RESEARCH ARTICLE

Exploring the impact of sleep and stress on daily physical activity of cardiac patients: a preliminary study

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Abstract

Background: Current approaches to cardiac rehabilitation services tailoring are often based on patient demographics or readiness for behavior change. However, the success of interventions acceptance and improved adherence to recommendations could be much higher when considering and adapting to a patient's lifestyle, such as sleep and stress.

Aims: We aimed to analyze the potential associations between patient sleep and stress and daily moderate-intensity activity in patients with cardiovascular disease and to gain experience on the methods to collect and analyze a combination of qualitative and quantitative data.

Methods: Patients with cardiovascular disease enrolled for an outpatient cardiac rehabilitation program were assessed at the study baseline regarding sociodemographic, clinical profile, and perceived level of stress. To collect daily physical activity and sleep data, all participants had two-week long diaries. Collected data was analyzed through correlation analysis, linear regression, and one-way ANOVA analysis.

Results: The mean age of the participants (n =11) was 67.3 ± 9.6 years old. The patients were mainly male (82 %), married (91 %), and having at least one comorbid disease (64 %). The results of the analysis revealed that the night sleep duration is associated with moderate-intensity physical activity [$F(1,6) = 7.417$, $p = 0.034$]. Stress was not associated with patients' moderate-intensity daily physical activity.

Conclusion: The outcomes of the study can support the development of e-health and home-based interventions design and strategies to promote adherence to physical activity. Tailoring an intervention to a daily behavioral pattern of a patient, such as sleep, can support the planning of the physical activity in a form to be easier accepted by the patient. This finding emphasizes the need for further investigation of the association with a larger population sample and the use of objective physical activity and sleep-related measure instruments. HIPPOKRATIA 2019, 23(1): 15-20.

Keywords: Patient adherence, cardiac care, cardiac rehabilitation, cardiovascular disease, daily physical activity, lifestyle

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Introduction

Regular daily physical activity and exercise are essential components of a healthy lifestyle and significant parts of chronic disease management, including the management of cardiovascular disease (CVD)[1]. Pharmacological interventions remain the first-line treatment for primary and secondary prevention and control of CVD. However, patients' healthy lifestyle behavior can additionally help to stabilize the condition, reduce the symptoms, and prevent complications and potential comorbidity (e.g., obesity, diabetes) from the disease[2,3]. The importance of the physical component of a daily routine is raised and expanded by healthcare professionals globally. However, global estimates show that CVD patient adherence to physical activity and exercise remains to be insufficient[4,5].

The increasing interest in the domain of CVD patient adherence to physical activity regimen is often associated with the development of successful strategies and design approaches applied to hospital-based and eHealth interventions[6-9]. Such interventions are usually designed to target behavior under specific settings, such as daily physical activity or cardiac rehabilitation exercise. They are based on a theory or a model supported by psychology or social science domain (e.g., transtheoretical model of behavior change, social cognitive theory). Currently applied approaches for interventions tailoring are often based on a limited set of factors, including patient demographics, disease severity, motivation, or readiness for behavior change towards a healthier lifestyle[10]. However, the success of interventions acceptance and improved adherence to recommendations could be much higher when

considering and adapting to the patient lifestyle[11,12].

Until now, a limited number of studies investigating CVD patient physical activity-related behavior has been published[5,13-18]. Moreover, there is a lack of research exploring lifestyle behavior affecting daily physical activity. At the same time, stress and sleep are not only the risk factors that lead to CVD if not adequately attended but can precipitate a worsening of the condition of the patient with heart disease[19-21]. The objectives of this study were to investigate associations between stress, sleep, and daily moderate-intensity activity in CVD patients and gain the first experience on hybrid data collection and analysis (i.e., qualitative (e.g., having a diet) and quantitative (e.g., sleep duration).

Methods

Study design, settings, and participants

The study had an exploratory observational character. We focused on a CVD patient group enrolled for an outpatient cardiac rehabilitation (CR) program. The preference was given to a small sample size. We targeted to become familiar with the lifestyle data behavior, to gather first insights and signs in the context of the data, and discover approaches regarding methods to collect and analyze such data before continuing with a larger sample study.

The CR program is a municipal outpatient third phase cardiac rehabilitation program organized and ran under the supervision of the Laboratory of Sports Medicine, School of Physical Education and Sports Science, the Aristotle University of Thessaloniki in Thessaloniki, Greece from April to May 2018. Four local community gyms represented the study environment. Each of the facilities had an assisting trainer assigned for the full duration of the study.

A CVD patient was assigned to the study if i) he or she was at least 18 years old, ii) being in a stable clinical condition, iii) having no symptoms or symptoms of I or II class of heart failure according to the New York Heart Association (NYHA) classification, iv) willing to participate, and v) being available for a continuous two-week period. No sample size calculation was performed to represent the population.

Ethical approval

The investigation conforms with the principles outlined in the Declaration of Helsinki of 1975, revised in 2008. The study protocol, consent forms, and data collection instruments were approved by the School of Medicine Research Ethics Committee of the Aristotle University of Thessaloniki, Greece (decision: 414, date: 16/04/2018). All study participants were informed beforehand of the type of data collection that would take place. Before inclusion in the study group, each participant gave written and signed consent for participation in the study. Collected paper-based data did not contain any personal information such as name or participant's contact information.

Variables, collections procedure, and measurements

The data was obtained through the paper-based assessments and diaries that had to be filled in by the participants. Patient characteristics reflecting patient sociodemographic (i.e., age, gender, ethnicity, marital status, the highest level of education, occupation) and clinical profile (i.e., symptoms, comorbidity, years being diagnosed) were collected through the baseline assessment. The participants filled the baseline assessments under the supervision of CR program trainers at the community gyms at the beginning of the study.

Perceived level of stress was assessed through the established and validated, in the Greek clinical environment, instrument; perceived stress level for the past month (PSS-10)[22]. The perceived level of stress was expressed through the score and the leveled by low, moderate, and high stress[22]. The assessment was completed outside of the CR program facility. Such a decision was made to avoid an effect of the third-party's presence that might influence assessments' scores.

For the physical activity and sleep-related data collection, all participants were provided with two-week-long diaries. Patients were expected to register the type of their daily activity performed from the proposed list [i.e., household activity, leisure activity, and activity spent with (grand-) children] and the time (in minutes) spent on the activity. The list of the activities was based on the analytical tool in physical activity research resources (Epidemiology and Genomics Research Program of National Cancer Institute, United Sates[23]). All activities that are of 3 to 6 in metabolic equivalence (MET) were classified as a moderate-intensity activity[24]. Sleep-related questions were selected from the sleep diary (National Sleep Foundation, Washington, United States[25]). In our diary, the questions related to patient sleep behavior were limited to assessing wake-up, bedtime, and the number and duration of night interruptions, to calculate the values of night sleep duration. Patients were expected to fill in the diary twice daily, every morning, and before going for a night rest. The total night sleep duration was calculated in minutes. The completed logs were collected from the study participants using the gyms as collection points. To minimize reporting bias and avoid missing values of the data, we proposed the participants with support whenever was needed regarding the baseline assessment, and activity and sleep diaries.

Statistical analysis

The collected data was translated from Greek to the English language. Further, the data was conveyed from paper-based sources to the electronic version and inspected for missing values in the baseline assessment. If the majority of the values were missing, the patient was excluded from the total sample for the analysis. Characteristics of study participants are expressed as mean ± standard deviation (SD) or a number with the percentage in brackets (%).

We performed an exploratory factor analysis between

the total amount of daily moderate physical activity in the settings of leisure time, household, and children-related activity, and lifestyle behavior, including the perceived level of stress and night sleep duration. For the analysis, we used the average weekly values. The IBM SPSS Statistics for iOS, Version 25.0.0.0 (IBM Corp., Armonk, NY, United States) was employed for the statistical analysis. An association between two continuous variables first was analyzed through Pearson's r for the linearity of the relationship. The variables found to be correlated were further studied using linear regression analysis. If two continuous variables were not found to be linearly correlated, Spearman's rank correlation analysis was applied to investigate a monotonic correlation between the variables. A one-way ANOVA analysis was utilized to determine statistical differences between the means of the total amount of weekly moderate physical activity in independent groups by the patient lifestyle factors. All assumptions for the mentioned analyses were examined beforehand. A 2-tailed $p < 0.05$ was considered significant. Visualization of the results of correlation analysis was achieved through RStudio software environment (RStudio Inc., Boston, MA, United States) using "corrplot" package[26].

Results

Participants' characteristics

Fifteen patients were examined for their eligibility for the study; two patients were not available for the full period of the study; two patients were not compliant with logging the sleep data with the majority of the values missing. Eleven patients were confirmed as eligible and included in the study sample. All eligible patients were compliant with the instructions and included in the sample for further analysis. The mean age of the participants was 66.45 ± 9.63 years, with the younger patient being 44, and the oldest 77 years old. Participants were mainly male (81.8 %), married (90.9 %), holding elementary school educational level (63.6 %), and having at least one comorbid disease (72.7 %). From the perspective of lifestyle, patients mainly were having a moderate level of perceived stress (54.5 %) with an average night sleep duration of 6.98 ± 0.89 hours. The Greek ethnic group fully represented the study sample. All patients were retired from their job. Table 1 illustrates the sociodemographic and clinical characteristics of the participants.

Lifestyle behavior associated with daily physical activity

Stress and sleep were studied for the association with the daily moderate-intensity physical activity in total and independently in the settings of household activity, leisure time, and children-related physical activity. The analysis between daily physical activity and perceived level of stress did not show any association. An association of medium strength was found between sleep and moderate physical activity ($r = 0.58$). Figure 1 visualizes the results of the correlation analysis between continuous variables; physical activity behavior (moderActiv, houseActiv, leisureActiv, childActiv), perceived level of stress (stress), and night sleep duration (sleep).

Table 1: Sociodemographic and clinical characteristics of study participants (patients with cardiovascular disease enrolled for an outpatient cardiac rehabilitation program).

Variable	Mean (SD) or n (%)
Age	66.45 (9.63)
Gender = Male	9 (81.8)
Ethnicity = Greek	11 (100)
Marital status:	
Married	10 (90.9)
Widower	1 (9.1)
The highest educational level	
Elementary school	7 (63.6)
High school	1 (9.1)
College or University	3 (27.3)
Occupation = Retired	11 (100)
Years being diagnosed	
≤ 1 year	1 (9.0)
≤ 10 years	5 (45.5)
> 10 years	5 (45.5)
Presence of symptoms = Yes	5 (45.5)
Comorbidity = Yes	8 (72.7)
Level of perceived stress	
Normal	5 (45.5)
Moderate	6 (54.5)
Average night sleep duration in hours	6.98 (0.89)
Average amount of weekly moderate-intensity physical activity in hours	
Moderate daily physical activity	11.18 (5.60)
Household-related activity	5.10 (4.56)
Leisure time activity	8.13 (3.96)
Children-related activity	2.03 (3.57)

Values are expressed as mean ± standard deviation or number with percentage in brackets (%), SD: standard deviation, n: number.

Further, a positive linear correlation between the total weekly amount of moderate activity (moderate activity) and night sleep duration (sleep) based on mean values for two weeks was determined by Pearson's correlation analysis ($p = 0.034$, $r = 0.584$, $|r| > 0.5$). The linear regression analysis showed that the night sleep duration (predictor variable) is associated with moderate activity (response variable) [$F(1,6) = 7.417$, $p = 0.034$] (Table 2). The model

Table 2: ANOVA result for the association between the total weekly amount of moderate activity and night sleep duration.

Model	Sum of squares	df	Mean square	F	Sig.
Regression	205741.487	1	205741.487	7.417	**.034**
Residual	166433.513	6	27738.919		
Total	372175.000	7			

Dependent variable: moderate activity, min. Predictor: (Constant), night sleep duration, min.

Table 3: Coefficients for linear regression analysis for the total weekly amount of moderate activity and night sleep duration.

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	SE	Beta		
(Constant)	-674.145	456.513		-1.477	.190
Sleep duration	3.053	1.121	.584	2.723	**.034**

Dependent variable: moderate activity, min. Predictor: (Constant), night sleep duration, min.

Table 4: Model summary demonstrating the percentage of the variation in the total weekly amount of moderate activity that is explained by average nighttime sleep.

				Change statistics				
R	R^2	Adjusted R^2	Std. error of the estimate	R^2 change	F change	df1	df2	Sig. F change
.584	.553	.478	166.550	.553	7.417	1	6	**.034**

Dependent variable: moderate activity, min. Predictor: (Constant), night sleep duration, min.

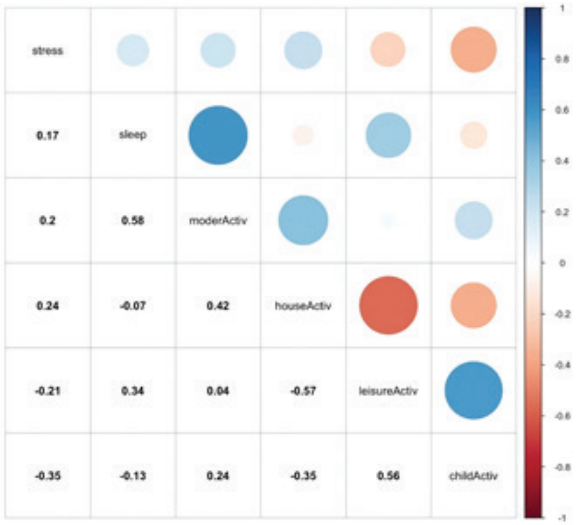

Figure 1: Corrplot of studied associations between daily physical activity, night sleep duration, and perceived stress; Positive correlations are displayed in blue color, negative correlations in red. The size of the circle and color intensity are proportional to the correlation coefficient r [-1;1][26].

is "moderate activity =3.053 x sleep - 674.145" (Table 3). About 55.3 % of the variation in the total weekly amount of moderate activity is explained by average nighttime sleep (r^2 =0.553) as summarized in Table 4.

Discussion

The current study reveals the results of the exploratory factor analysis between lifestyle-related behavior and daily moderate physical activity. We found that the night sleep duration was positively associated with the weekly amount of daily moderate-intensity physical activity. In recent years, the researchers have been attracted to the concept of sleep and its influence on physiology, cognitive response, and health impact in general. The role of sleep and its relationship with CVD is studied from the perspective of risk behaviors, demographics, social context, occupational factors, and others[27]. Moreover, the short and long duration of night sleep is a predictor, or marker, of cardiovascular outcomes[28]. From the perspective of physical fitness, it is known that sleep affects the performance of the physical activity and *vice versa*[29,30]. We find it worth to mention that the analysis of the relationships between sleep duration and leisure time, household and children-related activity did not show any significant results. At the same time, the combination of mentioned activities as moderate physical activity was found to be associated. It might highlight the importance of the research considering different combinations of lifestyle behavior.

The perceived level of stress was not found to be associated with total moderate-intensity physical activity or its settings as leisure time, household, and children-related physical activity. In another study, the stress factor as home-related stress showed to be a barrier to physical activity[31]. In its turn, we assessed the perceived level of stress without linking it to its cause.

In our study, the average amount of moderate-intensity physical activity (including household, leisure, and activity spent with (grand-) children) was relatively high, with around eleven hours a week (11.18 ± 5.60). It might be explained by the majority of the patients in the sample group is participating in the CR program for up to ten years or more (91 %). Studies show that patients who participate in CR can experience significantly greater improvement in most quality of life domains, which in-

clude optimum levels of physical and social functioning, involving a person's occupational and life roles[32,33].

The findings presented do not conflict with the results of the studies carried internationally, but support and highlight other aspects or settings of studied lifestyle variables. The results of the study suggest further directions for investigations, considering the lifestyle of a patient.

Our exploratory study has several limitations. First, the study sample was limited to the number of cases. While a small population size was chosen as a preliminary study, the statistical power of the described results can be considered as relatively moderate, and do not represent the population. Second, the data collection period was comparatively short, with a two-week duration. Patient daily physical activity and exercise is a longitudinal behavioral concept. Therefore, the longer-duration studies are beneficial to explore further the activity behavior patterns and the influence of associated lifestyle behaviors. Third, the collected and analyzed values of the performed physical activity and sleep are exclusively self-reported during the study period by the patients. We recognize that the reporting and recall biases could potentially influence the described study results that should be interpreted with caution.

Conclusion

Based on the outcomes of the exploratory study, the night sleep duration showed to be associated with weekly daily moderate physical activity in the settings of leisure time, household, and time spent on activities involving (grand-) children.

The study outcomes can support the development of intervention design and strategies to promote physical activity and adherence to a healthier lifestyle. However, further research with a larger population sample and the use of objective physical activity and sleep-related measure instruments is required. Further data investigation and analysis should be extended with multiple relationships of lifestyle behavior and physical activity behavior to explore daily behavioral patterns.

Conflict of interest

The authors declare no conflict of interest.

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