Medication Knowledge and Health Status in the Seattle Longitudinal Study

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ABSTRACT

This paper examined how the relationship between cognition (i.e., Verbal Comprehension, Inductive Reasoning, and Semantic Memory) and health as measured by self-reported health, numbers of medication, number of doctor visits and estimated health care costs, is mediated by medication knowledge in two samples. The cardiovascular medication (CVD) sample consisted of 255 (Males=146; females=109; M=68 years) and a non-steroidal anti-inflammatory drug (NSAID) sample consisting of 185 (Males=102; Females=85; M=68 years). Medication knowledge was not highly associated with level of cognitive abilities, however, a lack of knowledge was associated with increased estimated health care costs for both groups as well as decreased self-reported health and increased medication usage for the CVD sample. For the CVD sample, increased Inductive Reasoning was related to decreased medical expenditures and women were more likely to be inaccurate. For the NSAID sample, increased memory was associated with increased medication use and decreased hospital visits and men were more likely to be correct.

KEY WORDS: Health Maintenance Organization (HMO), Perceived Therapeutic Purpose, Cognitive Ability, Elderly, CVD medication, NSAIDS, Health

Medication Knowledge and Health Status in the Seattle Longitudinal Study

A majority of older adults understand the purpose of their medication; however, there still remain many individuals who for various reasons lack this knowledge. A study of a large rural community residing sample found that as many as 90 percent of all reported drug purposes were considered appropriate (Semla, Lemke, Helling, Wallace, & Chrischelles, 1991). In another study of 45 healthy World War I veterans, 41 subjects correctly named the purpose of their drug (Delafuente, Mueleman, Conlin, Hoffman, & Lowenthal, 1992). Gilbert, Luszcz, and Owen (1993) in an urban-dwelling sample found a comparable percentage of subjects reported the correct use of their medication. In a large community dwelling sample, 90% of those using Cardiovascular medication (CVD) and 83% of the individuals using Non-steroidal anti-inflammatory medication (NSAID) understood the purpose of their medication (Bosworth & Schaie, under review). Other studies have found smaller percentages of individuals who understood the purpose of their medication. In a small geriatric patient sample, 78.3 percent of the sample could identify the therapeutic purpose of at least one of their medications (O'Connell & Johnson, 1992), and a smaller percentage of individuals (i.e., 68.1 percent) were found in a large Black elderly sample (Bazargan & Barbre, 1992).

Considerable attention has focused on the relationship between cognitive function and compliance (Morrell, Park, & Poon, 1989; Morrow, Leiner, & Scheilich, 1988; Park, Willis, Morrow, Diehl & Gaines, 1994). However, few have examined the relationship between cognitive level of functioning and understanding the therapeutic purpose of one's medication. An understanding of the therapeutic function of prescription medications is necessary, but not sufficient, to ensure compliance in medication use (Ascione, Kirscht, & Shimp, 1986; Conrad, 1982).

Evidence has accumulated that demonstrates that medication noncompliance can lead to serious medical problems. Between 4-35% of noncompliant adults endanger their health by taking their medication incorrectly (Stewart & Cluff, 1980). Medication nonadherence can produce adverse side effects because patients take wrong amounts of medications or because they combine incompatible medications. Because of their complicated medical schedules, older adults are most prone to these mistakes (Morrow, Von Leirer, & Sheikh, 1988). Older adults are also vulnerable to the incorrect use of medications because of age-related changes in such functions as liver metabolism and renal excretion (Gryfe & Gryfe, 1984). Despite the information on the ramifications of medication noncompliance, there is a lack of information on understanding the purpose of one's medication and its relation to health outcome and service utilization.

The Seattle Longitudinal Study (SLS) provides an opportunity to examine the relationship between multiple indicators of cognition and understanding the therapeutic purposes of one's medication. The study also allows for the examination of whether knowledge of one's medication mediates the relationship between cognition and health status and service utilization. Two issues were explored: First, we wanted to examine the influence of multiple indicators of cognition on understanding the purpose of one's medication (e.g., NSAIDS or CVD). Second, we were interested in whether the understanding of one's therapeutic purpose of medication mediated the relationship between cognition and health outcome and service utilization.

METHOD

Participants

The sub-sample for which the perceived therapeutic purpose of CVD was examined consisted of 146 males and 109 females (N=255) with a mean age of 68.22 years (range 31-89 years). The NSAID sample consisted of 102 males and 83 females (N=185) with a mean age of 68.41 years (range 31-86 years)(see Table 1). The total sample represented a wide range of income and education levels. Subjects were drawn from the Seattle Longitudinal Study, a longitudinal-sequential study of psychometric intelligence in adulthood (Schaie, 1995). Subjects were selected randomly by gender and age/cohort from the membership of a large (HMO) in the Seattle Area.

Insert Table 1 about here

Procedures

Data on medications were collected as part of the administration of a battery of cognitive tests. Subjects were asked to bring all medications taken regularly for at least one month to the testing session. A large majority of the subjects had all their medications filled by the HMO. The name of the medication, dosage level, subjects' perceived purpose for the medication, and physicians' instructions were recorded. Each medication was assigned a drug code based on the American Hospital Formulary Service (1991) coding scheme. Cardiovascular medications included codes 240400-241600 and the NSAIDS included code numbers 280804 to 280808.

Accuracy was determined by the listing of indicators given in the Physicians' Desk Reference (1992).

Measures

Cognitive Measures - The psychometric tests used in this study assessed three dimensions of mental abilities: Semantic Memory, Inductive Reasoning, and Verbal Comprehension. Semantic Memory is the ability to encode, store, and recall meaningful language units. Inductive Reasoning is the ability to educe novel concepts or relationships. Verbal Comprehension pertains to language knowledge and comprehension (see Table 1 for specific measures).

Insert Table 1 about here

The Life Complexity Inventory (LCI) - Various demographic and personal information were extracted from the Life Complexity Index (LCI) survey of background characteristics (see Schaie, 1995 for greater detail). Information from the LCI included subject's age, family income and education.

Health Outcome Measures - In 1993, participants rated their health on a six-point Likert scale (1="very good" to 6="very poor"). Individuals also reported the number of doctor visits, and hospital stays for 1993. Numbers of medication in 1991 was also considered. Estimated total care costs for 1991 were based upon a Chronic Disease Score (CDS). The CDS was based on empirically derived weights based on age, gender, and pharmacy utilization of the HMO's

pharmacies. These weights were then used to calculate a predicted score for total care costs (Clark, Von Korff, Saunders, Baluch, & Simon, 1994).

ANALYSES

Perceived Therapeutic Purpose (PTP) - Individual PTP responses were classified as accurate and inaccurate for CVD and NSAIDS medications. CVD and NSAIDS medication categories were examined because they are two of the most commonly prescribed drugs (Baum, Kennedy, Knapp, Juergens, & Faich, 1988; Bosworth & Schaie, under review). The PTP was considered accurate when the PTP and Actual Therapeutic Purpose (ATP) corresponded for a given drug (see Appendix A for CVD; see Appendix B for NSAIDS). If the PTP did not correspond with the ATP of the medication, the response was categorized as inaccurate. For example, if an individual used CVD medication and reported the PTP as being "hypertension" the response was coded as correct. If an individual used CVD medication but reported it was used for the treatment of diabetes the response was coded as incorrect. Responses were also categorized as being inaccurate if individuals were not using CVD or NSAIDS but misattributed the function of their medication and listed a purpose associated with CVD or NSAIDS, respectively.

A score of 1 was assigned if the response matched and 2 if it did not. If an individual took more than one of the same types of medication, the average response was accepted. Generally, most participants using one medication or more were consistent in their responses.

Structural Equation Modeling - Before testing the structural model , we evaluated the underlying measurement model by means of confirmatory factor analysis (CFA) using LISREL VIII (Jöreskog & Sörbom, 1989)(see Figure 1). Before evaluating the fit of the model, it is necessary to discuss criteria used to assess the model. Chi-square alone is not an adequate measure of model fit when a relatively large number of subjects are used (Marsh, Balla, & McDonald, 1988). It has been criticized for being overly sensitive in detecting small discrepancies between the model and the data when the distribution of the observed variables are non-normal or the sample size is large (Bollen, 1989). The Non-normed Fit Index (NNFI) and the Normed Fit Index (NFI) formerly the Bentler-Bonnett Index (BBI; Bentler & Bonnett, 1980) are useful in CFA studies to compare a fit of a proposed model to the fit of a null model where all the variables are assumed to be uncorrelated. Both indices suggest that values less than .9 indicate the model may be substantially improved. The Comparative Fit Index (CFI; Bentler,1990) is a robust measure of comparative fit that corrects some of the shortcomings of the NFI. CFI values range from 0 to 1.0, with values closer to 1.0 suggesting a better fitting model. The CFI is based on the noncentrality parameter of the chi-square statistic and the Goodness-of-Fit statistic. The Root Mean Square Error of the Approximation (RMSEA; Steiger, 1990) provides a measure of discrepancy per degree of freedom of the model. Values less than or equal to .05 are considered a good fit of the model relative to the degrees of freedom (Browne & Cudek, 1993). The Goodness-of-fit Index (GFI and the Adjusted-Goodness-

of-Fit (AGFI) measure the relative amount of variances and covariances accounted for by the model (Jöreskog & Sörbom, 1981).

Measurement Model - The cognitive abilities assessed in this study (Verbal Comprehension, Semantic Memory, and Inductive Reasoning) were selected based upon the premise that successfully reporting the purpose of one's medication is dependent on understanding the medication's purpose which is assessed by the PMA verbal comprehension. Making inferences is the next important component of medication comprehension (Park, Willis, Morrow, Diehl & Gaines, 1994). That is, the ability to draw conclusions or make interpretations when information needed is not explicitly stated is assessed by inductive reasoning. Once individuals understand the purpose of their medication, memory becomes necessary to store this information and retrieve it when needed. The three cognitive variables were treated as latent variables with 3 to 4 indicators. Age, income, education, and gender were entered as manifest variables; they were unique factors in and of themselves. The observed dependent variables were treated as latent variables in order to assess whether they were impacted by cognitive functioning, gender, education, income, age and medication knowledge.

Mediational Effects - To establish the mediational influence of medication knowledge on health the following conditions need to be met: a) variations in levels of the independent variable significantly account for variations in the presumed mediation path (path a); b) variations in the mediator account for variations in the independent variable path (path b);

and c) paths a and b are controlled and the previous significant relationship between the independent and dependent variables are no longer significant when path c is reduced to zero. This latter condition provides strong evidence for a single mediator variable. If path c is not zero it may indicate multiple mediating factors (Baron & Kenny, 1986).

RESULTS

The means and standard deviations for health outcome and utilization variables are shown in Table 2. The measurement model will first be discussed followed by the results of the structural path.

Insert Table 2 about here

Measurement Model For CVD - The overall goodness of fit indexes for this CFA were quite satisfactory $X^2[96; n=255]=142.16$, $p<.002$; GFI =.95, AGFI=.89, and the RMR =.033. The NFI was .95 and the NNFI was .97. The RMSEA was .044 and the CFI=.98. The correlations among the latent variables (the PSI matrix) are shown in Table 3. Medication knowledge was negatively correlated with estimated health care costs, self-reported health, and number of hospital visits, but was not significantly correlated with any of the cognitive latent variables. Inductive Reasoning was negatively correlated with the number of medications used, number of doctor visits, total cost of care, and self-reported health while Verbal Comprehension was negatively correlated with number of medications

used, total cost of care, self-reported health and positively correlated with hospital visits. Semantic Memory was negatively correlated with total cost of care. Higher factor loadings indicate a closer relationship between the manifest variable and the underlying latent factor. The estimated factor loadings were of substantial magnitude and differed significantly ($p < .05$) from zero. The factor loadings for the latent variables with multiple indicators are listed in Table 4.

Insert Tables 3 & 4 about here

Structural Path Analyses for CVD Model - The maximum likelihood procedure was chosen as the preferred method of parameter estimation (Jöreskog & Sörbom, 1988). Each model contained direct paths and indirect paths of the independent latent variables to the dependent latent variables. Indirect paths were used to estimate the mediating influence of medication knowledge. Correlations among the exogenous variables were permitted to be freely estimated. Figure 1 presents the significant path coefficients which indicate the magnitude of the effects for each path. Medication knowledge was not predicted by cognitive measures, but a lack of understanding of one's medication predicted increased health care costs, poor self-report health, and an increased number of hospital stays. The mediating effect of medication knowledge on the relationship between gender and hospital visits was only b=.01 and not significant, however the total effect was b=.08 for this relationship. Increased age predicted increased health care costs, number of doctor visits, and decreased self-reported health. Variance that was accounted for by the structural equations were as follows: medication usage 9%, estimated total health care costs 59%, self-reported health 10%, hospital visits 5%, doctor visits 9%, and medication knowledge 3%.

Insert Figure 1 about here

Measurement Model For NSAIDS - The same model was tested on the NSAID sample. The overall goodness of fit indexes for this CFA were quite satisfactory X^2[96; n=185]=152.87, $p<.001$; GFI =.93, AGFI=.84, and the RMR =.045. The NFI was .93 and the NNFI was .94. The RMSEA was .057 and the CFI=.97. The correlation matrix among the latent variables (the PSI matrix) is shown in Table 5. Medication knowledge was negatively correlated with estimated health care costs, but was not correlated with any cognitive measures. Inductive Reasoning and Verbal Comprehension were negatively correlated with number of medications used, estimated total care costs, and self-reported health. Inductive Reasoning was also negatively correlated with number of doctor visits and Verbal Comprehension was positively correlated with hospital visits. Semantic Memory was negatively correlated with total cost of care. The estimated factor loadings were of substantial magnitude and differ significantly ($p < .05$) from zero (Table 6).

Insert Tables 5 & 6 about here

Structural Path Analyses for NSAIDS Model - Figure 2 represents the significant path coefficients which indicate the magnitude of the effects for each path. Cognitive abilities did not predict medication knowledge, but a lack of medication knowledge did predict increased estimated total health care costs for 1991. Men were significantly more likely to be inaccurate than men. Decrease in verbal memory predicted increase medication use and increase number of hospital visits. Increase age predicted increase health care costs and decrease number of hospital visits. Variance that was accounted for by the structural equations were as follows: Medication usage 14%, estimated health care costs 50%, self-reported health 5%, hospital visits 9%, doctor visits 8%, and medication knowledge 5% (Figure 2).

Insert Figure 2 about here

DISCUSSION

Prior investigations have obtained different reports of the number of individuals who reported the correct purpose of their medication. In our study, it appears that Verbal Comprehension, Semantic Memory, and Inductive Reasoning are not substantial predictors of medication knowledge. However, a lack of understanding of the therapeutic purpose of one's medication does have health consequences. In the CVD model, medication knowledge was predictive of increased health care costs, decreased self-reported rating of health, and increased hospital visits. In contrast, in the NSAIDS model, a lack of medication knowledge was associated only with increased health care costs.

Although cardiovascular disease is the leading cause of death and can be debilitating, the majority of individuals suffering from it are still able to maintain fairly high functioning lives. For these individuals, the presence of the disease may require fewer life-style changes and hence result in fewer direct cognitive effects. Our failure to find cognitive abilities that predict correct understanding of one's medication for the CVD users is similar to results of other studies that examined the relationship between cardiovascular disease and cognition. For example, Hertzog, Schaie, and Gribbin (1978) examined multiple mental abilities on 156 adults 43 to 73 years old in an earlier sample of the Seattle Longitudinal Study. They found that the presence of CVD puts one at a greater risk of experiencing a significant cognitive decline over a given period. However, once they controlled for age and cohort membership, the only Primary Mental Ability (PMA) significantly effected by CVD was Numbers. In the Framingham Heart Study, neither blood pressure nor hypertensive treatment was significantly associated with cognitive performance in a sample of 2,032 subjects (Farmer, White, Abott, Kittner, Kaplan, Wolz, Brody, & Wolf, 1987). The Iowa +65 study of an elderly rural sample also found no relationship between antihypertensive treatment and performance on a brief

screening test for memory recall (Wallace, Lemke, Morris et al. 1985). Thus, it is possible that in the case of mild to moderate hypertension, medication may attenuate the effects of CVD on cognitive performance.

NSAIDS may relieve the effects of arthritis and permit individuals to function and carry out daily activities. The relief provided by NSAIDS may delay any changes in life-styles that may indirectly lead to changes (i.e., life-style alterations) that may directly affect cognitive behavior. Furthermore, the lack of evidence that cognitive ability was not found to significantly predict medication knowledge in this sample leads one to search for alternative explanations as to why individual's lack knowledge of their medication.

Other factors besides level of cognitive functioning may also have contributed to decreased knowledge about medication purposes among our respondents. An alternative explanation for the fact that some medication users do not know the purpose of their medication could be that patients do not receive the appropriate information from their physician or pharmacist. For example, in an FDA telephone survey, only five percent of respondents reported that the pharmacist had told them the medication's purpose, and only fifty-one percent of respondents had been told the purpose of their medication by their physician (Morris, 1982).

It is well documented that medication compliance among the elderly is a serious health problem. Between 4% and 35% of complying elders endanger their lives (Carasanos, Stewart, & Cluff, 1974). Hospital admissions in the general population due to noncompliance are estimated at 3% in the United States (Cooper, Love, & Raffoul, 1982).

However, there has been little research to indicate how poor medication knowledge is related to health. We found that this relationship between cognition and health depended upon the type of medication. A lack of knowledge of CVD medication had worse health consequences (i.e., increased estimated health care costs, low self-reported health, and increased number of doctor visits) than that of NSAIDS (i.e., only increased estimated health costs). This difference can be a function of the greater severity and mortality risks of CVD as compared to NSAIDS.

An examination of perceived therapeutic purpose indicated that individuals who reported using CVD and NSAIDS medications were generally correct in identifying the purpose of their medications (Bosworth & Schaie, under review). Our results were fairly consistent with other community studies (Delafuente et al., 1992; Gilbert et al., 1993; Semla et al.,1991). However, no evidence was found to support the hypothesis that older adults would have lower congruence between PTP and ATP for both CVD and NSAIDS medications than do younger adults. In fact, older persons were more accurate than their younger comparisons. By contrast, as expected, increased age predicted more health problems. As a result of time-dependent changes, physiological functions decline and susceptibility to stress increases, chronic illness and disability become more prevalent with increased age (Revenson, 1986).

In conclusion, prior research has demonstrated that medication compliance is related to health. An understanding of the therapeutic function of prescription medication has been found to be necessary, but not sufficient, to ensure compliance in medication use.

It is evident from this study that medication knowledge is associated with the maintenance of good health but factors other than cognitive abilities are most likely to be associated with understanding the purpose of one's medication.

APPENDIX A

Therapeutic Purpose of Cardiovascular Medication

Heart attacks, chest pain, and heart condition
Anticoagulant, "blood thinner"
Blood pressure
Hypertension
Problems with extremities (arms, legs, hips) phlebitis
Strokes, hardening of the arteries, blood clot
Circulation

APPENDIX B

Therapeutic Purpose of Non-Steroidal Anti-inflammatory Medications

Pain
Stiffness
blood thinner
circulation

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Table 1
Psychometric Intelligence Measurement Battery

Primary Ability	Test	Source
Inductive Reasoning	PMA Reasoning (1949)	Thurstone & Thurstone (1949)
	ADEPT Letter Series	Blieszner, Willis & Baltes (1981)
	Word Series	Schaie (1985)
	Number Series	Ekstrom, French, Harman, & Derman (1976)
Verbal Comprehension	PMA Verbal Meaning (1940)	Thurstone & Thurstone (1949)
	ETS Vocabulary	Ekstrom et al. (1976)
	ETS Advanced Vocabulary	Ekstrom et al. (1976)
Verbal Memory	Immediate Recall	Zelinski, Gilewski, & Schaie (1979)
	Delayed Recall	Zelinski, Gilewski, & Schaie (1979)
	PMA Word Fluency	Thurstone & Thurstone (1949)

Table 2: Univariate Statistics for Sociodemographic and Health Variables for CVD and NSAID Medications

	CVD			NSAIDS		
	Mean	Stand Dev.	Range	Mean	Stand Dev.	Range
Age	68.22	10.64	31-89	68.41	11.38	31-86
Income	$40,000	$8,320	$2,000->50,000	$40,000	$7,651	$2,000->50,000
Education	14.4	2.85	7-20	14.43	2.73	9-20
Total Health Care	$4,643.70	$2,369.27	$641-15,450	$4,611.83	$2738.08	$613-15,450
Usage	3.21	2.15	1-12	3.28	2.24	1-12
Self-rated Health - 1993	2.27	.89	1-5	2.37	.96	1-5 .
Hospital Days 1993	1.92	10.4	0-145	3.39	18.16	0-180
Num. Doctor Visits 1993	4.61	4.27	0-30	5	5.14	0-35

Table 3: Inter-correlations for CVD

	Age 1	Income 2	Gender 3	Educat-ion 4	Med know. 5	Reason 6	Verbal 7	Mem-ory 8	# meds used 9	Health Costs 10	self-health 11	# hosp visits 12	#Dr. visits 13
2	-.36*												
3	.10*	-.25*											
4	-.22*	.34*	-.19*										
5	.01	.02	.16*	-.01									
6	-.47*	.30*	.04	.38*	.01								
7	-.14*	.24*	-.02	.38*	-.01	.54*							
8	-.34*	.15*	.10	.25*	-.01	.49*	.39*						
9	.06	-.18*	.15*	-.21*	-.08	-.14*	-.16*	-.09					
10	.34*	-.19*	-.03	-.15*	-.66*	-.27*	-.15*	-.20*	.32*				
11	-.06	-.12*	.02	-.11*	-.19*	-.12*	-.13*	-.02	.32*	.16*			
12	-.05	.10	,05	.07	-.12*	.06	.09*	.06	-.20*	-.03	-.14*		
13	.19*	-.12*	.02	-.09	-.09	-.12*	-.03	-.01	.29*	.23*	.16*	-.37*	

* = p<.05

Table 4: Standardized Factor Loadings for Cognitive Abilities (CVD)

	Inductive Reason	Verbal Comprehension	Memory
PMA Reason	.91		
ADEPT Letter Series	.89		
Word Series	.90		
Number Series	.73		
PMA Verbal ability		.89	
Vocabulary		.65	
Advanced Vocabulary		.75	
PMA Word Fluency		.44	.26
Immediate Recall			.95
Delayed Recall			.93

NOTE: all loadings significant at the $p<.05$

Table 5: Inter-correlations for NSAIDS

	Age 1	Income 2	Gender 3	Educat-ion 4	Med know. 5	Reason 6	Verbal 7	Mem-ory 8	# meds used 9	Health Costs 10	self-health 11	# hosp visits 12	#Dr. visits 13
2	-.37*												
3	.03	-.26*											
4	-.26*	.31*	-.10*										
5	-.01	.05	18*	.07									
6	-.48*	.33*	.15*	.31*	.04								
7	-.05	.23*	.05	.31*	.01	.48*							
8	-.39*	.27*	.27*	.30*	.05	.54*	.37*						
9	.11	-.21*	.16*	-.25*	-.02	-.20*	-.18*	-.04					
10	.44*	-.27*	-.05	-.19*	-.49*	-.37*	-.15*	-.30*	.45*				
11	.01	-.11	-.06	-.07	.01	-.14*	-.19*	-.05	.39*	.20*			
12	-.13*	.13	-.01	.19*	.03	.10	.13*	.04	-.27*	-.15*	-.02		
13	.17*	-.07	.04	-.06	-.05	-.17*	-.06	-.01	.33*	.36*	.19*	-.40*	

* = p<.05

Table 6: Standardized Factor Loadings for Cognitive Abilities (NSAIDS)

	Inductive Reason	Verbal Comprehension	Memory
PMA Reason	.92		
ADEPT Letter Series	.89		
Word Series	.89		
Number Series	.77		
PMA Verbal ability		.92	
Vocabulary		.52	
Advanced Vocabulary		.57	
PMA Word Fluency		.29	.32
Immediate Recall			.91
Delayed Recall			.99

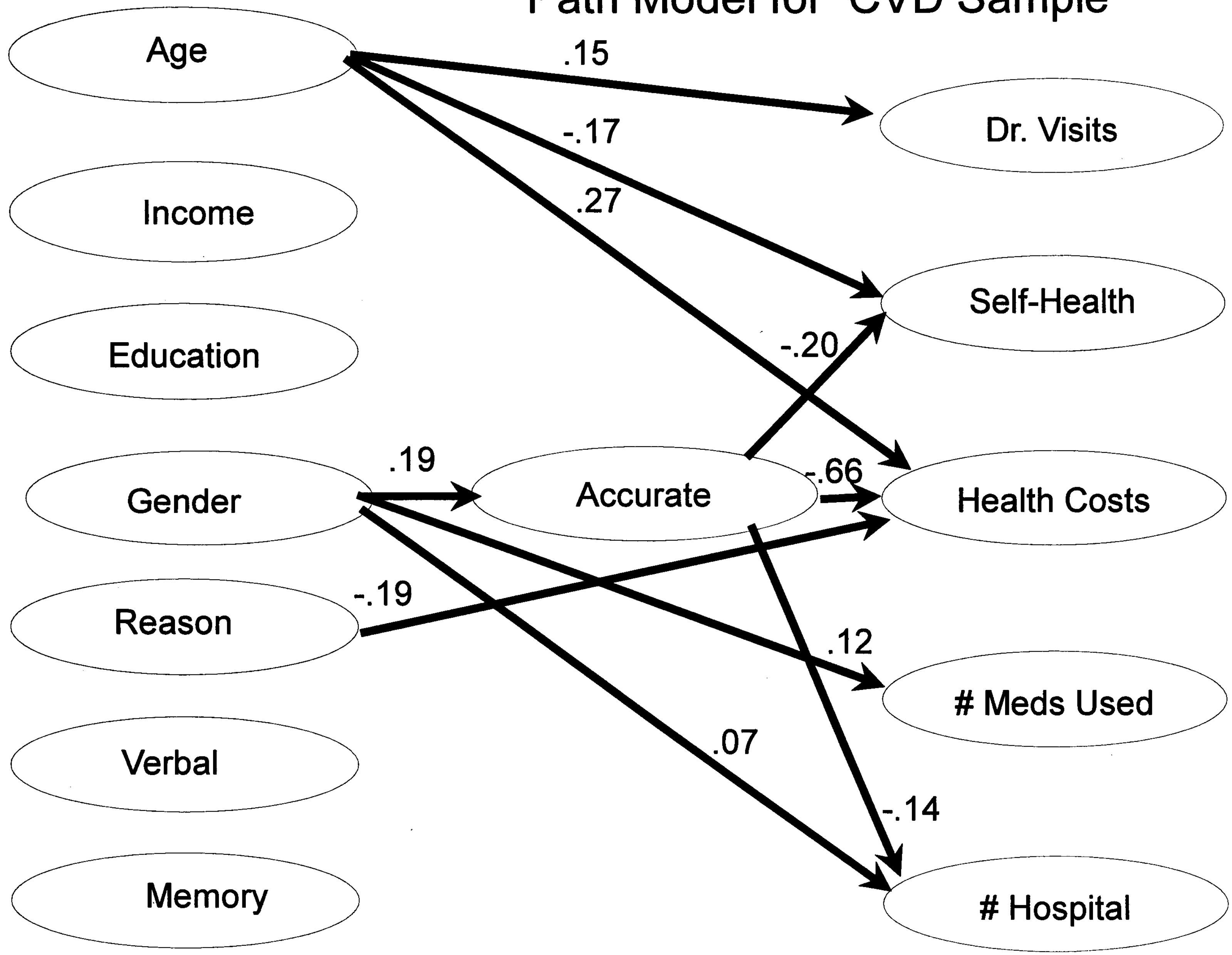
NOTE: all loadings significant at the $p<.05$

Figure Captions

Figure 1 Path Analyses for CVD Model.

Figure 2 Path Analyses for NSAID Model

Path Model for CVD Sample



Path Model for NSAID Sample