Clustering of unhealthy lifestyle behaviors, self-rated health and disability

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Highlights:

- Most participants, 3 out of 4 individuals, reported 2 or more risk factors
- Clustering was more common in men, middle-age, with low educational level
- Worse self-rated health increased as the number of risk behaviors accumulated
- Clustering was associated with both physical and mental health limitations

Abstract

The main objective was to identify sociodemographic characteristics of the population at risk for a greater clustering of unhealthy behaviors and to evaluate the association of such clustering with self-rated health status and disability. Data come from the 2017 Spanish National Health Survey with a sample of 21,947 participants of 15 years of age or older. Based on tobacco consumption, risk drinking, unbalanced diet, sedentarism, and body mass index <18.5/≥25 we created two indicators of risk factor clustering: 1) Number of unhealthy behaviors (0-5); and 2) Unhealthy lifestyle index (score: 0-15). Self-rated health was dichotomized into "optimal" and "suboptimal," and disability was classified as "no disability," "mild," and "severe" based on the Global Activity Limitation Index (GALI). We estimated prevalence ratios (PR) adjusted for covariates using generalized linear models using the clustering count variable, and dose-response curves using the unhealthy lifestyle index. Most participants (77.4%) reported 2 or more risk factors, with men, middle-age individuals, and those with low socioeconomic status being more likely to do so. Compared to those with 0-1 risk factors, the PR for suboptimal health was 1.26 (95%CI:1.18-1.34) for those reporting 2-3 factors, reaching 1.43 (95%CI:1.31-1.55) for 4-5 factors. The PR for severe activity limitation was 1.66 (95%CI:1.35-2.03) for those reporting 2-3 factors and 2.06 (95%CI:1.59-2.67) for 4-5 factors. The prevalence of both health indicators increased in a non-linear fashion as the unhealthy lifestyle index score increased, increasing rapidly up to 5 points, slowing down between 5 and 10 points, and plateauing afterwards.

Introduction

Cardiovascular diseases, diabetes, chronic respiratory diseases, and certain types of cancer make up the main causes of death and disability in the world (GBD 2019 Diseases and Injuries Collaborators, 2020). These diseases share several modifiable risk factors such as tobacco consumption, excessive alcohol consumption, unbalanced diet, sedentarism, and being overweight or obese (World Health Organization, 2002a). One third of all mortality in Spain is caused by these factors, in fact, tobacco alone accounts for 16% followed by unbalanced diet which is responsible for 12% of all deaths. It has also been estimated that a high body mass index (BMI), excessive alcohol consumption, and low levels of physical activity explain 10%, 8%, and 2% of all mortality, respectively. (Institute for Health Metrics and Evaluation, 2019).

The literature on the role of each risk behavior in the development of chronic diseases individually is abundant. However, lifestyles exhibit multidimensional patterns (Berrigan et al., 2003) where is common for healthy behaviors to coexist with unhealthy ones (Laaksonen et al., 2001; Schuit et al., 2002). The combination of risk health factors create synergies with a greater health impact than the accumulation of the individual effects (Noble et al., 2015). In contrast, a healthy lifestyle is associated with a lower disease burden and a net gain of two disability-free years of life (May et al., 2015), a reduction in premature death, and an increase in life expectancy (Ford et al., 2012; Karavasiloglou et al., 2019; Li et al., 2018).

Self-rated health is considered a good overall indicator of health and it has been shown to be a strong predictor of morbidity and mortality (Idler and Benyamini, 1997) in diverse population groups (Smith et al., 2010). Several studies have evaluated the association between the sum of risk factors and self-rated health, reporting a worse health status as

the number of risk factors increased (Conry et al., 2011; Dieteren et al., 2020; Galán et al., 2005; Tsai et al., 2010).

Disability is a complex phenomenon as it captures the interaction between human body characteristics and the characteristics and accessibility of the society where the individual lives. According to the World Health Organization, the concept of disability also includes the deficiencies, activity limitations, and barriers to a full participation in that society (World Health Organization, 2002b.). People with disabilities are burdened with health worsening and a higher risk of premature death. The increase of life expectancy in recent years and the subsequent population aging is the likely cause of the increase in chronic conditions and greater functional disability (European Observatory on Health Systems and policies, 2019).

Spain enjoys the longest life expectancy at age 65 of all the members of the European Union (21.5 years) of which 9.1 are spent with disability (European Observatory on Health Systems and Policies, 2019). A common indicator for identifying and monitoring disability is called the Global Activity Limitation Index (GALI) (Robine et al., 2003; Verbrugge, 1997). Similarly to self-rated health, the GALI has been validated and it has proven to be a strong predictor of mortality in different sociodemographic groups (Berger et al., 2015). Though to a lesser extent, its association to risk behaviors has also been examined (Johnsen et al., 2017; Otavova et al., 2020). Nevertheless, the bulk of the studies evaluating the association between the clustering of risk factors and disability has targeted older populations (Koster et al., 2007; Lee and Park, 2006; Liu et al., 2019; Sabia et al., 2014); thus, the evidence of its impact on younger and middle age populations is scarce.

The aim of this study was to identify the sociodemographic groups more likely to report greater numbers of unhealthy behaviors based on two indices of unhealthy behavior clustering, and to examine their association with self-rated health and disability.

Methods

Design and Study Population

This study is based on the 2017 Spanish National Health Survey (ENSE for its Spanish acronym) carried out by the Spanish National Statistics Institute in collaboration with the Ministry of Health. The study population is comprised of individuals 15 years of age and older, residing in their primary family residence throughout all the Spanish territory. We used a multistage sample design. First, we selected all provinces and then municipalities for each province, stratifying by municipality size. Second, we selected a sample of census tracts for each of the previously picked municipalities. Finally, all residences in these tracts were sampled and an adult ≥15 years of age residing in each household was selected for a face-to-face interview (Spanish Ministry of Health and Spanish National Institute of Statistics, 2017). Response rate (i.e., number of performed interviews out of all the eligible residences) was 69.9% with a sample size of 23,089 participants. Due to missing data on BMI we excluded 1,070 observations and an additional 72 records were also excluded for lack of data on smoking, alcohol consumption, sedentarism, activity limitation, or marital status (0.3%). The final sample size for this study was 21,947 individuals and the distribution of main variables was very similar to that of the original sample.

Variables

Behavioral Risk Factors

Unbalanced Diet. Based on the diet quality index MEDAS (Mediterranean Diet Adherence Screener), we adapted an index that scores the adherence to the Mediterranean diet (Schröder et al., 2011). The total score ranges between 0 and 10 according to the different scores to the individual items: 1-2 servings of fruit/day (1 point), ≥3 pieces/day (2 points); 1 serving of vegetables/day (1 point), >1/day (2 points); ≥3 servings of legumes/week (1 point); ≥3 servings of fish/week (1 point); <1 serving of meat/day (1 point); <1 serving of sugary drinks/day (1 point); <3 servings of sweets/pastries/week (1 point); <3 servings of fast food (including snacks)/week (1 point).

Leisure-time sedentarism. This variable was created based on the following responses to a 2017 ENSE question: your leisure time is spent: almost completely sedentary; occasionally doing some physical activity or sports; doing physical activity several times per month; performing sports or physical training several times per week.

Body Mass Index (BMI). Based on self-reported data, we calculated the ratio between the individual´s weight in kgs and the square of its height in meters (kg/m^2).

Tobacco Consumption. Participants were classified into current daily smokers, current occasional smokers, ex-smokers, and never-smokers.

Alcohol Consumption. We defined one alcoholic drink as 10 gr of alcohol. Average daily alcohol consumption was estimated based on the reported frequency of regular consumption of 6 types of alcoholic drinks for each day of the week. We defined high risk average consumption as the consumption of >20 gr/day for men and >10 gr/day for women (Sordo et al., 2020). Binge drinking was defined as the consumption of 6 or more alcoholic drinks for men and 5 or more for women within 4-6 hours during the previous month.

Indicators of risk factor clustering were typified (Table 1): 1) Sum of dichotomized scores resulting in scores ranging between 0 (no risk behaviors) and 5 (all five risk behaviors); 2) Unhealthy lifestyle index: sum of scores from a quantitative scale, resulting in individual scores ranging from 0 to 15.

Socio-demographic Variables

The following information was included in the study: sex, age (15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 year-olds (y.o.) and older); educational level (primary [6 to 12 y.o.] or less, secondary [first stage, 12 to 16 y.o.], secondary [second stage, 16 to 18 y.o.], and university studies [≥18 y.o.]); household income level adjusted by household size (high, middle, or low based on tertiles, including a category for no response); country of birth (Spain or other); marital status (married, single, widow/er, widow/er, separated, or divorced).

Health Status

Self-rated Health. This variable is based on the individual´s self-perceived health status during the previous 12 months (very good, good, average, poor, and very poor). Responses were dichotomized as follows: "very good/good" as optimal health and "average/poor/very poor" as suboptimal health.

Global Activity Limitation Index (GALI). This index is considered a self-reported disability evaluation (van Oyen et al., 2006). Participants were asked "to what extent, at least during the previous 6 months, have you felt limited to perform common activities due to a health problem? Response options included: severe activity limitation, mild activity limitation, not limited at all. In addition, the type of said limitation, i.e., physical and/or mental, was also collected.

Statistical Analysis

We performed descriptive analyses of the sociodemographic characteristics of the sample, and we calculated the prevalence and distribution of unhealthy lifestyle factors and the prevalence of health indicators. To identify population groups with the greatest likelihood of unhealthy lifestyle factor clustering, the number of risk factors reported were classified into 0-1, 2-3, and 4-5 factors. This variable was analyzed using fully-adjusted multinomial logistic regression model. The association of socio-demographic characteristics and the unhealthy lifestyle index was examined using lineal regression models. The prevalence of suboptimal self-rated health by number of unhealthy lifestyle factors was standardized to the overall distribution of sociodemographic characteristics in the entire adult population. We initially fitted a design-based logistic regression model adjusted for sociodemographic characteristics, and then computed a weighted average of the predicted probabilities of having suboptimal self-rated health, assuming that every participant was in each category of number of unhealthy lifestyle factors (Greenland, 2004). Standardized prevalence differences and ratios for suboptimal self-rated health were calculated across categories of number of unhealthy factors. Using the same model-based standardization, we also estimated the smooth trend in standardized prevalence ratios for suboptimal health as a restricted quadratic spline function of unhealthy lifestyle index with knots at 2, 4, 6, 8, and 10 points and the upper tail constrained to be linear (Greenland, 1995).

The standardized prevalence differences and ratios for mild and severe activity limitations across categories of number of unhealthy lifestyle factors were calculated using similar standardization methods from a design-based multinomial logistic regression model adjusted for sociodemographic characteristics. The smooth trends in standardized prevalence ratios for mild and severe activity limitations were also estimated through

restricted quadratic splines for unhealthy lifestyle index with the same knots and linear constraint described above.

Finally, we evaluated whether the associations between unhealthy lifestyle factor clustering and suboptimal self-rated health, and between said clustering and mild and severe activity limitations, were modified by sex and age.

Analyses were done using survey commands in Stata v.16 (StataCorp, College Station, EE.UU) and R version R3.6.1.This study was approved by the Institutional Review Board of the Institute of Health Carlos III.

Results

Table 2 shows the sample´s sociodemographic characteristics. The most common unhealthy lifestyle factors were unbalanced diet (76.8%), unhealthy BMI (55.5%), and (ever) smoking (50.0%). Two or more unhealthy behaviors were reported by 77.4% and 43.3% reported 3 or more. The mean score for the unhealthy lifestyle index was 5.8 (SD:2.4). In regards to self-rated health status, 29.0% reported suboptimal health and 25.4% reported one limitation to carry out daily tasks, most of them a physical limitation (21.3%). Table 1S (see Appendix 1) shows the sample distribution in terms of the unhealthy lifestyle index.

The 2-factor combinations with the highest prevalence were unbalanced diet and unhealthy BMI (10.6%), followed by unbalanced diet and smoking (8.6%). The 3-factor combination with the highest prevalence was tobacco consumption, unbalanced diet and unhealthy BMI (9.9%). Finally, smoking, unbalanced diet, unhealthy BMI, and sedentarism were the most prevalent 4-factor combination reported by 7.8% of the sample (Figure 1S in Appendix 2).

Table 3 and shows the risk of clustering of behavioral risk factors by sociodemographic characteristics. Subgroups most likely to report 2 or 3 risk behaviors were: men, those

between the ages of 55 and 64, individuals with low educational status and low income levels. We observed a similar association pattern regarding the likelihood of 4 or 5 risk factors though it is worth underlying that the risks doubled in men (Relative Risk Ratios, RRR)=3.26; 95% CI: 2.88-3.68), and tripled among 55-64 year-olds (RRR=8.49; 95% CI: 6.18-11.66). In contrast, differences in risk increase by income levels were modest. Further no significant associations were found by marital status or country of birth.

A similar pattern of associations was found between sociodemographic characteristics and the unhealthy lifestyle index showing, additionally, a small but statistically significant increase in the score among single and separated individuals (Table 4).

Table 5 shows standardized prevalence differences and ratios for suboptimal self-rated health by the number of unhealthy lifestyle factors. When compared to participants reporting 0-1 unhealthy behaviors, the probability of reporting suboptimal health was 26% greater among those reporting 2-3 unhealthy behaviors (Prevalence Ratio, PR: 1.26; 95%CI: 1.31-1.55).

Table 5 also shows standardized prevalence differences and ratios of the number of unhealthy behaviors in relation to type of limitation. Looking at mild activity limitation, in comparison to participants reporting no unhealthy behavior clustering, those with 2-3 unhealthy behaviors had a PR of 1.29 (95%CI: 1.19-1.40) reaching 1.37 (95CI%: 1.23-1.54) among those reporting 3-5 risk factors. In regards to severe activity limitation the associations grew stronger with a PR of 1.66 (95%CI: 1.35-2.03) for those engaging in 2-3 risk behaviors and a PR of 2.06 (95%CI: 1.59-2.67) for those reporting 4-5 behavioral risk factors.

We did not find any effect modification by sex (Table 2S in Appendix 3). However, the association between unhealthy behavior clustering and self-rated health did vary

significantly by age (interaction p-value=0.034), being stronger among 15-34 years than their older counterparts, although the precision size was scarce (Table 3S in Appendix 4).

Table 6 shows the standardized prevalence differences and ratios for the two types of activity limitations, by number of unhealthy lifestyle factors. When compared to participants reporting no factor clustering, those reporting 4-5 unhealthy behaviors had a PR of 1.42 (95%CI: 1.28-1.59) of having a physical limitation, a PR of 1.85 (95%CI: 1.06-3.23) of having a mental limitation, and a PR of 1.80 (95%CI: 1.26-2.58) of having both types of limitations. We also observed statistically significant PR for those reporting 2-3 factors, although of smaller magnitude.

Finally, figure 1 shows the dose-response curves of the unhealthy lifestyle index and health indicators. Fig. 1 shows a steep increase in the standardized PR of suboptimal self-rated health as the score of the unhealthy lifestyle index increases up to 5 points. Between 5 and 10 points the slope decreases and it plateaus after 10 points. The PR associated to suboptimal self-rated health with a score of 10 was 1.44 (95%CI: 1.28-1.62) versus a score of 2 points. A similar association was found regarding mild activity limitation and severe activity limitation, while the association with severe activity limitation was stronger. We estimated a PR of 2.30 (95%CI: 1.56-3.40) for a score of 8.

Discussion

We observed a very high prevalence of behavioral risk factor clustering as 3 out of 4 participants reported 2 or more unhealthy behaviors. Various sociodemographic characteristics associated with this clustering were identified.

The association between clustering and self-rated health was very strong, the likelihood of reporting worse perceived health substantially increased as the number of risk behaviors accumulated. Similarly, unhealthy behavior clustering was associated with

both physical and mental health limitations. These results were consistent across our two measures, the clustering indicator (number of unhealthy behaviors) and the unhealthy lifestyle index.

Our results show that there are specific population groups more likely to engage in multiple unhealthy behaviors. Although differences in methodologies across studies hinder direct comparisons, these results support those previously reported in terms of sex (higher level of clustering among men than women) and educational differences (higher level of clustering among those with low educational achievement than higher levels) (Meader et al., 2016; Noble et al., 2015). Regarding age differences, findings are not as conclusive: whereas some studies have reported higher risk of clustering at earlier life stages (Conry et al., 2011; Poortinga, 2007), our results support those of other work showing greater prevalence of unhealthy behaviors during middle age (Gu et al., 2005; Li et al., 2012). We should keep in mind that once a young individual engages in risk behaviors those tend to linger through adulthood (Jepson et al., 2010). Further, because young and middle-age adults do not substantially participate in health promotion activities, those unhealthy behaviors are harder to modify in the absence of appropriate intervention (Jepson et al., 2010).

Our results provide further evidence that the clustering of simultaneous risk behaviors is associated to suboptimal health status. This is consistent with past research showing a gradient effect between risk factor clustering and worse self-rated health status (Conry et al., 2011; Dieteren et al., 2020; Galán et al., 2005; Schuit et al., 2002). Similarly, but by examining healthy lifestyles, Tsai et al. found a positive gradient between concurrent healthy behaviors and optimal health status (Tsai et al., 2010).

Akin to self-rated health, we show that individuals with unhealthy behavior clustering are at higher risk for disability with a dose-response effect supporting previous work despite

differing methodologies measuring disability. Some defined disability as mobility limitation (Artaud et al., 2016; Koster et al., 2007), limitation in instrumental activities of daily living (Artaud et al., 2016, 2013) or limitation in basic activities of daily living (Artaud et al., 2016, 2013; Liao et al., 2011; Vita et al., 1998), physical function (Sabia et al., 2014), frailty (Gil-Salcedo et al., 2020), or based on official certified disability records (Liu et al., 2019). And a South Korean study underscores the importance of a healthy lifestyle in the process of recovering from functional limitations (Lee and Park, 2006).

Regarding age differences in the magnitude of the association between unhealthy behavior clustering and self-rated health, since there was small precision size to evaluate interactions, further studies should investigate this finding.

However, most of the literature on risk factor clustering and disability is focused on adults 65 year of age and older. Despite substantial levels of functional limitation as observed on our work (10.5% of 15-34 year-olds and 23.6% of 35-64 year-olds reported some degree of limitation), there is scarce published evidence of such association among young and middle-age adults. One of our contributions to this literature is having differentiated between physical and mental limitations which allowed us to identify a stronger association between mental limitations (by themselves or co-occurring with physical ones) and behavior clustering both at the intermediate level (2-3 factors) as well as at the higher level of 4-5 factors. These results underscore the tight relationship between risk factor clustering and the existence of mental health issues (Conry et al., 2011; Verger et al., 2009).

Finally, as far as we know, this is the first study closely examining the relationship dose-response between risk factor clustering and both self-rated health status and disability. In this work, our unhealthy lifestyle index scoring reveals how suboptimal health and

disability levels vary in a non-linear fashion as unhealthy lifestyle scores go up, increasing rapidly for scores <5, then slowing down up to 10 points, after which they plateau. This plateauing has also been observed at upper limit clustering levels both for perceived health (Tsai et al., 2010) and disability (Gil-Salcedo et al., 2020).

Strengths and Limitations

Certain limitations should be kept in mind when interpreting this study´s results. First, the cross-sectional nature of the data prevents establishing any causal relationship. Furthermore, the associations in observational studies can be afflicted by reverse causality. This is particularly true in the case of disability which may influence lifestyle behaviors rather than the other way around (Casseus et al., 2021, 2020). Nevertheless reverse causation bias has been disproven in this setting by longitudinal studies excluding participants who developed disability in the first years of follow-up (Artaud et al., 2013). Second, the thresholds used here to define a behavior as a risk factor are not standardized which hampers comparisons with similar studies and, thus, possibly contributing to the heterogeneity in results observed in the literature. Finally, all the unhealthy behaviors are defined based on self-reported data which is far from free of measurement errors. Further, GALI, an instrument with good concurrent and predictive validity and reliability widely used to monitor disability levels in Europe (mainly functional disability and participatory limitations) (Van Oyen et al., 2018), has shown some weakness in accurately classifying by degree of disability, especially due to its moderate sensitivity (Tarazona et al., 2020).

The main strength in our study resides in the source of the data: a large population-based sample of the population residing in Spain. Second, the risk factor clustering was measured with two complementary indicators which is important in the absence of a consensus around the definition of clustering. The variable based on the accumulation of risk behaviors is the most commonly used given its simple construction and easy

interpretation. The unhealthy lifestyle index, however, captures risk segmentation in finer detail and allows for an accurate estimate of dose-response relationship. Findings in the same direction by both indicators provide reliability to our results.

Conclusions

Multiple risk behavior clustering is associated in a non-linear fashion, to worse self-rated health and greater likelihood of disability, both physical and mental. Our findings suggest that intervention programs targeting the concurrent practice of multiple unhealthy behaviors, rather than the practice of isolated risk factors, are likely to yield greater population health benefits. Further, these interventions should be combined with programs adapted to individuals with disabilities to avoid furthering health disparities and to contribute to the gain of healthy life years.

In Spain, men, middle-age adults, and low socioeconomic status individuals are the population groups who stand the benefit the most from these programs and should be given priority. Nevertheless, evidence on the effectiveness of interventions designed to modify multiple health risk factors, either concurrently or sequentially, remains scarce. Thus, further research is needed to understand how to approach lifestyles from an inclusive perspective (James et al., 2016; Meader et al., 2017; Prochaska and Prochaska, 2011).

Declaration of interest

The authors declared no potential conflicts of interest.

This article presents independent research. The views expressed are those of the authors and not necessarily those of the Carlos III Institute of Health.

Funding

This work was supported by the Institute of Health Carlos III, Ministry of Science and Innovation [grant number PI19CIII/00021].

Table 1. Definition of clustering of behavioral risk factors

Variable	Definition	Score
Clustering of behavioral risk factors (score 0-5)		
Tobbaco	Current or past tobacco consumption	1
Alcohol	Average consumption >20 g/d (men) or >10 g/d (women) and/or binge drinking in previous month	1
Diet	<7 score in the dietary questionnaire	1
Leisure time sedentarism	Totally sedentary leisure time	1
Body Mass Index	<18.5 or ≥25	1
Unhealthy lifestyle index (score 0-15)		
Tobbaco	Never smoker	0
	Past smoker	1
	Current smoker 1-14 cigarettes	2
	Current smoker ≥15 cigarettes	3
Alcohol	No consumption	0
	Average consumption ≤20 g/d (men) ≤10 g/d (women) and no binge drinking	1
	Average consumption >20 g/d (men) >10 g/d (women) or binge drinking	2
	Average consumption >20 g/d (men) >10 g/d (women) and binge drinking	3
Diet (score in the dietary questionnaire)	7-10 points	0
	6 points	1
	5 points	2
	0-4 points	3
Leisure time sedentarism	Sports or physical training several times a week	0
	Physical activity several times a month	1
	Some physical or sports activity occasionally	2
	Leisure time is spent almost completely sedentary	3
Body Mass Index	18.5-24.9	0
	≥25-29.9	1
	<18.5	2
	≥30	3

Table 2. Sample sociodemographic and health status characteristics, according to risk factor clustering among participants in the National Health Survey, Spain, 2017

	Total		Clustering of risk factors					
			0-1		2-3		4-5	
	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]
Sex								
Woman	11,666	50.7	1701	39.3	6521	48.7	2059	68.0
Men	10,281	49.3	3176	60.7	7501	51.3	989	32.0
Age (years)								
15-24	1,581	11.4	599	19.4	869	10.0	113	5.4
25-34	2,197	14	509	14.9	1411	14.0	277	12.8
35-44	4,057	19.8	864	18.2	2585	19.9	608	21.8
45-54	3,999	18.8	766	15.5	2539	18.9	694	23.4
55-64	3,759	14.9	665	11.3	2418	15.2	676	19.1
65-74	3,189	11.2	735	11.1	2055	11.4	399	10.6
75 and more	3,165	9.8	739	9.6	2145	10.6	281	6.9
Educational Level								
Primary or lower	6,522	25.3	1315	26.5	4365	18.4	842	12.1
Secondary 1st stage	5,327	26	988	29.4	3399	29.1	940	30.5
Secondary 2nd stage	6,004	29.4	1334	23.0	3786	25.8	884	31.8
University	4,094	19.3	1240	21.2	2472	26.7	382	25.6
Income Level								
Tertile 1 (Low)	5,922	24	1027	18.7	3724	25.3	818	26.7
Tertile 2 (Medium)	5,762	24.5	1240	24.2	3499	24.0	820	26.9
Tertile 3 (High)	5,835	26.1	1385	28.9	3530	25.4	798	24.9
No Response	5,570	25.4	1225	28.2	3269	25.3	612	21.5
Marital Status*								
Married	12,012	59.3	2452	52.9	7793	60.5	1767	64.0
Single	5,640	29	1477	36.2	3356	27.0	807	26.4
Widow/er	2,610	6.4	636	6.6	1782	7.0	192	3.6
Separated or legally divorced	1,685	5.3	312	4.3	1091	5.5	282	6.0
Country of Birth								
Spain	19,792	86.3	4412	86.2	12610	86.0	2770	87.5
Other	2,155	13.7	465	13.8	1412	14.0	278	12.5
Self-Rated Health Status								
Optimal Health	14,737	71	3599	78.3	9192	69.6	1946	66.2
Suboptimal Health	7,210	29	1278	21.7	4830	30.4	1102	33.8
Global Activity Limitation Indicator (GALI)								
Not limited at all	15,699	74.6	3818	81.4	9766	72.9	2115	71.3
Mild activity limitation	5,098	20.6	908	15.8	6452	21.9	738	22.5
Severe activity limitation	1,150	4.8	151	2.8	804	5.2	195	6.2
Limitation Type								
No Limitations	15699	74.6	3818	81.4	9766	72.9	2115	71.3
Physical Limitation	5307	21.3	920	16.1	3601	22.5	786	23.9
Mental Limitation	301	1.4	48	0.8	199	1.5	54	1.8
Both Limitations	640	2.7	91	1.7	456	3.1	93	3.0

Unhealthy lifestyle index (score 0-15)	21,947	5.8 [c] (2.4)	3.1 [c] (1.3)	6.0 [c] (1.7)	9.1 [c] (1.7)

[a] Unweighted number of participants
[b] Weighted percentage
[c] Mean (SD)

Table 3. Associations between sociodemographic variables and clustering of behavioral risk factors among participants in the National Health Survey, Spain, 2017.

		Clustering of risk factors			
		2-3 risk factors		4-5 risk factors	
	N	RRR[a]	95%CI	RRR[a]	95%CI
Sex					
Woman	11666	1(ref)		1(ref)	
Men	10281	1.51	1.39 to 1.64	3.26	2.88 to 3.68
Age (years)					
15-24	1581	1(ref)		1(ref)	
25-34	2197	2.14	1.79 to 2.55	4.52	3.34 to 6.12
35-44	4057	2.42	2.02 to2.89	6.53	4.84 to 8.82
45-54	3999	2.57	2.14 to 3.09	7.81	5.78 to 10.56
55-64	3759	2.72	2.25 to 3.29	8.49	6.18 to 11.66
65-74	3189	1.90	1.56 to 2.32	4.36	3.14 to 6.06
75 and more	3165	1.93	1.56 to 2.40	3.4	2.38 to 4.87
Educational Level					
University	4094	1(ref)		1(ref)	
Secondary 2nd stage	6004	1.51	1.35 to 1.70	2.42	2.02 to 2.90
Secondary 1st stage	5327	1.81	1.59 to 2.05	3.44	2.85 to 4.16
Primary or lower	6522	1.79	1.57 to 2.05	2.99	2.43 to 3.67
Income Level (euros)[b]					
Tertile 3 (High)	5835	1(ref)		1(ref)	
Tertile 2 (Medium)	5762	1.04	0.93 to 1.17	1.13	0.96 to 1.32
Tertile 1 (Low)	5922	1.39	1.23 to 1.58	1.46	1.23 to 1.74
No Response	5570	1.02	0.91 to 1.15	0.89	0.75 to 1.04
Marital Status*					
Married	12012	1(ref)		1(ref)	
Single	5640	0.92	0.82 to 1.04	1.12	0.95 to 1.31
Widow/er	2610	1.01	0.87 to 1.18	0.77	0.60 to 1.01
Separated or legally divorced	1685	1.10	0.93 to 1.31	1.17	0.93 to 1.47
Country of Birth					
Spain	19792	1(ref)		1(ref)	
Other	2155	1.01	0.88 to 1.14	0.89	0.74 to 1.08

confidence interval (CI)

[a] Relative risk ratios estimated using fully-adjusted multinomial logistic regression for all the variables simultaneously. Reference category: 0-1 risk factors

[b] Income level adjusted by household size

Table 4. Associations between sociodemographic variables and the unhealthy lifestyle index among participants in the National Health Survey, Spain, 2017.

	Unhealthy lifestyle index		
		Score 0-15	
	N	β^a	95%CI
Sex			
Woman	11666	(ref)	
Men	10281	0.72	0.64 to 0.79
Age (years)			
15-24	1581	(ref)	
25-34	2197	1.07	0.89 to 1.25
35-44	4057	1.29	1.11 to 1.47
45-54	3999	1.33	1.15 to 1.52
55-64	3759	1.26	1.07 to 1.45
65-74	3189	0.73	0.54 to 0.93
75 and more	3165	0.45	0.25 to 0.66
Educational Level			
University	4094	(ref)	
Secondary 2nd stage	6004	0.69	0.58 to 0.80
Secondary 1st stage	5327	1.10	0.97 to 1.22
Primary or lower	6522	1.02	0.89 to 1.15
Income Level (euros)[b]			
Tertile 3 (High)	5835	(ref)	
Tertile 2 (Medium)	5762	0.16	0.05 to 0.27
Tertile 1 (Low)	5922	0.35	0.23 to 0.47
No Response	5570	0.04	-0.07 to 0.15
Marital Status*			
Married	12012	(ref)	
Single	5640	0.16	0.05 to 0.29
Widow/er	2610	-0.04	-0.17 to 0.09
Separated or legally divorced	1685	0.24	0.09 to 0.39
Country of Birth			
Spain	19792	(ref)	
Other	2155	-0.12	-0.24 to 0.01

confidence interval (CI)

[a] β Coefficients estimated using fully-adjusted linear regression.

[b] Income level adjusted by household size

Table 5. Standardized prevalence differences and ratios for suboptimal self-rated health and mild and severe activity limitation by number of unhealthy lifestyle factors among participants in the National Health Survey, Spain, 2017.

No. of unhealthy lifestyle factors	No. of participants	No. of cases	Prevalence[a] (%)	95% CI	Standardized prevalence difference[b] (%)	95% CI	Standardized prevalence ratio[b]	95% CI
Suboptimal Self-rated health								
0–1	4,877	1,278	21.7	(20.3–23.1)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	4,830	30.5	(29.5–31.4)	6.1	(4.5–7.6)	1.26	(1.18–1.34)
4–5	3,048	1,102	33.8	(31.8–35.9)	10.0	(7.7–12.4)	1.43	(1.31–1.55)
Mild activity limitation								
0–1	4,877	908	15.8	(14.6–17.1)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	3,452	21.9	(21.1–22.8)	4.8	(3.3–6.2)	1.29	(1.19–1.40)
4–5	3,048	738	22.5	(20.8–24.3)	6.2	(4.0–8.5)	1.37	(1.23–1.54)
Severe activity limitation								
0–1	4,877	151	2.7	(2.3–3.3)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	804	5.2	(4.7–5.6)	2.0	(1.3–2.7)	1.64	(1.19–1.40)
4–5	3,048	195	6.1	(5.2–7.2)	3.1	(2.0–4.4)	2.04	(1.23–1.54)

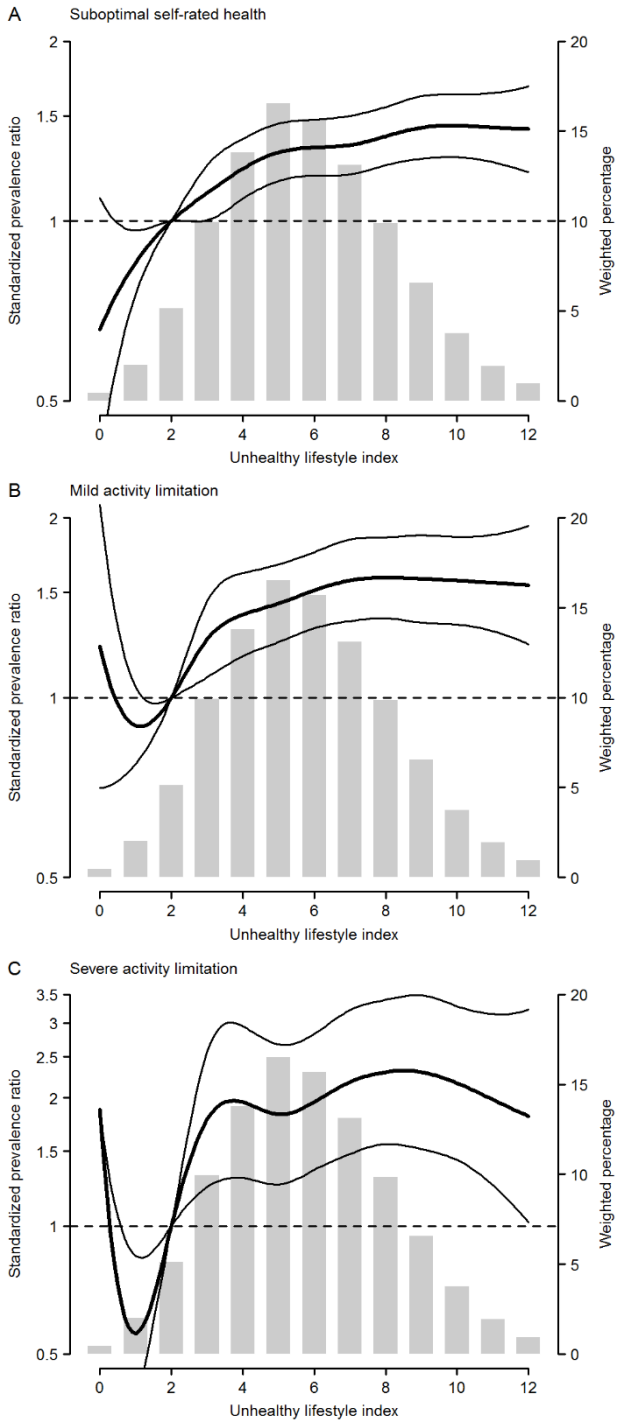
[a] Population prevalence and 95% confidence interval (CI) accounting for sampling weights and survey design effects due to stratification and clustering.
[b] Prevalence difference and ratio and 95% confidence intervals (CIs) standardized to the overall distribution of sex, age, nationality, educational level, income level, and marital status in the entire adult population of Spain.

Table 6. Standardized prevalence differences and ratios for physical, mental, and both activity limitations by number of unhealthy lifestyle factors among participants in the National Health Survey, Spain, 2017.

No. of unhealthy lifestyle factors	No. of participants	No. of cases	Prevalence[a] (%)	95% CI	Standardized prevalence difference[b] (%)	95% CI	Standardized prevalence ratio[b]	95% CI
Physical limitation								
0–1	4,877	920	16.1	(14.9–17.4)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	3,601	22.6	(21.7–23.4)	5.0	(3.5–6.4)	1.29	(1.19–1.40)
4–5	3,048	786	23.9	(22.1–25.8)	7.2	(5.0–9.5)	1.42	(1.28–1.59)
Mental limitation								
0–1	4,877	48	0.8	(0.6–1.2)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	199	1.5	(1.2–1.7)	0.5	(0.1–1.0)	1.62	(1.07–2.45)
4–5	3,048	54	1.8	(1.3–2.4)	0.8	(0.0–1.5)	1.85	(1.06–3.23)
Both activity limitations								
0–1	4,877	91	1.7	(1.3–2.2)	0 (ref)	(ref)	1 (ref)	(ref)
2–3	14,022	456	3.1	(2.8–3.5)	1.2	(0.6–1.8)	1.67	(1.27–2.21)
4–5	3,048	93	3.0	(2.3–3.8)	1.4	(0.5–2.3)	1.80	(1.26–2.58)

[a] Population prevalence and 95% confidence interval (CI) accounting for sampling weights and survey design effects due to stratification and clustering.
[b] Prevalence difference and ratio and 95% confidence intervals (CIs) standardized to the overall distribution of sex, age, nationality, educational level, income level, and marital status in the entire adult population of Spain.

Figure 1. Standardized prevalence ratios for (A) suboptimal self-rated health, (B) mild activity limitation, and (C) severe activity limitation as a smooth function of unhealthy lifestyle index among participants in the National Health Survey, Spain, 2017.



Curves represent standardized prevalence ratios (thick lines) and their 95% confidence intervals (thin lines) obtained from a design-based binary logistic regression for suboptimal self-rated health and a design-based multinomial logistic regression for mild and severe activity limitations based on restricted quadratic splines for unhealthy lifestyle index with knots at 2, 4, 6, 8, and 10 points and the upper tail restricted to be linear. The reference value (prevalence ratio = 1) was set at 2 points of the unhealthy lifestyle index. Prevalence ratios were standardized to the overall distribution of sex, age, nationality, educational level, income level, and marital status in the entire Spanish adult population. Bars represent the weighted bar chart of unhealthy lifestyle index.

Appendix 1

Table 1S. Distribution of the unhealthy lifestyle index, by suboptimal self-rated health status, degree and type of activity limitation among participants in the National Health Survey, Spain, 2017.

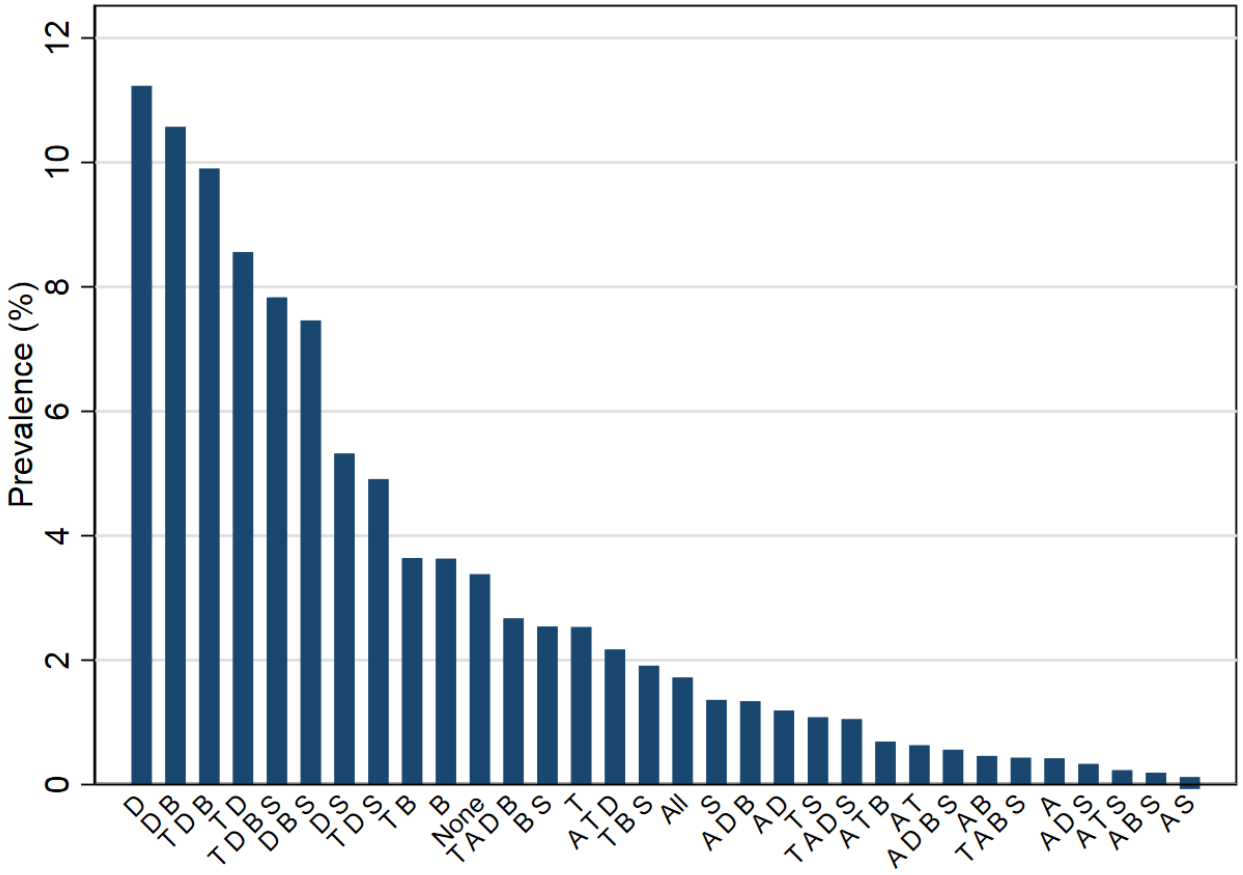
Risk Factor (score: 0 to 3)	Total		Suboptimal health status		Degree of activity limitation				Type of activity limitation					
					Severe activity limitation		Mild activity limitation		Limitation física		Limitation mental		Both	
	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]	N[a]	%[b]
	21947		7210		1150		5098		5307		301		640	
Diet														
7-10 points (0)	5635	23.2	2193	17.4	382	31.4	1511	27.7	1632	28.8	70	20.8	191	29.5
6 points (1)	6170	26.8	2255	23.4	383	32.5	1521	28.6	1615	29.1	86	27.5	203	31.5
5 points (2)	5521	25.7	1664	30.4	225	20.4	1260	25.2	1257	24.7	78	24.2	150	21.4
0-4 points (3)	4621	24.3	1098	28.8	160	15.7	806	18.5	803	17.4	67	27.5	96	17.6
Leisure time sedentarism														
Sports or physical training several times a week (0)	2568	13.9	380	6.2	43	4.0	295	7.2	305	7.0	16	4.3	17	4.3
Physical activity several times a month	2504	12.6	431	6.5	36	3.4	369	8.1	372	7.9	11	5.4	22	4.0
Some physical or sports activity occasionally	8679	36.5	2848	38.1	239	21.0	2081	39.2	2043	37.2	110	33.9	167	25.7
Leisure time is spent almost completely sedentary	8196	37.0	3551	49.2	832	71.6	2353	45.5	2587	47.9	164	56.4	434	66.0
Body Mass Index (kg/m^2)														
18.5-24.9 (0)	9270	44.5	2401	33.8	403	36.2	1713	34.7	1775	34.8	110	37.6	231	34.6
25-29.9 (1)	8302	36.1	2895	39.9	404	34.0	2075	39.6	2125	38.8	119	37.2	235	37.8
< 18.5 (2)	475	2.5	126	1.8	29	2.5	89	2.0	91	1.9	8	2.7	19	3.4
> 30 (3)	3900	16.9	1788	24.5	314	27.3	1221	23.7	1316	24.5	64	22.5	155	24.2
Smoking														
Never smoker (0)	10953	50.0	3679	48.9	630	52.1	2606	49.4	2734	49.5	154	48.0	348	53.7
Ex smoker (1)	5777	25.3	2071	29.4	311	28.0	1481	29.4	1562	29.8	56	18.8	174	29.0
1-14 cigarettes (2)	3434	16.6	882	13.2	136	12.9	637	13.7	655	13.8	49	17.8	69	9.6
≥15 cigarettes (3)	1783	8.1	578	8.5	73	7.0	374	7.5	356	6.9	42	15.4	49	7.7
Alcohol consumption (gr/day) and Binge Drinking (BD)														
No comsumption (0)	13389	60.6	5007	68.7	903	78.1	3418	66.4	3554	65.9	233	79.5	534	83.8
Average consumption ≤20 g/d (men) ≤10 g/d (women) and no binge drinking (1)	5560	25.3	1446	20.3	161	14.1	1125	21.9	1173	22.3	44	12.1	69	10.4
Average consumption >20 g/d (men) >10 g/d (women) or binge drinking (2)	2457	11.5	613	8.9	68	6.5	441	9.2	467	9.4	19	6.7	23	4.0
Average consumption >20 g/d (men) >10 g/d (women) and binge drinking (3)	541	2.6	144	2.1	18	1.3	114	2.5	113	2.4	5	1.7	14	1.8

[a] Unweighted N

[b] Weighted percentage

Appendix 2

Figure 1S. Combinations of risk factors



A: Alcohol (risky alcohol consumption); B: Body mass index <18.5/≥25; D: Unbalanced diet; S: Sedentarism; T: Tobacco (current and former smokers)

Appendix 3

Table 2S. Standardized prevalence ratios by sex for suboptimal self-rated and mild and severe activity limitation by number of unhealthy lifestyle factors among participants in the National Health Survey, Spain, 2017.

	Men			Women			
No. of unhealthy lifestyle factors	**No. of participants**	**Standardized prevalence ratio[a]**	**95%CI**	**No. of participants**	**Standardized prevalence ratio[a]**	**95%CI**	**Interaction p-value[b]**
Suboptimal Self-rated health							
0-1	1701	1 (ref)		3176	1 (ref)		0.198
2-3	6521	1,17	(1,05-1,31)	7501	1,32	(1,23-1,43)	
4-5	2059	1,36	(1,20-1,55)	989	1,51	(1,35-1,69)	
Mild activity limitation							
0-1	1701	1(ref)		3176	1(ref)		0.736
2-3	6521	1,24	(1,07-1,45)	7501	1,33	(1,21-1,47)	
4-5	2059	1,35	(1,14-1,61)	989	1,43	(1,23-1,65)	
Severe Activity Limitacion							
0-1	1701	1(ref)		3176	1(ref)		0.085
2-3	6521	1,24	(0,88-1,74)	7501	1,98	(1,55-2,53)	
4-5	2059	1,56	(1,07-2,28)	989	2,47	(1,72-3,55)	

[a] Prevalence ratio and 95% confidence intervals (CIs) standardized to the distribution of the adult population of Spain by sex, nationality, educational level, income level and marital status .[b] p-value interactions calculated with test for homogeneity of standardized prevalence ratios.

Appendix 4

Table 3S. Standardized prevalence ratios by age groups for suboptimal self-rated health and mild and severe activity limitation by number of unhealthy lifestyle factors among participants in the National Health Survey, Spain, 2017.

	15-34 years			35-64 years			65 and older			
No. of unhealthy lifestyle factors	**No. of participants**	**Standardized prevalence ratio[a]**	**95%CI**	**No. of participants**	**Standardized prevalence ratio[a]**	**95%CI**	**No. of participants**	**Standardized prevalence ratio[a]**	**95%CI**	**Interaction p-value[b]**
Suboptimal Self-rated health										
0-1	1108	1 (ref)		2295	1 (ref)		1474	1 (ref)		0.034
2-3	2280	1,62	(1,26-2,10)	7542	1,31	(1,18-1,45)	4200	1,18	(1,08-1,28)	
4-5	390	1,98	(1,41-2,78)	1978	1,54	(1,37-1,74)	680	1,27	(1,12-1,42)	
Mild activity limitation										
0-1	1108	1(ref)		2295	1(ref)		1474	1(ref)		0.278
2-3	2280	1,22	(0,94-1,59)	7542	1,32	(1,16-1,50)	4200	1,37	(1,23-1,53)	
4-5	390	1,10	(0,74-1,66)	1978	1,53	(1,32-1,78)	680	1,36	(1,15-1,59)	
Severe Activity Limitacion										
0-1	1108	1(ref)		2295	1(ref)		1474	1(ref)		0.627
2-3	2280	2,84	(1,26-6,38)	7542	1,51	(1,32-2,23)	4200	1,71	(1,32-2,23)	
4-5	390	3,46	(1,20-9,97)	1978	1,99	(1,33-2,82)	680	1,94	(1,33-2,82)	

[a] Prevalence ratio and 95% confidence intervals (CIs) standardized to the distribution of the adult population of Spain by sex, nationality, educational level, income level and marital status .

[b] p-value interactions calculated with test for homogeneity of standardized prevalence ratios.

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