Structure of Health Behaviors in Older Adults

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Abstract

Although certain specific health behaviors (e.g., diet) have been studied intensively, the interrelationship among diverse health practices has received less examination. 430 older adults (M=78.0 years) received the Penn State Health Behavior Questionnaire (HBQ), a 44 item survey that assesses self-reported health practices and self-perceptions of health status. Confirmatory factor analysis indicated that four health practice (i.e., Substance Use, Positive Nutrition Behaviors, Medical Check-ups, Health Maintenance Activities) and three health status factors (i.e., Positive Health Perception, Positive Health Status, High Blood Pressure) sufficiently accounted for the observed variability in HBQ items. Comparing young-old (N=202) and old-old (N=228) participants, partial measurement invariance was established for the seven factor model. Factor intercorrelations were moderate in magnitude and they did not differ across the two age groups. Results indicated that health behaviors should be conceptualized as multidimensional, and that the proposed model holds for both young-old and old-old.

Structure of Health Behaviors in Older Adults

Health behaviors are activities that people engage in spontaneously or can be induced to perform with the intention of preventing disease or detecting it in an asymptomatic stage (Kasl & Cobb, 1966; Kirscht, 1983). Favorable health outcomes for some health behaviors (e.g., regular physical activity, maintaining proper weight, not smoking) are well established (Wiley & Camacho, 1980). Effects of other health behaviors (e.g., alcohol consumption, eating breakfast) are less clear (Stampfer, Colditz, Willet, Speizer, & Hennekens, 1986; Wingard, Bergman, & Brand, 1982).

In recognition of the importance of a healthy lifestyle, current research (Sobal, Revicki, & DeForge, 1992; Vickers, Conway, & Hervig, 1990; Ungemack, 1994) has focused on the interrelationship among health behaviors. Do people practice multiple "good" health behaviors together, or are these practices unrelated? Understanding the interrelationships among health behaviors can provide useful insights for public health programs and for health care providers. Depending on whether or not people practice groups of behaviors concurrently, strategies for intervention will differ.

Surveys involving United States (Sobal et al., 1992) and Canadian (Stephens, 1986) national samples indicated that health behaviors are related, but the association is usually of small magnitude. However, some practices (e.g., alcohol consumption and smoking) are more closely

associated than others. This has led to the assumption that health behaviors are multidimensional (Kannas, 1981; Krick & Sobal, 1990), but there is less agreement on the number and content of these dimensions (Sobal et al., 1992).

Research examining health behaviors has often focused on younger age groups and less is known about health practices in older adults. Prohaska, Leventhal, Leventhal, and Keller (1985) reported that older adults practiced more health-promoting and stress-avoidance behaviors when compared to young and middle-aged adults. United States national data show that both smoking and alcohol consumption decrease with age, but so does regular physical activity (Stephens, 1988). Studies examining patterns of health behaviors in older adults suggest that health practices are related (Amir, 1990; Rakowski, Julius, Hickey, & Halter, 1987; Walker, Sechrist, & Pender, 1987), but differences between young-old and old-old adults have received less attention.

The present study examined patterns of interrelationships among health behaviors in rural elderly. Two research questions were addressed. We first examined whether various disparate health practices could be grouped into more general but meaningful categories. We hypothesized that four health behavior factors (substance use, nutrition behaviors, medical checkups, health-maintenance activities) and three health status factors (health perceptions, health status, high blood pressure) would be sufficient to explain the interrelationships among single health practices. Second, we

examined whether the seven-factor model was useful to describe health practices of both young-old and old-old adults. We predicted that the seven-factor model would be applicable to both age groups.

Method

Sample

Participants in this study were part of a larger on-going study of adult cognitive development, the Adult Development and Enrichment Project. Participants were 430 community-dwelling older adults, 366 females and 64 males. Their age range in 1993 was 62 to 100 years (M=78.0, SD=6.5), and their years of education ranged from 0 to 22 years (M=11.6, SD=2.6). Participants rated their health as good (M=2.24, SD=.89) on a six-point Likert scale (1="very good" to 6="very poor").

Procedure and health behavior measure

The Penn State Health Behavior Questionnaire (HBQ) is a new instrument developed to assess health behaviors and health-related issues in adults. The HBQ was mailed to participants and completed in their homes. The response rate for this survey was 75.5%. The HBQ is comprised of 86 items with different response formats (multiple-choice, open-ended, and rating scale formats). HBQ items tap seven health-related domains: Substance use, nutrition behaviors, medical checkups, health maintenance activities, health perceptions, general health status, and cardiovascular health status. 44 HBQ items were used in this study. A brief description of these items may be found in the first column of Table 2.

Results

The results are organized in two sections. Development of the factor structure of the 44 HBQ items will be described first. Analyses addressing group differences (young-old versus old-old) will then follow.

Measurement model of seven health factors. The 44 HBQ items used in this study represent quite different and heterogeneous domains. We hypothesized that the 44 items could be reduced to seven health factors. We assumed that four health behavior factors (substance use, nutrition behaviors, medical checkups, health-maintenance activities) would reflect practices that individuals undertake to protect their health. We further expected that three health status factors (health perceptions, health status, high blood pressure) would reflect how healthy individuals are. A substantive interpretation of the hypothesized seven health factors is provided in Table 1.

Insert Table 1 about here

We first examined the 946 correlations among the 44 HBQ items. Absolute values of these correlations ranged from 0 to .858 (M=.100, SD=.112) with a median of .072, suggesting that item intercorrelations were quite low. We then applied Bartlett's test for significance of the correlation matrix (Gorsuch, 1983). The null hypothesis that there were no common factors was rejected ($\chi^2[946]=4774.35$, $p<.0001$), suggesting that it was

reasonable to proceed with factor analysis.

A common factors analysis with squared multiple correlations in the diagonal was conducted. The scree plot indicated that seven factors should be extracted. This conclusion was supported by the fact that seven eigenvalues were larger than one. An exploratory factor analysis with promax rotation resulted in the factor loadings shown in Table 2.

Insert Table 2 about here

For the most part, the obtained factor pattern supported the hypothesized seven factor structure. Six of the seven hypothesized factors emerged in this analysis, all but the Health Maintenance Activities factor. Health behavior items hypothesized to comprise the Health Maintenance Activities factor loaded on other factors, but their loadings were quite low. The unexpected seventh factor was mainly marked by two items assessing participants' use of butter. We decided that conflicting evidence from exploratory factor analysis was small and we retained the hypothesized seven factor model.

We next conducted a confirmatory factor analysis (Joereskog & Soerbom, 1989) to achieve simple structure in the factor pattern matrix (all or most items loading on only one factor). In a first model, we specified only primary loadings (i.e., all items loading only on their hypothesized factor). This model resulted in a poor fit to the data ($\chi^2[881]=2160.50$,

GFI=.799, AGFI=.744, $p<.001$). Following Joereskog's (1993) suggestions, we used modification indices of fixed parameters for subsequent model modification. We first examined fixed factor loadings for large modification indices. The were two secondary loadings that could be interpreted substantively: "self-reported health" on the Positive Health Status factor, and "body mass index" on the Blood Pressure factor. Incorporating the two secondary loadings into the model yielded a better fit in comparison to the first model ($\Delta\chi^2=58.79$, $\Delta df=2$, $p<.001$), but the overall fit of the second model was still modest ($\chi^2[879]=2101.71$, GFI=.805, AGFI=.780, $p<.001$).

Modification indices for fixed residual correlations suggested that there were several correlated residuals due to two sources: (1) additional shared variance among items loading on the same factor that was not accounted for by the factor (e.g., "brushing teeth" and "flossing teeth"); and (2) shared variance among variables loading on different factors that was not accounted for by factor intercorrelations (e.g., "perceived eyesight" and "reading without glasses"). Subsequently, 19 correlated residuals were specified. Residuals were only allowed to correlate if their correlation was both substantively meaningful and statistically significant ($p<.0001$). A model incorporating the correlated residuals fit the data quite well ($\chi^2[860]=1362.60$, GFI=.876, AGFI=.858, $p<.001$), considering the heterogeneity of the behaviors investigated and the parsimony of the model imposed.

A frequent criticism of this type of structural modeling is that parameters are added post-hoc to arrive at a well-fitting model. One method of estimating the substantive invariance of solutions obtained under alternative model assumptions is to correlate the major parameters obtained from these alternative models (Tanaka & Huba, 1984). In our case, the parameters of interest are factor loadings and factor intercorrelations. The correlation between parameter estimates obtained from a model without correlated residuals and estimates obtained from the model assuming correlated residuals was $r=.96$. Coefficients larger than .90 support the stability of the initial model and the triviality of the post-hoc parameters (Byrne, Shavelson and Muthen (1989), and we are confident that our parameters of interest are not adversely affected by the introduction of correlated residuals. Given the substantive invariance, we have chosen to present parameter estimates obtained from the best-fitting model. The factor loadings estimated by this model are shown in Table 3. Although some loadings are of low magnitude, all factor loadings were significantly ($p<.01$) different from zero.

Insert Table 3 about here

Health factor intercorrelations are shown in Table 4. The seven health factors were related ($\chi^2[21]=234.01$, $p<.001$), only five of 21 correlations were not significantly ($p<.05$) different from zero. Although health factors

were related, the correlations were on average moderate in magnitude (ranging from r=.007 to r=.505). This indicated that health factors are sufficiently distinct and that they should be treated as separate constructs.

Insert Table 4 about here

Equivalence of the seven factor model for young-old and old-old adults. We split the sample into two approximately equal halves to compare the health factor measurement model across age groups. There were N=208 young-old adults (range: 62-77 years, M=72.43 years) and N=228 old-old adults (range: 78-100 years, M=82.82 years). Simultaneous estimation of parameters for young-old and old-old was based on the covariance rather than the correlation matrices (see Joereskog & Soerbom, 1989).

As a prerequisite to test for factorial invariance, it is convenient to consider a baseline model. More restrictive models involving various levels of factorial invariance may be compared against this model. We chose the seven factor model described above as a baseline model. This model was simultaneously estimated for both groups (young-old and old-old) without between-groups constraints and is labeled TG1 in Table 5. This model fitted to both groups equally well (GFI[young]=.787, GFI[old]=.817). The second model (labeled TG2 in Table 5) specified invariant factor loadings between groups. This model fit the data worse than TG1 ($\Delta\chi^2$=54.72, Δdf=39, p<.05), indicating group differences in factor loadings. Given noninvariance

of the factor loading matrix, follow-up procedures can be applied to pinpoint the source of inequality (Byrne, Shavelson, & Muthen, 1989; Reise, Widaman, & Pugh, 1993). We examined the modification indices for the constrained factor loading matrix and found that noninvariance could mainly be attributed to four loadings. The deviant loadings were "amount smoked present" (larger for young-old), "use of seat belts" (larger for old-old), "blood pressure taken by a medical person" (larger for young-old) and "blood pressure taken - self" (larger for young-old). We specified a model, labeled TG3 in Table 5, that relaxed the between-group equality constraints for these four loadings. This model did not fit significantly worse than TG1 ($\Delta\chi^2$=26.89, Δdf=35, p=.84), suggesting that partial measurement invariance can be accepted. Further testing of invariance can be conducted when partial measurement invariance is established (Byrne, Shavelson, & Muthen, 1989). We specified a model TG4 constraining the factor variance-covariance matrices to be equal across groups. This model did not fit significantly worse than TG3 ($\Delta\chi^2$=37.92, Δdf=~~32~~ 28, p=.10), suggesting that there were no group differences in variances and covariances of the seven health factors. Table 5 summarizes model comparisons, and Table 6 shows the partially invariant factor loading matrices for young-old and old-old adults.

Insert Tables 5 and 6 about here

Discussion

This study examined interrelationships among various health behaviors in rural elderly. Consistent with prior studies, our data indicated that these behaviors are related, but that associations are of small magnitude. Exploratory and confirmatory factor analyses supported our concept that single health practices could be grouped into four broad health behavior domains: substance use, nutrition behaviors, medical checkups, and health maintenance activities. The domains or health factors were moderately correlated.

These results suggest that older adults do practice groups of health behaviors together. Although interrelationships among single practices were low, the notion of a health life-style was supported. Older adults who practiced more health maintenance activities were also more likely to avoid harmful substances, to practice better nutrition habits, and to have preventive medical checkups more often. This result is consistent with prior research. Both Schwirian (1991) and Walker, Sechrist, and Pender (1987) have reported that higher-order constructs of preventive health behaviors were positively associated.

Health behaviors in older adults are an interesting issue in itself, but their practical relevance arises with regard to health outcomes. For younger adults, beneficial effects of "good" health behaviors are well established (e.g., Wiley & Camacho, 1980). The association between health behaviors and health outcomes is less clear for the elderly (Branch & Jette, 1984; Brown

& McCreedy, 1986). Due to the crossectional nature of our study, we cannot disentangle the intricate relationship between health behaviors and health status. However, some observations can be made. Prior research has recommended "sleeping 7 or 8 hours per night" as a favorable health practice (e.g., Wingard, Berkman, & Brand, 1982). In our study, this practice was unrelated to all health behavior constructs, but was associated with better health status. It may be that older adults' sleeping patterns reflect their actual health status, and are less determined by individuals' preventive efforts.

Factor intercorrelations revealed some interesting patterns with regard to the intertwined relationship between health behaviors and health status. Positive self-reported health status was not uniformly associated with better health practices. There was a positive association between health maintenance activities and health status, possibly reflecting protective effects of these preventive practices. There was, however, a negative association between medical checkups and health status. It may be that less healthy elderly receive more examinations due to their regular contact with health services providers.

We have proposed a model that explains interrelationships among many single practices through fewer higher order constructs. We examined whether this model is useful to describe health practices in both young-old and old-old adults. A comparison of the two groups indicated that there were only minor differences, probably reflecting the fact that there is less

variability in some practices for the old-old group (e.g., "amount currently smoked"). There were no group differences for the majority of relevant model parameters. This suggests that the broad categories were appropriate to describe health behaviors in both young-old and old-old adults.

The reported analyses represent our first attempt to arrive at a comprehensive and parsimonious model of health behaviors. We relied on substantive considerations and statistical criteria in making judgements of the adequacy of a particular model, and the nature of this study was exploratory. The large degree of invariance across age groups provides preliminary support for the generalizability of the seven factor model. However, cross-validation involving one or more different samples will be helpful in evaluating the feasibility of the proposed model.

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Table 1
Interpretation of Seven Health Factors.

Factor	Interpretation
Substance Use	High values indicate current or past smoking (i.e., cigarette, pipe, cigar) and consumption of alcoholic beverages.
Positive Nutrition Behaviors	High values indicate adherence to a low fat and low sodium diet, and low consumption of caffeinated beverages.
Medical Check-ups	High values indicate frequent preventative medical examinations and treatments (e.g., cholesterol checks, mammograms or prostate exams, flu shots).
Health Maintenance Activities	High values indicate engagement in behaviors that promote health (e.g., exercise) and avoid risks (e.g., use of seat belts).
Positive Health Perception	High values indicate a positive evaluation of sensory functioning (i.e., vision and hearing) and general health, both with regard to prior level of function and in comparison to other people of the same age.
Positive Health Status	High values indicate a good general health status, as measured by few doctor visits due to medical problems, no hospitalization, and the absence of frailty.
High Blood Pressure	High values indicate a diagnosed cardiovascular condition and the intake of cardiovascular medication.

Table 2
Factor Loadings Obtained from Exploratory Factor Analysis (Common Factors, Promax Rotation).

	Factor 2: Substance Use	Factor 1: Positive Nutrition Behaviors	Factor 5: Medical Check-ups	Factor 7: (Use of Butter)	Factor 4: Positive Health Perception	Factor 3: Positive Health Status	Factor 6: High Blood Pressure
Current smoker	.933						
Years smoked	.872						
Amount smoked present	.616						
Amount smoked past	.735						
Attempt to quit smoking (-)	.512						
Alcohol consumption	.287						
Read sodium labels		.851					
Buy low sodium		.861					
Cook low sodium		.527					
Read fat labels		.753					
Buy low fat		.754					
Eat butter (-)				.688			
Cook without butter				.673			
Drink caffeinated beverages (-)		.228					
Vision checked			.255				
Flu shots			.362				
Cholesterol checked			.447				
Medical check-up			.410				
Colon/rectal check-up			.429				
Mammogram or prostate exam			.588				
Regular exercise				.204			
Teeth brushing			.215				
Teeth flossing						.260	
Use of seat belts						.356	
Good vision (self-rating)					.574		
Good hearing (self-rating)					.676		
Decline in vision (self-rating) (-)					.608		
Decline in hearing (self-rating) (-)					.808		
Health (self-rating)						.505	
Decline in health (self-rating)(-)					.470		
Read without glasses					.242		
Blood pressure taken by medical person (-)						.405	
Number of doctor visits (-)						.481	
Days in hospital (-)						.340	
Diabetes diagnosed (-)							.217
Bowel stimulant						.208	
Sleep 7 or 8 hours						.193	
Need assistance for stairs (-)						.663	
Use walker (-)						.614	
Number falls last year (-)						.428	
Blood pressure taken - self							.155
High blood pressure diagnosed							.852
Blood pressure medication							.867
Body Mass Index						.298	

Note. (-) indicates reverse scoring.
For each variable, only its major loading is reported. Minor loadings are omitted.

Table 3
Measurement Model for Seven Health Factors (N=430).

	Substance Use	Positive Nutrition Behaviors	Medical Check-ups	Health Maint. Activities	Positive Health Perception	Positive Health Status	High Blood Pressure
Current smoker	.711						
Years smoked	.827						
Amount smoked present	.637						
Amount smoked past	.989						
Attempt to quit smoking (-)	.415						
Alcohol consumption	.195						
Read sodium labels		.802					
Buy low sodium		.798					
Cook low sodium		.459					
Read fat labels		.833					
Buy low fat		.805					
Eat butter (-)		.325					
Cook without butter		.352					
Drink caffeinated beverages (-)		.233					
Vision checked			.281				
Flu shots			.322				
Cholesterol checked			.633				
Medical check-up			.593				
Colon/rectal check-up			.449				
Mammogram or prostate exam			.543				
Regular exercise				.233			
Teeth brushing				.303			
Teeth flossing				.360			
Use of seat belts				.489			
Good vision (self-rating)					.578		
Good hearing (self-rating)					.405		
Decline in vision (self-rating) (-)					.638		
Decline in hearing (self-rating) (-)					.522		
Health (self-rating)					.207	.486	
Decline in health (self-rating)(-)					.717		
Read without glasses						.206	
Blood pressure taken by medical person (-)						.414	
Number of doctor visits (-)						.471	
Days in hospital (-)						.366	
Diabetes diagnosed (-)						.206	
Bowel stimulant						.269	
Sleep 7 or 8 hours						.175	
Need assistance for stairs (-)						.607	
Use walker (-)						.475	
Number falls last year (-)						.392	
Blood pressure taken - self							.188
High blood pressure diagnosed							.864
Blood pressure medication							.946
Body Mass Index				-.255			.151

Note. (-) indicates reverse scoring.
All factor loadings are significantly ($p < .01$) different from zero.

Table 4
Correlations among Seven Health Factors.

Factor	1	2	3	4	5	6	7
1. Substance Use	--						
2. Positive Nutrition Behaviors	-.170	--					
3. Medical Check-ups	-.150	.432	--				
4. Health Maintenance Activities	-.173	.412	.231	--			
5. Positive Health Perception	-.139	.180	*-.008*	.271	--		
6. Positive Health Status	*.007*	*-.053*	-.261	.505	.488	--	
7. High Blood Pressure	*-.088*	.170	.303	*-.125*	-.166	-.237	--

Note. Correlations in *italics* are not significantly ($p < .05$) different from zero.

Table 5
Simultaneous Tests of Invariance for Seven Health Factor Model.

Competing Models	χ^2	df	GFI (young-old/old-old)	Comparison	$\Delta\chi^2$	Δdf	p
TG1: No invariance constraints between groups	2265.31	1720	.787/.817				
TG2: Factor loadings invariant	2320.03	1759	.783/.811	TG2-TG1	54.72	39	<.049
TG3: Partial measurement invariance (see text)	2292.20	1755	.785/.814	TG3-TG1	26.89	35	n.s.
TG4: As TG3, plus factor variances and covariances invariant	2330.12	1783	.782/.811	TG4-TG3	37.92	28	n.s.

Table 6
Factor Loadings for Young-Old and Old-Old (Old-Old in parentheses, if different).

	Substance Use	Positive Nutrition Behaviors	Medical Check-ups	Health Maint. Activities	Positive Health Perception	Positive Health Status	High Blood Pressure
Current smoker	.731						
Years smoked	.806						
Amount smoked present	.952(.226)						
Amount smoked past	.961						
Attempt to quit smoking (-)	.430						
Alcohol consumption	.195						
Read sodium labels		.797					
Buy low sodium		.796					
Cook low sodium		.459					
Read fat labels		.839					
Buy low fat		.808					
Eat butter (-)		.329					
Cook without butter		.361					
Drink caffeinated beverages (-)		.233					
Vision checked			.278				
Flu shots			.312				
Cholesterol checked			.637				
Medical check-up			.603				
Colon/rectal check-up			.446				
Mammogram or prostate exam			.570				
Regular exercise				.313			
Teeth brushing				.323			
Teeth flossing				.370			
Use of seat belts				.332(.816)			
Good vision (self-rating)					.560		
Good hearing (self-rating)					.382		
Decline in vision (self-rating) (-)					.602		
Decline in hearing (self-rating) (-)					.483		
Health (self-rating)					.257	.485	
Decline in health (self-rating)(-)					.748		
Read without glasses						.212	
Blood pressure taken by medical person (-)						.538(.266)	
Number of doctor visits (-)						.474	
Days in hospital (-)						.348	
Diabetes diagnosed (-)						.193	
Bowel stimulant						.261	
Sleep 7 or 8 hours						.165	
Need assistance for stairs (-)						.587	
Use walker (-)						.437	
Number falls last year (-)						.389	
Blood pressure taken - self							.309(.064)
High blood pressure diagnosed							.862
Blood pressure medication							.951
Body Mass Index				-.264			.149

Note. (-) indicates reverse scoring.
Factor loadings completely standardized to a common metric (Joereskog & Soerbom, 1989) are reported to facilitate between-group comparisons