.6 (161)	4.1 (22)	2.24 <sup>**</sup> (1.42,3.54)
Bathing difficulty	8.1 (150)	4.4 (24)	1.89 <sup>††</sup> (1.22,2.95)
Difficulty in walking around the house	8.5 (158)	2.4 (13)	3.78 <sup>**</sup> (2.13,6.71)

\* Sample size, <sup>†</sup> relative odds compare Hawaii to Japan.

<sup>‡</sup> Number with the impairment, <sup>§</sup> 95% confidence interval.

Significant excess odds of having an ADL impairment in Hawaii versus Japan: <sup>||</sup>  $P = .013$ , <sup>¶</sup>  $P = .018$ , <sup>\*\*</sup>  $P < .001$ , <sup>††</sup>  $P = .005$ .

In instances where the number of participants with an ADL impairment was small, exact testing methods were used, including Fisher's exact test and exact testing methods for logistic regression [21]. To compare the concomitant risk factors between the Hawaii and Japan samples, similar adjustment techniques were employed [20], including general linear regression models for continuous risk factors. To assess cohort effect and the association between a risk factor and ADL, the number of ADL impairments was treated as an ordinal dependent response using a proportional odds regression model [22]. Estimates of the relative odds of having  $\geq 1$  ADL impairment that could be associated with an important risk factor and cohort difference (along with 95% confidence intervals) were based on corresponding regression coefficients and standard errors. Interaction terms between cohort and each risk factor were further examined to determine if effects on impaired ADL were similar in Hawaii and Japan. All reported  $P$  values were based on two-sided tests of significance.

### 3. Results

Overall, 281 of the 1,863 elderly men in Hawaii had  $\geq 1$  ADL impairment as compared to 32 of the 543 men in Japan (15.1 versus 5.9%,  $P < .001$ ). The percent of men with a specific ADL impairment within each cohort is further described in Table 1. In all instances, the frequency of an ADL impairment is significantly higher in Hawaii than in Japan. The excess in Hawaii ranges from 85% for difficulty in toileting to a near 4-fold excess in difficulty in walking around the house. Comparisons after age and risk factor adjustment are described later in the paper.

In Table 2, risk factor characteristics of the two cohorts are compared based on the physical examinations that were given from 1991 to 1993 in Hawaii and in 1990 in Japan. Among the characteristics, the average age in Hawaii was 6.5 years older than in Japan ( $P < .001$ ). After accounting for the age disparity, there were several important risk factor differences. Most notable is that men in Hawaii had more than a 2-fold excess in the prevalence of diabetes than men in Japan (19.3 versus 8.5%,  $P < .001$ ). On average, body mass index was 2.2 kg/m<sup>2</sup> higher in Hawaii ( $P < .001$ ). For an average height of 162 cm, the latter corresponds to a difference of 5.8 kg. As a possible consequence of a greater

TABLE 2: Average age and age-adjusted risk factors in elderly men in Hawaii and Japan.

Risk factor	Hawaii (1863)*	Japan (543)	$P$ value
Age (y)	82.5 $\pm$ 3.9 <sup>†</sup>	76.0 $\pm$ 5.1	<.001
Systolic blood pressure (mm Hg)	147 $\pm$ 21	150 $\pm$ 21	.029
Hypertensive (%)	51.7 (980) <sup>‡</sup>	49.4 (252)	.417
Treatment for hypertension (%)	37.3 (688)	27.6 (153)	<.001
Diabetes (%)	19.3 (341)	8.5 (47)	<.001
Body mass index (kg/m <sup>2</sup> )	24.0 $\pm$ 3.0	21.8 $\pm$ 3.0	<.001
Total cholesterol (mg/dL)	194 $\pm$ 31	192 $\pm$ 35	.253
History of cardiovascular disease (%)			
Myocardial infarction	6.8 (116)	3.2 (22)	.007
Stroke	5.8 (110)	6.5 (33)	.631
Either event	11.8 (215)	8.7 (51)	.077
Cigarette smoking status (%)			
Past	55.3 (1010)	34.0 (202)	<.001
Current	6.6 (109)	35.6 (237)	<.001
Alcohol drinking status (%)			
Past	21.5 (395)	11.9 (67)	<.001
Current	38.9 (699)	41.5 (248)	.361

\* Sample size, <sup>†</sup> average  $\pm$  standard deviation, <sup>‡</sup> subjects with the risk factor.

frequency of treatment for hypertension in Hawaii (37.3 versus 27.6% in Japan,  $P < .001$ ), systolic blood pressure was higher in Japan ( $P = .029$ ). A history of myocardial infarction was doubled in Hawaii versus Japan (6.8 versus 3.2%,  $P = .007$ ) while a history of stroke was similar. Men in Japan were more than 5-times as likely to be current cigarette smokers versus Hawaii (35.6 versus 6.6%,  $P < .001$ ), while men in Japan were nearly half as likely to have been past alcohol drinkers (11.9 versus 21.5%,  $P < .001$ ).

Table 3 describes the association between the risk factors in Table 2 and the relative odds of having  $\geq 1$  ADL impairment at the 1997–1999 survey in Hawaii and the 1995 survey in Japan. As might be expected, a 10-year increase in age is

TABLE 3: Age-adjusted relative odds of having  $\geq 1$  impairment in activities of daily living (ADL) according to risk factor differences in elderly Japanese men in Hawaii and Japan.

Risk factor	Risk factor difference*	Age-adjusted relative odds	
		Hawaii	Japan
Age (unadjusted)	10 years	2.62 <sup>‡</sup> (1.96,3.51) <sup>†</sup>	3.87 <sup>‡</sup> (2.10,7.14)
Systolic blood pressure	20 mm Hg	0.92 (0.82,1.04)	1.02 (0.72,1.44)
Hypertension	Yes versus no	0.86 (0.67,1.11)	1.42 (0.68,2.97)
Treatment for hypertension	Yes versus no	0.88 (0.67,1.15)	1.67 (0.79,3.54)
Diabetes	Yes versus no	1.45 <sup>§</sup> (1.06,1.99)	0.72 (0.16,3.15)
Body mass index	3 kg/m <sup>2</sup>	1.01 (0.88,1.15)	1.05 (0.72,1.52)
Total cholesterol	40 mg/dL	0.85 (0.72,1.01)	0.91 (0.58,1.43)
History of cardiovascular disease			
Myocardial infarction	Yes versus no	1.45 (0.88,2.37)	0.65 (0.08, 5.11)
Stroke	Yes versus no	1.43 (0.88,2.34)	5.55 <sup>‡</sup> (2.20,14.03)
Either event	Yes versus no	1.54 <sup>  </sup> (1.06,2.22)	3.87 <sup>¶</sup> (1.64,9.13)
Cigarette smoking status			
Past	Yes versus never	0.95 (0.74,1.23)	0.71 (0.32,1.55)
Current	Yes versus never	1.07 (0.62,1.84)	1.36 (0.64,2.89)
Alcohol drinking status			
Past	Yes versus never	1.38 <sup>**</sup> (1.03,1.85)	3.13 <sup>††</sup> (1.35,7.25)
Current	Yes versus never	0.55 <sup>‡</sup> (0.41,0.73)	0.72 (0.33,1.55)

\* For continuous risk factors, estimated relative odds compare the risk of  $\geq 1$  ADL impairment in men with a high versus low risk factor level where risk factors differ by the amount specified.<sup>†</sup>95% confidence interval.

Significant risk factor effect: <sup>‡</sup> $P < .001$ , <sup>§</sup> $P = .020$ , <sup>||</sup> $P = .022$ , <sup>¶</sup> $P = .002$ , <sup>\*\*</sup> $P = .034$ , <sup>††</sup> $P = .008$ .

Note: the association between a history of stroke and having  $\geq 1$  ADL impairment is significantly stronger in Japan versus Hawaii ( $P = .007$ ).

associated with a significant increase in the odds of an ADL impairment that ranges from a 2.62-fold excess in Hawaii to a near 4-fold excess in Japan. All of the other relative odds are adjusted for the difference in age between the two cohorts. Among the risk factors, measures of blood pressure and its treatment were unrelated to impairments in ADL. Associations with body mass index, total cholesterol, and cigarette smoking status were also absent.

In contrast, compared to men without diabetes in Hawaii, those with diabetes had a 1.45-fold excess in the odds of an ADL impairment ( $P = .020$ ). A similar association was absent in Japan. Contrary to the association of diabetes in Hawaii, a history of stroke in Japan was associated with more than a 5-fold excess in the odds of an impaired ADL ( $P < .001$ ). Its association with ADL was significantly stronger than in Hawaii ( $P = .007$ ).

Past drinking among men in either cohort was also associated with a significant excess in the odds of an impaired ADL. In Japan, there was more than a 3-fold excess while in Hawaii, it was weaker (but not significantly different from Japan). In Hawaii, current drinking was associated with an odds of impaired ADL that was 45% lower than in those who never consumed alcohol ( $P < .001$ ). A similar association in Japan was less strong and not statistically significant.

Table 4 indicates that the excess in ADL impairment in Hawaii is only partly explained by the observed differences in risk factor profiles and associations with impaired ADL. Some of the excess is due to the average age being older in Hawaii. After age-adjustment, the relative odds of an impaired ADL in Japan versus Hawaii is reduced from 2.84

TABLE 4: Unadjusted and adjusted percent of elderly men with  $\geq 1$  impairment in activities of daily living (ADL) in Hawaii and Japan.

	Percent with $\geq 1$ ADL impairment		
	Hawaii (1863)*	Japan (543)	Relative odds <sup>†</sup>
Unadjusted	15.1 (281) <sup>‡</sup>	5.9 (32)	2.84 <sup>¶</sup> (1.94,4.14) <sup>§</sup>
Age adjusted	13.7	9.3	1.56 <sup>**</sup> (1.04,2.34)
Risk factor adjusted <sup>  </sup>	13.2	8.9	1.58 <sup>††</sup> (1.01,2.47)

\* Sample size, <sup>†</sup>relative odds compare Hawaii to Japan.

<sup>‡</sup>Number of men with  $\geq 1$  ADL impairment, <sup>§</sup>95% confidence interval.

<sup>||</sup>Adjusted for age, hypertension, diabetes, body mass index, total cholesterol, history of myocardial infarction and stroke, and cigarette smoking and alcohol drinking status.

Significant excess odds of having  $\geq 1$  ADL impairment in Hawaii versus Japan: <sup>¶</sup> $P < .001$ , <sup>\*\*</sup> $P = .032$ , <sup>††</sup> $P = .045$ .

( $P < .001$ ) to 1.56 ( $P = .032$ ). After further adjustment for hypertension, diabetes, body mass index, total cholesterol, history of myocardial infarction and stroke, and cigarette smoking and alcohol drinking status, there continued to be an excess in impaired ADL in Hawaii versus Japan (13.2 versus 8.9%,  $P = .045$ ).

#### 4. Conclusions

In this comparison of genetically similar elderly men, findings suggest that diabetes is an important correlate of ADL in Hawaii. In contrast, stroke is dominant in Japan. While in need of further study, attention to risk factor



clusters (obesity and diabetes) that are more prevalent in Hawaii and westernized societies may have a greater impact on altering ADL impairment than attention to other risk factors. Risk factors with underlying links to hypertension (to avoid stroke and alter its affect on impaired ADL) may be more important in Japan. Observations are consistent with differences in risk factor effects on total mortality that have been observed between these cohorts [1].

Unfortunately, life-time exposure to coexisting disease makes it difficult to regard one set of risk factors as more important than another. Diabetes in Hawaii may have been of longer duration and greater severity due to a high excess in body mass index that could have existed since middle adulthood. In studies where diabetes had an association with functional status and physical disability, the average body mass index was 29 kg/m<sup>2</sup> and higher [4, 8]. In the Japanese sample in Japan, the average body mass index was 21.8 kg/m<sup>2</sup> (Table 2). Use of fasting glucose levels in Hawaii and nonfasting levels in Japan as part of the definition of diabetes is inconsequential in this report. When diabetes is defined solely on a physician diagnosis, medical history, or the use of medications to treat diabetes, the significance and magnitudes of association with impaired ADL are nearly the same as reported in Table 3.

In contrast to diabetes, a history of stroke was associated with more than a 5-fold excess in ADL impairment in Japan. Although there was an excess in ADL impairment among those with stroke in Hawaii, it was not statistically significant. In addition, the association between a history of stroke and ADL impairment was stronger in the sample from Japan versus Hawaii ( $P = .007$ ). In an earlier report from the NIPPON DATA, stroke was also reported to be the main cause of impaired ADL [2]. Death from stroke has been further linked with longer periods of disability than other causes of death [23].

Hypertension, a leading risk factor for stroke, might also be associated with impaired ADL. In Japan, there was a 42% excess in ADL impairment in the presence versus the absence of hypertension (Table 3), although it was not statistically significant. In a recent report from the 1980 NIPPON DATA survey (among participants aged 47–59 years), impaired ADL was more likely in those with elevated blood pressure [3]. The lack of association between hypertension (and stroke) and more frequent ADL impairment in Hawaii is especially noteworthy, particularly since the Hawaii sample is older and considerably larger than the sample from Japan.

Given that ADL has a significant association with diabetes in Hawaii, it seems interesting that there is a lack of association with body mass index. This is not unexpected, however, since effects of obesity on survival tend to attenuate with advancing age. In general, this is true for a variety of traditional risk factors [24–27]. In the elderly, relationships between risk factors and disease are complex, largely due to high levels of heterogeneity in illness and subclinical frailty that are less common in younger samples. Risk factor levels can also change with age [28–30]. Some evidence supports the possibility that mid life risk factors are better in describing the risk of cardiovascular disease than are those measured in later life. Investigators from the Atherosclerotic Risk

in Communities Study suggest that hypercholesterolemia, hypertension, and the use of cigarettes in middle adulthood may have residual effects on the development of subclinical disease later in life [31]. In the Framingham Study, carotid stenosis in a sample of men whose average age was 75 years had a markedly reduced association with late-life cholesterol levels as compared to cholesterol levels measured earlier [32]. In the Honolulu Heart Program, it has been observed that the one-time measurement of total cholesterol in late-life could result in an underestimate of the real risk of disease if past cholesterol levels were high [33]. In elderly men, an excess of coronary heart disease begins to appear for total cholesterol levels <160 mg/dL [34]. In contrast, diabetes in Japanese men in Hawaii continues to be a dominant risk factor across all age strata for total mortality, stroke, and coronary heart disease [1, 24, 25]. While it is currently less important than other risk factors in Japan, the Japanese in Japan have fewer exposure to factors that promote diabetes versus Japanese in Hawaii [1, 35]. This could change as Japan becomes increasingly westernized [1, 36–38].

One might expect that elevated body mass index (throughout life) could also promote impairments in ADL through other mechanisms that include associations with diabetes and possibly knee joint injuries in late life or difficulties in walking around the house (more common in Hawaii but unrelated to body mass index in the current sample). It may be that impairments in ADL are more frequent in the presence of subclinical frailty where weight loss is a problem. Long-term followup of the effects of body mass in middle adulthood on the risk of late-life ADL impairment might reveal a clearer association. While midlife data in the sample from Japan are not available, in Hawaii, impaired ADL in later life tended to be more frequent ( $P = .077$ ) in men with higher body mass index when measured more than 25 years earlier at the time of initiation of the Honolulu Heart Program (1965–1968).

Among the other risk factors having an association with impaired ADL, past alcohol drinking was significantly associated with impaired ADL in both cohorts. The association was stronger in Japan, although the difference from Hawaii was not significant. In both samples, drinking cessation might have been voluntary due to poor health or to disability that limited access to alcohol.

Other unknown risk factors that could be important include physical activity and diet. Because of high residential density and access to shopping, services, and business, physical activity could be higher in Japan than in Hawaii [39–41]. Its effect on the future risk of impaired ADL could be critical. Traditional life-long behaviors in Japan that include squatting and rising from floor level could have effects on balance and lower extremity strength [42].

Consumption of a Japanese diet rich in fish and soy may also be a factor in contributing to less body mass index in early life and to less frequent or severe forms of diabetes. In a direct comparison with Japanese men in Hawaii, men in Japan had an exceptionally low prevalence of subclinical atherosclerosis that was largely attributed to a significantly higher intake of marine-derived n-3 fatty acids [36]. High consumption of fish in a large Korean sample was also

associated with a lower risk of the metabolic syndrome [43]. The latter may be particularly relevant as it relates to the association between diabetes and ADL. The Japanese also consume high amounts of salt which promote stroke. Differences in the cultural milieu and family support systems between Japan and Hawaii may also have a role, but they are complex and cannot be measured from existing data.

With a comparison between Japanese men in Hawaii and Japan, genetic factors may offer less of an explanation for the current findings versus factors that have a cultural or environmental origin. Of course, this assumes that gene distributions and genetic susceptibilities are similar between the samples being compared, which is much more likely than in comparisons involving groups with different ancestry. While being entirely Japanese, the two samples were also all men. Even with equal frequencies of genetic susceptibility, however, genetics may still be important. An excess in nongenetic risk factors in one sample could alter disease risk by providing an environment for genetic effects to have a role in disease processes.

Although there are several limitations in the current study, the most important might be the inclusion of men in the Japan sample who were younger than those in Hawaii (ages 70–98 years in Japan versus 77–98 years in Hawaii). While the inclusion of the younger men in Japan was meant to increase the sample size from the NIPPON DATA, there is still a broad overlap in age range. Whether age explains entire cohort differences in relationships that diabetes and stroke have with ADL seems unlikely based on similar associations that these factors have with total mortality [1]. Presenting the two samples together at least provides a format for describing the correlates of ADL that were observed within each cohort. Confounding due to age may also be modest since most comparisons were age adjusted. The strong association between stroke and ADL in the smaller and younger sample from Japan further suggests that the difference from the stroke association in Hawaii is real. Whether time differences in living factors are important cannot be determined. Additional limitations include the inability to provide generalizations to other population segments, particularly in women. Both samples from Japan and Hawaii, however, are characterized by a broad range of clinically important risk factors that were collected in similar fashion and within a reasonable period of time. For those less willing to participate in medical research, risk factor associations could be stronger.

In conclusion, the finding of a difference in the correlates of ADL between communities with genetically similar backgrounds suggests that impaired ADL is not an inevitable consequence of aging but has an important and highly modifiable cultural or environmental component. It may be that the most effective countermeasures or campaigns to prevent declines in ADL are those that consider regional differences in risk factor prevalence and strengths of association.

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