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ANALYSIS OF HEALTH AND ACTIVITY LIMITATION INDEX (HALex), ITS DISTRIBUTION, AND ITS DISTRIBUTION BY INCOME IN JAPAN, 1989 AND 1998

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ABSTRACT

It is a widely shared view in the population health field that the future of the analysis of population health lies in the assessment both of the length of life and health-adjusted quality of life, and the parallel examination of the average health and health distribution within a population. Using a nationally representative sample of the 1989 and 1998 wave of the Japanese Comprehensive Survey of Living Conditions of the People on Health and Welfare (CSLC), this research aims to conduct such assessment of the health of Japanese people: examination of the average health-adjusted quality of life, its distribution, and its distribution by income share. This study departs from previous health inequality analyses in the following two ways: (1) construction of a health state measure in the CSLC equivalent to the Health and Activity Limitation Index (HALex) and its application to health inequality analysis, and (2) inclusion of the dead in health inequality analysis. This study found that between 1989 and 1998 overall in Japan the HALex on average slightly reduced (0.005 reduction), its inequality by income slightly reduced (0.002 reduction in the difference between the top 20% and bottom 20% income share groups), and its inequality measured by the Gini Coefficient slightly increased (0.002 increase). Women's HALex was almost always lower than men's, except in earlier ages younger than ten years old. The HALex was more unequally distributed among women than men and in older ages. This analysis shows that the success in the improvement in the length of life in Japan did not always coincide with the improvement in the health-adjusted quality of life and provides a basis for the future population health research.

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INTRODUCTION

Recently, there is a growing interest in health inequality. Such an influential health policy-making body as the World Health Organization (WHO) now claims that a traditional average health of a population does not provide enough information as a population health measure, and investigation of the distribution of health within a population is necessary (World Health Organization 2000). The goals of improving the health of a population are thus often expressed as the increase in the average level of health and the decrease in health inequality. These two objectives are, for example, clearly specified in the *Healthy People 2000* (U.S. Department of Health and Human Services 1991) and the *World Health Report 2000* (World Health Organization 2000).

Analysis of health inequality in Japan should attract keen interest by many. Japanese people's average health attainment is already received as a miracle. In the past decades, for example, the average health of Japanese people measured by life expectancy has improved dramatically - life expectancy was 63.6 years for men and 67.8 years for women in 1955 and 77.1 years for men and 84.0 years for women in 1999 (Statistics and Information Department 1999). In the *World Health Report 2000*, Disability-adjusted Life Expectancy or DALE at birth for Japanese people in 1997-1999 is estimated as 74.5 years and ranked the top among 191 countries (World Health Organization 2000). Explanation of exactly what brought this dramatic health improvement remains unsatisfactory beyond such general speculations as the public health system, work ethic, diet, and economy in Japan (Marmot and Smith 1989). In addition to the wonder at this dramatic improvement of health among Japanese people, there is also a general perception of the Japanese society as "egalitarian." Is this perception true – more precisely, regarding health, has the health improvement occurred equally to everyone? How has health distribution changed during the rapid improvement of the average health? Might the high overall health attainment relate to how health is distributed among Japanese people?

With a rapidly growing interest in health inequality in general and that of Japan in particular, analysis of health inequality in Japan has just begun. At the overall country level, the WHO ranks equality of child survival in Japan as the third among its 191 member countries (World Health Organization 2000). Regarding inequalities in health beyond survival and health of older ages, we must wait for further research. In terms of so-called socioeconomic differences in health (Murray, Gakidou, and Frenk 1999), there are a few studies suggesting differences in health by income in Japan. Shibuya, Hashimoto, and Yano found a graded inverse relationship statistically significant at the $p<0.05$ level between the household income and self-reported health

among a nationally representative sample of about 81,000 people who were 15 years of age and older in 1995 (2002). Using all persons who were 65 years of age and older in one city as study subjects (N=5124), Kondo reported that, adjusting for sex and age, every decrement of $10,000 household income increased the risk for requiring care from others among the elderly 1.69 times (95% confidence interval (CI): 1.49-1.92) (2000).

Studies have also reported geographic differences in health in Japan. Using cross-sectional data, Hasegawa found prefectual differences in infant mortality dropped as the infant mortality for the entire nation increased (2001). The absolute rate difference between the best and the worst prefecture was 100 infant deaths per 1000 in 1930, less than 30 per 1000 in 1960, and less than 3 per 1000 in 1990. The Gini coefficient for prefectual differences in life expectancy was greater than 0.3 before the Second World War, and 0.05 after that war. There have also been reports on geographic difference in mortality using a smaller unit, for example, in Kawasaki city, and the increasing geographic difference in life expectancy in Tokyo district between 1970 and 1990 (Takano 1998).

Furthermore, it has also been suggested that differences in health by occupation exist in Japan. Using vital statistics between 1965 and 1990, Hasegawa examined occupational differences in age-adjusted mortality rates for men (2001). He found that all occupational groups experienced decline in mortality rates, but the benefit was not equal among occupational groups. The managerial, professional/technical, clerical and sales workers improved their mortality rates more than workers in the service and agriculture, fishery, and forestry categories. Interestingly, the same analysis using the 1980-1990 data for women suggested that female clerical workers had the lowest mortality rates, lower than professional/technical. The author speculated that this might have reflected the difficulty for Japanese women to seek professional jobs in the Japanese society.

With these few studies, each of which has focused on different aspects of health inequalities, it is difficult to provide an overall picture of how health per se or health in relation to other goods (e.g., income, geographic location, or occupation) is distributed within the country. Nonetheless, these studies suggest that we should think that health inequalities do exist in Japan, and it is unwise of anyone blindly to accept the "egalitarian" perception of the Japanese society and put the research endeavor aside.

We investigate a trend of health inequality in Japan between 1989 and 1998 using the nationally representative sample of the Comprehensive Survey of Living Conditions of the People on Health and Welfare (CSLC). This analysis departs from

previous health inequality analyses in Japan in the following two ways: (1) construction of a health state measure in the CSLC equivalent to the Health and Activity Limitation Index (HALex), that is, the quality of life part of the Years of Health Life (YHL) in the US and its application to health inequality analysis, and (2) inclusion of the dead in health inequality analysis.

"Health state measures" are a cutting-edge health measure. In our appreciation of health, we value both "living long" and "living well." In addition to the former, the most traditional concern of health, health state measures attempt to capture the latter, the health-adjusted quality of life that goes along with the length of life. Various health state measures have been developed by different research groups, including the EQ/5D, the Health Utilities Index (HUI), the Quality of Well-being, the SF-36, and the YHL (for an excellent, comprehensive guide, see McDowell and Newll 1996). None of these measures is perfect, but the development is rapid and their use is expeditiously expanding. For example, the gold standard measure of the improvement of health in cost-effectiveness analysis is now considered to be quality-adjusted life years (QALYs) obtained by these health state measures (Gold et al. 1998; Russell et al. 1996). Also, in the effort of assessing the health-adjusted quality of life among its people, the Canadian government began to include the HUI questions in population health surveys (Statistics Canada).

The HALex was created for the purpose of assisting one of the three goals of *Healthy People 2000*: increasing the span of healthy life for Americans. Monitoring both quality and quantity aspects of the health of the population, a new variable, the HALex, was developed. Often constructing a health state measure requires an explicit value assessment, yet there was no resource to conduct such a value assessment. Erickson and her colleagues then based a new measurement on existing information, the life table of the US population and morbidity information from the National Health Interview Survey (NHIS) (Erickson, Wilson, and Shannon 1995). Its construct and incremental validity have later been evaluated and confirmed (Erickson 1998).

While many industrialized countries are keen on introducing health state measures, Japan is slow in this regard. The EQ-5D, the HUI, and the SF-36 were translated into Japanese (see, for example, the special issue of *Kosei no shihyo*), but their application has been limited to small, exploratory samples and never been applied to a nationally representative sample. This research is the first to use a cutting-edge health state measure in analysis of the health of a nationally representative sample of Japanese people. Cross-national application of a health state measure is challenging and at times problematic, yet we believe that this attempt is an important step forward

for a better analysis of the population health in Japan.

The second feature of this research is the inclusion of the dead in analysis of health inequality, despite the use of a cross-sectional survey. A cross-sectional health survey usually only collects health information of the living and neglects the dead of the target population. Recognizing death as a health outcome, one might argue that analysis of the health of the living only provides partial information of the population health. However healthy the living population may be, if there were also a great proportion of deaths in the population, we may not be able to capture the state of the population health merely by looking at the health of the living. Accordingly, in this analysis, we attempt to assess the health of the Japanese population not only by the living but also including the dead.

We set the following three objectives in this research:

(1) What was the average health-adjusted quality of life measured by the HALex in Japan, overall, by sex and by age group in 1989 and 1998?

(2) How was the HALex distributed by income share in Japan, overall, by sex and by age group in 1989 and 1998?

(3) How was the HALex, from death to the "full" health, distributed in Japan, overall, by sex and by age group in 1989 and 1998?

The plan of this report is as follows. First, we explain data sources, construction of the HALex, and health inequality measures used in this study. Second, we present results in order of the three questions above. Finally, we discuss issues raised in this analysis and make policy recommendations.

Before proceeding, a word of caution is in order. There is as yet no commonly accepted definition of "health inequality." In this report, "health distribution" is a way in which health is spread among individuals or groups of people in a population of concern, "health equality" suggests the health distribution in which health is spread equally to every party of focus in a population, and "health inequality" means all health distributions that are otherwise.

METHODS

Data Sources

The living

Data of the living come from the Comprehensive Survey of Living Conditions of the People on Health and Welfare (CSLC) conducted by the Ministry of Health, Labor and Welfare, Japan (Statistics and Information Department 1989a; Statistics and Information Department 1998a). This cross-sectional survey consists of four parts: household,

health, income, and assets. The purpose of the survey is to collect basic information on health, health care, pension, welfare, and income of Japanese people useful for national health policy-making. Data on all four parts have been collected every three years since 1986. This study used household, health, and income data in 1989 and 1998, the earliest and the latest available years that provide all necessary variables for our analysis.

The survey sample consists of a nationally representative sample of non-institutionalized individuals selected by probability sampling methods. There is no oversampling. One-stage cluster sampling with equal probabilities is used for the household and health parts: for the 1998 data, all 276,289 households were chosen from 5,240 census units randomly selected from the 1995 census units. Each census unit contains about 50 households. The response rate (i.e., number of questionnaires collected / number of questionnaires distributed) for the household and health part in 1998 was 89.7%. Two-stage cluster sampling with equal probabilities is used for the income and asset parts: all 40,430 households were chosen from 2,000 sub-census units randomly selected from these 5,240 census units. Each sub-census unit contains 20-30 households. In 1989, about 260,000 households were selected for the household and health part, and about 50,000 households for the income and asset part. The response rate for the income and asset parts in 1998 was 80.6%. Once a household is chosen, all family members are invited to complete the survey. Ministry officials interview respondents at their home for income and assets information. For the household and health part, they distribute and collected the questionnaires, but respondents answer the health part of the survey in a self-administered manner. Surrogate responses are used for children younger than 12 years old and people with difficulties answering the questionnaire by themselves.

The original sample size of the 1989 household and health data is 803,228 and the 1998 household and health data, 721,403. For the income part, the original sample size is 125,492 for 1989 and 90,059 for 1998. For this analysis, we used data of individuals between 6 years and 94 years of age who had answered all questions necessary for this analysis, resulting in the sample size of 700,421 for the 1989 health data, 630,521 for the 1998 health data, 109,492 for the 1989 income data, and 79,377 for the 1998 income data. We excluded data of individuals younger than 6 years old because they had not been invited to answer questions on activity limitations. We excluded data of individuals 95 years of age and older because it was not possible to obtain data of the dead for this cohort of individuals (see below).

The dead

A cross-sectional survey only collects information of the living. We imputed the number of the dead and included them in our analysis of distribution of health. The most straightforward dead imputation might appear to be calculating the number of people who died between their births and the time of the survey and adding them into the existing living sample. This strategy unfortunately suffers from technical and conceptual difficulties. Although it is theoretically possible to trace back a number of the dead from the vital statistics, the data quality may be questionable. Also, adjusting the vital statistics for migration of multiple years will be cumbersome, if not impossible. Moreover, even if we could obtain good quality vital statistics and adjust them for migration perfectly, results emerging from this sample of the living and the dead combined would not be of much use for policy-making. Some of the dead in this sample have "just died," that is, deaths occurred last year, while others among the dead have been dead for many years. This mixture of various deaths makes it difficult to make policy recommendation useful at the current time. In other words, it is conceptually confusing to treat deaths spreading over years cross-sectionally and to look at deaths occurred over years and health states of the living captured at a much shorter period of time.

Thus, we instead focus on deaths occurring around the survey years. We used the mortality rate of each age between 6 and 94 years old published in the abridged life tables for Japan 1989 and 1998 (Statistics and Information Department 1989b; Statistics and Information Department 1998b) and computed how many people in our living sample of 1989 and 1998 would be dead on the following years. A drawback of this method is that a number of imputed deaths will always be smaller than the actual number of deaths because the mortality rates we used are not adjusted for health states. Our results, therefore, should be regarded as being biased towards the healthy. Tables 1-6 show the process of the dead calculation and a resulting number of the imputed dead for 1989 and 1998, overall, by sex, and by sex and age group (6-14, 15-24, 25-44, 45-64, 65-74, 75-94), along with the corresponding living populations.

Table 1. Calculation of the dead for male, 1989

age	Number in 1989 data	1989 mortality rate	Number of deaths in 1990 among the 1989 sample	Total number including the dead
6	4506	0.00025	1	4507
7	4782	0.00023	1	4783
8	4987	0.00021	1	4988
9	5318	0.00018	1	5319
10	5502	0.00016	1	5503
11	5717	0.00015	1	5718
12	5825	0.00015	1	5826
13	6104	0.00017	1	6105
14	6384	0.00023	1	6385
15	6580	0.00036	2	6582
16	6663	0.00052	3	6666
17	6338	0.00069	4	6342
18	5476	0.00081	4	5480
19	4942	0.00087	4	4946
20	4801	0.00087	4	4805
21	4651	0.00083	4	4655
22	4198	0.00077	3	4201
23	4100	0.00073	3	4103
24	4398	0.00072	3	4401
25	4277	0.00074	3	4280
26	4196	0.00076	3	4199
27	4246	0.00076	3	4249
28	4255	0.00076	3	4258
29	4441	0.00076	3	4444
30	4710	0.00078	4	4714
31	4520	0.0008	4	4524
32	4617	0.00082	4	4621
33	4810	0.00086	4	4814
34	5252	0.00091	5	5257
35	5233	0.00097	5	5238
36	5601	0.00105	6	5607
37	5937	0.00115	7	5944
38	6464	0.00127	8	6472
39	7020	0.0014	10	7030
40	7329	0.00155	11	7340
41	7607	0.00172	13	7620
42	6328	0.00192	12	6340
43	3945	0.00216	9	3954
44	5026	0.0024	12	5038
45	5763	0.00264	15	5778
46	5366	0.00286	15	5381
47	5819	0.00308	18	5837
48	5363	0.00336	18	5381
49	4865	0.00372	18	4883
50	4410	0.00416	18	4428

Table 1. Calculation of the dead for male, 1989, cont.

age	Number in 1989 data	1989 mortality rate	Number of deaths in 1990 among the 1989 sample	Total number including the dead
51	4998	0.00464	23	5021
52	4850	0.00518	25	4875
53	5045	0.00579	29	5074
54	4737	0.00648	31	4768
55	4740	0.00727	34	4774
56	4740	0.00808	38	4778
57	4723	0.00888	42	4765
58	4724	0.00963	45	4769
59	4405	0.01034	46	4451
60	4413	0.01108	49	4462
61	4170	0.0119	50	4220
62	4153	0.01286	53	4206
63	3882	0.01397	54	3936
64	3608	0.01518	55	3663
65	3275	0.01654	54	3329
66	2798	0.01803	50	2848
67	2572	0.01977	51	2623
68	2527	0.02176	55	2582
69	2377	0.0241	57	2434
70	2182	0.02675	58	2240
71	2005	0.02975	60	2065
72	1988	0.03308	66	2054
73	1932	0.03673	71	2003
74	1832	0.04067	75	1907
75	1742	0.04527	79	1821
76	1582	0.05071	80	1662
77	1486	0.05698	85	1571
78	1294	0.064	83	1377
79	1254	0.07189	90	1344
80	1033	0.07987	83	1116
81	907	0.08861	80	987
82	783	0.09805	77	860
83	634	0.10824	69	703
84	495	0.11922	59	554
85	436	0.13106	57	493
86	381	0.14379	55	436
87	266	0.15747	42	308
88	217	0.17214	37	254
89	170	0.18787	32	202
90	120	0.20468	25	145
91	88	0.22264	20	108
92	61	0.24176	15	76
93	38	0.2621	10	48
94	26	0.28366	7	33

Table 2. Calculation of the dead for female, 1989

age	Number in 1989 data	1989 mortality rate	Number of deaths in 1990 among the 1989 sample	Total number including the dead
6	4241	0.00016	1	4242
7	4706	0.00015	1	4707
8	4702	0.00014	1	4703
9	5093	0.00013	1	5094
10	5243	0.00012	1	5244
11	5514	0.00012	1	5515
12	5484	0.00012	1	5485
13	5920	0.00012	1	5921
14	6174	0.00013	1	6175
15	6283	0.00016	1	6284
16	6329	0.0002	1	6330
17	6135	0.00024	1	6136
18	5534	0.00028	2	5536
19	5022	0.00031	2	5024
20	4948	0.00031	2	4950
21	4948	0.00031	2	4950
22	4403	0.0003	1	4404
23	4412	0.0003	1	4413
24	4777	0.00031	1	4778
25	4475	0.00032	1	4476
26	4446	0.00034	2	4448
27	4585	0.00036	2	4587
28	4591	0.00039	2	4593
29	4710	0.0004	2	4712
30	4901	0.00042	2	4903
31	4715	0.00043	2	4717
32	4726	0.00046	2	4728
33	4996	0.00049	2	4998
34	5277	0.00054	3	5280
35	5465	0.00059	3	5468
36	5807	0.00065	4	5811
37	5997	0.00072	4	6001
38	6606	0.00079	5	6611
39	7201	0.00087	6	7207
40	7300	0.00095	7	7307
41	7648	0.00102	8	7656
42	6273	0.0011	7	6280
43	3974	0.00118	5	3979
44	5182	0.00127	7	5189
45	5819	0.00138	8	5827
46	5496	0.00149	8	5504
47	5829	0.00163	10	5839
48	5361	0.0018	10	5371
49	5115	0.00199	10	5125
50	4445	0.00217	10	4455

Table 2. Calculation of the dead for female, 1989, cont.

age	Number in 1989 data	1989 mortality rate	Number of deaths in 1990 among the 1989 sample	Total number including the dead
51	5146	0.00235	12	5158
52	5124	0.00253	13	5137
53	5185	0.00275	14	5199
54	5057	0.00301	15	5072
55	4904	0.00329	16	4920
56	5183	0.00358	19	5202
57	5047	0.00386	19	5066
58	4951	0.00416	21	4972
59	4664	0.00448	21	4685
60	4845	0.00483	23	4868
61	4644	0.00525	24	4668
62	4591	0.00573	26	4617
63	4518	0.00629	28	4546
64	4237	0.00695	29	4266
65	4047	0.00773	31	4078
66	3897	0.00859	33	3930
67	3816	0.00957	37	3853
68	3655	0.01069	39	3694
69	3405	0.01197	41	3446
70	2882	0.01341	39	2921
71	2883	0.01504	43	2926
72	2794	0.01689	47	2841
73	2847	0.01896	54	2901
74	2648	0.02138	57	2705
75	2499	0.02428	61	2560
76	2355	0.02771	65	2420
77	2235	0.03176	71	2306
78	2061	0.03662	75	2136
79	1816	0.04233	77	1893
80	1625	0.04856	79	1704
81	1416	0.05526	78	1494
82	1206	0.06272	76	1282
83	923	0.07101	66	989
84	842	0.08021	68	910
85	719	0.09043	65	784
86	608	0.10174	62	670
87	566	0.11426	65	631
88	426	0.12808	55	481
89	308	0.14332	44	352
90	237	0.1601	38	275
91	171	0.17851	31	202
92	111	0.19867	22	133
93	101	0.22068	22	123
94	57	0.24465	14	71

Table 3. Calculation of the dead for male, 1998

age	Number in 1998 data	1998 mortality rate	Number of deaths in 1999 among the 1998 sample	Total number including the dead
6	3109	0.0002	1	3110
7	3408	0.00019	1	3409
8	3640	0.00017	1	3641
9	3871	0.00014	1	3872
10	3834	0.00012	0	3834
11	4133	0.00012	0	4133
12	4172	0.00013	1	4173
13	4319	0.00017	1	4320
14	4488	0.00023	1	4489
15	4624	0.00031	1	4625
16	4650	0.00042	2	4652
17	4665	0.00053	2	4667
18	4402	0.00063	3	4405
19	4327	0.00069	3	4330
20	4256	0.0007	3	4259
21	4168	0.0007	3	4171
22	4305	0.00069	3	4308
23	4505	0.00068	3	4508
24	4517	0.00068	3	4520
25	4531	0.00068	3	4534
26	4298	0.00069	3	4301
27	4278	0.00071	3	4281
28	4174	0.00073	3	4177
29	4182	0.00075	3	4185
30	4169	0.00078	3	4172
31	3724	0.00082	3	3727
32	3620	0.00086	3	3623
33	4190	0.0009	4	4194
34	3907	0.00095	4	3911
35	3994	0.00102	4	3998
36	3947	0.0011	4	3951
37	4109	0.00118	5	4114
38	4153	0.00127	5	4158
39	4397	0.00137	6	4403
40	4240	0.00148	6	4246
41	4235	0.00162	7	4242
42	4269	0.00178	8	4277
43	4672	0.00196	9	4681
44	4735	0.00216	10	4745
45	5106	0.00241	12	5118
46	5230	0.00268	14	5244
47	5627	0.00299	17	5644
48	6063	0.00334	20	6083
49	6447	0.00371	24	6471
50	6564	0.00408	27	6591

Table 3. Calculation of the dead for male, 1998, cont.

age	Number in 1998 data	1998 mortality rate	Number of deaths in 1999 among the 1998 sample	Total number including the dead
51	5387	0.0045	24	5411
52	3081	0.00494	15	3096
53	4127	0.0054	22	4149
54	4732	0.00585	28	4760
55	4478	0.00633	28	4506
56	4747	0.00681	32	4779
57	4521	0.00736	33	4554
58	4075	0.00801	33	4108
59	3784	0.00878	33	3817
60	4247	0.00966	41	4288
61	4036	0.01068	43	4079
62	3627	0.01184	43	3670
63	3928	0.01314	52	3980
64	3956	0.01457	58	4014
65	4046	0.01607	65	4111
66	3881	0.01762	68	3949
67	3704	0.01928	71	3775
68	3522	0.02105	74	3596
69	3470	0.02293	80	3550
70	3244	0.02494	81	3325
71	3155	0.02717	86	3241
72	2465	0.0297	73	2538
73	2455	0.03251	80	2535
74	2153	0.0358	77	2230
75	1860	0.0395	73	1933
76	1720	0.04381	75	1795
77	1570	0.04871	76	1646
78	1467	0.05419	79	1546
79	1138	0.0629	72	1210
80	1104	0.06712	74	1178
81	1038	0.07472	78	1116
82	815	0.0831	68	883
83	826	0.09185	76	902
84	758	0.10127	77	835
85	614	0.11155	68	682
86	508	0.12308	63	571
87	372	0.1364	51	423
88	285	0.15037	43	328
89	255	0.165	42	297
90	206	0.1803	37	243
91	139	0.1963	27	166
92	77	0.213	16	93
93	80	0.23041	18	98
94	38	0.24852	9	47

Table 4. Calculation of the dead for female, 1998

age	Number in 1998 data	1998 mortality rate	Number of deaths in 1999 among the 1998 sample	Total number including the dead
6	2892	0.00013	0	2892
7	3323	0.00013	0	3323
8	3413	0.00012	0	3413
9	3670	0.0001	0	3670
10	3694	0.00009	0	3694
11	3953	0.00009	0	3953
12	3890	0.0001	0	3890
13	4261	0.00011	0	4261
14	4247	0.00012	1	4248
15	4470	0.00014	1	4471
16	4423	0.00018	1	4424
17	4344	0.00022	1	4345
18	4109	0.00025	1	4110
19	4070	0.00027	1	4071
20	4265	0.00028	1	4266
21	4195	0.00028	1	4196
22	4347	0.00028	1	4348
23	4643	0.00029	1	4644
24	4691	0.0003	1	4692
25	4641	0.00031	1	4642
26	4547	0.00032	1	4548
27	4397	0.00034	1	4398
28	4255	0.00035	1	4256
29	4363	0.00036	2	4365
30	4346	0.00039	2	4348
31	4020	0.00042	2	4022
32	4017	0.00045	2	4019
33	4261	0.00049	2	4263
34	4172	0.00052	2	4174
35	4219	0.00055	2	4221
36	4055	0.00058	2	4057
37	4212	0.00062	3	4215
38	4300	0.00067	3	4303
39	4578	0.00074	3	4581
40	4230	0.00081	3	4233
41	4346	0.00088	4	4350
42	4834	0.00094	5	4839
43	4671	0.00102	5	4676
44	4734	0.00112	5	4739
45	5164	0.00124	6	5170
46	5398	0.00138	7	5405
47	5832	0.00153	9	5841
48	6108	0.0017	10	6118
49	6356	0.00188	12	6368
50	6330	0.00206	13	6343

Table 4. Calculation of the dead for female, 1998, cont.

age	Number in 1998 data	1998 mortality rate	Number of deaths in 1999 among the 1998 sample	Total number including the dead
51	5229	0.00222	12	5241
52	3592	0.00236	8	3600
53	4353	0.00251	11	4364
54	4927	0.00268	13	4940
55	4664	0.00287	13	4677
56	4924	0.00305	15	4939
57	4613	0.00324	15	4628
58	4209	0.00348	15	4224
59	3820	0.00378	14	3834
60	4463	0.00412	18	4481
61	4304	0.00448	19	4323
62	5195	0.0049	25	5220
63	4310	0.00538	23	4333
64	4350	0.00593	26	4376
65	4464	0.00651	29	4493
66	4229	0.00712	30	4259
67	4281	0.0078	33	4314
68	3837	0.00859	33	3870
69	4042	0.00952	38	4080
70	3776	0.01055	40	3816
71	3621	0.01168	42	3663
72	3914	0.01302	51	3965
73	3263	0.01462	48	3311
74	3009	0.01662	50	3059
75	2919	0.01886	55	2974
76	2766	0.02142	59	2825
77	2584	0.02432	63	2647
78	2237	0.02769	62	2299
79	1977	0.03159	62	2039
80	1816	0.03613	66	1882
81	1771	0.04131	73	1844
82	1813	0.0469	85	1898
83	1478	0.05283	78	1556
84	1315	0.0596	78	1393
85	1144	0.06745	77	1221
86	950	0.07655	73	1023
87	835	0.08705	73	908
88	635	0.09865	63	698
89	494	0.11022	54	548
90	431	0.1223	53	484
91	290	0.13593	39	329
92	190	0.15001	29	219
93	157	0.16454	26	183
94	99	0.17952	18	117

Table 5. The living and dead populations, by sex and age group, 1989

age group	Number in 1989 data	Number of deaths in 1990 among the 1989 sample	Total number including the dead	Percent dead in the total sample	Percent living in the total sample
Male					
6-14 years old	49125	9	49134	0.02	99.98
15-24	52147	36	52183	0.07	99.93
25-44	105814	129	105943	0.12	99.88
45-64	94774	678	95452	0.71	99.29
65-74	23488	597	24085	2.48	97.52
75-94	13013	1083	14096	7.69	92.31
Total	338361	2532	340893	0.74	99.26
Female					
6-14 years old	47077	6	47083	0.01	99.99
15-24	52791	14	52805	0.03	99.97
25-44	108875	76	108951	0.07	99.93
45-64	100161	337	100498	0.34	99.66
65-74	32874	421	33295	1.26	98.74
75-94	20282	1132	21414	5.29	94.71
Total	362060	1986	364046	0.55	99.45

Table 6. The living and dead populations, by sex and age group, 1998

age group	Number in 1998 data	Number of deaths in 1999 among the 1998 sample	Total number including the dead	Percent dead in the total sample	Percent living in the total sample
Male					
6-14 years old	34974	6	34980	0.02	99.98
15-24	44419	27	44446	0.06	99.94
25-44	83824	97	83921	0.12	99.88
45-64	93763	600	94363	0.64	99.36
65-74	32095	755	32850	2.30	97.70
75-94	14870	1124	15994	7.03	92.97
Total	303945	2609	306554	0.85	99.15
Female					
6-14 years old	33343	4	33347	0.01	99.99
15-24	43557	11	43568	0.02	99.98
25-44	87198	52	87250	0.06	99.94
45-64	98141	287	98428	0.29	99.71
65-74	38436	395	38831	1.02	98.98
75-94	25901	1186	27087	4.38	95.62
Total	326576	1935	328511	0.59	99.41

Measure of Health: the Health and Activity Limitation Index (HALex)

We constructed the health variable using the Health and Activity Limitation Index (HALex), that is, the quality of life part of the Years of Healthy Life (YHL) (Erickson, Wilson, and Shannon 1995). For the health-related quality information, the HALex combines two types of questions asked in the National Health Interview Survey (NHIS), one assessing activity limitations and the other measuring self-perceived health. The activity limitation questions create six categories: (1) not limited, (2) limited in other activities, (3) limited in major activity, (4) unable to perform major activity, (5) unable to perform instrumental activities of daily living, and (6) unable to perform activities of daily living. Self-perceived health is in five categories: excellent, very good, good, fair, and poor. These two items together make up a matrix of 30 combinations. To assign a value to each of these 30 combinations, between zero, suggesting the dead, and one, the best health, first, the correspondence analysis determined the distance between different levels for each of the two dimensions, the activity limitation and self-perceived health. The general multiplicative model combined the information from the two dimensions, and the Health Utilities Index was used in addition. The completed HALex assigns values ranging from 1.00 for persons without any activity limitation and perceive the excellent health to 0.10 for persons limited in activities in daily living and perceive poor health.

Tables 8 and 9 show the NHIS questions from which the HALex was constructed and the CSLC questions that we used as equivalent to them. For most of these NHIS questions, one can find corresponding questions in the CSLC, except one question: “Does any impairment or health problem NOW keep XXX from attending school/working at a job or business/doing any housework at all?” For this, we used the CSLC question: “For the past month, how many days were you in the bed all day?” The answers were categorical: none, 1-3, 4-6, 7-14, and 15+ days, and the distribution of the answers is shown in Table 7. We treated answers equal to or more than 4 bed-ridden days as being unable to attend school/work at a job or business/do any housework at all.

Table 7. Distribution of a number of bed-ridden days in the past month, 1989, 1998

Number of bed-ridden days in the past month	1989		1998	
	Freq.	Percent	Freq.	Percent
None	649040	92.8	587716	93.68
1-3 days	38724	5.54	30162	4.81
4-6 days	5903	0.84	4857	0.77
7-14 days	2982	0.43	2599	0.41
15+ days	2737	0.39	2027	0.32
Total	699386	100	627361	100

Table 8. Questions for the HALex: activity limitations

HALex Categories	NHIS Questions	English Translation of Equivalent Questions in the CSLC
5-17 years		
Unable to perform major activity	Does any impairment or health problem NOW keep xxx from attending school?	For the past month, how many days were you in the bed all day? (four or more days)
Limited in performing major activity	Does xxx attend a special school or special classes because of any impariment or health problem?	
	Does xxx need to attend a special school or special classes because of any impairment or health problem?	
	Is xxx limited in school attendance because of health?	Do you have any problem of work, housework, or study because of health?
Limited in other activities	Is xxx limited in ANY WAY in any activities because of an impariment or health problem?	Do you have any problem of usual activities, going out, exercise, or any other [activities] because of health?
18-64 years		
Unable to perform major activity	Does any impairment or health problem NOW keep xxx from working at a job or business?	For the past month, how many days were you in the bed all day? (four or more days)
	Does any impairment or health problem NOW keep xxx from doing any housework at all?	
Limited in performing major activity	Is xxx limited in the kind OR amount of work xxx can do because of any impariment or health problem?	Do you have any problem of work, housework, or study because of health?
	Is xxx limited in the kind OR amount of housework xxx can do because of any impariment or health problem?	
Limited in other activities	Is xxx limited in ANY WAY in any activities because of an impariment or health problem?	Do you have any problem of usual activities, going out, exercise, or any other [activities] because of health?

Table 8. Questions for the HALex: activity limitations, cont.

HALex Categories	NHIS Questions	English Translation of Equivalent Questions in the CSLC
65 years and older		
Limited in activities of daily living	Because of any impariment or health problem, does xxx need the help of other persons with xxx personal care needs, such as eating, bathing, dressing, or getting around this home?	Do you have any problem of usual activities because of health?
Limited in instrumental activities of daily living (IADL)	Because of any impariment or health problem, does xxx need the help of other persons in handling xxx routine needs, such as everyday household chores, doing necessary business, shopping, or getting around for other purposes?	Do you have any problem of work, housework, or study because of health?
Limited in other activities	Is xxx limited in ANY WAY in any activities because of an impariment or health problem?	Do you have any problem of exercise or any other [activities] because of health?

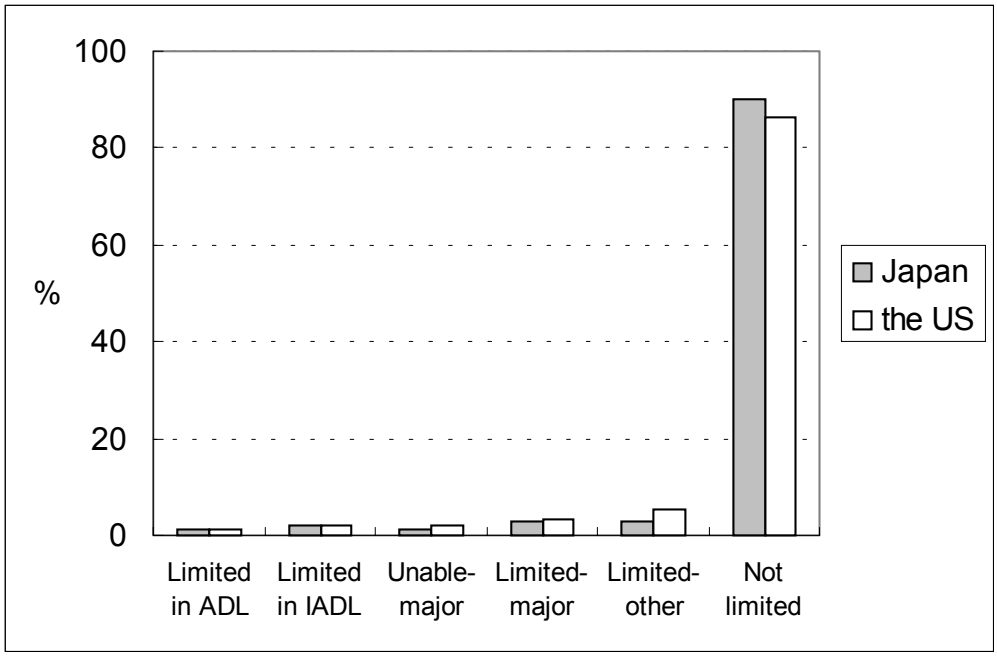
Table 9. Questions for the HALex: self-perceived health

NHIS Questions	English Translation of Equivalent Questions in the CSLC
Would you say your health in general is excellent, very good, good, fair, or poor?	How do you assess your current health condition? Please choose one number: 1. Good, 2. Fairly good, 3. Usual, 4. Not very good, 5. Not good

Despite the similarities in questions between the NHIS and the CSLC, one should doubt whether the HALex constructed based on the NHIS can be legitimately applied to the CSLC. Both surveys, for example, use five-category answers for the self-perceived health question, but words assigned to these five categories of both surveys are very different (Table 9). Does the difference in wording only reflect the degrees of expressiveness of Americans and Japanese? Or might the best category in the CSLC assess the same level of self-perceived health of the middle category of the NHIS?

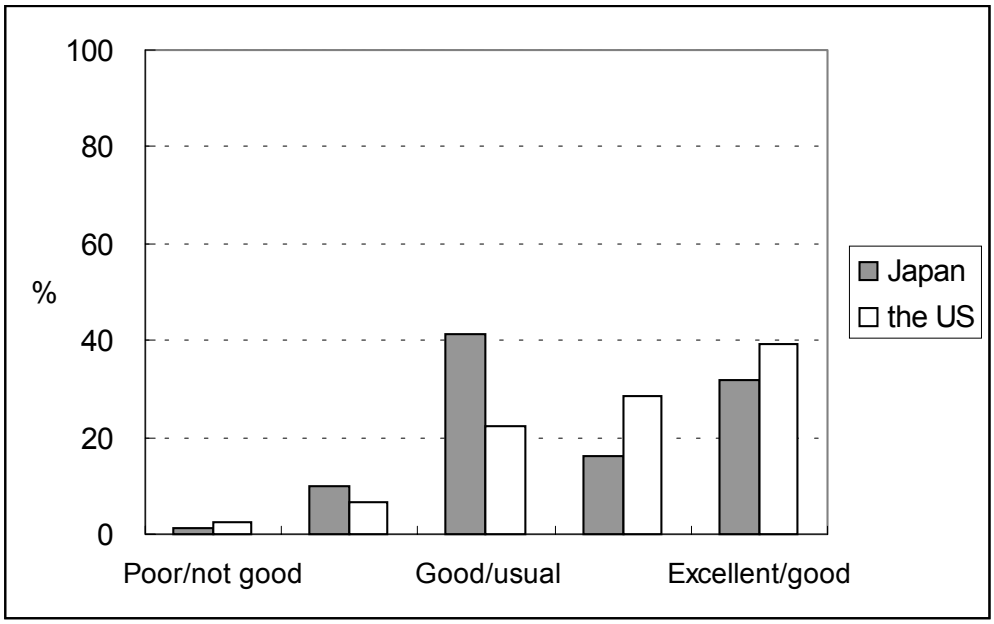
In order to examine the legitimacy, we compared distributions of activity limitations and self-perceived health in the 1989 CSLC data aged 0 to 98 to those of the 1990 NHIS (Table 1 and 2 of Erickson, Wilson, and Shannon 1995), based on which the HALex was constructed. Recall that the HALex is based on joint distributions of these two health variables. If distributions of activity limitations were different but those of self-perceived health were similar, we could assume that the scoring was appropriate for the CSLC and differences in the HALex would come from differences in distributions of disabilities. If, on the other hand, distributions of self-perceived health were different but those of activity limitations were similar, we should assume that perceptions of the same disability states would be different in these countries and the US-based scoring may not be right for assessing the health of Japanese people.

Figure1., Table 10. Distribution of activity limitations in the US and Japan



	Limited in ADL	Limited in IADL	Unable-major	Limited-major	Limited-other	Not limited
Japan	1.6	2.0	0.9	2.4	2.7	90.5
the US	1.1	2.0	1.9	3.4	5.2	86.2

Figure2., Table 11. Distribution of self-perceived health in the US and Japan



Self-perceived Health	Poor Not good	Fair Not very good	Good Usual	Very good Fairly good	Excellent Good
Japan	1.1	9.9	41.1	16.2	31.7
the US	2.5	6.8	22.5	28.6	39.4

Figures 1 and 2 and Tables 10 and 11 show distributions of activity limitations and self-perceived health in the US and Japan. We judged that distributions of activity limitations in these two countries were similar but not those of self-perceived health, thereby, we might need to consider adjustment of the scoring system for its application to Japanese data.

One possible post-adjustment of the HALex is to use its frequency distributions in the NHIS and the CSLC data. Figure 3 illustrates how this post-adjustment can be proceeded. In this hypothetical case, the US frequency distribution, cumulative 10 percent is 0.2 HALex score, while in the Japanese frequency distribution, the same cumulative 10 percent is 0.8 HALex score. We make ad hoc adjustment so the Japanese 0.8 HALex score becomes 0.2 HALex score. When we repeat this process for every HALex score point, post-adjustment of the HALex for Japanese data is complete.

Figure 3. Hypothetical cumulative distributions of the HALex

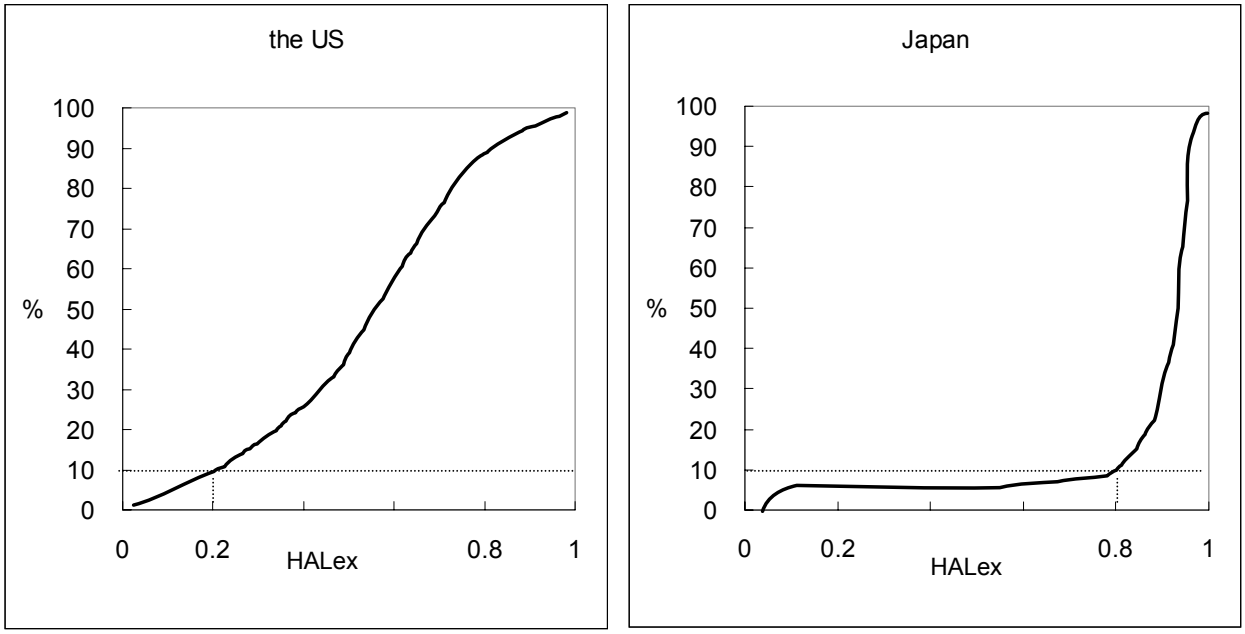


Figure 4 and Table 12 show the actual frequency distributions of the HALex in the US (the 1990 NHIS) and Japan (the 1989 CSLC). Figure 4 and Table 12 suggest that distributions of the HALex in the US and Japan are actually not much different. Most of the difference occurs between 0.72 and 0.92 reflecting differences in the upper three categories of self-perceived health (good, very good, and excellent). The post-adjustment explained above would inflate the Japanese 0.84 score to some degree, but its effect would be primarily limited to this value. Consequently, we judged that making a limited ad hoc adjustment would not be worth pursuing. Legitimacy of applying the US-based HALex score to Japanese data remains an issue, but in this analysis we left it aside for the future development.

Figure 4. Actual cumulative distributions of the HALex in the US and Japan

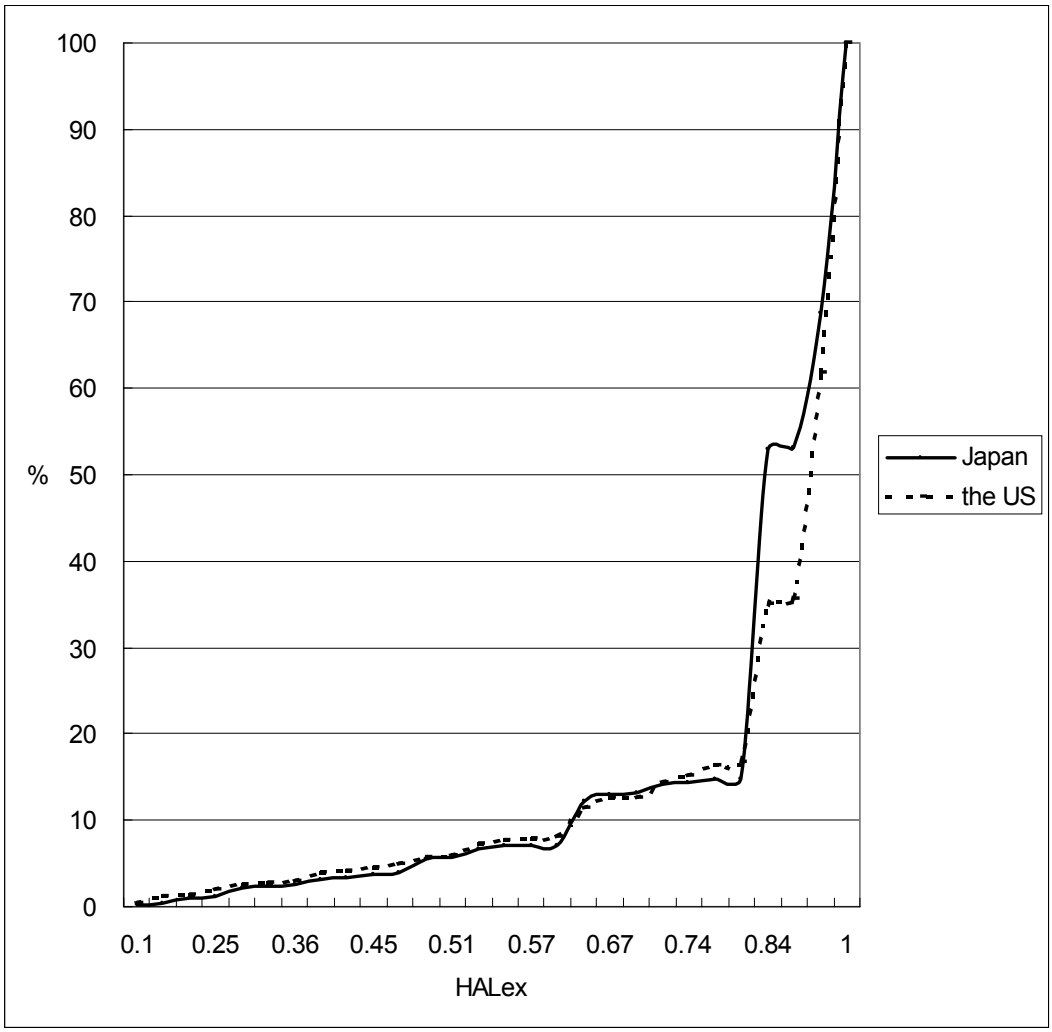


Table 12. Actual cumulative distribution of the HALex in Japan and the US

HALex			Japan 1989			the US 1990		
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Cum.**	**Freq.**	**Percent**	**Cum.**
Poor	Limited in ADL	0.10	1323	0.19	0.19	1203	0.49	0.49
Poor	Limited in IADL	0.17	1004	0.14	0.33	1451	0.59	1.08
Fair	Limited in ADL	0.21	4015	0.57	0.91	692	0.28	1.37
Poor	Unable-major	0.25	1291	0.18	1.09	1283	0.52	1.89
Fair	Limited in IADL	0.29	7290	1.04	2.13	1586	0.65	2.54
Poor	Limited-major	0.34	1562	0.22	2.35	529	0.22	2.75
Good	Limited in ADL	0.36	1682	0.24	2.59	555	0.23	2.98
Fair/Unable-major, Poor/Limited-other		0.38	4224	0.60	3.20	2548	1.04	4.02
Very good	Limited in ADL	0.41	487	0.07	3.27	206	0.08	4.11
Good	Limited in IADL	0.45	3748	0.53	3.80	1242	0.51	4.61
Excellent/Limited in ADL, Poor/Not limited		0.47	1619	0.23	4.03	933	0.38	4.99
Fair	Limited-major	0.48	10751	1.53	5.57	1828	0.75	5.74
Very good	Limited in IADL	0.51	827	0.12	5.68	470	0.19	5.93
Fair	Limited-other	0.52	7764	1.11	6.79	3087	1.26	7.19
Good	Unable-major	0.55	1588	0.23	7.02	1303	0.53	7.73
Excellent	Limited in IADL	0.57	208	0.03	7.05	237	0.10	7.82
Very good	Unable-major	0.62	474	0.07	7.12	455	0.19	8.01
Fair	Not limited	0.63	35663	5.09	12.21	8127	3.32	11.33
Good	Limited-major	0.67	6065	0.87	13.07	3075	1.26	12.58
Excellent	Unable-major	0.68	395	0.06	13.13	261	0.11	12.69
Good	Limited-other	0.72	7836	1.12	14.25	4316	1.76	14.45
Very good	Limited-major	0.74	1356	0.19	14.44	1823	0.74	15.20
Very good	Limited-other	0.79	2175	0.31	14.75	2709	1.11	16.30
Excellent	Limited-major	0.81	526	0.08	14.83	1131	0.46	16.77
Good	Not limited	0.84	267511	38.18	53.01	44538	18.19	34.96
Excellent	Limited-other	0.87	1395	0.20	53.21	1558	0.64	35.59
Very good	Not limited	0.92	108815	15.53	68.74	64336	26.28	61.87
Excellent	Not limited	1.00	218976	31.26	100.00	93362	38.13	100.00
		Total	700570	100		244844	100	

Measure of Health Inequality by Income

To examine if the HALex differed by income level, we compared the average HALex of five income share groups (the bottom 20%, the bottom 20-40%, the middle 20%, the top 20-40%, and the top 20% income share groups). Following the recommendation by the Panel on Poverty and Family Assistance: Concepts, Information Needs, and Measurement Methods in the US National Research Council (1995), we adjusted the household income for the family size and economies of scale. More precisely, the scale value we used for this analysis is as follows:

$$\text{Scale Value} = (A + 0.70K)^{0.70}$$

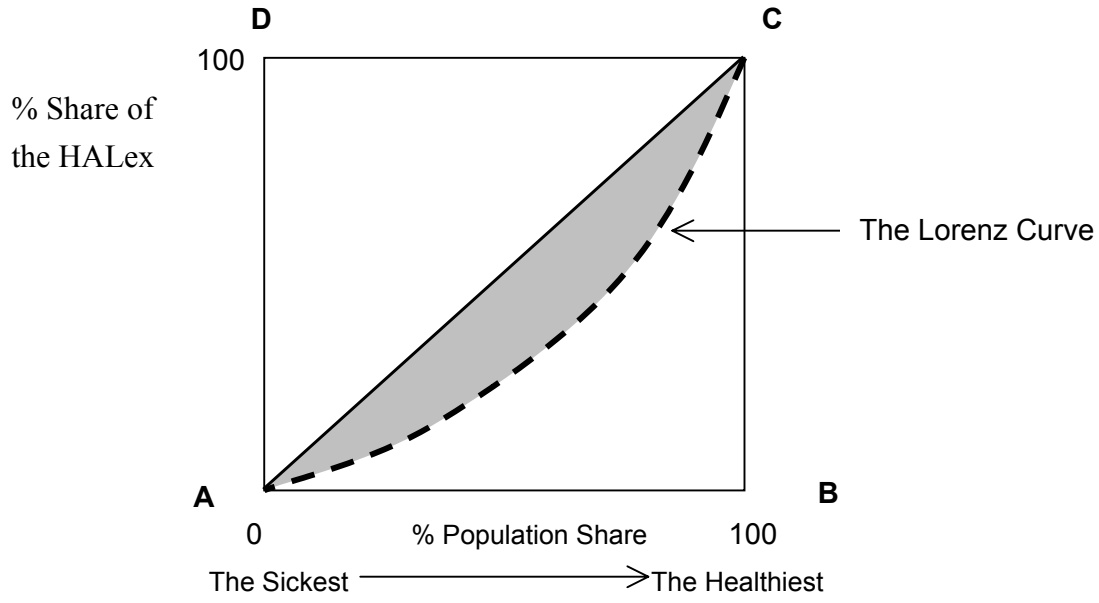
Where, A is a number of adults in the household, and K is a number of children in the household.

The advantage of using income share, as opposed to the absolute income level, is the ease of comparison; in this way, without further adjustment, we could compare health inequality by income in different years, by sex, and by age group. Judging the degree of health inequality by income, we calculated the difference in the HALex between the top 20% and the bottom 20% income share groups, and the middle 20% and the bottom 20% income share groups.

Measure of Health Inequality

We used the Gini Coefficient as the measure of health inequality. Which health inequality measure to use is an important question, but for this analysis, we assumed that its use is justifiable and followed previous studies (Illsley and Le Grand 1987; Le Grand 1987). The Gini Coefficient can be understood most easily by the Lorenz Curve. If used for the distribution of the HALex, the Lorenz curve can be illustrated in Figure 5. Imagine that we line up people in the population of focus from the sickest to the healthiest horizontally and these people's health share, in this analysis, the cumulative percentage of the HALex, vertically. The resulting curve AC is called the Lorenz Curve. When the population is perfectly equal, the Lorenz Curve is diagonal, AC. When the population is most unequal – one person is alive with or without health-adjusted quality and all others are dead – the Lorenz Curve follows AB and BC. The Gini Coefficient is the shaded area in the graph divided by the triangle, ABC. It presents a value between zero when the Lorenz Curve is diagonal, thus, perfectly equal, and one when the Lorenz Curve goes AB and BC, the most unequal.

Figure 5. Lorenz Curve



Arithmetically, the Gini Coefficient (G) is shown to be the same as the relative mean difference, and expressed as:

$$G = \frac{1}{2}\sum_{i=1}^{n}\sum_{J=1}^{n}\frac{|y_i - y_j|}{n^2\mu}$$

Where the population of focus holds n people, each of them presents the health level, y, and the average HALex in the population is μ.

Statistical Analysis

This study consists of three parts: analysis of the average HALex, analysis of distributions of the HALex by income share, and analysis of distributions of the HALex. All three parts used both 1989 and 1998 data and analyzed the overall picture, that is, including both sexes and all ages, and by sex and age group (6-14, 15-24, 25-44, 45-64, 65-74, 75-94 years old). These age groups are intended to reflect epidemiological profiles, human development, and policy relevance at different stages of human life. The elderly 75 years of age and older are, for example, often categorized as the "oldest old" in the delivery of health care in Japan.

In addition, the analysis of distributions of the HALex was conducted both for the living only population and the population of the living and the dead combined. We believe that health inequality analysis should target populations including the dead, because neglecting a health state, death, only provides a partial picture of the population health. Yet

we all must die at some point in our lives, and we usually wish deaths to happen at older ages. This suggests that a greater degree of health inequality due to deaths at younger ages and older ages should be treated differently and we are not yet quite certain about how exactly we should deal with deaths at older ages in health inequality analysis. For this reason, in this analysis, we report health inequalities of both living only population and population of the living and the dead combined.

We used unweighted data for this analysis. The CSLC uses the cluster sampling, in which clusters are constructed based on a number of households. We can thus consider that the CSLC uses the cluster sampling with equal probabilities, and the resulting sample is self-weighting, that is, every individual in the sample has the same weight and represents the same number of units in the population. Our point estimates then would not be biased due to sampling. To estimate accurate standard errors, one must still account for the cluster sampling. But in this analysis we are only concerned about point estimates, and this consideration is irrelevant.

RESULTS

(1) What was the average health-adjusted quality of life measured by the HALex in the Japanese living population, overall, by sex and by age group in 1989 and 1998?

Overall HALex in 1989 and 1998

Table 13 shows life expectancies for male and female in 1989 and 1998 (Statistics and Information Department 1989b; Statistics and Information Department 1998b), and Table 14 presents the health-adjusted quality of life measured by the HALex for the living population in these years. Between 1989 and 1998, overall Japanese people's health improved in terms of the length of life (1.25-year increase for men, 2.24-year increase for women), but not the health-adjusted quality of life measured by the HALex (0.006 decrease for male, 0.004 decrease for female).

Table 13. Life expectancy

	Male	Female
1989	75.91	81.77
1998	77.16	84.01

Table 14. Health-adjusted quality of life measured by the HALex

	Total	Male	Female
1989	0.857	0.868	0.847
1998	0.852	0.862	0.843

The HALex by age group

Figure 6 and Table 15 suggest that the change in the HALex of the living population between 1989 and 1998 was not consistent at every age. Between 1989 and 1998, overall, the HALex stayed the same for the young children (6-8 years olds) and the middle age (24-48 years olds), but decreased for the adolescents and young adults (9-23 years old), and increased for older ages (49 years old+). Men and women followed the same trend (Figures 7 and 8). The sudden drop at 65 years old appears to be due to the HALex construction. The HALex uses two different scoring systems, one is for those who younger than 65, and the other for those who are 65 years of age and older. Scores of the system for the older people are more spread at lower values than ones of the system for the younger people. While a greater number of old people are likely to present lower scores, the sudden drop at age 65 is perhaps an artifact. Fluctuation of the HALex at older ages may be due to the small number of observations.

Figure 6. The average HALex in 1989 (o) and 1998 (the solid line; both sexes)

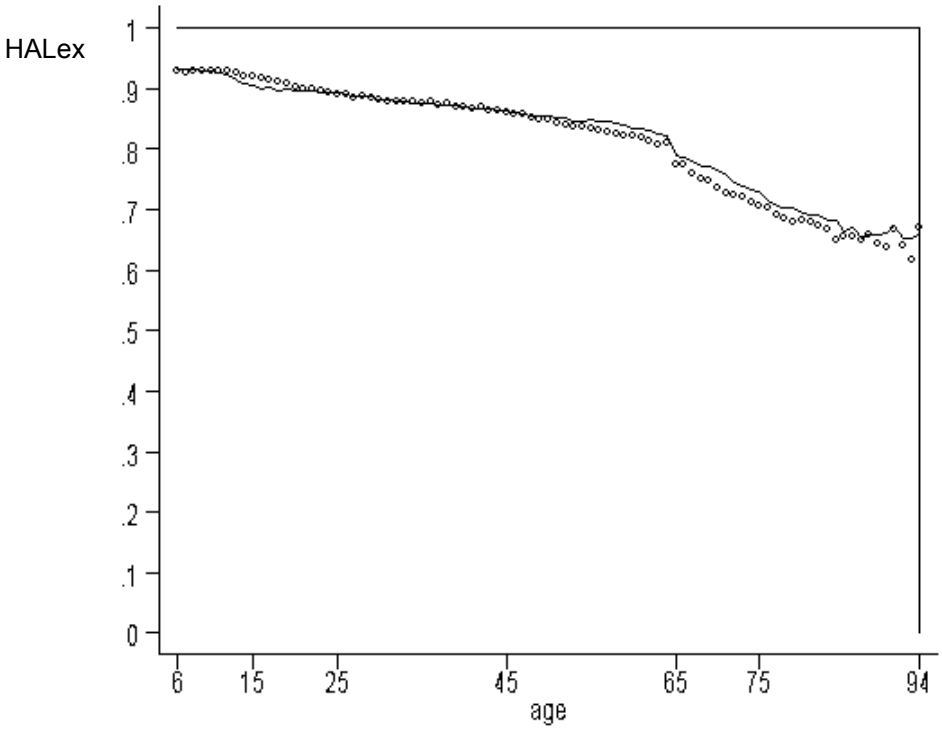


Figure 7. The average HALex in 1989 (o) and 1998 (the solid line), male

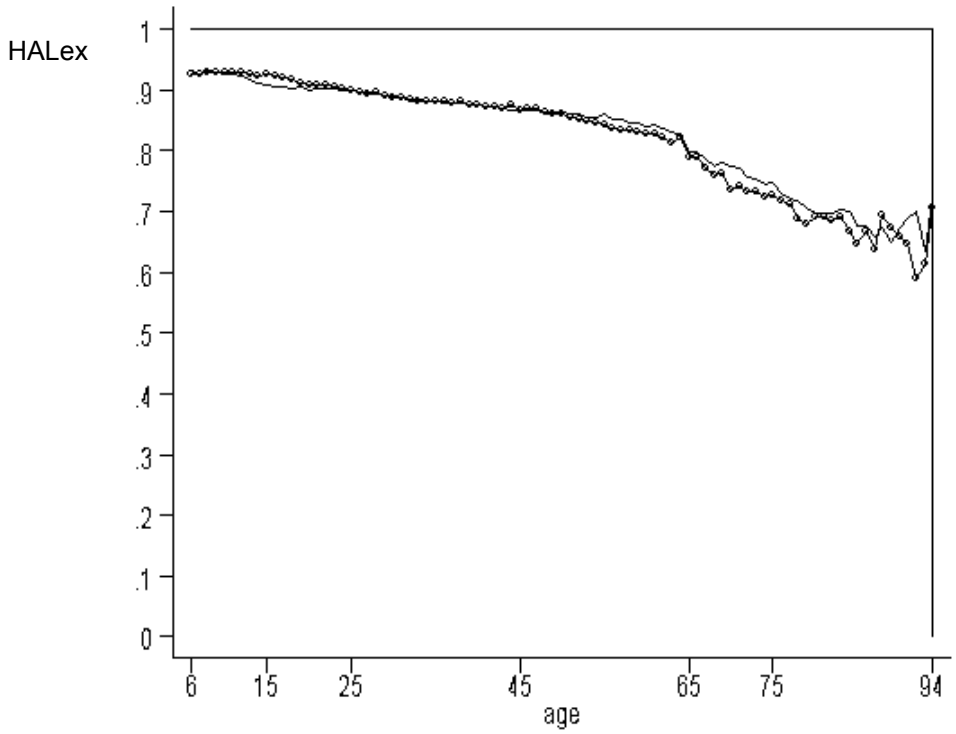


Figure 8. The average HALex in 1989 (o) and 1998 (the solid line), female

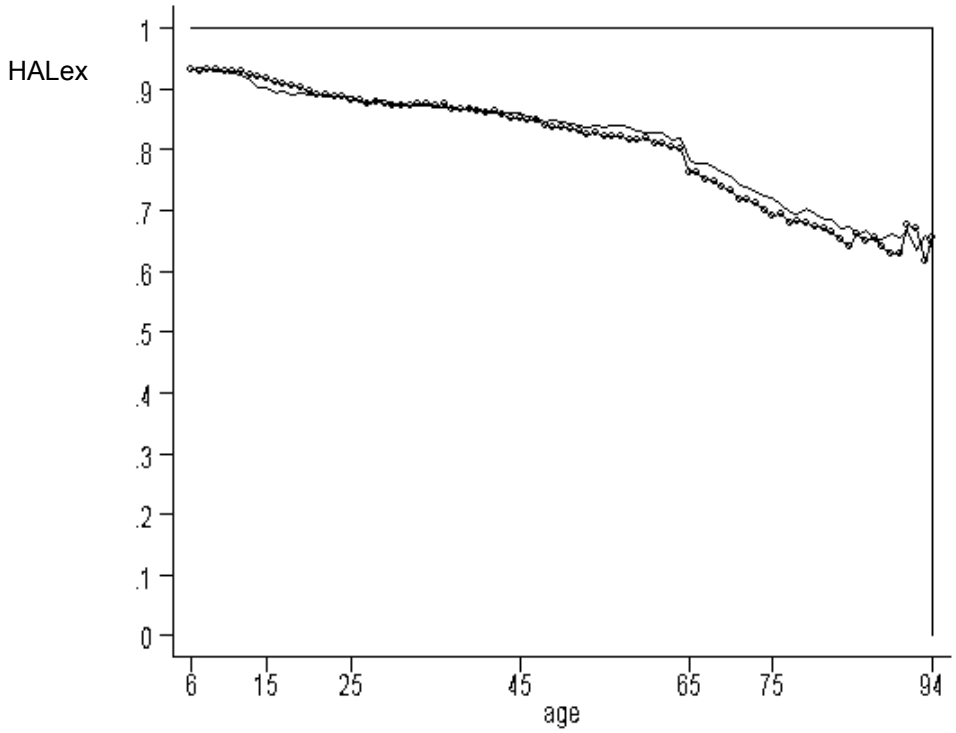


Table 15. Average HALex by age, 1989 and 1998

(Shaded ages suggest ones whose HALex was worse in 1998 than in 1989)

Age	Total			Male			Female		
	1989	1998	98-89	1989	1998	98-89	1989	1998	98-89
6	0.929	0.932	0.002	0.928	0.932	0.005	0.931	0.931	0.000
7	0.928	0.931	0.004	0.927	0.927	0.000	0.928	0.935	0.007
8	0.930	0.932	0.002	0.929	0.931	0.003	0.931	0.932	0.001
9	0.930	0.929	-0.001	0.929	0.928	-0.001	0.931	0.930	-0.001
10	0.930	0.928	-0.001	0.930	0.927	-0.003	0.930	0.930	0.000
11	0.930	0.927	-0.003	0.929	0.927	-0.002	0.930	0.927	-0.003
12	0.929	0.923	-0.006	0.929	0.923	-0.006	0.929	0.923	-0.006
13	0.926	0.916	-0.011	0.928	0.916	-0.012	0.925	0.915	-0.010
14	0.921	0.907	-0.014	0.922	0.911	-0.012	0.920	0.903	-0.016
15	0.922	0.905	-0.017	0.926	0.909	-0.018	0.917	0.902	-0.015
16	0.917	0.901	-0.016	0.923	0.906	-0.017	0.911	0.895	-0.016
17	0.915	0.901	-0.013	0.921	0.906	-0.014	0.909	0.896	-0.013
18	0.911	0.897	-0.014	0.917	0.902	-0.016	0.904	0.892	-0.013
19	0.907	0.899	-0.008	0.912	0.905	-0.007	0.902	0.893	-0.009
20	0.902	0.896	-0.006	0.909	0.901	-0.008	0.895	0.891	-0.004
21	0.899	0.896	-0.002	0.907	0.903	-0.004	0.891	0.890	-0.001
22	0.900	0.895	-0.005	0.909	0.903	-0.006	0.892	0.888	-0.004
23	0.897	0.895	-0.001	0.905	0.903	-0.002	0.889	0.888	-0.001
24	0.894	0.894	0.000	0.902	0.900	-0.001	0.887	0.887	0.001
25	0.890	0.894	0.005	0.899	0.901	0.002	0.881	0.888	0.006
26	0.890	0.890	0.000	0.898	0.898	0.000	0.882	0.883	0.001
27	0.885	0.887	0.002	0.894	0.896	0.001	0.876	0.879	0.002
28	0.887	0.889	0.002	0.896	0.895	-0.001	0.879	0.883	0.004
29	0.884	0.886	0.002	0.892	0.892	0.000	0.877	0.881	0.004
30	0.881	0.882	0.001	0.889	0.890	0.001	0.874	0.875	0.001

Age	Total			Male			Female		
	1989	1998	98-89	1989	1998	98-89	1989	1998	98-89
65	0.775	0.791	0.016	0.788	0.799	0.010	0.764	0.783	0.019
66	0.774	0.788	0.014	0.789	0.798	0.009	0.763	0.778	0.015
67	0.759	0.781	0.023	0.771	0.785	0.014	0.751	0.778	0.027
68	0.752	0.772	0.020	0.759	0.774	0.016	0.748	0.770	0.023
69	0.748	0.771	0.024	0.762	0.781	0.020	0.738	0.763	0.025
70	0.735	0.765	0.030	0.737	0.775	0.038	0.733	0.755	0.022
71	0.728	0.756	0.028	0.743	0.773	0.030	0.717	0.742	0.024
72	0.725	0.746	0.021	0.734	0.756	0.022	0.719	0.740	0.021
73	0.720	0.739	0.019	0.734	0.753	0.019	0.711	0.729	0.018
74	0.711	0.733	0.022	0.725	0.745	0.020	0.701	0.725	0.024
75	0.705	0.730	0.025	0.727	0.746	0.020	0.690	0.720	0.030
76	0.704	0.716	0.012	0.717	0.729	0.012	0.694	0.708	0.014
77	0.692	0.707	0.015	0.712	0.721	0.009	0.678	0.698	0.020
78	0.684	0.704	0.019	0.688	0.719	0.032	0.682	0.693	0.011
79	0.679	0.703	0.024	0.679	0.706	0.027	0.679	0.702	0.023
80	0.681	0.695	0.014	0.692	0.697	0.005	0.674	0.693	0.019
81	0.679	0.691	0.012	0.690	0.698	0.008	0.671	0.686	0.015
82	0.673	0.690	0.017	0.687	0.699	0.012	0.664	0.686	0.022
83	0.668	0.683	0.015	0.690	0.704	0.014	0.654	0.672	0.018
84	0.651	0.684	0.033	0.666	0.700	0.033	0.642	0.675	0.033
85	0.656	0.665	0.009	0.647	0.676	0.029	0.661	0.659	-0.002
86	0.656	0.670	0.014	0.666	0.676	0.010	0.649	0.666	0.017
87	0.650	0.652	0.002	0.637	0.660	0.022	0.656	0.649	-0.007
88	0.660	0.659	-0.001	0.695	0.673	-0.022	0.642	0.653	0.011
89	0.645	0.658	0.014	0.675	0.649	-0.025	0.628	0.663	0.035
90	0.639	0.662	0.023	0.659	0.674	0.015	0.629	0.657	0.028
91	0.666	0.675	0.008	0.648	0.688	0.040	0.676	0.668	-0.008
92	0.642	0.653	0.010	0.592	0.700	0.108	0.670	0.634	-0.036
93	0.616	0.651	0.035	0.614	0.636	0.022	0.617	0.659	0.042
94	0.671	0.659	-0.012	0.706	0.722	0.015	0.655	0.635	-0.020

Difference in the HALex by sex

Japanese women are believed to be the healthiest people in the world. Their life expectancy is higher than any other group of people in the world, and it is often used as a benchmark (for example, for the calculation of the Disability Adjusted Life Years by the World Health Organization (Murray and Lopez 1996). This claim, however, may be based on the length of life that Japanese women on average live but not the quality of life it goes with. The average HALex of the living population at each age by sex suggests that Japanese women's HALex was almost always lower than Japanese men's, except in earlier ages, younger than ten (Figures 9 and 10, Table 16).

Figure 9. The average HALex, men (o) and women (the solid line) in 1989

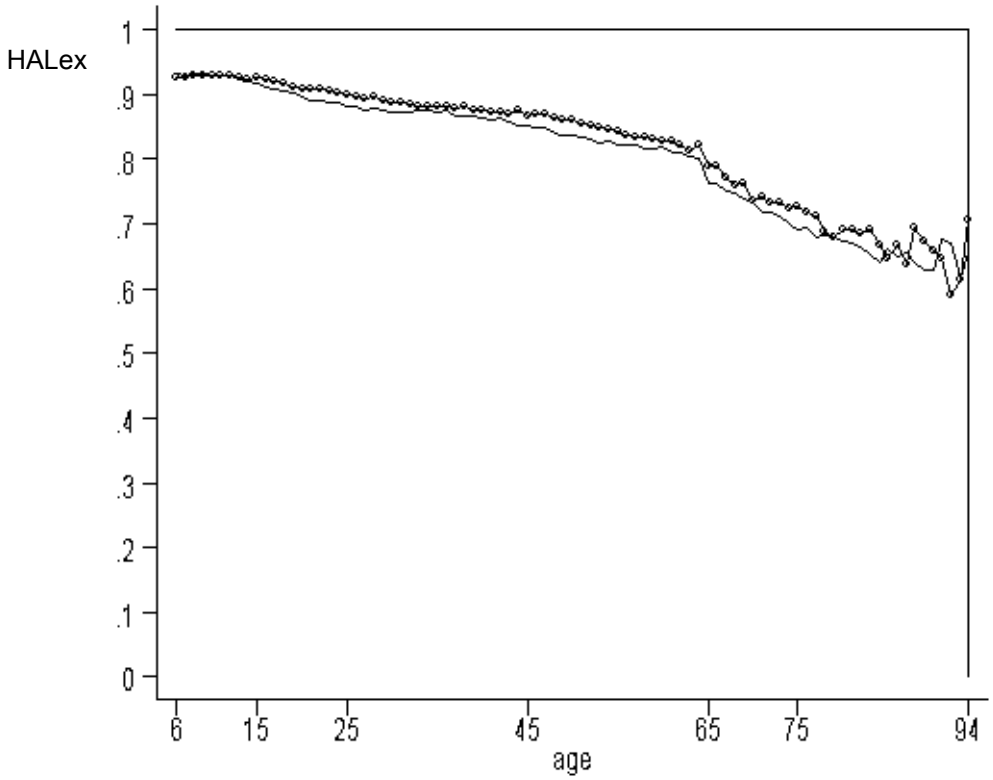


Figure 10. The average HALex, men (o) and women (the solid line) in 1998

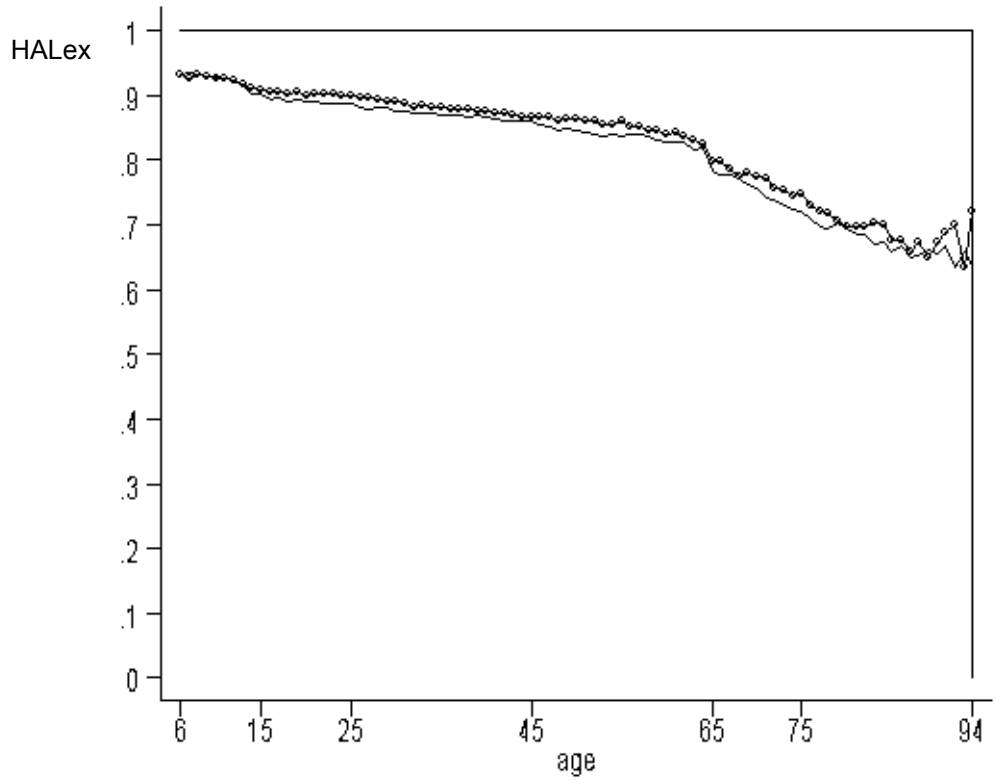


Table16. Difference in the HALex by Sex, 1989 and 1998

(Shaded ages suggest that men's HALex was worse than women's)

Age	1989			1998		
	Male	Female	M-F	Male	Female	M-F
6	0.928	0.931	-0.004	0.932	0.931	0.001
7	0.927	0.928	-0.001	0.927	0.935	-0.008
8	0.929	0.931	-0.003	0.931	0.932	0.000
9	0.929	0.931	-0.002	0.928	0.930	-0.002
10	0.930	0.930	0.001	0.927	0.930	-0.003
11	0.929	0.930	-0.001	0.927	0.927	0.000
12	0.929	0.929	0.000	0.923	0.923	0.000
13	0.928	0.925	0.003	0.916	0.915	0.001
14	0.922	0.920	0.003	0.911	0.903	0.007
15	0.926	0.917	0.009	0.909	0.902	0.007
16	0.923	0.911	0.012	0.906	0.895	0.011
17	0.921	0.909	0.012	0.906	0.896	0.010
18	0.917	0.904	0.013	0.902	0.892	0.010
19	0.912	0.902	0.010	0.905	0.893	0.012
20	0.909	0.895	0.014	0.901	0.891	0.010
21	0.907	0.891	0.017	0.903	0.890	0.014
22	0.909	0.892	0.017	0.903	0.888	0.015
23	0.905	0.889	0.016	0.903	0.888	0.015
24	0.902	0.887	0.015	0.900	0.887	0.013
25	0.899	0.881	0.017	0.901	0.888	0.013
26	0.898	0.882	0.016	0.898	0.883	0.014
27	0.894	0.876	0.018	0.896	0.879	0.017
28	0.896	0.879	0.017	0.895	0.883	0.012
29	0.892	0.877	0.015	0.892	0.881	0.011
30	0.889	0.874	0.014	0.890	0.875	0.014
31	0.888	0.872	0.016	0.888	0.875	0.013
32	0.885	0.873	0.011	0.883	0.874	0.009
33	0.882	0.874	0.008	0.885	0.873	0.013
34	0.881	0.875	0.005	0.881	0.873	0.009
35	0.882	0.871	0.010	0.880	0.870	0.010
36	0.881	0.877	0.003	0.879	0.871	0.008
37	0.879	0.867	0.012	0.879	0.870	0.009
38	0.882	0.868	0.015	0.879	0.868	0.011
39	0.877	0.866	0.011	0.876	0.869	0.007
40	0.875	0.864	0.012	0.875	0.867	0.008
41	0.873	0.860	0.013	0.873	0.863	0.010
42	0.873	0.865	0.008	0.871	0.861	0.010
43	0.870	0.857	0.013	0.871	0.860	0.011
44	0.874	0.853	0.022	0.868	0.861	0.007

Age	1989			1998		
	Male	Female	M-F	Male	Female	M-F
45	0.867	0.852	0.015	0.867	0.860	0.007
46	0.871	0.848	0.023	0.868	0.855	0.012
47	0.868	0.849	0.020	0.865	0.853	0.012
48	0.864	0.840	0.025	0.861	0.847	0.014
49	0.862	0.838	0.024	0.864	0.848	0.016
50	0.860	0.837	0.023	0.863	0.847	0.016
51	0.855	0.833	0.023	0.862	0.844	0.019
52	0.851	0.830	0.021	0.862	0.841	0.020
53	0.850	0.826	0.024	0.855	0.838	0.017
54	0.845	0.829	0.016	0.854	0.841	0.013
55	0.844	0.824	0.020	0.861	0.838	0.023
56	0.838	0.822	0.016	0.852	0.839	0.013
57	0.834	0.821	0.013	0.851	0.840	0.011
58	0.835	0.817	0.018	0.847	0.839	0.009
59	0.831	0.816	0.015	0.847	0.831	0.016
60	0.827	0.820	0.007	0.839	0.829	0.010
61	0.830	0.810	0.019	0.842	0.828	0.014
62	0.821	0.809	0.012	0.838	0.828	0.009
63	0.813	0.804	0.009	0.833	0.818	0.015
64	0.821	0.802	0.019	0.827	0.820	0.007
65	0.788	0.764	0.024	0.799	0.783	0.015
66	0.789	0.763	0.026	0.798	0.778	0.020
67	0.771	0.751	0.020	0.785	0.778	0.007
68	0.759	0.748	0.011	0.774	0.770	0.004
69	0.762	0.738	0.024	0.781	0.763	0.019
70	0.737	0.733	0.004	0.775	0.755	0.019
71	0.743	0.717	0.026	0.773	0.742	0.031
72	0.734	0.719	0.014	0.756	0.740	0.016
73	0.734	0.711	0.023	0.753	0.729	0.024
74	0.725	0.701	0.024	0.745	0.725	0.020
75	0.727	0.690	0.037	0.746	0.720	0.026
76	0.717	0.694	0.023	0.729	0.708	0.021
77	0.712	0.678	0.034	0.721	0.698	0.024
78	0.688	0.682	0.006	0.719	0.693	0.026
79	0.679	0.679	0.000	0.706	0.702	0.003
80	0.692	0.674	0.018	0.697	0.693	0.004
81	0.690	0.671	0.019	0.698	0.686	0.012
82	0.687	0.664	0.023	0.699	0.686	0.013
83	0.690	0.654	0.036	0.704	0.672	0.033
84	0.666	0.642	0.025	0.700	0.675	0.025
85	0.647	0.661	-0.014	0.676	0.659	0.017
86	0.666	0.649	0.017	0.676	0.666	0.010
87	0.637	0.656	-0.019	0.660	0.649	0.011
88	0.695	0.642	0.053	0.673	0.653	0.020
89	0.675	0.628	0.046	0.649	0.663	-0.013
90	0.659	0.629	0.030	0.674	0.657	0.017
91	0.648	0.676	-0.027	0.688	0.668	0.020
92	0.592	0.670	-0.078	0.700	0.634	0.066
93	0.614	0.617	-0.004	0.636	0.659	-0.023
94	0.706	0.655	0.051	0.722	0.635	0.087

Why was Japanese women's HALex almost always lower than men's? Full investigation is beyond the scope of this analysis, but we looked at distributions of two components of the HALex, activity limitation and self-perceived health (Figures 11 and 12, Tables 17 and 18). In both variables, we observe a general tendency that men were healthier than women, that is, women had more activity limitations and perceived their health conditions lower than men. Judging from the magnitude of these differences by sex, women's lower HALex is likely to be driven more by self-perceived health than activity limitations.

Table 17. Activity limitations by sex in 1989 and 1998

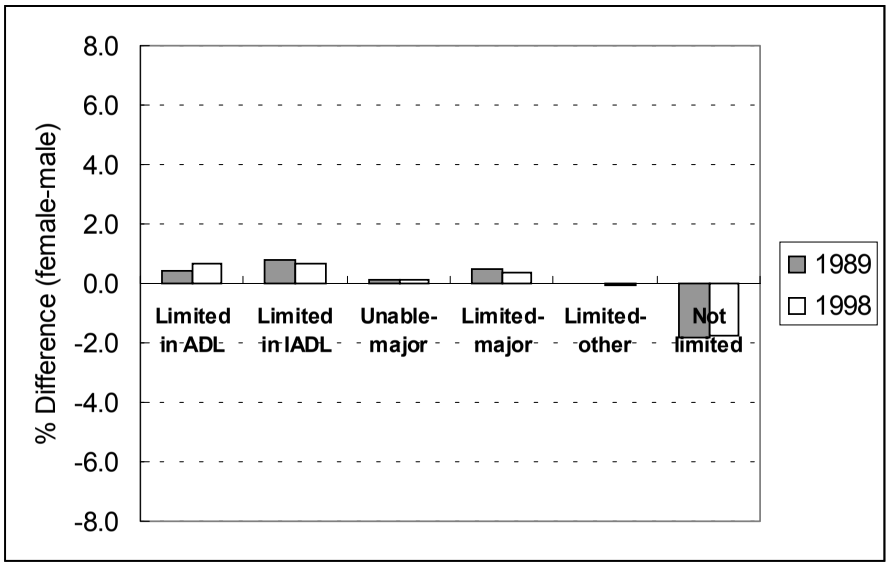
Activity limitations			Limited in ADL	Limtied in IADL	Unable-major	Limited-major	Limited-other	Not limited
1989	Male	Freq.	2992	4915	3268	8962	9572	308652
		Percent	0.88	1.45	0.97	2.65	2.83	91.22
	Female	Freq.	4663	8137	4002	11298	10299	323661
		Percent	1.29	2.25	1.11	3.12	2.84	89.39
1998	Male	Freq.	3622	5008	2401	6697	8309	277908
		Percent	1.19	1.65	0.79	2.2	2.73	91.43
	Female	Freq.	6112	7492	3081	8345	8640	292906
		Percent	1.87	2.29	0.94	2.56	2.65	89.69

Table 18. Self-perceived health by sex in 1989 and 1998

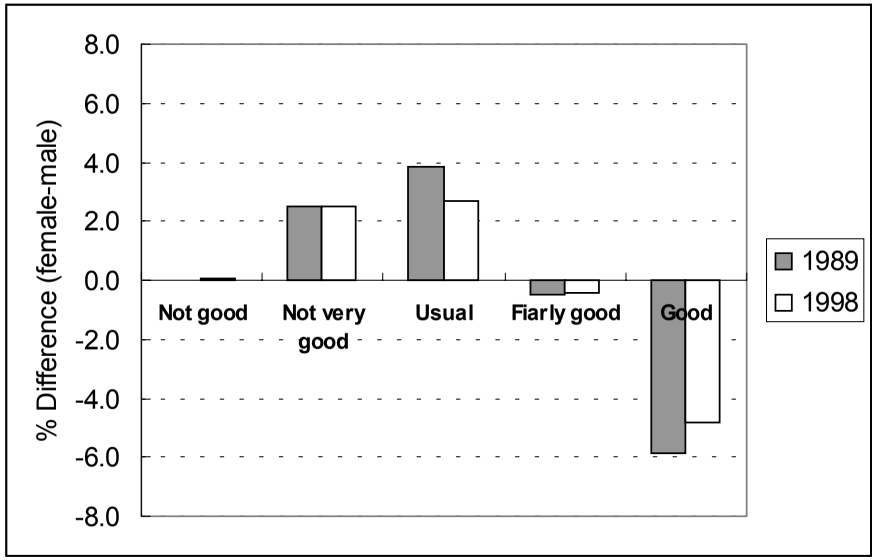
Self-perceived health			Not good	Not very good	Usual	Fairly good	Good
1989	Male	Freq.	3524	28967	132548	55990	117332
		Percent	1.04	8.56	39.17	16.55	34.68
	Female	Freq.	3786	39994	155819	58126	104335
		Percent	1.05	11.05	43.04	16.05	28.82
1998	Male	Freq.	3028	26360	126389	53308	94860
		Percent	1.00	8.67	41.58	17.54	31.21
	Female	Freq.	3561	36404	144508	55895	86208
		Percent	1.09	11.15	44.25	17.12	26.4

Figures 12-13. Percentage difference of activity limitation and self-perceived health (female-male)

	1989	1998
Limited in ADL	0.4	0.7
Limited in IADL	0.8	0.6
Unable-major	0.1	0.2
Limited-major	0.5	0.4
Limited-other	0.0	-0.1
Not limited	-1.8	-1.7



	1989	1998
Not good	0.0	0.1
Not very good	2.5	2.5
Usual	3.9	2.7
Fiarly good	-0.5	-0.4
Good	-5.9	-4.8



(2) How was the HALex distributed by income share among the living population in Japan, overall, by sex and by age group in 1989 and 1998?

Overall differences in the HALex by income

Figure 13 and Table 19 show differences in the HALex of the living population by income share in 1989 and 1998. Consistent with the analysis of the overall HALex change between 1989 and 1998, at every income group, the HALex in 1998 was slightly lower than that of 1989. The pattern stayed the same in 1989 and 1998: the HALex was higher at a higher income group at every step, except the two highest income groups in 1998. Comparing the average HALex of the top 20% group and the bottom 20% group, the difference is 0.034 in 1989 and 0.032 in 1998, thus the slope is steeper in 1989 by 0.002.

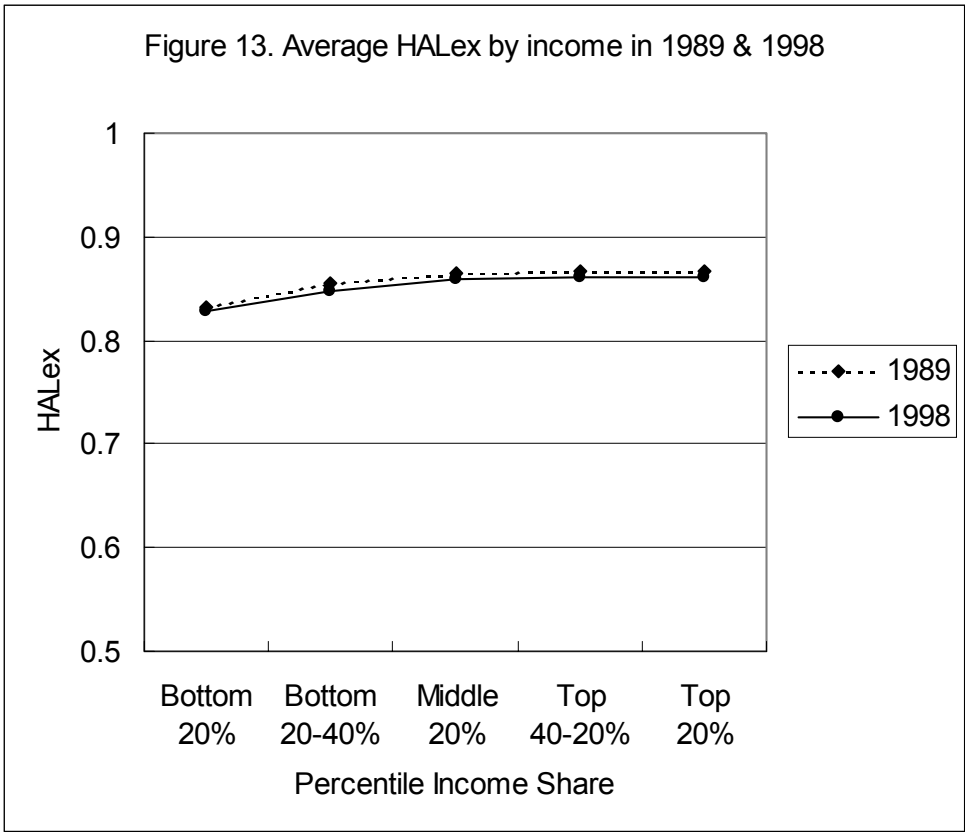


Table 19. Average HALex by income in 1989 and 1998

Income group	1989		1998	
	Mean HALex	Median HALex	Mean HALex	Median HALex
Bottom 20%	0.833	0.84	0.829	0.84
Bottom 20-40%	0.856	0.84	0.848	0.84
Middle 20%	0.864	0.84	0.859	0.84
Top 40-20%	0.866	0.84	0.861	0.84
Top 20%	0.867	0.84	0.861	0.84
(Top 20%) - (Bottom 20%)	0.034		0.032	
(Middle 20%) - (Bottom 20%)	0.031		0.030	

Differences in the HALex by income and sex

Figures 14 and 15 and Tables 20 and 21 break down differences in the HALex by income share by sex. As the analysis of the HALex by sex above suggests, here we also observe that women's HALex were lower than men's HALex in every income group both in 1989 and 1998. Differences in the HALex by income share suggest a gentle slope all the way through the five income groups for men, but not for women. Among women, the highest two income groups showed the highest HALex in 1989, and the second highest income group in 1998; gradients of the HALex by income were only present at lower income groups. 1989 observed steeper gradients than in 1998 by 0.002 between the top 20% and the bottom 20% among men. The same was true for partial gradients observed among women.

Figure 14. Average HALex by income in 1989

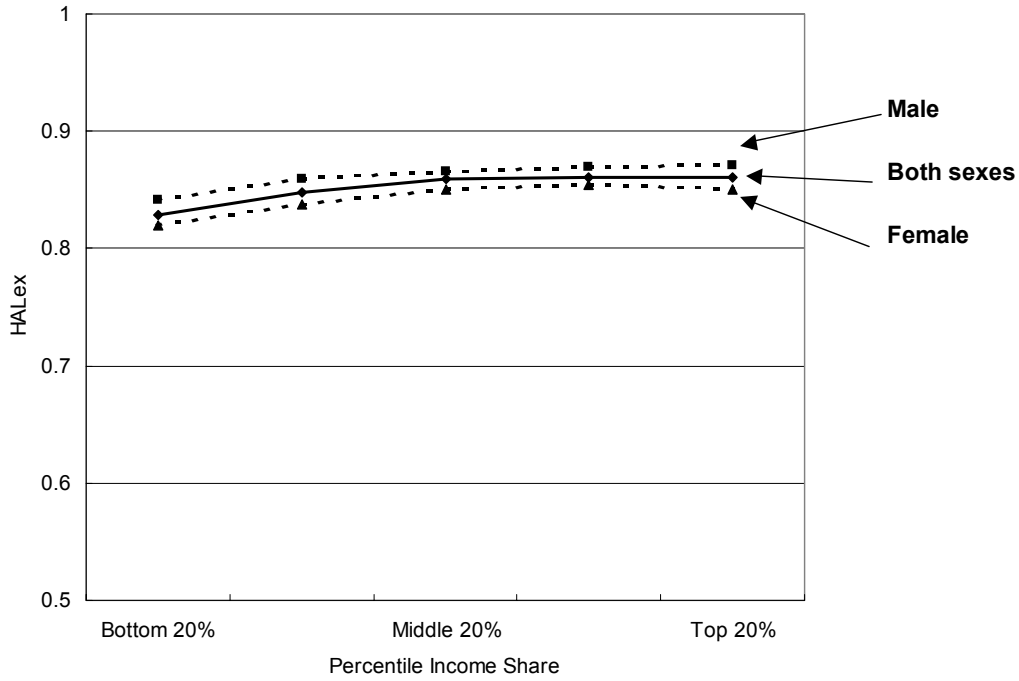


Figure 15. Average HALex by income in 1998

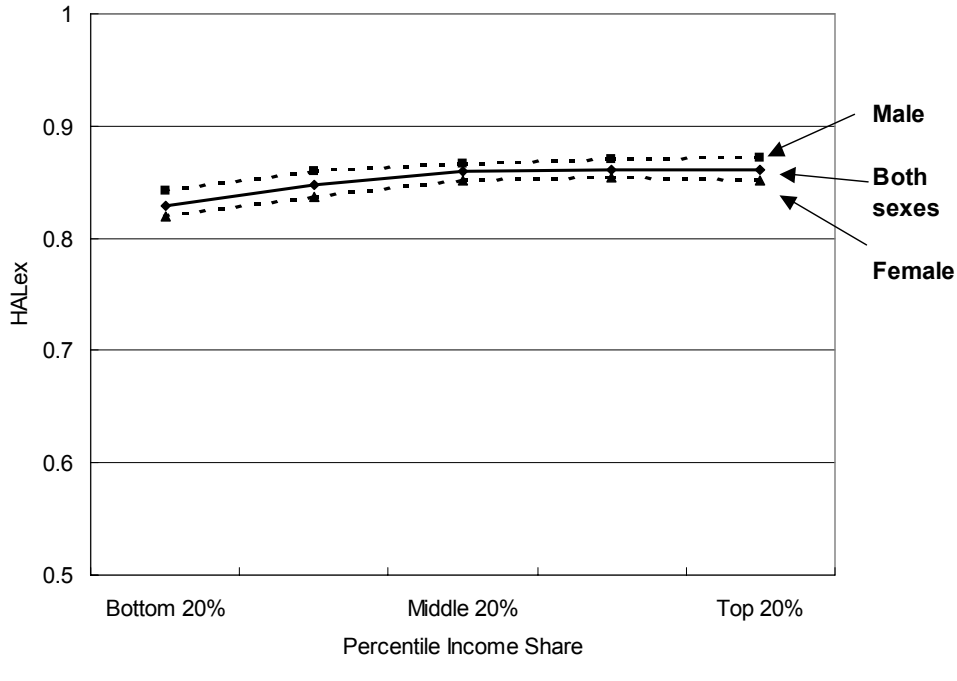


Table 20. HALex by income, both sexes, male, and female, in 1989

Income is in 10,000 yen, this also applies to later tables.

Income group	Income range	Mean HALex	Median HALex
Both sexes			
Bottom 20%	<128.9952	0.833	0.84
Bottom20-40%	[128.9952, 186.2178)	0.856	0.84
Middle 20%	[186.2178, 246.3398)	0.864	0.84
Top 40-20%	[246.3398, 336.1242)	0.866	0.84
Top 20%	>=336.1242	0.867	0.84
	(Top 20%) - (Bottom 20%)	0.034	
	(Middle 20%) - (Bottom 20%)	0.031	
Male			
Bottom 20%	<132.2182	0.847	0.84
Bottom20-40%	[132.2182, 189.5564)	0.869	0.84
Middle 20%	[189.5564, 249.8874)	0.873	0.84
Top 40-20%	[249.8874, 339.3803)	0.875	0.84
Top 20%	>=339.3803	0.878	0.84
	(Top 20%) - (Bottom 20%)	0.031	
	(Middle 20%) - (Bottom 20%)	0.026	
Female			
Bottom 20%	<126.6196	0.821	0.84
Bottom20-40%	[126.6196, 183.5905)	0.846	0.84
Middle 20%	[183.5905, 243.6592)	0.854	0.84
Top 40-20%	[243.6592,333.0632)	0.856	0.84
Top 20%	>=333.0632	0.856	0.84
	(Top 20%) - (Bottom 20%)	0.035	
	(Middle 20%) - (Bottom 20%)	0.033	

Table 20. HALex by income, both sexes, male, and female, in 1998

Income group	Income range	Mean HALex	Median HALex
Both sexes			
Bottom 20%	<170	0.829	0.84
Bottom20-40%	[170, 246.3039)	0.848	0.84
Middle 20%	[246.3039, 327.3672)	0.859	0.84
Top 40-20%	[327.3672, 448.2736)	0.861	0.84
Top 20%	>=448.2736	0.861	0.84
	(Top 20%) - (Bottom 20%)	0.032	
	(Middle 20%) - (Bottom 20%)	0.030	
Male			
Bottom 20%	<177.6813	0.842	0.84
Bottom20-40%	[177.6813, 252.5874)	0.859	0.84
Middle 20%	[252.5874, 333.6934)	0.866	0.84
Top 40-20%	[333.6934, 457.0046)	0.870	0.84
Top 20%	>=457.0046	0.871	0.84
	(Top 20%) - (Bottom 20%)	0.029	
	(Middle 20%) - (Bottom 20%)	0.024	
Female			
Bottom 20%	<165.2131	0.820	0.84
Bottom20-40%	[165.2131, 240.1099)	0.837	0.84
Middle 20%	[240.1099, 321.4948)	0.851	0.84
Top 40-20%	[321.4948, 440.2015)	0.854	0.84
Top 20%	>=440.2015	0.851	0.84
	(Top 20%) - (Bottom 20%)	0.031	
	(Middle 20%) - (Bottom 20%)	0.031	

Differences in the HALex by income and age group

Figures 16-19 and tables 22-25 show how the HALex changed by income at different age groups. In both 1989 and 1998 and both sexes, only the middle age group (45-64 years old) showed a clear gradient of the HALex by income, though even in this case the degree of the gradient was small (0.031-0.038). Among men, the slope in 1989 (0.038 difference between the top 20% and the bottom 20% income groups) was about the same as that of 1998 (0.039), while among women, the 1998 slope (0.031) was less steep than the 1989 slope (0.038). Children (6-14 years old), adolescents (15-24 years old), and the oldest old (75-94 years old) did not present such a gradient in both sexes and both survey years. Differences in the HALex by income among young adults (25-44 years old) and the young old (65-74 years old) were not clear whether they should be treated as gradients. Although the HALex did not improve at every higher income group, the male young old (65-74 years old) presented the biggest gap between the top 20% and the bottom 20% income group: 0.083 in 1989 and 0.058 in 1998.

Figure 16. The HALex by income by age group, male, 1989

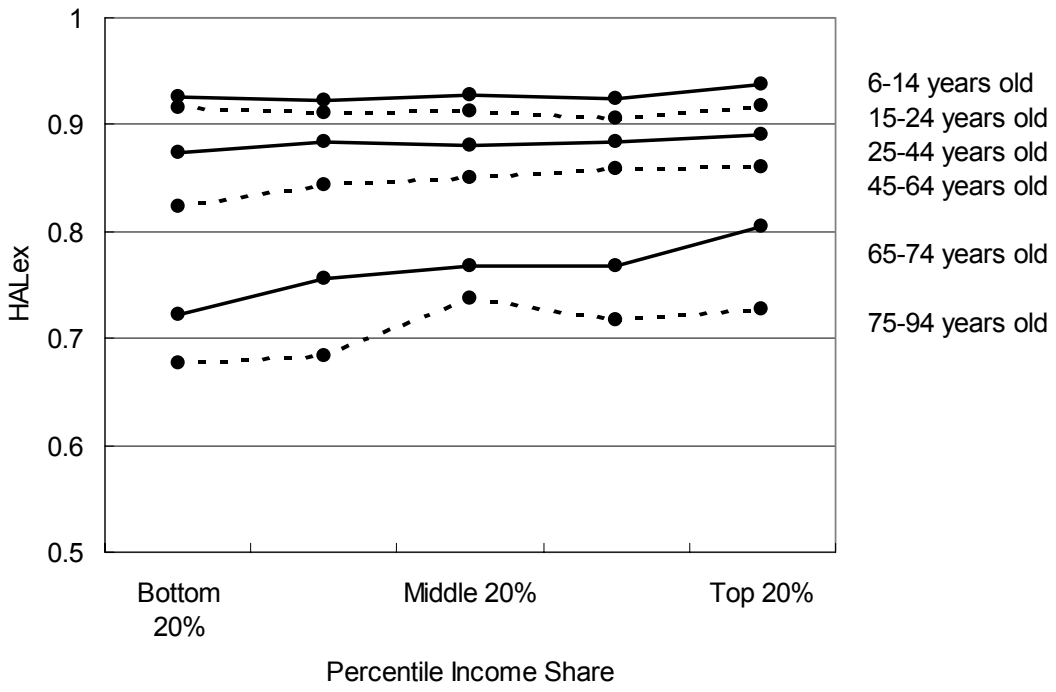


Figure 17. The HALex by income by age group, female, 1989

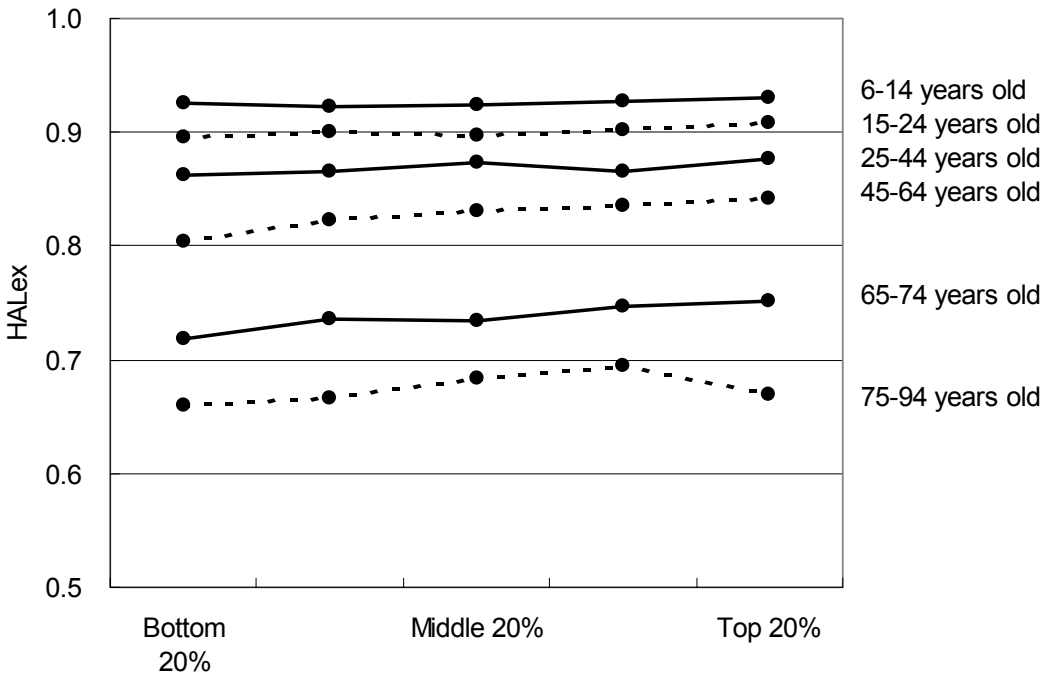


Figure 18. The HALex by income by age group, male, 1998

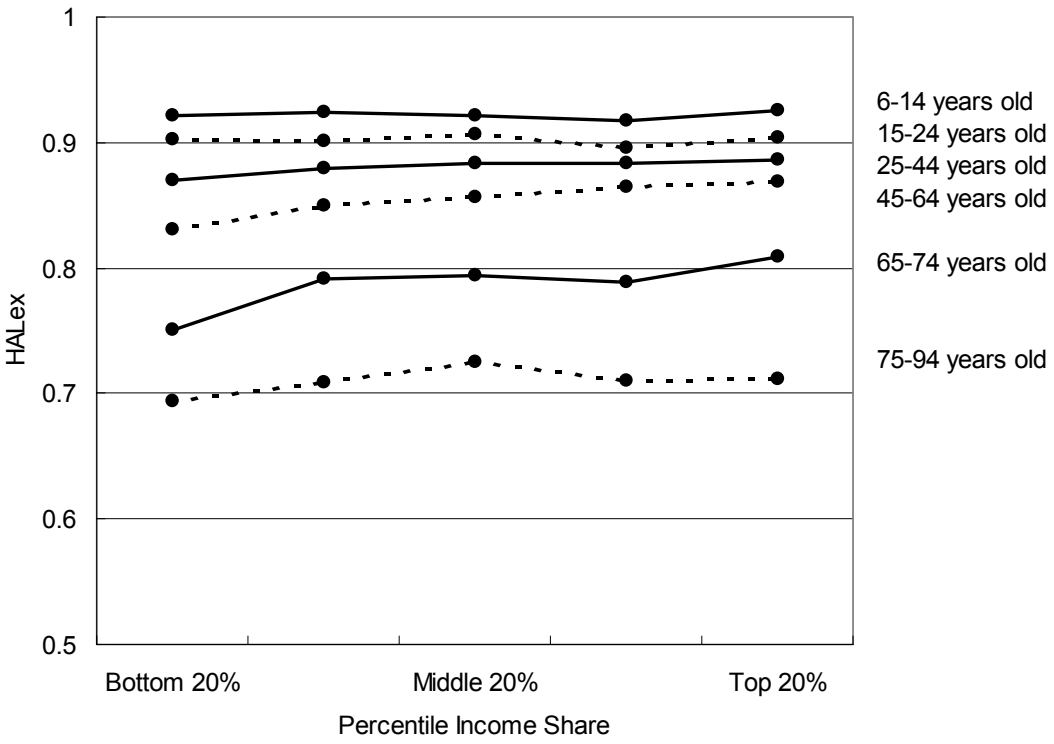


Figure 19. The HALex by income by age group, female, 1998

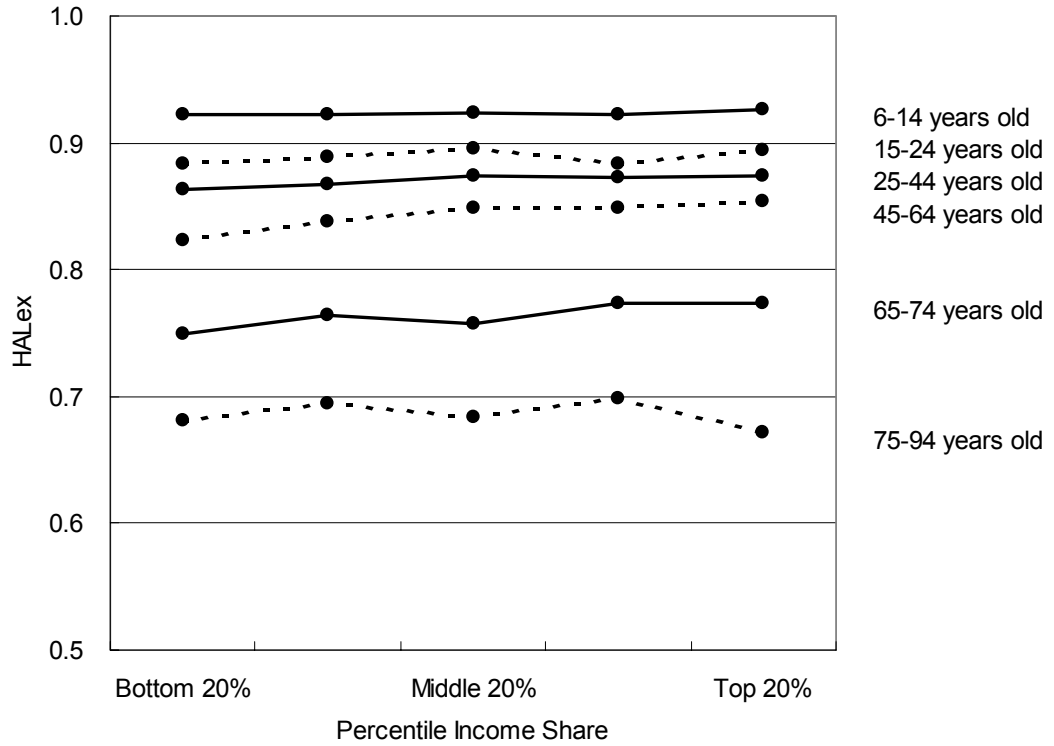


Table 22. The HALex, male, 1989

Income group	Income range	Mean HALex	Median HALex
6-14 years old			
Bottom 20%	<126.951	0.926	1
Bottom20-40%	[126.951, 177.9012)	0.922	1
Middle 20%	[177.9012, 226.3039)	0.928	1
Top 40-20%	[226.3039, 293.8737)	0.925	1
Top 20%	>=293.8737	0.937	1
	(Top 20%) - (Bottom 20%)	0.011	
	(Middle 20%) - (Bottom 20%)	0.002	
15-24 years old			
Bottom 20%	<128.2835	0.916	1
Bottom20-40%	[128.2835, 189.8435)	0.911	1
Middle 20%	[189.8435, 256.874)	0.912	1
Top 40-20%	[256.874, 341.1088)	0.906	1
Top 20%	>=341.1088	0.917	1
	(Top 20%) - (Bottom 20%)	0.001	
	(Middle 20%) - (Bottom 20%)	-0.004	
25-44 years old			
Bottom 20%	<139.7022	0.874	0.84
Bottom20-40%	[139.7022, 191.4102)	0.884	0.84
Middle 20%	[191.4102, 243.7119)	0.881	0.84
Top 40-20%	[243.7119, 323.791)	0.884	0.84
Top 20%	>=323.791	0.891	0.84
	(Top 20%) - (Bottom 20%)	0.017	
	(Middle 20%) - (Bottom 20%)	0.007	
45-64 years old			
Bottom 20%	<145.275	0.823	0.84
Bottom20-40%	[145.275, 212.2262)	0.844	0.84
Middle 20%	[212.2262, 286.403)	0.850	0.84
Top 40-20%	[286.403, 391.8127)	0.858	0.84
Top 20%	>=391.8127	0.861	0.84
	(Top 20%) - (Bottom 20%)	0.038	
	(Middle 20%) - (Bottom 20%)	0.027	
65-74 years old			
Bottom 20%	<107.7251	0.722	0.84
Bottom20-40%	[107.7251, 158.8176)	0.756	0.84
Middle 20%	[158.8176, 212.9582)	0.767	0.84
Top 40-20%	[212.9582, 297.8767)	0.767	0.84
Top 20%	>=297.8767	0.805	0.84
	(Top 20%) - (Bottom 20%)	0.083	
	(Middle 20%) - (Bottom 20%)	0.045	
75-94 years old			
Bottom 20%	<95.00993	0.676	0.84
Bottom20-40%	[95.00993, 140.966)	0.684	0.84
Middle 20%	[140.966, 198.0778)	0.738	0.84
Top 40-20%	[198.0778, 286.2466)	0.718	0.84
Top 20%	>=286.2466	0.728	0.84
	(Top 20%) - (Bottom 20%)	0.052	
	(Middle 20%) - (Bottom 20%)	0.062	

Table 23. The HALex, female, 1989

Income group	Income range	Mean HALex	Median HALex
6-14 years old			
Bottom 20%	<126.8556	0.926	1
Bottom20-40%	[126.8556, 178.0196)	0.922	1
Middle 20%	[178.0196, 225.0253)	0.924	1
Top 40-20%	[225.0253, 292.7413)	0.928	1
Top 20%	>=292.7413	0.930	1
	(Top 20%) - (Bottom 20%)	0.004	
	(Middle 20%) - (Bottom 20%)	-0.002	
15-24 years old			
Bottom 20%	<135.3662	0.895	1
Bottom20-40%	[135.3662, 195.6896)	0.901	1
Middle 20%	[195.6896, 262.2222)	0.897	1
Top 40-20%	[262.2222, 352.7229)	0.902	1
Top 20%	>=352.7229	0.908	1
	(Top 20%) - (Bottom 20%)	0.013	
	(Middle 20%) - (Bottom 20%)	0.002	
25-44 years old			
Bottom 20%	<134.9004	0.862	0.84
Bottom20-40%	[134.9004, 187.6002)	0.866	0.84
Middle 20%	[187.6002, 240.4874)	0.873	0.84
Top 40-20%	[240.4874, 316.9428)	0.865	0.84
Top 20%	>=316.9428	0.877	0.84
	(Top 20%) - (Bottom 20%)	0.015	
	(Middle 20%) - (Bottom 20%)	0.011	
45-64 years old			
Bottom 20%	<131.8673	0.804	0.84
Bottom20-40%	[131.8673, 195.5274)	0.822	0.84
Middle 20%	[195.5274, 269.7975)	0.830	0.84
Top 40-20%	[269.7975, 378.9291)	0.836	0.84
Top 20%	>=378.9291	0.842	0.84
	(Top 20%) - (Bottom 20%)	0.038	
	(Middle 20%) - (Bottom 20%)	0.026	
65-74 years old			
Bottom 20%	<97.26041	0.719	0.84
Bottom20-40%	[97.26041, 144.1915)	0.735	0.84
Middle 20%	[144.1915, 199.2912)	0.734	0.84
Top 40-20%	[199.2912, 278.0778)	0.747	0.84
Top 20%	>=278.0778	0.751	0.84
	(Top 20%) - (Bottom 20%)	0.032	
	(Middle 20%) - (Bottom 20%)	0.015	
75-94 years old			
Bottom 20%	<95.47339	0.660	0.84
Bottom20-40%	[95.47339, 149.1849)	0.666	0.84
Middle 20%	[149.1849, 208.8494)	0.684	0.84
Top 40-20%	[208.8494, 309.8957)	0.694	0.84
Top 20%	>=309.8957	0.670	0.84
	(Top 20%) - (Bottom 20%)	0.010	
	(Middle 20%) - (Bottom 20%)	0.024	

Table 24. The HALex, male, 1998

Income group	Income range	Mean HALex	Median HALex
6-14 years old			
Bottom 20%	<169.834	0.921	1
Bottom20-40%	[169.834, 233.7171)	0.924	1
Middle 20%	[233.7171, 293.3883)	0.922	1
Top 40-20%	[293.3883, 376.1824)	0.918	1
Top 20%	>=376.1824	0.926	1
	(Top 20%) - (Bottom 20%)	0.005	
	(Middle 20%) - (Bottom 20%)	0.001	
15-24 years old			
Bottom 20%	<159.4235	0.903	1
Bottom20-40%	[159.4235, 241.3354)	0.901	1
Middle 20%	[241.3354, 327.0485)	0.906	1
Top 40-20%	[327.0485, 435.9307)	0.896	1
Top 20%	>=435.9307	0.904	1
	(Top 20%) - (Bottom 20%)	0.001	
	(Middle 20%) - (Bottom 20%)	0.003	
25-44 years old			
Bottom 20%	<189.9975	0.870	0.84
Bottom20-40%	[189.9975, 256.6936)	0.879	0.84
Middle 20%	[256.6936, 332.7907)	0.884	0.84
Top 40-20%	[332.7907, 450)	0.883	0.84
Top 20%	>=450	0.886	0.84
	(Top 20%) - (Bottom 20%)	0.016	
	(Middle 20%) - (Bottom 20%)	0.014	
45-64 years old			
Bottom 20%	<199.078	0.830	0.84
Bottom20-40%	[199.078, 289.3189)	0.849	0.84
Middle 20%	[289.3189, 386.5793)	0.856	0.84
Top 40-20%	[386.5793, 523.7826)	0.865	0.84
Top 20%	>=523.7826	0.869	0.84
	(Top 20%) - (Bottom 20%)	0.039	
	(Middle 20%) - (Bottom 20%)	0.026	
65-74 years old			
Bottom 20%	<155.6712	0.751	0.84
Bottom20-40%	[155.6712, 214.9341)	0.792	0.84
Middle 20%	[214.9341, 284.3943)	0.794	0.84
Top 40-20%	[284.3943, 395.5854)	0.789	0.84
Top 20%	>=395.5854	0.809	0.84
	(Top 20%) - (Bottom 20%)	0.058	
	(Middle 20%) - (Bottom 20%)	0.043	
75-94 years old			
Bottom 20%	<129.2702	0.694	0.84
Bottom20-40%	[129.2702, 198)	0.708	0.84
Middle 20%	[198, 268.3895)	0.725	0.84
Top 40-20%	[268.3895, 386.0404)	0.710	0.84
Top 20%	>=386.0404	0.712	0.84
	(Top 20%) - (Bottom 20%)	0.018	
	(Middle 20%) - (Bottom 20%)	0.031	

Table 25. The HALex, female, 1998

Income group	Income range	Mean HALex	Median HALex
6-14 years old			
Bottom 20%	<169.834	0.922	1
Bottom20-40%	[169.834, 233.469)	0.922	1
Middle 20%	[233.469, 298.4833)	0.923	1
Top 40-20%	[298.4833, 382.1266)	0.922	1
Top 20%	>=382.1266	0.926	1
	(Top 20%) - (Bottom 20%)	0.004	
	(Middle 20%) - (Bottom 20%)	0.001	
15-24 years old			
Bottom 20%	<168.5483	0.884	0.84
Bottom20-40%	[168.5483, 254.7511)	0.889	0.84
Middle 20%	[254.7511, 339.9396)	0.896	1
Top 40-20%	[339.9396, 445.2417)	0.884	0.84
Top 20%	>=445.2417	0.894	1
	(Top 20%) - (Bottom 20%)	0.010	
	(Middle 20%) - (Bottom 20%)	0.012	
25-44 years old			
Bottom 20%	<179.5995	0.863	0.84
Bottom20-40%	[179.5995, 246.7132)	0.867	0.84
Middle 20%	[246.7132, 318.4388)	0.874	0.84
Top 40-20%	[318.4388, 424.5851)	0.872	0.84
Top 20%	>=424.5851	0.874	0.84
	(Top 20%) - (Bottom 20%)	0.011	
	(Middle 20%) - (Bottom 20%)	0.011	
45-64 years old			
Bottom 20%	<177.2848	0.823	0.84
Bottom20-40%	[177.2848, 265.2504)	0.838	0.84
Middle 20%	[265.2504, 362.572)	0.848	0.84
Top 40-20%	[362.572, 504.3483)	0.849	0.84
Top 20%	>=504.3483	0.854	0.84
	(Top 20%) - (Bottom 20%)	0.031	
	(Middle 20%) - (Bottom 20%)	0.025	
65-74 years old			
Bottom 20%	<137	0.749	0.84
Bottom20-40%	[137, 201.2921)	0.764	0.84
Middle 20%	[201.2921, 269.0051)	0.758	0.84
Top 40-20%	[269.0051, 377.2589)	0.774	0.84
Top 20%	>=377.2589	0.773	0.84
	(Top 20%) - (Bottom 20%)	0.024	
	(Middle 20%) - (Bottom 20%)	0.009	
75-94 years old			
Bottom 20%	<115.8658	0.681	0.84
Bottom20-40%	[115.8658, 185.82491)	0.694	0.84
Middle 20%	[185.8249, 269.0051)	0.683	0.84
Top 40-20%	[269.0051, 398.2752)	0.698	0.84
Top 20%	>=398.2752	0.671	0.84
	(Top 20%) - (Bottom 20%)	-0.010	
	(Middle 20%) - (Bottom 20%)	0.002	

(3) How was the HALex, from death to the "full" health, distributed in Japan, overall, by sex and by age group in 1989 and 1998?

Tables 26 presents the Gini Coefficients of the HALex among Japanese people in 1989 and 1998. In addition to the overall Gini Coefficient, we calculated it for men, women, and different age groups (6-14, 15-24, 25-44, 45-64, 65-74, and 75-94 years old). Furthermore, this table presents the Gini Coefficients for the sample including the dead and the sample of the living only reflecting the concern for the interpretation of death in health inequality analysis discussed in the method section above. Following to the Gini Coefficient table, we attach tables (Tables 27-34), histograms (Figures 20-27), and the Lorenz Curves (Figures 28-31) of distributions of the HALex for the overall population and by sex and age group.

Overall distribution of the HALex

Between 1989 and 1998, the overall health inequality in Japan slightly increased (0.002). Health inequalities among men and women had the same trend of the slight increase between these years (0.001 increase for men, 0.002 increase for women). Health inequality trends between 1989 and 1998 differed by age groups, however: health inequalities increased among children (6-14 years old) and adolescents (15-24 years old), while they decreased among adults and the elderly (25-94 years old).

Distribution of the HALex by sex

Comparing health inequalities among men and women, both in 1989 and 1998, health was more unequally distributed among women than men (0.008 difference in 1989 and 0.009 difference in 1998). Looking at different age groups, it appears that there was no sex difference in health inequalities among children (6-14 years old), but for those who were 15 years of age and older, health was generally more unequally distributed among women than men. The increase in health inequalities among older men is most likely to be due to a greater number of deaths occurring to them than their female counterparts.

Distribution of the HALex by age group

In both years and both sexes, health inequalities increased at older age groups. The Lorenz Curves by age groups in Figures 30 and 31 most clearly illustrate this. A distribution is perfectly equal when the Lorenz Curve coincides with the diagonal line, and it is most unequal when the Lorenz Curve follows the x-axis and the right vertical line. The Lorenz Curves in Figures 30 and 31 move between these extremes in order at every older age group. This trend of the increasing health inequalities at older age groups is not only due to the effect

of the increasing number of deaths, because this trend is also present among the samples of the living only.

Table 26. The Gini Coefficients in 1989 and 1998

Age group	Both sexes		Male		Female	
	1989	1998	1989	1998	1989	1998
The living + the dead						
All ages	0.096	0.098	0.092	0.093	0.100	0.102
6--14	0.050	0.051	0.050	0.052	0.049	0.051
15-24	0.059	0.062	0.050	0.060	0.062	0.064
25-44	0.072	0.070	0.070	0.068	0.073	0.072
45-64	0.096	0.086	0.096	0.086	0.096	0.087
65-74	0.181	0.163	0.184	0.165	0.179	0.161
75-94	0.264	0.247	0.271	0.255	0.259	0.243
The living only						
All ages	0.091	0.091	0.085	0.086	0.095	0.096
6--14	0.050	0.051	0.050	0.052	0.049	0.051
15-24	0.059	0.061	0.056	0.059	0.061	0.064
25-44	0.071	0.069	0.069	0.067	0.073	0.071
45-64	0.092	0.082	0.089	0.080	0.093	0.084
65-74	0.167	0.149	0.164	0.146	0.168	0.152
75-94	0.215	0.205	0.211	0.199	0.217	0.208

Figure 20. Histograms of the HALex, male (sex=1), female (sex=2), and both sexes, 1986

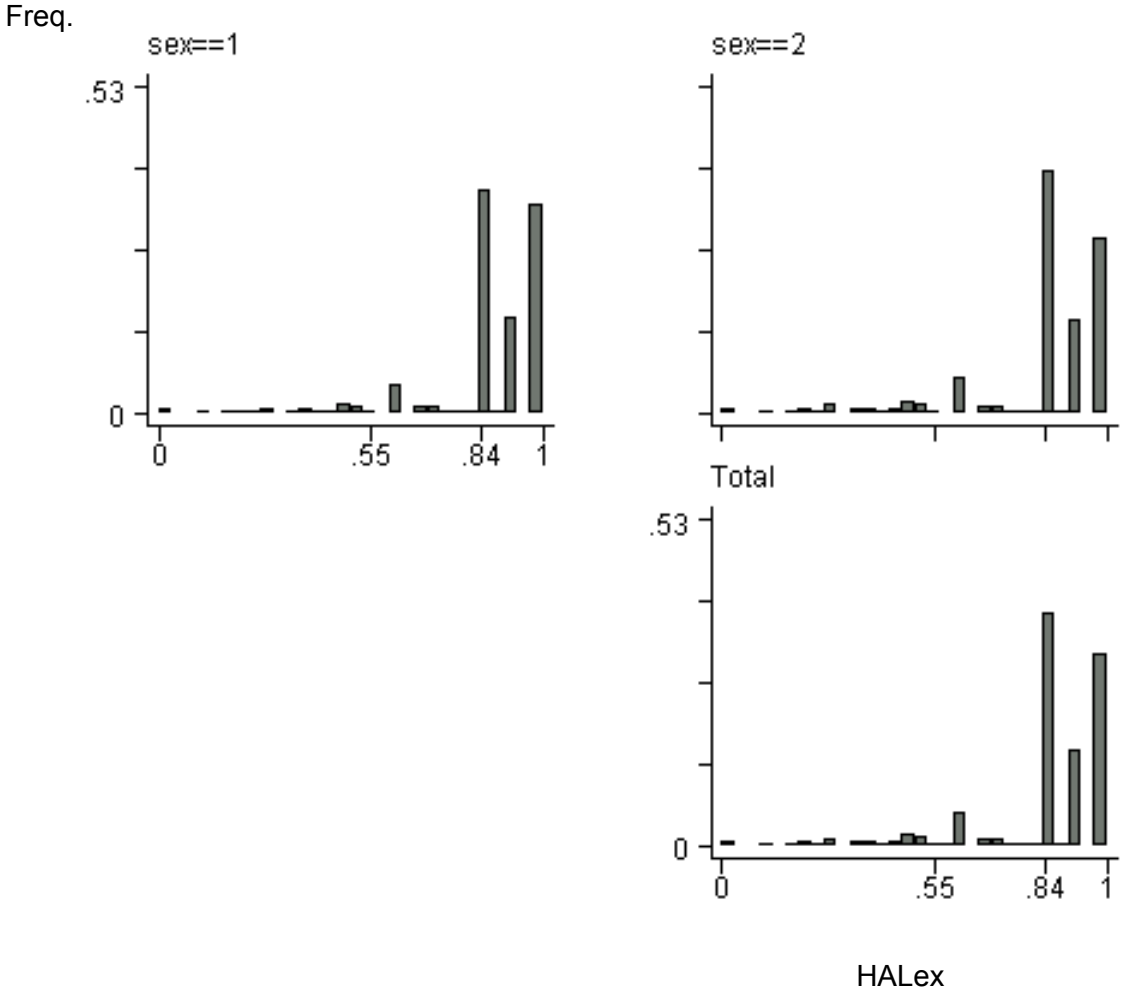


Table 27. The HALex, both sexes, male, and female, 1989

HALex			Both sexes		Male		Female	
Self-perceived Health	Activity Limitation	Score	Freq.	Percent	Freq.	Percent	Freq.	Percent
Dead		0	4518	0.64	2532	0.74	1986	0.55
Poor	Limited in ADL	0.1	1319	0.19	597	0.18	722	0.20
Poor	Limited in IADL	0.17	1004	0.14	452	0.13	552	0.15
Fair	Limited in ADL	0.21	3989	0.57	1469	0.43	2520	0.69
Poor	Unable-major	0.25	1291	0.18	637	0.19	654	0.18
Fair	Limited in IADL	0.29	7278	1.03	2669	0.78	4609	1.27
Poor	Limited-major	0.34	1562	0.22	779	0.23	783	0.22
Good	Limited in ADL	0.36	1676	0.24	634	0.19	1042	0.29
Fair/Unable-major, Poor/Limited-other		0.38	4224	0.60	1846	0.54	2378	0.65
Very good	Limited in ADL	0.41	486	0.07	205	0.06	281	0.08
Good	Limited in IADL	0.45	3739	0.53	1369	0.40	2370	0.65
Excellent/Limited in ADL, Poor/Not limited		0.47	1617	0.23	795	0.23	822	0.23
Fair	Limited-major	0.48	10751	1.53	4561	1.34	6190	1.70
Very good	Limited in IADL	0.51	825	0.12	330	0.10	495	0.14
Fair	Limited-other	0.52	7764	1.10	3531	1.04	4233	1.16
Good	Unable-major	0.55	1588	0.23	720	0.21	868	0.24
Excellent	Limited in IADL	0.57	206	0.03	95	0.03	111	0.03
Very good	Unable-major	0.62	474	0.07	218	0.06	256	0.07
Fair	Not limited	0.63	35657	5.06	15242	4.47	20415	5.61
Good	Limited-major	0.67	6065	0.86	2692	0.79	3373	0.93
Excellent	Unable-major	0.68	395	0.06	198	0.06	197	0.05
Good	Limited-other	0.72	7835	1.11	3808	1.12	4027	1.11
Very good	Limited-major	0.74	1356	0.19	639	0.19	717	0.20
Very good	Limited-other	0.79	2175	0.31	1120	0.33	1055	0.29
Excellent	Limited-major	0.81	526	0.07	291	0.09	235	0.06
Good	Not limited	0.84	267464	37.94	123325	36.18	144139	39.59
Excellent	Limited-other	0.87	1395	0.20	762	0.22	633	0.17
Very good	Not limited	0.92	108800	15.43	53478	15.69	55322	15.20
Excellent	Not limited	1	218960	31.06	115899	34.00	103061	28.31
Total (the living + the dead)			704939	100	340893	100	364046	100
Total (the living only)			700421		338361		362060	

Figure 21. Histograms of the HALex, both sexes, male, and female, 1998

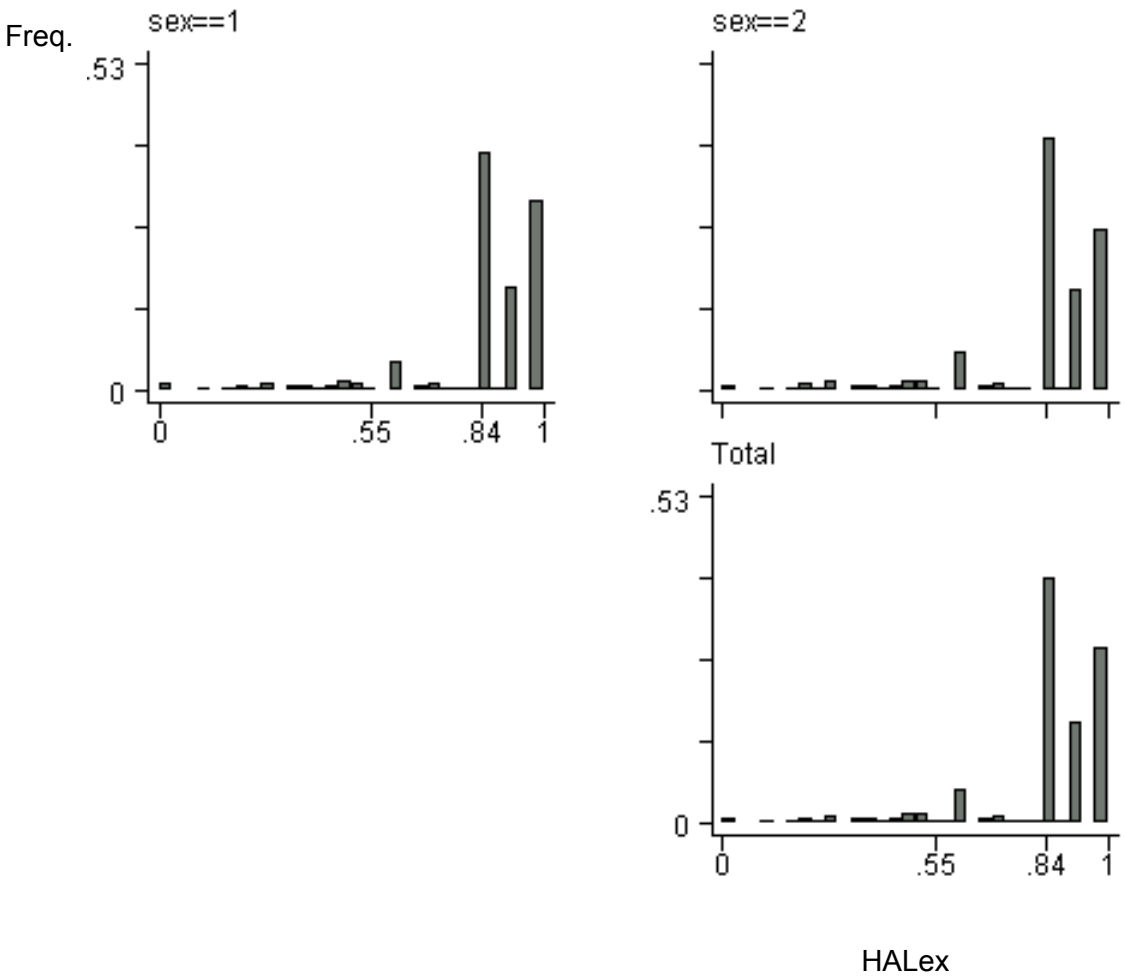


Table 28. The HALex, both sexes, male, and female, 1998

HALex			Both sexes		Male		Female	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	4544	0.72	2609	0.85	1935	0.59
Poor	Limited in ADL	0.1	1598	0.25	628	0.20	970	0.30
Poor	Limited in IADL	0.17	966	0.15	433	0.14	533	0.16
Fair	Limited in ADL	0.21	5101	0.80	1806	0.59	3295	1.00
Poor	Unable-major	0.25	739	0.12	345	0.11	394	0.12
Fair	Limited in IADL	0.29	6771	1.07	2699	0.88	4072	1.24
Poor	Limited-major	0.34	1259	0.20	626	0.20	633	0.19
Good	Limited in ADL	0.36	2231	0.35	860	0.28	1371	0.42
Fair/Unable-major, Poor/Limited-other		0.38	3282	0.52	1436	0.47	1846	0.56
Very good	Limited in ADL	0.41	656	0.10	253	0.08	403	0.12
Good	Limited in IADL	0.45	3593	0.57	1380	0.45	2213	0.67
Excellent/Limited in ADL, Poor/Not limited		0.47	1356	0.21	648	0.21	708	0.22
Fair	Limited-major	0.48	7986	1.26	3408	1.11	4578	1.39
Very good	Limited in IADL	0.51	1000	0.16	417	0.14	583	0.18
Fair	Limited-other	0.52	6894	1.09	3218	1.05	3676	1.12
Good	Unable-major	0.55	1429	0.23	650	0.21	779	0.24
Excellent	Limited in IADL	0.57	170	0.03	79	0.03	91	0.03
Very good	Unable-major	0.62	535	0.08	232	0.08	303	0.09
Fair	Not limited	0.63	33549	5.28	14216	4.64	19333	5.89
Good	Limited-major	0.67	4340	0.68	1969	0.64	2371	0.72
Excellent	Unable-major	0.68	316	0.05	161	0.05	155	0.05
Good	Limited-other	0.72	6472	1.02	3162	1.03	3310	1.01
Very good	Limited-major	0.74	1166	0.18	524	0.17	642	0.20
Very good	Limited-other	0.79	1979	0.31	1053	0.34	926	0.28
Excellent	Limited-major	0.81	291	0.05	170	0.06	121	0.04
Good	Not limited	0.84	252832	39.81	118368	38.61	134464	40.93
Excellent	Limited-other	0.87	785	0.12	453	0.15	332	0.10
Very good	Not limited	0.92	103867	16.36	50829	16.58	53038	16.14
Excellent	Not limited	1	179358	28.24	93922	30.64	85436	26.01
Total (the living + the dead)			635065	100	306554	100	328511	100
Total (the living only)			630521		303945		326576	

Figure 22. Histograms of the HALex by age, 1989

agegp==1: 6-14 years old, agegp==2: 15-24 years old, agegp==3: 25-44 years old
agegp==4: 45-64 years old, agegp==5: 65-74 years old, agegp==6: 75-94 years old

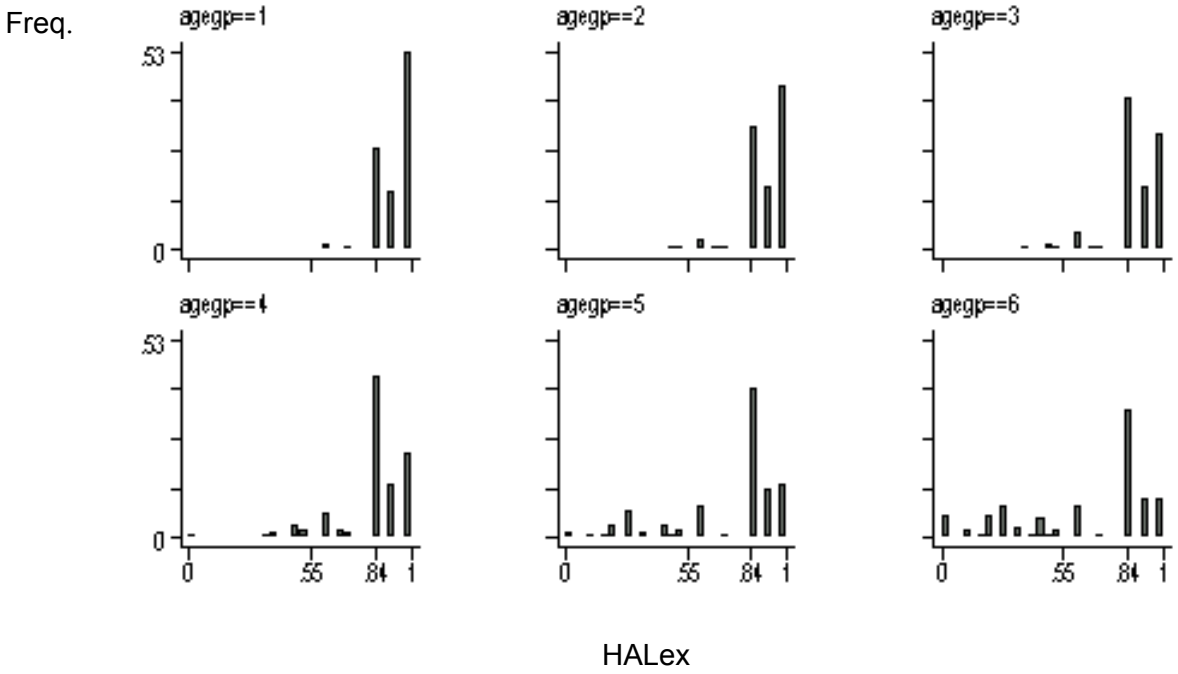


Figure 23. Histograms of the HALex by age, 1998

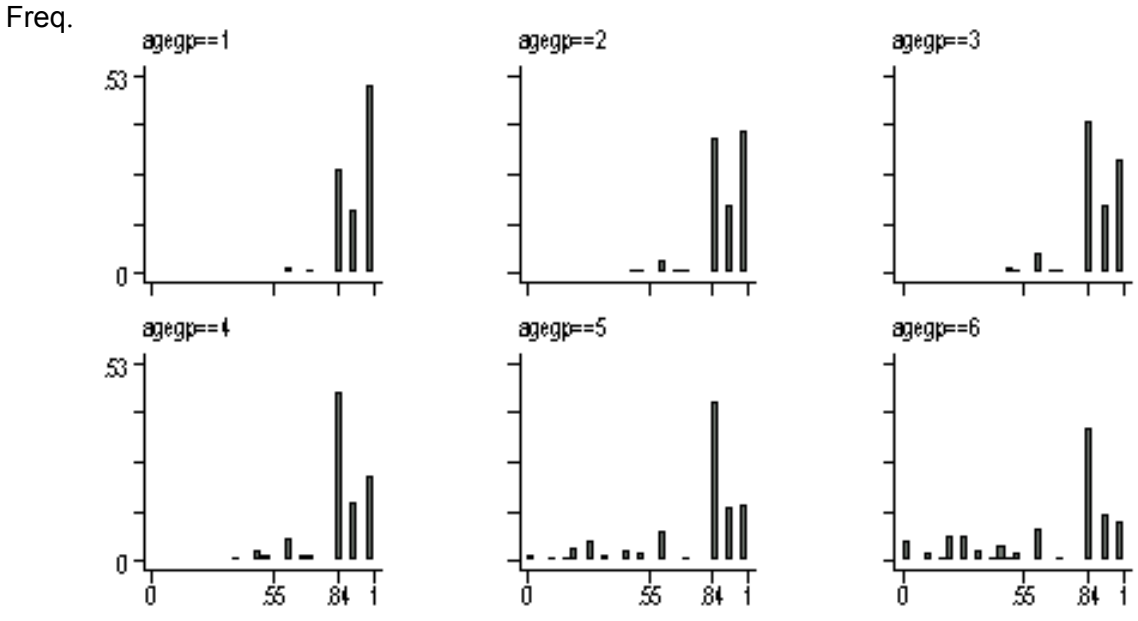


Table 29. The HALex by age, 1989

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	15	0.02	50	0.05	205	0.1	1015	0.52
Poor	Unable-major	0.25	42	0.04	65	0.06	291	0.1	893	0.46
Poor	Limited-major	0.34	38	0.04	79	0.08	387	0.2	1058	0.54
Fair/Unable-major, Poor/Limited-other		0.38	185	0.19	321	0.31	1182	0.6	2416	1.23
Poor	Not limited	0.47	44	0.05	140	0.13	295	0.1	514	0.26
Fair	Limited-major	0.48	233	0.24	628	0.60	3239	1.5	6651	3.39
Fair	Limited-other	0.52	393	0.41	558	0.53	1985	0.9	3741	1.91
Good	Unable-major	0.55	199	0.21	203	0.19	617	0.3	569	0.29
Very good	Unable-major	0.62	94	0.10	71	0.07	138	0.1	171	0.09
Fair	Not limited	0.63	1149	1.19	3018	2.87	10379	4.8	13251	6.76
Good	Limited-major	0.67	260	0.27	528	0.50	1852	0.9	3425	1.75
Excellent	Unable-major	0.68	100	0.10	60	0.06	121	0.1	114	0.06
Good	Limited-other	0.72	854	0.89	877	0.84	1975	0.9	3159	1.61
Very good	Limited-major	0.74	85	0.09	139	0.13	456	0.2	676	0.34
Very good	Limited-other	0.79	310	0.32	296	0.28	531	0.3	758	0.39
Excellent	Limited-major	0.81	51	0.05	94	0.09	153	0.1	228	0.12
Good	Not limited	0.84	26253	27.29	34242	32.62	87559	40.8	84416	43.08
Excellent	Limited-other	0.87	280	0.29	245	0.23	352	0.2	412	0.21
Very good	Not limited	0.92	14833	15.42	17728	16.89	36465	17.0	28540	14.56
Excellent	Not limited	1	50799	52.80	45646	43.48	66712	31.0	43943	22.43
Total (the living + the dead)			96217	100	104988	100	214894	100	195950	100
Total (the living only)			96202		104938		214689		194935	

Table 29. The HALex by age, 1989, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	1018	1.77	2215	6.24
Poor	Limited in ADL	0.1	626	1.09	693	1.95
Poor	Limited in IADL	0.17	597	1.04	407	1.15
Fair	Limited in ADL	0.21	1836	3.20	2153	6.06
Fair	Limited in IADL	0.29	4147	7.23	3131	8.82
Good	Limited in ADL	0.36	815	1.42	861	2.42
Poor	Limited-other	0.38	74	0.13	46	0.13
Very good	Limited in ADL	0.41	239	0.42	247	0.70
Good	Limited in IADL	0.45	1928	3.36	1811	5.10
Excellent/Limited in ADL, Poor/Not limited		0.47	351	0.61	273	0.77
Very good	Limited in IADL	0.51	460	0.80	365	1.03
Fair	Limited-other	0.52	715	1.25	372	1.05
Excellent	Limited in IADL	0.57	113	0.20	93	0.26
Fair	Not limited	0.63	4841	8.44	3019	8.50
Good	Limited-other	0.72	618	1.08	352	0.99
Very good	Limited-other	0.79	201	0.35	79	0.22
Good	Not limited	0.84	22917	39.94	12077	34.01
Excellent	Limited-other	0.87	68	0.12	38	0.11
Very good	Not limited	0.92	7575	13.20	3659	10.30
Excellent	Not limited	1	8241	14.36	3619	10.19
Total (the living + the dead)			57380	100	35510	100
Total (the living only)			56362		33295	

Table 30. The HALex by age, 1998

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	10	0.01	38	0.04	149	0.09	887	0.46
Poor	Unable-major	0.25	24	0.04	50	0.06	177	0.10	488	0.25
Poor	Limited-major	0.34	25	0.04	95	0.11	318	0.19	821	0.43
Fair/Unable-major, Poor/Limited-other		0.38	136	0.20	282	0.32	879	0.51	1822	0.95
Poor	Not limited	0.47	30	0.04	151	0.17	244	0.14	390	0.20
Fair	Limited-major	0.48	201	0.29	523	0.59	2352	1.37	4910	2.55
Fair	Limited-other	0.52	331	0.48	512	0.58	1333	0.78	3289	1.71
Good	Unable-major	0.55	159	0.23	225	0.26	481	0.28	564	0.29
Very good	Unable-major	0.62	71	0.10	89	0.10	156	0.09	219	0.11
Fair	Not limited	0.63	1008	1.48	3063	3.48	8604	5.03	11786	6.11
Good	Limited-major	0.67	179	0.26	453	0.51	1303	0.76	2405	1.25
Excellent	Unable-major	0.68	78	0.11	71	0.08	93	0.05	74	0.04
Good	Limited-other	0.72	613	0.90	688	0.78	1252	0.73	2685	1.39
Very good	Limited-major	0.74	74	0.11	141	0.16	367	0.21	584	0.30
Very good	Limited-other	0.79	272	0.40	263	0.30	414	0.24	670	0.35
Excellent	Limited-major	0.81	31	0.05	50	0.06	83	0.05	127	0.07
Good	Not limited	0.84	18912	27.68	31770	36.10	69540	40.63	87030	45.14
Excellent	Limited-other	0.87	163	0.24	130	0.15	134	0.08	237	0.12
Very good	Not limited	0.92	11505	16.84	15750	17.89	30970	18.09	30159	15.64
Excellent	Not limited	1	34505	50.50	33670	38.26	52322	30.57	43644	22.64
Total (the living + the dead)			68327	100	88014	100	171171	100	192791	100
Total (the living only)			68317		87976		171022		191904	

Table 30. The HALex by age, 1998, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	1150	1.60	2310	5.36
Poor	Limited in ADL	0.1	762	1.06	836	1.94
Poor	Limited in IADL	0.17	552	0.77	414	0.96
Fair	Limited in ADL	0.21	2202	3.07	2899	6.73
Fair	Limited in IADL	0.29	3928	5.48	2843	6.60
Good	Limited in ADL	0.36	940	1.31	1291	3.00
Poor	Limited-other	0.38	99	0.14	64	0.15
Very good	Limited in ADL	0.41	303	0.42	353	0.82
Good	Limited in IADL	0.45	1906	2.66	1687	3.92
Excellent/Limited in ADL, Poor/Not limited		0.47	290	0.40	251	0.58
Very good	Limited in IADL	0.51	523	0.73	477	1.11
Fair	Limited-other	0.52	915	1.28	514	1.19
Excellent	Limited in IADL	0.57	84	0.12	86	0.20
Fair	Not limited	0.63	5492	7.66	3596	8.35
Good	Limited-other	0.72	762	1.06	472	1.10
Very good	Limited-other	0.79	245	0.34	115	0.27
Good	Not limited	0.84	30380	42.38	15200	35.28
Excellent	Limited-other	0.87	82	0.11	39	0.09
Very good	Not limited	0.92	10255	14.31	5228	12.14
Excellent	Not limited	1	10811	15.08	4406	10.23
Total (the living + the dead)			71681	100	43081	100
Total (the living only)			70531		40771	

Figure 24. Histogram of the HALex for male by age, 1989

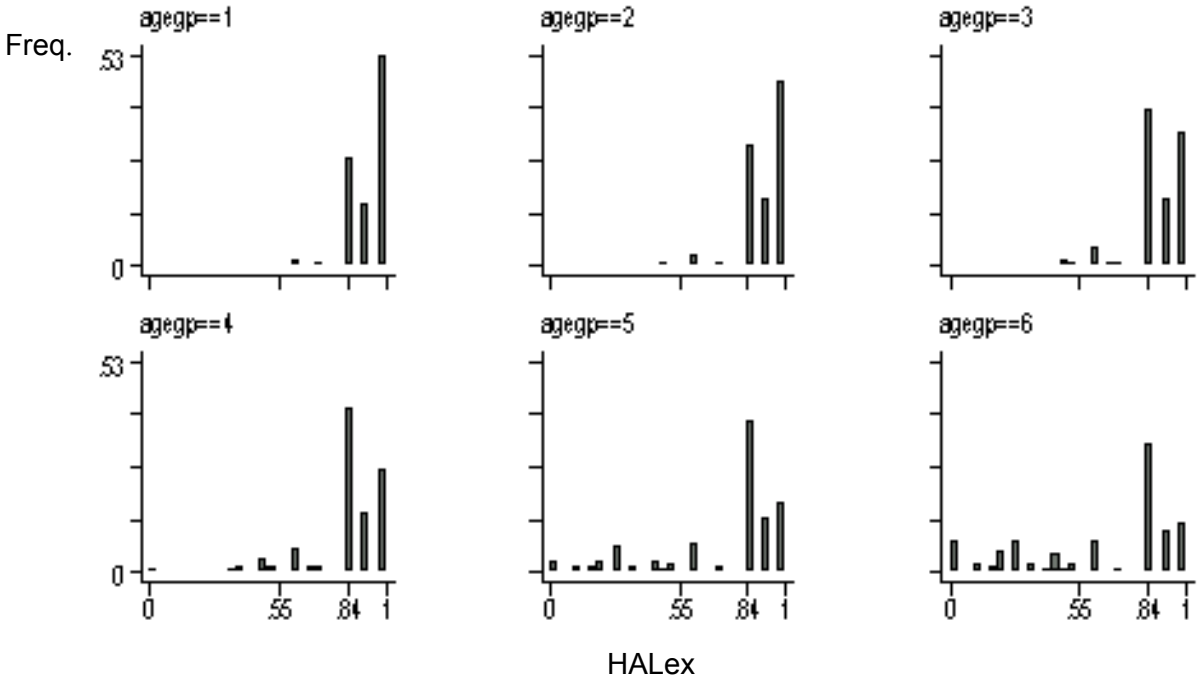


Figure 25. Histogram of the HALex for female by age, 1989

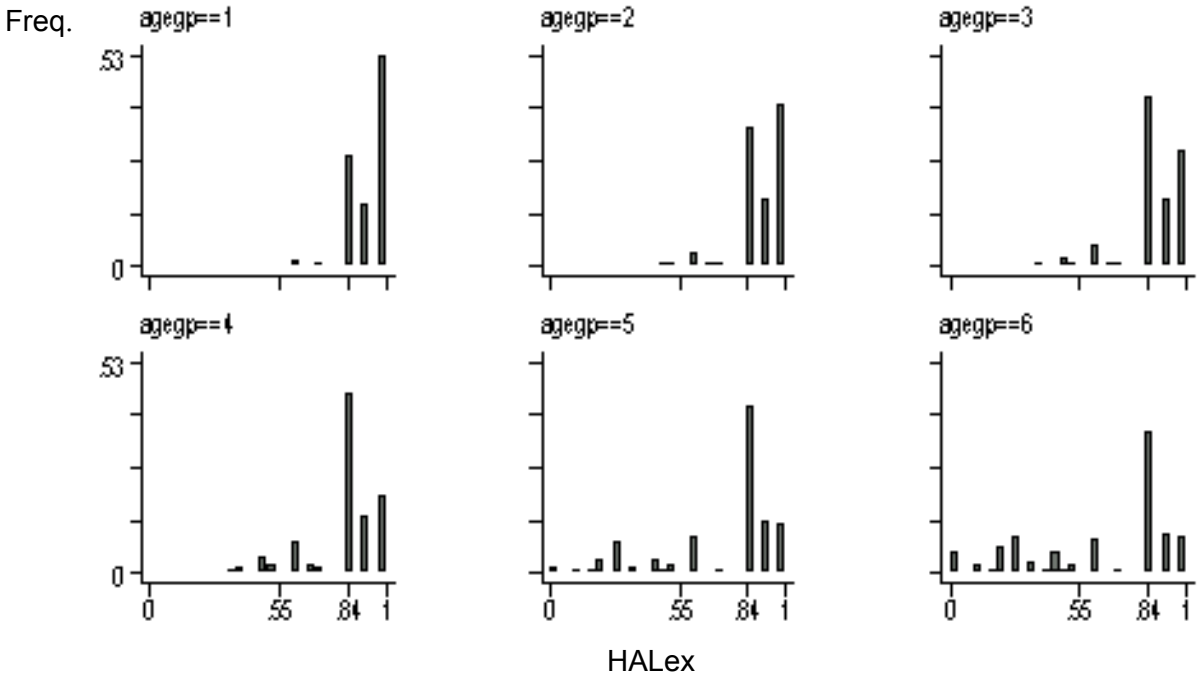


Table 31. The HALex for male by age, 1986

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	9	0.02	36	0.07	129	0.12	678	0.71
Poor	Unable-major	0.25	24	0.05	30	0.06	139	0.13	444	0.47
Poor	Limited-major	0.34	21	0.04	38	0.07	198	0.19	522	0.55
Fair/Unable-major, Poor/Limited-other		0.38	89	0.18	114	0.22	446	0.42	1134	1.19
Poor	Not limited	0.47	17	0.03	73	0.14	172	0.16	250	0.26
Fair	Limited-major	0.48	116	0.24	283	0.54	1356	1.28	2806	2.94
Fair	Limited-other	0.52	215	0.44	248	0.48	915	0.86	1667	1.75
Good	Unable-major	0.55	115	0.23	86	0.16	247	0.23	272	0.28
Very good	Unable-major	0.62	53	0.11	34	0.07	59	0.06	72	0.08
Fair	Not limited	0.63	594	1.21	1250	2.40	4849	4.58	5638	5.91
Good	Limited-major	0.67	138	0.28	238	0.46	800	0.76	1516	1.59
Excellent	Unable-major	0.68	53	0.11	24	0.05	58	0.05	63	0.07
Good	Limited-other	0.72	458	0.93	430	0.82	936	0.88	1559	1.63
Very good	Limited-major	0.74	49	0.10	82	0.16	197	0.19	311	0.33
Very good	Limited-other	0.79	176	0.36	155	0.30	280	0.26	375	0.39
Excellent	Limited-major	0.81	29	0.06	51	0.10	86	0.08	125	0.13
Good	Not limited	0.84	13257	26.98	15860	30.39	41445	39.12	39145	41.01
Excellent	Limited-other	0.87	150	0.31	130	0.25	196	0.19	226	0.24
Very good	Not limited	0.92	7589	15.45	8705	16.68	18092	17.08	14319	15.00
Excellent	Not limited	1	25982	52.88	24316	46.60	35343	33.36	24330	25.49
Total (the living + the dead)			49134	100	52183	100	105943	100	95452	100
Total (the living only)			49125		52147		105814		94774	

Table 32. The HALex for male by age, 1986, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	597	2.48	1083	7.68
Poor	Limited in ADL	0.1	296	1.23	301	2.14
Poor	Limited in IADL	0.17	282	1.17	170	1.21
Fair	Limited in ADL	0.21	705	2.93	764	5.42
Fair	Limited in IADL	0.29	1557	6.46	1112	7.89
Good	Limited in ADL	0.36	318	1.32	316	2.24
Poor	Limited-other	0.38	42	0.17	21	0.15
Very good	Limited in ADL	0.41	108	0.45	97	0.69
Good	Limited in IADL	0.45	722	3.00	647	4.59
Excellent/Limited in ADL, Poor/Not limited		0.47	163	0.68	120	0.85
Very good	Limited in IADL	0.51	178	0.74	152	1.08
Fair	Limited-other	0.52	327	1.36	159	1.13
Excellent	Limited in IADL	0.57	56	0.23	39	0.28
Fair	Not limited	0.63	1774	7.37	1137	8.07
Good	Limited-other	0.72	296	1.23	129	0.92
Very good	Limited-other	0.79	94	0.39	40	0.28
Good	Not limited	0.84	9072	37.67	4546	32.25
Excellent	Limited-other	0.87	36	0.15	24	0.17
Very good	Not limited	0.92	3258	13.53	1515	10.75
Excellent	Not limited	1	4204	17.45	1724	12.23
Total (the living + the dead)			24085	100	14096	100
Total (the living only)			23488		13013	

Table 32. The HALex for female by age, 1989

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	6	0.010	14	0.03	76	0.07	337	0.34
Poor	Unable-major	0.25	18	0.040	35	0.07	152	0.14	449	0.45
Poor	Limited-major	0.34	17	0.040	41	0.08	189	0.17	536	0.53
Fair/Unable-major, Poor/Limited-other		0.38	96	0.200	207	0.39	736	0.68	1282	1.28
Poor	Not limited	0.47	27	0.060	67	0.13	123	0.11	264	0.26
Fair	Limited-major	0.48	117	0.250	345	0.65	1883	1.73	3845	3.83
Fair	Limited-other	0.52	178	0.380	310	0.59	1070	0.98	2074	2.06
Good	Unable-major	0.55	84	0.180	117	0.22	370	0.34	297	0.30
Very good	Unable-major	0.62	41	0.090	37	0.07	79	0.07	99	0.10
Fair	Not limited	0.63	555	1.180	1768	3.35	5530	5.08	7613	7.58
Good	Limited-major	0.67	122	0.260	290	0.55	1052	0.97	1909	1.90
Excellent	Unable-major	0.68	47	0.100	36	0.07	63	0.06	51	0.05
Good	Limited-other	0.72	396	0.840	447	0.85	1039	0.95	1600	1.59
Very good	Limited-major	0.74	36	0.080	57	0.11	259	0.24	365	0.36
Very good	Limited-other	0.79	134	0.280	141	0.27	251	0.23	383	0.38
Excellent	Limited-major	0.81	22	0.050	43	0.08	67	0.06	103	0.10
Good	Not limited	0.84	12996	27.600	18382	34.81	46114	42.33	45271	45.05
Excellent	Limited-other	0.87	130	0.280	115	0.22	156	0.14	186	0.19
Very good	Not limited	0.92	7244	15.390	9023	17.09	18373	16.86	14221	14.15
Excellent	Not limited	1	24817	52.710	21330	40.39	31369	28.79	19613	19.52
Total (the living + the dead)			47083	100	52805	100	108951	100	100498	100
Total (the living only)			47077		52791		108875		100161	

Table 32. The HALex for female by age, 1989, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	421	1.26	1132	5.29
Poor	Limited in ADL	0.1	330	0.99	392	1.83
Poor	Limited in IADL	0.17	315	0.95	237	1.11
Fair	Limited in ADL	0.21	1131	3.40	1389	6.49
Fair	Limited in IADL	0.29	2590	7.78	2019	9.43
Good	Limited in ADL	0.36	497	1.49	545	2.55
Poor	Limited-other	0.38	32	0.10	25	0.12
Very good	Limited in ADL	0.41	131	0.39	150	0.70
Good	Limited in IADL	0.45	1206	3.62	1164	5.44
Excellent/Limited in ADL, Poor/Not limited		0.47	188	0.56	153	0.71
Very good	Limited in IADL	0.51	282	0.85	213	0.99
Fair	Limited-other	0.52	388	1.17	213	0.99
Excellent	Limited in IADL	0.57	57	0.17	54	0.25
Fair	Not limited	0.63	3067	9.21	1882	8.79
Good	Limited-other	0.72	322	0.97	223	1.04
Very good	Limited-other	0.79	107	0.32	39	0.18
Good	Not limited	0.84	13845	41.58	7531	35.17
Excellent	Limited-other	0.87	32	0.10	14	0.07
Very good	Not limited	0.92	4317	12.97	2144	10.01
Excellent	Not limited	1	4037	12.12	1895	8.85
Total (the living + the dead)			33295	100	21414	100
Total (the living only)			32874		20282	

Figure 26. Histogram of the HALex for male by age, 1998

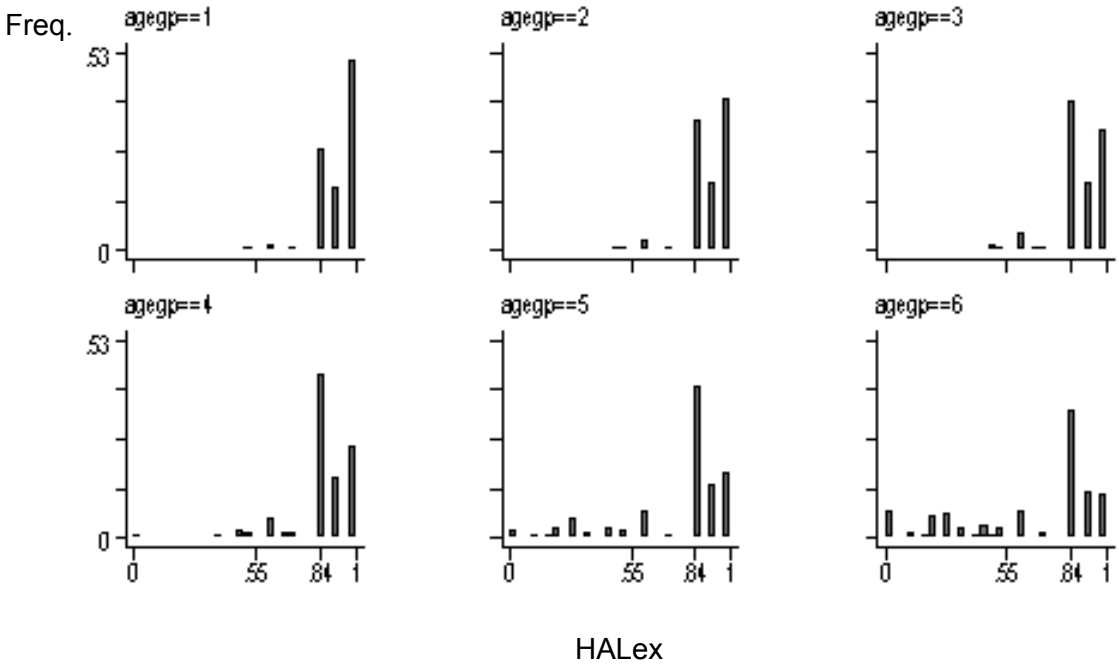


Figure 27. Histogram of the HALex for female by age, 1998

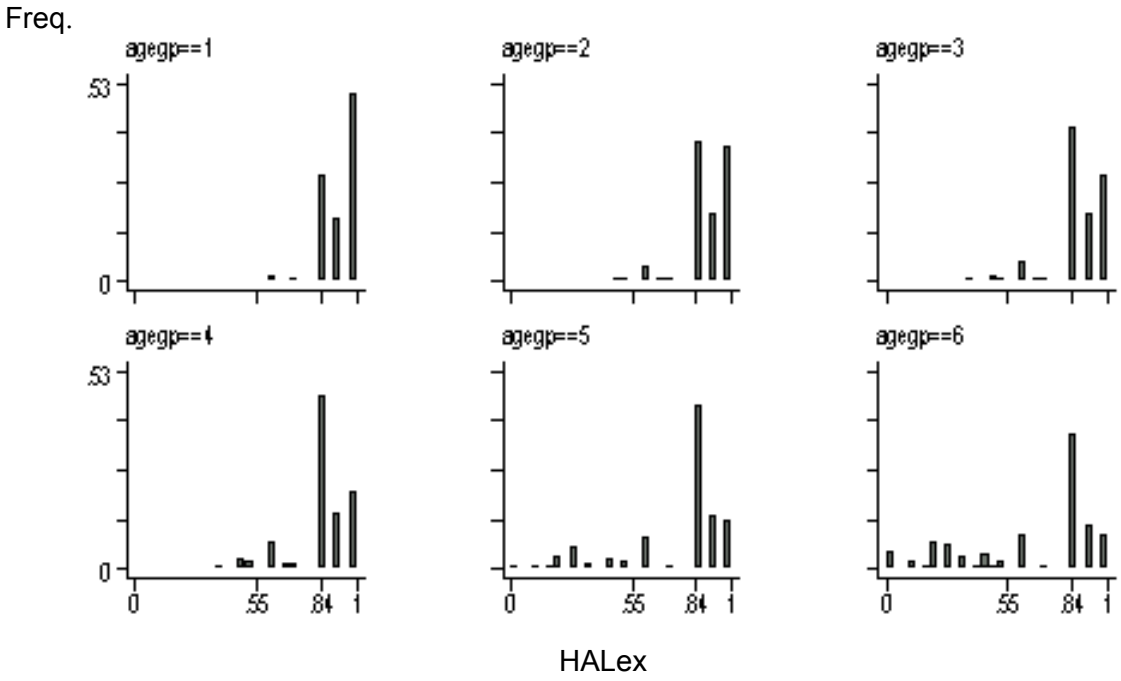


Table 33. The HALex for male by age, 1998

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	Activity Limitation	Score	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Dead		0	6	0.02	27	0.06	97	0.12	600	0.64
Poor	Unable-major	0.25	14	0.04	22	0.05	79	0.09	230	0.24
Poor	Limited-major	0.34	12	0.03	50	0.11	163	0.19	401	0.42
Fair/Unable-major, Poor/Limited-other		0.38	75	0.21	122	0.27	333	0.40	815	0.86
Poor	Not limited	0.47	14	0.04	81	0.18	153	0.18	182	0.19
Fair	Limited-major	0.48	114	0.33	214	0.48	979	1.17	2101	2.23
Fair	Limited-other	0.52	185	0.53	245	0.55	621	0.74	1507	1.60
Good	Unable-major	0.55	85	0.24	96	0.22	198	0.24	271	0.29
Very good	Unable-major	0.62	36	0.10	42	0.09	52	0.06	102	0.11
Fair	Not limited	0.63	492	1.41	1277	2.87	3867	4.61	5087	5.39
Good	Limited-major	0.67	93	0.27	197	0.44	543	0.65	1136	1.20
Excellent	Unable-major	0.68	47	0.13	29	0.07	40	0.05	45	0.05
Good	Limited-other	0.72	332	0.95	364	0.82	595	0.71	1319	1.40
Very good	Limited-major	0.74	44	0.13	59	0.13	159	0.19	262	0.28
Very good	Limited-other	0.79	168	0.48	149	0.34	201	0.24	358	0.38
Excellent	Limited-major	0.81	18	0.05	31	0.07	50	0.06	71	0.08
Good	Not limited	0.84	9500	27.16	15432	34.72	33434	39.84	41278	43.74
Excellent	Limited-other	0.87	97	0.28	74	0.17	76	0.09	136	0.14
Very good	Not limited	0.92	5942	16.99	7923	17.83	15007	17.88	15204	16.11
Excellent	Not limited	1	17706	50.62	18012	40.53	27274	32.50	23258	24.65
Total (the living + the dead)			34980	100	44446	100	83921	100	94363	100
Total (the living only)			34974		44419		83824		93763	

Table 33. The HALex for male by age, 1998, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	755	2.3	1124	7.03
Poor	Limited in ADL	0.1	344	1.05	284	1.78
Poor	Limited in IADL	0.17	269	0.82	164	1.03
Fair	Limited in ADL	0.21	899	2.74	907	5.67
Fair	Limited in IADL	0.29	1646	5.01	1053	6.58
Good	Limited in ADL	0.36	433	1.32	427	2.67
Poor	Limited-other	0.38	59	0.18	32	0.2
Very good	Limited in ADL	0.41	120	0.37	133	0.83
Good	Limited in IADL	0.45	811	2.47	569	3.56
Excellent/Limited in ADL, Poor/Not limited		0.47	120	0.37	98	0.61
Very good	Limited in IADL	0.51	236	0.72	181	1.13
Fair	Limited-other	0.52	451	1.37	209	1.31
Excellent	Limited in IADL	0.57	45	0.14	34	0.21
Fair	Not limited	0.63	2291	6.97	1202	7.52
Good	Limited-other	0.72	364	1.11	188	1.18
Very good	Limited-other	0.79	115	0.35	62	0.39
Good	Not limited	0.84	13314	40.53	5410	33.83
Excellent	Limited-other	0.87	53	0.16	17	0.11
Very good	Not limited	0.92	4775	14.54	1978	12.37
Excellent	Not limited	1	5750	17.5	1922	12.02
Total (the living + the dead)			32850	100	15994	100
Total (the living only)			32095		14870	

Table 34. The HALex for female by age, 1998

HALex			6-14 years old		15-24 years old		25-44 years old		45-64 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	4	0.01	11	0.03	52	0.06	287	0.29
Poor	Unable-major	0.25	10	0.03	28	0.06	98	0.11	258	0.26
Poor	Limited-major	0.34	13	0.04	45	0.10	155	0.18	420	0.43
Fair/Unable-major, Poor/Limited-other		0.38	61	0.18	160	0.37	546	0.63	1007	1.02
Poor	Not limited	0.47	16	0.05	70	0.16	91	0.10	208	0.21
Fair	Limited-major	0.48	87	0.26	309	0.71	1373	1.57	2809	2.85
Fair	Limited-other	0.52	146	0.44	267	0.61	712	0.82	1782	1.81
Good	Unable-major	0.55	74	0.22	129	0.30	283	0.32	293	0.30
Very good	Unable-major	0.62	35	0.10	47	0.11	104	0.12	117	0.12
Fair	Not limited	0.63	516	1.55	1786	4.10	4737	5.43	6699	6.81
Good	Limited-major	0.67	86	0.26	256	0.59	760	0.87	1269	1.29
Excellent	Unable-major	0.68	31	0.09	42	0.10	53	0.06	29	0.03
Good	Limited-other	0.72	281	0.84	324	0.74	657	0.75	1366	1.39
Very good	Limited-major	0.74	30	0.09	82	0.19	208	0.24	322	0.33
Very good	Limited-other	0.79	104	0.31	114	0.26	213	0.24	312	0.32
Excellent	Limited-major	0.81	13	0.04	19	0.04	33	0.04	56	0.06
Good	Not limited	0.84	9412	28.22	16338	37.50	36106	41.38	45752	46.48
Excellent	Limited-other	0.87	66	0.20	56	0.13	58	0.07	101	0.10
Very good	Not limited	0.92	5563	16.68	7827	17.97	15963	18.30	14955	15.19
Excellent	Not limited	1	16799	50.38	15658	35.94	25048	28.71	20386	20.71
Total (the living + the dead)			33347	100	43568	100	87250	100	98428	100
Total (the living only)			33343		43557		87198		98141	

Table 34. The HALex for female by age, 1998, cont.

HALex			65-74 years old		75-94 years old	
Self-perceived Health	**Activity Limitation**	**Score**	**Freq.**	**Percent**	**Freq.**	**Percent**
Dead		0	395	1.02	1186	4.38
Poor	Limited in ADL	0.1	418	1.08	552	2.04
Poor	Limited in IADL	0.17	283	0.73	250	0.92
Fair	Limited in ADL	0.21	1303	3.36	1992	7.35
Fair	Limited in IADL	0.29	2282	5.88	1790	6.61
Good	Limited in ADL	0.36	507	1.31	864	3.19
Poor	Limited-other	0.38	40	0.10	32	0.12
Very good	Limited in ADL	0.41	183	0.47	220	0.81
Good	Limited in IADL	0.45	1095	2.82	1118	4.13
Excellent/Limited in ADL, Poor/Not limited		0.47	170	0.44	153	0.56
Very good	Limited in IADL	0.51	287	0.74	296	1.09
Fair	Limited-other	0.52	464	1.19	305	1.13
Excellent	Limited in IADL	0.57	39	0.10	52	0.19
Fair	Not limited	0.63	3201	8.24	2394	8.84
Good	Limited-other	0.72	398	1.02	284	1.05
Very good	Limited-other	0.79	130	0.33	53	0.20
Good	Not limited	0.84	17066	43.95	9790	36.14
Excellent	Limited-other	0.87	29	0.07	22	0.08
Very good	Not limited	0.92	5480	14.11	3250	12.00
Excellent	Not limited	1	5061	13.03	2484	9.17
Total (the living + the dead)			38831	100	27087	100
Total (the living only)			38436		25901	

Figure 28. Lorenz Curves for both sexes, male, female in 1989

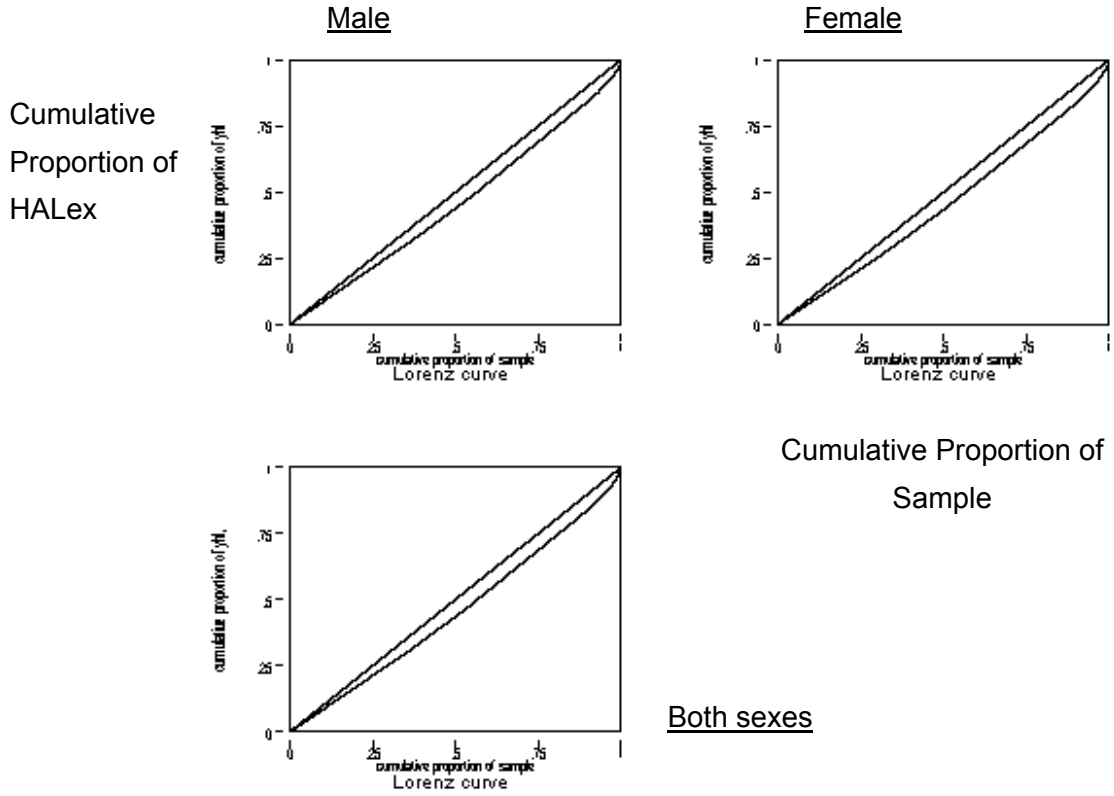


Figure 29. Lorenz Curves for both sexes, male, female in 1998

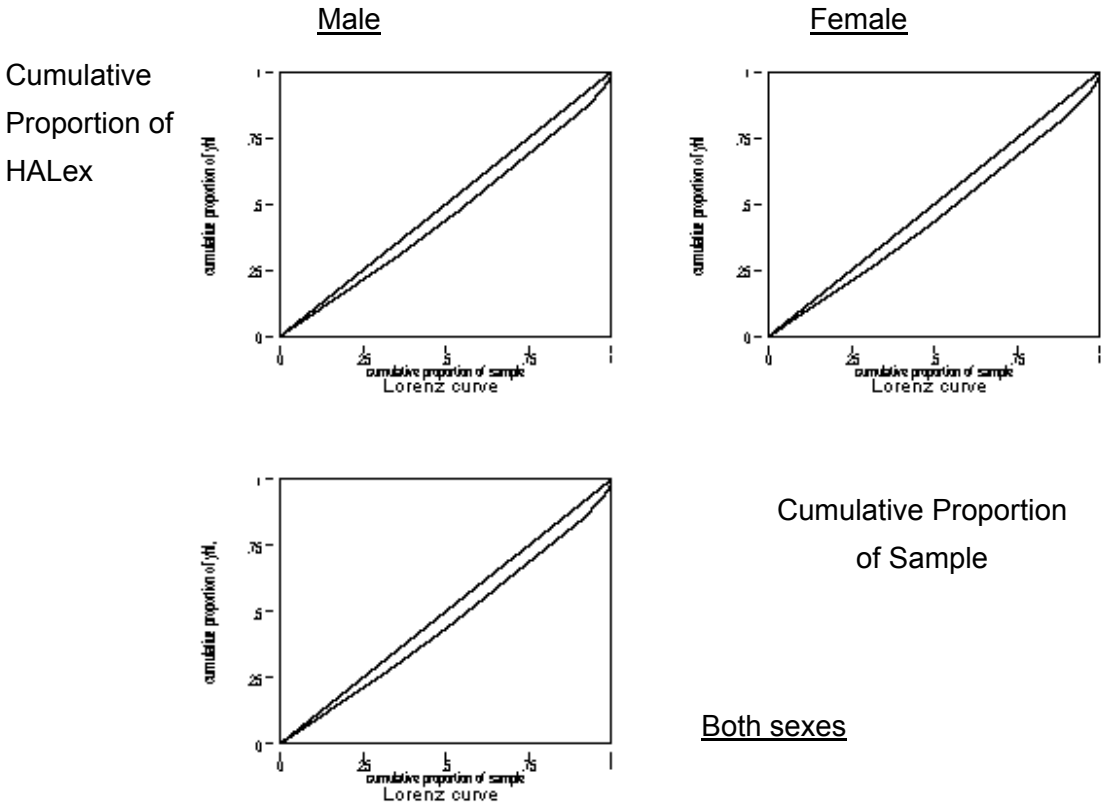


Figure 30. Lorenz Curves for both sexes by age group in 1989

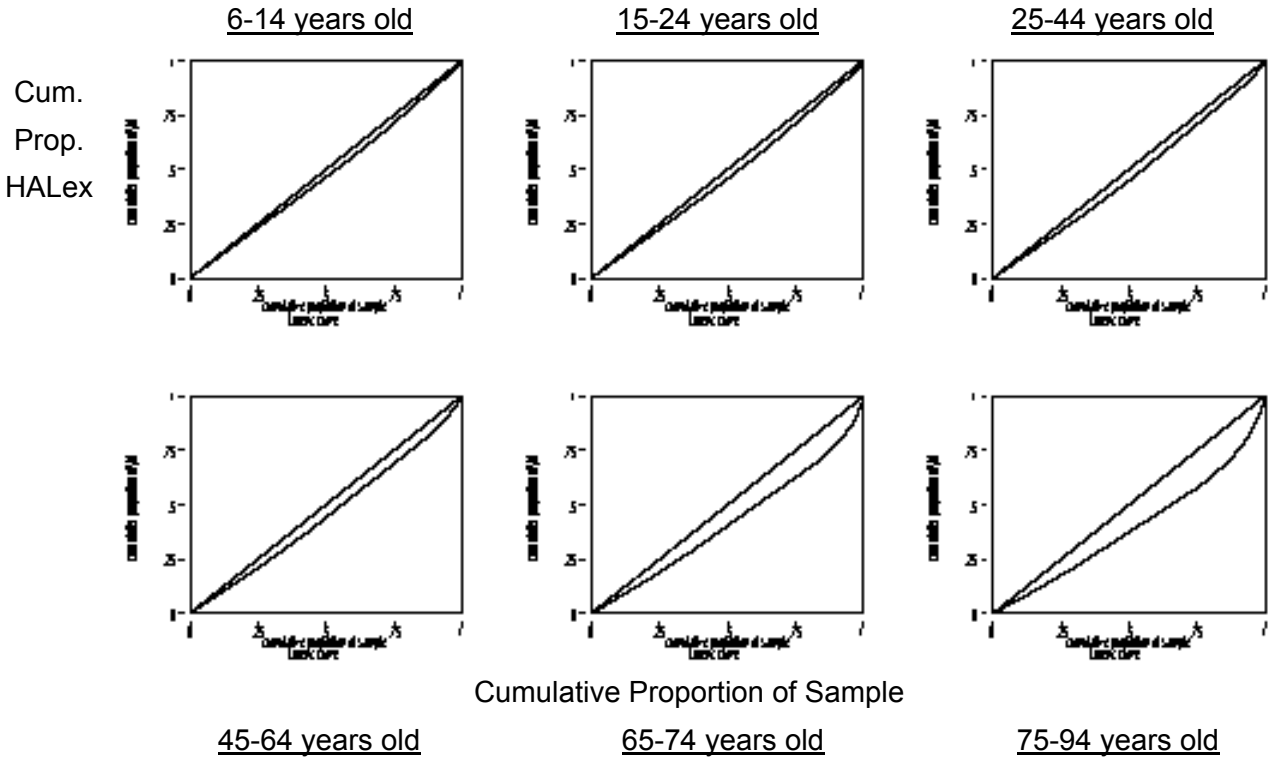
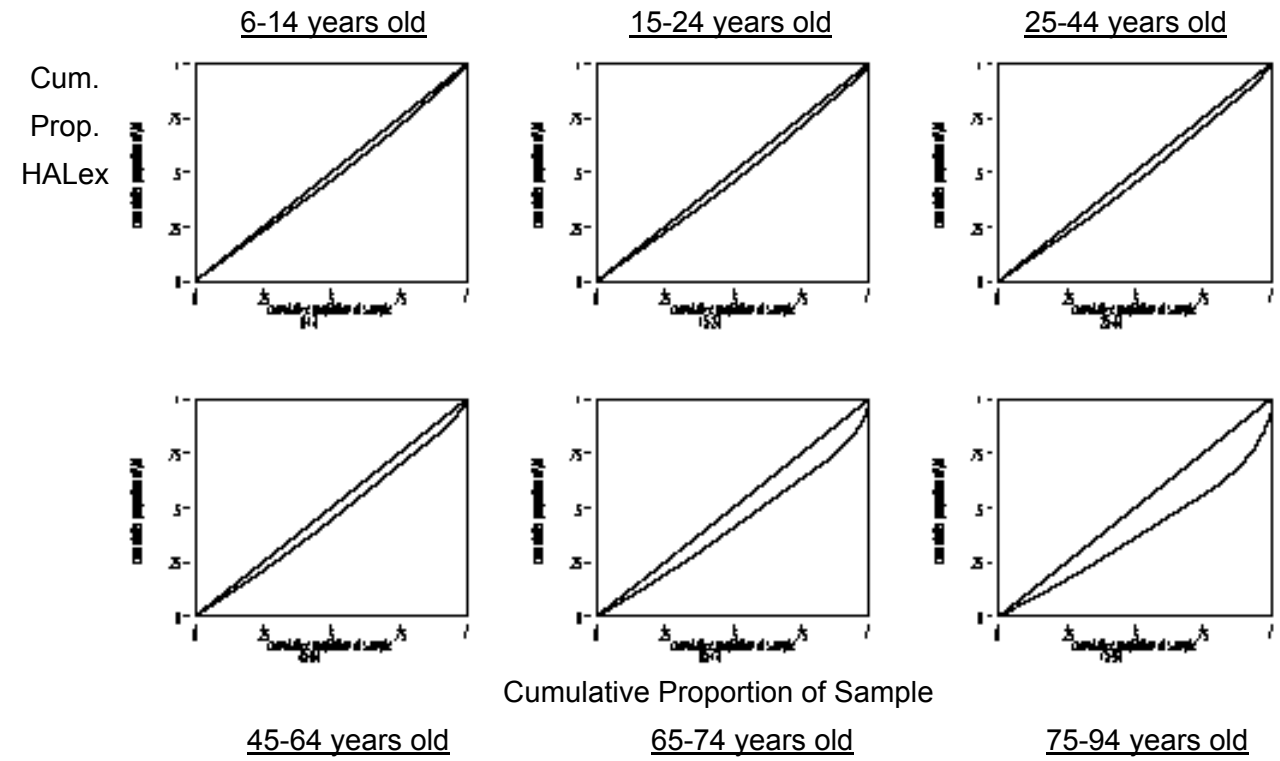


Figure 31. Lorenz Curves for both sexes by age group in 1998



DISCUSSION

This study examined the average health-adjusted quality of life measured by the HALex, its distribution by income, and its distribution per se among Japanese people in 1989 and 1998. This cross-sectional analysis showed that between 1989 and 1998 overall in Japan the HALex on average slightly reduced (0.005 reduction in the HALex), its inequality by income slightly reduced (0.002 reduction in the difference between the top 20% and bottom 20% income share groups), and its inequality measured by the Gini Coefficient slightly increased (0.002 increase in the Gini Coefficient). These overall trends in the average HALex, its distribution by income, and its distribution per se were the same both for men and women.

Regarding differences by sex, the average HALex among women was almost always lower than that of men, except in earlier ages younger than ten. This appeared primarily to result from the lower perception of health among women than men. The HALex was more unequally distributed among women than men. A small inverse gradient in the HALex by income was observed throughout the five income share groups among men, but only at poorer income groups among women.

Age group analysis revealed interesting pictures that were invisible in the analysis of all ages combined. Between 1989 and 1998, the average HALex stayed the same at ages between 6 and 8 years old, and 25 and 48 years old, decreased at ages between 9 and 23 years old, and increased among those who were 49 years old or older. No inverse gradient in the HALex by income was observed among children (6-14 years old), adolescents (15-24 years old), and the oldest old (75-94 years old). In fact, a clear gradient was present only among the middle age (45-64 years old) in both sexes and survey years. Inequality in the HALex increased at older ages in both 1989 and 1998, and this was not only because of the increasing number of deaths among the elderly.

A difficulty in interpreting these results comes from the 0-1 unit that the HALex uses. We all know how long one year of life is, but it is not obvious how bad the 0.002 HALex reduction may be. For example, perhaps, the inverse gradient we observed in the HALex by income may be too clinically insignificant to be concerned as the “socioeconomic” gradient. Even among the middle age group (45-64 years old) that most clearly revealed the improvement in the HALex at every increment of income share groups, the gap of the HALex between the top 20% and the bottom 20% income groups was 0.031-0.038. In the estimation of the health-adjusted quality of life scores between zero and one for various health conditions and diseases, Honda and Ohkusa report that suffering from dermatitis reduces the quality of life score about 0.033, anemia, about 0.034 (Honda and Ohkusa 2001). Accordingly, roughly speaking, this result suggests that the degree of health inequality we are talking about here is equivalent to the world in which everyone with the bottom 20% of total income suffers

from nothing but anemia, while everyone who holds the top 20% of income share is in the "full" health. Should this be a concern of health policy?

It is well-known that we often reach different conclusions of varying degrees of health inequality, even when examining the same population, if we use different health variables. Shibuya, Hashimoto, and Yano, for example, used the sample of 80,899 persons older than 15 years old in the 1995 CSLC and discovered that, comparing people whose household income was equal to or more than 500 million yen, people whose household income was less than 1.5 million yen were 1.93 times more likely to perceive their own health as the worst two categories (not good or not very good) than the other three upper categories (good, fairly good, or usual; 95% CI: 1.72-2.15) (2002). Their analysis and this analysis used very similar samples and health variables, yet impressions these two results give are rather different. Which analysis is more useful depends on what we want to know about health inequality. While such specification of a question is important, these two analyses may complement rather than compete with each other; various analyses with different focuses should help us identify what exactly is the aspect of health inequality we wish to assess.

Similar to the difficulty associated with the 0-1 unit of the HALex, the use of the Gini Coefficient for health distributions is premature. The Gini Coefficient was developed and has been extensively used for income distribution. The Gini Coefficients for income distributions in industrialized countries are around 0.3 (Luxembourg Income Study 2001). Our analysis suggests that the Gini Coefficient for the health distribution in Japan is around 0.1. This means that, considering both income and health as a multi-purpose resource useful for any life plans, health is much more equally distributed than income. Whether the Gini Coefficient, 0.1, is an acceptable degree of health inequality, we must wait for further research using different populations and the development of the conceptual framework within which these results can be meaningfully interpreted.

In addition to the difficulties above, this analysis has at least a couple of obvious limitations, including: the validity of the application of the HALex to the Japanese population may be questionable in a precise sense. Although the inclusion of the dead in cross-sectional data may be an interesting idea, we lack the conceptual framework for how to deal with deaths among the elderly in health inequality analysis. And, we only examined health inequality by income and health inequality per se with gaps between the top 20%, middle 20%, and bottom 20% income groups and the Gini Coefficient. It is widely known that different health inequality measures can lead to different conclusions. Although we did not expand our analysis to comparison of different health inequality measures, we hope that the extensive tables and graphs listed will be useful for anyone who might wish to apply different health inequality measures using these results in the future.

Despite a number of the shortcomings, we believe that this analysis provides useful policy implications. Most obviously, this study indicates that the success in the improvement in the length of life in Japan did not always coincide with the improvement in the health-adjusted quality of life. Further investigation is needed on the reduction in the health-adjusted quality of life at ages 9-23 years old between 1989 and 1998 and the disparity in the health-adjusted quality of life by sex. We also hope that this research provides a basis for health inequality analysis in Japan. With it, we can now begin to ask an interesting question related to health inequality, for example, we all knew that our health would on average deteriorate as we got older, but why is the health distributed more unequally as we get older?

It is a widely shared view among the academics and policy-makers in the population health field that the future of the analysis of population health lies in: (a) the assessment both of the length of life and health-adjusted quality of life, and (b) the parallel examination of the average health and its distribution within a population. We strongly encourage that a kind of analysis shown in this report will be included in the future assessment of the health of Japanese people led by the government. That would be the first promising step for Japan to be a leader not only in terms of the overall health attainment but also of its evaluation.

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