always robust and facility-specific factors may have a strong influence on the mortality and morbidity associated with evacuation[13]; furthermore, experience in the immediate aftermath of Katrina showed that even the best plans of specific facilities may be insufficient to prevent significant morbidity and mortality under a generalized infrastructure collapse, and that support from government both before and after a disaster is essential[14].

Given the importance of disaster- and facility-specific factors in determining the success of disaster plans and the possibility of significant increases in mortality due to evacuation, it is important to conduct detailed epidemiological assessments of the efficacy and safety of evacuation procedures in the aftermath of Japan's triple disaster. Almost a year since the nuclear accident, at the request of the local hospital, we conducted a retrospective cohort survival survey of nursing care home residents in Minamisoma city. Minamisoma city was the only town in Japan that was seriously affected by all three elements of the triple disaster, experiencing infrastructure destruction, significant radiation exposure, and a series of evacuation orders simultaneously. The experience of care home operators in Minamisoma thus paralleled many of the challenges faced in the aftermath of Hurricane Katrina. This is the first detailed assessment of mortality risk associated with evacuation of elderly residents after the Fukushima Dai-Ichi nuclear accident, and offers the first opportunity to explore evacuation-related mortality in detail, as well as a chance to generalize from the specific experience of care home operators in Minamisoma to some of the complex policy issues associated with multiple-cause disasters.

Materials and Methods

Ethics Statement

Ethical approval for the study was granted by the ethics committee of the Institute of Medical Science, the University of Tokyo, authorization number 23-61-3038. For monitoring residents' survival, an information sheet on the research objectives and confidentiality of study participation were sent to the care homes' presidents and verbal consent was obtained. The ethics committees agreed that written consent was not required for each care home resident.

Design, settings, and participants

Five of the eight care homes in Minamisoma participated in this study, representing 62% of all individuals resident in a care home at the time of the earthquake; of those that did not participate, one was unable to due to the loss of all records during the tsunami, and one could not provide sufficient quality evacuation or mortality records. Four facilities are intensive care homes for the elderly, which admit those who have difficulty rehabilitating at home. One facility is a rehabilitation facility for the elderly, which make efforts to enable residents to rehabilitate at home. All elderly residents who had been admitted to the five facilities between 11th March 2006 and 11th March 2011 were included in this study. Information on demographic and clinical characteristics and entry records was obtained from medical records at the facilities, which were recorded by the care practitioners for all residents at entry to the facility. Evacuation history was also recorded by the facilities at the end of 2011 or the beginning of 2012, and this data was collected along with date of withdrawal.

Demographic and clinical characteristics included age at withdrawal or death, sex, and care level, based on the Japanese Category of Condition of Need for Long-Term Care, a number between one and five measuring severity of care needs [15]. This grade is an indicator of severity of disability and does not necessarily indicate health condition[16]. Patients with care level 1 to 4 were defined as requiring low or moderate care and those with care level 5 as requiring high care. Evacuation history consisted of date and site of evacuation recorded separately for each evacuation. Many residents had multiple evacuations, so evacuation distances, indicating the distance between each resident's current location and their next evacuation site, were calculated for each evacuation site as the shortest distance between sites on a public road. Finally, we interviewed facility presidents to obtain further care home-specific evacuation details.

Data Analysis

To assess the impact of the earthquake on mortality, death incidence density before and after the earthquake was calculated as the number of deaths divided by sum of person-years at risk, which were measured from the date of admission until the end of the study period, death or withdrawal. Person-years of risk were divided into pre-and post-earthquake periods to compare relative mortality and crude relative mortality risk calculated as the ratio of post- and pre-earthquake mortality incidence densities. A seasonal or cohort effect in the data was investigated through visual inspection of a quarterly time-series trend of incidence density. Because Facility 4 lacked data for those who left the nursing home before the earthquake, the total person-years and incidence density before the earthquake was estimated based on the average proportion of person-years for the residents who left the nursing homes before the earthquake in other facilities. Thus the relative incidence density before the earthquake for this facility was an estimate.

Survival probability was assessed using the Kaplan-Meier product limit method, comparison of which was on the basis of the Wilcoxon test and Log-rank test, and plotted with survival curves. Effects of the earthquake itself and mortality risk associated with the evacuation procedures implemented by each nursing home were examined using cox proportional hazards multiple regression. Comparison of survival before and after the earthquake was initially conducted without evacuation history data, to measure the effects of the earthquake on mortality. Evacuation history was explored using only post-earthquake data to estimate risks associated with different evacuation patterns. In both analyses, variables were selected using backward-stepwise model-building. Both analyses included a fixed effect to model unobserved, facility-specific confounders. In the analysis comparing pre-and post-earthquake mortality, a facility-earthquake interaction term was included to test for the possibility of facility-specific moderators of evacuation- or earthquake-related mortality. All analyses were conducted using Stata/MP 11.

The report is presented in accordance with STROBE guidelines.

Results

Basic characteristics of care home residents

From 11th March 2006 to 11th March 2011 records were collected for all 596 elderly residents from four of five facilities. Data on residents who had left the facility before the earthquake were missing in one facility. Characteristics of the 715 residents included in this study are shown in Table 1, and interview results with facility presidents and information on facility-specific care level are summarized in Table 2. Other facility-specific evacuation details are described in Table 3. Average number of evacuations indicates the average number of times each facility's residents evacuated.

Table 1. Subject characteristics.

Characteristic	Total residents	Number of residents on March 11, 2011	Percentage of total residents
Sex			
Male	192	80	42
Female	523	248	47
Facility Number			
1	144	72	50
2	94	50	53
3	99	50	51
4	119[†]	69	58
5	259	87	34
Age at death or withdrawal			
50–69	30	21	70
70–79	110	52	47
80–89	339	153	45
90+	236	102	43
Care Level			
Low/moderate	399	224	56
High	316	104	33
Number of deaths by Facility			
1	78	23	29
2	43	12	28
3	52	9	17
4	75	25	33
5	57	6	11

[†]Pre-disaster data included only those who died.

doi:10.1371/journal.pone.0060192.t001

Table 2. Interview results.

Facility	1	2	3	4	5
Type	Intensive care	Intensive care	Intensive care	Intensive care	Rehabilitation
Basic characteristics					
In-house nutritionists	No	No	Yes	Yes	Yes
Medical service	No	No	No	No	Yes
Presence of adjacent hospital	Yes	No	No	Yes	No
Before the initial evacuation					
Short evacuation from tsunami	No	Yes	No	No	No
Continuity of food preparation	Poor	Poor	Good	Good	Good
			(until 17/3/2011)		
Heating	No	No	Yes	Yes	Yes
Time to initial evacuation	19/3/2011	19/3/2011	19/3/2011	15–22/3/2011	17–22/3/2011
During the evacuation					
Suitability of vehicles for evacuation	Poor	Poor	Poor	Good	Good
Support of government	No	No	No	Yes	Yes
After initial evacuation					
Continuity of care	Poor	Poor	Poor	Good	Good
Care quality of evacuation site	Poor	Poor	Poor	Fair	Fair

doi:10.1371/journal.pone.0060192.t002

Table 3. Evacuation history by facility.

	Facility Number				
	1	2	3	4	5
Study end	1/12/2011	1/12/2011	1/12/2011	2/2/2012	31/8/2011
Average number of evacuations	2.9	2.6	3.1	1.7	1.0
Average evacuation distance (km) by stage					
Initial	306	303	325	203	242
Second	238	193	261	238	N/A
Third	209	143	223	97	N/A
Fourth	52	145	161	48	N/A

doi:10.1371/journal.pone.0060192.t003

Examination of possible cohort- and season-effects

The time-series of quarterly death incidence density for the whole study period is shown in Figure 1. No seasonal effect or upward trend, which might indicate a cohort effect, were observed before the earthquake, suggesting limited observable influence of seasonal or trend effects on the high increase in mortality incidence density after the earthquake.

Facility-specific mortality risk

Details of the facility-specific relative mortality risk based on the incidence death density are shown in Table 4. A three- to four-fold increase in mortality was observed in three facilities. Facility 5, which did not show a significant increase in mortality, had only one evacuation with a distance of 240 km, suggesting that evacuation number and distance are relevant to the increase in mortality risk; however, Facility 4 had a relatively similar evacuation profile (Table 2), and experienced increased mortality density.

Probability of survival

Figure 2 shows probability of survival before and after the earthquake for all facilities combined. Analysis time started from the date of nursing home admission and the date of the earthquake respectively. A significant influence of the earthquake on mortality was observed. Facility-specific probability of survival after the earthquake is shown in Figure 3, plotted against analysis time from the date of the earthquake, and shows a large difference between Facility 5 and Facility 1. Facility 5 evacuated once, approximately 240 km distance, while Facility 1 experienced about three evacuations ranging in distance from 200 to 300 km, suggesting that this differential mortality might be explained by the influence of long and repeated evacuations. Facility 4, however, also had high mortality compared with Facility 5 even though their evacuation profiles were relatively similar. This might indicate that other facility-specific evacuation processes are associated with these differences in mortality.

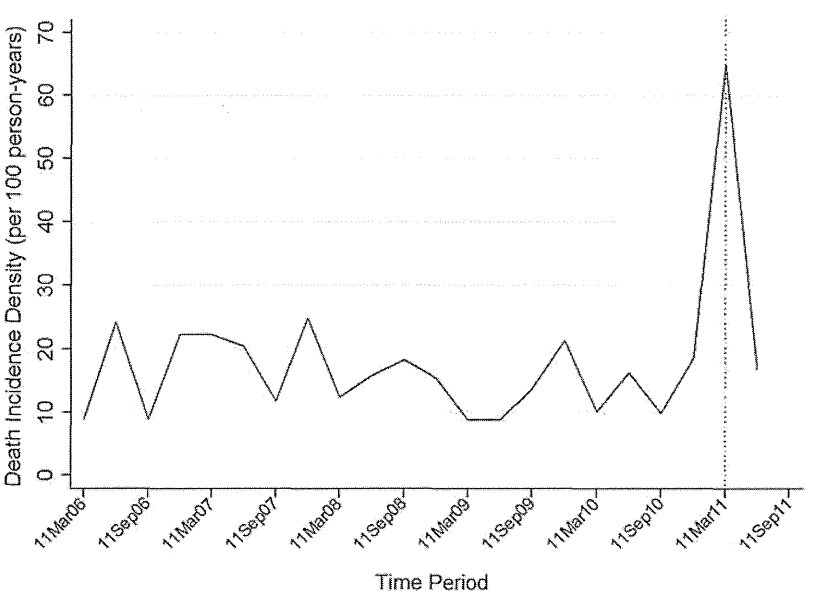

Figure 1. Time series trend of death in elderly homes. Dotted line indicates the time of the earthquake (11/3/2011)
doi:10.1371/journal.pone.0060192.g001

Table 4. Facility-specific relative death incidence density.

Facility	Disasters	Population	Death	Incidence Density (/100 person-years)	Relative Risk	95% Confidence interval
1	Before	144	55	14.82	3.78	NA
	After	72	23	56.09		2.22 to 6.26
2	Before	94	31	12.89	3.01	NA
	After	50	12	38.87		1.41 to 6.04
3	Before	99	43	17.36	1.63	NA
	After	50	9	28.24		0.70 to 3.38
4	Before	119†	50	13.95†	3.93††	NA
	After	69	25	54.75		2.36 to 6.57††
5	Before	259	51	15.69	0.98	NA
	After	87	6	15.41		0.34 to 2.29
Combined	Before	596†	230	14.91†	2.68††	NA
	After	328	75	39.82		2.04 to 3.49††

†does not include those who left before the earthquake in Facility 4
††estimated values
doi:10.1371/journal.pone.0060192.t004

Regression analysis

Findings from the multiple regression analysis without any evacuation history data indicated that mortality after the earthquake increased by a factor of three in Facility 1 (Table 5). The interaction term for facility and earthquake suggests significant differences in post-earthquake mortality between facilities. Facility-specific hazard ratios with confidence intervals are shown in Table 6 and indicate that Facilities 1, 2 and 4 experienced significantly elevated mortality after the earthquake.

Table 7 shows results of the Cox multiple regression analysis with evacuation history. After adjusting for facility, age, care level, sex and evacuation distance, initial evacuation had twice the mortality of subsequent evacuations. Evacuation distance had no significant impact on mortality, indicating that regardless of length of the evacuations a lot of the residents died after the initial evacuation, and/or that more resilient residents who survived it could also have survived subsequent evacuations.

Discussion

This study — the first assessment on the health impact of the evacuation after the Fukushima Dai-ichi nuclear accident — showed that under very different disaster conditions, elderly homes in Minamisoma experienced higher increases in mortality risk than US nursing homes that evacuated in the wake of Hurricane Katrina[12], but that increases in mortality were highly dependent

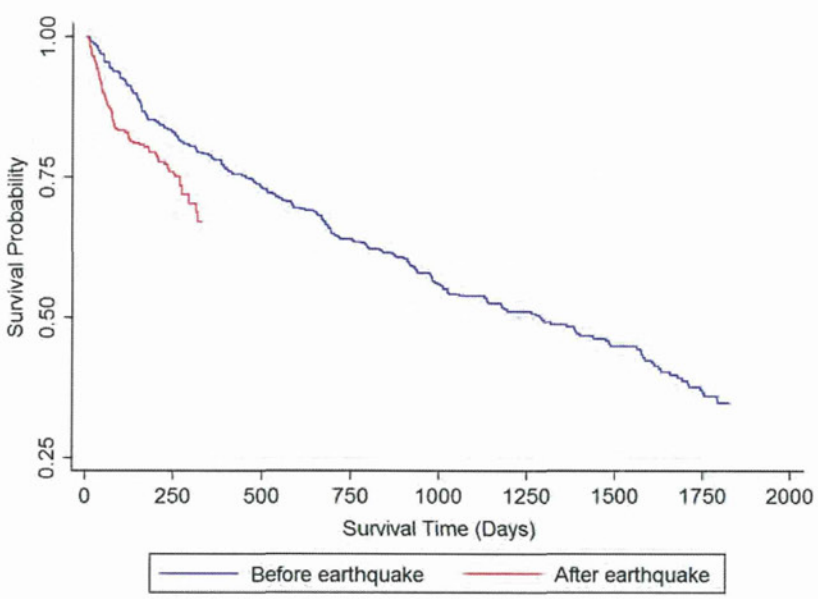

Figure 2. Estimated pre- and post-earthquake survival.
doi:10.1371/journal.pone.0060192.g002

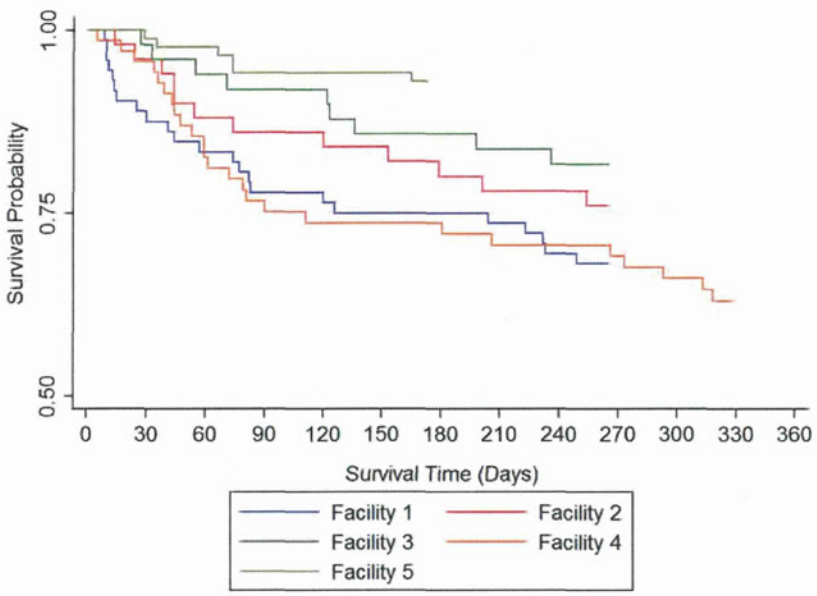

Figure 3. Estimated post-earthquake survival by facility.
doi:10.1371/journal.pone.0060192.g003

Table 5. Multiple regression model of survival by period.

Variable	Hazard ratio	95% Confidence interval	T statistic	P-value
Facility Number				
1	1.00	NA		
2	0.76	0.50 to 1.14	−1.32	0.2
3	1.01	0.70 to 1.45	0.07	0.9
4	1.20	0.85 to 1.68	1.04	0.3
5	1.04	0.72 to 1.52	0.21	0.8
Sex				
Male	1.00	NA		
Female	0.72	0.55 to 0.96	−2.28	0.02
Age				
50–69	1.00	NA		
70–79	1.37	0.61 to 3.09	0.77	0.4
80–89	1.79	0.84 to 3.80	1.52	0.1
90+	3.11	1.46 to 6.62	2.95	0.003
Care Level				
Low/moderate	1.00	NA		
High	2.05	1.60 to 2.63	5.65	<0.001
Earthquake				
Before	1.00	NA		
After	2.88	1.74 to 4.76	4.13	<0.001
Facility-earthquake interaction				
1	1.00	NA		
2	0.83	0.40 to 1.74	−0.48	0.6
3	0.48	0.22 to 1.05	−1.83	0.07
4	0.82	0.46 to 1.47	−0.66	0.5
5	0.27	0.11 to 0.65	−2.88	0.004

doi:10.1371/journal.pone.0060192.t005

Table 6. Post-earthquake facility-specific hazard ratios.

Facility Number	Facility-specific hazard ratio	95% Confidence interval
1	2.88	1.74 to 4.76
2	2.40	1.24 to 4.67
3	1.39	0.69 to 2.81
4	2.37	1.49 to 3.76
5	0.77	0.34 to 1.76

doi:10.1371/journal.pone.0060192.t006

on facility-specific factors. Significant increases in mortality after the earthquake were shown in three facilities, and the initial evacuation was associated with twice as many deaths as subsequent evacuations.

There was also a substantial difference in mortality risks across facilities. These differences may be affected by factors such as residents' psychological state or health condition at the time of evacuation, facility-specific evacuation patterns, and the conditions in evacuation sites to which elderly evacuees were admitted[13,14]. Evacuation distance did not show a significant influence on mortality in the present study. But it was not possible to investigate with certainty whether increases in mortality were due to generalized stress from the earthquake[17–19], facility-specific evacuation processes or care quality at evacuation sites because there was no non-evacuated control. According to the interview results with the facility presidents (Table 2), both facilities 4 and 5 evacuated to a distance of about 200 km with support from the government about two weeks after the nuclear accident, but mortality rates were quite different. Facility 4 is an intensive care home for the elderly, whose residents are constantly in and out of the hospital, and this facility's president thought that evacuation might have imposed a higher burden on its residents than in Facility 5, which also had onsite medical services. Facilities 1, 2 and 3 evacuated their residents to areas 300 km or more from Minamisoma city immediately after the nuclear accident without any support from the government. Because of this unplanned relocation, facilities in the evacuation area were not prepared for the evacuees' care: residents had only simple floor mattresses (Japanese *futon*) and medical supplies ceased for three days. This, rather than evacuation distance itself, might explain the high mortality after the initial evacuation; however, it is difficult to measure the quality and continuity of care quantitatively in evacuation sites because no reliable records exist from that period.

Before the earthquake, the Ministry of Internal Affairs and Communications conducted a national survey to investigate prefectural support for disaster management plans for elderly people. This survey assessed whether facilities had an evacuation plan in accordance with the Evacuation Guidelines for Disaster Management[20]. In 2006, 54 of 59 municipalities (91.5%) in Fukushima prefecture reported that they had formulated evacuation strategies[21]. These strategies comprised a five point system in cooperation with the prefectural government: (1) development

Table 7. Multiple regression model of survival by evacuation characteristics.

Variable	Hazard ratio	95% Confidence interval	T statistics	P-value
Facility Number				
1	1.00	NA		
2	0.59	0.28 to 1.26	−1.37	0.2
3	0.46	0.21 to 1.02	−1.91	0.06
4	0.90	0.27 to 3.30	−0.16	0.9
5	0.12	0.03 to 0.47	−3.08	0.002
Sex				
Male	1.00	NA		
Female	0.70	0.40 to 1.22	−1.25	0.2
Age				
50–69	1.00	NA		
70–79	0.58	0.15 to 2.29	−0.78	0.4
80–89	0.83	0.26 to 2.68	−0.31	0.8
90+	1.81	0.56 to 5.90	0.99	0.3
Care Level				
Low/moderate	1.00	NA		
High	2.09	1.33 to 3.28	3.20	0.001
Evacuation distance (km)				
<150	1.00	NA		
>=150 & <300	1.01	0.35 to 2.91	0.02	1.0
>=300	0.92	0.41 to 2.07	−0.19	0.8
Evacuation type				
Initial	1.94	1.07 to 3.49	2.20	0.03
Subsequent	1.00	NA	−0.48	0.6

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of an information communication system among disaster-mitigation organizations and social welfare institutions; (2) sharing of elderly residents' data among responsible agencies; (3) implementation of evacuation planning; (4) establishment of support systems in evacuation sites; and (5) coordination and cooperation of relevant organizations in times of disaster[20]. Our findings, however, reveal that the preparation level for a major disaster varied widely between facilities and furthermore, in reality some facilities did not coordinate evacuations with the prefectural government in Minamisoma.

This study had several limitations. There was potential underestimation of relative mortality risk after the earthquake in the Cox proportional hazards analyses, because Facility 4 lacked data on residents who left the facility before the earthquake, which would result in overestimates of incidence density before the earthquake and subsequent underestimation of the relative mortality risk after the earthquake. In addition to this, because there was only one evacuation in Facility 5 it is difficult to compare this facility with the remaining four due to lack of reference to the initial evacuation. However, a sensitivity analysis excluding Facility 5 indicated little influence of this limitation on the regression analysis results. Therefore, the finding that initial evacuation is the most dangerous appears to be robust. Another limitation is that only five of eight nursing homes were involved in this study: one facility lost the residents' records during the tsunami, one had insufficient data for inclusion in the study, and one refused to participate. Because the facilities recorded health information intermittently and/or outsourced health care to external providers, it was not possible to obtain a comprehensive picture of the residents' level of physical health. Unfortunately, the chaotic situation in the prefecture at the time and the rapid reduction in service providers within Minamisoma made obtaining health records from diverse providers within Minamisoma impossible[22]. Thus the confounding effect of poor health on mortality risk during evacuation can only be inferred at a facility level and adjusted for through the fixed effects model, and it is possible that a more refined set of confounders would enable a better understanding of individual-specific risk factors. Future studies on the impact of forced evacuation on the general elderly population are needed to generalize our findings, and to better understand these facility-level influences, such future studies should include detailed interviews and other forms of qualitative research to establish the context in which evacuation mortality occurred.

The necessity of evacuation of vulnerable residents in a post-disaster setting is a controversial issue[9]. The rarity of radiation disasters means that, to date, findings on evacuation-related mortality have been confined to more conventional storm- or earthquake-related disasters. In such settings, such as the aftermath of hurricane Katrina, the decision about whether to evacuate was based on the viability of sheltering in place given the available resources, but in Fukushima the decision to evacuate was at least partly driven by concerns about radiation risk[23] even though there has been no evidence of acute radiation syndrome occurring in residents living in radiation affected areas, or even of high levels of internal exposure[24]. Evacuation has adverse effects, not only on mortality but also clinical status relevant to lifestyle diseases, and leads to an increase in cardiovascular events or other chronic disease sequela[19]. Despite this, fear of radiation exposure in the affected area was severe enough to make evacuation inevitable: almost all residents of Minamisoma city evacuated in a relatively short period. Questions, therefore, about the safety of evacuation of elderly residents and how best to balance the competing risks of radiation exposure and evacuation mortality are of paramount importance. Where the severity of infrastructure collapse and structural damage does not in itself warrant evacuation, careful judgment needs to be exercised in deciding the risk of mortality due to radiation, as it is possible that the evacuation process itself will yield higher mortality than can be expected from radiation exposure. The need for this balancing of risks may apply even in situations where it may ultimately be judged unsafe for residents to return to the affected area, since delays in evacuation, or staggering of evacuation between different institutions on the basis of evacuation mortality risk and preparedness, may lead to significant reductions in mortality due to the initial evacuation process. In this respect, radiation-related evacuations differ from storm-related evacuations, since there may be little or no infrastructure damage in the former, and with proper preparation and support elderly care homes may be able to shelter in place for sufficient time to adequately prepare evacuation sites and mechanisms, and thus reduce the burden of mortality.

In a post-disaster situation where infrastructure collapse affects the essential conditions for maintaining elderly peoples' health[25,26], evacuation may be essential regardless of the environmental risks posed by radiation exposure. However, the findings of this study indicate that evacuation may not be the best life-saving strategy. In-site relief and care should also be considered as an alternative strategy for disaster planning[27]. Although the Japanese government had issued guidelines for the evacuation strategy and most facilities had been assessed positively, their preparations were not necessarily sufficient to meet the challenges of this triple disaster. The USA maintains a system of regular monitoring and oversight, including fines for breaches and insufficient preparation [13], but the same degree of oversight is lacking in Japan and enforcement mechanisms have not been established: in consequence of this a 2011 review of Japanese facilities found many lacked detailed plans [28]. The national government should consider urgently updating its requirements of nursing homes, reviewing current plans, and strengthening monitoring systems to ensure all areas of the country learn from the lessons of Minamisoma and are prepared for the worst possible contingencies.

This study shows that even under the extreme circumstances experienced in the aftermath of the Great East Japan Earthquake and subsequent radiation accident, some facilities were able to ensure that their residents suffered no significant increase in mortality risk. Balancing the competing risks of radiation exposure and evacuation mortality is of paramount importance when infrastructure collapse and damage do not themselves warrant evacuation. Health planners, disaster coordinators and facility managers in areas that may be subject to similar disasters should consider the lessons of Minamisoma, Fukushima when developing their own plans for disaster response.

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Author Contributions

Conceived and designed the experiments: SN SG MT. Performed the experiments: SN SG DY KS. Analyzed the data: SN SG DY. Contributed reagents/materials/analysis tools: SN SG MT AS TO MK KS. Wrote the paper: SN SG KS.

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特集／「社会保障と税の一体改革」とはいったい何だったのか

～消費税増税で社会保障は充実するのか～

視 点　我が国の医療の進むべき道：グローバルヘルスの観点から

●第 37 回診療報酬請求事務能力認定試験（医科）：問題と解答

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1 保健医療は投資という発想

私は国内外の保健医療政策の研究を専門にしているが，この道に足を踏み入れたのは千葉県の田舎の病院で救急当直の合間にたまたま読んだ一冊のレポート，世界銀行の「世界開発報告1993年度版：健康への投資」であった[1]。当時はラリー・サマーズが主任エコノミストであり，世界銀行が従来のインフラ整備から人間開発へとシフトを始めた時期であった。また，世界保健機関（WHO）のリーダーシップ欠如に対する批判が世界中で巻き起こり，世界の保健政策の中心がジュネーブからワシントンへ移ろうとしている時期でもあった。

そのレポートには，発展途上国においても急速に高齢化と疾病構造の変化が進展していること，費用効果分析によると予防のみならず治療にも対費用効果の高い介入があること，そして，何よりも**健康は投資であり必ずしもコストではないこと**，が実証的に示されていた。それまで，WHOを中心とした，途上国といえば感染症と母子保健対策，そして基本的サービスへのアクセスを軸とした政策議論に慣れていた私には目から鱗の落ちる思いであり，筆頭著者を調べ，彼に会いにボストンまで行ったのが，保健医療政策との付き合いの始まりであった。

時は巡り，ちょうど20年後の2013年，世界の保健政策は再度，ジュネーブからワシントン，そしてシアトルへと移り，国内では社会保障が大きな政治アジェンダになった。しかし，世界的には欧州を中心とした経済危機の影響が世界を蝕み，国内的には惰性と既得権益のために医療を含む社会保障に関しては時代遅れの制度が継続し，その結果，真の弱者への保護は手薄く，また若い世代への負担が増大している。

現行の税と社会保障の一体改革は，増税という既存の制度の維持に必要な財源の調達に関する議論に終始している。しかし，**今こそ「健康への投資」というメッセージを再度検討すべき時期に来ているのではないだろうか。**そして，それは，必ずしも健康な生産労働人口を増やすというエコノミスト的ロジックのみでなく，斜陽化する製造業に代わる産業としての保健医療の構築という意味合いも含まれる。事実，保健医療の海外展開は世界の潮流であり，本稿では，グローバルな文脈から我が国の医療制度，そして我が国が今後国内外において採るべき戦略に関して私見を述べたい。

2 グローバル化する保健医療

保健医療制度は元来，各国の歴史や文化，社会経済状態，法制度に密接に関わるローカルなものである。しかし，グローバル化の流れのなかで，保健医療もそれと無関係ではいられなくなってきた。

「**グローバルヘルス**」とは，主に国内の人口を対象とする公衆衛生，植民地熱帯病を対象とする熱帯医学，先進国から途上国への技術移転を目的とする国際保健，それらがグローバル化の流れのなかで結びついた分野のことである。日本語では「**国境を越える保健医療課題**」と訳されるが，それは，先進国と発展途上国間での双方向の連携，そして経験と知識の共有が必要であり，きわめて学際的かつイノベーションを重視し，社会医学に限らず，ワクチン開発等の基礎研究や臨床も含まれる[2]。

このグローバルヘルス興隆の始まりは2000年に遡る。当時の国連事務総長コフィ・アナンが提唱し，国連加盟189カ国が合意したミレニアム開発目標（MDGs）である。MDGsは2015年までに国連加盟各国が達成すべき開発目標であるが，8つの目標のうち実に3つが保健医療関連目標であり，このMDGsによって保健医療は世界の開発のアジェンダとなった。

このような流れを受け，アメリカでは2005年頃から「グローバルヘルス」という言葉が使われ出したが，近年，この言葉は瞬く間に世界中に広まった。今や世界の主な大学にはグローバルヘルスを標榜する教室が存在し，さ

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1991年，東京大学医学部医学科卒．同年，帝京大学付属市原病院麻酔科医員（研修医）として勤務。93年，東京大学医学部付属病院医師（産婦人科）を経て，米国ハーバード大学リサーチ・フェロー。99年に同大学より公衆衛生学博士号取得。同年，帝京大学医学部産婦人科助手。2000年，衛生学公衆衛生学講師。01年に世界保健機関（WHO）シニア・サイエンティスト（保健政策のエビデンスのための世界プログラム）就任。04年にWHOコーディネーター（評価・保健情報システム/保健統計・エビデンス）を経て，現職。

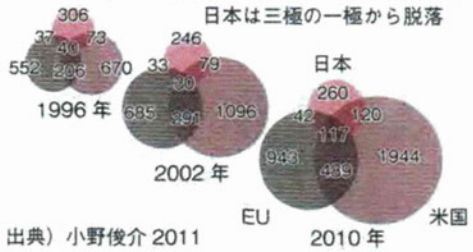
らには，米戦略国際問題研究所（CSIS）や英王立国際問題研究所（チャタムハウス）といった著名な外交政策シンクタンクにおいてもグローバルヘルスに関する部門が設けられている。

このように，保健医療のグローバル化は世界の潮流となっている。アジア諸国においても，タイやシンガポール，インドはメディカルツーリズムを推進しており，患者も医師も国境を越えて移動している。また，韓国は医療を国家戦略と定め，済州島での医療特区構想（各国の医師免許を容認，医師の所得税撤廃）を提唱し，韓流ブーム戦略さながらの大胆な施策を打ち出している。さらに，世界各地で「財源不足，医師不足，低収入の環境で，どのように良い医療を提供するか」という課題に対する様々な革新的取組みがなされており（例：営利型慈善病院，バウチャー制度，タスクシフティング，ICT活用等），我が国がこのような事例から学ぶべきものは多い。

他方，我が国では，こうした世界の潮流に逆行している。不活化ポリオワクチン輸入と国内生産の例をとっても明らかなように，**数十年前の金融行政の護送船団を思わせる旧態然とした仕組みは，我が国の保健医療のグローバル化と発展を大きく妨げている**。例えば臨床開発の分野においては，**図表1**に示すように，欧米では特に共同開発数が急激に増加しているが，我が国のみが過去15年間ほとんど変わらない[3]。

また，我が国の保健医療のグローバル化の遅れは，保健関連ODAにも如実に示されている。2000年にMDGsが宣言されて以降，世界的には保健関連ODA予算は急増したのに対し，OECD加盟国のうち我が国のみが縮小している。また，日本の保健医療分野に対するODAは，ODA全体のわずか2%であり，これはOECD諸国平均の15%と比べてきわめて低い[4]。未だに「健康への投資」という戦略的発想がないのが日本なのである。

図表1　日米欧・臨床開発プロジェクト数の推移



出典）小野俊介 2011

3 皆保険制度がグローバルヘルスのアジェンダに

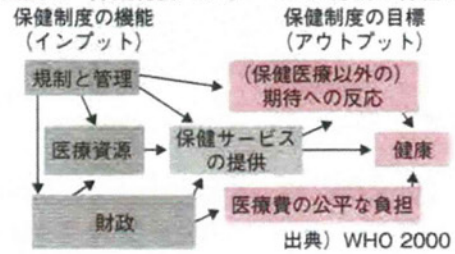
現在のグローバルヘルスの特徴は2つある。まず，その関係者が多様であること。WHOの財政的・政策的求心力の低下に伴い，官民連携型の国際機関やビル・ゲイツがマイクロソフトを引退後に設立したビル・アンド・メリンダ・ゲイツ財団（ゲイツ財団）などの民間財団，そして近年では民間企業の存在感が増している。また，活動の中心が小規模な個別のプロジェクトから多国間・官民連携を軸とする大規模なプログラム，そしてアジェンダ設定やルール作りへと変化していることが挙げられる。

次に，世界的な高齢化と疾病構造の変化により，優先課題が感染症から生活習慣病対策，そして皆保険制度構築へと変化している。2005年の第58回世界保健機関総会では，財政的に持続可能な皆保険制度の構築に向け努力することを加盟国に求める決議が採択された。実際，過去10年間でガーナやルワンダといった低所得国においても，低コストで国民皆保険を実現するための保険制度が導入されはじめている。皆保険制度構築は今最もホットなグローバルヘルスのアジェンダなのである[5]。

4 なぜランセットが日本の保健医療制度の特集をしたか？

2011年は，我が国が皆保険制度を達成してから50年目にあたる年であった。その節目に，イギリスのランセット誌と共同で，日本の保健医療制度を特集する機会を得た[6]。ご存知のように，ランセット誌は世界で数百万人の読者をもつ世界で最も権威のある医学雑誌の一つである。しかし，ランセット誌がニュー・イングランド・ジャーナル・オブ・メディシンやJAMAなどのライバル誌と異なるユニークな点は，現編集長のリチャード・ホートンの編集方針によるところが大きい。もちろん最大の読者である一般臨床家対象の論文が中心であるが，世界の医療制度，人権，健康と社会的公正，戦争等のテーマも定期的に取り上げる，きわめて社会派的な雑誌なのである。それもそのはず，1823年の創刊時の編集長

図表2　保健制度パフォーマンス分析の枠組み



出典）WHO 2000

トーマス・ウェイクリーのモットーは，「読者に情報を伝え，楽しませ，そして，社会を変革すること」であり，その伝統が今も連綿と生きている。

なぜそのランセットが日本の医療制度の特集を企画したかといえば，それは，リチャード・ホートン本人の言葉がすべてを物語るであろう。「**日本の医療制度は日本国民のみならず，世界の人々の健康のバロメーターであるという点でも，きわめて重要である。…日本は大変なソフトパワーをもっている。世界における確固たる地位を確保する努力と国内での政策を改善する力を発揮しようとしている**」[7]。閉塞感に覆われた国内状況だが，世界の我が国に対する信頼と期待はいまだに高いのである。

特に，我が国の医療制度は2つの点で世界的にも注目を集めている。まず，**低コストで良好な健康指標を実現し，公平性を徐々に高めてきた皆保険制度は，今まさにグローバルヘルスの主要課題となっており**，特に，高度経済成長を迎えようとする発展途上国のモデルとなりうること。次に，**高度経済成長期に作られた現行制度が少子高齢化の進む現在の日本では持続不可能**になっており，今後どのような制度を構築していくのか，我が国の将来ビジョンが試されている点である。

5 保健医療制度パフォーマンス分析の枠組み

ランセット日本特集号では，編集部から3つの要望があった。まず，過去と現在のみならず将来を見据えること。次に，日本の特殊事情のみならずグローバルな教訓も示すこと。そして，エビデンスに基づく議論をすることであった。分析の枠組みは，筆者もその枠組み作りに関わった「世界保健報告2000年度版：保健制度パフォーマンスの改善」の枠組みを用いた（**図表2**）[8]。

保健制度パフォーマンス分析は，元々は次の5つの重要な比較分析を行うことを目的としたものであった。①健康アウトカムのばらつきはどのくらい保健医療制度の相違によって説明できるのか，②保健医療制度パフォーマンスの改善によって健康アウトカムはどのくらい改善できるか，③どの保健医療制度が健康アウトカムを改善するのによいか，④どの保健医療制度が対費用効果が高いか，⑤保健医療制度のパフォーマンスの決定要因は何か。

この枠組みは，保健医療制度をその機能（インプット）と目標（アウトプット）に分けたシンプルなものであるが，ともするとインプット（財源や医療従事者数など）の議論に終始する医療制度改革の議論において，何が本質であるかを忘れないためにはきわめて有用である。保健医療制度の主な目標は，健康アウトカムの増進であり，それに加えて，保健サービス以外の期待への対応や医療費の公平な負担を達成することが重要であるとしている[8]。

6 我が国の保健医療制度の現状と課題：グローバルヘルスの観点から

Savedoffらの研究によると，皆保険が成り立つ条件としては，経済成長，人口構成が若いこと，そして，政治的後押しがあることの3つがあるという[5]。我が国が皆保険を達成した1961年前後の政治，社会経済状況を鑑みれば，日本はまさにその3条件を満たしていた。つまり，我が国の皆保険制度は，加入者の負担による社会保険制度をもとに，まだ若く経済成長のまっただなかにできた，いわば発展途上国モデルである。50年後の今，この条件が満たされつつあるのが，現在のアジアやアフリカの多くの新興国である。第2次大戦後，発展途上国型の皆保険制度を完璧に作り上げた我が国のこれまでの経験と教訓こそが，これから世界で生かされるのである。

北原茂実氏（医療法人社団KNI理事長）は，こうした点を鑑み，我が国の保健医療の産業化と制度のパッケージ輸出を提言している[9]。実際，経済成長が急速に起こる場合，保健医療供給体制のキャッチアップは通常遅れるために，確実に保険制度が導入されるのであれば，初期投資は十分に回収できる。この際，大切なことは，保険制度に関する研修や単独の病院建設といった従来のODAプロジェクトや企業のCSRではなく，**現地で持続可能なビジネスモデルを開発することや付加価値のある戦略形成支援**である。例えば，日本型の医療を中心とし，保健医療システムにITを導入し，同時に日本式教育での現地の人材育成，さらには公務員共済や企業共済を組み合わせて日本の病院と提携し，企業の福利厚生を充実させることで日本式システムをパッケージとして導入することが可能であり，経済的リターンとともに外交的に

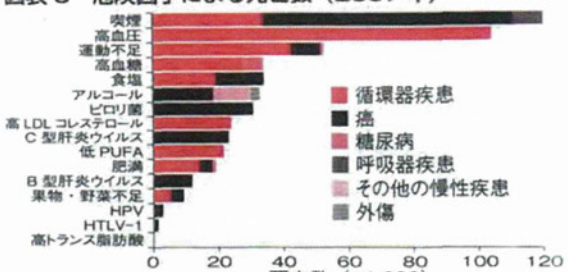
も我が国のイメージ向上が可能である。こうした方策は，現在のグローバルヘルスの潮流でもある。すなわち，資金やプロジェクトの供与のみではなく，バリュー感のある戦略とビジネスモデルの開発が重要となっている。資金は後からついてくるのである。

考えてみると，後藤新平が台湾で行ったことはまさに，日本型の医療，教育や農業のパッケージ輸出による地域おこし，国づくりであった。この日本型モデルに着目したのが，MDGsの土台を築いた著名なマクロ経済学者であるジェフリー・サックスである。彼は，アフリカの最貧地域がMDGsを達成するために，ミレニアム・ビレッジ・プロジェクト（MVP）を2006年に立ち上げ，保健医療，教育，農業，テクノロジーとイノベーション，水とエネルギー，ジェンダーと公平性，環境，ビジネスと起業家精神という8つのセクターごとに戦略を設定し，これに基づく施策をコミュニティ主導の包括的アプローチを用いて極度の貧困となる要因を削減しようとした。また，MVPは学界やビジネス，市民社会，政府の全員参加型アプローチを用いている。MVPは，日本政府やゲイツ財団の支援を受け，大きな成果を上げた[10]。

我が国の保健医療分野における過去50年間の最大の成果は，国民間での公平性を高めながら低コストで良好な健康アウトカムを実現したことである。健康アウトカムに関しては，日本は，食事等のおかげで虚血性心疾患および一部のがんの危険因子が元々低かったことから多大な恩恵を受けてきており，1950年代にはすでに他の先進国に比べて生活習慣病による死亡率は一般に低かった。ただし，脳卒中死亡率はきわめて高く，平均寿命の急激な伸びの一つの理由は，主に公衆衛生対策および血圧などの主要危険因子のプライマリ・ケアにおける管理によるものであり，やはり保健医療制度のインパクトは大きい[11]。また，我々の分析では，**少なくとも同じニーズをもつ人が同等の医療を受けられるか，医療費は公平に負担されているかという点，そして，家計の壊滅的な負担の予防の割合に関しては他国と比較しても比較的良好であり，現行の皆保険制度下での保健制度パフォーマンスは世界的にもこれまでは満足できるものであった**[12]。

しかし，良好な健康アウトカムにも陰りが見え始めている。1990年代中頃以降は，他国に比べ成人男性死亡率の低下率が鈍化しており，成人女性も成人男性ほどではないが鈍化している。日本の男性の死亡率はスウェーデン，イタリア，オーストラリアの，また女性の死亡率

図表3　危険因子による死亡数（2007年）



出典）Ikeda et al. 2011

図表4　日米の危険因子の診察率と管理の状況

出典）Hashimoto et al. 2011

はスウェーデンの後塵を拝している。近年の傾向が続けば，他の国の成人死亡率が日本を下回る可能性がある[13]。

ランセット日本特集号で池田らは，他の先進国に比べて喫煙や高血圧がまだ多いこと（**図表3**），肥満が少しずつ上昇していること，自殺率が高くまた上昇していることなど，実績悪化の原因を数多く提示している[11]。さらに，**日本には国民皆保険制度がありアクセスはよいが，提供されている医療の質が低い可能性も指摘されている。**例えば，我が国では高血圧や高コレステロール血症の患者が実際に治療される割合は他の先進国に比べてはるかに低い[12]。**図表4**に示すように，高血圧症および高コレステロール血症を抑える薬剤を現在処方されている患者のうち，目標数値を達成したのは半数にすぎなかった。さらに，未診察・未治療患者の割合は，アメリカの推計数よりも多かった。医療の質が不十分なことを考慮すれば，日本の健康アウトカムをさらに改善させるには保健医療制度を刷新する必要がある。

これまでの途上国型モデルは国外の医療展開にはきわめて有用であるが，国内ではそれでは対応できない。日本は基本政策として，診療報酬点数表により支払条件を供給側で厳格に管理する一方，サービスの提供方法については自由放任主義的アプローチを取ってきたために，深刻な受給ミスマッチが生じている[12]。

ワシントン大学のマレーは，経済停滞，政治の混乱，高齢化，十分ではないタバコ対策という状況のなかで，

日本は保健医療の新たな課題に効果的に対応しておらず，これらの課題に取り組むには，安価で多くの患者を診る，従来どおりのアクセスを全国民に保証する制度だけでは不十分であると指摘している。我が国は一致協力して取り組まなければ，アメリカと同様，世界での平均寿命ランキングが下がっていく可能性があるとさえ指摘する[13]。しかし，少子高齢化の進む今もなお，高度経済成長時代の制度が惰性的に継続されているのが現状である。また，橋本らの試算では，無保険者もすでに百万人以上おり，皆保険は実質破綻していると考える[12]。

また，医療費を賄うために税を投入しているが，社会保険のリスクシェアリングという原則，あるいは税の応能負担による所得再分配機能という二つの目的がきわめて曖昧にされながら，多くの保険制度改革議論は財源論に終始している。財源論はもちろん重要である。さらに，給付抑制，無駄なサービスのカットや成果に基づく支払い，混合診療，医療の規制緩和などは，やるかやらないかではなく，いつどのようにやるかというイシューであろう。だが，それらは必ずしも今後の医療の価値やあり方の本質ではない。我が国の医療のあり方を論ずることなく，**既存制度の財源をとりあえず確保し，延命するという現在の医療行政の継続はきわめて困難な時期にきている。**

7 国民皆保険制度が抱える今後の課題は世界から注目されている

日本は，**少子高齢化の進展，経済的不確実性の増大，そしてグローバル化という今日的文脈のもとで，「健康」の意味を考え直す必要に直面している。**特に，国民が健康に対して抱いている価値観に寄りそって，国内外ともに整合性のある健康ビジョンを策定する必要がある[4]。これが，ランセット日本特集号の最大のメッセージである。

日本は，伝統的な国家安全保障に加えて「**人間の安全保障**」，つまり，すべての人々を脅威から守り，生存・暮らし・尊厳のための糧を与えることを外交政策の礎にした。緒方貞子氏とアマルティア・セン教授を委員長として国連に「人間の安全保障委員会」を作り，その意義を広めた。それは日本が政治・経済・社会の発展の相互依存性を理解していたからであるといえよう。これまで機能してきた我が国の保健医療制度は破綻し始めており，最近の震災でも明らかなように，現在では国内の人間の安全保障をも脅かし始めている。**人間の安全保障がこれまで以上に重要であり，このコンセプトをもっと積極的に国内政策に応用することが必要である**と筆者は考える。アマルティア・センの弟子である経済学者アナンドは，**人間の安全保障のコンセプトの主要な課題の一つは人々の健康を守ることであり，そのために包括的な国民皆保険制度は必須である**，と述べている[14]。

国民皆保険制度が達成した成果は大きい。しかし，過去の成功が現状に合わなくなっているのも事実である。国民皆保険制度は目的ではなく，あくまでも保健医療の目標を達成するための一つの手段である。日本の国民皆保険制度が抱えている課題の一つは，財源もそうだが，保健医療のあり方やそれに対する人々の価値観が変わってきていることをまず認識すべきことである。今までのように，**安くて皆が同じような医療を受けられればそれでよいという時代ではなく，個人のニーズ，価値観を重視した高付加価値の保健医療へと質的に転換しなければならない。**そして，困っている人々には手厚い保護を行う。その際に核となる考えが「**人間の安全保障**」であり，それを達成する際に必要となる発想が「**保健医療は投資**」であるということである。

実状に合わせて我が国の保健医療制度をよりよいものにするには，官僚や学者，政治家任せにするのではなく，国民が自分たちの切実な問題として考え，従来の保健セクターを越えて連携し，行動しなくてはいけない。外交安全保障と同様に，保健医療は存在するのが当たり前ではなく，自分たちで守らなくてはいけない。日本のような急速に高齢化が進む国はほとんどなく，日本がこうした問題をどのように解決していくかは，今後のモデルとして世界中が注目している。

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Horizontal inequity in healthcare access under the universal coverage in Japan; 1986–2007

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ABSTRACT

Universal coverage of healthcare aims at securing access to appropriate healthcare for all at an affordable cost. Since 1961, Japan's national health insurance has provided an equal package of benefits including outpatient, inpatient, dental, and pharmaceutical services. Reduced copayment and other welfare programs are available to the elderly. However, social health insurance may not be a panacea to achieve healthcare for all, especially when facing household impoverishment due to economic stagnation. Using time-series cross-sectional data of a nationally representative survey of Japan, we assessed the degree of inequity in healthcare access in terms of the "equal treatment for equal needs" concept, to identify the impact of changing economic conditions on people's healthcare access. Concentration indices of actual healthcare use (C_M) and standardized health status as a marker of healthcare needs (C_N) were obtained. We decomposed C_M to identify factors contributing to inequalities in healthcare use. Results showed that horizontal inequities in healthcare access in favor of the rich gradually increased over the period with a widening health gap among the poor. The inequality in favor of the rich was specifically observed among people aged 20–64 years, whereas high horizontal equity was achieved among those aged >65 years. Decomposition of C_M also demonstrated that income and health status were major contributors to widening inequality, which implies that changes in household economic conditions and copayment policy during the study period were responsible for the diminished horizontal equity. Our results suggest that the achievement of horizontal equity through universal coverage should be regarded as an ongoing project that requires continuous redesign of contribution and benefit in the nation's healthcare system.

Introduction

Universal coverage of healthcare has become a global policy agenda, aiming to secure access to appropriate healthcare for all at an affordable cost (Carrin, Mathauer, Xu, & Evans, 2008). To achieve this egalitarian goal many countries including Japan have adopted social health insurance systems. Japan introduced social health insurance for factory workers in 1922, and gradually expanded the coverage until it achieved mandatory and universal coverage in 1961. Since then, Japanese health insurance has provided an equal package of benefits for all, including outpatient, inpatient, dental, and pharmaceutical services. Relatively generous coverage resulted in a rapid increase of medical care utilization, which at least partially contributed to the decrease in stroke and the consequent world's longest life expectancy of Japanese adults (Ikeda, Saito, Kondo, et al., 2011).

However, social health insurance may not be a panacea to achieve healthcare for all at an affordable cost. Previous studies across European and East-Asian countries revealed that the horizontal inequity (HI) in healthcare access over household economic conditions, or the degree of "equal access for equal needs" (Le Grand, 1978; Wagstaff, Paci, & van Doorslaer, 1991) varied across countries even with social insurance systems under universal coverage schemes (van Doorslaer, Koolman, & Puffer, 2002; Lu et al., 2007). In Japan, Ohkusa and Honda (2003) were the first to estimate the degree of HI using nationwide micro data from 1992, 1995 and 1998 (Ohkusa & Honda, 2003). They found that access was slightly unequal in favor of the poor in Japan. However, their analysis failed to incorporate the existing policy of reduced copayment for those aged ≥70 years, and was thus likely to overestimate the pro-poor nature of the system because the elderly tend to consume a large portion of medical expense and their income is limited after retirement (Ministry of Health, Labour and Welfare, 2009a).

With the prolonged recession after the "bubble" economy implosion in 1991, the premium collection for Japanese public

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health insurance has decreased because of decreased wages, while the demand for healthcare has been increasing with population aging (Ikegami & Campbell, 1999). The Japanese government responded to the situation by gradually raising copayment rates for the elderly and the employed since the late 1990s as shown in Table 1. Economic recession also led to increasing income disparity and relative poverty, which could result in a widening gap in access to necessary healthcare across income groups (Organization for Economic Cooperation and Development, 2006; Tachibanaki & Urakawa, 2008). Indeed, Babazono, Kuwabara, Hagihara, Yamamoto, and Hillman (2005) reported a significant reduction in outpatient care utilization among diabetic patients who were covered by health insurance for the employed after a copayment amendment in 2003. However, until now, there has been no nationwide assessment of the impact of economic recession and policy change on the HI in healthcare access in Japan. With emerging global interest in constructing universal coverage schemes (World Health Organization, 2010), Japan's experience provides an important lesson on how HI in access to effective healthcare would be threatened in the face of economic difficulties and population aging. This paper aimed to fill the gap in the evidence discussed above by analyzing nationwide data throughout the 1980s and 2000s, when Japan struggled through demographic and economic challenges.

Methods

For our purpose, we basically followed previous studies (van Doorslaer et al., 1997; van Doorslaer et al., 2002; Lu et al., 2007; Ohkusa & Honda, 2003) to assess income-related HI by calculating concentration indices (CIs) of healthcare utilization using time-series cross-sectional data of nationally representative samples, the details of which are below.

Data sources: comprehensive survey of living conditions (CSLCP)

We followed Ohkusa and Honda (2003) and used CSLCP micro data. A large-scale CSLCP was conducted every 3 years, in which all households and their members living in sample unit areas, which were cluster-sampled from 47 prefectures nationwide in Japan, were invited to participate. The survey comprised self-administered questionnaires on household and members' health statuses, and an interview questionnaire on household income. The income survey was conducted in a subsample of household and health surveys. Household and health questionnaires were administered in June of each survey year, and the interview survey on income status was conducted in July of the same year.

In the 2007 survey, the household and health questionnaires were distributed to a total of 287,807 households located in 5440 unit areas that were selected by stratified random sampling from areas of the Population Census conducted in 2005. A total of 230,596 households completed the questionnaires (response rate, 80.1%). The income survey, on the other hand, was conducted in 36,285 households in 2000 sample unit areas; 24,578 households responded (response rate, 67.7%). We merged a dataset for these three questionnaires by unique IDs for households and individuals, which included data from 45,586 individuals (M/F, 21,656/23,930) in 16,177 households. Using similar procedures we obtained 7 databases for the years 1986, 1989, 1992, 1995, 1998, 2001, and 2004.

Household income

The survey assessed annual pretax income including labor income, asset income, pension, and other social security transfers. Following a previous study (Shibuya, Hashimoto, & Yano, 2002), we obtained equivalent pre-tax income by dividing total household pre-tax income by the square root of the number of family members.

Healthcare utilization

To measure healthcare utilization we used self-reported "physician visits in the previous 1 month" in the questionnaires. Physician visits included outpatient and inpatient services provided by western medicine physicians as well as traditional care such as acupuncture for musculoskeletal conditions covered by public health insurance.

Estimation of healthcare needs

Healthcare needs are often operationalized as expected likelihood (e.g. probability or amount) of healthcare use (van Doorslaer et al., 1997). More concretely, actual healthcare use was regressed on the "needs" and "non-needs" factors of individuals, and a predicted value using the actual values of the "needs" variables was obtained as the estimate of "healthcare needs" solely attributable to the individual's needs status. "Needs" variables often include the individual's demographic and health conditions, while "non-needs" variables are composed of household income, regional availability of services, and other socio-economic conditions that may affect access to healthcare. However, in this study, we chose not to use this method because we believe that predicted health utilization would underestimate healthcare needs, especially among the poor. Linearly predicted healthcare utilization should reflect healthcare need if the threshold of health conditions that leads to care utilization is independent of income status and year.

Table 1
Transition of copayment rate in Japan.

Type of insurance	Year							
	1983	1997	2001	2002	2003	2006		2008
Health services for elderly	IP: 300 yen/day OP: 400 yen/day	IP: 1000 yen/day OP: 500 yen/day + medication sharing	10%	10% (20%)		10% (30%)	Age 75 and over Age 70–74	10% (30%) 20% (30%)
National health insurance[a]		30%		IP: 30% OP: 30% + medication sharing		30%	Under 70	30%
Employee's health insurance	Beneficiary	Fixed payment (-1984) 10%(1984-)		IP: 20% OP: 20%; medication sharing		30%		
	Beneficiary's dependent family	IP: 30% (-1981) IP: 20%(1981-) OP: 30%		IP: 20% OP: 30%; medication sharing		30%		

IP: inpatient, OP: outpatient.
Source: Ministry of Health, Labour and Welfare. Annual Health, Labour and Welfare Report: 2007 (in Japanse).
[a] Self-employed, retired, and their family.

We doubt that the assumption may not hold because worsening economic conditions and increasing burden of out-of-pocket payment over time could selectively deter healthcare utilization among the poor until they get sicker. Thus, instead of predicted healthcare use, we used predicted health status to more directly reflect one's healthcare needs.

For this purpose, we started from self-reported health (SRH) status measured in 5 response levels, which is commonly employed as an indicator of individual health status and is known to significantly predict mortality and utilization of healthcare (DeSalvo, Fan, McDonell, & Fihn, 2005). However, some researchers have criticized the measure as being susceptible to reporting bias, and its comparability across populations is questionable (Lindeboom & van Doorslaer, 2004). A possible solution for this is to construct a single measure of health status by regressing SRH on several conditions that are objectively measured or subjectively reported with less susceptibility to response bias such as sex, age, diagnosed chronic conditions and functional limitations (Jürges, 2005). More specifically, we constructed an ordered probit model with SRH as the target outcome regressed on the above factors. Based on the estimated response we calculated the estimated risk of reporting less than "fair" health, standardized for the needs conditions of the individuals.

Estimation of horizontal inequity

To evaluate HI we used two methods of estimating CI as a relative measurement of income-related inequality in healthcare utilization and healthcare need, following previous studies (van Doorslaer et al., 1997).

CI corresponds to twice the area between the concentration curve and the 45° line, and runs from −1 (over-diagonal, implying pro-poor) to +1 (under-diagonal, implying pro-rich). The basic idea is that we could measure the degree of HI as the difference between the CI of healthcare use (C_M) and that of healthcare need (C_N).

C_M was therefore calculated by the following formula:

$$C_M = \frac{2}{N\bar{y}} \sum_{i=1}^{N} (y_i - \bar{y}) \left(R_i - \frac{1}{2} \right) \tag{1.1}$$

$$= \frac{2}{\bar{y}} \mathrm{cov}(y_i, R_i) \tag{1.2}$$

Where y_i is the measure of healthcare utilization of ith individual, N the sample size, and $\bar{y}$ mean healthcare use. R_i is relative fractional rank in income of the ith individual. If we replace y_i with estimated health status as healthcare need, we can calculate C_N. Subtracting C_N from C_M provides HI. A positive HI value indicates a distribution of healthcare access for health conditions in favor of the rich, and vise versa.

Another method used to obtain HI is via a decomposition of C_M (van Doorslaer et al., 2002; Wagstaff, van Doorslaer, & Watanabe, 2003). Suppose healthcare utilization (y) is predicted in a linear additive regression model such as:

$$y = \alpha + \sum_k \beta_k x_k + \varepsilon \tag{1.3}$$

Where x_k is the kth factor of the vector including the source of inequality such as demographics, income, and access to other healthcare resources. Then, C_M can be decomposed into the sum of CIs for each factor weighted by its elasticity as follows:

$$C_M = \sum_k \left(\frac{\beta_k \bar{x}_k}{\bar{y}} \right) C_k + \frac{GC_\varepsilon}{\bar{y}} \tag{1.4}$$

Where C_k is CI for x_k and GC_e is the generalized CI for the error term.

Although healthcare utilization was expressed in binary term, we relied on linear decomposition rather than nonlinear decomposition for analytic simplicity, following previous studies that reported that the difference between linear and nonlinear estimators was only moderate (van Doorslaer, Koolman, & Jones, 2004; Lu et al., 2007).

As explanatory factors of the linear model, previous studies have included health needs measured by sex, age, and subjective health status and non-need factors such as equivalized household income, education, labor force participation, marital status, and residential region (van Doorslaer et al., 2004; Lu et al., 2007). In our study, we did not include sex or age because we have already controlled for them in the estimation of the health status indicator. We did not include education or labor force participation because of data limitation; however, their effects should be reflected in the CI for the error term in our case. We additionally included in the model the number of physicians per 1000 population at 47 prefectural levels to reflect regional accessibility to healthcare resources.

HI was calculated for each year for all people aged ≥20 years because copayment of child care was subsidized by municipal authorities in Japan, although the conditions of and eligibility for subsidies varied across municipalities. We also carried out subgroup analyses stratified by age with 65 years as the cutoff point because the copayment rate was potentially deducted for those aged ≥65 years with means tests in some municipalities. People aged ≥75 were unconditionally and universally eligible for reduced copayments at a rate of 10–20% according to their income levels. Finally, households that did not pay income tax were regarded as those under livelihood assistance by the welfare program and were excluded from analyses because they were exempt from copayments and premium payments, which would have affected their healthcare utilization behavior.

Results

Descriptive statistics

Descriptive statistics for each year are shown in Table 2. The sample size gradually decreased because of a decreasing response rate over time. The sex ratio was almost stable, and a gradual elevation of mean age was observed reflecting population aging. The average equivalent income was the highest in 1998 (4.2 million Japanese yen; approximately US$35,000 in exchange rate of 1998). The rate of healthcare utilization gradually increased from 25.1% in 1986 to 42.0% in 2007, again reflecting the increased proportion of elderly in the sample who tended to have larger demand for healthcare.

Horizontal inequity measured as the gap between healthcare utilization and health status

Fig. 1a shows CI and HI indices for all age categories >20 years. CIs for healthcare use (C_M) were negative throughout the study period, indicating the poor used relatively more healthcare services. Overall, the C_M values were almost constant across years (between −0.032 and −0.052). The CIs for healthcare needs (C_N) were also negative throughout the period, indicating larger healthcare needs in households with lower versus higher income. C_N decreased from −0.058 in 1986 to −0.108 in 2007. Therefore, the HI indices for healthcare access gradually increased from 0.026 to 0.072 over the period, indicating a widening gap in healthcare utilization for healthcare needs in favor of the rich.

Fig. 1b presents CI and HI indices limited to people aged 20–64 years. C_M turned positive, suggesting more utilization by the rich. C_N was constantly negative in this group across years. Subsequently,

Table 2
Descriptive statistics of waves of the comprehensive survey of people's living conditions; 1986–2007.

		Year							
		1986	1989	1992	1995	1998	2001	2004	2007
Sample sizes		85,243	87,484	81,378	73,821	66,444	63,711	50,875	45,586
Sex (female)	%	52.8%	52.6%	52.8%	52.6%	52.5%	52.9%	52.7%	52.5%
Age	Mean	46.5	47.2	47.8	48.1	49.1	50.9	52.2	53.0
	SD	16.0	16.3	16.6	16.9	17.3	17.6	17.7	17.9
Equivalent income (thousand yen)	Mean	2,850.6	3,189.3	3,801.4	4,117.1	4,190.9	3,870.1	3,682.1	3,644.3
	SD	2,269.7	2,585.3	3,067.3	3,359.0	3,340.2	3,241.6	2,506.9	2,684.8
	Median	2,437.2	2,683.3	3,228.9	3,488.3	3,544.9	3,264.7	3,203.2	3,095.0
Physician visit in previous month	%	25.1%	27.4%	28.3%	30.2%	34.1%	38.4%	40.9%	42.0%
Estimated health status less than "fair"	%	18.3%	17.8%	15.1%	10.0%	12.9%	15.2%	17.6%	21.9%

HIs were positive, and the indices increased over time from 0.027 to 0.074, again suggesting a widening gap in favor of the rich.

Fig. 1c presented the results limited to people aged ≥65 years. Compared with the younger layer, both C_M and C_N were consistently closer to 0, and the HIs were positive, yet to a smaller degree, ranging between 0.014 and 0.028.

Decomposition of CIs for healthcare utilization

Fig. 2 presents the contributions of estimated health status, equivalent household income, and regional physician density to the CI of healthcare utilization for each year. Income and estimated health status were major contributors to inequality in healthcare utilization each year. Estimated health status was consistently negative throughout the study period (between −0.004 and −0.017). The contribution of equivalent household income was consistently positive (between 0.010 and 0.026), and became larger after 2001. The contribution of regional physician density was almost null.

Discussion

This paper provides cross-sectional time-series data of income-related inequality in healthcare utilization in Japan. In the whole population aged ≥20 years the distribution of healthcare utilization was consistently weighted towards the poor, as shown by the negative C_M values. However, when the population was divided at age 65 years the values became positive, suggesting a distribution of utilization in favor of the rich. This finding may be attributable to the observation that elderly households tended to have lower income, and had more frequent use of medical services because of their higher demand for medical care and lower copayment rate for the elderly in the Japanese health insurance system (Ministry of Health, Labour and Welfare, 2008). However, after stratifying the population by age, the distribution in each age category was revealed as unequal in favor of the rich.

The distribution of healthcare needs, depicted as an individual's estimated likelihood to have poor health status, was consistently weighted towards the poor; suggesting that those with lower household income tended to have poor health. The degree of distribution inequality was more manifest in the later part of the study period. As a result, we found that income-related inequity in healthcare access for healthcare needs increased slightly over time mainly because of increasing inequality in health status.

When we focused on people aged ≥65 years, the magnitude of HI was small, and consistent over time, while the increasing gap between healthcare utilization and health needs was more apparent among the younger population. The decomposition analyses of this younger layer further confirmed that equivalent household income consistently exhibited the largest contribution to the unequal distribution of healthcare utilization in favor of the rich, and the contribution became larger after 2001, when economic deterioration and the subsequent income gap became societal problems in Japan (Tachibanaki & Urakawa, 2008).

Using a decomposition analysis Lu et al. (2007) showed that the HI index of western physician visits was 0.0209 in Taiwan, −0.0090 in Korea, and 0.0927 in Hong Kong as of 2004. In our decomposition analysis, our estimation in the same year would be C_M (0.016) minus the contribution of estimated health status (−0.009) = 0.025, which seems comparable with Taiwan. Thus, in the comparative sense Japan still achieved a high degree of horizontal equity in healthcare utilization across household income status. However, when we observed the trend over time, our analysis strongly indicated an early sign of deterioration in this achievement since 2001.

Several studies based on community surveys have revealed that a non-ignorable portion of the population do not seek medical care in spite of felt needs; the major reasons were the time cost to make a visit and the out-of-pocket copayment at visit (Abe, 2010; Murata et al., 2010). Employees' Health Insurance, which mainly covers younger workers, covers 60% of the total population, and the copayment rate for beneficiaries in this plan was revised from 20% to 30% in 2003. In addition, the income gap among the younger population has widened since the 2000s (Tachibanaki & Urakawa, 2008). These conditions may be behind the widening HI in healthcare access among young people. Although some studies showed that the price elasticity of demand for medical care is small (Yashiro, Suzuki, & Suzuki, 2006), Babazono et al. (2008) reported a reduction in healthcare use in lower-income groups after the increase of the copayment rate using aggregated data of Employees' Health Insurance. Ikegami et al. (2011) also attributed the decrease in outpatient service use since the 1990s among those with Employee's Health Insurance to the increased copayment rate. According to the RAND Health Insurance Experiment, higher co-insurance rates significantly reduced access to healthcare and negatively affected health among the vulnerable population with lower income (Gruber, 2006).

In addition to the economic barrier of the increased copayment rate, a widening gap in health literacy across socio-economic groups may also affect access to healthcare. According to the Patients' Behavior Survey Report in 2008, only 15% of outpatients could actually access necessary information when they chose outpatient clinics and had to make a decision for treatment (Ministry of Health, Labour and Welfare, 2009b). Almost half of them depended on physician's referral, and only about 4% used the Internet and other independent sources that became newly available since the late 1990s and were likely to contain detailed information. This information divide might have worsened the unequal utilization of healthcare services (Ishikawa & Yano, 2008).

Our results contradict previous findings by Ohkusa and Honda (2003) who reported that both healthcare utilization and needs were in favor of the poor in 1992, 1995, and 1998. They attributed to

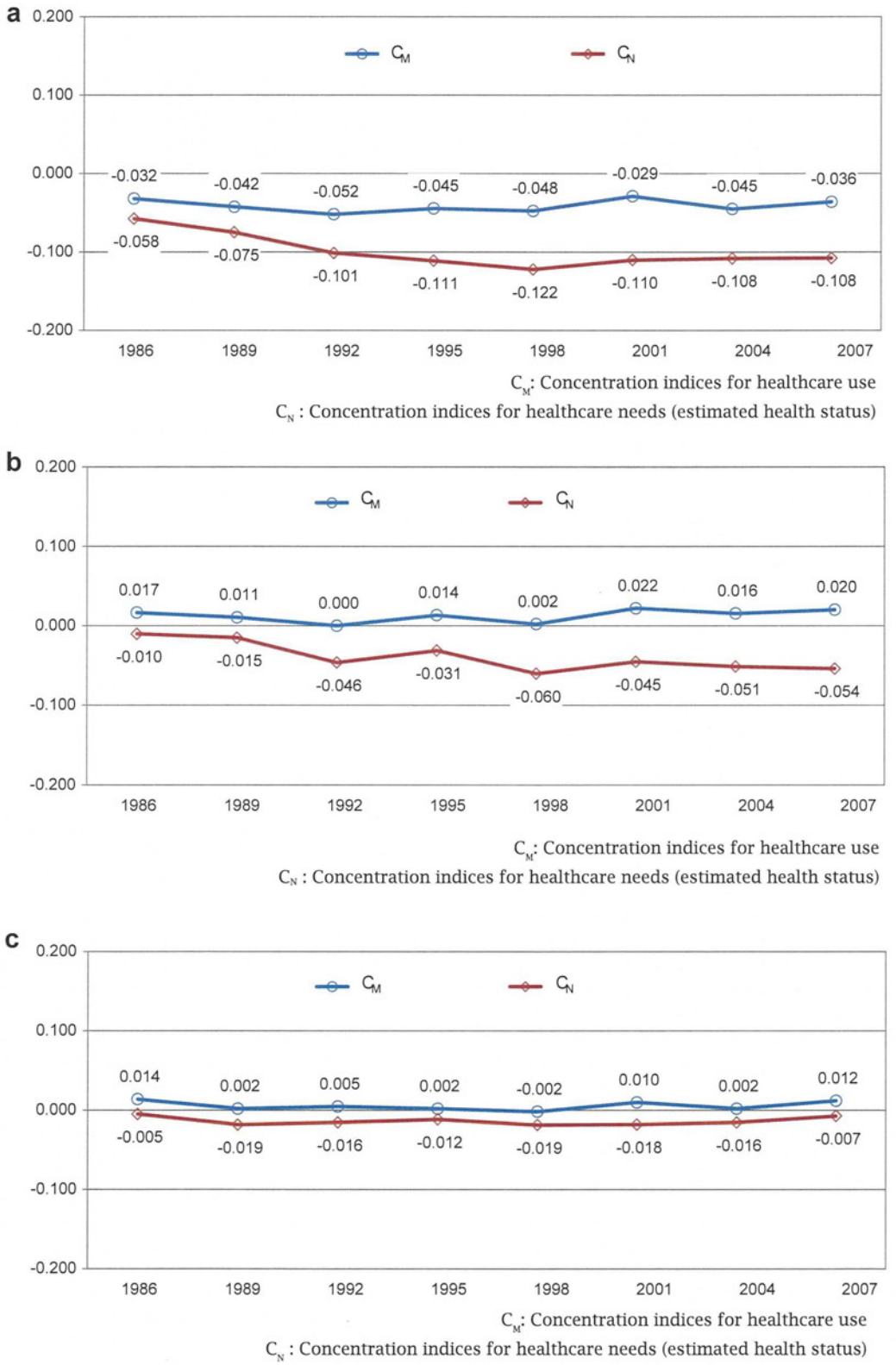

Fig. 1. Estimation of concentration indices and horizontal inequity indices of healthcare access;1986–2007. a) age 20 and over, b) age from 20 to 64, c) age 65 and over.

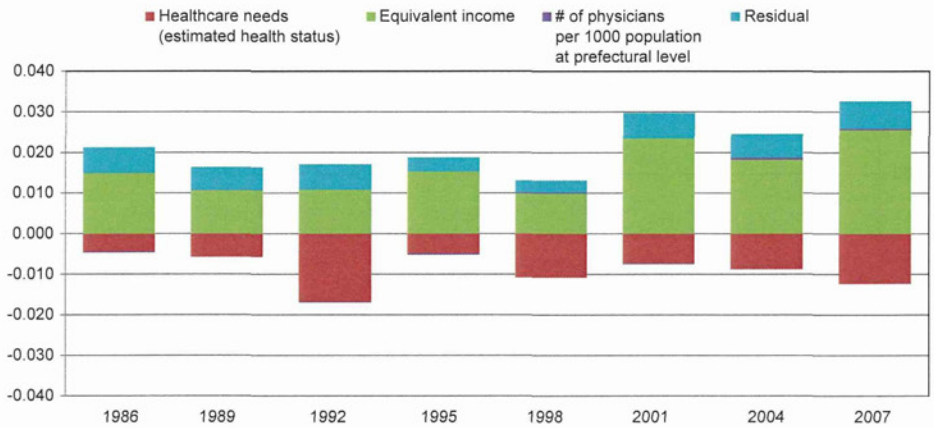

Fig. 2. Results of decomposition analysis of horizontal inequality on healthcare access; 1986–2007, age 20–64.

the improvement of horizontal equity the amendment of the copayment rate for beneficiaries in Employees' Insurance Plans in 1997 from 10% to 20%, which closed the gap between the other plans that bore a 30% copayment. We confirmed that the degree of disparity in healthcare use among people aged 20–64 years was slightly improved from 0.014 in 1995 to 0.002 in 1998, but the improvement was short-lived. Because a similar change was also observed among those aged ≥65 years we do not believe that the argument of Ohkusa and Honda (2003) is valid, since the elderly were mainly covered by the National Health Insurance and Elderly Insurance Plans, whose copayment rates remained the same at the time. Instead, our study revealed a growing gap in health status and the contribution of household income to healthcare utilization since the late 1990s and 2000s, suggesting that horizontal equity of healthcare access is deteriorating over time due to the widening income gap and rising out-of-pocket contributions.

Political implications

The copayment rate for people aged <70 was unified to 30% after healthcare reforms in 2003. This reform achieved equity in the contribution through out-of-pocket payment regardless of income levels, because before the reform, lower copayment rate was applied to those with Employees' Health Insurance who tended to have higher income compared with other public plans. However, even among those with Employee's Health Insurance there was a wide gap in financial status; members with lower income were already burdened with a higher premium rate and out-of-pocket payment (Ikegami et al., 2011). Because of this regressive nature of the current social health insurance scheme, universally raising the copayment rate regardless of income levels would rather aggravate HI in healthcare access. Instead, horizontal equity will be facilitated by introducing a system of fair contribution proportional to ability to pay.

One possible solution could be the introduction of tax-based financing, although its political feasibility seems quite low in Japan because of the conflict of interests among public insurers. Another promising solution might be to standardize the premium contribution rules across plans. Currently, monthly premium contribution under Employees' Health Insurance is calculated by multiplying each worker's monthly wage by a premium rate determined by each insurer, whereas premiums of the National Health Insurance are charged by a varied mix of per capita basis and per household. As the All-Japan Federation of National Health Insurance Organizations argued, making the premium collection proportional to income and expanding prepayment contribution rather than copayment would ease the financial burden of out-of-pocket medical expenditure among households with low-to-middle income, and may lead to improvements in horizontal equity in access (All-Japan Federation of National Health Insurance Organization, n.d.).

Limitations

This study revealed early signs of deterioration in horizontal equity in healthcare utilization even under the universal coverage of healthcare in Japan. However, there are several weaknesses and limitations of our results that require careful consideration.

First, the data source of this study was a cross-sectional survey; healthcare utilization was assessed in a period previous to the survey (e.g. in a previous month or year), whereas health status was assessed at the time of survey. Thus there was time inconsistency between the actual utilization and estimated healthcare needs. We share this limitation with previous studies that rely on cross sectional surveys (Lu et al., 2007; Ohkusa & Honda, 2003). Thus the results presented in this paper need confirmation using panel datasets in future.

Second, again due to data limitation, we could not consider the types and quality of healthcare utilization. The available data did not discriminate outpatient and inpatient services or general and specialized care. Furthermore, CSLCP does not assess the number of visits. Previous studies conducted with more detailed data in the European Household Panel Survey identified that many European countries have more pro-rich inequalities in the probability of specialist visits whereas most countries showed pro-poor inequalities in the probability and conditional number of GP visits (van Doorslaer et al., 2004). Whether the degree of HI differs across the types and quality of care is also worthy of further investigation because Japanese people currently enjoy frequent visits to physician services under unrestricted approval to access to any type of care (Organization for Economic Cooperation and Development, 2006). Detailed data on the type of healthcare consumption are required to conquer this limitation.

Our data did not allow us to evaluate Japan's refund system against catastrophic copayment, which was introduced in 1973. This system refunds to patients an allowance for the amount exceeding the liable payment according to a means test, which may contribute to the relatively high achievement in horizontal equity compared with other OECD and Asian countries. Ikegami et al. (2011) showed that the Kakwani index of out-of-pocket payment, or the inequity index of payment burden across household ability to