

Invariance of Health Behavior Factors in Adults Over Two Occasions

Grace I. L. Caskie, K. Warner Schaie, & Sherry L. Willis
The Pennsylvania State University

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Abstract

Confirmatory factor analysis was used to examine whether the eight-factor structure found for the first administration of the Health Behavior Questionnaire (HBQ) in 1993 was invariant across a second occasion of data collected in 1996/98. The present sample included 1612 Seattle Longitudinal Study (SLS) members who completed the HBQ at both occasions (M=701, F=911). All individual health behavior items were significantly correlated over time ($p < .001$), and many health behaviors also showed a high degree of stability ($r > .5$). Stability of the health behavior items did not vary by gender, and only a few differences were observed by age group. Partial weak invariance of the health behavior factor structure was demonstrated. Setting factor loadings equal across time in this model for six of the eight health behavior factors resulted in a reasonable fit to the data and a non-significant change in model fit ($p > .01$) compared to the configural model, which required only the same number of factors and same factor pattern across time. Thus, results indicated that, except for the medical checkups and seat belt use factors, the health behavior factors were measuring the same constructs across the two occasions. At both occasions, women practiced better food consumption habits, seat belt use, and dental care than men. Age group differences in medical checkups, dental care, food consumption, food preparation, and smoking were also observed.

The leading causes of adult mortality in middle and old age in western societies are associated with unhealthy behaviors or lifestyles (National Center for Health Statistics, 1999; U.S. Department of Health and Human Services, 1990). Thus, promotion of a healthy lifestyle is important for the development of prevention and intervention programs that promote positive health behaviors. Understanding the domains of health behaviors and whether these domains may vary over time is important for such intervention efforts.

In 1993, the Health Behavior Questionnaire (HBQ), a new measure developed to assess health behavior and health-related issues in adults, was added to the Seattle Longitudinal Study (SLS). Confirmatory factor analysis showed that the HBQ tapped eight health-related domains: Not Smoking, Alcohol Use, Avoid Unhealthy Food, Food Preparation, Exercise, Seat Belt Use, Dental Care, and Medical Checkups. In the most recent 1996/98 wave of the SLS, a second occasion of HBQ data was obtained, making it possible to study the structural invariance of these health behavior domains over time. The demonstration of longitudinal invariance is important for making interpretable comparisons across time for these domains (Horn, 1991).

A minimum requirement of longitudinal invariance is the demonstration of configural invariance, which requires only that the indicators of the factors have the same pattern of zero and non-zero loadings across time (Meredith, 1993; Horn, McArdle, & Mason, 1983). The next level of invariance is metric invariance, or weak factorial invariance. Weak factorial invariance requires the equality of the unstandardized factor loadings across time. Meredith further proposed the level of strong factorial invariance, which additionally requires equality of the unique (error) variances and intercepts across time. Because stricter levels of invariance can be difficult to meet in many complex studies, it may only be possible to demonstrate partial measurement invariance (Bryne, Shavelson, and Muthén, 1989), where longitudinal invariance can be demonstrated for only a subset of the factors of interest across time.

Three main research questions were addressed in this study regarding the longitudinal invariance of the health behaviors and health behavior domains included on the HBQ. First, how correlated and stable are the individual health behaviors over time? Further, does the stability of a health behavior vary by gender or by age group? Second, is the health behavior factor structure invariant over the two occasions of data? Finally, are there significant relationships of gender and age group to the health behavior factors at either or both occasions?

Method

Participants

The sample included 1612 participants (701 males and 911 females) who were part of a larger on-going study of adult cognitive development, the Seattle Longitudinal Study (SLS; Schaie, 1996). The mean education of the sample was 15.3 years (range = 7 to 20 years), and the mean age in 1993 was 56.7 years (range = 24 to 91 years).

Measures

Health Behavior Questionnaire (HBQ). The HBQ covered a wide range of health behaviors and included a variety of item formats (Likert scale, open-ended, multiple choice, etc.). Prior work on data from the first administration of the HBQ in 1993 had found that an eight-factor structure best fit the data. These eight factors included 26 items, created from 34 HBQ items. All items were coded so that higher values indicated more healthy behaviors. In 1996/98, a second wave of HBQ data was collected for SLS participants. Because the actual length of time between waves varied from approximately 2.4 to 6.9 years, length of time between waves was included in all analyses to account for any structural variation attributable to this variable.

Demographics. Information about the participants' age and gender was obtained from the Life Complexity Inventory (Gribbin, Schaie & Parham, 1980).

Results

Results are presented in three sections. First, the correlation and stability of individual health behaviors over time is examined. Second, the invariance of the health behavior factor structure is examined. Third, the relationships of gender and age group to the health behavior factors at Wave 1 and Wave 2 were examined. In all analyses, gender was included as a directly observed variable. Age group was included as three effects-coded variables, with the old-old adults set as the reference group. Length of follow-up time was also included as a predictor and examined for effects on the health behavior factors. Because of the large sample size in this study, a probability level of .01 was chosen to indicate statistical significance throughout the results.

Correlation and stability of individual health behaviors.

As shown in Table 1, all 26 health behaviors included in this analysis were significantly correlated over time ($p < .001$). Additionally, 15 of the 26 health behaviors showed a high degree

of stability over time, as indicated by a correlation of .5 or greater. Other health behaviors were somewhat less stable over time, with correlations ranging from .26 to .44.

Health behavior item correlations over time were also examined by gender and for four age groups. The age groups were young adults (24 – 44 years, $n = 409$), middle-aged adults (45-64 years, $n = 616$), young-old adults (65-74 years, $n = 376$), and old-old adults (75-91 years, $n = 211$). Correlations for males and females were all significant at $p < .001$ and were very similar to the values shown in Table 1 for the total sample. With a few exceptions, the correlations over time for the four age groups were also quite similar to the values found for the total sample, and almost all were significant at $p < .001$. For young adults, the dental checkup and flu shots items were less stable over time ($r = .21$ and $.51$, respectively) than in the total sample. For middle-aged adults, the use of seat belts on the highway item was more stable over time ($r = .82$) and less stable for young-old and old-old adults ($r = .59$ and $r = .52$, respectively) than for the total sample. For young-old adults, the vision checkup item was also less stable over time ($r = .15$, $p < .01$) than for the total sample. Correlations over time for the old-old group varied the most from the total sample, particularly on the Medical Checkups factor. For all indicators of the Medical Checkups factor except cholesterol checkups, the correlation over time for this group was much smaller than for the other age groups or the total sample and was sometimes non-significant. Also, the correlation over time for the cook low sodium item ($r = .56$) was also less stable than for the total sample. However, the correlation of the amount smoked item in the old-old group was much higher ($r = .99$) than the total sample.

Invariance of the health behavior factor structure

Confirmatory factor analyses were conducted to examine the longitudinal invariance of the HBQ factor structure over two occasions of data. A configural invariance model was first established as a baseline model that set the factor pattern equal across time. In this model, as in subsequent models, the factor variance-covariance matrices and unique variances were not constrained across time, and autocorrelations of the residuals were included to account for repeated measures of the same items over time. Given its complexity, this model showed reasonably good fit to the data: $\chi^2(1304, N = 1612) = 4,326.32$, $p < .001$, $GFI = .91$, $CFI = .90$, $RMSEA = .04$.

A weak metric invariance model was next fit to the data. This model constrained the factor loadings to be equal across time for all eight factors. This model resulted in a significant

reduction in fit: $\chi^2(1322, N = 1612) = 4,504.59, p < .001, GFI = .91, CFI = .90, RMSEA = .04; \Delta\chi^2(18) = 178.27, p < .001$. Thus, the model was rejected, and we could not conclude that the loadings on all eight health behavior factors were invariant across time.

Examination of the factor loadings from the configural model showed that the differences in loadings over time were primarily located in the Medical Checkups and Seat Belt Use factors. A partial weak metric invariance model was then fit to the data, relaxing the constraint that these two factors be invariant across time. Compared to the configural invariance model, this model showed a statistically non-significant reduction in fit: $\chi^2(1316, N = 1612) = 4,342.58, p < .001, GFI = .91, CFI = .90, RMSEA = .04; \Delta\chi^2(12) = 16.26, p > .01$. The partial weak metric invariance model also fit significantly better than the weak metric invariance model constraining all factor loadings to be equal across time: $\Delta\chi^2(6) = 162.01, p < .001$. Thus, we concluded that, except for the Medical Checkups and Seat Belt Use factors, the health behavior factors were measuring the same constructs across the two occasions.

Relationship of gender, age group, and length of follow-up time to health behavior factors

Gender was a significant predictor at both Wave 1 and Wave 2 of Avoid Unhealthy Food ($\beta = .17$ at both waves), Seat Belt Use ($\beta = .10$ at Wave 1 and $\beta = .12$ at Wave 2), and Dental Care ($\beta = .24$ at both waves). Females practiced more favorable health behaviors than males on these factors: better food consumption habits, more seat belt use, and better dental care.

To examine the relationship of age group to the health behavior factors, the old-old group was compared with the other three age groups (young adults, middle-aged adults, and young-old adults). Significant relationships ($p < .01$) of the age group variables to five health behavior factors at each wave were found. Old-old adults differed from all other age groups on the Medical Checkups factor at both Wave 1 and Wave 2. Old-old adults had more medical checkups than young adults ($\beta = -.68, \beta = -.65$) and middle-aged adults ($\beta = -.25, \beta = -.08$) but less checkups than young-old adults ($\beta = .35, \beta = .39$). Old-old adults also had better dental care ($\beta = -.16, \beta = -.65$) and food preparation habits ($\beta = -.14, \beta = -.08$) than young adults but poorer dental care ($\beta = .10, \beta = .12$) and food preparation habits ($\beta = .10$ at both waves) than young-old adults. Although the old-old had better food preparation habits than young adults, young adults ate fewer unhealthy foods than the old-old adults ($\beta = .19$ at both waves). Finally, old-old adults abstained more from smoking than middle-aged adults ($\beta = -.11, \beta = -.10$).

Length of follow-up time was a significant predictor at Wave 2 of the Not Smoking ($\beta = .08$) and Medical Checkups ($\beta = .10$) factors. Longer periods of time between waves was associated with reporting more favorable health behavior on both factors, indicating that the greater amount of time may have allowed individuals to reduce or eliminate smoking habits as well as obtain more medical check-ups.

Discussion

These results provided support that six of the eight health behavior domains assessed by the HBQ can be compared across time. Demonstration of the invariance of these factors is important for being able to assess change in health behaviors. Predictors of change in these factors could be investigated to help identify variables that intervention efforts could target in the encouragement of healthy lifestyles. The observed relationship of gender to the Avoid Unhealthy Food, Dental Care, and Seat Belt Use factors in this study is in agreement with previous research indicating that women tend to practice more favorable health behaviors than men (Mechanic & Cleary, 1980; Stephens, 1988; Sobal, Revicki, & DeForge, 1992). It is likely that the Medical Checkups factor was not invariant across time due to the age differences observed in this factor. We also observed that the individual items that comprise the Medical Checkups factor tended to be less stable over time. The old-old adults had the least stability for these items, with the correlations for vision checkups and physical checkups not even reaching statistical significance. Age differences in the health behavior factors over time should be further explored.

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Table 1. Stability of health behaviors over time

Health Behavior Indicator	Correlation over Time
Factor 1: Not Smoking	
Amount smoked	.80***
Factor 2: Alcohol Use	
Amount alcohol	.44***
Factor 3: Avoid Unhealthy Food	
Amount caffeine	.68***
Beef consumption	.35***
Other meat consumption	.29***
Egg yolks consumption	.39***
Factor 4: Food Preparation	
Eat without butter	.59***
Read sodium labels	.58***
Buy low sodium	.60***
Cook low sodium	.69***
Read fat labels	.57***
Buy low fat	.52***
Cook without butter	.54***
Factor 5: Exercise	
Exercise: Hours per week	.33***
Exercise: Times per week	.32***
Factor 6: Seat Belt Use	
Seat belt: highway	.69***
Seat belt: town	.66***
Factor 7: Dental Care	
Teeth brushing	.60***
Teeth flossing	.64***
Dental checkup	.37***
Factor 8: Medical Checkups	
Vision checkup	.26***
Hearing checkup	.33***
Physical checkup	.35***
Cholesterol checkup	.50***
Colon-rectal checkup	.28***
Flu shots	.63***

Note. $N = 1,612$.

*** $p < .001$.

Appendix

Coding of Health Behavior Items

Health Behavior Item	Coding
<u>I. Not Smoking</u>	
Amount smoked (per day)	1 = 2 or more packs of cigarettes, 5 or more cigars, or 5 or more pipes 2 = 1.5 packs of cigarettes, 4 cigars, or 4 pipes 3 = 1 pack of cigarettes, 3 cigars, or 3 pipes 4 = Half pack of cigarettes, 2 cigars, or 2 pipes 5 = Less than half pack of cigarettes, 1 cigar, or 1 pipe bowl 6 = Does not smoke
<u>II. Alcohol use</u>	
Amount alcohol	The sum of the number of glasses of wine, bottles/cans of beer, and drinks containing hard liquor drunk per week was coded as: 1 = More than 14 alcoholic drinks per week 2 = Less than 7 alcoholic drinks per week 3 = 7-14 alcoholic drinks per week
<u>III. Avoid Unhealthy Food</u>	
Amount caffeine	Sum of the amount of caffeinated coffee, amount of caffeinated tea, and caffeinated soda, where each item was on a 5-point scale ranging from "1 = 6 or more cups/day" to "5 = 0 to less than one cup/day."
Beef consumption	These two items were each coded on a 3-point scale:
Egg yolks consumption	1 = 5-7 days per week 2 = 3-4 days per week 3 = 0-2 days per week
Consumption of other meat	Sum of three items assessing consumption of pork, veal, and lamb was coded on a 3-point scale: 1 = More than 4 total servings per week 2 = 3-4 total servings per week 3 = 0-2 total servings per week

(table continues)

Health Behavior Item	Coding
<u>IV. Food Preparation</u>	
Eat without butter Read sodium labels Buy low sodium Cook low sodium Read fat labels Buy low fat Cook without butter	Each of these seven items was coded on a 5-point scale: 1 = never 2 = seldom 3 = sometimes 4 = often 5 = almost always
<u>V. Exercise</u>	
Exercise: hours per week	Open-ended responses were coded on a 3-point scale: 1 = Less than 2 hours per week 2 = More than 7 hours per week 3 = 2-7 hours per week
Exercise: times per week	Open-ended responses were coded on a 3-point scale: 1 = Less than 3 times per week 2 = More than 7 times per week 3 = 3-7 times per week
<u>VI. Seat Belt Use</u>	
Seat Belt: highway Seat Belt: town	Both items were coded on a 5-point scale: 1 = never 2 = rarely 3 = sometimes 4 = often 5 = always
<u>VII. Dental Care</u>	
Teeth brushing (in past 7 days)	1 = never 2 = once or twice 3 = 3-6 times 4 = once per day 5 = twice per day 6 = 3 or more times per day
Teeth flossing (in past 7 days)	1 = never 2 = 1 or 2 days 3 = 3-6 days 4 = once per day 5 = 2 or more times per day
Dental Check-up	1 = No dental visit in past 12 months 2 = Dental visit for regular check-up, dental problems, or related to dentures

(table continues)

Health Behavior Item	Coding
<u>VII. Medical Check-ups</u>	
Vision Check-up	1 = No vision check-up in past 24 months 2 = Vision check-up in past 24 months
Hearing Check-up	1 = No hearing check-up in past 24 months 2 = Hearing check-up in past 24 months
Physical Check-up	1 = No medical check-up 2 = Regular check-up or check-up due to a problem
Cholesterol Check-up ^a	<u>1993 HBQ</u>
	<u>1996/98 HBQ</u>
	1 = Not at all 2 = Once since 1984 3 = 2-3 times since 1984 4 = 4-6 times since 1984 5 = 7-8 times since 1984 6 = Yearly or more often since 1984
	1 = Not at all 2 = Once since 1993/94 3 = 2-3 times since 1993/94 4 = Yearly or more often since 1993/94
Colon/Rectal Check-up	1 = No colon/rectal check-up in past 12 months 2 = Colon/rectal check-up in past 12 months
Flu Shots ^a	<u>1993 HBQ</u>
	<u>1996/98 HBQ</u>
	1 = None since 1984 2 = 1-2 shots since 1984 3 = 3-6 shots since 1984 4 = 7-9 shots since 1984 5 = Once a year since 1984
	1 = None since 1993/94 2 = 1-2 shots since 1993/94 3 = Once a year since 1993/94

^a These items were asked differently on the HBQ between Wave 1 (1993) and Wave 2 (1996/98). Where 1993/94 is noted, the item on the 1996 HBQ used 1993, and the item on the 1998 HBQ used 1994. All other items were asked in the same way across waves.