

USING ORDINAL LOGISTIC REGRESSION WITH PROPORTIONAL ODDS TO ANALYZE HEALTH CARE DATA WHERE THE OUTCOME VARIABLE CAN BE ORDERED

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ABSTRACT

The aim of this study was to determine how satisfied patients were with their primary care professionals' services based on a Likert scale (1 to 4 with 1 = very dissatisfied and 4 = very satisfied). People in the sample were characterized by site of care (Clinic A = 1 and clinic B = 0), gender (1= females, 0=males), socioeconomic status (0 = Low class, 1 = middle class, 2 = Upper class), and age. In this study, 384 patients (204 females, 180 males) were available for investigating the association between their ratings of professional health care services and the factors of gender, clinical location, socioeconomic status and age as a covariate. Patients ranged from 23 to 68 years of age, with a mean age of 38.23 (SD +/- 8.52) and a median age of 37.00 years. A cumulative odds ordinal logistic regression with proportional odds was run to determine the effect of these predictors on patients' satisfaction with health care services at these clinics. Power analysis for a multiple regression with four predictors was conducted in G-POWER to determine a sufficient sample size using an alpha of 0.05, a power of 0.80, and a medium effect size (f = 0.15). IBM Statistical Package for the Social Sciences (SPSS) software version 24 and G-POWER 3.0.10 were used to analyze the data.

Keywords: primary care services, ordinal logistic regression, professional health care services, patients' satisfaction with health care services.

INTRODUCTION

Patient satisfaction is a frequently occurring topic in the literature of clinical health care, and medical education. Interest in the study of customer satisfaction in general has persisted since the beginning of the twentieth century. Despite all the work that has been done in this area, researchers are still unclear what they really mean by patient satisfaction and how to measure it precisely. The debate consists of two points: the definition of what satisfaction actually consists of and how to measure it properly. Smith (2018) noted that patient satisfaction has an important role in hospital and clinic operations- from repeat visits and compensation to adherence and quality of care-yet the validity of some survey measurements is open to question. Smith also noted that safety-net hospitals tend to score lower on patient satisfaction than hospitals that provide less care to underserved populations. So low satisfaction scores could cause physicians to avoid caring for more challenging patients, such as poorer people and persons with mental illness. The American Medical Association code of Medical Ethics, Opinion 1.1.6 on Quality, states that physicians should share the obligation to ensure that the care patients receive is safe, effective, patient centered, timely, efficient, and equitable. Although most of the customer/patient satisfaction literature deals with the area of industrial management, there is a growing need for understanding its effects in the health care industry. Chue 2006; Glickma. et al. 2010 contended that results from patient satisfaction surveys can make positive change and quality improvement (QI) initiatives in health-care delivery that are responsive to patient needs. Evidence based data can potentially bring benefits of high patient satisfaction; satisfied patients can have higher treatment adherence and may improve the overall health outcomes. Priority Metrics Group (PMG 2017) contended that approaches to patient satisfaction surveys are wasting time and effort. In general, a chronic level of weakness prevails in typical patient satisfaction surveys due to the following factors: limited or no statistical validity, use of only experiential attributes, poorly communicated results, absence of comparative benchmarks, and low importance placed on analysis.

Objective: The study reported here aimed at gauging patient satisfaction with clinical care they receive at certain primary care settings in the Southeastern Region of the United States.

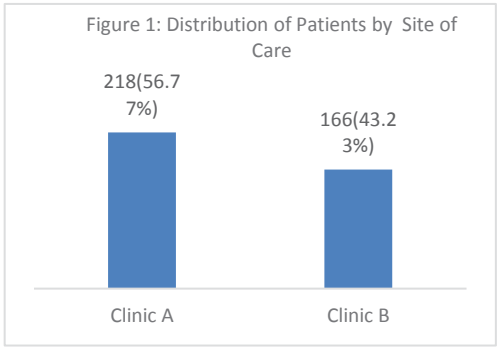
METHODS

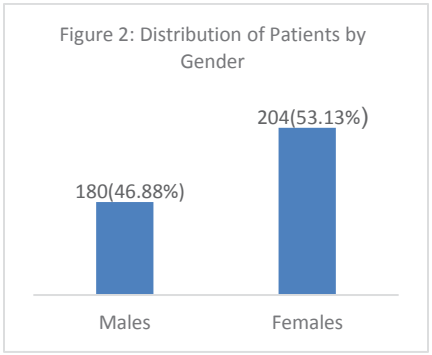
The paper-based questionnaire consisted of two parts. The first part, the 14 close ended questions, measured the participants' satisfaction with the primary care professionals' services they received based on a Likert scale (1 to 4 with 1 = very dissatisfied and 4 = very satisfied). These ordered responses were the categories of the dependent variable, and overall satisfaction. The second part of the satisfaction questionnaire included the age of the patient, clinical site, socioeconomic status, and gender. The respondents were asked to identify one or more items which they felt contributed most to their satisfaction and to identify one or more items that they felt contributed most to their dissatisfaction. The data collection covered a 6-month period, starting on June 6 and closing on December 6, 2017. The observational study was a survey-based design in which 753 patients from two clinics were polled. Out of 753 people surveyed, 29 questionnaires were unusable due to incomplete demographic information, yielding 384 usable forms or 51% of the original total. A total of 218 (56.8%) patients from site A, and 166 (43.2%) patients from site B completed the survey. Reliability coefficients of internal consistency were from 0.79 to 0.91.

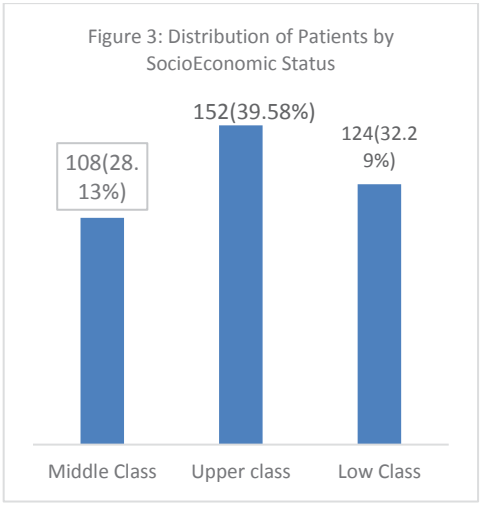
Descriptive statistics were used to examine the proportion of patients by key variables including clinical location, gender, age, and socioeconomic status. Approximately 384 participants completed the survey. In this study, out of 384 patients who rated their experiences with the primary care services, 53% were females and 47% were males (Figure 2); 57% from clinic A and 43% from clinic B (Figure 1). The composition of respondents for gender, site, and socioeconomic status are presented in Table 1 and Figures 1 -4. Patients ranged from 23 to 68 years of age, with a mean age of 38.23 (SD +/- 8.52) and a median age of 37.00 years.

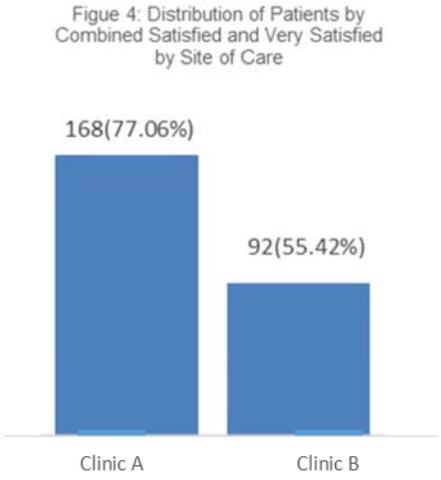
Table 1: Distribution of Patients by Demographic Characteristics

Variable	Group	Frequency	Percent
Gender	Females	204	69.85%
	Males	180	30.15%
	Total	384	100%
Variable	Group	Frequency	Percent
Site	Clinic A	218	57%
	Clinic B	166	43%
	Total	384	100%
Variable	Group	Frequency	Percent
Socioeconomic Status	Middle Class	108	28%
	Upper class	152	40%
	Low Class	124	32%
	Total	384	100%









Power analysis for a multiple regression with four predictors(clinical Site, gender, socioeconomic status and age) was conducted in G-POWER to determine a sufficient sample size using an alpha of 0.05, a power of 0.80, and a medium effect size (f = 0.15). G-POWER 3.0.10 was used to perform power analysis and determined that 85 participants needed to conduct this study. Lehmann (2006) recommends using this typical calculation for sample size if the independent variable data are normally distributed. However, if the independent variable data does not follow a normal distribution, Lehmann (2006) suggested to sample 15% more subjects. In this case, the sample required for a regression with a power of .80, assumed medium effect, and four predictors is Y (from G*power). By adding an additional 15% to the 85 patients, the required sample for the ordinal logistic regression is (=Y*1.15) or 98 cases. The addition of 13 more cases to the sample reconstitutes the loss of power associated with the use of non-normal data within this non-parametric analysis.

Basic requirements of ordinal logistic regression: Assumption #1: You have one dependent variable that is measured at the ordinal level. In this case, examples of ordinal variables include Likert items (How satisfied are you with the medical care that you received at this clinic? e.g., a 4-point scale from “1 = Very Dissatisfied" through to " 4 = Very Satisfied ").

Assumption #2: You have one or more independent variables that are continuous (age), ordinal or categorical (including dichotomous variables with two categories including clinical site and gender, and a multi-category variable which is socioeconomic status.

Assumption #3: Determining if you have multicollinearity**;** Multicollinearity occurs when you have two or more independent variables that are highly correlated with each other (socioeconomic status, gender, and age). This leads to problems with understanding which variable contributes to the explanation of the dependent variable and technical issues in calculating an ordinal logistic regression. There should be no multicollinearity. Notice below, in Table 2, that the VIF (Variance Inflation Factor) statistics are all less than 10, so one can be fairly confident that there is no problem with collinearity in this particular data set.

Table 2: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-1.225	.294		-4.162	.000		
	Age	.087	.007	.508	11.631	.000	.957	1.045
	Gender	-.062	.079	-.034	-.778	.437	.982	1.018
	socioeconomic status	-.021	.051	-.017	-.403	.687	.972	1.029
	Site of Care	-.308	.080	-.166	-3.852	.000	.981	1.019

a. Dependent Variable: Overall Satisfaction with the medical care received at this clinic?

Assumption #4: Each independent variable has an identical effect at each cumulative split of the ordinal dependent variable. This assumption can be tested using two methods: (a) with a full likelihood ratio test comparing the fit of the proportional odds model to a model with varying location parameters; and (b) by running separate binomial logistic regressions on cumulative dichotomous dependent variables. The odd ratio does not change for any comparison between one level of the dependent variable (Satisfied) and its highest level. So we assumed the effect of the independent variable is constant, or the distances between the different levels of the dependent variable were constant.

In Table 3, the Likelihood-ratio test indicates that the independent variables add statistical significance to the model or, in other words, at least one independent variable is statistically significant. The final model significantly predicted the dependent variable over and above the intercept-only model, $\chi^2(4) = 175.82$, $p < .001$.

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	736.345			
Final	560.523	175.821	4	.000

Link function: Logit.

RESULTS

Descriptive statistics were used to examine the proportion of patients by key variables including clinical location, gender, age, and socioeconomic status. The satisfaction variable was regarded as the dependent variable in the ordinal logistic regression analyses when calculating the odds ratios (OR) and the 95% confidence intervals (95% CI). All the other variables, i.e. age, sex, socioeconomic status, and by site of care were considered as independent variables. The findings indicated that when the results were analyzed by site, the odds ratio of being in a higher category of the dependent variable (such as Very satisfied) for

Clinic A patients versus Clinic B patients is 1.944 (95% CI, 1.30 to 2.91), a statistically significant effect, $\chi^2(1) = 10.509$, $p = 0.001$.

Table 4 demonstrates the omnibus test results for the socioeconomic status variable using the Wald test statistic. The Socioeconomic status has a statistically significant effect on the prediction of whether the patient is satisfied with health care service at the clinical site, Wald $\chi^2(2) = 28.555$, $p = .001$.

Table 4: Tests of Model Effects

	Type III		
Source	Wald Chi-Square	df	Sig.
Socioeconomic status	28.855	2	0.000
Dependent Variable: Overall Satisfaction with the medical care received			

Post hoc comparisons revealed that the odds ratio of being in a higher category of the dependent variable for upper class versus low socioeconomic patients is 3.194 (95% CI, 1.98 to 5.15), which is statistically significant, $\chi^2(1) = 22.715$, $p < .001$. Thus, you are more likely to be highly satisfied if you are upper socioeconomic than if you are low socioeconomic patient. Also the odds ratio of being in a higher category of the dependent variable for middle socioeconomic group versus low group is 1.04 (95% CI, 0.63 to 1.72), which is not statistically significant, $\chi^2(1) = 0.021$, $p = 0.886$. Thus, middle group and low groups appear to have the same opinion when it comes to their satisfaction level with health care services.

The predictor variable, age was also positively associated with the overall satisfaction of patients. This means that a change in one unit of age (i.e., a one year increase in age) is associated with an odds ratio of 1.27; that is, for every one year increase in age, the odds of being very satisfied increases by 1.27 times. An increase in age (expressed in years) was associated with an increase in the odds of being very satisfied with health services, with an odds ratio of 1.274 (95% CI, 1.22 to 1.33), Wald $\chi^2(1) = 112.71$, $p < 0.0005$.

The impact of gender variable was not significant. The odds ratio of being in a higher category of the dependent variable (such as Very satisfied) for males' patients versus female patients is 1.168(95% CI, 0.786 to 1.735), which is not statistically significant, $\chi^2(1) = .591$, $p = 0.442$.

The likelihood of patients writing comments on their rating forms was the same for site A and site B. The evidence on this question comes from a comparison of comments made by respondents in 2017. All words and expressions that concerned satisfaction or dissatisfaction were highlighted. All statements were broken into themes and classified as either as positive or negative. Themes include 1. Interpersonal skills: a) Positive examples: provide friendly greeting, engaging, appropriate eye contact, non-verbal behavior, she is very nice, knocks before enters the room; and b) negative examples: arrogant, looks distant, not interested. 2. Competence: a) Positive: good data gathering, thorough check-up, takes time with me; and b) negative: prescribe the same old stuff that is not working. 3. Environment: a) positive: clean area, nice room, friendly staff, up-to-date equipment; and b) negative: very cold room, awful. Results show that 61% of the patients in clinic A and 63% of students in clinic B wrote comments. The difference is small, and it is not statistically significant, $\chi^2(1) = 0.69$, $p = 0.254$.

DISCUSSION AND CONCLUSION

Overall, patients reported favorable perceptions of primary care services at the health care clinics. Age, socioeconomic status, and clinical location were significantly and independently related to patient satisfaction in the ordinal logistic regression analysis adjusted for all confounders. This study included only outpatients seen by primary care providers. The findings of this study agreed with Al-Windi A (2005) and Nguyen et al (2002) that older patients are more satisfied with health care than the younger patients, but did not find enough evidence to support their claim about the significant impact of gender variable on the

overall patient satisfaction. The response rate in the present study of 51% is acceptable, since a higher response rate is difficult to achieve in a questionnaire survey. In spite of the fact that the older patients have more diseases and are sicker than young subjects, this study found that the younger respondents were less satisfied than the older respondents. Patient satisfaction is a complicated phenomenon, and identifying dissatisfied patients and identifying their views on health care is essential in order to improve the quality of health care. Respondents with high SES were significantly more satisfied when compared with respondents with low or middle SES ($P<0.001$).

Patient satisfaction is a complex and difficult concept to measure. There is a lot of contradiction in the results of various studies. Future research should be more comprehensive and it should include more factors in order to understand patients' ratings of health care. Items related to patients' experiences such as waiting times, information/communication, involvement in decision making, treatment with respect, responsiveness of staff, privacy, management of pain, physical environment, and management of complaints should be standardized to allow comparative analysis. To improve the quality of patient experiences, health care providers should take special care to ensure the quality of their interactions with patients. Priority Metrics Group (PMG 2017) stated that patient satisfaction surveys are about improvement – in satisfaction certainly, but more importantly in the drivers of satisfaction. If a practice can improve performance in the areas that matter most to patients, they are rewarded with higher retention and loyalty, new patients (through recommendations), and improved margins (through allocating dollars to areas of performance. They need to put the patients first and at the center of everything they do. It should be learned from the food industry, that the customer always comes first. The same should apply to the healthcare industry.

DISCLOSURES

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