Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Does subsidy work? Price elasticity of demand for influenza vaccination among the elderly in Japan

Masahide Kondo *, Shu-ling Hoshi, Ichiro Okubo

Department of Health Care Policy and Management, Graduate School of Comprehensive Human Sciences, University of Tsukuba, Ibaraki, Japan

**A B S T R A C T**

**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.

© 2008 Elsevier Ireland Ltd. All rights reserved.

**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 counteracting 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,
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 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 an 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:

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

where \( r \) is uptake rate, \( p \) is price of a shot, \( d \) is density of shot location, \( y \) is income per capita, \( \epsilon \) 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 \( \beta_1 \) and \( \beta_2 \) as elasticity [25]. Income is also converted into logarithm, since unit of measurement, yen, is the same as price, while we do not interpret \( \beta_3 \) as income elasticity. According to this equation, season models from 2001/2002 to 2004/2005 season are estimated

\[
\ln r_i = \alpha + \beta_1 \ln \frac{p_i}{C_t} + \beta_2 \ln d_i + \beta_3 \ln \frac{y_i}{C_t} + \epsilon_i, \\
i = 1, \ldots, M, \ t = 1, \ldots, T \text{(pool model)}
\]

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

\[
\ln r_{it} = \alpha + \beta_1 \ln \frac{p_{it}}{C_t} + \beta_2 \ln d_{it} + \beta_3 \ln \frac{y_{it}}{C_t} + \nu_{it}, \\
i = 1, \ldots, N, \ t = 1, \ldots, T \text{(panel random effect model)}
\]

where \( \nu \) represents disturbance. This equation is for panel estimation of random effect model.

\[
\ln r_{it} = \alpha + \alpha_i + \beta_1 \ln \frac{p_{it}}{C_t} + \beta_2 \ln d_{it} + \beta_3 \ln \frac{y_{it}}{C_t} + u_{it}, \\
i = 1, \ldots, N, \ t = 1, \ldots, T \text{(panel fixed effect model)}
\]
### Table 1

Summary statistics.

|                                      | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 | Pool |
|--------------------------------------|-----------|-----------|-----------|-----------|------|
| **National**                         |           |           |           |           |      |
| **Uptake rate**                      |           |           |           |           |      |
| 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                                 | 1.995     | 2.021     | 2.041     | 2.066     | 2.031|
| Std. Dev.                            | 3.113     | 3.145     | 3.178     | 3.220     | 3.160|
| **Density of shot location** (km²)   |           |           |           |           |      |
| 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 (10⁴ 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 (%)**                |           |           |           |           |      |
| 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** (km²)   |           |           |           |           |      |
| 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 (10⁴ 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|
where \( \alpha_i \) represents fixed effect regarding \( i \)th 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 km², and it ranges from 0.0023 per km² to 20 per km². 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 \(-0.0032\) 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 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 \(-0.0236\) in national model, \(-0.0113\) in urban model, and \(-0.0626\) 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.
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.

**Table 3**
OLS estimation of Eq. (2).

|               | National pool model | Urban pool model | Rural pool model |
|---------------|---------------------|------------------|------------------|
| **Coefficient** | **t-Statistics**    | **Coefficient**  | **Coefficient**  |
| ln(price + 1)  | -0.0985             | -0.109           | -0.0254          |
| ln(density)   | 0.0560              | 0.0223           | -0.504           |
| ln(income)    | -0.254              | 0.345            | 0.44             |
| Constant      | 1.67                | 3.01             | 2.36             |
| Prob > F(3,192) | 0.0001              | Prob > F(3,891) | Prob > F(3,390)  |
| Adj R² = 0.0867 |                   | Adj R² = 0.1266 | Adj R² = 0.0434  |

|               | **Coefficient** | **t-Statistics** |
|---------------|----------------|------------------|
| ln(price + 1) | -0.0384        | -2.44            |
| ln(density)  | -0.0956        | -3.19            |
| ln(income)   | 0.145          | 0.50             |
| Constant     | -2.20          | -0.92            |
| Prob > F(3,192) | 0.0001          |                 |
| Adj R² = 0.0867 |               |                 |

|               | **Coefficient** | **t-Statistics** |
|---------------|----------------|------------------|
| ln(price + 1) | -0.0437        | -2.93            |
| ln(density)  | -0.0413        | -1.98            |
| ln(income)   | -0.0953        | -0.38            |
| Constant     | -0.201         | -0.10            |
| Prob > F(3,234) | 0.0005          |                 |
| Adj R² = 0.0606 |               |                 |

- p < 0.05.
- **p < 0.001.

by Breusch and Pagan Lagrange 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.

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 | Coefficient | t-Statistics | 95% Conf. interval | National fixed effect model | Coefficient | t-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    | −0.746                      | −17.7*       | −8.29 to −6.63   |
| Constant                     | 6.49        | 5.97**       | 4.04 to 8.94       | 60.1                        | 17.4**       | 53.3 to 66.8    |

Number of observation = 1019, number of groups = 266

Breusch and Pagan Lagrangian Multiplier test for random effects: $F_{194,61} = 4.06$, Prob > $F = 0.0000$

Hausman specification test: $\chi^2(3) = 57.08$, Prob > $\chi^2 = 0.0000$

Urban random effect model

| Coefficient | t-Statistics | 95% Conf. interval | Urban fixed effect model | Coefficient | t-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

Breusch and Pagan Lagrangian Multiplier test for random effects: $F_{210,61} = 4.09$, Prob > $F = 0.0000$

Hausman specification test: $\chi^2(3) = 336.67$, Prob > $\chi^2 = 0.0000$

Rural random effect model

| Coefficient | t-Statistics | 95% Conf. interval | Rural fixed effect model | Coefficient | t-Statistics | 95% Conf. interval |
|-------------|--------------|--------------------|--------------------------|-------------|--------------|--------------------|
| ln((price + 1)/cpi) | −0.0537 | −1.99*            | −1.07 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

Breusch and Pagan Lagrangian Multiplier test for random effects: $F_{54,136} = 4.17$, Prob > $F = 0.0000$

Hausman specification test: $\chi^2(3) = 57.08$, Prob > $\chi^2 = 0.0000$

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

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 recommended 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.

Acknowledgement

This work is funded by Japan’s Ministry of Health, Labour and Welfare grant for “Policy Evaluation of Influenza Vaccination based on EBM” (2004) led by principal investigator, Prof. Yoshio Hirota, Osaka City University.

References

[1] Dolin R. Influenza. In: Kasper DL, Braunwald E, Fauci A, Hauser SL, Longo DL, Jameson JL, editors. Harrison’s principles of internal medicine. 16th ed. New York: McGraw-Hill, Medical Publ. Division; 2004.
[2] Ebrahim S. Health of elderly people. In: Detels R, McEwan J, Beaglehole R, Tanaka H, editors. Oxford textbook of public health. 4th ed. Oxford: Oxford University Press; 2002.
[3] Govaert TM, Thijs CT, Masurel N, Sprenger MJ, Dinant GJ, Knottnerus JA. The efficacy of influenza vaccination in elderly individuals. A randomized double-blind placebo-controlled trial. The Journal of American Medical Association 1994;272:1661–5.
[4] Jefferson T, Rivetti D, Rivetti A, Rudin M, Di Pietrantonj C, Demicheli V. Efficacy and effectiveness of influenza vaccines in elderly people: a systematic review. Lancet 2005;366:1165–74.
[5] Smith L, Roberts TA, Viboud C, Blackwelder WC, Taylor RJ, Miller MA. Impact of influenza vaccination on seasonal mortality in the US elderly population. Archives of Internal Medicine 2005;165:265–72.
[6] Jackson LA, Jackson ML, Nelson JC, Neužil KM, Weiss NS. Evidence of bias in estimates of influenza vaccine effectiveness in seniors. International Journal of Epidemiology 2006;35:337–44.
[7] Jackson LA, Nelson JC, Benson P, Neužil KM, Reid RJ, Psaty BM, et al. Functional status is a confounder of the association of influenza vaccine and risk of all cause mortality in seniors. International Journal of Epidemiology 2006;35:345–52.
[8] Macroepidemiology of Influenza Vaccination (MIV) Study Group. The macro-epidemiology of influenza vaccination in 56 countries, 1997–2003. Vaccine 2005;23:5133–43.
[9] Mullahy J. It’ll only hurt a second? Microeconomic determinants of demand responses to changes in infectious disease mortality. Health Services Research 2004;39:905–25.
[10] Simonsen L, Reichert TA, Viboud C, Blackwelder WC, Taylor RJ, Miller MA. Impact of influenza vaccination on seasonal mortality in the US elderly population. Archives of Internal Medicine 2005;165:265–72.
[11] Jackson LA, Jackson ML, Nelson JC, Neužil KM, Weiss NS. Evidence of bias in estimates of influenza vaccine effectiveness in seniors. International Journal of Epidemiology 2006;35:337–44.
[12] Murali J. Will only hurt a second? Microeconomic determinants of demand responses to changes in infectious disease mortality. Health Services Research 2004;39:905–25.
[13] Simonsen L, Reichert TA, Viboud C, Blackwelder WC, Taylor RJ, Miller MA. Impact of influenza vaccination on seasonal mortality in the US elderly population. Archives of Internal Medicine 2005;165:265–72.
[14] Jackson LA, Jackson ML, Nelson JC, Neužil KM, Weiss NS. Evidence of bias in estimates of influenza vaccine effectiveness in seniors. International Journal of Epidemiology 2006;35:337–44.
[15] Fedson DS, Hannoun C, Leese J, Sprenger MJ, Hampson AW, Bro-Jorgensen K, et al. Influenza vaccination in 18 developed countries, 1980–1992. Vaccine 1995;13:623–7.
[16] Ives DG, Lave JR, Traven ND, Kuller LH. Impact of Medicare reimbursement on influenza vaccination rates in the elderly. Preventive Medicine 1994;23:134–41.
[17] Acton JP. Nonmonetary factors in the demand for medical services: some empirical evidence. Journal of Political Economy 1975;83:595–614.
[18] Mullany L. Will only hurt a second? Microeconomic determinants of demand responses to changes in infectious disease mortality. Health Services Research 2004;39:905–25.
[19] Statistics Bureau. Statistical Observations of Shi, Ku, Machi, etc. Mura. Tokyo: Ministry of Internal Affairs and Communications; 2006.
[20] Hoshi SL, Kondo M, Okubo I. Study on pricing and uptake rate of influenza vaccination for the elderly with a simple random sampling method. Nippon Kosho Eisei Zasshi 2008;55:19–29.
[21] Acton JP. Nonmonetary factors in the demand for medical services: some empirical evidence. Journal of Political Economy 1975;83:595–614.
[22] Mullahy J. Will only hurt a second? Microeconomic determinants of demand responses to changes in infectious disease mortality. Health Services Research 2004;39:905–25.
[23] Wooldridge JM. Econometric analysis of cross section and panel data. Cambridge: MIT Press; 2002.
[24] Hsiao C. Analysis of panel data. 2nd ed. Cambridge: Cambridge University Press; 2002.
[25] Bhatia BH. Econometric analysis of panel data. 3rd ed. Chichester: John Wiley & Sons; 2005.
[26] Berndt ER. The practice of econometrics: classic and contemporary. Reading: Addison-Wesley; 1990.
[27] Wang B, Yanagawa H, Sakata K. Gastric cancer screening programme in Japan: how to improve its implementation in the community. Journal of Epidemiology and Community Health 1994;48:182–7.
[28] Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press; 2003.
[29] Deaton A. The analysis of household surveys: a microeconometric approach to development policy. Baltimore: The Johns Hopkins University Press; 1997.

[30] Levy PS, Lemeshow S. Sampling of populations: methods and applications. 3rd ed. New York: Wiley-Interscience; 2003.
[31] Hoshi SL, Kondo M, Honda Y, Okubo I. Cost-effectiveness analysis of influenza vaccination for people aged 65 and over in Japan. Vaccine 2007;25:6511–21.