Individual and Lifestyle Antecedents of Cardiovascular Disease

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Abstract

The present study examined the use of cognitive, attitudinal flexibility, and lifestyle measures in logistic regression models to predict the presence of cardiovascular disease (CVD). A sample of 370 subjects (m=169; f=201; Mean age = 66.5 yrs) were drawn from the Seattle Longitudinal Study and divided into two separate analyses groups. The first tested all subjects with CVD (AllCVD) versus controls without CVD. The second model used only those developing CVD after the 1977 data collection point (NewCVD) versus those without CVD.

The overall model for the AllCVD group revealed age, gender, attitudinal flexibility, education, and decline in spatial ability as significant predictors of CVD ($X^2[13]=80.96$, $p<.0001$). Testing the gender differences revealed age and attitudinal flexibility significant for females ($X^2[12]=39.02$, $p<.0001$); while age, attitudinal flexibility and education were significant predictors of CVD for males ($X^2[12]=44.67$, $p<.00001$).

The model examining NewCVD found age, attitudinal flexibility, decline in psychomotor speed, spatial ability decline, and decline in reasoning ability significant ($X^2[13]=43.14$, $p<.00001$). Gender differences revealed age, decline of reasoning ability, and word fluency decline significant for males ($X^2[12]=29.13$, $p<.004$); for NewCVD in females attitudinal flexibility was the only significant predictor ($X^2=4.15$, $p<.04$). Lifestyle predictors of change of activity level and smoking habit were not significant.

Individual and Lifestyle Antecedents of Cardiovascular Disease

There are two causal directions that may be evaluated in the study of disease. Disease may be employed as a predictor of potential outcome, eg. functional impairment/disability, or cognitive decline; or alternatively one might examine what factors within a person's life might determine a disease outcome. Cardiovascular disease (CVD) is probably the most commonly studied process in both literatures due to its potentially dangerous and wide-spread impact.

Many studies have examined the role of disease as a predictor of decline in cognitive abilities (Eisdorfer & Wilkie, 1977; Gruber-Baldini & Schaie, 1990; Hertzog, Schaie, & Gribben, 1978). Individuals with CVD have also been shown to decline in speeded tasks (Goldman, Kleinman, Snow, Bidus & Korol, 1974; Spieth, 1964). The question remains why this has been the usual direction of testing the relationship between cognitive abilities and CVD?

This purpose of this study was to examine decline of cognitive abilities, attitudinal flexibility measures, and lifestyle variables as predictors of CVD in a retrospective, longitudinal design.

Method

Subjects

The subjects for this study (N=370) were drawn from the Seattle Longitudinal Study database (Schaie, 1983). The SLS began

in 1956 and has been examining cognitive functioning, flexibility-rigidity, lifestyle and behavior, among other measures using a longitudinal-sequential design. Subjects were recruited through a large Health Maintenance Organization (HMO) in the Seattle area and were subsequently tested at seven year intervals. Age range for this sample was 36-95 years (see table 1).

Particular to this study was the availability of subjects with complete health data as well as the 1977 and 1984 data. The health data were transcribed from medical records by qualified technicians using the International Classification for Disease (ICDA) coding scheme (USPHS, 1968). Full description of these records can be found elsewhere (Parham, Gribben, Hertzog & Schaie, 1975). We have continued to utilize the ICDA-8 for consistency and acknowledge the newer ICDA-9.

A classification scheme was utilized to delineate those subjects with CVD that was severe enough to cause possible cognitive and behavioral effects. This severity classification has been defined elsewhere (Parham, et al., 1975). They key feature of this step was to eliminate those CVD diagnoses seen as benign (ie varicose veins, hemorrhoids).

Insert Table 2 about here

After classification, a total of 215 subjects were found to have CVD diagnoses. This design required dividing the CVD subjects

into two groups; all those with CVD diagnoses (AllCVD), and those diagnosed with CVD after the 1977 data collection (NewCVD) (see tables 3&4). These different groups allowed for two sets of analyses. The first tested CVD regardless of diagnosis time (AllCVD) versus controls (NoCVD's); while the second tested new cases of the disease (NewCVD) against NoCVD's. The number of CVD incidents was not examined as our interest was in differentiating those with CVD from those without as a definitive category.

Measures

Measures were selected from various instruments in the SLS battery. Demographic and lifestyle variables included gender, age, education, and smoking status. Smoking status was defined as a dummy variable for these analyses with not smoking coded as zero and smoking as one. Along with these measures from the Life Complexity Inventory, a measure of participation in various activities was also utilized.

Participants responded to a list of 33 activities by reporting the number of hours per week that they engaged in each activity. These activities included participant sports, educational activities, hiking/outdoor hobbies, reading, travel, games, radio listening and television watching. A change score was developed to examine whether a decline in total number of activities would prove significant, as diversity of activity was shown to be important in our past work (Maitland, O'Hanlon, & Schaie, 1990).

Cognitive Abilities

The test of Primary Mental Abilities (PMA, Thurstone & Thurstone, 1949) was used to examine the following cognitive abilities:

Spatial Orientation. measures the ability to manipulate objects in two-dimensional space. Subjects choose direct rotations of the stimulus object from among six options.

Inductive Reasoning. involves the ability of logical problems - to foresee and plan. This has been noted as probably the most important of the mental abilities (Schaie, 1958).

Number. reflects the ability to work with numbers and measure speed and accuracy using simple arithmetic problems.

Verbal. tests the ability to understand ideas expressed in words.

Word Fluency. measures the subject's ability to write and talk easily. This measures speed while Verbal measures understanding of words.

Flexibility-Rigidity

Flexibility-rigidity was measured using the Test of Behavioral Rigidity (TBR, Schaie, 1955; Schaie & Parham, 1975). Two of three factor scores and one scale from the TBR were included. Motor-cognitive flexibility (MCF) and psychomotor speed (PS) were used to derive change scores from 1977 to 1984. The MCF score reflects the ability to shift between cognitive activities. Psychomotor speed measures the speed of a subject's responses. A third factor

score, Personality-perceptual flexibility (PPF), was not utilized. The Rigidity scale (R-scale), a questionnaire measuring attitudinal flexibility, was utilized in the models and is a component of the PPF factor score which was ignored for this reason.

Results

Dividing the total sample resulted in 215 subjects with CVD overall, and 155 without the diagnosis. Splitting the groups for analyses the AllCVD group had 215 subjects while the NewCVD group had 62, the 155 subjects without CVD served as controls.

Selection of predictors. All five ability measures from the PMA were included in the model. Scores were standardized to T-scores (mean = 50; standard deviation = 10) referenced to the overall SLS sample. Change scores were then derived by subtracting the 1977 scores from the 1984 scores. Decline could then be examined for prediction of CVD. As previously described change scores for MCR and PS were used from the TBR as well as the R-scale score. For each of these scales higher score indicates higher flexibility.

Also included were age, change in number of activities, education and smoking status. Gender was used in the overall model to determine whether tests for gender differences were warranted.

Overall model for AllCVD. A logistic regression was performed trying to predict the dichotomous CVD/NoCVD outcome. The model was significant ($X^2[13]=80.96$, $p<.00001$). All of the above variables were included with the following results.

Insert Table 5 about here

Significance was found for age ($X^2=40.48$, $p<.00001$); attitudinal flexibility ($X^2=13.61$, $p<.0002$); education ($X^2=6.89$, $p<.009$) and change in spatial ability ($X^2=6.04$, $p<.01$). Therefore increasing age, flexible attitude, lower education level and decline in spatial abilities were found to predict the AllCVD group.

AllCVD by gender. Logistic regression was performed to examine gender differences with the following results. The overall model for females was significant ($X^2[12]=39.02$, $p<.0001$), as was the model for males ($X^2[12]=44.67$, $p<.00001$).

Insert Table 6 about here

Significant predictors for females were age ($X^2=19.86$, $p<.00001$); and attitudinal flexibility ($X^2=8.33$, $p<.004$). Older female participants as well as those who were more flexible were more likely to have CVD. There was a trend for spatial ability decline which did not test significant. For males age ($X^2=19.28$, $p<.00001$); attitudinal flexibility ($X^2=4.49$, $p<.03$); and years of education ($X^2=4.09$, $p<.04$) were significant. As with the overall model, males who were older, more flexible in attitude, and had lower education were more likely to have CVD.

Overall model for NewCVD. Logistic regression for the overall model revealed the following ($X^2[13]=43.14$, $p<.00001$).

Insert Table 7 about here

Age was again found to be significant ($X^2=9.66$, $p<.002$); as was attitudinal flexibility ($X^2=6.68$, $p<.01$); decline in psychomotor speed ($X^2=6.65$, $p<.01$); decline in spatial ability ($X^2=4.51$, $p<.03$); and decline in inductive reasoning ability ($X^2=5.19$, $p<.02$). Older subjects, as well as those who were more flexible were more likely to have CVD. Decline in psychomotor speed was found only in those with NewCVD. Controls and the AllCVD group showed stability or increased in psychomotor speed. Both reasoning and spatial ability measure fluid abilities which have been shown to decline before crystallized abilities (Schaie, 1983; Horn, 1978).

NewCVD by gender. The results by gender for those developing CVD after 1977 versus NoCVD were as follows. The model for males was significant ($X^2[12]=29.13$, $p<.004$), while the model for females was not significant ($X^2[12]=19.73$, $p<.07$).

Insert Table 8 about here

For females only attitudinal flexibility was significant with higher flexibility more likely to have CVD ($X^2=4.15$, $p<.04$); with

a trend for decline of psychomotor speed not testing significant. In males, increasing age ($X^2=5.15$, $p<.02$); inductive reasoning decline ($X^2=4.27$, $p<.04$); and word fluency decline ($X^2=5.47$, $p<.02$) were significant. A trend for spatial decline was also noted while not significant. Lifestyle variables including decline of number of activities performed and smoking status did not prove to be useful in these models.

Discussion

The results from this study provide both expected and surprising findings. Declines in spatial ability and inductive reasoning were found, confirming that fluid abilities will not only decline first, but may decline in the presence of CVD. Declines in psychomotor speed were found only for those in the NewCVD group. The lack of this finding in the AllCVD group may show the importance of the age of the disease. Without controlling for length of time with the disease it is possible that decline of psychomotor speed had already taken place in these subjects.

The most interesting finding was that attitudinal flexibility was associated with CVD regardless of time of onset of disease. The following explanations are offered, while other possibilities exist. It is possible that those subjects considered highly rigid in attitudinal flexibility have already dropped out of the study due to lack of time, interest, or poor health while the flexible subjects survive and learn to adapt to life with CVD. In a study of attrition in longitudinal studies (Cooney, Schaie, & Willis,

1988), it was found that those subjects who dropped out due to illness were performing even worse prior to drop-out than subjects whose attrition was due to mortality.

A second explanation that has implications for the health professions would expect patients with more rigid attitudes to be those who have always taken care of themselves and are attentive to their health behaviors. If these subjects or their physician noticed potential for decline in health they would be more likely to follow through with exercise or other positive health behaviors to avoid a disease outcome. Both of these explanations are testable and it is hoped that future work might confirm these results in other samples.

Several limitations must be acknowledged. It is very difficult to determine causality in the study of health outcomes. This study discusses associations between the tested variables and their relationship to CVD. Without knowledge of which subjects are under treatment for their CVD; who complied to physician orders; and better measurement of health status these findings have limited application. The attitudinal flexibility result has impact in the areas of compliance to treatment and may reflect potential for satisfactory outcome for subjects with CVD.

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Table 1: Overall Sample Means by Gender
(N=370)

Male (n=169)					Female (n=201)			
Variable	Mean	s.d.	Range		Variable	Mean	s.d.	Range
Flexibility	10.04	4.17	0 - 21		Flexibility	10.64	4.08	3 - 20
Spatial ch	-1.81	6.11	-17 - 19		Spatial ch	-2.38	6.35	-28 - 18
Reason ch	-1.25	5.02	-21 - 12		Reason ch	-2.15	5.06	-24 - 9
Verbal ch	-1.94	5.35	-21 - 14		Verbal ch	-2.60	6.17	-30 - 13
Number ch	-1.63	5.37	-15 - 16		Number ch	-1.66	5.19	-16 - 11
Word Flu ch	-1.89	6.09	-17 - 15		Word Flu ch	-1.78	6.80	-25 - 17
PPS ch	.09	5.15	-23 - 14		PPS ch	.52	6.80	-16 - 13
MCF ch	-1.81	5.95	-20 - 14		MCF ch	-2.64	6.33	-28 - 16
Action(S/D)	.89	.33	0 - 1		Action(S/D)	.85	.36	0 - 1
Education	14.46	3.22	7 - 20		Education	13.91	2.60	8 - 20
Smoke (Y/N)	.24	.43	0 - 1	*	Smoke (Y/N)	.12	.33	0 - 1
Age	66.60	10.95	36 - 95		Age	66.49	10.95	37 - 92

(*p<.05, **p<.01, ***p<.001; ch=change score)

Table 2: CVD Group Classifications

ICDA Code	Description
	Hypertension
401	Essential hypertension
403	Renal hypertension
	Atherosclerosis
410.9	Acute myocardial infarction
411.9	Acute ischemic heart disease
412.9	Chronic ischemic heart disease
413.9	Angina pectoris
426	Pulmonary heart disease
427.0	Congestive heart failure
427.1	Left ventricular failure
427.2	Cardiac arrest
427.3	Other heart block
428	Other myocardial insufficiency
440.0	Arteriosclerosis of aorta
440.9	Arteriosclerosis (generalized)
	Hypertension and Atherosclerosis
402	Hypertensive heart disease
411.0	Acute ischemic heart disease, with hypertension
412.0	Chronic ischemic heart disease, with hypertension
413.0	Angina pectoris, with hypertension
	Cerebrovascular Disease
430.0	Subarachnoid hemorrhage, with hypertension
431.9	Cerebral hemorrhage
431.0	431.9, with hypertension
432.9	Occlusion of precerebral arteries
432.0	432.9, with hypertension
433.9	Cerebral thrombosis
433.0	433.9, with hypertension
434.9	Cerebral embolism
435.9	Transient cerebral ischemia
436.9	Acute, ill-defined cerebrovascular disease
436.0	436.9, with hypertension
437.9	Generalized ischemic cerebrovascular disease
438.9	Other ill-defined cerebrovascular disease
438.0	438.9, with hypertension
	Miscellaneous CVD
394.0	Mitral valve disease, rheumatic
395.0	Aortic valve disease, rheumatic
396.0	Both 394.0 and 395.0
398	Rheumatic heart disease
424.1, 424.9	Chronic disease of endocardial structures
427.4-427.9	Disorders of heart rhythm
429.0	Cardiac enlargement & hypertrophy
429.9	Other ill-defined heart disease
440.2	Arteriosclerosis of extremities
441.2	Aneurysm of abdominal aorta
443.0, 443.9	Peripheral vascular disease
444.4, 444.9	Embolism and thrombosis of minor arteries
445	Gangrene
447	Other disease of arteries and arterioles
448	Diseases of capillaries
450	Pulmonary embolism and infarction
451.0, 451.9	Phlebitis and thrombophlebitis
453	Other venous embolism and thrombosis
458.0	Hypotension
	Benign CVD
454.0-454.9	
456.1	Varicose veins (assorted sites)
455	Hemorrhoids
458.9	Other and unspecified circulatory disorders

From Hertzog, Schaie & Gribben, 1978
All codes except Benign CVD were included in CVD groups.

Table 3: Sample Means for AllCVD vs NoCVD

AllCVD (n=215)					NoCVD (n=155)			
Variable	Mean	s.d.	Range		Variable	Mean	s.d.	Range
Flexibility	10.66	4.18	1 - 20		Flexibility	9.95	4.03	0 - 21
Spatial ch	-2.85	5.75	-28 - 19	**	Spatial ch	-1.10	6.75	-24 - 18
Reason ch	-2.38	5.24	-24 - 9	**	Reason ch	- .84	4.66	-14 - 12
Verbal ch	-2.76	6.09	-30 - 14		Verbal ch	-1.64	5.33	-25 - 14
Number ch	-1.58	5.40	-16 - 13		Number ch	-1.73	5.09	-15 - 16
Word Flu ch	-2.38	6.54	-25 - 15		Word Flu ch	-1.07	6.34	-24 - 17
PPS ch	- .18	5.05	-16 - 12	*	PPS ch	1.01	4.90	-23 - 14
MCF ch	-2.49	6.40	-28 - 16		MCF ch	-1.94	5.83	-22 - 14
Action(S/D)	.88	.32	0 - 1	*	Action(S/D)	.83	.38	0 - 1
Education	14.01	3.10	7 - 20		Education	14.38	2.63	8 - 20
Smoke (Y/N)	.17	.37	0 - 1		Smoke(Y/N)	.19	.39	0 - 1
Age	70.08	8.84	50 - 95	***	Age	61.61	11.66	36 - 85

(*p<.05, **p<.01, ***p<.001; ch=change score)

Table 4: Sample Means for NewCVD vs NoCVD

NewCVD (n=62)					NoCVD (n=155)			
Variable	Mean	s.d.	Range		Variable	Mean	s.d.	Range
Flexibility	11.15	4.09	3 - 19	*	Flexibility	9.95	4.03	0 - 21
Spatial ch	-3.84	5.90	-24 - 9	**	Spatial ch	-1.10	6.75	-24 - 18
Reason ch	-3.38	5.26	-21 - 6	***	Reason ch	- .84	4.66	-14 - 12
Verbal ch	-3.52	7.16	-30 - 12	*	Verbal ch	-1.64	5.32	-25 - 14
Number ch	-2.23	5.00	-15 - 11		Number ch	-1.73	5.09	-15 - 16
Word Flu ch	-2.86	6.72	-25 - 11		Word Flu ch	-1.07	6.33	-24 - 17
PPS ch	-1.53	4.91	-16 - 9	***	PPS ch	1.01	4.90	-23 - 14
MCF ch	-1.67	5.64	-23 - 9		MCF ch	-1.94	5.83	-22 - 14
Action(S/D)	.85	.36	0 - 1		Action(S/D)	.83	.38	0 - 1
Education	14.36	2.73	8 - 20		Education	14.38	2.63	8 - 20
Smoke(Y/N)	.13	.34	0 - 1		Smoke(Y/N)	.19	.39	0 - 1
Age	70.16	9.33	50 - 90	***	Age	61.61	11.66	36 - 85

Table 5: Logistic Regression Analysis of ALLCVD vs Controls (NOCVD)

Independent variable	coefficient	Standard error	X^2	P value
AGE	.08785	.01380	40.48	.0000*
ATT. FLEX.	.12575	.03408	13.61	.0002*
CHPPS	-.03992	.02811	2.02	.1556
CHMCR	.00386	.02160	0.03	.8580
ACTION(I/D)	.31802	.36460	0.76	.3831
EDUC	-.12634	.04812	6.89	.0087*
TSCH7784	-.05071	.02064	6.04	.0140*
TRCH7784	-.04428	.02642	2.81	.0938
TNCH7784	.03211	.02505	1.64	.1999
TWCH7784	-.01414	.01951	0.53	.4686
TVCH7784	.01343	.02432	0.30	.5808
DSMOKE (N/Y)	-.09738	.33329	0.09	.7701
GENDER (F/M)	.60517	.25818	5.49	.0191*

* Significant P-values

Table 6: Logistic Regression Analysis of ALLCVD vs Controls (NOCVD) by Females

Independent variable	coefficient	Standard error	X^2	P value
AGE	.08092	.01815	19.86	.0000*
ATT. FLEX.	.12716	.04406	8.33	.0039*
CHPPS	-.03777	.03609	1.10	.2953
CHMCR	.00393	.02833	0.02	.8897
ACTION(I/D)	-.00432	.45900	0.00	.9925
EDUC	-.10318	.06750	2.34	.1264
TSCH7784	-.04803	.02736	3.08	.0792
TRCH7784	-.03893	.03784	1.06	.3036
TNCH7784	.04534	.03395	1.78	.1817
TWCH7784	.00372	.02507	0.02	.8820
TVCH7784	.00760	.03011	0.06	.8006
DSMOKE (N/Y)	.32450	.55329	0.34	.5575

* Significant P-values

Logistic Regression Analysis of ALLCVD vs Controls (NOCVD) for Males

Independent variable	coefficient	Standard error	X^2	P value
AGE	.09870	.02248	19.28	.0000*
ATT. FLEX.	.12231	.05774	4.49	.0342*
CHPPS	-.03141	.04627	0.46	.4972
CHMCR	.00320	.03522	0.01	.9275
ACTION(I/D)	1.03561	.64680	2.56	.1094
EDUC	-.14544	.07194	4.09	.0432*
TSCH7784	-.04489	.03326	1.82	.1772
TRCH7784	-.05952	.04045	2.16	.1413
TNCH7784	.00448	.04091	0.01	.9128
TWCH7784	-.05418	.03373	2.58	.1082
TVCH7784	.00742	.04181	0.03	.8591
DSMOKE (N/Y)	-.47090	.44700	1.11	.2921

* Significant P-values

Table 7: Logistic Regression Analysis of NEWCVD vs Controls (NOCVD)

Independent variable	coefficient	Standard error	X^2	P value
AGE	.05562	.01789	9.66	.0019*
ATT. FLEX.	.12281	.04752	6.68	.0098*
CHPPS	-.11191	.04340	6.65	.0099*
CHMCR	.01401	.03048	0.21	.6456
ACTION(I/D)	.50256	.52114	0.93	.3349
EDUC	-.13043	.07335	3.16	.0754
TSCH7784	-.06134	.02889	4.51	.0338*
TRCH7784	-.08868	.03894	5.19	.0228*
TNCH7784	.02408	.03826	0.40	.5291
TWCH7784	-.02196	.02810	0.61	.4346
TVCH7784	.01128	.03584	0.10	.7530
DSMOKE (N/Y)	-.54912	.53814	1.04	.3075
GENDER (F/M)	.42035	.37223	1.28	.2588

* Significant P-values

Table 8: Logistic Regression Analysis of NEWCVD vs Controls (NOCVD) for Females

Independent variable	coefficient	Standard error	X^2	P value
AGE	.03765	.02283	2.72	.0991
ATT. FLEX.	.12466	.06121	4.15	.0417*
CHPPS	-.09723	.05300	3.37	.0666
CHMCR	.01513	.04056	0.14	.7091
ACTION(I/D)	.35897	.63479	0.32	.5717
EDUC	-.12759	.10696	1.42	.2329
TSCH7784	-.05507	.03491	2.49	.1147
TRCH7784	-.08113	.05368	2.28	.1307
TNCH7784	.01626	.05098	0.10	.7497
TWCH7784	.02175	.03407	0.41	.5231
TVCH7784	.00415	.04568	0.01	.9274
DSMOKE (N/Y)	-.85954	.98443	0.76	.3826

* Significant P-values

Logistic Regression Analysis of NEWCVD vs Controls (NOCVD) for Males

Independent variable	coefficient	Standard error	X^2	P value
AGE	.07170	.03159	5.15	.0232*
ATT. FLEX.	.10771	.08949	1.45	.2287
CHPPS	-.14060	.08582	2.68	.1014
CHMCR	-.00369	.05514	0.00	.9465
ACTION(I/D)	1.50256	1.01716	1.07	.3009
EDUC	-.13042	.11450	1.30	.2547
TSCH7784	-.10506	.06083	2.98	.0841
TRCH7784	-.14523	.07030	4.27	.0389*
TNCH7784	.02845	.06609	0.19	.6669
TWCH7784	-.15130	.06469	5.47	.0194*
TVCH7784	.00952	.06129	0.02	.8766
DSMOKE (N/Y)	-.55598	.73481	0.57	.4493

* Significant P-values