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The effect of Taiwan's National Health Insurance on infants' preventive care use and inpatient care use

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Abstract

Objective: To test whether utilization of infant preventive care services has reduced utilization of inpatient care and to determine whether implementation of Taiwan's National Health Insurance (NHI) has brought about any differences in the utilization of infant health care services.
Data sources: Data were taken from the 1989 and 1996 National Maternal and Infant Health Surveys (NMIHSs). In total, 1662 and 3623 effective samples were used in the study from the 2 years.
Study design: We constructed a simultaneous recursive model to obtain efficient estimates by treating preventive care (neonatal care and well-baby care) and inpatient care (hospitalization admissions) as dependent variables.
Principal findings: Utilization of neonatal care had strongly negative significant coefficients for the likelihood of being admitted to the hospital. The impact of the NHI was found to be significant.
Conclusions: The hypothesis that the NHI interferes with the effectiveness of preventive care at reducing inpatient care use was not reinforced. Since support from the NHI depends on a balance of push and pull between access to inpatient care and the benefits of preventive care, it can further improve infant health by promoting the benefits of preventive care while making both types of care more accessible.

Keywords: Preventive care; Inpatient care; Infant; National Health Insurance; Taiwan

1. Introduction

Taiwan has the lowest neonatal and infant mortality rates among the world's developing countries. Over the past 40 years, the neonatal mortality rate has declined from 12.61‰ in 1962 to 3.32‰ in 2001. The infant mortality rate dropped even more dramatically during the same period, from 31.41 to 5.99‰ [1], a rate even below that of the US (7‰) [2]. This remarkable decrease in neonatal and infant mortality has largely been the result of a fast-growing economy, higher edu-

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cational levels, improvements in medical technology, and successful implementation of public health programs [3].

Taiwan's Maternal and Child Health Program was launched over 50 years ago in 1952 to improve the health of mothers, infants, and children. One of the major goals of this infant and child health program was to detect and treat abnormalities as early as possible. This was done through promoting physical examinations of infants and children, which were conducted through public hospitals and clinics, and government-sponsored health stations. Health stations in particular took charge of providing basic health education and general physical examinations, including examinations of oral hygiene, vision, and parasites for children in nursery school and kindergarten. Another major goal was to improve the survival rate of premature infants. A pilot project was first carried out at National Cheng Kung University Hospital in southern Taiwan, where a neonatal intensive care unit center and perinatal care unit with well-equipped ambulances and sufficient emergency care personnel were first established. Similar projects have since been extended nationwide [4].

With better living standards and improved control over infectious diseases, birth trauma and acute infectious diseases have fallen behind accidents, prematurity, malignant neoplasms, and congenital defects as the leading causes of death for children between the ages of 0 and 4 years. To further reduce infant mortality and morbidity rates, health authorities began to pay more attention to preventive and curative care for high-risk infants [3]. With implementation of National Health Insurance (NHI) in 1995, all children under 4 years of age became eligible for six free well-baby care visits available at either public or private medical institutions to help detect and treat disorders early. Infants below the age of 1 year are eligible for four visits which are free, except for a nominal registration fee. Another visit is available for either of the second or the third year while the final one is in the fourth year. Neonatal care is supplied to infants aged below 1 month. Preventive services are almost completely accessible since more than 90% of medical institutions in Taiwan are contracted with the Bureau of NHI (BNHI) to provide them.

Curative care services are also provided, although for reasons related to moral hazard, co-payments are required. Co-payments for outpatient care are set amounts based on estimated medical expenses. The higher the government-designated level of a medical facility, the higher the rate (range, NT$ 50–210; the average exchange rate in 2005 was US$ 1 ≈ NT$ 32). Patients are also required to make co-payments for inpatient care. The rates depend on the type of ward and length of stay (range, 5–30% of total medical expenses). Ceilings are set on co-payments for inpatient care by the NHI so that a patient and his/her family do not incur catastrophic expenses that they are unable to afford. The ceilings are set at 6% of the national average income for acute ward admissions within 30 days over the entire year and 10% for up to 180 days in a chronic ward over the entire year. In 2005, the ceiling on co-payment was NT$ 24,000 per admission and the cumulative amount for the entire calendar year was NT$ 41,000. In addition, if beneficiaries suffer a major illness or injury and require long-term and highly expensive treatment, they are exempted from any co-payment obligation under Article 36 of the *National Health Insurance Act*. Exemption of co-payments is also for childbirth and preventive health services and for people residing in mountainous areas or on offshore islands [5,6]. With all this coverage, one would naturally expect that infants, who before 1995 had financial barriers to medical care and are now free to seek medical care as required, would exhibit increased demands for medical care.

Taiwan had three major social insurance programs before the NHI was implemented: Labor Insurance, Government Employees' Insurance, and Farmers' Insurance. These programs covered employed workers, who accounted for about 58% of the population. The remaining 42%, including approximately 9 million children, elderly people, and non-working adults, had no insurance. From this point, we believe that the NHI would have had an overall impact on infants because they were uninsured before implementation of the NHI.

In the US, children covered by health insurance plans tend to make greater use of preventive care and other health care services [7–16]. In Taiwan, three recent studies focused on the relationship between the NHI and maternal and infant health care use. In one, it was found that with the 10 free prenatal care visits provided by the NHI, regional differences in prenatal care were reduced [17]. In another, it was found that the NHI's free well-baby care program stimulated

demand for immunization [18]. The other study found that, although the NHI had not significantly affected the utilization of neonatal preventive health care services, it had reduced regional inequalities in the level of care [19]. All three studies also found that the utilization of preventive health services was significantly influenced by character variables associated with maternal, neonatal, and geographic factors.

Most studies related to child utilization of preventive care services focused on the relationship of prenatal care with birth weight and infant mortality [16,20–27]. Some investigated the relationship between utilization of neonatal care and improved infant health through trial experimental procedures [28,29]. To the best of our knowledge, none has examined the impact of preventive neonatal and well-baby care on later inpatient care use in Taiwan based on nationwide survey data. Nor has any study addressed differences in such a relationship before and after implementation of the NHI. To address these questions, this study first sought to determine if utilization of preventive infant care has reduced inpatient care use and if the introduction of Taiwan's NHI neonatal and well-baby care programs brought about any significant differences in the use of these two infant healthcare services.

2. Methodology

2.1. Data

The data were taken from national preventative National Maternal and Infant Health Surveys (NMIHS) conducted in Taiwan in 1989 and 1996. The surveys were conducted in 23 administrative districts in Taiwan, including 2 metropolitan areas, Taipei and Kaohsiung, using a two-stage sampling procedure. To recruit samples from the target population, birth event recording forms were first handed out to all medical facilities through local health authorities. Samples included all pregnant women who gave birth between 15th and 17th May 1989 and between 12th and 16th February 1996, with gestational outcomes occurring at $\geq$20 weeks' gestation. In total, 1926 and 3998 birth events were, respectively, enrolled for the 1989 and 1996 surveys. Once the infants had reached 1 year of age, well-trained public health nurses conducted interviews in the homes of the children. There were 1662 and 3626 completed surveys in the 1989 and 1996 surveys, for respective response rates of 86.3 and 90.6%. After deleting invalid data, we were left with 1406 and 3271 effective samples.

These two surveys contain a wide variety of information on maternal and infant characteristics, healthcare utilization, and geographic locations. Since these surveys were conducted before (1989) and after (1995) Taiwan's NHI was implemented, they represent the only available and currently best dataset for analyzing the impact of the NHI on utilization of maternal and infant healthcare services. Estimates of infant medical services use are based both on information recorded in the Children Health Handbook [30,31], and on the mother's recall. The handbook contains records of vaccinations, well-baby care visits, and NHI-supported outpatient care visits. To improve the accuracy of the data, the handbooks were personally reviewed by interviewers. Approximately 70 and 90% of the 1989 and 1996 cohorts presented the related records. Outpatient care use in the pre-NHI period was generally based on maternal recall. Inpatient care uses were self-reported and defined as all hospitalizations except for neonatal intensive care offered after delivery for premature births.

To assess the impact of the NHI, we pooled the survey data from these two cohorts and ended up with 4677 observations. Definitions of the variables used in this study are given in Table 1. Since the objective of this study was to assess the impact of preventive neonatal and well-baby care on later inpatient care use in Taiwan and to explore whether implementation of the NHI caused any differences, the definitions of neonatal care and well-baby care visits and their differences in content before and after the NHI need to be addressed in more detail.

A preventive care program, as mentioned above, was provided by the Department of Health before the NHI. Children received services either at public hospitals and clinics, or at government-sponsored health stations. There is no difference in the contents, but accessibility significantly improved after the NHI because more than 90% of medical institutions were contracted with the BNHI. Neonatal care includes general physical examinations (height, weight, head circumference, skin, and gonads), and a test for icterus neonatorum. In addition,

Table 1
Definition of variables

Variables	Definitions
Dependent variables	
Inpatient care use	Infant received inpatient care use; yes = 1, other = 0
Neonatal care use	Infant received neonatal care; yes = 1, other = 0
Well-baby care use	Infant received well-baby care; yes = 1, other = 0
Independent variables	
NHI	Infant was born after National Health Insurance; yes = 1, other = 0
Geographic location	
North	Infant lives in Keelung City, Taipei County, Ilan County, Taoyuan County, Hsinchu County, Miaoli County, and Taipei City; yes = 1, other = 0
Center	Infant lives in Taichung County, Changhua County, Nantou County, Yunlin County, and Taichung City; yes = 1, other = 0
South	Infant lives in Chiayi County, Tainan County, Kaohsiung County, Pingtung County, Kaohsiung City, Chiayi City, and Tainan City; yes = 1, other = 0
East	Infant lives in Taitung County, Hualien County, and Penghu County; yes = 1, other = 0 (North is the reference category)
Maternal health conditions	
Disease	Mother had one or more diseases during the current pregnancy; yes = 1, other = 0
Stillbirth experience	Mother previously had a stillbirth; yes = 1, other = 0
Cesarean section	Mother had a cesarean section delivery; yes = 1, other = 0
Complication	Mother had pregnancy complications; yes = 1, other = 0
Infantile characteristics	
Gender	Infant's gender; male = 1, other = 0
Weight	Infant's weight (g)
Gestational age	Gestational age in weeks
Parity	Infant is non-first order of birth; yes = 1, other = 0
Infantile health conditions	
Icterus neonatorum	Infant has icterus neonatorum; yes = 1, other = 0
Intensive care	Infant underwent intensive care; yes = 1, other = 0

neonatal screening (i.e., inborn error metabolism) was provided for finding inborn diseases as early as possible and obtaining earlier treatment.

Screening of the newborns for congenital metabolic disorders included five diseases: phenylketonuria (PKU), homocystinuria (HCU), galactosemia (GAL), congenital hypothyroidism (CHT), and glucose-6-phosphate dehydrogenase deficiency (G_6_PD deficiency). Although the program began in 1984, only 6.7% of all newborns were examined. Under the NHI system with over 800 child delivery institutions participating in the program, the number screened reached 99.0% of newborns in 1998 [3]. In general, with implementation of the NHI, most of the contracted medical institutions were willing to provide services to their facility-born infants for effective detection for early care.

Well-baby care includes physical examinations (height, weight, head circumference, nutrition, eye, response to sound, heart murmur, and joints) and consultation (feeding). There are a few differences in the contents among the four visits. For example, in the first visit, lip, hernia, and gonads are examined; however, in the second one, the liver and spleen are also included. Both the third and fourth visits include the mouth and teeth. In addition, the third one also includes developmental evaluation and the fourth one includes an examination of the gonads.

It is also noteworthy that the immunization program is another type of preventive care program financed by the Department of Health both before and after the NHI. Most children receive scheduled immunizations along with neonatal care and well-baby care. Sixteen doses of vaccines are provided free of charge for children

by 18 months of age, including one dose of bacillus Calmette-Gúerin vaccine (BCG), three doses of hepatitis B vaccine (3 Hep B), four doses of diphtheria/tetanus/pertussis (4 DTP), four doses of oral poliomyelitis vaccine (4 polio), one dose of measles vaccine (MV), one dose of measles/mumps/rubella vaccine (MMR), and two doses of Japanese encephalitis vaccine. HBIG, BCG, HBV (3–5 days), and HBV (1 month) were given to all neonates aged 1 month [3].

2.2. Analytic techniques

The empirical models we used in this study addressed our objectives: to estimate whether utilization of infant preventive care services reduces inpatient care use and to determine whether the NHI has had an effect on infant preventive care use and later inpatient care use. We used dummy dependent variables for inpatient care use and preventive care use and included preventive care use in the inpatient care use equation in order to avoid biased and inconsistent estimates. We constructed the following recursive simultaneous model with binary variables to avoid endogeneity problems. The observed binary variable, Y_1, from the first equation appeared in the second equation. The structural model is presented below [32]:

$$Y_1^* = \beta_1{}'X_1 + \varepsilon_1, \quad Y_1 = 1(Y_1^* > 0) \quad \text{and}$$

$$Y_2^* = \gamma Y_1^* + \beta_2{}'X_2 + \varepsilon_2, \quad Y_2 = 1(Y_2^* > 0),$$

$$[\varepsilon_1, \varepsilon_2] \sim \text{BVN}[(0,0)\sigma_1^2, \sigma_2^2, \rho];$$

where Y_1 and Y_2 denote utilization of infant preventive care and inpatient care, X_1 and X_2 are explanatory variables, β and γ are assumed to be vectors of unknown coefficients, the εs are unobserved disturbances which are assumed to be correlated across the equations, σ_j is the standard deviation, and ρ is the correlation of error terms (ε_1, ε_2). Table 1 contains all exogenous variable names and definitions.

We used four models in this empirical study. Models I and II estimate the impact of utilization of preventive care services on inpatient care use by simply including utilization of neonatal care and well-baby care in the second equation (inpatient care use equation). To determine how the NHI may have helped preventive care reduce inpatient care use, we needed to add an interaction variable to the second equation. In models III and IV, the interaction variables, neonatal/NHI and well-baby/NHI, were, respectively, included.

As far as we know, this is the only study that analyses the link between utilization of infant preventive care services and inpatient care use in Taiwan. It estimates the parameters by regressing a recursive simultaneous model rather than performing a single equation model in which utilization of preventive care was treated as an exogenous variable. To examine the validity of a recursive simultaneous equation model in this study, we adopted the likelihood ratio test to provide evidence that the two error terms (ε_1 and ε_2) are not independent. The results suggested that the assumption of independent error terms between utilization of preventive care services and hospitalization was rejected for models I and III, in which utilization of neonatal care was included (Table 2). Therefore, a recursive simultaneous equation model for these two models was appropriate for this study. To be consistent, a recursive model was used in the study even though a single equation may have been suitable for models II and IV. Consistent and asymptotically efficient parameters can be obtained by using the Full Information Maximum Likelihood (FIML) estimation.

2.3. Preventive care equation

The first equation in this model defines preventive care use as a function of all exogenous variables, including the NHI, regional variables, and the interactive variables of regions with NHI, maternal characteristics, and infant characteristics. The purpose of this equation was to explore the decision of whether or not to seek infant preventive care. The endogenous variable can take only two values: 0 if infants are nonusers (i.e., did not seek preventive care) or 1 if infants sought preventive care. By definition, use of preventive care is assumed to be determined by a variety of factors, most of which are discussed in the previous literature [18,19]. Since this study focuses more on analyzing later infant inpatient care use, elaborating these various factors is not worthwhile.

2.4. Inpatient care use equation

2.4.1. Preventive care

High infant mortality and high morbidity rates are serious problems in some developing countries, and

Table 2
Regression results of the recursive models

Independent variables	Dependent variables							
	Model I		Model II		Model III		Model IV	
	Hospital	Neonatal	Hospital	Well-baby	Hospital	Neonatal	Hospital	Well-baby
Constant	−0.464 (0.70)	1.166*** (0.25)	−1.482** (0.58)	0.319* (0.17)	0.038* (0.58)	1.152*** (0.25)	−1.521** (0.59)	0.319* (0.17)
Neonatal care use	−1.360** (0.65)	–	–	–	−1.870*** (0.51)	–	–	–
Well-baby care use	–	–	−0.378 (0.66)	–	–	–	−0.326 (0.68)	–
NHI	0.396*** (0.10)	−0.314*** (0.10)	0.377*** (0.15)	−0.433 (0.07)	0.124 (0.17)	−0.327*** (0.10)	0.405** (0.18)	−0.433*** (0.07)
Interaction effects								
Neonatal/NHI	–	–	–	–	0.291* (0.16)	–	–	–
Well-baby/NHI	–	–	–	–	–	–	−0.034 (0.13)	–
Center/NHI	−0.048 (0.15)	0.690*** (0.15)	−0.051 (0.20)	0.609*** (0.10)	−0.010 (0.15)	0.687*** (0.15)	−0.063 (0.21)	0.609*** (0.10)
South/NHI	0.034 (0.15)	0.266* (0.14)	0.086 (0.18)	0.497*** (0.10)	0.069 (0.15)	0.272* (0.14)	0.075 (0.19)	0.496*** (0.10)
East/NHI	−0.226 (0.22)	0.272 (0.24)	−0.119 (0.32)	0.953*** (0.17)	−0.204 (0.22)	0.269** (0.24)	−0.140 (0.34)	0.952*** (0.17)
Geographic location								
Center	−0.028 (0.13)	−0.499*** (0.12)	−0.032 (0.16)	−0.472*** (0.08)	−0.064 (0.13)	−0.498*** (0.12)	−0.022 (0.17)	−0.471*** (0.08)
South	−0.111 (0.14)	−0.494*** (0.12)	−0.126 (0.18)	−0.558*** (0.09)	−0.151 (0.14)	−0.490*** (0.12)	−0.115 (0.19)	−0.558*** (0.09)
East	0.218 (0.20)	−0.275 (0.20)	0.108 (0.32)	−1.001*** (0.15)	0.195 (0.19)	−0.266 (0.21)	0.130 (0.33)	−1.000*** (0.15)
Maternal characteristics								
Age	−0.004 (0.01)	0.023*** (0.01)	−0.006 (0.01)	0.004 (0.01)	−0.004 (0.01)	0.023*** (0.01)	−0.006 (0.01)	0.004 (0.01)
Married	0.150 (0.16)	−0.092 (0.16)	0.198 (0.16)	0.153 (0.11)	0.138 (0.16)	−0.082 (0.16)	0.196 (0.16)	0.153 (0.11)
Maternal educational level	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)
Paternal educational level	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)	0.001 (0.01)
Employment status		0.072 (0.06)		0.179*** (0.04)		0.067 (0.06)		0.180*** (0.04)
Maternal health conditions								
Disease	0.143** (0.06)	0.167** (0.07)	0.119* (0.06)	0.023 (0.05)	0.146* (0.06)	0.159 (0.07)	0.119* (0.06)	0.023 (0.05)
Stillbirth experience	−0.059 (0.19)	−0.211 (0.20)	−0.048 (0.20)	−0.228 (0.15)	−0.073 (0.19)	−0.197 (0.20)	−0.046 (0.21)	−0.228 (0.15)
Cesarean section	0.009 (0.06)	0.014 (0.07)	0.015 (0.06)	0.036 (0.05)	0.013 (0.06)	0.012 (0.07)	0.015 (0.06)	0.036 (0.05)
Complications	0.143** (0.07)	0.079 (0.08)	0.125* (0.08)	−0.087 (0.05)	0.141** (0.07)	0.085 (0.08)	0.126 (0.08)	−0.087 (0.05)
Infant characteristics								
Gender	0.127*** (0.05)	−0.091* (0.05)	0.145*** (0.05)	0.033 (0.04)	0.124*** (0.05)	−0.090* (0.05)	0.145*** (0.05)	0.033 (0.04)
Weight	−0.058 (0.05)	−0.039 (0.05)	−0.057 (0.05)	−0.030 (0.04)	−0.056 (0.05)	−0.038 (0.05)	−0.057 (0.05)	−0.030 (0.04)
Gestational age	−0.030 (0.06)	−0.119** (0.06)	−0.027 (0.06)	−0.129*** (0.04)	−0.034 (0.06)	−0.116** (0.06)	−0.025 (0.06)	−0.129*** (0.04)
Parity	0.052 (0.05)	−0.121** (0.06)	0.040 (0.08)	−0.187*** (0.04)	0.051 (0.05)	−0.124** (0.06)	0.042 (0.08)	−0.187*** (0.04)
Infant health conditions								
Icterus neonatorum	0.001 (0.05)	0.101* (0.05)	−0.010 (0.05)	0.004 (0.04)	0.005 (0.05)	0.103* (0.05)	−0.010 (0.05)	0.004 (0.04)
Intensive care	0.869*** (0.08)	0.253** (0.12)	0.846*** (0.10)	0.063 (0.08)	0.866*** (0.08)	0.255* (0.12)	0.849*** (0.09)	0.063 (0.08)
Disturbance correlation, ρ (P, C)		0.591** (0.26)		0.301 (0.40)		0.706*** (0.19)		0.286 (0.40)
Number of observations		4677						

Coefficient estimates (standard error in parentheses).
* Significant at the 0.1 level.
** Significant at the 0.05 level.
*** Significant at the 0.01 level.

preventive care for infants, including neonatal care and well-baby care, is thought to be a major way of reducing those rates. Therefore, it is worthwhile studying how demand for preventive care services might affect future inpatient care use. Would the utilization of more preventive care services for infants reduce infant morbidity and result in less need for curative care services (i.e., medical treatment) in Taiwan? It would be reasonable to expect that increased utilization of preventive care services would have a significant negative impact on infant inpatient care use. The answer to this should help health policy-makers in Taiwan and other countries meet the healthcare needs of their citizens.

2.4.2. NHI

Taiwan's NHI provides comprehensive curative health care for all children regardless of their financial position. It covers outpatient care, inpatient care, dental care, and prescription drugs. Although co-payments were adopted for healthcare use, the BNHI has also imposed ceilings on co-payments to prevent the public from incurring catastrophic expenses. In addition, if beneficiaries suffer a major illness or injury and require long-term and highly expensive treatment, they are exempted from any co-payment obligation. Since most infants were uninsured before the NHI, this generous program seems to have dramatically decreased the financial burdens for medical expenditures and may have induced a demand for inpatient care use. Therefore, we hypothesized that after the NHI was implemented, infants in Taiwan are more likely to have a greater demand for inpatient care use.

2.4.3. Preventive care/NHI

As indicated above, neonatal care use and well-baby care tend to mitigate infant mortality and morbidity. We hypothesized that utilization of preventive care services has a negative impact on inpatient care use. In order to determine whether any change occurred in the effect that utilization of preventive care might have had on inpatient care use after the NHI, we included a preventive care/NHI interaction variable in the model and attempted to explore how NHI's free preventive care helps improve the health of infants and reduce inpatient care use. Although implementation of the NHI may have stimulated utilization of hospital care by children, we believe that the negative effect of neonatal care on inpatient care use might dominate the positive effect of the NHI due to the free preventive care it provides. Therefore, we hypothesized that the coefficient of the preventive care–NHI interaction variable would have a negative sign.

2.4.4. Geographic location

In a few past studies, regional differences in health care use were found in Taiwan [19,33]. Since the northern area is the most developed and populated region in Taiwan and has more medical care resources, infants living the northern area tend to receive more preventive care than those in non-northern areas. Thus, the northern area was chosen as our regional reference category. We assumed that the three regional variables have a negative effect on the likelihood of seeking infant preventive care. In addition, to further explore whether the NHI helps to reduce regional disparities of such care use, we included three region/NHI interaction variables: center/NHI, south/NHI, and east/NHI. Since one of the major targets of the NHI is to improve the accessibility of medical care service for people in remotes areas, implementation of the NHI tended to lessen regional differences in care use among difference areas. Thus, we expected that these three variables would have a positive coefficient, so people in non-northern areas should be found to have greater increases in use of preventive infant care than those in northern areas.

2.4.5. Maternal characteristics

Maternal characteristics included five maternal demographic factors (age, marital status, employment status, and maternal and paternal education levels) and four maternal health status-related variables (disease, complications, C-section and still-birth). Maternal characteristics may also be important factors in determining use of infant health care. For example, mothers who are older, married, and highly educated may have more experience and knowledge in taking good care of infants and may be less likely to have a demand for inpatient care use. Employment status was included in the preventive care equation but excluded from the inpatient care use equation, because working mothers tend to have more opportunities to learn about childhood preventive care programs and are more likely to take their children for regular health check-ups. However, this advantage being employed might not obviously and directly reduce the probability of

infant inpatient care use. Therefore, we excluded this variable from the inpatient care use equation in order to satisfy the order condition for identification of the estimation model. To justify the exclusion of employment status from the equation of hospitalization, a *t*-test was performed to explore the relationship between hospitalization and employment status on the basis of a bivariate analysis. Since this variable had a value of $p > 0.15$, it was not considered to be statistically significant and therefore was omitted from the multivariate regression model analysis.

2.4.6. Infant characteristics

Infant characteristics included four demographic factors (gestational age, gender, weight, and maternal parity) and two health status-related variables (icterus neonatorum and intensive care). Infants with shorter gestational ages and lower body weights may be weaker, leading to higher odds of inpatient care use. The firstborn might be more likely to be admitted to a hospital because the parents lack child-rearing experience. The impact of the gender of the child, however, is unclear and needs further examination. In general, infants born with a poor maternal or infantile health status are weaker and have a greater demand for inpatient care use. We expected health status-related variables to have a positive impact on infant inpatient care use.

3. Results

3.1. A profile of healthcare use by 1-year-old infants: pre-NHI versus post-NHI

The NHI with its free neonatal care and four free well-baby visits might have improved infant health and indirectly reduced the odds of inpatient care use, but it may also have encouraged greater utilization of medical services. Based on the statistics of this study, the percentages of infants receiving neonatal care and well-baby care were approximately 90.38 and 54.37% in Taiwan, with no apparent difference found between the pre- and post-NHI periods. The percentage of neonatal care and well-baby care use slightly increased by less than 1%, from 89.76 and 53.98% in the pre-NHI period to 90.64 and 54.54% in the post-NHI period. In contrast, a dramatic 6.04% increase occurred with inpatient care use, from 6.40% in the pre-NHI period

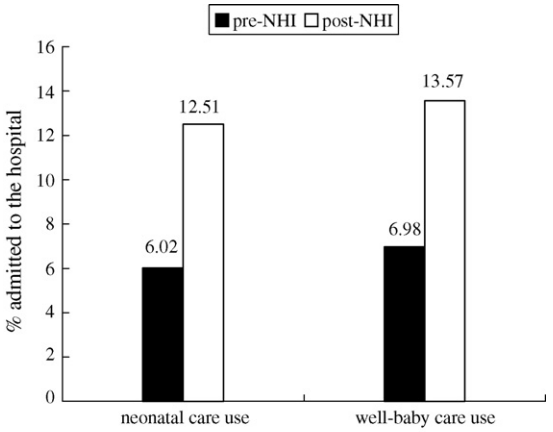

Fig. 1. Percentage of inpatient care use for infants who received preventive care.

to 12.44% in the post-NHI period. According to Chen et al. [34], the main reasons for not receiving well-baby care were that mothers did not know whether the NHI provided free well-baby care (35.2%) or where to obtain the service (23.9%). A mother's perception of their babies' health is another important reason determining whether or not preventive services are used. Mothers who feel that their infants have a good health condition are less likely to seek such services (21.5%), and almost all responded that they would take their babies to a doctor once they got sick [34].

To discuss the impact of infant preventive care on the utilization of curative care services with the NHI factor, we needed to evaluate interactions of the NHI and preventive care on the utilization of curative care. For those who had used neonatal preventive care and well-baby preventive care services, the percentage of infants who had been admitted to hospitals considerably increased (Fig. 1). The percentages increased by 6.49 and 6.59% (a 107.81 and 94.41% overall increase), from 6.02 to 12.51% and 6.98 to 13.57%, respectively. These increases suggest that the NHI dramatically and unexpectedly increased inpatient care use even in those who had received preventive care. Similarly, for those who did not receive neonatal care or well-baby care, the percentage of those seeking hospital admittance increased by 2.04 and 5.38%, representing 20.98 and 94.06% overall increases, respectively (Fig. 2). There seemed to be a larger magnitude of increase in post-NHI inpatient care use for those who sought preventive

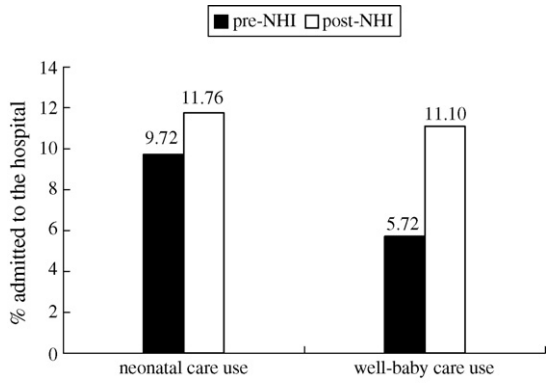

Fig. 2. Percentage of inpatient care use for infants who did not receive preventive care.

care than those who did not (94–108% versus 21–94%). Infants in the pre-NHI period who had received neonatal care tended to seek less inpatient care use than those who had not (6.02 versus 9.72%), but those in the post-NHI period had more inpatient care use than their counterparts (12.51 versus 11.76%). Infants who had received well-baby care also had similar results.

3.2. Regression results of the recursive models

Table 2 shows the estimated effect of the utilization of preventive care for infants and socio-demographic characteristics on the likelihood of receiving inpatient care. Few factors were found to be significantly related to inpatient care use, with the most crucial factors being neonatal care, the NHI, and the need for intensive care. The study found that utilization of neonatal care had strongly negative significant ($p < 0.001$) coefficients on the likelihood of being admitted to a hospital in models I and III. Well-baby care was also found to have negative coefficients in both models II and IV, but failed to reach the lowest significant level ($p < 0.1$). These findings suggest that utilization of neonatal care exerted greater power than utilization of well-baby care in reducing inpatient care use.

The impact of the NHI on the probability of inpatient care use was found to be significant and positive in models I and II, which reinforces our hypothesis that the NHI created a demand for curative care. However, the negative impact of the NHI on the utilization of preventive care was also found to be strongly significant ($p < 0.001$) among the models with regard to utilization of both neonatal care services and well-baby care services. This negative impact surprisingly went against our hypothesis that introduction of the NHI would increase the utilization of preventive care and suggests that the NHI did not improve utilization of preventive care for infants.

Disease, birth complications, and the need for intensive care were other significant factors related to maternal health and infant health. As expected, these three variables had positive coefficients, indicating that infants were more likely to be admitted to the hospital when the mother or infant was in poor health. The gender of the infant was another variable found to be significant. A positive coefficient indicated that infant boys were more likely to be admitted to the hospital than were infant girls.

The interaction variable of neonatal care use and the NHI was shown to have a significant positive coefficient in model III, suggesting that infants who received neonatal care tended to have a higher probability of being admitted to the hospital than those who did not after the NHI. This striking result might have resulted from the greater positive effects that the NHI had on inpatient care use in those infants who received neonatal care, which dominated the negative impacts of neonatal care use on the utilization of hospital care.

There were no regional inequalities in the utilization of hospital services, although there were inequalities in utilization of preventive care services. The regional variables were not found to be associated with utilization of hospitalization service in any of the four models. However, with regard to utilization of preventive care services, three coefficients of regional dummy variables were found to be strongly significant ($p < 0.001$) and negative, indicating that the infants who lived in northern areas were more likely to receive preventive care than those in non-northern areas. Furthermore, three interaction variables of regions and NHI were also found to have significant and positive coefficients for the utilization of preventive care services, indicating that the NHI had a larger impact on infants who lived in non-northern areas than it did for those who lived in the northern area. This impact suggests that the NHI helped lessen regional variations in the utilization of preventive care services, which is consistent with the findings of previous studies [17,18].

4. Discussion

In this study we analyzed the relationship between the utilization of preventive care services and inpatient care for infants by examining the impact of the utilization of neonatal care and the utilization of well-baby care on the likelihood of being admitted to a hospital later. As expected, we found negative relationships between the utilization of neonatal care use and the likelihood that one would be hospitalized, but we did not find a link between the utilization of well-baby care and hospitalization, demonstrating that utilization of neonatal care services helps reduce later utilization of hospital services. Utilization of well-baby care did not seem to have any obvious effect. Health authorities should pay more attention to preventive care for infants, particularly on neonatal care, for two reasons. First, infant mortality and morbidity can be improved through the early detection of high-risk conditions and potential disorders and through more-timely medical treatments. Second, an increase in utilization of preventative care services may mitigate the dramatic increase in medical expenditures existing in the current healthcare system in Taiwan by reducing the need for curative care (i.e., later inpatient care use).

The possible reason for a decrease in the utilization of preventive care could be that most parents had little awareness that such preventive services were provided by the NHI, but they did have more information on curative care including outpatient and inpatient care. Substitution of preventive care by curative care would be another possible reason.

Around 90% of neonates receive neonatal care regardless of the implementation of the NHI. Not much difference was found in the percent receiving care, possibly due to 96% of Taiwanese neonates being born in medical facilities and automatically receiving such care provided by the institution. As to well-baby care, only public health stations provided free care in the pre-NHI period, and around 61.0% of the study sample received such care. However, after the NHI, the percent receiving such care (58.9%) was also not high, possibly due to the registration fee required, which ranged US$ 1.5–3.0. Most importantly, curative care of children was covered after implementation of the NHI. Whenever children get sick, parents can take them to most medical institutions for treatment without many co-payments. Therefore, parents may be more likely to neglect the importance of child preventive care after the NHI.

Utilization of inpatient care use seemed to replace utilization of preventive care when the NHI was implemented; the main reason for this replacement being that free preventive care was provided in both the pre- and post-NHI periods, but inpatient care use is only provided under the NHI program. In the pre-NHI period, most babies only received preventive care free of charge at public health stations, but after the NHI, they can obtain care from both public and private contracted facilities as long as they pay a small registration fee. Although the NHI provides more choices of facilities for parents seeking preventive care, it does not provide relatively lower prices for preventive care services. Thus, the NHI failed to spark a demand for more preventive services for infants in monetary terms. Conversely, the NHI provided curative care with minimal co-payment requirements and ceilings to hold down total costs. Since the out-of-pocket expense was almost certainly the driver that affected the demand for health care and implementation of the NHI provided a reduction in out-of-pocket medical expenses, this tended to increase the likelihood of inpatient care use. Infants born in the post-NHI period were found to be more likely to have later inpatient care use than those born before the NHI.

Whether the NHI's provision of free preventive care reduced the demand for inpatient care use raises much concern in Taiwan, as it does in other countries. This study provides evidence and guidance that can help policy-makers design more-effective health policies. The interaction variables, neonatal care/NHI and well-baby/NHI were both found to be positive, with only the former reaching a significant level, suggesting that the NHI has a larger (more-positive) impact on those infants who receive neonatal care than those who do not. This result, which is somewhat surprising, failed to support our hypothesis that the negative impact of preventive care on curative care may dominate the positive impact of the NHI. This is not to imply that the NHI interferes with the effectiveness of preventive care in reducing inpatient care use. Instead, one likely explanation for this may involve balancing the push and pull between access to inpatient care use and the benefits of preventive care.

Although this paper found the NHI to be associated with a statistically significant increase in the

demand for inpatient care use, it also found a significant decrease in the utilization of neonatal care and well-baby care. This suggests that the NHI induces the utilization of inpatient care for infants, but does not encourage the utilization of preventive care services. It might be said that the NHI program seems to place too much emphasis on medical treatment for infants, and not enough attention on such preventive care services as neonatal care and well-baby care. Preventive care use has been proven to effectively reduce inpatient care use in Taiwan's health care system. If parents fully understand the importance of preventive care for their babies in reducing serious illness, they would prefer to receive preventive care to protect their babies from getting sick instead of seeking curative care after an illness has occurred. The BNHI needs to invest more effort in increasing parental awareness of the importance of preventive care and disseminating information on the benefit of the NHI's infant preventive care package. By doing so they can help lead the way to greater improvements in the health of infants in Taiwan.

On the other hand, the BNHI can also increase the utilization rate of preventive care from the supply side through increases in physician payments. The low payment for preventive care discourages the provision of such care and has consistently been criticized by pediatric and family physicians who are the only medical personnel allowed to provide infant's preventive care. The average physician fees for well-baby care, outpatient care visits, and inpatient care use are NT$ 222 (US$ 6.53), NT$ 405 (US$ 11.91), and NT$ 17,000 (US$ 498.03), respectively [35]. It is obvious that the payment for infant preventive care is much lower than that for curative care, and accounts for approximately one-half of outpatient visits. Thus, pediatric and family physicians have few financial incentives to offer well-baby care. Instead, they prefer to provide more curative care if they can make a choice. To further increase the utilization rate of well-baby care from the supply side, the BNHI needs to adjust physician payments to a reasonable level to guarantee providers' revenues.

Although both surveys covered utilization of infant healthcare services, there were some differences in the two surveys. In the 1989 cohort, one outpatient question which asked whether the infant had visited a doctor because of illness during the past month was changed to whether the infant had visited a doctor because of illness since the time of birth. This inconsistency made it impossible for us to analyze changes in this important kind of curative care. In both surveys, preventive care and inpatient care use were surveyed from the time of birth, therefore, inpatient care use was merely used as a measure of the use of infant curative care and a measure for determining how use of preventive care affects use of curative care. While it is important to be aware of these data quality issues, because most had health handbooks that could be used to re-check the answers, the data are fairly reliable.

The 6-year time gap between the two surveys was another problem. There may have been some unobserved changes (e.g., in economic growth) over that period that we were not able to capture and control for in the model. This limitation may have weakened the power of the estimates. Nevertheless, the two cohorts of data are considered to be excellent representations of the national population and are currently the only data available in Taiwan for analyzing differences in the utilization of maternal and infant healthcare services before and after implementation of the NHI.

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