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Original Research

The effect of patient satisfaction with pharmacist consultation on medication adherence: an instrumental variable approach

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ABSTRACT*

There are limited studies on quantifying the impact of patient satisfaction with pharmacist consultation on patient medication adherence.

Objectives: The objective of this study is to evaluate the effect of patient satisfaction with pharmacist consultation services on medication adherence in a large managed care organization.

Methods: We analyzed data from a patient satisfaction survey of 6,916 patients who had used pharmacist consultation services in Kaiser Permanente Southern California from 1993 to 1996. We compared treating patient satisfaction as exogenous, in a single-equation probit model, with a bivariate probit model where patient satisfaction was treated as endogenous. Different sets of instrumental variables were employed, including measures of patients' emotional well-being and patients' propensity to fill their prescriptions at a non-Kaiser Permanente (KP) pharmacy. The Smith-Blundell test was used to test whether patient satisfaction was endogenous. Over-identification tests were used to test the validity of the instrumental variables. The Staiger-Stock weak instrument test was used to evaluate the explanatory power of the instrumental variables.

Results: All tests indicated that the instrumental variables method was valid and the instrumental variables used have significant explanatory power. The single equation probit model indicated that the effect of patient satisfaction with pharmacist consultation was significant ($p<0.010$). However, the bivariate probit models revealed that the marginal effect of pharmacist consultation on medication adherence was significantly greater than the single equation probit. The effect increased from 7% to 30% ($p<0.010$) after controlling for endogeneity bias.

Conclusion: After appropriate adjustment for endogeneity bias, patients satisfied with their pharmacy services are substantially more likely to adhere to their medication. The results have important policy implications given the increasing focus on the roles of pharmacists and regulatory changes in professional scope of practice.

Keywords: Patient Satisfaction. Patient Compliance. Pharmacists. United States.

EFECTO DE LA SATISFACCIÓN DEL PACIENTE CON LA CONSULTA DEL FARMACÉUTICO SOBRE LA ADHERENCIA A LA MEDICACIÓN: ABORDAJE DE VARIABLE INSTRUMENTAL

RESUMEN

Hay pocos estudios que cuantifiquen el impacto de la satisfacción del paciente con la consulta farmacéutica sobre la adherencia a la medicación.

Objetivos: El objetivo de este estudio es evaluar el efecto de la satisfacción del paciente con los servicios de consulta farmacéutica sobre la adherencia a la medicación en una gran organización de gestión de cuidados.

Métodos: Analizamos datos de un cuestionario de satisfacción de 6.916 pacientes que habían usado consultas farmacéuticas de la Kaiser Permanente Southern California desde 1993 a 1996. Comparamos, tratando la satisfacción del paciente como exógena, en un modelo probit de una ecuación, con un modelo proibit bivariado donde la satisfacción se trató como endógena. Se utilizaron diferentes conjuntos de variables, incluyendo medidas del bienestar emocional de los pacientes y propensión de los pacientes a adquirir sus medicamentos en una farmacia no Kaiser Permanente (KP). Se usó el test Smith-Blundell para probar si la satisfacción del paciente era endógena. Se usaron test de sobre-identificación para probar la validez de las variables instrumentales. El instrumento débil de Staiger-Stock fue utilizado para evaluar el poder explicativo de las variables instrumentales.

Resultados: Todos los métodos indicaron que el método de variables instrumentales utilizado tuvo poder explicativo. El modelo probit de una ecuación indicó que el efecto de la satisfacción del paciente con la consulta farmacéutica fue significativo ($p<0,010$). Sin embargo, el modelo probit bivariado revela que el efecto marginal de la consulta farmacéutica en la adherencia a la medicación fue significativamente mayor que en probit de una ecuación. El efecto se incrementó del 7% al 30% ($p<0,010$) después de controlar el sesgo de endogenicidad.

Conclusión: Después del adecuado ajuste del sesgo de endogenicidad, los pacientes satisfechos con los servicios de sus farmacias tiene sustancialmente más probabilidad de cumplir su medicación. Los resultados tienen importantes implicaciones políticas dado el creciente enfoque en los papeles del farmacéutico y los cambios reglamentarios en el ámbito del ejercicio profesional.

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Palabras clave: Satisfacción del paciente. Cumplimiento del paciente. Farmacéuticos. Estados Unidos.

INTRODUCTION

In recent years, there has been an increasing focus on the evolution of the role of the pharmacists from traditional drug dispensing to a more active and participative role in risk assessment, risk management, and other medication related consultation activities.[1-6] State and federal health care programs have required ambulatory care pharmacies to provide pharmacist consultation to Medicaid patients with new or changed prescriptions.[1] A large number of State Pharmacy Boards have added similar pharmacy consultation requirements for other patient groups. After passage of the 2003 Medicare Modernization Act, pharmacists can be compensated for providing therapy management to Medicare beneficiaries who are at risk for potential medication problems such as diabetes, asthma, hypertension, and congestive heart failure or multiple prescriptions that need appropriately used to optimize therapeutic outcomes and to reduce the risk of adverse events, including adverse drug interactions.[2] Previous studies have found generally favorable evidence for pharmacist consultation services on various outcomes such as patient medication adherence[7], reduction in hospital admission, mortality, overall health care costs[8,9], as well as clinical benefits particular in chronic conditions.[10-14]

The aforementioned studies treat whether or not patients are given pharmacist consultation as the control variable. Providing services, however, is just one aspect. Patient satisfaction with pharmacist consultation is another important aspect of medication management. Patient satisfaction has emerged as one of the most important factors in medical care because of its relationship with healthcare outcomes. Hospitals, physicians and insurance companies have a long tradition of tracking and analyzing patient satisfaction. According to the review by Aharony & Strasser (1993), satisfied patients are more likely to 1) continue using health care services 2) maintain a relationship with a specific health care provider 3) comply with medical regimens (including medications) 4) participate in their own treatment and 5) cooperate with their health care providers.[15]

Measuring and analyzing patient satisfaction with pharmacist consultation is a relatively new development. Some researchers hypothesize that increased patient satisfaction with pharmacist consultation would bring financial and clinical benefits for both pharmacists and patients.[16-19] However, there has not yet been empirical evidence to support this hypothesis. The focus of this study is to assess how patient satisfaction with pharmacist consultation affects medication adherence. Several methodological difficulties have discouraged research associating patient satisfaction with patient medication adherence. One problem is the omitted variable bias. Besides patient satisfaction with pharmacist consultation, patients' medication adherence depends on complex interactions of medical, medication, personal, and economic factors.[20] Some factors such as personal information including memory, overall intellectual ability, organization skills, and health literacy cannot be easily measured and consequently are often omitted in surveys. These factors affect medication adherence as well as patient satisfaction with pharmacist consultation. Without accounting for these omitted factors, the estimated outcomes effect of patient satisfaction with pharmacist consultation will be biased. Due to the complex correlations of these omitted variables with patient satisfaction and medication adherence, we cannot conclude the direction of the potential bias.

The second problem is the possible reverse causality between patient satisfaction and medication adherence. Satisfied patients are more likely to have better healthcare outcomes. But patients who have improved healthcare outcomes are more likely to evaluate their healthcare providers, (e.g., physicians and pharmacists) more favorably. This reversed causality could be more prevalent in surveys when patients are asked to rate their healthcare providers retrospectively. Because of the reversed causality problem, patient satisfaction with pharmacist consultation is an endogenous variable, i.e. the causality is not one way from satisfaction to adherence but rather the two mutually affecting each other, and similar to omitted variable bias, it can lead to biased estimates of the effect of patient satisfaction on medication adherence.

In absence of clinical trials to control for all variables in the models, the instrumental variables method can be used to correct for the potential biases induced by endogeneity that confound observational studies.[21-26] This technique was popularized in health care services in early 90's by McClellan and Newhouse.[21-22] When good instrumental variables can be identified, the instrumental variable method is a useful and robust method to evaluate the effectiveness of an intervention that is potentially confounded by unobservable factors.

We hypothesize that a conventional single-equation model, which ignores endogeneity bias, underestimates the magnitude of effectiveness of patient satisfaction with pharmacist consultation on medication adherence. The unbiased estimate of the effect of patient satisfaction with pharmacist consultation on patient medication adherence will only be manifested through proper adjustment for this potential endogeneity bias.

METHODS

Data

A retrospective analysis using data from the Kaiser Permanente (KP) pharmacist consultation intervention survey from 1993 to 1996 was

conducted. Details of study design and implementation have been described elsewhere.[3,27] Patient self-reported data on medication adherence collected at the completion year was used, adjusted for the baseline demographic characteristics and health status. The study sample includes patients who underwent the pharmacist consultation intervention (California-mandated patient consultation to patients with new or changed prescriptions, instructions for use, relevant warnings and precautions, storage requirements, and the importance of compliance) and had completed survey responses on their medication behaviors. 6,916 patients (92% of the total sample) met the inclusion criteria. The large sample size in this study fulfilled the database requirement for instrumental variable estimation.[21]

Variables

The primary outcome measure was the patient self-reported medication adherence. This was constructed from a set of four binary (1=yes/2=no) questions regarding patients' medication use: 1) whether or not patient had problems remembering to use medication 2) did the patient stop medication when they felt better 3) did the patient forget medication when away from home 4) did the patient stop medication when they felt worse. If a patient answered yes to all four questions, i.e. worst medication adherence, the minimum score was 4. On the other hand, the score was 8, for the best medication adherence. We constructed a dichotomous single dependent variable based on the univariate analysis on the summated score. About 4,335 (62.7%) patients were above the summated median score of 7 and coded as adherent patients. Although there are pros and cons associated with patient self-reported surveys[8,28], recent research has shown that these measures have a strong to moderate correlation with objective measures such as pharmacy records, insurance claims and electronic monitoring.[29-31]

The endogenous regressor, patient satisfaction, was also constructed dichotomously from the survey question concerning patient general satisfaction with pharmacist consultation services, which used a rating scale with four response categories that ranged from very satisfied (=1) to very dissatisfied (=4). About 4,469 (64.6%) patients reported to be very satisfied with pharmacist consultation services and were assigned a binary code of 1 and, 0 was assigned to patients responded otherwise.

A total of 3 instrumental variables were identified from the data. Two were indicative of patients' emotional well-being and personality by questioning patient whether or not s/he was a happy or a calm person. Rating scale categories that ranged from all of the time (=1) to none of the time (=6) were used on these questions. It has been suggested that patients' personality or emotional status directly affect their report of satisfaction.[32,33] Another instrumental variable was indicative of patients' propensity to fill their prescriptions at a non-KP pharmacy, which was selected to indicate the amount of workload at a KP pharmacy. The data revealed that 90.6% of the prescriptions were filled at KP pharmacies. We acknowledge that a patient may choose a non-KP pharmacy for reasons that are not specifically related to patient satisfaction, such as distance, but the propensity to use non-KP pharmacies is inversely related with patient satisfaction with KP pharmacy services. Whether this variable is a valid instrument is an empirical and testable issue. The 3 instrumental variables were included separately as well as in different combinations. Additional covariates used in the model included patients' age, gender, race, marital status, education levels, working status and current health status indicated by self-reported disease conditions. Detailed definitions and sample distributions are included in table 1. Further, we assume that whether or not a patient has clear understanding on the directions for how to take the medication prescribed may have a direct effect on his/her medication adherence. Hence, a binary question concerning whether or not the pharmacist consultation service involved giving instructions on "how to take medication" was included in the model. An earlier study has suggested that questions concerning the directions of medication intake are of importance for eliciting more accurate information from the patient.[20]

Table 1: Demographic Characteristics of the Study Population (n = 6916)

Continuous Variables	Mean (SD)
Age	50.98 (15.64)
Categorical Variables	**%**
Gender (% Female)	63.81
Race (%)	
White	58.28
Black	22.08
Latino/Hispanic	12.21
Asian	6.85
American Indian/Other	0.58
Marital Status (%)	
Married	65.05
Single	13.11
Divorced	12.27
Widowed	6.87
Separated	2.70
Health status (%)	
Good	40.21
Very good	31.45
Fair	18.38
Poor	2.73
Excellent	2.73
Education (%)	
Some college/trade school	41.88
College graduate	20.95
High school graduate	18.29
Postgraduate degree	11.01
Some high school	6.19
Grade school	1.68
Work Status (%)	
Full-time	52.76
Retired	23.84
Not seeking employment	11.04
Part-time	9.63
Unemployed	2.72
Disease condition (%)	
High blood pressure	24.36
Arthritis, muscle or back pain	13.81
Diabetes	8.08
Heart problems	7.52
Blood clotting	2.28

Models

Treating patient satisfaction with pharmacy services as exogenous, i.e. not correlated with error term, a single-equation probit model was used to estimate the relation between patient satisfaction and medication adherence. Because of the omitted variables and two-way causality, patient satisfaction is correlated with error term in single-equation probit model and thus violates the assumption of unbiased estimator. To address the endogeneity bias, bivariate probit models were subsequently employed using different sets of instrumental variables. Bivariate probit models simultaneously estimated the equations for the dependent variable (adherence) and the endogenous explanatory variable (patient satisfaction with pharmacy services). Because of the non-linear nature of the probit model, the 2-step procedure common in linear models (estimate the instrumental variable regression for the endogenous variable in the first stage and use the fitted value of the endogenous variable in the second stage) could not be used. The bivariate probit model is an appropriate model to use when the dependent variable and the endogenous explanatory variable are dichotomous. In the presence of endogeneity problems, the bivariate probit model gives asymptotically unbiased, consistent and efficient estimates.[23,24]

The single-equation model with exogenous patient satisfaction was estimated as:

$$adherence_i = \gamma_0 + \gamma_1 (satisfaction_i) + \gamma_2 (X_i) + \eta \qquad (1)$$

Where

$$adherence_i = \begin{cases} 1 \ if \ patient \ i \ adhere \ to \ medicatoin \ recommendations \\ 0 \ otherwise \end{cases}$$

In terms of the data generating process, adherence was the dichotomous outcome of interest. Patient satisfaction was treated as the dichotomous exogenous regressor in the single-equation probit model and X_i was a vector of other exogenous covariates determining medication adherence.

The bivariate probit model is the 2-equation endogenous satisfaction model. The first-stage equation is specified as:

$$satisfaction_i^* = \alpha_0 + \alpha_1 (IV_i) + \alpha_2 (X_i) + \varepsilon_1 \qquad (2)$$

$$satisfaction_i = 1(satisfaction_i^* > 0)$$

The second-stage equation is specified as:

$$adherence_i^* = \beta_0 + \beta_1 (satisfaction_i) + \beta_2 (X_i) + \varepsilon_2 \qquad (3)$$

$$adherence_i = 1(adherence_i^* > 0)$$

Where X_i is the vector of other exogenous covariates. We assume ε1 and ε2 are serially independent and identically distributed (i.i.d) bivariate normal variables (BVN) and have the following distribution:

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim BVN\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right)$$

The instrumental variables used in the first-stage equation (2) were different combinations of the 3 instrumental variables discussed above. This is a recursive simultaneous binary choice model and the two equations are estimated simultaneously using the Maximum Likelihood method.[24]

Rho (ρ) is the correlation coefficient that measures the residual association between the two equations. A Wald test of the significance of ρ is a direct test of the endogeneity of patient satisfaction.[24] The null hypothesis is that ρ equals zero and it is appropriate to use the univariate (single-equation) probit model. If ρ is significantly different from zero then medication adherence is not only directly affected by patient satisfaction but also indirectly influenced through other latent omitted factors, hence, justifying the use of bivariate probit models.

The magnitude of the patient satisfaction effect is our primary concern mainly because the coefficient estimates from a binary choice model can be misleading. As Greene (1998) pointed out "the absolute scale of the coefficients gives a distorted picture of the response of the dependent variable to a change in one of the stimuli".[23] The reported marginal effects in this study are the combined effects that consist of an indirect effect generated by the equation (2), as well as a direct effect produced by the equation (3). The instrumental variables enter the satisfaction equation (2), which influences the probability that the patient is satisfied with pharmacy services.

For a continuous independent variable, the marginal effect assesses how one unit change in the independent variable influences the dependent variable. For a binary independent variable, the marginal effect evaluates how a discrete change from 0 to 1 affects the outcome probability for the dependent variable (e.g., medication adherence). The analytical form is exceedingly complicated and most software including STATA uses numerical approximation to compute the derivatives and standard errors. The standard error is calculated using the delta method for the asymptotic estimator of variance. The analytical expression of the marginal effect and detailed illustration on the delta method can be found in Greene (2003) and Christofides (1997).[23,34]

Specification Test

We used the Smith-Blundell test of exogeneity to test the null hypothesis that patient satisfaction is e exogenous.[35] The test statistic is evaluated with respect to a chi-square distribution and the associated p-values. A rejection of the null hypothesis validates that patient satisfaction is endogenous. Sargan and Basmann over-identification tests were employed to test the null hypothesis that the excluded instruments are valid exclusions, i.e. they are uncorrelated with the error term and correctly excluded from the main estimation equation.[36,37] In addition, being valid is

one of the requirements for the instrumental variables. Another requirement is that they must have high explanatory powers. In other words, weak instruments can result in biased instrumental variable estimates.[21] The Staiger & Stock (1997)[38] weak instrument test is then used to test the strength of explanatory power of the instrumental variables. The null hypothesis is that the instrumental variables are jointly insignificant and a rejection of the null indicates that the selected instrumental variables have strong explanatory power for the endogenous variables.

Statistical test

SAS 9.1 was used to extract the study intake population. STATA 9.0 was used for executing all descriptive and statistical analyses. Regression coefficient estimates as well as marginal effects for selected variables were reported. Robust standard errors were computed for bivariate probit models given the possibility of heteroskedasticity induced by the selection bias.

RESULTS

Table 1 summarizes demographic characteristics for the study population. The mean age was about 51 years with 64% being female patients. About 58% of the patients were white and 65% of the patients were married. Over 70% indicated they had good or very good overall health status. Around 42% had some college education and 21% completed college degree. More than half (53%) of the patients had full-time jobs. With regard to patients' health status, about 24% were high blood pressure, 14% had arthritis or back pain problems, 8% had diabetes and approximately 8% had cardiovascular problems.

Table 2: Instrumental Variables Specification Tests

Tests	Combinations of instrumental variables									
	Non KP pharmacy use		Happy + non KP pharmacy use		Calm + non KP pharmacy use		Happy + Calm		Happy + Calm + non KP pharmacy use	
	Stats	P-value	Stats	P-value	Stats	P-value	Stats	P-value	Stats	P-value
Smith-Blundell test of exogeneity	6.553	0.011	22.907	<0.001	28.324	<0.001	26.976	<0.001	31.376	<0.001
Sargan Over Identification Test	--*	--	0.528	0.468	0.759	0.384	0.060	0.806	0.703	0.704
Basmann Over Identification Test	--*	--	0.525	0.469	0.755	0.385	0.060	0.807	0.699	0.705
Staiger-Stock Weak Instrument Test	24.710	<0.001	24.450	<0.001	26.400	<0.001	19.740	<0.001	19.480	<0.001

* Over identification tests were not performed when only one instrument was used to avoid exact identification problem

Table 2 gives the model specification test results on the instrumental variables. The Smith-Blundell test of exogeneity gives significant test results on all combinations of instrumental variables ($p < 0.011$), indicating a rejection of the null hypothesis that patient satisfaction is exogenous. Thus patient satisfaction should be treated as endogenous variable and instrumental variable method should be adopted. Both Sargan and Basmann over-identification tests failed to reject the null hypothesis for all five different combinations of the instrumental variables ($p>0.05$). Thus we conclude that the selected instrumental variables are valid and justifiably excluded from the main equation estimations. The Staiger-Stock weak instrument test gave significant results ($p<0.001$) suggest that the instrumental variables are jointly significant. This means that there was sufficient explanatory power of the instrumental variables used. All tests are indicative that the instrumental variables are strongly correlated with patient satisfaction.

The model estimations of the pharmacist consultation effectiveness were given in Table 3 with estimated results from both the single equation probit model (column 1) and the bivariate probit models (column 2 to column 6). Robust standard errors are reported in parentheses. We found that correlation coefficients (ρ) were significantly different from zero for all bivariate probit models. Hence, we are able to reject the null hypothesis and confirm the simultaneous estimation approach under the bivariate probit models.

Table 4 exhibits the marginal effects from the model estimation. Similar to Table 3, column 1 gives the marginal effects estimated by the single equation probit model and column 2 to column 6 gives the results estimated by the bivariate probit models. The significant and positive marginal effects of patient satisfaction with pharmacist consultation service were found under both the single equation probit and bivariate probit models, reflecting a positive association between patient satisfaction and medication adherence, as hypothesized. Further, the magnitude of the effect differs significantly between the single equation probit and bivariate probit models. The single equation probit model reported a marginal effect of 0.07 ($p<0.01$) for patient satisfaction with pharmacist consultation service on medication adherence, reflecting that the likelihood of a 7% increase in medication adherence for a satisfied patient with average values for all explanatory variables. Under the bivariate probit models, the marginal effect of patient satisfaction ranged from 0.20 ($p<0.05$) to 0.30 ($p<0.01$), reflecting that a satisfied patient increases the likelihood of adherence 20% to 30% once the endogeneity is corrected for. This result is statistically significant since the marginal effect under the single equation probit fell outside of the 95% CI (0.07 ± 1.96 (0.013), see Table 4). We obtained similar marginal effects of patient

satisfaction across models using five different sets of instrumental variables. This outcome provides strong evidence of the robustness of the model and the validity of the instrumental variables selected.

Table 3: Model Estimation

Variables	Single-equation Probit Model	Bivariate Probit Models				
		non KP pharmacy use	Happy + non KP pharmacy use	Calm + non KP pharmacy use	Happy + Calm	Happy + Calm + non KP pharmacy use
Patient satisfaction	0.183*** (0.035)	0.753*** (0.285)	1.021*** (0.151)	1.095*** (0.136)	1.067*** (0.145)	1.102*** (0.128)
Age	0.015*** (0.002)	0.012*** (0.003)	0.010*** (0.002)	0.009*** (0.002)	0.009*** (0.002)	0.009*** (0.002)
Gender (female)	-0.053 (0.037)	-0.065* (0.037)	-0.072** (0.036)	-0.068* (0.036)	-0.069* (0.036)	-0.069* (0.036)
Race						
White	0.093 (0.132)	0.039 (0.133)	-0.001 (0.129)	-0.01 (0.130)	-0.007 (0.129)	-0.031 (0.130)
Black	-0.026 (0.135)	-0.074 (0.135)	-0.106 (0.132)	-0.112 (0.132)	-0.109 (0.131)	-0.135 (0.133)
Other race	-0.022 (0.135)	-0.012 (0.135)	-0.021 (0.132)	-0.028 (0.133)	-0.038 (0.132)	-0.049 (0.133)
Education						
High school	-0.321 (0.301)	-0.375 (0.316)	-0.363 (0.315)	-0.359 (0.316)	-0.312 (0.304)	-0.352 (0.315)
Some college	-0.376 (0.301)	-0.422 (0.316)	-0.401 (0.315)	-0.395 (0.315)	-0.347 (0.304)	-0.387 (0.315)
College	-0.348 (0.301)	-0.344 (0.318)	-0.313 (0.316)	-0.296 (0.316)	-0.261 (0.304)	-0.291 (0.316)
Marital status						
Single	0.386 (0.242)	0.463* (0.278)	0.480* (0.274)	0.464 (0.283)	0.397 (0.277)	0.466* (0.283)
Married	0.381 (0.238)	0.480* (0.275)	0.497* (0.271)	0.480* (0.28)	0.409 (0.274)	0.484* (0.280)
Separated	0.359 (0.256)	0.433 (0.291)	0.462 (0.286)	0.430 (0.295)	0.376 (0.289)	0.436 (0.295)
Divorced	0.247 (0.242)	0.318 (0.278)	0.328 (0.274)	0.311 (0.283)	0.243 (0.277)	0.314 (0.283)
Widowed	0.318 (0.247)	0.447 (0.286)	0.475* (0.28)	0.449 (0.289)	0.365 (0.283)	0.458 (0.289)
Work status						
Full-time	-0.133** (0.059)	-0.125** (0.061)	-0.103* (0.059)	-0.097* (0.059)	-0.086 (0.058)	-0.094 (0.059)
Part-time	-0.076 (0.075)	-0.090 (0.074)	-0.081 (0.073)	-0.073 (0.073)	-0.063 (0.072)	-0.074 (0.073)
Unemployed	-0.045 (0.113)	-0.041 (0.110)	-0.035 (0.108)	-0.028 (0.107)	-0.031 (0.105)	-0.026 (0.107)
Retired	-0.008 (0.075)	-0.031 (0.074)	-0.032 (0.073)	-0.025 (0.072)	-0.009 (0.071)	-0.022 (0.072)
Not seeking	0.053 (0.102)	0.002 (0.107)	-0.027 (0.104)	-0.032 (0.105)	-0.038 (0.103)	-0.032 (0.104)
Health status						
General	-0.065** (0.026)	-0.048* (0.029)	-0.038 (0.027)	-0.026 (0.027)	-0.028 (0.027)	-0.030 (0.027)
Arthritis /back pain	-0.273*** (0.048)	-0.265*** (0.049)	-0.259*** (0.048)	-0.257*** (0.047)	-0.259*** (0.047)	-0.260*** (0.047)
Diabetes	0.336*** (0.067)	0.315*** (0.068)	0.288*** (0.066)	0.294*** (0.065)	0.300*** (0.065)	0.289*** (0.065)
High blood press.	0.325*** (0.042)	0.305*** (0.044)	0.286*** (0.043)	0.275*** (0.042)	0.281*** (0.042)	0.276*** (0.042)
Seizure disorder	0.814*** (0.221)	0.779*** (0.204)	0.727*** (0.195)	0.720*** (0.194)	0.722*** (0.195)	0.716*** (0.193)
Heart problem	0.249*** (0.073)	0.201*** (0.076)	0.170** (0.072)	0.171** (0.071)	0.175** (0.071)	0.169** (0.071)
Blood clotting	0.064 (0.126)	0.060 (0.124)	0.046 (0.120)	0.065 (0.120)	0.054 (0.118)	0.054 (0.119)
How to take medication	-0.167*** (0.037)	-0.243*** (0.049)	-0.272*** (0.039)	-0.279*** (0.038)	-0.268*** (0.039)	-0.279*** (0.038)
Constant	-0.671* (0.349)	-0.805** (0.383)	-0.858** (0.370)	-0.899** (0.372)	-0.844** (0.351)	-0.858** (0.371)
Observations	6662	6529	6461	6461	6543	6414
Disturbance correlation, ρ		-0.368* (0.202)	-0.582*** (0.131)	-0.650*** (0.128)	-0.622*** (0.133)	-0.659*** (0.122)
Log likelihood	-4044.862	-7916.132	-7819.802	-7777.899	-7946.915	-7749.045

Note: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In addition, other significant marginal effects were found for age, full-time employment status and disease conditions. Specifically, older patients are more likely to adhere to their medications since a one year increase in age increases the likelihood of being adherent by 0.6 to 0.7 percent (p<0.01). This result is consistent with previous published study that older patients have a higher incident of adhering to medications.20, 39 Further, for a satisfied fully employed patient, the likelihood of medication adherence is decreased by 4% - 5% as compared to a satisfied but not fully employed patient (p<0.05). Moreover, satisfied patients with life-threatening chronic conditions such as diabetes, high blood pressure, heart problems and seizure disorder are more likely to adhere to their medications as compared to satisfied patients without life-threatening chronic health conditions. The magnitude of increase in the likelihood of medication adherence ranged from 8% - 17% (p<0.01). Contrariwise, satisfied patients with manageable chronic conditions such as arthritis or back pain are about 8% less likely to adhere to their medications (p<0.01). These findings imply that the severity of illness has significant effect on patient medication adherence. Patients with manageable chronic health conditions seem to place medication adherence on a lower priority level compared to patients with more severe diseases. Furthermore, satisfied patients who received instructional help from the pharmacist on how to take their medications tend to be 2% - 3% more likely to adhere (p<0.1) under the bivariate probit models. On the contrary, such patients were about 6% less likely to adhere under the single equation probit model. These rather counter-intuitive results are, perhaps, indicative of the presence of endogeneity bias. Patient satisfaction with pharmacist consultation is likely to be correlated with this "how-to" variable. When patient satisfaction is treated as

an exogenous variable, this correlation will cause downward bias of the coefficient for this "how-to" variable, i.e. making it more negative. When endogeneity is corrected, this correlation is mitigated and the downward bias is also corrected.

Table 4: Marginal Effects

Variables	Single-equation Probit Model	Bivariate Probit Models				
		non KP pharmacy use	Happy + non KP pharmacy use	Calm + non KP pharmacy use	Happy + Calm	Happy + Calm + non KP pharmacy use
Satisfaction	0.069*** (0.013)	0.199** (0.08)	0.275*** (0.042)	0.296*** (0.038)	0.287*** (0.041)	0.298*** (0.036)
Age	0.006*** (0.001)	0.007*** (0.001)	0.007*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)
Gender (female)	-0.02 (0.014)	0.005 (0.012)	0.003 (0.012)	0.007 (0.012)	0.004 (0.012)	0.006 (0.012)
Race						
White	0.035 (0.050)	0.053 (0.045)	0.043 (0.044)	0.045 (0.044)	0.044 (0.043)	0.040 (0.044)
Black	-0.010 (0.051)	0.012 (0.046)	-0.0001 (0.045)	-0.001 (0.045)	0.0004 (0.044)	-0.007 (0.045)
Other race	-0.008 (0.051)	-0.026 (0.046)	-0.035 (0.044)	-0.035 (0.044)	-0.037 (0.044)	-0.041 (0.044)
Education						
High school	-0.123 (0.117)	-0.068 (0.087)	-0.070 (0.085)	-0.071 (0.084)	-0.056 (0.082)	-0.067 (0.084)
Some college	-0.142 (0.113)	-0.088 (0.087)	-0.088 (0.085)	-0.091 (0.084)	-0.074 (0.082)	-0.085 (0.084)
college	-0.132 (0.116)	-0.118 (0.085)	-0.117 (0.083)	-0.119 (0.082)	-0.106 (0.080)	-0.114 (0.083)
Marital status						
Single	0.135 (0.078)	0.010 (0.088)	0.013 (0.090)	-0.028 (0.084)	0.002 (0.081)	-0.028 (0.085)
Married	0.145 (0.091)	0.029 (0.084)	0.030 (0.084)	-0.002 (0.081)	0.010 (0.078)	-0.003 (0.082)
Separated	0.124 (0.080)	-0.007 (0.094)	0.009 (0.096)	-0.034 (0.089)	0.001 (0.087)	-0.030 (0.091)
Divorced	0.089 (0.083)	-0.007 (0.088)	-0.006 (0.089)	-0.046 (0.082)	-0.016 (0.080)	-0.045 (0.084)
Widowed	0.112 (0.081)	-0.047 (0.088)	-0.050 (0.089)	-0.087 (0.081)	-0.060 (0.079)	-0.091 (0.082)
Work status						
Full-time	-0.050** (0.022)	-0.055*** (0.020)	-0.049** (0.019)	-0.048** (0.019)	-0.042** (0.019)	-0.047** (0.019)
Part-time	-0.029 (0.028)	-0.023 (0.024)	-0.018 (0.024)	-0.014 (0.024)	-0.009 (0.023)	-0.016 (0.024)
Unemployed	-0.017 (0.043)	-0.014 (0.037)	-0.008 (0.036)	-0.009 (0.036)	-0.008 (0.035)	-0.007 (0.036)
Retired	-0.003 (0.028)	0.002 (0.025)	0.008 (0.025)	0.010 (0.025)	0.023 (0.025)	0.013 (0.025)
Not seeking	0.020 (0.037)	0.075** (0.035)	0.079** (0.035)	0.086** (0.035)	0.083** (0.035)	0.088** (0.035)
Health status						
General	-0.024** (0.010)	-0.035*** (0.009)	-0.028*** (0.009)	-0.024*** (0.009)	-0.021** (0.009)	-0.023** (0.009)
Arthritis / back pain	-0.105*** (0.019)	-0.074*** (0.016)	-0.077*** (0.015)	-0.078*** (0.015)	-0.078*** (0.015)	-0.079*** (0.015)
Diabetes	0.118*** (0.022)	0.087*** (0.022)	0.083*** (0.022)	0.078*** (0.022)	0.079*** (0.022)	0.078*** (0.022)
High blood press.	0.117*** (0.015)	0.088*** (0.014)	0.086*** (0.014)	0.086*** (0.014)	0.086*** (0.014)	0.086*** (0.014)
Seizure disorder	0.241*** (0.045)	0.155** (0.072)	0.176** (0.073)	0.171** (0.072)	0.17** (0.073)	0.172** (0.072)
Heart problem	0.089*** (0.025)	0.109*** (0.026)	0.102*** (0.027)	0.108*** (0.027)	0.102*** (0.026)	0.103*** (0.027)
Blood clotting	0.024 (0.046)	0.032 (0.045)	0.031 (0.045)	0.024 (0.045)	0.020 (0.045)	0.027 (0.045)
How to take medication	-0.063*** (0.014)	0.030** (0.015)	0.024* (0.013)	0.022* (0.013)	0.023* (0.013)	0.023* (0.013)
Observations	6662	6529	6461	6434	6543	6414

Note: Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

DISCUSSION

Although the single equation probit model exhibited a significant positive effect of patient satisfaction with pharmacist consultation on patient medication adherence, it underestimated the magnitude of this effect. Bivariate probit models showed that the magnitude of the effect of patient satisfaction with pharmacist consultation on medication adherence was substantially greater. The marginal effect statistically significantly increased from about 0.07 to as much as 0.30 after correcting for endogeneity bias ($p<0.01$) indicating that for a satisfied patient, the likelihood of being adherent to his/her medication, relative to an unsatisfied patient, can be more than 4-fold when estimated with the bivariate probit model. This finding is relevant to targeting and evaluating the effectiveness of pharmacist consultation services.

In this study, we have demonstrated a successful application of the IV method for correcting endogeneity bias in patient self-reported satisfaction with pharmacist consultation services. The approach used in this study is applicable when dichotomous dependent and endogenous regressors are present. In addition to a methodological contribution, this research also provides important policy implications. Both healthcare professionals and patients recognize the importance of pharmacist consultation. The function of pharmacists has evolved from drug dispensing to a more active role of information sharing, risk management and other consultation. This change has been documented by the 2003 Medicare Modernization Act and the 2004 Joint Commission of Pharmacy Practitioners. Several studies[4,5,17,40] have found that there is a disagreement between patients and pharmacists on the appropriate role of the pharmacist. For instance, patients may not view pharmacists as a resource for drug-related risk management or for long-term healthcare issues, while more and more pharmacists are taking upon a more active role in patient healthcare management. On the other hand, some patients' concerns are not adequately addressed by the pharmacists. Patients may have concerns over the costs of their

medications, especially for patients of low-income, no health insurance, or insurance with deductibles. Pharmacists may address these concerns by providing advice on medication management or generic drug alternatives with similar clinical results. The discrepancy between patients' expectations and the new role of pharmacists can affect the overall patient satisfaction with pharmacist consultation. Recent studies suggested several channels to help both parties to agree on their roles and expectations of the other. One suggestion is through patient education and collaborative efforts of other healthcare providers, especially physicians, so that patients can be better informed and can expect more help from the pharmacists.[4,5] These interactions may improve understanding between pharmacists and the patients and lead to higher patient satisfaction level.

Certain study limitations should be mentioned. First, in this paper it is not directly analyzed how pharmacists can improve patient satisfaction because "satisfaction" in this survey is an aggregate measure. This problem should be studied in future research when factors influencing patient satisfactions are disaggregated into detailed components.

Second, although prior study has shown that self-reported medication adherence is correlated with actual adherence recorded by more objective measures, adherence measurement may, to some extent, bias our results.[28] Therefore, the next step of the research in this area is to merge patient satisfaction survey and other demographic and clinical information with pharmacy patient medication reports or other objective measurements of patient medication adherence. Third, ceiling effects in both the dichotomized dependent variable (medication adherence) and the endogenous regressor (patient satisfaction) may have reduced variation in the underlying ordinal rating scales. Fourth, as we focus on the hypothesis with regard to pharmacist consultation, there may still be other important variables that were either not available or not included in our model specification. For example, pharmacists' technical capability, pharmacist courtesy, pharmacy convenience or, physician services, etc., could also be correlated with patient satisfaction. Fifth, the results should be interpreted with appropriate caveats because of omitted variables. For example, we did not control for drugs or drug types in the study. Hence, some findings such as older patients are more likely to adhere their medications may also imply that these patients may be on drugs that are for maintenance purposes for chronic health conditions. Sixth, the variable(s) used from the current instrument may not be the best or the most complete patient satisfaction survey with pharmacist consultation. The satisfaction in this study is an overall evaluation. In future studies, more detailed questions are needed to analyze how patients react to different aspects of pharmacist consultation including friendliness, professional manner, the information provided, waiting time, etc.[41] Further, the sample patients are all members of a large managed care organization; hence, the findings in this study may not be fully generalizable to other health care settings. Finally, while instrumental variable estimation has many nice properties, it is often hard to identify a set of valid and strong instrumental variables in specific empirical studies.

CONCLUSION

Using a bivariate probit econometric model to appropriately adjust for endogeneity bias, this study supports previous researches that satisfied patients are more likely to adhere to their medications. The results have important policy implications given the increasing focus on the roles of pharmacists and regulatory changes in professional scope of practice. The results suggest that simple single equation specifications suffer from endogeneity bias due to either omitted variable bias or reversed causality. This study support the use of the instrumental variable approach in which the true magnitude of effect can be demonstrated by correcting potential endogeneity bias. The validity of our findings is supported by formal specification tests and evaluation of parameter sensitivity to different combinations of instrumental variables.

CONFLICT OF INTEREST

There is no financial support or conflict of interest associated with this paper.

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