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The Relationships Among Health Behaviors in Older Persons

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Abstract

Objective: To examine the relationships among health behaviors in older persons and whether they form related groups of behaviors. **Method:** Health behaviors (physical activity, alcohol use, nutrition, weight stability, and smoking) were analyzed using factor analysis in two representative samples of two cohorts of Israeli older persons aged 75 to 94. Data collection was conducted during 1989-1992 for the first cohort (*N* = 1,200) and during 2000-2002 for the second (*N* = 421). **Results:** Four factors of health behaviors were found mostly unrelated: (a) physical activity and weight stability, (b) alcohol use, (c) smoking, and (d) nutrition. **Discussion:** The analysis enables identification of underlying health-behavior dimensions in an understudied population. Furthermore, the findings have important implications for health-promotion policy, indicating that prevention and health-promotion programs for older persons should target each health behavior, and not assume that the practice of any health behavior implies a healthy overall lifestyle in this population.

Keywords

health behaviors, health promotion, physical activity, alcohol drinking, smoking

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Introduction

Health behaviors are defined as "any behaviour that people engage in spontaneously or that can be induced with the intention of alleviating the impact of potential health risks and hazards in their environment" (Zanjani, Schaie, & Willis, 2006). Health behaviors (e.g., physical activity, not smoking, maintaining moderate weight levels) in older persons have been linked to favorable outcomes in terms of mortality and physical functioning outcomes (House, Lepkowski, Kinney, & Mero, 1994; Kaplan, 1992; Kaplan, Seeman, Cohen, Knudsen, & Guralnik, 1987). These behaviors can help older persons delay the onset of health-related problems associated with aging, maintain, if not improve, their functional abilities, and even improve their quality of life (Jensen, Counte, & Glandon, 1992). In general, a significant link exists between health behaviors and beneficial health outcomes (Marks & Lutgendorf, 1999), and therefore it is important to understand the interrelationship between them.

Several approaches have been used to explore the interrelationship between health behaviors. In some studies health behaviors were considered unidimensionally as a cluster, classifying participants as leading either a healthy or unhealthy lifestyle (Blaxter, 1990; Haefner, Kegeles, Kirscht, & Rosenstock, 1967). However, a growing body of evidence indicates that different health behaviors are not necessarily interrelated (Berrigan, Dodd, Troiano, Krebs-Smith, & Barbash, 2003; De-Vries, Kremers, Smeets, & Reubsaet, 2008; Harris & Guten, 1979; Johnson, Nichols, Sallis, Calfas, & Hovell, 1998; Kremers, De Bruijn, Schaalma, & Brug, 2004; Kulbok & Cox, 2002; Langlie, 1977; Liang, Shediac-Rizkallah, Celentano, & Rohde, 1999; Patterson, Haines, & Popkin, 1994; Reeves & Rafferty, 2005; Steele & McBroom, 1972; Williams & Wechsler, 1972). Other scholars have studied the relationships between two health behaviors at a time (Burke et al., 1997; Emmons, Marcus, Linnan, Rossi, & Abrams, 1994; Istvan & Matarazzo, 1985; Milligan et al., 1997; Padrao, Lunet, Santos, & Barros, 2007; Patterson et al., 1994; Simoes et al., 1995). For example, smoking has been found to correlate positively with alcohol consumption (Istvan & Matarazzo, 1985; Milligan et al., 1997; Padrao et al., 2007) and negatively with physical activity (Emmons et al., 1994; Patterson et al., 1994) and healthy nutrition (Padrao et al., 2007; Simoes et al., 1995).

Several other studies have taken a multidimensional approach to discern the typology of health behaviors using multivariate statistical methods to find factors or clusters of behaviors (Harris & Guten, 1979; Patterson et al., 1994; Stefansdottir & Vilhjalmsson, 2007). For instance, Patterson et al. (1994)

found, using cluster analysis, seven clusters for health behavior typologies: health-promoting lifestyle (very good diet, very high activity level, little or moderate drinking, and little smoking), good diet lifestyle (good diet, very sedentary, low levels of drinking/smoking), fitness lifestyle (poor diet, high activity level, little drinking or smoking), passive lifestyle (worst diet quality, low physical activity, slightly better than average drinking and smoking behaviors), drinking lifestyle (fair physical activity levels, more than recommended alcohol consumption, little-some cigarette smoking), smoking lifestyle (poor diet, sedentary activity levels, high smoking levels), and hedonic lifestyle (fair to poor diet, moderate activity, very heavy drinking, and about one pack of cigarettes per day). More recently, Stefansdottir and Vilhjalmsson (2007) found, using factor analysis, four underlying health-related lifestyles: (a) physical activity; (b) an unhealthy diet; (c) substance abuse; and (d) a healthy diet. Thus, the aforementioned findings support the tendency for health-related behaviors to form patterns. Nonetheless, considering that the four factors identified by Stefansdottir and Vilhjalmsson only accounted for 35% of total item variance and correlations between them were weak, as well as the divergence in number and definition of dimensions across studies, it seems that a full understanding of the interrelationship among different health behaviors is yet to be reached.

Much less is known about health behaviors among older persons. Most of the existing literature has looked into the relationship between two health behaviors at a time (Lian, Gan, Pin, Wee, & Ye, 1999; Walmsley, Bates, Prentice, & Cole, 2007; Yamauchi, Midorikawa, Hagihara, & Sasaki, 2007) without relating to the possibility of there being a few different dimensions of health behaviors in older individuals. Lian et al.(1999), for instance, found leisure-time physical activity to correlate negatively with smoking among 2,494 people aged 60 and older. They also found a positive correlation between physical activity and healthy dietary habits, a link that was corroborated in other studies as well (Walmsley et al., 2007; Yamauchi et al., 2007).

Due to the lack of clarity on the subject of interrelationships among different health behaviors (Harris & Guten, 1979; Patterson et al., 1994; Stefansdottir & Vilhjalmsson, 2007) and the paucity of research in the older population, the present study focuses on the relationships among health behaviors in older persons, while assuming a multidimensional approach.

Health behaviors, including physical activity, alcohol use, nutrition, weight stability, and smoking, were analyzed using factor analysis in representative samples of two cohorts of older persons. This analysis enables identification of underlying health-behavior dimensions in a population largely neglected in the literature. The use of two cohorts allowed us to validate the results.

Method

Participants and Procedure

The first cohort consisted of participants from the first wave of the Cross-Sectional and Longitudinal Aging Study (CALAS). The second cohort was from the Israeli Multidisciplinary Aging Study (IMAS). Both samples included a multidimensional assessment of a random sample of the older Jewish population in Israel, drawn from the National Population Registry (NPR) were stratified by age group (75-79, 80-84, 85-89, 90-94), gender, and place of birth (Asia-Africa, Europe-America, Israel). Data collection was conducted during 1989-1992 for the CALAS and during 2000-2002 for the IMAS. The inclusion criteria were being self-respondent, community dwelling, and between 75 and 94 years of age. Participants were 75 and older because the old-old, that is, more than 75 years of age, were the focus of the CALAS data set.

The assessments administered in the IMAS were taken from the CALAS with slight modifications, and in both studies interviews were conducted in the participant's home after the participant had signed an informed consent. As institutionalization involves a host of factors that can affect health behaviors (e.g., living in a group setting may allow or hinder physical activity; physical limitations that may have prompted institutionalization may affect the availability of alcohol), this study focused on participants who were self-respondent and not institutionalized. We did not include proxy responses because of the following: (a) those responses were less reliable and less complete and (b) persons who have proxy responses are usually dependent on others, affecting their health behaviors in a similar way as institutionalization. This procedure has also been applied in similar studies (Ben-Ezra & Shmotkin, 2006; Shmotkin, Blumstein, & Modan, 2003).

In the CALAS sample, of the initial potential sample of 2,400 individuals aged 75 to 94 drawn from the NPR on 1 January 1989, 1,820 (75.8%) were located and interviewed, 15.7% of the sampled individuals were not located, and an additional 8.5% refused to be interviewed.

Of the 1,820 individuals remaining, 75.2% (n = 1,369) were interviewed in person, and 24.8% (n = 451) were proxy interviews. Of the 1,369 participants interviewed in person, 1,200 were noninstitutionalized. The IMAS sample was drawn from the NPR in December 1999. Out of 1,757 sampled individuals (after exclusion of 438 who lived in institutions or abroad, or

Table 1. Background Information of Self-Respondent Community Dwelling Participants of Two Cohorts (CALAS and IMAS)[a]

	CALAS cohort (N = 1,200)	IMAS cohort (N = 421)
	M (SD)/%	M (SD)/%
Age	83.10 (5.3)	83.13 (5.2)
Females	44.9	43
Place of birth		
Israel	30.3	31.8
Europe	37	34.7
Middle East/N. Africa	32.7	33.5
Education	7.63 (5.51)	9.4 (5.15)
Married	46.6	49.6
Comorbidity	2.63 (2.08)	3.42 (2.40)
BMI		
Obese	14	11
Underweight	18.4	12.1
Number of medications used	2.97 (2.26)	4.13 (2.69)
Subjective health (1-4)	1.98 (.85)	2.24 (.70)

a. Data collection was conducted during 1989-1992 for the CALAS and during 2000-2002 for the IMAS in Israel.

passed away between the sampling day and the interview date), 15.1% were not located, 32.3% refused to be interviewed, and 5.7% could not complete the interview because of language or health difficulties. During 2000-2002, 825 participants were interviewed either as self-respondents (87.4%) or by proxies for those who were incapable of responding.

The CALAS and IMAS were approved for ethical treatment of human participants by the Institutional Review Board of the Chaim Sheba Medical Center in Israel. More information regarding the CALAS appears in various publications (e.g., Ben-Ezra & Shmotkin, 2006; Blumstein, Shmotkin, Eyal, Shorek, & Lerner-Geva, 2008).

The present analyses include only self-respondent community dwelling participants of parallel age groups (75-94) in the two surveys. In the CALAS, there were 1,200 such participants, and in the IMAS, 421. Examination of the two cohorts allowed us to validate the results. Background information of the participants is displayed in Table 1.

Measures

Five health behaviors variables were assessed: physical activity, alcohol use, nutrition, weight change, and smoking. Measures of alcohol use, weight change, and smoking were based on the Established Populations for Epidemiologic Studies of the Elderly (EPESE; Cornoni-Huntley, 1986) questionnaire, consisting of prospective epidemiologic studies of approximately 14,000 persons aged 65 and older in four different communities in the United States.

Physical activity. This was measured by two items: Participant's level of physical activity in comparison to the previous year (1 = *less*, 2 = *same*, and 3 = *more*), and frequency of engagement in five physical activities (1 = *does not do any of the five activities at all*, 2 = *exercises* (*in one of the five activities*) *less than once a week*, 3 = *once or twice a week*, and 4 = *three or more times a week*; (Cornoni-Huntley, 1986; Pate et al., 1995).

Alcohol use. The alcohol section was taken, with slight modifications, from the EPESE questionnaire (Cornoni-Huntley, 1986). For each type of alcohol beverage (wine, beer, liquor, and whiskey), two measures were obtained capturing behavior during the previous month: The frequency of drinking and the number of drinks during each drinking episode. Approximate total alcohol consumption in grams during the last month was calculated by multiplying the approximate frequency of use in days per month by the number of drinks for each type of beverage weighted by the relative amount of alcohol in each type of beverage (Abramson, Williams, Krumholz, & Vaccarino, 2001). A vast body of knowledge indicates that moderate alcohol consumption (up to 1-2 drinks per day) has a favorable influence on health and health-related variables (Cohen, Tyrrell, Russell, Jarvis, & Smith, 1993; Josephs & Steele, 1990; National Institute on Alcohol Abuse and Alcoholism, 2003; Poikolainen, 1995; Vahtera, Poikolainen, Kivimaki, Ala-Mursula, & Pentti, 2002; U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2000). Therefore, we grouped the two alcohol variables into two categories, that is, 0 = *moderate/no drinking*, 1 = *excessive*, according to the standard amounts normally used in studies in this field (National Institute on Alcohol Abuse and Alcoholism, 2003). Drinking was considered excessive if the total amount of alcohol consumed per month was higher than 675 g (calculated according to 1.5 drinks per day × 15 g of alcohol per drink × 30 days per month) or if the total number of alcoholic drinks was higher than 45 (calculated according to 1.5 drinks per day × 30 days per month). The total number of alcoholic drinks consumed in the last month was calculated by multiplying the number of drinks consumed in each drinking episode by the number of days of drinking for each beverage separately and summing up the results.

Nutrition. This was measured by five items: Eating 3 meals every day (1 = *yes*, 2 = *no*), skipping meals in the past week (1 = *yes*, 2 = *no*), eating a warm meal every day (1 = *yes*, 2 = *no*). Eating between meals index was calculated by multiplying two measures: Eating between meals (1 = *yes*, 2 = *no*), and frequency of eating between meals during the day (0 = *never*, 1 = *sometimes*, 2 = *frequently*). Information on nutritional habits was collected only in the CALAS cohort.

Weight change. The questions were taken, with slight modifications, from the EPESE questionnaire (Cornoni-Huntley, 1986). These questions refer to weight changes of over 5 kg in the past year (0 = *no change*, 1 = *weight had been gained*, 2 = *weight had been lost*, 3 = *weight had been lost and gained*, 9 = *unknown*) and whether they were intentional (0 = *no*, 1 = *yes*), as recent studies indicate that weight changes, and especially unintentional ones, are related to negative health outcomes (Meltzer & Everhart, 1995; Wannamethee, Shaper, & Lennon, 2005).

Smoking. This section was also based on the EPESE questionnaire (Cornoni-Huntley, 1986) and includes current smoking status, age of beginning to smoke, age of smoking cessation, daily quantity, and smoking substance (cigarettes, cigars, pipe, hookah, or chewing tobacco). Total nicotine consumption was calculated by multiplying the number of cigarettes smoked each day (taking into account the relative amount of nicotine in each smoking substance) by the number of years of smoking. Total number of years of smoking was calculated by subtracting the age of beginning smoking from the participant's current age (or the age of smoking cessation in cases of past smoking).

Four health variables were assessed: *Subjective health* (1 = *terrible*, 2 = *okay*, 3 = *good*, 4 = *great*); *Number of medications* as inspected and counted by the interviewer (range 0-8); *BMI*—the interviewer measured the participant's weight and height and Body Mass Index was calculated (< 22 = *underweight*, 22-25, 25-30, > 30 = *obese*; Alfaro-Acha, Ostir, Markides, & Ottenbacher, 2006). *Comorbidity* was assessed by the number of diseases the participant had been diagnosed with from a list of 18 chronic diseases (range = 0-18).

Statistical Methods

To analyze the data from both cohorts, we conducted exploratory factor analysis using principal component (PCA) extraction with Oblimin rotation in SPSS 15.0. The number of factors was determined using a lower than 1 Eigenvalue criterion, whereas a minimum loading of .40 on any factor was required for an item to be considered as loading on the factor.

Results

The descriptive statistics of the health behaviors are displayed in Table 2. The correlations among the variables (Table 3) are mostly low, with the significant correlations being mostly within the health behaviors.

A factor analysis of the different health behaviors was conducted to examine the component structure of health behaviors. The component matrix and the factors' loadings are presented in Table 4, separately for each of the two cohorts. As can be seen, the components structure were identical for the two cohorts: The first factor included all smoking variables; the second factor was comprised of the two alcohol indices; the third factor included both physical activity variables and weight stability, and the fourth factor included nutrition variables (only in the CALAS, as nutrition variables were not collected in the IMAS), excluding the frequency of eating between meals which was not found to be part of any of the factors. The components in the principle components analysis explained 65.2% of the variance for the CALAS cohort and 73.53% of the variance for the IMAS cohort. As can be seen in Table 5, in the CALAS, healthy nutrition was positively related to physical activity and weight stability and negatively related to smoking and excessive alcohol use. In addition, in both cohorts physical activity and weight stability were unrelated to smoking and alcohol use. Finally, excessive alcohol use was positively related to smoking in both cohorts.

Discussion

The purpose of the present study was to examine the interrelationships among health behaviors in older persons. In the two different cohorts, we found four factors of health behaviors. The fact that the pattern of findings was identical in both cohorts lends support to the validity of the findings and suggests that the interrelationships between health behaviors in older persons remained virtually unchanged in the years that passed between the two studies (8-13 years: 1989-1992 vs. 2000-2002).

The factors found in our study resemble the factors that emerged in Stefansdottir and Vilhjalmsson's (2007) study, as both studies included factors of physical activity, nutrition, and substance abuse. However, Stefansdottir et al.'s study was conducted among young adults and not among older persons, and there are a few differences between the studies' findings. First, Stefansdottir et al. found only one factor of substance abuse which includes smoking, alcohol use, and caffeine use, whereas we found separate factors for different kinds of substance abuse (smoking and alcohol consumption). This

Table 2. Descriptive Statistics of Health Behavior Variables and Indices

		CALAS cohort (n =1,081-1,200)				IMAS cohort (n = 393-421)			
Category	Variable	N	M (SD)/%		Range	N	M (SD)/%		Range
Physical activity	Physical activity in comparison to the previous year	1,186	Less	45.90		393	Less	48.90	
			Same	47.80			Same	46.80	
			More	6.30			More	4.30	
	Physical activity engagement	1,188	No activity	61.90		420	No activity	43.30	
			Less than once a week	5.30			Once or twice a week	4.30	
			Once or twice a week	6.90			3-6 times a week	12.20	
			3 or more times a week	25.90			Daily	40.20	
Weight changes	Weight changes	1,081	No	68.20		395	No	69.40	
			Yes, intentional	3.40			Yes, intentional	5.50	
			Yes, unintentional	28.40			Yes, unintentional	25.10	
Alcohol use	Total alcohol consumption in the last month	1,193	Moderate/no drinking	96.30		420	Moderate/no drinking	95.70	
			Excessive drinking	3.70			Excessive drinking	4.30	
	Number of drinks in the last month	1,193	Moderate/no drinking	96.60		420	Moderate/no drinking	96.70	
			Excessive drinking	3.40			Excessive drinking	3.30	

(continued)

Table 2. (continued)

		CALAS cohort (n =1,081-1,200)				IMAS cohort (n = 393-421)			
Category	Variable	*N*	*M* (*SD*)/%		Range	*N*	*M* (*SD*)/%		Range
Smoking	Smoking	1,195	No	59.70		421	No	60.80	
			In the past	29.80			In the past	31.80	
			Yes	10.50			Yes	7.40	
	Total nicotine consumption	1,100	28.68 (48.60)		0-231	412	22.72 (42.02)		0-177
	Daily quantity of smoking	1,155	None	62.10		421	None	66.30	
			Up to 10	16.00			Up to 10	14.50	
			11-20	11.90			11-20	10.40	
			More than 20	10.00			More than 20	8.80	
	Years of smoking	1,131	16.10 (23.73)		0-79	409	14.42 (22.21)		0-76
Nutrition	Eating a hot meal every day	1,195	No	7.20		Not collected			
			Yes	92.80					
	Skipping meals	1,191	No	94.70					
			Yes	5.30					
	Eating three meals every day	1,181	No	11.70					
			Yes	88.30					
	Eating between meals index	1,200	1.67 (1.53)		0-4				

Note: Data collection was conducted in Israel during 1989-1992 for the CALAS and during 2000-2002 for the IMAS.

Table 3. Correlations Among Health Behaviors in the CALAS (Below Diagonal) and the IMAS (Above Diagonal)

	Category	Physical activity		Weight changes	Alcohol use		Smoking				Nutrition			
Category	Variable	Physical activity in comparison to the previous year	Physical activity engagement	Weight changes	Total alcohol consumption in the last month	Number of drinks in the last month	Smoking	Total nicotine consumption	Daily quantity of smoking	Years of smoking	Eating a hot meal every day	Skipping meals	Eating three meals every day	Eating between meals index
Physical activity	Physical activity in comparison to the previous year		.208**	−.186**	0.002	−0.030	0.045	0.042	0.061	0.051	Not collected			
	Physical activity engagement	.183**		−.205**	0.044	0.078	0.017	−0.034	0.001	−0.010				
Weight changes	Weight change	−.117**	−.090**		0.009	0.013	0.007	0.004	−0.024	0.015				
Alcohol use	Total alcohol consumption in the last month	0.054	0.049	−0.013		.878**	.235**	.194**	.153**	.236**				
	Number of drinks in the last month	0.029	0.047	0.000	.952**		.199**	.181**	.152**	.228**				
Smoking	Smoking	0.008	.066*	.066*	.155**	.149**		.651**	.654**	.888**				
	Total nicotine consumption	−0.002	.066*	.068*	.194**	.195**	.753**		.887**	.798**				

(continued)

Table 3. (continued)

	Category	Physical activity		Weight changes	Alcohol use		Smoking				Nutrition			
Category	Variable	Physical activity in comparison to the previous year	Physical activity engagement	Weight changes	Total alcohol consumption in the last month	Number of drinks in the last month	Smoking	Total nicotine consumption	Daily quantity of smoking	Years of smoking	Eating a hot meal every day	Skipping meals	Eating three meals every day	Eating between meals index
	Daily quantity of smoking	0.044	.074*	0.053	.149**	.145**	.735**	.915**		.666**				
	Years of smoking	−0.008	.064*	.065*	.181**	.178**	.907**	.884**	.789**					
Nutrition	Eating a hot meal every day	0.016	0.046	−0.031	−0.031	−0.020	−0.025	−0.039	−0.012	−0.030				
	Skipping meals	−0.072*	−0.040	0.048	0.013	0.018	.075**	0.056	0.042	.062*	−.195**			
	Eating three meals every day	.064*	0.044	−0.006	−.129**	−.098**	−.136**	−.087**	−0.052	−.100**	.158**	−.151**		
	Eating between meals index	.077**	0.041	−0.023	.062*	.064*	−0.002	−0.028	0.006	−0.028	0.035	−0.017	.075*	

Note: Data collection was conducted in Israel during 1989-1992 for the CALAS (n = 996-1200) and during 2000-2002 for the IMAS (n = 371-421).
$*p < .05$, two-tailed. $**p < .01$, two-tailed.

Table 4. Results of the Exploratory Factor Analysis

		CALAS (n = 1200)				IMAS (n = 421)		
Category	Variable	1	2	3	4	1	2	3
Physical activity	Physical activity in comparison to the previous year				−0.689			0.682
	Physical activity engagement				−0.694			0.699
Weight change	Weight change				0.561			−0.671
Alcohol use	Number of drinks in the last month		0.887				0.956	
	Total alcohol consumption in the last month		0.904				0.963	
Smoking	Smoking	0.907				0.876		
	Total nicotine consumption	0.950				0.933		
	Daily quantity of smoking	0.925				0.907		
	Years of smoking	0.957				0.910		
Nutrition	Eating a hot meal every day			0.695		Not collected		
	Skipping meals			−0.700				
	Eating three meals every day			0.587				

Note: Data collection was conducted in Israel during 1989-1992 for the CALAS and during 2000-2002 for the IMAS.

difference could have resulted from the fact that we did not measure caffeine use and that we used a weighted measure of alcohol use, including both the frequency and the quantity of use, whereas Stefansdottir et al. used these measures separately and found that the quantity of use did not load on the substance abuse factor. It is possible that weighing the quantity of alcohol use in our study decreased the correlation between alcohol use and smoking, which was low though significant, thus forming two separate factors.

Table 5. Correlations Among Factors in the CALAS (Below Diagonal) and IMAS (Above Diagonal) Cohorts

	Physical activity and weight change	Alcohol use	Smoking	Nutrition
Physical activity and weight change		0.015	0.012	Not collected
Alcohol use	0.050		0.230**	
Smoking	0.004	0.174**		
Nutrition	0.106**	−0.085**	−0.104**	

Note: Data collection was conducted in Israel during 1989-1992 for the CALAS (n = 1193-1200) and during 2000-2002 for the IMAS (n = 420-421).
**$p < .01$, two-tailed.

Second, in our study we found only one nutrition factor whereas Stefansdottir et al. found separate factors for healthy nutrition and unhealthy nutrition. This inconsistency could have stemmed from differences in the nutrition measures between the studies: In Stefansdottir et al.'s study, nutrition was measured mostly by asking the participants how often they had consumed certain healthy/unhealthy food and drinks, whereas in our study, nutrition was measured by assessing daily meal routines. In sum, different measures used in health behavior studies result in somewhat different health behavior typologies and reduce the ability to more precisely compare between different studies.

We found a positive relationship between smoking and excessive alcohol use. Similar findings were reported in other studies as well, although they were not conducted among older persons and the relationships found were all moderate to strong and not weak, as in our study (Istvan & Matarazzo, 1985; Milligan et al., 1997; Padrao et al., 2007; Schuit, van Loon, Tijhuis, & Ock, 2002). A possible cause for the discrepancy in the strength of the relationship can be found in Schuit et al.'s (2002) article in which the clustering of smoking and alcohol consumption was strongest among the young participants. Schuit et al. suggest that the high degree of self-consciousness (excessive preoccupation with one's own social image) in younger age groups leads both to smoking and alcohol consumption, and hence the connection between the two. This could explain the lower correlation in our sample. Nevertheless, the lack of information regarding self-consciousness in our sample renders this explanation a mere speculation that warrants further exploration.

Healthy nutrition in our study was positively related to physical activity and negatively related to excessive alcohol use and smoking. Similar findings were found in previous research in younger populations (Blair, Jacobs, & Powell, 1985; Burke et al., 1997; Padrao et al., 2007; Poortinga, 2007b; Simoes et al., 1995), and also in research conducted among older persons (Lian et al., 1999; Walmsley et al., 2007; Yamauchi et al., 2007). Nevertheless, in the large samples in our study, the relationships found were very weak, albeit significant, which raises doubts regarding the importance of these relationships and their potential implication for health programs.

Alcohol use was not related to physical activity in our sample. This finding is consistent with the findings in Schuit et al.'s (2002) study, which was conducted among 16,789 men and women aged 20 to 59. However, our finding is in contrast to the positive correlation usually found between alcohol use and physical activity (Addicott, Marsh-Richard, Mathias, & Dougherty, 2007; Moore & Werch, 2008; Poortinga, 2007a). Addicott et al. (2007) collected measurements of physical activity of 30 young adults following various doses of alcohol or placebo consumption and found that all alcohol doses increased physical activity. Furthermore, Moore and Werch (2008) explored the relationship between self-reported vigorous exercise frequency and alcohol use behaviors among freshmen students and concluded that frequent exercisers drank significantly more often and a significantly greater quantity than did infrequent exercisers. The relationship between alcohol and physical activity among older persons is yet unclear and necessitates further investigation.

Past findings regarding the relationship between physical activity and smoking are inconsistent as well: Although some studies report a negative relationship (Blair et al., 1985; Lian et al., 1999; Padrao et al., 2007; Patterson et al., 1994), others report a positive relationship (Moore & Werch, 2008; Poortinga, 2007a). In our research, we found smoking to be unrelated to physical activity, which might reflect the inconsistency of past findings. Thus, it may be beneficial for future research to explore moderating variables in this relationship such as social activity level.

One interesting finding in our research is that eating between meals was not related to any of the other health variables or to the other nutrition variables. This finding suggests that, contrary to common belief, eating between meals, as such, does not necessarily indicate poor health practices, a notion which is in accordance with past findings (Drummond, Crombie, & Kirk, 1996; Wingard, Berkman, & Brand, 1982). For instance, snacking did not have significant independent associations with higher mortality (Wingard et al., 1982), and may not necessarily predispose people to obesity (Drummond et al., 1996), However, as our research focused on the interrelationships between health behaviors and not on the outcomes of good health practices, the consequences of eating between meals among older persons remains to be ascertained by future studies.

Study Limitations and Strengths

One limitation of the study is the reliance on self-report measures, which may be problematic in terms of their validity, especially among older persons. However, there is evidence that self-ratings of physical functional capacity in older persons are accurate (Dorevitch et al., 1992), indicating that self-report measures are in fact a valid method of assessment in older persons. Another limitation of the study relates to the response rates in the different cohorts. Although the response rate in the CALAS cohort (75.8%) was relatively high for studies among older persons (Bowling & Browne, 1991), the response rate in the IMAS cohort (47%) was rather low and one cannot overlook the possibility of a selective nonresponse bias.

Our ability to use two independently collected data sets of different cohorts provides us with an opportunity to check the results. The facts that the results were similar for cohorts that differ in about 10 years, support the robustness of the findings.

Conclusions

Taken as a whole, our findings indicate that health behaviors in older persons, much like health behaviors at younger ages (Berrigan et al., 2003; De-Vries et al., 2008; Harris & Guten, 1979; Johnson et al., 1998; Kremers et al., 2004; Kulbok & Cox, 2002; Langlie, 1977; Liang et al., 1999; Patterson et al., 1994; Reeves & Rafferty, 2005; Steele & McBroom, 1972; Williams & Wechsler, 1972), seem to be generally unrelated. Although we did find weak and significant relationships among some health behaviors, those correlations were very small, lending a very weak support to the interrelationships among health behaviors. This counter-intuitive finding has important implications for health promotion policy. It indicates that to promote a healthy lifestyle among older persons, prevention and health-promotion programs should address each health behavior and cannot address general healthy lifestyle. Furthermore, it is not likely that change in a single behavior will transfer to others. Therefore any comprehensive program needs to address multiple health behaviors rather than only one, as is usually the case (Goldstein, Whitlock, & DePue, 2004; Nigg, Allegrante, & Ory, 2002; Orleans, 2004; Strecher, Wang, Derry, Wildenhaus, & Johnson, 2002). McEachan, Lawton, and Conner (2010) have recently questioned the value of classifying health behaviors based on their frequencies. As an alternative, they propose classifying the behaviors based on their perceived characteristics, such as perceived risk. Future research should also explore specific subgroups of the older population whose health practices are the worst and could benefit the most from health-promotion programs.

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