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ORIGINAL ARTICLE

Diffusion of new medication across different income groups under a universal health insurance program: an example involving newly enlisted nonsteroidal anti-inflammatory drugs for elderly osteoarthritis patients

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Abstract
Objectives The aim of this research was to determine whether socioeconomic status, as measured by income level, impacts on the diffusion to patients of newly reimbursed nonsteroidal anti-inflammatory drugs (NSAIDs) under the National Health Insurance program in Taiwan.
Methods We used income tax records to identify the income levels of 324 male and 551 female randomly sampled osteoarthritis patients aged over 60 years in 2000. The study period was 2 years (t_1 = April 2001–March 2002 and t_2 = April 2002–March 2003). Generalized estimating equation models were used to analyze the impact of income level on being prescribed one of the newly reimbursed NSAIDs.
Results The impact of income level on being treated with the new drug was positive and significant for females (OR = 2.11, $p < 0.01$) but not for males. The interaction term between income groups and the time trend was insignificant. Other factors associated with being treated with the new drug include age, habit of health-care utilization, and residential characteristics.
Conclusions Diffusion of new drugs still depends on income level despite the presence of a universal national health insurance system in Taiwan.

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Introduction

This research investigates the impact of income on diffusion of new drugs under a universal national health insurance program. Socioeconomic status (SES) is closely related to health status (Mulatu and Schooler 2002), and much of this relationship is attributed to access to health-care utilization (Dunlop et al. 2000). However, while the relationship between SES and access to health care is well established, little research has focused on the impact of SES on the diffusion of new drugs. This issue is of particular policy importance because if the diffusion of new drugs favors those with higher SES, then health disparities between the various SES groups may actually be widened by the introduction of new drugs, at least initially.

Previous literature has suggested that health insurance can reduce the impact of SES differences (for example, Andrulis 1998). Evidence from the USA and Germany has suggested that lack of insurance coverage is a key contributor to unequal access to medical care (Alter et al. 1999; Poisal and Murray 2001; Xu 2003), while conclusions drawn from studies in other countries with universal health care are inconsistent (Pilote et al. 2003; Britton et al. 2004; Hetemaa et al. 2004). The question that remains is thus whether such inequalities due to different SES, measured by income level, still persists under a universal health insurance system, since such a system hypothetically should reduce the financial barriers to access to medical care.

Taiwan has implemented a universal national health insurance program since 1995, where one of the main goals was to eliminate financial barriers affecting access to health care (Cheng 2003). Although there is evidence that such a program can reduce the gap in health-care utilization between the rich and poor (Lu and Hsiao 2003; Huang et al. 2007), nonetheless, whether the disparity in diffusion of new drugs among the various income groups still exists after the implementation of such a program remains uninvestigated. We used osteoarthritis patients as an example in order to develop a model for assessing the diffusion of a newly covered medication across different income groups in Taiwan.

The Taiwan National Health Insurance (NHI), which was implemented in March 1995, is a program with compulsory enrollment. This program enabled the public in Taiwan to obtain comprehensive medical care in health prevention, ambulatory care, traditional Chinese medicine, dental services, drugs, hospitalization, resident care, and social rehabilitation. The NHI beneficiaries in Taiwan have the freedom to seek their preferred health-care provider at various levels, namely medical centers, regional hospitals, community hospitals, and clinics. An amount of co-payment is required for outpatient services, and a mildly progressive co-insurance is applied to inpatient services. The total amount of outpatient co-payment and inpatient co-insurance contributes around 10% to the NHI expenditure.

One of the major objectives of Taiwan's NHI was to provide equal access to adequate health care. Studies on Taiwan's health-care system based on the Kakwani's index and World Health Organization (WHO)'s fairness of financial contribution index has shown obvious improvement in financial equity after the implementation of the NHI program (Lu and Hsiao 2003).

According to the WHO, osteoarthritis is one of the 10 most disabling diseases in developed countries. From April 2001, Taiwan NHI began reimbursement for the new generation nonsteroidal anti-inflammatory drugs (NSAIDs), which include Rofecoxib, Celecoxib, and Nimesulide. By Taiwan's NHI drug reimbursement rules, osteoarthritis patients must be 60 years or older to gain reimbursement for the above named NSAIDs. Patients who are not prescribed with the new generation NSAIDs may be prescribed with the previously enlisted NSAIDs (Nabumetone, Etodolac, and Meloxicam) or other types of treatments depending on the physician's choice. The new generation NSAIDS has the benefit of retaining efficacy while producing less adverse side effects relating to the gastrointestinal tract and airways (Warner and Mitchell 2004). While there are some noted potential side effects, such as those related to cardiovascular diseases, Huang et al. (2006) used a sample of patients in Taiwan and found that the new generation NSAIDs, such as Rofecoxib, do not cause a higher level of cardiovascular disease than Meloxicam. In addition, they also found that patients using Celecoxib, also a new generation NSAID, actually had a lower risk for developing AMI compared with Meloxicam. Given the advantages of using the new generation NSAIDs, the efficiency of diffusion of these drugs among patients is of particular importance.

Reimbursement for the new NSAIDS and the previously enlisted NSAIDs are as follows (based on the exchange rate 1 US dollar = 33.2 NTD): new generation NSAIDs: *Rofecoxib*—US$1.03/25 mg, *Celecoxib*—US$0.51/100 mg, and *Nimesulide*—US$0.25/100 mg); and previously enlisted NSAIDs: *Nabumetone*—1US$0.38/500 mg, *Etodolac*—US$0.29/200 mg, and *Meloxicam*—US$0.55/7.5 mg. However, since the reimbursement rule under Taiwan's NHI concerning drugs does not vary across the type of medical institution involved (medical center, regional hospital, district hospital or clinic), the possible reasons for physicians not to prescribe the new generation NSAIDs may include the physician's habits or preference; these factors may be influenced by the SES of the patients. For example, patients with a lower SES may be less aware of the new drugs than their higher SES counterparts and hence do not request the physician to prescribe such a drug.

Previous studies that have investigated the relationship between SES and access to certain kind of health care normally lack good measures for the SES variable. This is especially true when using income as the measure. In most cases, income level is proxied using a neighborhood median or mean income derived from a census (for example, Roos and Mustard 1997; Alter et al. 1999). Such proxies may not reflect the true income level of each individual. Even when actual household income level has been obtained from an interview, very few of the studies adjusted such data in terms of household-structure (for example, Wong et al. 2005). It is important to bear in mind that household-structure is closely related to availability of resource utilization by each household member.

Studies conducted in Taiwan that have investigated the relationship between SES and health-care utilization of some kind have mainly used the NHI's enrollment income or enrolled categories as a proxy for socioeconomic status (for example, Wang and Lin 2008; Chen et al. 2007, 2008). The enrollment income levels may not be the study subjects' actual income level since the insured can be enrolled as a dependent family member, with himself not earning any income at all. We therefore argue that such a measure of socioeconomic status is inadequate and misleading. Our dataset allows us to identify the income level of our osteoarthritis patients using their income tax records, which should be much more accurate. This is discussed in detail below.

Methods

A retrospective fixed cohort study was conducted. The NHI sample files, constructed and managed by the National Health Research Institute (NHRI), consist of comprehensive utilization and enrollment information for a nationally representative sample of 100,000 NHI beneficiaries, which represents approximately 0.5% of the country's enrollees in 2000. Details of the design and sampling scheme and applications have been reported elsewhere (Aronson et al. 1994; Tsai et al. 2005). We excluded those individuals with incomplete data for health-care utilization, household registration records, NHI enrollment records and those who had died during the study period. This left us with 81,690 subjects. Out of these subjects, 8,710 were aged 60 years or above in 2000. Osteoarthritis patients were identified using ICD-9-CM (715, osteoarthritis and allied disorders).We then excluded those who did not have any record of seeking outpatient care for osteoarthritis during the study period of April 2001 to March 2003. The final sample thus comprised 875 osteoarthritis patients (551 females and 324 males) who had undertaken at least one outpatient visit for osteoarthritis each year during the 2-year study period.

Eight electronic databases, each with different information, were linked to construct a database for this study. The NHI enrollment files provide information on NHI enrollment status, the premiums paid and the physical disability status; the NHI ambulatory care claim files contain individual records on the use of ambulatory care services and the NHI inpatient files provide records of each admission case. These records include information, such as gender, date of birth, date of service, and reimbursements for all insured physician services, procedures, laboratory tests, diagnostic imaging, and prescription drugs for each ambulatory care visit or hospital admission. Furthermore, the NHI major-disease (catastrophic disease) file identifies individuals in the sample with serious diseases, such as end stage of renal disease, cancer, and major chronic mental illness, while the household registry provides information on the racial status (Aboriginal or Han) and residential location of each individual in the sample. Death certificates were used to track those who died during the study period. In addition, the 2000 Population and Housing Census file, managed by the Directorate-General of Budget, Accounting and Statistics (DGBAS), was linked by residential location code to provide neighborhood (town) information on educational attainment of population aged 6 years and over, and working status of population aged 15 years and over. Finally, the income tax file for 2000, managed by the Ministry of Finance, was linked to provide income information on individual and household incomes, number of household members within the economic family unit, number of household members aged 70 or over and number of household members aged 20 or under.

Unique anonymous individual identification numbers and dates of birth were used to link all eight datasets. The data linkage process was conducted within the Bureau of National Health Insurance and followed the government's confidentiality regulations during the linkage and analysis processes.

A patient was coded 1 if he was treated with the newly enlisted NSAIDs at any time during the study period (t_1 = April 2001–March 2002; t_2 = April 2002–March 2003), and 0 otherwise. Individual gross household income was calculated by summing the gross income of all members within the same economic household unit from the income tax files in 2000. This income was then adjusted for household-structure using the method proposed by Buhmann et al. (1988) (for more details please see Huang et al. 2007) to obtain the adjusted per capita household income. The number of subjects available in this study allows us to group the sample into two income categories. Those subjects with an adjusted per capita household income >NTD 393,221, which is the median income for the sample of 100,000 subjects, were classified into the higher-income group, and the rest were classified into the lower-income group. Among the 875 osteoarthritis patients included in the analysis, 50.6 and 36.7% were classified into the higher-income group for the female and male cohorts, respectively.

A conventional Chi-square test was used to examine the association between the dependent and each independent variable in a bivariate analysis. In the longitudinal multivariate analysis, the generalized estimating equations (GEE) model (Diggle et al. 1994) with *logit* link function for the dependent variable was used to estimate the effects of income on receiving the newly enlisted NSAIDs over the 2 years after the drug was covered by the NHI. To make the models more complete, we also included a set of control variables, including demographic variables (age, gender, and aboriginal status) and health information (physical disability, catastrophic disease and prior utilization).

To control for the availability of medical resources, we included supply-side resource variables in the analysis, namely density of beds, and density of physicians. Direct data on health-care utilizing habits are unavailable and therefore we proxied this using the subjects' choice of level of healthcare provider (most frequent choice of healthcare provider in last year). Finally, a time trend as well as its interaction with the income level was added to measure the impact of SES over time.

Since co-morbidity might also affect whether the patient was prescribed with the new NSAIDs, we added a dummy variable determining whether the patient had co-morbidity

with a chronic disease, which is defined as whether the patient has visited an outpatient clinic four or more times due to another chronic disease (that is, a chronic disease other than osteoarthritis and/or gastrointestinal ulcer). The reason for excluding visits for gastrointestinal ulcer in the co-mobility measure is that treatment for gastrointestinal ulcer is often related to the prescription of the new NSAIDs. As a result of this exclusion, we generated another co-mobility measure defined as the number of outpatient visits for gastrointestinal ulcer to the regression.

Diffusion of drugs may also be affected by the characteristics of a geographical area, for example, information availability, and this can be closely related to participation in care (Berland et al. 2001). To control for such geographical area characteristics, we controlled for neighborhood average educational attainment and neighborhood general occupation. The former was measured by the percentage of residents with higher (university and above) educational attainment, while the latter was assessed as the percentage of agricultural workers in subjects' neighborhood area.

Results

Table 1 shows the sample characteristics in 2000 ($n = 551$ and $n = 324$ for females and males, respectively). The female group consisted of more patients belonging to the higher-income category (50.6 vs. 36.7%), and also included more aboriginal patients (1.8 vs. 1.5%). Female patients tend to be younger with fewer patients aged over 70 (48.2 vs. 60.2%) and the percentage of being disabled was also lower (12 vs. 18.5%). In terms of availability of medical resources (proxied by density of beds and density of physicians), the two gender groups showed similar patterns.

Table 2 shows the bivariate analysis for treatment incidence for the two time periods and the sample characteristics during the periods April 2001–March 2002 and April 2002–March 2003. The treatment incidence for both male and female osteoarthritis patients almost doubled over the 2 years after the drug was reimbursed by the NHI.

Significant differences in the treatment incidence were found across income groups. During the period 2001–2002, higher-income patients were more likely to receive the newly enlisted drugs than lower-income patients (19.6 vs. 14.5%, $p < 0.05$). Other significant differences were also found for gender, age, health characteristics, and healthcare provider seeking habit, with females, older, disabled patients, patients with catastrophic diseases, and those who sought larger hospitals have a significantly higher percentage of being treated with the new drugs.

Odds ratios (OR) and confidence intervals (CI) from the GEE models for whether the patient was treated with the newly enlisted NSAIDs are reported in Table 3. Interestingly, income was the only significant factor for females and was not significant for their male counterparts. For the female group, the odds ratio was 2.11 for the higher-income group (95% CI = [1.29, 3.46]), and this was not present among the males. Compared with patients whose most frequent choice of healthcare provider was a community hospitals or clinic, patients whose most frequent choice of healthcare provider is medical centers or regional hospitals had odds ratio of 1.66 (95% CI = [1.14, 2.43]). Since utilization of drugs may be closely linked to choice of health-care providers, an interaction term for income group and choice of health-care providers was included. However, this interaction term was insignificant and hence was not presented.

In terms of the other covariates, significant differences for whether the patients were treated with the newly enlisted NSAIDs were observed for age, gender, and habits of health-care utilization (total number of outpatient visit). More specifically, in the pooled regression, female osteoarthritis patients were more likely to receive the newly covered NSAIDs, with an OR = 1.51 (95% CI = [1.14, 2.0]). Compared with the youngest age group, older patients had a higher odds of being treated with the new drugs. Similar patterns were also observed when the model was run separately for gender.

The interaction term (not shown) between income groups and the time trend was insignificant for both males and females, showing that there was no significant widening or narrowing of the gap between income groups for either genders over time.

While ICD-9-CM 715 only capture patients with osteoarthritis and allied disorders, we also try to broaden the definition by including patients with arthropathies and related conditions (ICD-9-CM 711.0–719.3 and 721.0–733.9), and the results from GEE analysis remained similar (tables not shown), with income still being an important factor in determining whether the patients were treated with the new drug.

Discussion

This study investigates whether income level still plays a role in the diffusion of the newly reimbursed NSAIDs for elderly osteoarthritis patients under a universal health insurance program. This research has the merit of using a highly reliable measure of income level for the Taiwan population. We found that the impact of income level on being treated with the new drug was positive and significant for females. Thus, females who belonged to the higher-income group had higher odds of being treated with the new drugs.

Table 1 Characteristics of the sampled elderly osteoarthritis patient cohort in 2000

	Total ($n = 875$)	Female ($n = 551$)	Male ($n = 324$)
Socioeconomic factors			
Income group (%)			
Higher income[a]	45.5	50.6	36.7
Lower income	54.5	49.4	63.3
Demographic factors			
Female patients (%)	63.0		
Patient age [years], categories (%)			
60–64	21.1	22.7	18.5
65–69	26.3	29.2	21.3
70–74	26.2	24.7	28.7
75–79	16.9	15.3	19.8
80 and above	9.5	8.2	11.7
Aboriginal patients (%)	1.7	1.8	1.5
Health characteristics			
Disable patients (%)	14.4	12.0	18.5
Patients with catastrophic disease (%)	3.4	3.3	3.7
Habits of health-care utilization			
Utilization in the previous year, Mean ± SE			
Total number of outpatient visits	38.8 ± 1.1	38.8 ± 1.1	42.4 ± 1.7
Total number of inpatient days	2.0 ± 0.3	2.0 ± 0.3	3.0 ± 0.5
Number of outpatient visits for osteoarthritis	4.1 ± 0.3	4.1 ± 0.3	5.1 ± 0.6
Most frequent choice of healthcare provider in last year (%)			
Medical centers or regional hospitals	22.1	18.7	27.8
Community hospitals or clinics	77.9	81.3	72.2
Supply-side factors			
Density of physicians			
High[b] (%)	60.7	59.3	63.0
Low	39.3	40.7	37.0
Density of beds			
High[c] (%)	37.3	38.1	35.8
Low	62.7	61.9	64.2
Residential characteristics			
Percent of population with tertiary education or above			
High[d] (%)	64.6	61.9	69.1
Low	35.4	38.1	30.9
Percent of agricultural workers			
High[e] (%)	25.0	26.9	21.9
Low	75.0	73.1	78.1

[a] Beneficiary with average per capita household income adjusted for household-structure belonging to upper-half population with income tax records (>NTD 393,260)

[b] Medical area where the number of physicians per 1,000 residents >1.05 which was the mean among 17 major medical area

[c] Medical area where the number of beds per 1,000 residents >5.24 which was the mean among 17 major medical area

[d] Township where the percentage of population aged over 6 years with high educational attainments >15.1% which was the mean among 369 townships

[e] Township where the percentage of population aged over 15 years with agricultural work >12.1% which was the mean among 369 townships

According to Dominick et al. (2003) there are significant gender differences in NSAID utilization patterns, and these authors found that these differences were independent of the gastrointestinal adverse effects and self-reported symptoms. While they noted the causes of these gender variations, our study adds to this by incorporating a relative

Table 2 Bivariate analysis of the crude percentage receiving the newly enlisted NSAIDS among elderly osteoarthritis patient, April 2001–March 2003 (Unit %)

	Total ($n = 875$)		Female ($n = 551$)		Male ($n = 324$)	
	2001–2002	2002–2003	2001–2002	2002–2003	2001–2002	2002–2003
Overall	16.8	30.5	17.4	33.2	15.7	25.9
Socioeconomic factors						
Income group	**		***			
Higher income[a]	19.6	32.7	21.9	35.5	14.3	26.1
Lower income	14.5	28.7	12.9	30.9	16.6	25.9
Demographic factors						
Gender		**				
Female	17.4	33.2				
Male	15.7	25.9				
Patient age (years)	*					**
60–64	11.0	24.6	13.2	32.4	6.3	8.3
65–69	14.8	28.9	15.8	31.5	12.3	22.4
70–74	16.9	28.7	18.0	32.3	15.1	22.5
75–79	22.2	36.9	20.9	38.8	23.5	34.6
80 and above	20.6	32.6	22.8	32.1	17.8	33.3
Race						
Aboriginal patients	13.3	13.3	20.0	20.0	0.0	0.0
Non-aboriginal	16.9	30.8	17.4	33.5	16.0	26.3
Health characteristics						
Disable patients	*		**			
Yes	22.2	27.8	27.3	31.8	16.7	23.3
No	15.9	31.0	16.1	33.4	15.5	26.5
Patients with catastrophic disease	**					
Yes	30.0	23.3	22.2	16.7	41.7	33.3
No	16.3	30.8	17.3	33.8	14.7	25.6
Habits of health-care utilization						
Most frequent choice of healthcare provider in last year	*	**			*	***
Medical centers or regional hospitals	20.5	35.9	19.8	36.8	21.4	34.8
Community hospitals or clinics	15.5	28.4	16.7	32.1	13.1	21.1
Supply-side factors						
Density of physicians						
High[b]	17.5	29.9	17.4	31.8	17.7	27.0
Low	15.7	31.4	17.4	35.3	12.5	24.2
Density of beds					**	
High[c]	15.6	29.8	18.6	33.8	10.3	22.4
Low	17.5	31.0	16.7	32.8	18.8	27.9
Residential characteristics						
Percent of population with tertiary education or above						
High[d]	16.5	29.6	17.3	31.7	15.2	26.3
Low	17.4	32.3	17.6	35.7	17.0	25.0
Percent of agricultural workers						**
High[e]	14.6	27.9	14.9	33.1	14.1	16.9
Low	17.5	31.4	18.4	33.3	16.2	28.5

The newly enlisted NSAIDS was added in April 2001

Significance levels: * $0.05 \leqq p < 0.10$, ** $0.01 \leqq p < 0.05$, *** $p < 0.01$

[a] Beneficiary with average per capita household income adjusted for household-structure belonging to upper-half population with income tax records (>NTD 393,260)

[b] Medical area where the number of physicians per 1,000 residents >1.05 which was the mean among 17 major medical area

[c] Medical area where the number of beds per 1,000 residents >5.24 which was the mean among 17 major medical area

[d] Township where the percentage of population aged over 6 years with high educational attainments >15.1% which was the mean among 369 townships

[e] Township where the percentage of population aged over 15 years with agricultural work >12.1% which was the mean among 369 townships

Table 3 Multivariable regressions of receiving the newly enlisted NSAIDs for elderly osteoarthritis patients, April 2001–March 2003

	Total ($n = 875$)			Female ($n = 551$)			Male ($n = 324$)		
	OR[a]	95% CI	p	OR[b]	95% CI	p	OR[b]	95% CI	p
Socioeconomic factors									
Income group									
Higher income[c]	1.51	1.02, 2.24	**	2.11	1.29, 3.46	***	0.79	0.37, 1.71	
Lower income									
Demographic factors									
Gender (male = 0)									
Female	1.51	1.14, 2.00	***						
Male									
Patient age (years) (60–64 = 0)									
60–64									
65–69	1.33	0.86, 2.05		1.21	0.72, 2.01		2.62	1.03, 6.66	**
70–74	1.37	0.89, 2.13		1.26	0.74, 2.14		2.53	1.04, 6.16	**
75–79	1.99	1.27, 3.13	***	1.58	0.90, 2.76		4.64	1.94, 11.10	***
80 and above	1.66	1.01, 2.74	**	1.26	0.67, 2.37		3.97	1.58, 9.95	***
Aboriginal patients (Yes)	0.49	0.11, 2.07		0.69	0.16, 3.03		N/A		
Aboriginal patients (No)									
Health characteristics									
Disable patients (Yes)	1.03	0.70, 1.51		1.23	0.72, 2.08		N/A		
Patients with catastrophic disease (Yes)	1.06	0.52, 2.15		0.61	0.20, 1.88		N/A		
Co-morbidity with chronic disease (Yes)	0.82	0.63, 1.08		0.65	0.46, 0.92	**	1.49	0.93, 2.38	*
Habits of health-care utilization									
Utilization in the previous year									
Total number of outpatient visits	1.01	1.00, 1.01	***	1.01	1.00, 1.02	***	1.01	1.00, 1.01	
Total number of inpatient days	1.00	0.99, 1.01		1.00	0.99, 1.02		N/A		
Number of outpatient visits for osteoarthritis	0.99	0.98, 1.01		0.98	0.96, 1.00	**	1.01	0.99, 1.03	
Number of outpatient visits for GI ulcer	1.02	0.98, 1.06		1.03	0.95, 1.12		1.03	0.99, 1.07	
Most frequent choice of healthcare provider in last year (Community hospitals or clinics = 0)									
Medical centers or regional hospitals	1.66	1.14, 2.43	***	1.68	0.96, 2.95	*	1.67	0.98, 2.84	*
Supply-side factors									
Density of physicians (Low = 0)									
High[d]	0.94	0.70, 1.25		0.82	0.57, 1.16		1.19	0.71, 2.01	
Density of beds (Low = 0)									
High[e]	0.93	0.70, 1.23		1.11	0.78, 1.58		0.60	0.37, 0.99	**
Residential characteristics									
Percent of population with tertiary education or above (Low = 0)									
High[f]	0.66	0.46, 0.93	**	0.72	0.46, 1.13		0.48	0.27, 0.86	**
Percent of agricultural workers (Low = 0)									
High[g]	0.70	0.47, 1.02	*	0.73	0.45, 1.18		0.56	0.30, 1.05	*
Year trend (the 2nd vs. the 1st year after the new NSAIDs added)	2.35	1.76, 3.15	***	3.03	2.06, 4.47	***	1.75	1.11, 2.74	**

[a] Multiplicative (logit) regression. Generalized estimating equations (GEE) using unspecified correlation structure

[b] Odds ratio

[c] Beneficiary with average per capita household income adjusted for household-structure belonging to upper-half population with income tax records (>NTD 393,260)

[d] Medical area where the number of physicians per 1,000 residents >1.05 which was the mean among 17 major medical area

[e] Medical area where the number of beds per 1,000 residents >5.24 which was the mean among 17 major medical area

[f] Township where the percentage of population aged over 6 years with high educational attainments >15.1% which was the mean among 369 townships

[g] Township where the % of population aged over 15 years with agricultural work >12.1% which was the mean among 369 townships

p Significance levels: * $0.05 \leqq p < 0.10$, ** $0.01 \leqq p < 0.05$, *** $p < 0.01$

accurate measure of income level into the analysis, where we found income level is an important factor related to NSAID use despite the presence of a national health insurance program.

Our results are consistent with other research (Crystal et al. 1995; Pilote et al. 2003), where they found universal health insurance coverage or provision of a particular new drug (for example, Zidovudine for human immunodeficiency virus (HIV) disease) at no out-of-pocket cost sponsored by Medicaid did not eliminate inequalities in access to the new medication. This suggests that there may be underlying access differentials that go beyond direct financial barriers that affect access to medical care. Such underlying causal mechanisms are likely to be complex and multi-dimensional and include, for example, genetic heritage, health behavior, and environment (Marmot and Wilkinson 1999). For example, on the demand side of health care, patient's health behavior, information on the disease and related new drugs or technology, and a willingness to pay for a particular healthcare service may be correlated with SES. Our study has the merit of controlling for a relatively adequate set of variables mentioned in the previous literature that may cause disparity in the diffusion of a new medication across income groups. Future research should focus on the underlying mechanisms through which income level impacts on the diffusion of new drugs.

The finding that income level did not have a significant impact on male patients may be explained by individual health behavior. For example, males tend to be less active in seeking health care (Bertakis et al. 2000), and hence this reduces the role played by SES. In addition, controlling pain is one of the major treatments for osteoarthritis. In a study that investigates the relationship between gender and pain specifically for osteoarthritis patients, the authors found that females had significantly higher levels of pain, and exhibited more pain behavior than males (Keefe et al. 2000), whether such pain is actual or perceived. Moreover, in Chinese culture, male patients are traditionally expected to be able to endure more pain than female patients. This may explain the insignificant role played by income among male osteoarthritis patients.

Another plausible explanation for the higher odds of access to new drug for females is one related to access to health information. Previous research has shown that women tend to desire more information concerning their illness (Stewart et al. 2004), and there are significant gender differences favoring women in terms of health knowledge (Beier and Ackerman 2003). Health-related information and knowledge is often related to access to health care (Devillanova 2008; Eastin and Guinsler 2006). For NSAIDs, it has been found that drug information is closely associated with the decision to access the drug (Rosemann et al. 2006). The gender difference observed in this study thus may be reduced by improving access to health information for men. In addition, since income is closely associated with accessibility of information (Brantlinger 1987), it may explain why income is only significant for women since as discussed above, women are more active in health information seeking.

While not specifically investigated, health literacy may explain part of the relationship between SES and access to new medication. Previous research showed that health literacy may mediate the relationship between SES variables and health outcomes (Schillinger et al. 2006).

Although we found that there existed income disparity in access to the new medication, however, the gradients across the income groups did not enlarge or shrink significantly under the Taiwan NHI program. Income inequality during this study period actually increased in Taiwan. The ratio of disposable household incomes between top 20%-quintile of households and bottom 20%-quintile of households in year 1996, 1998, 2000, and 2002, were 5.38, 5.51, 5.55, and 6.16, respectively (Directorate-General of Budget). This shows that the NHI did play a role in reducing the gap between the rich and poor, although it did not eliminate the effect completely.

We also found that age is related to whether the patents received the newly enlisted NSAIDS. There may be some possible explanations. First, the elders may be in more need for pain control (Ferrell 1995). Second, while previous evidence do not show older patients are more active in seeking new treatment, however, there are evidence that physicians characteristics do affect treatment decisions (Weisse et al. 2001), whether older patients prefer physicians with special characteristics remain to be investigated.

The above results should be considered within the limitations of this study. First, the sample size does not allow us to separate the income groups into more categories than the two used. Despite this, the study used a more accurate categorization of income level than previous research. Second, the generalizability of our results to other types of drugs remains to be investigated. Third, the database only allows us to obtain 3 years of data and thus we are unable to determine whether there are longer time trends associated with the impact of income level on the diffusion of a new medication. Finally, the sample size does not allow us to analysis what type of treatment the patients obtained if they did not receive the newly reimbursed NSAIDs, as well as their respective outcomes under the different type of treatments.

Systematic research on access to newly reimbursed medication or technology is essential to ensuring equitable delivery of high-quality health care. Our results add to the

existing knowledge by arguing that a universal health insurance is not adequate when attempting to achieve total equality in receiving new drugs across all income groups. Future research may evaluate the cost-effectiveness of the use of NSAIDs for these targeted groups under a limited budget.

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