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Does subsidy work? Price elasticity of demand for influenza vaccination among the elderly in Japan

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ABSTRACT

Objectives: Subsidy for influenza vaccination is often provided to the elderly in order to encourage them to receive a flu shot in developed countries. However, its effect on uptake rate, i.e., price elasticity of demand, has not been well studied.
Methods: Japan's decentralised vaccination programme allows observation of various pairs in price and uptake rate of flu shots among the elderly by the municipality from 2001/2002 to 2004/2005 season. We combine our sample survey data ($n = 281$), which monitor price, subsidy and uptake rate, with published data on local characteristics in order to estimate price elasticity of demand with panel model.
Results: We find price elasticity of demand for influenza vaccine: nearly zero in nationwide, nearly zero in urban area, and −1.07 in rural area.
Conclusions: The results question the rationale for subsidy, especially in urban area. There are cases where maintaining or increasing the level of subsidy is not an efficient allocation of finite health care resources. When organising a vaccination programme, health manager should be careful about the balance between subsidy and other efforts in order to encourage the elderly to receive shots with price elasticity in mind.

1. Introduction

Seasonal influenza epidemics affect the health of population in many countries. The elderly is more vulnerable to the disease among them, which sometimes results in hospitalisation or death [1]. One way of countering this public health issue is to implement vaccination programme targeting the elderly [2], since influenza vaccine is considered as effective not only in preventing contraction of the disease [3], but also reducing risk of death after contraction [4]. Although some recent studies cast doubts as to the latter effectiveness, i.e., reducing mortality [5–7], a number of countries or regions organise such vaccination programmes [8]. In Japan, national government has set up a nationwide influenza vaccination programme for people aged 65 and over since 2001/2002 season.

These programmes usually employ several measures such as public relations or health education in order to encourage the elderly to receive shots. Subsidy is also provided [8], since reducing the price of a shot is believed to increase the uptake of vaccination. However, the response of the elderly as a consumer in regard to price changes, i.e., price elasticity of demand, has not been well studied. Theoretically, knowledge of price elasticity is of great help to design an efficient subsidy programme including vaccination programmes [9], but a few are reported in the literature. A correlation between subsidy levels and uptake rates is found in multinational comparison incorporating 18 developed countries [10]; a rise in uptake rate that is resulted from Medicare coverage in the U.S. [11]; the removal of fee increases uptake rate in an intervention study in Denmark [12]; price elasticity of demand, −0.022,

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is estimated by conjoint analysis before the launch of the national programme in Japan [13].

This lack of knowledge is probably due to the fact that such programmes usually set fixed price for all target population, which make it difficult to observe the consumer's response to price change. The current Japanese programme, however, obligates municipal authorities to manage vaccination for their aged inhabitants, and the decision of co-payment and subsidy level, that is, the price of a shot to a consumer, is devolved to municipal authorities. This arrangement makes the area of each municipality a market for flu shots, and it is possible to observe pairs of various prices and uptake rates. There is a study which reports price elasticity of −0.26 during 2001/2002 and 2002/2003 season by a survey covering 13 big cities [14]. We also take advantage of this "natural experiment", and aim to estimate price elasticity of demand for influenza vaccination among the elderly with national representative samples. The results of this study should be useful in managing vaccination programmes through price setting, and deepen the understanding of consumer behaviour toward preventive services.

2. Materials and methods

In Japan, due to the decentralised implementation of vaccination programme, price and subsidy by each municipality is not monitored or surveyed, while uptake rate by the municipality is published yearly by the central government [15]. We conducted a nationwide sample survey on price, subsidy, and uptake rate of vaccination in order to illustrate the trend of national averages, of which results were published elsewhere [16]. In this survey, operational 300 samples were randomly selected using a list of 22,671,944 people aged 65 and over inhabiting all 3252 municipalities during 2002/2003 season as a sampling frame. A questionnaire inquiring price charged to a recipient, subsidy provided by the municipality, the number of target population, and the number of vaccinated from 2001/2002 to 2004/2005 season was sent to each municipal authorities where operational samples inhabited. The use of the combination of individual level sampling frame and municipality level survey is chosen, since large-scale mergers of municipalities underwent in these years as a local government reform. 196 authorities out of 210 replied, which gave response rate of 94.0% at sample level.

In this study, we assume the operational samples of this survey as an operational panel, in which each sample faces various prices of flu shot for four times between 2001/2002 and 2004/2005 season, since the level of subsidy is usually set by a yearly negotiation between local authority and local medical association. We use uptake rates as a measure of demand assuming them as the probability of an operational sample to receive a shot.

In the literature, non-cash price such as travel cost or time cost has been proven to be significant in the demand for health care [17], including flu shots [18]. Since shots are usually provided at almost all local hospitals and clinics under cooperation with their municipal authority, we calculate the number of hospitals and clinics divided by the area of municipality to gain density of shot location as a variable of non-cash price surrogating travel cost using System of Social and Demographic Statistics (SSDS) by Statistics Bureau [19]. We added this variable to our operational panel data.

Income or budget constraint is also significant in the demand at individual level [20]. However, it is not possible to define any variable of income for our operational sample that can be combined with our operational panel data, because we construct our operational sample not through an actual observation of individuals but through an interpretation of market level observation. Average income of people aged 65 and over by the municipality is not available in SSDS, but average income per capita is available. We add this variable to our operational panel data as a controlling variable considering it as an activity level of local economy, although we do not speculate any systematic effect on the demand.

Some factors such as influenza morbidity or mortality in the previous season or current season are found influential on the demand for influenza vaccination [18,21]. In this study, however, we do not incorporate any variable that represent such factors. We also leave the level of public relations or health education untreated due to lack of data. Instead, we leave these as unobserved and intend to control their effect on the demand using panel estimation [22–24].

We specified four equations in order to estimate price elasticity as below:

$$\ln r_i = \alpha + \beta_1 \ln p_i + \beta_2 \ln d_i + \beta_3 \ln y_i + \varepsilon_t,$$
$$i = 1, \ldots, N \,(\text{season model}) \quad (1)$$

where r is uptake rate, p is price of a shot, d is density of shot location, y is income per capita, ε is error term, i represents each sample in a season, and N is number of samples in a season. Uptake rate, price of a shot, and density of shot location are converted into logarithm so that we can interpret coefficient β_1 and β_2 as elasticity [25]. Income is also converted into logarithm, since unit of measurement, yen, is the same as price, while we do not interpret β_3 as income elasticity. According to this equation, season models from 2001/2002 to 2004/2005 season are estimated

$$\ln r_i = \alpha + \beta_1 \ln \frac{p_i}{c_t} + \beta_2 \ln d_i + \beta_3 \ln \frac{y_i}{c_t} + \varepsilon_i,$$
$$i = 1, \ldots, M, \; t = 1, \ldots, T \,(\text{pool model}) \quad (2)$$

where c is consumer price index, t represents observed season, M represents each sample in the panel regardless of the observed season, and T is number of observed seasons. Consumer price index is incorporated for the purpose of controlling the effect of inflation over the season. With this equation, we estimate pool models

$$\ln r_{it} = \alpha + \beta_1 \ln \frac{p_{it}}{c_t} + \beta_2 \ln d_{it} + \beta_3 \ln \frac{y_{it}}{c_t} + v_{it},$$
$$i = 1, \ldots, N, \; t = 1, \ldots, T \,(\text{panel random effect model}) \quad (3)$$

where v_{it} represents disturbance. This equation is for panel estimation of random effect model.

$$\ln r_{it} = \alpha + \alpha_i + \beta_1 \ln \frac{p_{it}}{c_t} + \beta_2 \ln d_{it} + \beta_3 \ln \frac{y_{it}}{c_t} + u_{it},$$
$$i = 1, \ldots, N, \; t = 1, \ldots, T \,(\text{panel fixed effect model}) \quad (4)$$

Table 1
Summary statistics.

	2001/2002	2002/2003	2003/2004	2004/2005	Pool
National					
Uptake rate[a]					
Obs	257	277	281	279	1094
Mean	0.2988	0.3779	0.4611	0.4960	0.4108
Std. Dev.	0.09461	0.08658	0.08360	0.07913	0.1146
Price (Yen)					
Obs	252	261	264	263	1040
Mean	1134	1135	1138	1128	1134
Std. Dev.	449.0	419.0	399.4	384.1	412.6
Density of shot location[b] (km^2)					
Obs	282	282	282	282	1128
Mean	1.995	2.021	2.041	2.066	2.031
Std. Dev.	3.113	3.145	3.178	3.220	3.160
Income (10^3 Yen)					
Obs	282	282	282	282	1128
Mean	3508	3478	3405	3367	3439
Std. Dev.	491.6	486.4	456.5	458.1	476.1
Subsidy (Yen)					
Obs	268	278	275	281	1102
Mean	2972	2955	2966	2954	2962
Std. Dev.	883.0	806.6	752.5	747.5	784.3
Subsidy level[c] (%)					
Obs	249	260	259	263	1031
Mean	72.2	71.8	72.1	72.2	72.1
Std. Dev.	12.0	12.2	10.7	10.5	11.4
Urban					
Uptake rate					
Obs	203	217	218	216	854
Mean	0.2917	0.3692	0.4546	0.4883	0.4027
Std. Dev.	0.09032	0.07792	0.07700	0.06963	0.1094
Price (Yen)					
Obs	206	211	211	210	838
Mean	1119	1120	1131	1120	1122
Std. Dev.	464.8	430.6	399.0	385.9	420.2
Density of shot location (km^2)					
Obs	218	218	218	218	872
Mean	2.503	2.536	2.564	2.595	2.546
Std. Dev.	3.366	3.399	3.435	3.480	3.415
Income (10^3 Yen)					
Obs	218	218	218	218	872
Mean	3627	3597	3514	3478	3554
Std. Dev.	477.8	456. 1	428.3	429.6	446.7
Subsidy (Yen)					
Obs	212	217	213	218	860
Mean	3074	3049	3065	3043	3057
Std. Dev.	765.5	753.8	683.7	686.7	722.1
Subsidy level (%)					
Obs	207	214	211	213	845
Mean	73.2	72.7	73.1	73.1	73.0
Std. Dev.	11.0	11.3	9.2	9.2	10.2
Rural					
Uptake rate					
Obs	54	60	63	63	240
Mean	0.3258	0.4093	0.4836	0.5225	0.4397
Std. Dev.	0.1059	0.1075	0.1008	0.1017	0.1270
Price (Yen)					
Obs	46	50	53	53	202
Mean	1201	1199	1169	1169	1183
Std. Dev.	366.4	362.9	403.4	378.1	376.2

Table 1 (*Continued*)

	2001/2002	2002/2003	2003/2004	2004/2005	Pool
Density of shot location (km^2)					
Obs	64	64	64	64	256
Mean	0.2649	0.2688	0.2587	0.2607	0.2633
Std. Dev.	0.5284	0.5344	0.4762	0.4779	0.5020
Income (10^3 Yen)					
Obs	64	64	64	64	256
Mean	3104	3074	3032	2988	3050
Std. Dev.	372.8	352.7	339.4	334.6	350.9
Subsidy (Yen)					
Obs	56	61	62	63	242
Mean	2858	2622	2623	2648	2621
Std. Dev.	963.4	902.2	875.4	866.3	895.5
Subsidy level (%)					
Obs	42	46	48	50	186
Mean	67.3	67.4	67.6	68.5	67.7
Std. Dev.	15.5	15.2	14.9	14.5	14.9

[a] Ratio of the number of vaccinated to the target population during the season.
[b] The number of clinics and hospitals per km^2.
[c] Proportion of subsidy in the sum of price and subsidy.

where α_i represents fixed effect regarding ith sample, and u_{it} represents reminder disturbance. This equation is for panel estimation of fixed effect model.

With (3) and (4), we estimate two panel models, which are compared with pool model and each other with diagnostic tests such as Hausman test of misspecification.

A previous study [14] reports price elasticity in 13 big cities, and there are some that reports the difference in utilisation of preventive services, for example, mass health examination [26], and cancer screening programme [27], between urban and rural inhabitants in Japan. Inhabitants of rural area tend to use more preventive service voluntarily compared to urban inhabitants. Taking these studies into account, in addition to estimating national models using all operational samples, urban models using only samples that live in cities, and rural models using only samples that live in towns or villages are also estimated. Because of our sampling design, both models can be interpreted as representative of each area in Japan.

Statistical package software STATA 9 is used for computation.

3. Results

Table 1 shows summary statistics of variables. National average of uptake rate, the demand, increased remarkably from 29.9% in 2001/2002 season to 49.6% in 2004/2005 season, which resulted in 41.1% over all seasons. Similar increases are also observed in urban area and rural area, while higher rates are observed in rural area than in urban area. It should be noted that the observed period is the beginning of the programme, during which there is supposed to bring about the broad diffusion of vaccination [28]. Additionally, outbreaks such as Severe Acute Respiratory Syndrome (SARS) in 2002/2003 season and avian flu in 2002/2003 season occurred, and a word, “influenza”, was heavily publicised during these seasons. The need of preparation for the emergence of pandemic influenza virus was also emphasised by the government in the following years. Such information may have affect on consumers’ behaviour. National average of price in all seasons is ¥1134 (US$9.86: US$1 = ¥115). The lowest price is ¥0 (US$0), and the highest ¥2500 (US$21.74). A shot is slightly more expensive in rural area than in urban area. National average of density of shot location, the non-cash price, is 2.0 per km^2, and it ranges from 0.0023 per km^2 to 20 per km^2. Urban average is smaller than rural as anticipated. National average of income, the activity level of local economy, is ¥3,439,000 (US$29,900), and it ranges from ¥2,407,000 (US$20,900) to ¥4,970,000 (US$43,200). Urban average is larger than rural as anticipated. National average of subsidy is ¥2962 (US$25.76), and it ranges from ¥0 (US$0) to ¥4599 (US$39.99), while national average of subsidy level 72.1%, from 0% to 100%. Urban municipal authorities tend to expend more subsidy than rural authorities.

Table 2 shows the results of OLS estimation of Eq. (1), season models. The demand for influenza vaccination depends significantly on price and non-cash price in the majority of models with the exception of rural 2003/2004 model and rural 2004/2005 model. Price elasticity is estimated as −0.0441 to −0.0187 in national model, −0.0384 to −0.00323 in urban model, and −0.109 to −0.0152 in rural model, of which negative signs are anticipated. Negative non-cash price elasticity is found in most of the models, which is also anticipated. Activity level of local economy is not significant as a determinant of the demand in all models.

Table 3 shows the results of OLS estimation of Eq. (2), pool models. The demand depends significantly on price in national model and rural model. Price elasticity is estimated as −0.0236 in national model, −0.0113 in urban model, and −0.0626 in rural model. These values are within the range estimated in season models. Non-cash price becomes insignificant in national model and rural model. Non-cash price elasticity in rural model lessens its size and goes beyond zero, which contradicts the anticipation. With negative coefficient, activity level of local economy

Table 2
OLS estimation of Eq. (1).

	National 2001/2002 model		National 2002/2003 model		National 2003/2004 model		National 2004/2005 model	
	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics
ln(price + 1)	−0.0437	−2.93**	−0.0441	−4.13**	−0.0187	−1.58	−0.0358	−2.65**
ln(density)	−0.0413	−1.98*	−0.0442	−3.59**	−0.0321	−3.07**	−0.0252	−2.86**
ln(income)	−0.0953	−0.38	−0.07343	−0.50	0.0611	0.47	0.00310	0.03
Constant	−0.201	−0.10	−0.117	−0.10	−1.18	−1.11	−0.503	−0.57
	Prob > F(3,234) = 0.0005		Prob > F(3,254) = 0.0000		Prob > F(3,259) = 0.0001		Prob > F(3,256) = 0.0000	
	Adj R^2 = 0.0606		Adj R^2 = 0.1613		Adj R^2 = 0.0665		Adj R^2 = 0.0931	
	Urban 2001/2002 model		Urban 2002/2003 model		Urban 2003/2004 model		Urban 2004/2005 model	
	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics
ln(price + 1)	−0.0384	−2.44*	−0.00323	−3.03**	−0.0186	−1.27	−0.00920	−0.58
ln(density)	−0.0956	−3.19**	−0.0773	−4.62**	−0.0543	−3.82**	−0.0527	−4.47**
ln(income)	0.145	0.50	−0.0257	−0.16	0.0533	0.38	0.0647	0.56
constant	−2.20	−0.92	−0.569	−0.43	−1.10	−0.94	−1.18	−1.25
	Prob > F(3,192) = 0.0001		Prob > F(3,206) = 0.0000		Prob > F(3,207) = 0.0000		Prob > F(3,207) = 0.0000	
	Adj R^2 = 0.0867		Adj R^2 = 0.2159		Adj R^2 = 0.1279		Adj R^2 = 0.1617	
	Rural 2001/2002 model		Rural 2002/2003 model		Rural 2003/2004 model		Rural 2004/2005 model	
	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics
ln(price + 1)	−0.0985	−2.44*	−0.109	−3.47**	−0.0152	−0.69	−0.0509	−1.88
ln(density)	0.0560	1.61	−0.0223	−0.87	−0.0239	−1.00	0.00254	0.12
ln(income)	−0.254	−0.56	0.345	0.97	0.533	1.60	0.245	0.85
Constant	1.67	0.44	−3.01	−1.03	−5.00	−1.85	−2.28	−0.96
	Prob > F(3,38) = 0.0434		Prob > F(3,44) = 0.0057		Prob > F(3,48) = 0.3864		Prob > F(3,48) = 0.1599	
	Adj R^2 = 0.1266		Adj R^2 = 0.1949		Adj R^2 = 0.0019		Adj R^2 = 0.0449	

* $p < 0.05$.
** $p < 0.001$.

becomes significant as a determinant of the demand in national model and urban model.

Table 4 shows the results of panel estimation of Eqs. (3) and (4), random effect models and fixed effect models. Random effect models are selected over pool models by Breusch and Pagan Lagrangizan Multiplier tests, which reject null hypothesis that the variance of individual effect is zero. The demand depends significantly on price in rural model. Negative price elasticity is estimated as −0.00581 in national model, and −0.0537 in rural model, while positive price elasticity is estimated as 0.0248 in urban model, which is similar to pool models. Non-cash price elasticity becomes positive without significance in all models. With negative coefficient, activity level of local economy is significant as a determinant of the demand in national model and urban model, which is the same as pool models.

Table 3
OLS estimation of Eq. (2).

	Coefficient	*t*-Statistics
National pool model		
ln((price + 1)/cpi)	−0.0236	−2.69**
ln(density)	−0.0136	−1.48
ln(income/cpi)	−0.393	−3.55**
Constant	2.42	2.66**
	Prob > F(3,1015) = 0.0000	
	Adj R^2 = 0.0524	
Urban pool model		
ln((price + 1)/cpi)	−0.0113	−1.15
ln(density)	−0.0329	−2.44*
ln(income/cpi)	−0.398	−3.01**
Constant	2.36	2.19*
	Prob > F(3,821) = 0.0000	
	Adj R^2 = 0.0600	
Rural pool model		
ln((price + 1)/cpi)	−0.0626	−3.34**
ln(density)	0.00808	0.48
ln(income/cpi)	0.0176	0.08
Constant	−0.573	−0.31
	Prob > F(3,190) = 0.0088	
	Adj R^2 = 0.0443	

cpi: Consumer Price Index.
* $p < 0.05$.
** $p < 0.001$.

Fixed effect models are selected over pool model by F-tests, which rejects null hypothesis that individual effects are constant among all individual samples, and over random effect models by Hausman tests, which rejects null hypothesis that the variance of individual effect is zero. The demand depends significantly on price in rural model, of which elasticity inflates up to −1.07. Price elasticity becomes positive, 0.00221 in national model, as well as 0.00323 in urban model, which are nearly zero. Positive and relatively large non-cash elasticity is estimated with significance in national model and rural model, while negative and insignificant in rural model. The former results contradict our anticipation. With negative coefficient, activity level of local economy is significant as a determinant of the demand in all models.

4. Discussion

We estimate price elasticity of demand for influenza vaccine among the elderly in Japan with national represen-

Table 4
Panel estimation of Eqs. (3) and (4).

	National random effect model			National fixed effect model		
	Coefficient	*t*-Statistics	95% Conf. interval	Coefficient	*z*-Statistics	95% Conf. interval
ln((price + 1)/cpi)	−0.00581	−0.57	−0.02568 to 0.0140	0.00221	0.18	−0.0221 to 0.0265
ln(density)	0.0205	1.61	−0.00155 to 0.456	0.598	3.38**	0.251 to 0.945
ln(income/cpi)	−0.906	−5.95**	−1.20 to −0.607	−7.46	−17.7**	−8.29 to −6.63
Constant	6.49	5.19**	4.04 to 8.94	60.1	17.4**	53.3 to 66.8
Number of observation = 1019, number of groups = 266						
	Prob > Wald $\chi^2(3)$ = 0.0000, R^2(within) = 0.3061			Prob > $F(3,750)$ = 0.0000, R^2(within) = 0.3268		
	R^2(between) = 0.0.0454, R^2(overall) = 0.0416			R^2(between) = 0.0.0038, R^2(overall) = 0.0015		
F-test (pool model vs. fixed effect model): $F(265,750)$ = 4.06, Prob > F = 0.0000						
Breusch and Pagan Lagrangizan Multiplier test for random effects: $\chi^2(1)$ = 52.94, Prob > χ^2 = 0.0000						
Hausman specification test: $\chi^2(3)$ = 352.95, Prob > χ^2 = 0.0000						

	Urban random effect model			Urban fixed effect model		
	Coefficient	*z*-Statistics	95% Conf. interval	Coefficient	*z*-Statistics	95% Conf. interval
ln((price + 1)/cpi)	0.00248	0.23	−0.0190 to 0.0240	0.00323	0.26	−0.0211 to 0.0275
ln(density)	0.0112	0.62	−0.0245 to 0.0470	1.18	4.59**	0.676 to 1.69
ln(income/cpi)	−0.936	−5.36**	−1.28 to −0.594	−7.31	−15.3**	−8.25 to −6.37
Constant	6.69	4.67**	3.88 to 9.50	58.5	14.8**	50.7 to 66.3
Number of observation = 825, number of groups = 211						
	Prob > Wald $\chi^2(3)$ = 0.0000, R^2(within) = 0.3330			Prob > $F(3,611)$ = 0.0000, R^2(within) = 0.3543		
	R^2(between) = 0.0149, R^2(overall) = 0.0397			R^2(between) = 0.0960, R^2(overall) = 0.0157		
F-test (pool model vs. fixed effect model): $F(210,611)$ = 4.09, Prob > F = 0.0000						
Breusch and Pagan Lagrangizan Multiplier test for random effects: $\chi^2(1)$ = 31.20, Prob > χ^2 = 0.0000						
Hausman specification test: $\chi^2(3)$ = 336.67, Prob > χ^2 = 0.0000						

	Rural random effect model			Rural fixed effect model		
	Coefficient	*z*-Statistics	95% Conf. interval	Coefficient	*z*-Statistics	95% Conf. interval
ln((price + 1)/cpi)	−0.0537	−1.99*	−0.107 to −0.000736	−1.07	−3.24**	−1.72 to −0.416
ln(density)	0.0266	1.02	−0.0248 to 0.0780	−0.0521	−0.22	−0.519 to 0.415
ln(income/cpi)	−0.422	−1.23	−1.09 to 0.251	−6.10	−6.36**	−7.99 to −4.20
Constant	2.94	1.05	−2.57 to 8.44	55.5	7.15**	40.1 to 70.8
Number of observation = 194, number of groups = 55						
	Prob > Wald $\chi^2(3)$ = 0.1406, R^2(within) = 0.2784			Prob > $F(3,136)$ = 0.0000, R^2(within) = 0.2987		
	R^2(between) = 0.0.0454, R^2(overall) = 0.0416			R^2(between) = 0.0109, R^2(overall) = 0.0340		
F-test (pool model vs. fixed effect model): $F(54,136)$ = 4.17, Prob > F = 0.0000						
Breusch and Pagan Lagrangizan Multiplier test for random effects: $\chi^2(1)$ = 13.30, Prob > χ^2 = 0.0003						
Hausman specification test: $\chi^2(3)$ = 57.08, Prob > χ^2 = 0.0000						

cpi: Consumer Price Index.
* $p < 0.05$.
** $p < 0.001$.

tative panel data: nearly zero in nationwide, nearly zero in urban area, and −1.07 in rural area. The selection of fixed effect models among models estimated by diagnostic tests is not unexpected, when the rise in uptake rates through a process of diffusion and relative invariability of variables such as price, density of shot location, and average income per capita, are taken into account. The estimators in fixed effect models should be most statistically efficient among those models, and the figures of price elasticity can be considered as estimators after controlling not only observed factors but also unobserved ones.

The almost totally price inelastic result at national level is probably due to the contribution by urban samples, of which number is much larger than rural. Price elasticity of nearly zero in urban area is surprising, which contrasts with the previously reported relatively elastic −0.26 in 13 big cities in 2001/2002 season and 2002/2003 season [14]. Even if we limit by the season for the sake of comparison, our results, −0.00323 to −0.0384 is obviously less elastic. Perhaps this difference is explained by the difference in 'urban area' surveyed. In our survey, only 14.5% of urban samples inhabit the 13 big cities surveyed by the previous study.

Highly elastic result in rural area may be explained by a lower income of the elderly compared to those of urban area, which is suggested by our observation of the activity level of local economy. An opportunity cost of the difference in price around ¥1183 (US$10.29) may be higher in rural area. A previous study on participation in cancer screening in Japan [27] discussed that a small fee, arguably similar to the price in this study, seemed to have nothing to do with higher participation rate observed in rural communities, and ignored price as a determinant of participation in their analysis. Our results, however, implies that subsidy that reduce price to a consumer might be effective in such situation.

The unanticipated positive non-cash price elasticity in urban fixed effect model is not so surprising, since it is not difficult to imagine the easy geographical access in concentrated urban area that a consumer may not pay much attention to travel cost when seeking health care. Positive non-cash elasticity at national level is probably due to the contribution by the large number of urban samples, as well.

The sampling method used in the survey data of this study, simple random selection using individual level sampling frame, is chosen for the purpose of studying the expected level of price faced by an 'average' aged person, overcoming concurrent municipality mergers. Simple random selection at an individual level is rarely used in nationwide surveys, while the combination of selection using list of municipality as a frame and estimation with population weights is more frequently used mainly because of practicality [16,29,30]. Our approach, however, does not accompany any bias, and it is therefore methodologically rigorous as the other approach.

The results of this study question the rationale for subsidy in influenza vaccination programme targeting the elderly. The elderly is not sensitive to price change especially in urban area, which means that reducing the price does not encourage them more to receive a shot. A benefit-cost analysis of current Japanese programme speculates potential benefit gain obtainable from increasing subsidy based on the estimation of price elastic demand in big cities [14]. But given the price inelastic results of this study, it is not recommendable to hastily raise the subsidy level at least in urban area. Since we demonstrate the cost-effectiveness of current programme with average subsidy level of 71%, of which results unchanged even when the effectiveness of reducing mortality is assumed negligible, elsewhere [31], more effort on public relations or health education without the increase of subsidy level may be a preferred policy in urban area. There may be some potential benefit gain by increasing subsidy in rural area.

5. Conclusions

Our finding shows that demand for influenza vaccination among the elderly can vary from elastic to inelastic depending on the characteristics of locality, and there are cases where subsidy cannot be effective. This addresses implications for developed countries where similar vaccination programmes are implemented. There are cases that maintaining or increasing level of subsidy is not an efficient use of finite health care resources. When organising a vaccination programme, managers should be careful about the balance between subsidy and other efforts, by taking the characteristics of the locality into account and with price elasticity of demand in mind. Further studies looking at income elasticity of demand or the effect of other efforts to encourage people to receive a shot, which this study does not model directly, are awaited.

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