Preventive Medicine 67 (2014) 248–254

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

The association of major patterns of physical activity, sedentary behavior and sleep with health-related quality of life: A cohort study ☆

Pilar Guallar-Castillón [a,*], Ana Bayán-Bravo [a], Luz M. León-Muñoz [a], Teresa Balboa-Castillo [b], Esther López-García [a], Juan Luis Gutierrez-Fisac [a], Fernando Rodríguez-Artalejo [a]

[a] Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid/IdiPaz, CIBERESP, Madrid, Spain
[b] Department of Public Health, School of Medicine, Universidad de la Frontera, Temuco, Chile

ARTICLE INFO

Available online 17 August 2014

Keywords:
Physical activity
Sedentary behavior
Sleep
Health-related quality of life
Spain

ABSTRACT

Objective. To examine the prospective association of patterns of physical activity, sedentary behavior and sleep with health-related quality of life (HRQL) in the general population of Spain.

Methods. A cohort study with 4271 individuals aged ≥18 years was recruited in 2008–2010 and followed-up prospectively through 2012. Activity patterns were derived from factor analysis. HRQL was assessed with the SF-12 questionnaire, and suboptimal HRQL was defined as a score below the sex-specific sample median.

Results. Three main activity patterns were identified. A higher adherence to the pattern named "vigorous activity-seated at the computer" was inversely associated with a suboptimal score in the physical-composite summary (PCS) of the SF-12 (multivariate adjusted odds ratio [aOR] for the highest vs. the lowest quartile 0.71; 95% confidence interval [IC] 0.55–0.90; p-trend = 0.003). The "light activity-seated for reading" pattern was inversely associated with a suboptimal score in the mental-composite summary (aOR = 0.73; 95% CI = 0.61–0.89; p-trend = 0.002). However, a higher adherence to the "seated for watching TV-daytime sleeping" pattern was directly associated with suboptimal PCS (aOR = 1.35; 95% CI = 1.10–1.66; p-trend = 0.008).

Conclusion. Patterns including any physical activity were associated with better physical or mental HRQL. However, a pattern defined by sedentary behavior with diurnal sleep showed worse HRQL and should be a priority target of preventive interventions.

Introduction

Health-related quality of life (HRQL) represents the individuals' perception of physical, mental and social health status. There is evidence that HRQL is a stronger predictor of mortality than many objective measures of health. Given that HRQL is a global health indicator, using HRQL as study outcome can provide newer insights into the effect of risk factors as compared to using only disease-specific endpoints. Moreover, because HRQL is a subjective measure, it might be useful as motivational instrument to promote the adoption of health behaviors. Lastly, since HRQL is a broad multidimensional concept, it allows us to define public policy interventions addressing a variety of areas, including the social, mental and medical services. (Centers for Disease Control and Prevention).

There is evidence that physical activity (PA) is directly associated with HRQL (Luncheon and Zack, 2011; Bize et al., 2007; Martin et al., 2009; Sorensen et al., 2011; Eriksson et al., 2010; Balboa-Castillo et al., 2011; Davies et al., 2012; Heesch et al., 2012), while sedentary behavior (SB) is inversely associated (Balboa-Castillo et al., 2011; Davies et al., 2012; Rhodes et al., 2012). SB, in particular, has been associated with poor physical and mental health after adjusting for physical activity (Balboa-Castillo et al., 2011). However, most of the studies on SB were cross-sectional (Davies et al., 2012), primarily focused on watching TV, and were very heterogeneous (Rhodes et al., 2012). Moreover, sleep duration, particularly short and long sleep, has been linked to worse HRQL in some studies (Faubel et al., 2009; Furihata et al., 2012; Lima et al., 2012).

However, since the total number of hours in a day is fixed and finite for an individual, participating in one activity results in not participating in another. For instance, individuals who engage more in SB usually devote less time to PA; or persons who spend more time playing basketball usually spend less time playing tennis. Consequently, the health

☆ Funding: The data were taken from the ENRICA study, which was funded by Sanofi-Aventis. Funding specific for this analysis was obtained from FIS grants PI11-01379 and PI12/1166 (Ministry of Health of Spain), and from the "*Cátedra UAM de Epidemiología y Control del Riesgo Cardiovascular*". The study funders had no role in study design or in the collection, analysis, and interpretation of data. The authors have sole responsibility for the manuscript content.

* Corresponding author at: Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid, Avda. Arzobispo Morcillo, sn, 28029 Madrid, Spain. Fax: +34 91 3475353.
E-mail address: mpilar.guallar@uam.es (P. Guallar-Castillón).

http://dx.doi.org/10.1016/j.ypmed.2014.08.015
0091-7435/

effects of PA, SB and sleep duration depend not only on the specific activity, but also on the activities it displaces (Mekary et al., 2009). However, most studies on the impact of these three types of activities on HRQL do not directly account for these substitutions.

One method to address this issue is to summarize all activities across the day as activity patterns derived from the data (*a posteriori* patterns). This method is frequently used in nutritional epidemiology (Hu, 2002) and has served, for instance, to show that certain dietary patterns, such as the Prudent or the Mediterranean pattern, are associated with a lower risk of cardiovascular disease, while a Westernized dietary pattern is associated with a higher cardiovascular risk (Hu et al., 2000; Guallar-Castillon et al., 2012). Instead of looking at individual types of activities, pattern analysis examines the effect of overall physical activity; in fact, this type of analysis can account for substitution and interaction between PA, SB and sleep, as occurs in actual daily living, and goes beyond the somewhat artificial assessment of the independent (adjusted) effect of each of them. Conceptually, pattern analysis represents a broader picture of the time spent in different types of activities, and may thus be more predictive of health risks than each of them separately.

To our knowledge, however, no study has yet reported data on activity patterns based on the amount of time devoted to them. Therefore, this work has estimated these patterns and examined their prospective association with HRQL in the general population of Spain.

Methods

Study design and participants

The data were taken from the ENRICA study, whose methods have been reported elsewhere (Rodriguez-Artalejo et al., 2011). In brief, this is a cross-sectional study conducted from June 2008 to October 2010 with 12,948 persons representative of the non-institutionalized Spanish population aged 18 years and older. Data were collected in three stages: first, a phone interview using a structured questionnaire on socio-demographic variables, heath status, lifestyle, morbidity and health services use; second, a home visit to obtain biological samples (blood and urine); and third, another home visit to perform a physical exam and to conduct a dietary history. All persons who collected information (nurses to obtain biological samples, and non-health personnel for the rest of the tasks) received specific training in the study procedures.

Three years later (from May 2012 to January 2013), we attempted to contact a sample of study participants selected randomly, with overrepresentation of older adults. The sample consisted of 6207 individuals, and 4887 (78.7%) were successfully contacted. The socio-demographic, lifestyle and clinical characteristics were similar in subjects lost to follow-up and in those contacted, though differences reached statistical significance due to the large sample size (Table 1). At follow-up, data were collected through a phone interview conducted by trained staff. Data were analyzed in 2013.

Study participants gave written informed consent. The study protocol was approved by the Clinical Research Ethics Committees of the *La Paz* University Hospital in Madrid.

Patterns of physical activity/sedentary behavior/sleep

Habitual PA was assessed with the validated questionnaire developed in the EPIC-Spain cohort study (Pols et al., 1997). Specifically, participants were asked to indicate the number of hours during a usual week in the last year devoted to vigorous-intensity activities such as cycling (including commuting to work) and exercising (running, soccer, aerobics, swimming, tennis, gymnastics, etc.), separately for summer and winter. Additional information was obtained on the time spent walking (in commuting and in leisure time) and performing household chores (cleaning, washing, cooking, taking care of children, etc.), and the time devoted to gardening and do-it-yourself activities. In addition, the questionnaire of the Nurses' Health Study validated in Spain (Martinez-Gonzalez et al., 2005) was used to collect information on the time spent in six sedentary activities (seated while commuting, seated at the computer, seated while reading, seated and watching television, seated and listening to music, and seated or lying in the sun in summer and winter). We also collected information on the time spent seated while eating (breakfast, lunch and dinner). Lastly, the time spent sleeping was ascertained with the following questions: Can you tell me approximately how long you usually sleep at night? Can you tell me approximately how long you usually sleep during the day? Participants were asked to specify the number of hours and minutes they slept (Lopez-Garcia et al., 2008).

To identify patterns of PA, SB and sleep duration, we applied factor analysis (principal components) to the amount of time (minutes) devoted to each type of activity (Kleinbaum et al., 1988). This analysis generated various independent patterns (factors) made up of types of activities with a high degree of correlation. The factors were rotated by orthogonal transformation (Varimax rotation) (Kim and Mueller, 1978). Activity patterns to be retained for future analysis took into account their ease of interpretation, and required an eigenvalue >1 on the Scree test (a graphic representation where the patterns with eigenvalues >1 explain more variance than each individual activity). Factor loadings were obtained for each activity, making it possible for us to identify those most highly correlated with each pattern. Each subject received a score for each pattern, which was calculated as the sum of the time engaged in each activity weighted by the corresponding factor loading (Table 2). A higher score indicated a higher adherence to the respective pattern. The scores were classified in quartiles, where the highest quartile indicated a higher adherence to the activity pattern.

Health-related quality of life

HRQL was assessed with the SF-12 v.2 questionnaire, which has been validated in Spain (Schmidt et al., 2012). The 12 items of this questionnaire assess eight health dimensions: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health. Subjects' answers to any given item receive a numerical score which, after being coded, is then ranked on a scale of 0–100. Information on the eight health dimensions can

Table 1
Characteristics of subjects followed up and lost to follow-up in the study cohort.

	Lost to follow-up (N = 1320)	Followed up (N = 4887)	p value
Sex, %			
Men	47.5	49.2	0.264
Women	52.5	50.8	
Age, %			
18–29 years	16.8	11.4	<0.001
30–44 years	20.2	18.5	
45–64 years	24.5	31.8	
≥65 years	38.6	38.3	
Age, mean in years	53.4	54.3	<0.001
Level of education, %			
Primary or no formal education	42.8	38.0	<0.001
Secondary	36.6	35.8	
University	20.7	26.3	
Alcohol consumption, %			
Non-drinker	20.3	19.7	0.591
Moderate drinker	22.7	21.5	
Excessive drinker	45.7	47.7	
Former drinker	11.2	11.0	
Tobacco consumption, %			
Never smoker	48.1	49.5	0.009
Former smoker	25.4	27.8	
Current smoker	26.6	22.7	
Body mass index (BMI), %			
<25 kg/m^2	34.3	30.7	0.001
25–29.9 kg/m^2	38.3	44.0	
≥30 kg/m^2	27.4	25.3	
Physical activity during leisure time in METs h/week, mean	26.5	26.0	0.419
Adherence to Mediterranean diet (Trichopoulou Index), mean	4.3	4.4	0.011
Health-related quality of life			
Physical composite summary, mean	47.6	48.4	0.017
Mental composite summary, mean	49.7	51.0	<0.001
Chronic diseases, %[a]			
None	57.1	59.7	0.553
One	32.7	30.9	
Two	8.9	8.2	
Three or more	1.3	1.2	

[a] Including: chronic respiratory disease, coronary heart disease, stroke, osteoarthritis or arthritis, cancer, and diabetes mellitus.