American Journal of
Preventive Medicine

RESEARCH ARTICLE

Combined Healthy Behaviors and Healthcare Services Use in Older Adults

Ana Hernández-Aceituno, MD,[1] Raúl F. Pérez-Tasigchana, MD,[1] Pilar Guallar-Castillón, MD, PhD,[1] Esther López-García, BPharm, PhD,[1] Fernando Rodríguez-Artalejo, MD, PhD,[1,2] José R. Banegas, MD, PhD[1]

Introduction: Data on the combined impact of healthy behaviors on healthcare use in older adults are limited.

Methods: Study with community-dwelling individuals aged ≥60 years from the Spanish Seniors-ENRICA cohort, recruited in 2008–2010, followed through 2012–2013, and analyzed in 2016 (N=2,021). At baseline, the following healthy behaviors were self-reported: three traditional (never smoking, being physically active, having a healthy diet) and three emerging (sleeping 7–8 hours/day, sitting <8 hours/day, not living alone). Outcomes were self-reported polypharmacy (five or more drugs per day), primary care physician visits (one or more per month), medical specialist visits (more than one per year), and hospitalization (one or more in the last year). The associations between baseline healthy behaviors and healthcare services used in 2012–2013 were summarized with ORs and 95% CIs from multiple logistic regression, adjusting for demographics, lifestyles, comorbidities, and baseline health services used.

Results: Most single healthy behaviors were associated with lower use of most health services. Compared with participants with zero or one healthy behavior, those with five or six healthy behaviors showed lower risk of polypharmacy (OR=0.46, 95% CI=0.24, 0.85, *p*-trend=0.001), visits to the primary care physician (OR=0.50, 95% CI=0.26, 0.96, *p*-trend=0.013), and hospitalization (OR=0.50, 95% CI=0.24, 1.01, *p*-trend=0.016). No association was found with visits to the medical specialist.

Conclusions: The combination of five to six healthy behaviors in older adults is associated with half the risk of polypharmacy and using several healthcare services. In an era of constrained resources in most countries, this information may help inform health policy to control healthcare spending in the future.

Am J Prev Med 2017;▮(▮):▮▮▮–▮▮▮.

INTRODUCTION

Older adults are the population subgroup that has been growing the fastest in recent decades, with subsequent increasing prevalence of chronic disease and disability, and greater demand for healthcare services (www.who.int/ageing/events/world-report-2015-launch/en/).[1–4] In Spain, a recent study found that 65% of people aged ≥65 years went to primary care physicians once a month, 16.4% had been hospitalized at least once a year, and 55.7% had polypharmacy (five or more drugs per day).[2] These data are especially important considering that the Spanish National Health System provides universal health care to all its citizens

From the [1]Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid/IdiPAZ and CIBER in Epidemiology and Public Health (CIBERESP), Madrid, Spain; and [2]IMDEA-Food Institute, CEI UAM+CSIC, Madrid, Spain

Address correspondence to: José R. Banegas, MD, PhD, Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid, C/Arzobispo Morcillo 2, 28029 Madrid, Spain. E-mail: joseramon.banegas@uam.es.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2017.06.023

under a tax-financed scheme, being free of charge at the moment of use. Primary care physicians act as gatekeepers to access to specialist care, and citizens have to pay a percentage of the cost of prescription medicines baserd on their income or pensioner state.

Many factors influence healthcare utilization,[5] including sociodemographic characteristics, health system characteristics and accessibility, and comorbidity. More recently other factors, including lifestyles, have been studied.[6]

Some studies have found a protective association of several lifestyles with mortality or cardiovascular risk in adults, including the elderly.[7–12] However, few studies have reported the association of a few isolated behaviors,[13,14] or the combination of some biological risk factors[15] with healthcare utilization.

This study is the first to examine the combined impact of a number of traditional healthy behaviors (nonsmoking, physical activity, and adequate diet) and emerging healthy behaviors (adequate sleep duration, no excessive sedentary time, and cohabitation) on the use of common healthcare services (polypharmacy, visits to the primary care physician or medical specialist, and hospitalization) in the older population in Spain. This information is of high clinical and public health relevance because (1) the proportion of older adults who adhere to the traditional healthy behaviors is low,[10,16] (2) interventions that cover multiple health behaviors may be more effective than those addressing single behaviors,[17] and (3) it could have policy implications regarding healthcare costs.

METHODS

Study Population

Data were taken from the Seniors-ENRICA (study on Nutrition and Cardiovascular Risk in Spain) cohort. Briefly, the cohort was established in 2008–2010 with 2,519 individuals selected through stratified random sampling from the non-institutionalized population aged ≥60 years in Spain.[18] At baseline, data were gathered in three stages. First, a phone interview to obtain sociodemographic factors, health status, lifestyle, morbidity, and health services used; second, a home visit to collect blood samples; and third, another home visit to perform physical examination and record habitual diet and prescribed medication.

In 2012–2013 (median follow-up 3.5 years), updated data were collected on a second wave of 2,021 participants, including healthcare utilization, physical examination, and diet.

The study protocol was approved by the Clinical Research Ethics Committee of *La Paz* University Hospital (Madrid) and patients provided written informed consent.

Measures

Participants self-reported traditional health behaviors. First, whether they were never a smoker, former smoker, or current smoker. Physical activity was evaluated with a validated index that combined activity at work (sedentary, standing, manual, heavy manual, unemployed) and the hours spent in sports and cycling during leisure time (not active, <3.5 hours/week, 3.5 to ≤7.0 hours/week, or >7 hours/week).[19] Then the index assigned participants a score from one to four: one= inactive, two= moderately inactive, three= moderately active, and four= active.[20] Diet was assessed using a computerized dietary history validated in Spain.[21] Diet health was calculated with the Mediterranean Diet Adherence Screener (MEDAS),[22] which scores from zero to 14 depending on the food consumed, quantity, and frequency, where a higher score indicates better adherence. MEDAS was classified into sex-specific tertiles. Those in the highest tertile were considered as adherent.

Regarding non-traditional health behaviors, sleep duration was obtained by asking: *How many hours do you usually sleep per day (including both nighttime and daytime)?* Sedentary behavior was estimated by asking: *In a typical week during the past year, how many hours do you spend on each of the following activities: seated and watching video or TV, seated at the computer, seated on transport to work (as a driver or passenger in the car, subway, bus…), seated while reading or listening to music (except during transport), and seated or lying in the sun in summer and winter?* Participants were also asked: *On average, how many minutes it takes you to have breakfast, lunch at noon and dinner (seated while eating)?* Participants were then categorized according to whether they were sitting more or less than 8 hours a day.[23] Social network was assessed by asking whether participants lived alone or not.[24]

A healthy behavior score was developed where each individual was given one point for each of the following six positive behaviors: never a smoker, very or moderately physically active, healthy diet score (highest MEDAS tertile), sleeping 7–8 hours/day, sitting time <8 hours/day, and not living alone. This categorization was in accordance with previous prospective studies and reviews.[7–10,25]

Outcome variables were the utilization of healthcare services in 2012–2013, obtained by asking and then dichotomizing the response: (1) the number of medications currently being taken (five or more drugs per day [polypharmacy][3,26] versus less); (2) frequency of visits to primary care physician (one or more per month versus less); (3) admission to a hospital at least once in the past year; and (4) visits to medical specialist (more than one per year versus less). Reported medications use was checked by asking the participants in the second home visit to show the drug packages they had. Cutoff points for health services used were based on previous studies, including the Spanish National Health Survey, and took into account the frequency of healthcare use in Spain and, in the case of polypharmacy, the cutoff value used was reported to be the best to identify older people at risk of harm.[2,3,26,27]

Baseline information on potential confounders of the associations was collected. Sociodemographic variables included age, sex, and educational attainment (primary or less, secondary, or university). Total energy intake (kcal/day) was estimated from the dietary history.[21] Alcohol consumption was obtained with the frequency–quantity scale used in the Spanish National Health Survey.[28] Participants were classified as excessive drinkers (>24 g/day of alcohol intake in women, and >40 g/day in men) and non-excessive drinkers (never drinker, former drinker, moderate drinker). The following self-reported chronic diseases

diagnosed by the physician were considered: asthma or chronic bronchitis, arthritis, osteoarthritis, hip fracture, depression (in need of treatment), cardiovascular disease (ischemic heart disease, stroke, or heart failure), and cancer at any site.[29] Subjects were classified into two groups: zero to one and two or more comorbidities. Weight and height were measured using standardized procedures, and BMI was weight (kg) divided by squared height (m^2).[30] Blood pressure was measured three times using standardized conditions and validated devices.[31] Hypertension was defined as current blood pressure medication or mean systolic blood pressure ≥140 mmHg[31,32]; hypercholesterolemia as a previous diagnosis, total cholesterol >200 mg/dL, or lipid-lowering treatment; and diabetes mellitus as fasting glucose ≥126 mg/dL or current treatment.[15]

Statistical Analysis

This study analysis was performed in 2016. Among the 2,519 participants, 498 were excluded for having missing values for health behaviors or use of healthcare services. Therefore, the analyses were performed with 2,021 subjects. The associations between each health behavior or the behaviors score in 2008–2010 and healthcare services use in 2013 were summarized with ORs and 95% CIs, obtained from multiple logistic regression. P-values for linear trend were estimated by modeling the behaviors score as a continuous variable. Two models were built adjusting for baseline confounders. Model 1 was adjusted for age, sex, educational attainment, and baseline use of the corresponding healthcare service (as defined above). Model 2 was additionally adjusted for total energy intake, alcohol consumption, comorbidities, BMI, hypertension, diabetes, and hypercholesterolemia. Given the limited number of events, parsimonious models were built.[33] Because no significant interactions were found between study results and age and sex, results are presented for the total study sample.

Lastly, population attributable risks (PAR)[34] were calculated using the formula: PAR = Pe (RRe-1) / [1 + (Pe (RRe-1))], where Pe is the proportion of individuals who lack an optimal number of healthy behaviors (i.e., only having zero to four) and RRe is the relative risk (hazard ratio) of using healthcare services associated with that level of healthy behaviors.

Statistical significance was set at two-sided $p<0.05$. The analyses were conducted with Stata/SE, version 13.

RESULTS

Participants' mean age at baseline was 68.6 years (52% women). Participants who use healthcare services more frequently had in general significantly higher mean age, less education, lower energy intake, higher mean BMI, and higher frequency of comorbidities and diabetes than those using services less frequently (Table 1). Also, participants with polypharmacy were more frequently physically inactive, not sleeping 7–8 hours, and living alone than those using fewer than five drugs per day (Appendix Table 1, available online). Those who visit the primary care physician and the medical specialist more frequently were more likely to be inactive; and those who have been hospitalized one or more times in a year had a higher percentage of sedentary behavior.

Never smoking was associated with fewer hospitalizations (fully adjusted OR=0.69, 95% CI=0.50, 0.96) (Table 2). Physical activity was associated with a reduced risk of polypharmacy (fully adjusted OR=0.72, 95% CI=0.54, 0.94), visits to the primary care physician (fully adjusted OR=0.80, 95% CI=0.60, 1.00), and visits to the medical specialist (fully adjusted OR= 0.78, 95% CI=0.61, 0.99). Non-sedentary behavior was associated with lower risk of hospitalization (OR=0.58, 95% CI=0.39, 0.86). Most of the other healthy behaviors also showed a tendency to lower use of most health services (Table 2). The combination of two specific behaviors on specific services was more salient for polypharmacy (e.g., physical activity with sleeping 7–8 hours/day, physical activity with never smoking, and physical activity with cohabitation), yielded a reduced risk of this outcome (fully adjusted OR=0.50, 0.59, and 0.57, respectively, all with $p<0.01$). The combo of these three behaviors was also associated with a lower risk of polypharmacy (OR=0.41, $p<0.01$).

An increasing number of healthy behaviors was associated with a progressively lower use of health services (p-trend <0.05) except for visits to a medical specialist (Table 3). In the fully adjusted model, the aggregation of five to six healthy habits (versus zero to one) was associated with lower risk of polypharmacy (OR=0.46, 95% CI=0.24, 0.85) and of visits to the primary care physician (OR=0.50, 95% CI=0.26, 0.96), and was marginally associated with fewer hospitalizations (OR=0.50, 95% CI=0.24, 1.01).

Evaluated ordinally, each additional healthy behavior was associated with an 18% lower risk of polypharmacy (OR=0.82, 95% CI=0.74, 0.92, p-trend=0.001); 13% lower risk of primary care physician visits (OR=0.87, 95% CI=0.77, 0.97, p-trend=0.019); and 15% lower risk of hospitalization (OR=0.85, 95% CI=0.74, 0.97, p-trend=0.019) (Figure 1).

Lastly, PARs indicate that 42.7% of polypharmacy, 28.9% of monthly primary care physician visits, and 21.6% of annual hospitalizations were attributable to the lack of an optimal healthy behavior profile (i.e., only having zero to four healthy behaviors).

DISCUSSION

This study, carried out in a cohort of community-dwelling older adults in Spain, shows for the first time that the combination of five or six healthy habits is associated with a 50% reduction of the use of several common health services. Importantly, the combination of healthy habits impacted services used in a dose–related

Table 1. Baseline Characteristics of Participants in the Seniors-ENRICA Cohort, According to Healthcare Services Utilization

	Use of healthcare services in 2012–2013											
	Number of medications			Primary care physician visits			Hospitalization in the last year			Medical specialist visits		
Baseline characteristics (N=2,021)	**≥5/ day**	**<5/ day**	***p*-value**	**≥1/ month**	**<1/ month**	***p*-value**	**Yes**	**No**	***p*-value**	**>1/ year**	**≤1/ year**	***p*-value**
Baseline events, *n*	257	1,764		436	1,585		273	1,748		589	1,432	
Follow-up events, *n*	733	1,288		446	1,575		279	1,742		752	1,269	
Age, years (SD)	70.6 (6.7)	67.5 (5.8)	**<0.001**	69.6 (6.6)	68.3 (6.2)	**<0.001**	69.9 (7.0)	68.4 (6.2)	**0.001**	68.6 (6.2)	68.6 (6.4)	0.657
Sex, *n* (%)												
Women	399 (54.4)	652 (50.6)		243 (54.5)	808 (51.3)		141 (50.5)	910 (52.2)		381 (50.6)	670 (52.8)	
Men	334 (45.5)	636 (49.3)	0.099	203 (45.5)	767 (48.7)	0.235	138 (49.4)	832 (47.7)	0.597	371 (49.3)	599 (47.2)	0.354
Educational level, *n* (%)												
Primary or less	460 (62.7)	634 (49.2)		292 (65.4)	802 (50.9)		168 (60.2)	926 (53.1)		387 (51.5)	707 (55.1)	
Secondary	141 (19.2)	359 (27.8)		78 (17.4)	422 (26.8)		62 (22.2)	438 (25.1)		174 (23.1)	326 (25.7)	
University	132 (18.0)	295 (22.9)	**<0.001**	76 (17.04)	351 (22.3)	**<0.001**	49 (17.5)	378 (21.7)	0.082	191 (25.4)	236 (18.6)	**0.001**
Alcohol intake, *n* (%)												
Excessive drinkers	52 (7.2)	115 (9.0)		27 (6.1)	140 (9.0)		24 (8.9)	143 (8.3)		61 (8.2)	106 (8.5)	
Non-excessive drinkers	663 (92.7)	1,161 (90.9)	0.179	414 (93.8)	1,410 (0.9)	0.052	246 (91.1)	1,578 (91.6)	0.749	679 (91.7)	1,145 (91.5)	0.858
Energy, kcal/d (SD)	1,958.8 (638.0)	2,104.7 (748.4)	**<0.001**	1,983.0 (734.3)	2,074.5 (766.9)	**0.011**	2,044.5 (821.0)	2,054.2 (748.9)	0.819	2,018.3 (731.0)	2,075.5 (777.8)	0.068
Comorbidities, *n* (%)												
≥2 diseases	158 (21.5)	108 (8.3)		88 (19.7)	178 (11.3)		56 (20.0)	210 (12.0)		139 (18.5)	153 (12.1)	
<2 diseases	575 (78.4)	1,180 (91.6)	**<0.001**	358 (80.2)	1,397 (88.7)	**<0.001**	223 (79.9)	1,532 (87.9)	**<0.001**	613 (81.5)	1,116 (87.9)	**<0.001**
Risk factors, *n* (%)												
BMI (SD)	29.4 (4.6)	27.9 (4.0)	**<0.001**	29.3 (4.7)	28.2 (4.2)	**<0.001**	28.9 (4.2)	28.4 (4.3)	0.068	28.5 (4.2)	28.5 (4.4)	0.741
Hypertension	366 (50.2)	597 (46.6)	0.117	215 (48.5)	748 (47.8)	0.784	132 (48.0)	831 (47.9)	0.988	350 (46.9)	613 (48.6)	0.473
Diabetes mellitus	210 (28.9)	106 (8.3)	**<0.001**	90 (20.3)	226 (14.5)	**0.003**	56 (20.1)	260 (15.0)	**0.032**	141 (19.0)	175 (13.9)	**0.002**
Hypercholesterolemia	507 (69.3)	907 (70.6)	0.545	310 (69.5)	1104 (70.3)	0.727	193 (69.1)	1,221 (70.3)	0.695	529 (70.5)	885 (69.9)	0.786

Note: Boldface indicates statistical significance ($p<0.05$).
ENRICA, study on Nutrition and Cardiovascular Risk in Spain.

Table 2. Association Between Each Healthy Behavior and Healthcare Utilization in the Seniors-ENRICA Cohort

Baseline healthy behaviors (N=2,021)	Use of health care services in 2012–2013							
	Polypharmacy		Primary care physician visits		Hospitalization in the last year		Medical specialist visits	
	Event/*n*[a]	OR (95% CI)	Event/*n*[a]	OR (95% CI)	Event/*n*[a]	OR (95% CI)	Event/*n*[a]	OR (95% CI)
Model 1								
Never smoker	429/1,182	0.81 (0.64–1.04)	264/1,182	0.82 (0.62–1.08)	150/1,182	**0.70 (0.52–0.96)**	429/1,182	0.95 (0.76–1.18)
Physically active	114/439	**0.63 (0.48–0.82)**	76/439	0.75 (0.56–1.00)	49/439	0.81 (0.58–1.14)	142/439	**0.75 (0.59–0.95)**
Mediterranean diet	165/482	0.86 (0.68–1.10)	92/482	0.84 (0.64–1.11)	63/482	0.92 (0.67–1.25)	189/482	1.09 (0.88–1.36)
Sleeping 7–8 hours/day	236/762	**0.78 (0.63–0.97)**	152/762	0.87 (0.69–1.10)	106/762	1.07 (0.82–1.39)	279/762	0.99 (0.82–1.20)
Not sedentary behavior	646/1,807	0.77 (0.56–1.07)	397/1,807	0.85 (0.59–1.23)	236/1,807	**0.58 (0.40–0.85)**	661/1,807	0.88 (0.65–1.19)
Not living alone	590/1,693	0.84 (0.63–1.11)	374/1,693	1.19 (0.86–1.63)	228/1,693	0.89 (0.63–1.27)	631/1,693	1.01 (0.77–1.32)
Model 2								
Never smoker	429/1,182	0.77 (0.59–1.01)	264/1,182	0.76 (0.57–1.01)	150/1,182	**0.69 (0.50–0.96)**	429/1,182	0.96 (0.76–1.20)
Physically active	114/439	**0.72 (0.54–0.94)**	76/439	0.80 (0.60–1.00)	49/439	0.89 (0.64–1.26)	142/439	**0.78 (0.61–0.99)**
Mediterranean diet	165/482	0.90 (0.70–1.17)	92/482	0.78 (0.59–1.04)	63/482	0.89 (0.64–1.22)	189/482	1.10 (0.88–1.38)
Sleeping 7–8 hours/day	236/762	0.82 (0.65–1.03)	152/762	0.87 (0.68–1.11)	106/762	1.06 (0.81–1.40)	279/762	0.99 (0.82–1.22)
Not sedentary behavior	646/1,807	0.89 (0.63–1.26)	397/1,807	0.89 (0.61–1.30)	236/1,807	**0.58 (0.39–0.86)**	661/1,807	0.89 (0.66–1.23)
Not living alone	590/1,693	0.79 (0.58–1.06)	374/1,693	1.17 (0.84–1.63)	228/1,693	0.84 (0.58–1.21)	631/1,693	1.05 (0.79–1.38)

Note: Boldface indicates statistical significance ($p < 0.05$). Model 1: Logistic regression model adjusted for age, sex, level of education, and baseline use of the corresponding healthcare service. Model 2: Logistic regression model adjusted as Model 1 plus energy, alcohol consumption, comorbidities, BMI, hypertension, diabetes mellitus, and hypercholesterolemia.

[a]Event indicates the number of participants with the higher use category of the corresponding health service (polypharmacy, one or more primary-care visits per month, hospitalization in the last year, or more than one specialist visits per year), and *n* indicates the number of participants who fulfill the corresponding healthy behavior.

ENRICA, study on Nutrition and Cardiovascular Risk in Spain.

Table 3. Association Between Number of Healthy Behaviors and Healthcare Services Utilization, Seniors-ENRICA Cohort

Baseline number of healthy behaviors (N=2,021)	*n* (%)[a]	Use of healthcare services in 2012–2013							
		Polypharmacy		Primary care physician visits		Hospitalization in the last year		Medical specialist visits	
		Event[b]	OR (95% CI)	Event[b]	OR (95% CI)	Event[b]	OR (95% CI)	Event[b]	OR (95% CI)
Model 1									
0–1	101 (5.00)	45	1 (ref)	26	1 (ref)	21	1 (ref)	43	1 (ref)
2	415 (20.53)	170	0.84 (0.51–1.36)	99	0.76 (0.44–1.29)	63	0.72 (0.41–1.26)	153	0.89 (0.56–1.41)
3	787 (38.94)	321	0.82 (0.52–1.31)	187	0.79 (0.48–1.31)	115	0.68 (0.40–1.16)	310	1.02 (0.66–1.58)
4	533 (26.37)	156	**0.52 (0.32–0.85)**	103	0.61 (0.36–1.04)	61	**0.54 (0.30–0.94)**	183	0.83 (0.53–1.30)
5–6	185 (9.15)	41	**0.39 (0.22–0.69)**	31	0.53 (0.28–1.00)	19	**0.50 (0.25–0.99)**	63	0.82 (0.49–1.39)
p for trend			**<0.001**		0.020		0.016		0.096
Model 2									
0–1	101 (5.00)	45	1 (ref)	26	1 (ref)	21	1 (ref)	43	1 (ref)
2	415 (20.53)	170	0.95 (0.56–1.60)	99	0.78 (0.46–1.35)	63	0.75 (0.42–1.34)	153	0.94 (0.59–1.51)
3	787 (38.94)	321	0.93 (0.56–1.54)	187	0.76 (0.45–1.28)	115	0.64 (0.37–1.12)	310	1.06 (0.67–1.66)
4	533 (26.37)	156	0.63 (0.37–1.07)	103	0.61 (0.36–1.06)	61	**0.54 (0.30–0.98)**	183	0.88 (0.55–1.41)
5–6	185 (9.15)	41	**0.46 (0.24–0.85)**	31	**0.50 (0.26–0.96)**	19	0.50 (0.24–1.01)	63	0.89 (0.52–1.52)
p for trend			0.001		0.013		0.016		0.463

Note: Boldface indicates statistical significance ($p < 0.05$). Model 1: Logistic regression model adjusted for age, sex, level of education, and baseline use of the corresponding healthcare service. Model 2: Logistic regression model adjusted as Model 1 plus energy, alcohol consumption, comorbidities, BMI, hypertension, diabetes mellitus, and hypercholesterolemia.

[a]*n* indicates the absolute number of participants who fulfill the corresponding combination of healthy behaviors, in parentheses the percentage of each number of habits is represented with respect to the total score.

[b]Event indicates the number of participants with the higher use category of the corresponding health service (polypharmacy, one or more primary-care visits per month, hospitalization in the last year, or more than one specialist visits per year).

ENRICA, study on Nutrition and Cardiovascular Risk in Spain.

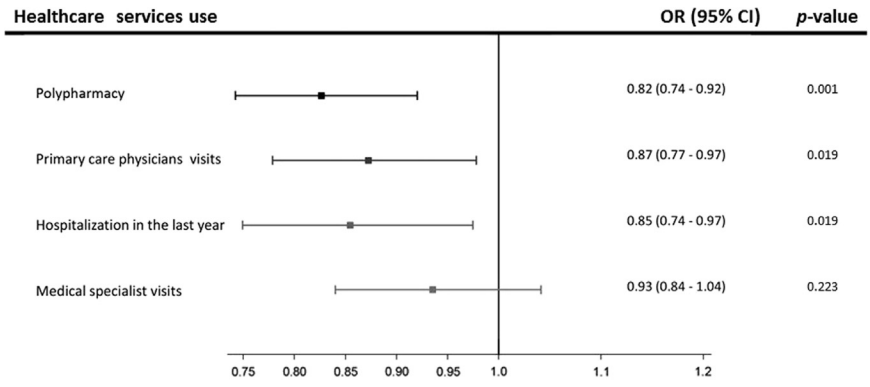

Figure 1. Association between each additional healthy behavior and selected healthcare services use in older people.
Note: Healthy behaviors: never smoking, being physically active, having a healthy diet, sleeping 7–8 hours/day, sitting <8 hours/day, and not living alone. Polypharmacy: currently taking five or more drugs daily. Primary care physician visits: one or more times per month. Medical specialist visits: more than one time per year. ORs were obtained from fully adjusted models (see Table 3 Note).

fashion: the more healthy habits a person follows, the fewer the healthcare services utilizations, except for visits to a medical specialist. It is possible that people who practice many healthy behaviors are more proactive or assertive in demanding specialist healthcare when they perceive it is warranted/ needed. Also, 20%–40% of the polypharmacy or the higher use of services in the older population is potentially avoidable (or may be postponed) by meeting all five to six healthy habits. This illustrates the great potential benefit of lifestyle promotion in terms of healthcare utilization and potential saving.

Some studies[35] have found an increased risk among older smokers (versus never smokers) for poorer health ratings, impaired mobility, and selected medication use. This is consistent with the present findings that never smoking, along with a non-sedentary lifestyle, is associated with lower hospitalization. Also, an inverse association has been reported between levels of physical activity and multimorbidity in adults, including older individuals,[36–39] which may explain the lower level of polypharmacy and frequent visits to specialists in individuals who were physically active as found in the present study. According to one study among older adults with polypharmacy,[40] those who lived with a partner were more knowledgeable of the indication of all their prescribed medications than those living alone. This is consistent with the marginally lower polypharmacy risk among older adults not living alone in the present study. Regarding sleep duration, some studies have shown that <6 hours of sleep is a risk factor for cardiovascular disease.[41] This could help explain the present findings that the elderly not sleeping 7–8 hours/day have more frequent polypharmacy. Although no significant association was found between diet and any particular habit (only marginally lower use of primary care physician), other studies have found that the Mediterranean diet reduces the risk of cardiovascular events,[42] which is compatible with that marginal association. Unfortunately no similar studies are available to compare the combined impact of these healthy behaviors on health services used.

Limitations

The strengths of this study include the adjustment for many potential confounders. This study also presents some limitations. Twenty percent of the sample was lost to follow-up. Nevertheless, the baseline sociodemographic, lifestyle, and clinical characteristics of individuals lost to follow-up and those remaining in the study were similar. Thus, among the 2,021 subjects without follow-up losses, 52% were women, mean age was 68.7 years, 54.1% had primary education or less, 14.5% had more than two diseases, mean BMI was 28.5, hypertension 47.9%, diabetes 15.8%, and hypercholesterolemia 70.1%. Among the 498 participants who had follow-up losses, 57% were women, average age was 68.8 years, 56% had primary education or less, 15.3% had more than two diseases, mean BMI was 28.6, hypertension 41.7%, diabetes 15.5%, and hypercholesterolemia 70.9%. Lifestyle was self-reported, which may have led to recall bias, particularly for assessing physical activity and non-traditional health behaviors. However, similar measures of these behavior variables have shown adequate validity.[8] Diet was also self-reported so some recall bias may exist, which usually leads to underestimating the study association. Health services used was also self-reported, but has been found to be a reliable method.[43] However, further studies using more objective and standardized measures of physician visits and utilization of other health services could strengthen results of this and similar studies. Data on long-term patterns of healthy behaviors were also lacking, and, although the follow-up was rather short, some changes over time are still possible and would

likely have led to underestimation of the protective effects observed. Hospitalization was significantly associated with the combination of four habits and only marginally significant with five to six habits, probably due to insufficient sample size. Given that polypharmacy is correlated with visits to primary care and specialists, and that access to specialist visits were controlled by primary care physicians, sensitivity analyses were run with additional adjustment for these variables, and found that main results presented in Table 3 did not materially change (data not shown). Although the study entailed a prospective design, the authors have not used incident outcomes because individuals with the study outcomes at baseline were not excluded but only adjusted for. Thus, the study results may reflect a cross-sectional association. Also, because of short follow-up, reverse causality cannot be completely ruled out, and future studies with longer follow-up need to replicate these results. Nevertheless, in a sensitivity analysis excluding cardiovascular disease and diabetes at baseline, the main results were practically unchanged (data not shown). Overall, these limitations did not preclude the observation of a clear association between combination of healthy behaviors and lower use of health care. Lastly, it is worth noting that the authors only studied more or less frequent healthcare services used according to commonly used criteria, and, as frequent attendance is not synonymous of abuse or inappropriate delivery of services, these problems require specific studies.

CONCLUSIONS

This study in Spanish older adults shows that adherence to a combination of healthy behaviors is independently associated with half the risk of polypharmacy, frequent visits to the primary care physician, and hospitalization. This is important given that, for example, polypharmacy affects 36% of older people in the present study, and increases the risk of using inadequate medications and having adverse reactions and lower treatment adherence.[44] Likewise, the decrease of primary care visits and hospitalizations associated with a healthy lifestyle could lead to improved care due to reduced workload, shorter waiting lists,[45] and a reduction of complications from hospitalization.[46] Hence, the information in this study may have implications for policy to control healthcare spending and support better behavioral health. Notwithstanding, further research with cohort studies should be done to confirm these results.

ACKNOWLEDGMENTS

Specific funding for this study was obtained from Fondo de Investigación Sanitaria (FIS) grant PI13/02321 and PI16/01460 (Instituto de Salud Carlos III and FEDER/FSE). RFP-T was supported by the National Government of Ecuador through the National Institution of Higher Education, Science, Technology and Innovation (SENESCYT). The funding agencies had no role in the study design; collection, analysis, and interpretation of the data; in writing the report; or in the decision to submit the manuscript for publication.

JRB and PG-C had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design were done by JRB and PG-C. Data analysis was performed by AH-A and RP-T. Acquisition or interpretation of data or drafting and revisions for important intellectual content were done by all authors. JRB, PG-C, EL-G, and FR-A designed the study and obtained funding. JRB supervised the study. All authors have read and approved the manuscript.

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.amepre.2017.06.023.

REFERENCES

1. Nie JX, Wang L, Tracy CS, Moineddin R, Upshur RE. Health care service utilization among the elderly: findings from the Study to Understand the Chronic Condition Experience of the Elderly and the Disabled (SUCCEED project). *J Eval Clin Pract*. 2008;14(6):1044–1049. https://doi.org/10.1111/j.1365-2753.2008.00952.x.
2. Cano Pérez MD, Castell Alcalá MV, Queipo Matas R, Martín Martín S, Mateo Pascual C, Otero Puime Á. Use of primary care services, care specialized and drug use by population 65 years and more in the community of Madrid, Spain. *Rev Esp Salud Publica*. 2016;90:e1–e11.
3. Bjerrum L, Søgaard J, Hallas J, Kragstrup J. Polypharmacy in general practice: differences between practitioners. *Br J Gen Pract J R Coll Gen Pract*. 1999;49(440):195–198.
4. Charlesworth CJ, Smit E, Lee DSH, Alramadhan F, Odden MC. Polypharmacy among adults aged 65 years and older in the United States: 1988-2010. *J Gerontol A Biol Sci Med Sci*. 2015;70(8):989–995. https://doi.org/10.1093/gerona/glv013.
5. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc*. 1973;51(1):95–124. https://doi.org/10.2307/3349613.
6. Østbye T, Taylor DH, Jung S-H. A longitudinal study of the effects of tobacco smoking and other modifiable risk factors on ill health in middle-aged and old Americans. *Prev Med*. 2002;34(3):334–345. https://doi.org/10.1006/pmed.2001.0991.
7. de Groot LCPMG, Verheijden MW, de Henauw S, Schroll M, van Staveren WA, SENECA Investigators. Lifestyle, nutritional status, health, and mortality in elderly people across Europe: a review of the longitudinal results of the SENECA study. *J Gerontol A Biol Sci Med Sci*. 2004;59(12):1277–1284. https://doi.org/10.1093/gerona/59.12.1277.
8. Martínez-Gómez D, Guallar-Castillón P, León-Muñoz LM, López-García E, Rodríguez-Artalejo F. Combined impact of traditional and non-traditional health behaviors on mortality: a national prospective cohort study in Spanish older adults. *BMC Med*. 2013;11:47. https://doi.org/10.1186/1741-7015-11-47.
9. Kvaavik E, Batty GD, Ursin G, Huxley R, Gale CR. Influence of individual and combined health behaviors on total and cause-specific mortality in men and women: the United Kingdom health and lifestyle

survey. *Arch Intern Med*. 2010;170(8):711–718. https://doi.org/10.1001/archinternmed.2010.76.
10. Knoops KTB, de Groot LCPGM, Kromhout D, et al. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE project. *JAMA*. 2004;292(12):1433–1439. https://doi.org/10.1001/jama.292.12.1433.
11. de Rezende LFM, Rey-López JP, Matsudo VKR, do Carmo Luiz O. Sedentary behavior and health outcomes among older adults: a systematic review. *BMC Public Health*. 2014;14:333. https://doi.org/10.1186/1471-2458-14-333.
12. Chen L-J, Lai Y-J, Sun W-J, Fox KR, Chu D, Ku P-W. Associations of exercise, sedentary time and insomnia with metabolic syndrome in Taiwanese older adults: a 1-year follow-up study. *Endocr Res*. 2015;40(4):220–226. https://doi.org/10.3109/07435800.2015.1020547.
13. Vals K, Kiivet R-A, Leinsalu M. Alcohol consumption, smoking and overweight as a burden for health care services utilization: a cross-sectional study in Estonia. *BMC Public Health*. 2013;13:772. https://doi.org/10.1186/1471-2458-13-772.
14. Davis MA, Bynum JPW, Sirovich BE. Association between apple consumption and physician visits. *JAMA Intern Med*. 2015;175(5):777–783. https://doi.org/10.1001/jamainternmed.2014.5466.
15. Natarajan S, Nietert PJ. Hypertension, diabetes, hypercholesterolemia, and their combinations increased health care utilization and decreased health status. *J Clin Epidemiol*. 2004;57(9):954–961. https://doi.org/10.1016/j.jclinepi.2004.01.011.
16. Graciani A, León-Muñoz LM, Guallar-Castillón P, Rodríguez-Artalejo F, Banegas JR. Cardiovascular health in a southern Mediterranean European country: a nationwide population-based study. *Circ Cardiovasc Qual Outcomes*. 2013;6(1):90–98. https://doi.org/10.1161/CIRCOUTCOMES.112.967893.
17. Prochaska JO. Multiple Health Behavior Research represents the future of preventive medicine. *Prev Med*. 2008;46(3):281–285. https://doi.org/10.1016/j.ypmed.2008.01.015.
18. Rodríguez-Artalejo F, Graciani A, Guallar-Castillón P, et al. [Rationale and methods of the study on nutrition and cardiovascular risk in Spain (ENRICA)]. *Rev Esp Cardiol*. 2011;64(10):876–882. https://doi.org/10.1016/j.recesp.2011.05.019.
19. Wareham NJ, Jakes RW, Rennie KL, et al. Validity and repeatability of a simple index derived from the short physical activity questionnaire used in the European Prospective Investigation into Cancer and Nutrition (EPIC) study. *Public Health Nutr*. 2003;6(4):407–413. https://doi.org/10.1079/PHN2002439.
20. The InterAct Consortium. Validity of a short questionnaire to assess physical activity in 10 European countries. *Eur J Epidemiol*. 2012;27(1):15–25. https://doi.org/10.1007/s10654-011-9625-y.
21. Guallar-Castillón P, Sagardui-Villamor J, Balboa-Castillo T, et al. Validity and reproducibility of a Spanish dietary history. *PloS One*. 2014;9(1):e86074. https://doi.org/10.1371/journal.pone.0086074.
22. Schröder H, Fitó M, Estruch R, et al. A short screener is valid for assessing Mediterranean Diet adherence among older Spanish men and women. *J Nutr*. 2011;141(6):1140–1145. https://doi.org/10.3945/jn.110.135566.
23. Pate RR, O'Neill JR, Lobelo F. The evolving definition of "sedentary." *Exerc Sport Sci Rev*. 2008;36(4):173–178. https://doi.org/10.1097/JES.0b013e3181877d1a.
24. Kharicha K, Iliffe S, Harari D, Swift C, Gillmann G, Stuck AE. Health risk appraisal in older people 1: Are older people living alone an "at-risk" group? *Br J Gen Pr*. 2007;57(537):271–276.
25. Mesas AE, López-García E, León-Muñoz LM, Guallar-Castillón P, Rodríguez-Artalejo F. Sleep duration and mortality according to health status in older adults. *J Am Geriatr Soc*. 2010;58(10):1870–1877. https://doi.org/10.1111/j.1532-5415.2010.03071.x.
26. Gnjidic D, Hilmer SN, Blyth FM, et al. Polypharmacy cutoff and outcomes: five or more medicines were used to identify community-dwelling older men at risk of different adverse outcomes. *J Clin Epidemiol*. 2012;65(9):989–995. https://doi.org/10.1016/j.jclinepi.2012.02.018.
27. Palacios-Ceña D, Hernández-Barrera V, Jiménez-García R, Valle-Martín B, Fernández-de-las-Peñas C, Carrasco-Garrido P. Has the prevalence of health care services use increased over the last decade (2001-2009) in elderly people? A Spanish population-based survey. *Maturitas*. 2013;76(4):326–333. https://doi.org/10.1016/j.maturitas.2013.07.016.
28. Guallar-Castillón P, Rodríguez-Artalejo F, Díez Gañán LD, Banegas Banegas JR, Lafuente Urdinguio PL, Herruzo Cabrera RH. Consumption of alcoholic beverages and subjective health in Spain. *J Epidemiol Community Health*. 2001;55(9):648–652. https://doi.org/10.1136/jech.55.9.648.
29. Bähler C, Huber CA, Brüngger B, Reich O. Multimorbidity, health care utilization and costs in an elderly community-dwelling population: a claims data based observational study. *BMC Health Serv Res*. 2015;15:23. https://doi.org/10.1186/s12913-015-0698-2.
30. Elrashidi MY, Jacobson DJ, St Sauver J, et al. Body mass index trajectories and healthcare utilization in young and middle-aged adults. *Medicine (Baltimore)*. 2016;95(2):e2467. https://doi.org/10.1097/MD.0000000000002467.
31. Banegas JR, Rodríguez-Artalejo F, Ruilope LM, et al. Hypertension magnitude and management in the elderly population of Spain. *J Hypertens*. 2002;20(11):2157–2164. https://doi.org/10.1097/00004872-200211000-00014.
32. Kobalava ZD, Kotovskaya YV. [Isolated systolic hypertension in different ages]. *Kardiologiia*. 2015;55(9):84–90. https://doi.org/10.18565/cardio.2015.9.84-90.
33. Katz MH. *Multivariable Analysis: A Practical Guide for Clinicians*. Cambridge: Cambridge University Press; 2006. https://doi.org/10.1017/CBO9780511811692.
34. Kleinbaum DG, Kupper LL, Morgenstern H. *Epidemiologic Research: Principles and Quantitative Methods*. New York: Van Nostrand Reinhold, 1982.
35. Maxwell CJ, Hirdes JP. The prevalence of smoking and implications for quality of life among the community-based elderly. *Am J Prev Med*. 1993;9(6):338–345.
36. Dankel SJ, Loenneke JP, Loprinzi PD. Combined associations of muscle-strengthening activities and accelerometer-assessed physical activity on multimorbidity: findings from NHANES. *Am J Health Promot*. 2017;31(4):274–277. https://doi.org/10.4278/ajhp.150520-QUAN-894.
37. Dhalwani NN, O'Donovan G, Zaccardi F, et al. Long terms trends of multimorbidity and association with physical activity in older English population. *Int J Behav Nutr Phys Act*. 2016;13:8. https://doi.org/10.1186/s12966-016-0330-9.
38. Dhalwani NN, Zaccardi F, O'Donovan G, et al. Association between lifestyle factors and the incidence of multimorbidity in an older English population. *J Gerontol A Biol Sci Med Sci*. 2017;72(4):528–534. https://doi.org/10.1093/gerona/glw146.
39. Autenrieth CS, Kirchberger I, Heier M, et al. Physical activity is inversely associated with multimorbidity in elderly men: results from the KORA-Age Augsburg Study. *Prev Med*. 2013;57(1):17–19. https://doi.org/10.1016/j.ypmed.2013.02.014.
40. Bosch-Lenders D, Maessen DWHA, Stoffers HEJHJ, Knottnerus JA, Winkens B, van den Akker M. Factors associated with appropriate knowledge of the indications for prescribed drugs among community-dwelling older patients with polypharmacy. *Age Ageing*. 2016;45(3):402–408. https://doi.org/10.1093/ageing/afw045.
41. Chaput J-P, McNeil J, Després J-P, Bouchard C, Tremblay A. Seven to eight hours of sleep a night is associated with a lower prevalence of the metabolic syndrome and reduced overall cardiometabolic risk in adults. *PloS One*. 2013;8(9):e72832. https://doi.org/10.1371/journal.pone.0072832.

42. Mitka M. Mediterranean diet may reduce stroke risk in individuals with genetic predisposition to diabetes. *JAMA*. 2013;310(10):1013. https://doi.org/10.1001/jama.2013.277647.
43. Roberts RO, Bergstralh EJ, Schmidt L, Jacobsen SJ. Comparison of self-reported and medical record health care utilization measures. *J Clin Epidemiol*. 1996;49(9):989–995. https://doi.org/10.1016/0895-4356(96)00143-6.
44. Salazar JA, Poon I, Nair M. Clinical consequences of polypharmacy in elderly: expect the unexpected, think the unthinkable. *Expert Opin Drug Saf*. 2007;6(6):695–704. https://doi.org/10.1517/14740338.6.6.695.
45. Weissman JS, Rothschild JM, Bendavid E, et al. Hospital workload and adverse events. *Med Care*. 2007;45(5):448–455. https://doi.org/10.1097/01.mlr.0000257231.86368.09.
46. Kaye KS, Marchaim D, Chen T-Y, et al. Effect of nosocomial bloodstream infections on mortality, length of stay, and hospital costs in older adults. *J Am Geriatr Soc*. 2014;62(2):306–311. https://doi.org/10.1111/jgs.12634.