Study of sedentary behaviour analysed by self-report questionnaire and accelerometry, and its association with cardiovascular risk factors in an adult population from a health centre

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Summary

Introduction: Currently, sedentary lifestyle has been gaining prominence in the daily life of adults, increasing the time they spend seated, with a relationship between sedentary time and increased mortality from any cause, higher incidence of cardiovascular diseases, cancer and type 2 diabetes.
Purpose: The aim of this study are to assess the applicability of subjective and objective recording methods in the field of physical activity and health, and to determine the possible relationships between sedentary behavior and its variables and the level of daily physical activity with the prevalence of one or more cardiovascular risk factors.
Material and method: A group of 64 adults from a Primary Care Center were studied, who were administered the International Physical Activity Self-Questionnaire (IPAQ) and an ActivPal triaxial accelerometer was applied for 72h.
Results: Significant differences were observed between self-reported sitting time and accelerometry values, IPAQ (265.45±129.67 min/day) and ActivPal (387.78±215.06 min/day). Significant differences were also observed between the accelerometry variables related to sedentary behavior and the presence of cardiovascular risk factors (CVRF), sedentary time (H=8.42; df=3; p=.03), number of transitions (H=10.41 ; df=3; p=.01) and number of total steps (H=13.4; df=3; p=.004).
Conclusions: The results of this study demonstrate the underestimation of sitting time by the population using the IPAQ, the relationship between sedentary behavior variables and the presence of CVRF, and the need to adopt promotional measures for the change towards an active lifestyle using strategies that can generate awareness of the importance in the acquisition of habits that generate transitions from sitting to standing.

Key words:
Sedentary behavior. Sitting time. Cardiovascular risk factors. Self-questionnaire Accelerometry.

Estudio del comportamiento sedentario analizado mediante autocuestionario y acelerometría y su asociación con factores de riesgo cardiovascular en población adulta de un centro de salud

Resumen

Introducción: En la actualidad, el sedentarismo ha ido ganando protagonismo en el día a día de las personas adultas aumentando el tiempo que pasan en sedestación, existiendo una relación entre tiempo sedentario y el aumento de la mortalidad por cualquier causa, mayor incidencia en enfermedades cardiovasculares, cáncer y diabetes tipo 2.
Objetivo: Los objetivos de este estudio son valorar la aplicabilidad de métodos de registro subjetivos y objetivos en el ámbito de la actividad física y la salud, y determinar las posibles relaciones entre el comportamiento sedentario y sus variables y el nivel de actividad física diaria con la prevalencia de uno o más factores de riesgo cardiovascular.
Material y método: Se estudió a un grupo de 64 adultos de un Centro de atención primaria a los que se les administró el Autocuestionario Internacional de Actividad Física (IPAQ) y se les aplicó un acelerómetro triaxial ActivPal durante 72h.
Resultados: Se obtuvieron diferencias significativas entre el tiempo sentado reportado mediante auto-cuestionario y los valores de acelerometría, IPAQ (265.45±129.67 min/día) y ActivPal (387.78±215.06 min/día). También se observaron diferencias significativas entre las variables de acelerometría relativas al comportamiento sedentario y la presencia de factores de riesgo cardiovascular (FRCV), tiempo sedentario (H=8.42; df=3; p=.03), número de transiciones (H=10.41; df=3; p=.01) y número de pasos totales (H=13.4; df=3; p=.004).
Conclusiones: Los resultados de este estudio demuestran la subestimación del tiempo sentado por parte de la población mediante el IPAQ, la relación entre las variables del comportamiento sedentario y la presencia de FRCV y la necesidad de adoptar medidas de promoción para el cambio hacia un estilo de vida activo utilizando estrategias que puedan generar consciencia de la importancia en la adquisición de hábitos que generen transiciones de sedestación a bipedestación.

Palabras clave:
Comportamiento sedentario. Tiempo sentado. Factores de riesgo cardiovasculares. Autocuestionario. Acelerometría.

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Introduction

Most epidemiological studies in large cohort populations show an inverse relationship between physical activity and the risk of cardiovascular disease. In turn, regular physical activity is the only behavioural intervention which has demonstrated any usefulness in increasing cardiorespiratory fitness, a strong indicator of good metabolic health, low morbidity and low risk of death[1].

Sedentary behaviour and its relationship with health is a topic which has been studied for many years[2–4]. Such behaviour has been defined as any waking behaviour characterised by an energy expenditure less than 1.5 times the basal metabolic rate, i.e. 1.5 metabolic equivalents (METs), while sitting, lying or reclining[5]. The concept of sedentary behaviour encompasses the concept of sitting time, defined as the time a person spends in a position in which their weight rests on the buttocks instead of the feet and in which the back is erect[6]. It has been observed that this time represents most of a person's waking time. These studies have proposed that, regardless of the level of physical activity, sedentary time is associated with a higher risk of mortality from any cause and a higher incidence of cardiovascular diseases, cancer and type 2 diabetes[6,7]. Due to these findings, many health science authorities, such as the American Heart Association, have published guidelines to reduce sitting time and increase active time[8].

Sitting time is a variable which has mainly been studied using self-report questionnaires and accelerometers[9–11]. The questionnaire which several studies have used is the International Physical Activity Questionnaire (IPAQ), in which the person is asked about the time he or she spends sitting in a day[10,12–14]. This variable has also been analysed in different studies with accelerometry devices like the activPAL accelerometer, which measure the acceleration of movement, at the same time as other variables, such as steps and breaks in sitting time[5,9,10].

When analysing behaviour, transitions should be understood as interrupted sitting time and we are beginning to understand the biological mechanisms behind the cardiovascular health benefits involved[6]. Transitions can be a strategy to counter the associated risks, such as vascular dysfunctions[15]. Paing *et al.*[16], in their study, observed effects on glucose control. It has also been observed that more breaks in sedentary time are beneficially associated with metabolic risk variables, in particular with measurements of adiposity, triglycerides and plasma glucose at 2 hours[17].

Another variable analysed over the years has been the number of daily steps taken and their relationship with cardiovascular risk factors[18–20]. These studies have obtained favourable results in reducing the risk of mortality and developing cardiovascular diseases in those who walk more.

The objectives of this study are to assess the applicability of subjective and objective recording methods in the field of physical activity and health, and to determine possible relationships between sedentary behaviour and level of daily physical activity, and the prevalence of one or more cardiovascular risk factors (CVRF) in adult patients from a primary health centre on the island of Menorca.

Materials and methods

Participants

Retrospective study with prospective data from a sample belonging to a group of 64 participants (36 men, 28 women) aged 50.1±5.6 (mean ± SD) years, weighing 74.4±1.6 kg., with a height of 167±1 cm and a BMI of 26.8±4.3, from the quota of patients assigned to a primary health centre in a population on the island of Menorca. The selection was carried out using the common characteristic shared by all the patients: belonging to the quota assigned to the centre and being diagnosed with one or more CVRF. With the help of the health centre database, adult patients between 40 and 80 years of age diagnosed with one or more cardiovascular risk factors were randomly selected from the primary health care quota. This age group was chosen due to the greater presence of CVRFs. The clinical study lasted from 3 January to 5 March 2020. The total number of patients meeting the inclusion criteria came to 580, but due to the state of health emergency, the sample was reduced to those patients who performed the complete protocol prior to its declaration (n=64). The following CVRFs were diagnosed: diabetes mellitus, hypertension, hypercholesterolemia, obesity and overweight (0.62±0.48), and tobacco use.

All the participants were informed of the risks and benefits of the study, and gave written informed consent to take part in the study. Participants could reject the inclusion of their data. The study was carried out following the ethical principles for biomedical research with human beings established in the Declaration of Helsinki of the World Medical Association (updated in 2013) and was approved by the Research Ethics Committee of the Autonomous Government of Catalonia's General Secretariat of Sport (032/CEICGC/2021).

Research design

Physical activity and sedentary behaviour were assessed using the IPAQ[21] questionnaire and a triaxial accelerometer (activPAL)[22] fitted on the right lower limb of selected patients for a period of 72 hours. The activPAL accelerometer monitored sitting, standing and activity time

Table 1. Participant data.

Variables	Records	Mean	Standard deviation	Minimum	Maximum
Age (years)	269	50.1	5.6	40	63
Weight (kg)	269	74.45	15.56	47	127
Height (cm)	269	167	8	150	183
BMI	269	26.41	5.7	0	41.8

(time in motion). A triaxial accelerometer is a device which measures the movement of the body in space on different planes (vertical, mediolateral and anteroposterior), using body acceleration to turn it into a quantifiable digital signal. This is a direct, objective measurement[23].

To select the patients, these were contacted by telephone and asked to come to the health centre or time was used during a regular consultation to explain the objectives of the study and conduct an individual interview with each of them. The data collected in the patients' medical history over the last 6 months were used to determine the degree of control of the condition through: HbA1c in diabetics, blood pressure in hypertensive patients, analytical lipid profile in dyslipidaemic patients, BMI in obese patients and cigarette consumption/day in smoking patients. How many of the patients under study had been recommended physical exercise in the previous year (reflected in their medical histories) and whether there was any difference with those who had not received recommendations was also taken into account.

Variables studied

The variables recorded and analysed in this study were those shown in Table 2.

Statistical method

The data are presented as the mean ± standard deviation (SD). After conducting a descriptive study of central tendency and considering the non-normality of the sample, the Mann-Whitney U test was used to determine possible differences between the variables obtained using IPAQ and activPAL. Subsequently, the Kruskal-Wallis test was used to determine the possible differences between the values of the variables by absolute values and by quartiles in relation to the sedentary behaviour of the CVRF.

Statistical analysis was performed with Jasp software version 0.11.1 (The Jasp Team, Amsterdam, The Netherlands). The significance level for the whole analysis was $p < 0.05$.

Results

The following CVRFs were diagnosed per patient: diabetes mellitus (0.1±0.31), arterial hypertension (AHT; 0.1±0.31), hypercholesterolemia (0.22±0.41), obesity and overweight (0.62±0.48) and tobacco use (0.44±0.49) (Table 3). 139 participants had at least one CVRF (50.9%); 96 had two CVRFs (35.1%); 33 had three (12%) and five had all four CVRFs

Table 2. Subjective and objective variables analysed in the study.

Variable	Abbreviation	Type of variable	Description	Unit of measurement
Hypertension	AHT	Objective	Presence of excessively high blood pressure. Systolic blood pressure which is greater than or equal to 140 mmHg and diastolic blood pressure greater than or equal to 90 mmHg.	mmHg
Dyslipidaemia	DLP	Objective	Presence of a high concentration of lipids (cholesterol, triglycerides or both) or a low concentration of cholesterol rich in lipoproteins (HDL).	mg/dL
Diabetes	DM	Objective	A chronic disease which occurs when the pancreas does not secrete enough insulin or when the body does not use the insulin it produces effectively. Greater than 126 mg/dL	mg/dL
Tobacco use	TU	Subjective	Daily tobacco consumption	Yes/no
Obesity/overweight	OB	Objective	Relationship between weight and height used to identify overweight and obesity in adults. This is calculated by dividing a person's weight in kilograms by the square of their height in metres (kg/m^2). Overweight: BMI equal to or greater than 25. Obesity: BMI equal to or greater than 30.	kg/m^2
activPAL sitting time	AST	Objective	Time recorded by the activPAL in the position in which the person remains vertical by resting the pelvis on a support, total or partial	Minutes
IPAQ sitting time	IST	Subjective	Time recorded by the IPAQ in the position in which the person remains vertical by resting the pelvis on a support, total or partial	Minutes
activPAL sedentary time	ASedT	Objective	Time recorded by activPAL of waking behaviour characterised by an energy expenditure <1.5 times the basal metabolic rate, i.e. 1.5 metabolic equivalents of task (METs), while sitting, lying or reclining.	Minutes
activPAL total steps	ATS	Objective	Number of steps counted in a day by the activPAL device	Cumulative count
activPAL transitions	AT	Objective	Number of breaks from sitting time passing to a bipedal position recorded by activPAL	Cumulative count

Table 3. Prevalence of cardiovascular risk factors.

Variable	Records	Sum	Percentage
Hypertension	273	61	22.34%
Dyslipidaemia	273	72	26.37%
Diabetes	273	29	10.62%
Tobacco use	273	120	43.96%
Overweight/obesity	273	168	61.54%

Table 4. Objective (activPAL) and subjective (IPAQ) physical activity and sedentary time variables.

Variables	n	Mean	Standard deviation	Minimum	Maximum
activPAL sitting time (AST)	273	387.78	215.06	0.27	888.06
IPAQ sitting time (min, IST)	273	265.2	129.6	90	600
activPAL sedentary time (min; ASedT)	273	731.17	396.56	0	2,010.63
activPAL total steps (ATS)	273	11,936.01	5,605.01	1,808	31,996
activPAL transitions (AT)	273	47.46	19.87	16	136

(2%). By CVRF analysed, 61 patients (22.34%) were diagnosed with AHT; 72 (26.37%) with dyslipidaemia; 29 (10.62%) with diabetes; 120 (43.96%) with tobacco use; and 168 (61.54%) with obesity or overweight.

As for accelerometry, a total of 273 valid records (4.2±1) were obtained per patient (Table 4). When it came to sedentary behaviour, the reported sitting time was 265.45±129.67 min/day with IST and 387.78 ±215.06 min/day with AST per patient. Statistical analysis determined significant differences in relation to IST and AST (W=115.00; p<.001; SE=-0.99).

Significant differences were observed between the accelerometry variables related to sedentary behaviour and the presence of CVRF, both for the activPAL sedentary time (H=8.42; df=3; p=.03), defined by quartiles <4h, 4-6h, 6-8h, >8h per day[6], and for the AT (H=10.41; df=3; p=.01). Also in relation to the presence of CVRF diagnosed, significant differences were observed with the total steps variable measured with the activPAL (H=13.4; df=3; p=.004), defined by quartiles <4000, 4000-7999, 8000-11999 and >12000 steps per day[24].

Discussion

One of the main objectives of the study was to assess the applicability of subjective and objective recording methods in the field of physical activity and sedentary behaviours. With the data obtained, significant differences are observed in the amount of time sitting during the day between values obtained by self-report questionnaire (IPAQ) and accelerometer (activPAL). These results support the idea that people tend to underestimate the time they spend sitting during the day, showing that the accelerometer registers an average sitting time 2 hours longer than that recorded in the IPAQ. These results are similar to those obtained by Chastin *et al.*[10], in which an underestimation of sitting time of 2 hours per day when using the IPAQ compared to the accelerometer, was also observed. Fitzsimons'[12] study obtained daily values with a difference of more than 2 hours.

Another objective of this study was to determine the possible relationships between sedentary behaviour and the level of daily physical activity, and the prevalence of one or more cardiovascular risk factors (CVRF). In our study, we obtained significant differences in the number of CVRFs presented and sedentary time, there being a greater prevalence in the number of risk factors in people with a longer sedentary time. These results are in line with the study by Leiva *et al.*[3], where a relationship between sedentary time and increased cardiovascular and metabolic risk factors was found. In their study, it was observed that the effect of a sedentary lifestyle on these risk factors was not determined by a higher caloric intake but reduced energy expenditure. Other studies in which the self-report questionnaire and accelerometry have been used have also obtained similar results, revealing an increased presence of risk factors with an increase in sedentary time[25,26].

One of the most surprising findings of the study by Charles E. M. *et al.*[27] was that those who reported more than 7 hours/week of moderate-to-vigorous physical activity during their leisure time but also watched television ≥7 hours/day had a 50% higher risk of any-cause mortality and twice the risk of death from cardiovascular disease compared to those who engaged in the same amount of physical activity but watched TV <1 h.

One way to reduce sedentary time is to transition from sitting to standing[15]. In our study, a lower presence of cardiovascular risk factors was observed in people with a higher number of transitions. In their study, Paing *et al.*[16] saw improvements in glucose control in people who recurrently interrupted their sedentary time. These results are similar to those obtained by Bergouignan et al. in their study of overweight people who interrupted sedentary time every 20 minutes[28]. Nakayama *et al.*[29] observed that a decrease in sitting time might induce parasympathetic activity during sleep. Therefore, reducing continuous sitting time during the day could contribute, in part, to improving the prognosis of patients with cardiovascular risk factors, not only by preventing muscle loss but also by providing positively influencing parasympathetic tone during sleep.

Peterson C. *et al.*[15] observed that exposure to acute prolonged, uninterrupted sitting results in significant increases in systolic blood pressure and mean arterial pressure, effects which could be reduced by including transitions to interrupt the prolongation of sitting time. The paper by Dunstan *et al.*[6] shows similar results. More studies have

observed improvements in variables associated with cardiovascular risk factors[30,31].

Another variable analysed in this study was the relationship between the number of steps and the prevalence of cardiovascular risk factors, where a lower prevalence of such factors was observed among people who walked more steps in a day. Our results agree with previous studies which have observed that increases in the number of steps are associated with a lower prevalence of risk factors and a lower risk of mortality in adults[25,32,33]. In their study, Katherine S. Hall *et al.*[20] observed that for every increase of 1,000 steps per day at the start of the study, there was a possible reduction in the risk of all-cause mortality (6-36%) over 4-10 years. Pierre F. Saint – Maurice *et al*.[24] obtained results along the same lines as the previous studies and also observed that there are no significant differences regarding walking intensity and the risk of mortality.

Historically, vital signs have been used as key indicators of health status. These include pulse, blood pressure, temperature, breathing rate and body weight (body mass index). As the causes of disease have changed over the last century, new health status measurements have been proposed to address the more contemporary causes of death and disability. Recording physical activity (or exercise) levels is an easy way to meet this need and is recommended as a key health care strategy in the U.S. National Physical Activity Plan. Data on daily physical activity levels should be recorded in the medical history of each patient visiting a primary health facility as a 'new' vital sign[34].

Conclusions

From the data obtained, we can conclude that there are differences in the measurement of sedentary behaviour time depending on the method used. The use of subjective methods (IPAQ self-report questionnaire) shows that the recorded minutes of sedentary behaviour, in general, underestimate the duration of such behaviour compared to objective measurement (activPAL accelerometer).

Furthermore, as demonstrated by our results and in line with other authors, greater sedentary behaviour could lead to an increase in the prevalence of associated cardiovascular risk factors.

Regarding the study of the number of steps per day variable, we obtained an inverse relationship between the number of steps and the presence of cardiovascular risk factors, observing a higher prevalence of risk factors in people who take fewer steps in their daily activities.

One of the contributions of our work has been the analysis of transitions from the sitting position to the standing position and their importance in the interruption of sedentary behaviour and the probable incidence of harm to the health caused by prolonged sitting. These transitions from sitting to the bipedal position limit the harmful physiological changes generated by sedentary behaviour.

Therefore, these conclusions reaffirm the need for a decrease in sedentary behaviour time to reduce the prevalence of cardiovascular risk factors. A useful strategy in public health could involve making transitions with active rest in certain work or academic activities which involve a long time sitting down.

Another area of significant incidence would be the child and adolescent population, ages in which the tendency to use electronic devices and watch television to an excessive degree may lead to long, uninterrupted sedentary behaviour times. Consequently, strategies capable of generating awareness of the importance of acquiring habits which involve transitions from sitting to standing could be useful as part of an active lifestyle in the future.

Finally, the validity and accuracy of the activPAL accelerometer for the measurement of sedentary behaviour and the specific analysis of its components can be reaffirmed. Thanks to its simplicity and manageability, this tool could be included in primary health consultations to obtain physical activity data for use as a vital sign.

Conflict of interest

The authors declare that they are not subject to any type of conflict of interest.

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