



Association of sedentary time and physical fitness with ideal cardiovascular health in perimenopausal women: The FLAMENCO project

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ABSTRACT

Introduction: Healthier lifestyle behaviours might be related to a lower cardiometabolic risk predisposed by menopause transition. The objectives of the study were: 1) to examine the association of sedentary time (ST) and physical fitness with “Ideal Cardiovascular Health” (ICH) in perimenopausal women, and 2) to determine the capacity of ST and physical fitness tests to discriminate between the presence or absence of ICH status in this population.

Study design: Observational cross-sectional study.

Main outcome measures: Sedentary time and different levels of physical activity were objectively assessed using triaxial accelerometry (on 7 consecutive days). Physical fitness was assessed with the Senior Fitness Test battery, handgrip strength, and sit-and-reach tests. ICH status was created from the cut-off values of several health behaviours (smoking, body mass index, physical activity, and diet) and classical cardiometabolic markers (plasma total cholesterol and fasting glucose, and blood pressure).

Results: A total of 122 perimenopausal women (52.6 ± 4.2 years old) participated in this study. After adjusting for covariates, perimenopausal women with ICH status spent less time in sedentary behaviours and had higher scores on the 6-min-walk, 30-s-chair-stand, and back-scratch tests than women with a non-ICH status (all, $P \leq .03$). Cut-off values of < 460 min/day in ST and ≥ -3 cm on the back-scratch test were associated with around threefold higher odds (95% confidence interval 0.14–0.71 and 1.47–7.01, respectively, all $P < .01$) of having ICH status.

Conclusion: Reduced ST and greater cardiorespiratory fitness, upper-body flexibility, and lower-body muscular strength were associated with a better cardiovascular profile in perimenopausal women. Including ST and upper-body flexibility as complementary ICH metrics might facilitate early identification of perimenopausal women with a higher risk of cardiovascular disease. However, further studies evaluating the usefulness of these potential complementary diagnostic tools in perimenopausal women are warranted before they are implemented in clinical practice.

1. Introduction

Nowadays, cardiovascular diseases (CVD) are the main cause of mortality worldwide among women [1]. Menopause is a critical stage characterised by reductions of oestrogens, which might predispose women to cardiometabolic and hemodynamic disruptions [2,3]. In fact, menopause is associated with greater android body fat, lipid metabolism abnormalities, pro-inflammatory state, and decreased adiponectin levels [2,3], which in turn might expose this population to an increased

CVD risk.

For a long time, physicians have mainly focused on the assessment and control of traditional CVD risk factors to diagnose and prevent CVD. However, in 2010, the American Heart Association proposed a novel concept, the “Ideal Cardiovascular Health” (ICH) [4]. This term is composed of health behaviours (smoking, body mass index, physical activity (PA), and diet) and classical cardiometabolic markers (plasma total cholesterol and fasting glucose, and blood pressure).

Since CVD are largely preventable, it is important to address

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primordial CVD prevention targeting specific components that could reduce adverse levels of health behaviours and classical cardiometabolic markers in this population. Hence, recent literature has emphasised the emerging importance of sedentary time (ST) and physical fitness levels as important predictors of CVD [1,5–10]. However, most related studies have been primarily focused on the assessment of cardiorespiratory fitness and muscular strength, and their relation with CVD risk. However, the evidence regarding the influence of other physical fitness components such as flexibility and speed-agility on CVD risk is still controversial.

Hence, there is a worrying gap in this research topic since no previous studies have analysed the association of objectively measured ST and physical fitness with such a complete cardiovascular profile (i.e. ICH, which includes relevant behaviours such as healthy diet and appropriate physical activity levels, usually unnoticed in the assessment of CVD risk) in perimenopausal women. Thus, it is of clinical interest to analyse the capacity of ST and physical fitness tests cut-offs to discriminate between the presence and absence of ICH in perimenopausal women.

Therefore, the aims of the present study were the following: 1) to examine the association of ST and physical fitness with ICH in perimenopausal women, and 2) to determine the capacity of ST and physical fitness tests to discriminate between the presence or absence of ICH status in this population at higher risk of CVD.

2. Methods

2.1. Design and participants

The methods of the present cross-sectional study (2014-January through 2016-June) are published elsewhere [11]. A total of 214 perimenopausal women were contacted from primary-care centres through press releases, social media, and informative meetings in Granada (southern Spain). All interested participants signed a written informed consent after receiving detailed information about the study. The study was reviewed and approved by the Ethics Committee for Research Involving Human Subjects at the University of Granada (Granada, Spain).

2.2. Procedures

The assessment procedure was completed on 2 non-consecutive days. On the first meeting, sociodemographic-clinical data, eating patterns, blood pressure, body composition, and physical fitness were assessed. Before leaving, each participant was asked to wear a triaxial accelerometer during 9 consecutive days. On the second appointment, participants attended the primary-care centre for blood samples extraction.

2.3. Sociodemographic-clinical data

A self-reported anamnesis was employed to collect socio-demographic and clinical (menopausal status, smoking habits, clinical history of CVD risk factors, and pharmacology) data. The degree of menopause was assessed with the Blatt-Kupperman Menopausal Index [12] to provide more specific information about the most common menopausal symptoms of our participants [13], and to facilitate comparisons with previous published articles using the same scale.

2.4. Sedentary time

The participants wore a triaxial accelerometer (ActiGraph GT3X+, Pensacola, Florida, US) on the hip during 9 consecutive days (24 h, excepting during water-related activities). A total recording of 7 days with at least ≥ 10 hours/day of registration was necessary to be included in the study. The accelerometer used a frequency rate of 30 Hz

and an epoch length of 60 s. ST was calculated as the amount of time accumulated below 200 counts/min [14] and was expressed in min/day.

2.5. Physical fitness

Based on the aims of the study, and the characteristics and age range of the sample, the Senior Fitness Test battery [15], along with the handgrip strength [16] and sit-and-reach [17] tests, were employed. This battery, which is characterized by very good psychometric properties and is usually employed in order to avoid potential risks during the evaluation process, has been proved to be reliable [15], valid, sensitive, and feasible in similar aged-adult populations [8,15,18–21]. These fitness tests are also safe, adaptable and viable for clinical populations; especially for those with comorbidities or at higher risk of CVD, such as perimenopausal women. Previous published articles support our methodology in this population [8,9,11,22]. Overall, the physical fitness tests (functional components) analysed were the following: the 6-min-walk (cardiorespiratory fitness (CRF)), sit-and-reach (lower-body flexibility), back-scratch (upper-body flexibility), 30-s-chair-stand (lower-body muscular strength), hand-grip strength (upper-body muscular strength), and timed-up-and-go (motor agility/dynamic balance) tests. More detailed information about physical fitness assessment is shown in supplementary material.

2.6. Ideal cardiovascular health

An ICH behaviour index, ICH factor index, and ICH status were created from the metrics and cut-offs for individual ICH behaviours and classical cardiometabolic markers for adults [4,23], with modified and adapted criteria for both PA and dietary pattern assessment in this Mediterranean population [24].

2.6.1. Health behaviours

Smoking habits: women were asked if they were current smokers, and the time since they gave up smoking. Ideal smoking was defined as “never smoking” or former smoker for more than 1 year.

Body mass index: body weight (InBody R20; Biospace, Seoul, Korea) and height (Seca 22, Hamburg, Germany) were measured, and body mass index was calculated as weight (kg) divided by squared height (m^2). The ideal body mass index was defined as having $< 25 \text{ kg}/m^2$.

Physical activity: PA was objectively measured with accelerometry. PA intensity levels (moderate, moderate-to-vigorous and vigorous) were calculated based on recommended PA vector magnitude cut-offs ≥ 2690 – 6166 , ≥ 2690 , and ≥ 6167 counts/min [25], respectively, and were expressed in min/day. The minutes of moderate-to-vigorous PA bouts (periods of ≥ 10 consecutive minutes spent in that behaviour) per week was calculated (bouted moderate-to-vigorous PA). The ideal PA was defined as meeting ≥ 150 min/week of bouted moderate-to-vigorous PA, or ≥ 75 min/week vigorous PA.

Dietary patterns: dietary habits were collected with a validated food frequency questionnaire [24]. The Mediterranean Diet Score [26] was used to assess the adherence to the Mediterranean Diet, a widely-known dietary pattern in Mediterranean countries characterised by its beneficial role on cardiometabolic health [3,24,26]. The ideal diet pattern was defined as showing a Mediterranean Diet Score ≥ 34 [24].

2.6.2. Classical cardiometabolic markers

Blood pressure: a blood pressure monitor (M6 upper arm blood pressure monitor Omron Health Care Europe B.V.) was used to assess systolic and diastolic blood pressure twice. The lowest value of the two measurements was used for the analysis. The ideal blood pressure was defined as untreated systolic blood pressure < 120 mmHg and diastolic blood pressure < 80 mmHg.

Plasma total cholesterol and fasting glucose: venous blood samples after all night fasting were centrifuged and pipetted. Plasma total

Table 1
Distribution of the cardiovascular health level metrics in the perimenopausal women (n = 122).

Metrics	Definition	n	(%)
Ideal cardiovascular health behaviour index^a	0–4 points from behaviour components (Low ideal cardiovascular health behaviour index)	44	(36.1)
	5–8 points from behaviour components (High ideal cardiovascular health behaviour index)	78	(63.9)
Current smoking			
-Poor	Current smoker	31	(25.4)
-Intermediate	Former ≤ 12 months	1	(0.8)
-Ideal	Never or quit ≥ 12 months	90	(73.8)
Body mass index			
-Poor	≥ 30 kg/m ²	28	(23.0)
-Intermediate	25–29.99 kg/m ²	53	(43.4)
-Ideal	< 25 kg/m ²	41	(33.6)
Physical activity ^b			
-Poor	None	3	(2.5)
-Intermediate	1–149 min/week MPA-MVPA or 1–74 min/week VPA (≥ 10 continuous min)	58	(47.5)
-Ideal	≥ 150 min/week MPA-MVPA or ≥ 75 min/week VPA (≥ 10 continuous min)	61	(50.0)
Healthy diet score ^c			
-Poor	≤ 29.99 points	40	(32.8)
-Intermediate	30–33.99 points	44	(36.1)
-Ideal	≥ 34 points	38	(31.1)
Ideal cardiovascular health factor index^d	0–4 points from factor components (Low ideal cardiovascular health factor index)	77	(63.1)
	5–6 points from factor components (High ideal cardiovascular health factor index)	45	(36.9)
Blood pressure			
-Poor	SBP ≥ 140 or DBP ≥ 90 mm Hg	12	(9.8)
-Intermediate	SBP 120–139 or DBP 80–89 mm Hg or treated to goal	52	(42.6)
-Ideal	SBP < 120 or DBP < 80 mm Hg	58	(47.5)
Total cholesterol			
-Poor	≥ 240 mg/dL	35	(28.7)
-Intermediate	200–239 mg/dL or treated to goal	57	(46.7)
-Ideal	< 200 mg/dL	30	(24.6)
Fasting glucose			
-Poor	≥ 126 mg/dL	1	(0.8)
-Intermediate	100–125 mg/dL or treated to goal	13	(10.7)
-Ideal	< 100 mg/dL	108	(88.5)
Ideal health metrics			
0	0 ideal health components	1	(0.8)
1	1 ideal health component	6	(4.9)
2	2 ideal health components	24	(19.7)
3	3 ideal health components	32	(26.2)
4	4 ideal health components	29	(23.8)
5	5 ideal health components	21	(17.2)
6	6 ideal health components	8	(6.6)
7	7 ideal health components	1	(0.8)
Ideal cardiovascular health status^e	0–3 ideal health metrics (Non-ideal cardiovascular health status)	63	(51.6)
	4–7 ideal health metrics (Ideal cardiovascular health status)	59	(48.4)

DBP, diastolic blood pressure; MPA, moderate physical activity; MVPA, moderate to vigorous physical activity; SBP, systolic blood pressure; VPA, vigorous physical activity. ^a 0, 1 and 2 points were assigned for poor, intermediate, and ideal health behaviour levels, respectively. Based on the sum of all health behaviour points, the ideal cardiovascular health behaviour index was categorized as low (0–4 points) or high (5–8 points) ideal cardiovascular health behaviour index; ^b Physical activity was measured objectively with accelerometry. ^c Health diet score was assessed with the Mediterranean Diet Score. ^d 0, 1, and 2 points were assigned for poor, intermediate, and ideal health factor levels, respectively. Based on the sum of all health factor points, the ideal cardiovascular health factor index was categorized as low (0–4 points) or high (5–6 points)

ideal cardiovascular health factor index; ^e a value of 0 was given if the criterion for ideal health behaviour/factor was not met, and 1 if the criterion was met. The ideal cardiovascular health status was categorized as non-ideal cardiovascular health status (0–3 ideal health metrics) or ideal cardiovascular health status (4–7 ideal health metrics).

cholesterol and fasting glucose concentrations were estimated using an autoanalyser (Hitachi-Roche p800, F. Hoffmann-La Roche Ltd.). Ideal fasting total cholesterol was defined as untreated total cholesterol < 200 mg/dL. The ideal fasting glucose was defined as untreated glucose < 100 mg/dL.

2.7. Ideal cardiovascular health categorisation

Regarding the ICH behaviour/factor index scoring (Table 1), 0, 1, and 2 points were assigned for poor, intermediate, and ICH behaviour/factor levels, respectively [23]. Similarly to Thacker, et al. [23] and based on the sum of all health behaviour points (smoking, body mass index, PA, diet), the ICH behaviour index was scored (ranging from 0 to 8) and categorised as low (0–4 points) or high (5–8 points) health behaviour index. Based on the sum of all health factor points (blood pressure, total cholesterol, and glucose), the ICH factor index was scored (ranging from 0 to 6) and categorised as low (0–4 points) or high (5–6 points) health factor index [23]. To create the ICH status (Table 1), a value of 0 was given if the criterion for the ICH behaviour/factor was not met, and 1 if the criterion was met. Non-ICH status was defined as meeting 0–3 ideal health metrics, whereas ICH status was defined as meeting 4–7 ideal health metrics. This categorisation was employed since it had been previously defined [27], and non-ICH (51.6%) and ICH (48.4%) women groups were distributed similarly.

2.8. Statistical analysis

Descriptive statistics for continuous and categorical variables were used to check the distribution of the cardiovascular health level metrics, and to describe the sociodemographic-clinical characteristics of this group of perimenopausal women. In order to detect additional confounders which might influence the results, raw differences between non-ICH/ICH status groups were examined by Student's t-tests (normal distribution, homoscedasticity) and Welch's tests (normal distribution, heteroscedasticity) for continuous variables, and the Chi-square tests for categorical variables.

The comparisons of ST and physical fitness tests between low/high ICH behaviour and factor groups, and between non-ICH/ICH status groups, were performed with one-way analysis of covariance after adjusting for age, menarche, monthly regular menstruation, and average accelerometer wear time (only for ST analysis). The Cohen's d was used to calculate the standardised effect size and was interpreted as small (~0.2), medium (~0.5), or large (~0.8 or greater) [28].

The ST and physical fitness tests thresholds, which best discriminated between the presence and absence of ICH status, were determined by using receiver operating characteristics (ROC) curve analysis. The distance between each 1-specificity and sensitivity pair with the perfect test was calculated. Then, the pair closest to 1 was chosen to identify the best cut-off to identify the presence of absence of ICH status.

The area under the curve (AUC) was calculated together with its 95% confidence interval (CI).

Binary logistic regression was employed to further analyse the predictive capacity of ST and physical fitness tests thresholds derived from the ROC curve for non-ICH status and ICH status, after adjusting for the potential confounders aforementioned. Only predictors which were statistically significant in previous ROC curve and AUC analyses were included in the current analysis.

All analyses were performed using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 22.0, Armonk, NY)

in 2017. The level of significance was set at $P < .05$.

3. Results

From all the recruited participants ($n = 214$), the final study sample was composed of 122 perimenopausal women (age 52.6 ± 4.2 years old). Five women did not answer calls for the appointment and 8 did not come to the evaluation. Twelve women were excluded because they did not meet accelerometry criteria. Three women did not perform all physical fitness tests. Sixty-one participants were excluded because they lacked values from some ICH metrics. Three women were excluded because they lacked complete data.

The distribution and prevalence of the ICH metrics in our sample are presented in Table 1. Approximately, 64% of our perimenopausal women showed a high health behaviour index. The ideal health behaviour levels were observed for current smoking, body mass index, PA, and diet in 74%, 34%, 50%, and 31% of the study sample, respectively. Roughly, 37% of our sample showed a high health factor index. Ideal health factor levels were observed for blood pressure, total cholesterol, and fasting glucose in 48%, 25%, and 89% of the study sample, respectively. Forty-eight percent of the study sample showed an ICH status.

The sociodemographic and clinical characteristics of the perimenopausal women are shown in Table 2.

The association of ICH behaviour and factor indexes and ICH status with ST and physical fitness are shown in Table 3. The perimenopausal

women characterised by a high health behaviour index showed higher scores in the 6-min-walk test [mean difference (95%CI) = 39.2 m (20.4, 58.1)], 30-s-chair-stand test [0.9rep (0.1, 0.7)], and timed-up-and-go test [0.3 s (0.1, 0.5)] compared to women with a low health behaviour index (all, $P \leq .04$). The effect size was large (Cohen’s $d \sim 0.8$) for the 6-min-walk test and medium (Cohen’s $d \sim 0.5$) for the 30-s-chair-stand and timed-up-and-go test. The perimenopausal women characterised by a high health factor index spent less time in sedentary behaviours compared to the women with a low health factor index [46.3 min (9.8, 76.7), $P = .01$]. The effect size was medium (Cohen’s $d \sim 0.5$). The perimenopausal women characterised by an ICH status spent less time in sedentary behaviours [46.6 min (15.9, 77.4)] and showed higher scores in the 6-min-walk test [24.6 m (5.7, 43.5)], back-scratch test [3.1 cm (0.4, 5.7)], and 30-s-chair-stand test [0.9rep (0.1, 1.7)] compared to the women with a non-ICH status (all, $P < .03$). The effect size was overall medium (Cohen’s $d \sim 0.5$). No differences were observed for the rest of outcome variables between the ICH behaviour and factor groups and between non-ICH and ICH status groups (all, $P > .05$).

The ability of ST and physical fitness to correctly discriminate between the presence and absence of ICH status is presented in Table S1. The ROC analysis showed that ST and the 6-min-walk, back-scratch, and 30-s-chair-stand tests were able to discriminate between the presence and absence of ICH status (AUC range 0.62-0.64, all $P < .03$) (Figure S1 in supplementary material).

The optimal cut-offs to better discriminate between the presence or absence of ICH status were ≥ 461 min/day, ≤ 605.5 m, ≤ -3.1 cm, and

Table 2
Sociodemographic and clinical characteristics of the perimenopausal women examined ($n = 122$).

	All participants ($n = 122$)		Non ICH status ($N = 63$)		ICH status ($N = 59$)		p-value
	Mean	SD	Mean	SD	Mean	SD	
Age (years)	52.6	4.2	53.2	4.3	52.1	4.0	.135
Educational level, n (%)							
Non university degree	79	64.8	40	63.5	39	66.1	.850
University degree	43	35.2	23	36.5	20	33.9	
Marital status, n (%)							
Married/with partner	88	72.1	44	69.8	44	74.6	.687
Without partner/divorced/widow	34	27.9	19	30.2	15	25.4	
Professional status, n (%)							
Full/part time work	65	53.7	35	55.6	30	51.7	.717
Unemployed/Retired/Housekeeper	56	46.3	28	44.4	28	48.3	
Currently regular menstruation, n (%)	34	27.9	15	23.8	19	32.2	.320
Age at first menstruation, n (%)							
8-12 years old	60	49.2	34	54	26	44.1	.284
13-16 years old	62	50.8	29	46	33	55.9	
Blatt-Kupperman Menopausal index score (0-45)	9.7	7.0	10.4	6.5	9.0	7.6	.286
Body mass index (kg/m²)	27.2	4.0	28.4	3.87	25.9	3.65	< .001
Physical activity							
Bouted moderate-vigorous PA (min/week)	186.8	149.8	143.2	127.6	233.5	158.5	.001
Sedentary lifestyle							
Sedentary time (min/day)	472.3	90.4	493.3	88.0	449.9	88.2	.008
Bouted sedentary time (min/week)	1988.1	669.6	2117.4	688.4	1849.9	625.4	.027
Average accelerometer wear time (min/day)	966.9	61.9	966.5	65.2	967.4	58.6	.940
Mediterranean diet score (0-55)	31.2	4.3	30.0	3.9	32.5	4.3	.001
Blood pressure (mmHg)							
Systolic blood pressure	121.0	16.5	128.1	17.3	113.4	11.8	< .001
Diastolic blood pressure	75.7	10.0	79.5	10.1	71.6	8.2	< .001
Biochemical parameters							
Total cholesterol (mg/dL)	223.9	35.4	235.9	33.0	211.4	33.6	< .001
Fasting glucose (mg/dL)	85.8	10.4	90.0	11.6	81.4	6.6	< .001
Physical fitness tests							
6-min-walk (m)	614.2	54.0	601.3	50.2	628.1	54.9	.006
Sit-and-reach (cm)	25.5	7.5	24.6	6.9	26.8	7.9	.105
30-s-chair stand (rep)	15.9	2.3	15.4	2.0	16.4	2.5	.017
Back-scratch (cm)	-2.7	7.4	-4.3	7.5	-1.1	7.1	.018
Hand-grip strength (kg)	26.4	3.9	26.4	3.9	26.4	4.0	.978
Timed-up-and-go (s)	5.0	0.6	5.0	0.5	4.9	0.7	.086

ICH, ideal cardiovascular health; PA, physical activity. Continuous variables are presented as mean (standard deviation) and categorical variables as number (percentage). P values were calculated using the independent sample Student’s *t*-test (normal distribution, homoscedasticity) and Welch’s test (normal distribution, heteroscedasticity) for continuous variables, and the Chi-square test for categorical variables.

Table 3
Association between sedentary time and physical fitness with the ideal cardiovascular health behaviour and factor index, and ideal cardiovascular health status (n = 122).

	Ideal cardiovascular health behaviour index			Ideal cardiovascular health factor index			Ideal cardiovascular health status			Effect size ^a
	Low	High	P-value	Low	High	P-value	Non ICH status	ICH status	P-value	
	Mean (SE)	Mean (SE)		Mean (SE)	Mean (SE)		Mean (SE)	Mean (SE)		
Sedentary lifestyle										
Sedentary time (min/day)	489.5 (13.3)	462.6 (9.9)	.11	488.3 (9.9)	445.0 (13.2)	.012	494.9 (10.7)	448.2 (11.1)	.003	-0.55 (-0.91, -0.18)
Physical fitness tests										
6-min-walk (m)	589.2 (7.6)	628.4 (5.7)	< .001	617.6 (6.1)	608.1 (8.2)	.37	602.4 (6.6)	627.0 (6.8)	.01	0.47 (0.11, 0.84)
Sit-and-reach (cm)	25.3 (1.1)	25.8 (0.9)	.69	25.4 (0.9)	26.0 (1.2)	.69	24.7 (1.0)	26.7 (1.0)	.15	0.27 (-0.09, 0.63)
Back-scratch (cm)	-4.4 (1.1)	-1.8 (0.8)	.07	-3.0 (0.9)	-2.2 (1.1)	.58	-4.3 (0.9)	-1.2 (1.0)	.02	0.42 (0.06, 0.78)
30-s-chair stand (rep)	15 (0.3)	16 (0.3)	.04	16 (0.3)	16 (0.3)	.12	15 (0.3)	16 (0.3)	.03	0.40 (0.03, 0.76)
Hand-grip strength (kg)	26.8 (0.6)	26.2 (0.4)	.46	26.4 (0.4)	26.4 (0.6)	.95	26.6 (0.5)	26.2 (0.5)	0.53	-0.12 (-0.47, 0.24)
Relative hand-grip strength (hand-grip strength/body weight)						.14				
Timed-up-and-go (s)	5.2 (0.1)	4.8 (0.1)	.006	5.0 (0.1)	4.9 (0.1)	.90	5.0 (0.1)	4.9 (0.1)	.15	-0.26 (-0.62, 0.10)

Values expressed as mean (standard error); ICH, ideal cardiovascular health; Model adjusted for age, menarche, and monthly regular menstruation; Sedentary time was additionally adjusted for average accelerometer wear time; ^a Effect size statistics were performed between non-ideal cardiovascular health status and ideal cardiovascular health status groups and are expressed as Cohen's d (95% confidence interval). The analyses of covariance were performed introducing ideal cardiovascular health behaviour index, ideal cardiovascular health factor index, and ideal cardiovascular health status as predictor variables.

≤ 16.5rep for ST, and 6-min-walk, back-scratch, and 30-s-chair-stand tests, respectively (Table 4). Lower odds of presenting non-ICH status were observed in perimenopausal women with values < 461 min/day for ST (Odds ratio, 0.32; 95% CI 0.14-0.71; P = 0.005), and higher odds of presenting ICH status were observed with values > -3.1 cm for the back-scratch test (Odds ratio, 3.21; 95% CI 1.47-7.01; P = .003).

4. Discussion

The main findings of the present study suggest that lower ST and greater values of CRF, upper-body flexibility, and lower-body muscular strength are associated with a more favourable cardiovascular health profile (i.e. ICH) in perimenopausal women. Moreover, our results identified ST and back-scratch tests cut-offs associated with a more favourable cardiovascular profile. Therefore, these findings support the relevance of implementing ST (< 460 min/day) and back-scratch (≥ -3 cm) testing as complementary tools for the diagnosis and primordial prevention of CVD in perimenopausal women. However, further studies evaluating the usefulness and discriminatory capacity of these potential diagnostic tools in perimenopausal women (before of being implemented in the clinical practice) are warranted.

Firstly, we analysed the association of ST and physical fitness with the ICH behaviour index [4,23] (without considering classical cardio-metabolic markers). The results indicated that better CRF, lower-body muscular strength, and motor ability/dynamic-balance were associated with a greater score of ICH behaviour index in perimenopausal women. As far as we know, no other studies have analysed this association in perimenopausal women. Hence, these results could not be confirmed. However, these findings seem logical since previous literature has verified that physical fitness is inversely associated with smoking [29] and obesity [6,7], and is positively associated with PA [6,7] and healthy diet [30].

Correspondingly, the association of ST and physical fitness with the ICH factor index (independently of lifestyle behaviours) [4,23] was explored in the current study. Overall, our participants spent approximately 8 h per day in sedentary behaviours. It is difficult to compare our data with other studies given the different methodologies employed for measuring ST, and the influence of diverse factors such as ethnicity, age, gender, etc. [31]. When comparing a large study performed in United States (using a similar approach for measuring sedentary time) with our results, it was observed that American middle-age women (50–59 years old) spent a similar amount of time in sedentary behaviours (7.8 h per day) [32]. However, when comparing our population with other European populations from different countries, our participants spent slightly more time on sedentary behaviours [31] (which might be explained by the different methodologies to assess ST and PA, cultural reasons, etc.). Finally, participants from our study, in comparison to southern Spanish women from the same region and with similar sociodemographic characteristics (using exactly the same criteria for measuring sedentary time), spent a similar amount of time in sedentary behaviours (7 to 7.7 h per day) [33]. Similarly to Healy, et al. [10] our results showed that ST was inversely associated with a favourable cardiometabolic profile. However, Knaeps, et al. [34] did not find any association between ST and a similar cardiometabolic risk score in middle-aged women. These discrepancies might be caused by using different instruments for ST assessment.

Regarding physical fitness, we did not find any association between CRF, flexibility, muscular strength, and motor ability/dynamic-balance with this health factor index. By contrast, other studies [8,9] observed that these physical fitness components were associated with the presence or absence of metabolic syndrome and adverse body-size phenotypes in perimenopausal women. Hence, the relatively healthy sample from the present study could have hampered the sensitivity in detecting those associations. Therefore, more evidence is needed to better understand if ST and which specific components of physical fitness are associated with this ICH health factor index in perimenopausal

Table 4

Binary logistic regression statistics analysing the predictive capacity of sedentary time and physical fitness tests thresholds derived from the receiver operating characteristic analysis for identifying presence or absence of ideal cardiovascular health status (n = 122).

Physical fitness tests	AUC	Cut-off point	Unadjusted model					Model adjusted for covariates ^a				
			B	SE	P-value	OR	95% CI	B	SE	P-value	OR	95% CI
Sedentary time (min/day)	0.615	≥ 461	-0.96	0.37	.01	0.38	(0.18 , 0.80)	-1.15	0.41	.005	0.32	(0.14 , 0.71)
6-min-walk (m)	0.644	≤ 605.5	0.70	0.37	.06	2.01	(0.97 , 4.18)	0.69	0.40	.08	1.99	(0.92 , 4.30)
Back-scratch (cm)	0.632	≤ -3.12	1.01	0.38	.008	2.75	(1.30 , 5.81)	1.16	0.40	.003	3.21	(1.47 , 7.01)
30-s-chair stand (rep)	0.622	≤ 16.5	0.73	0.38	.05	2.08	(1.00 , 4.34)	0.72	0.39	.07	2.05	(0.96 , 4.40)

AUC, area under the curve; B, non-standardized regression coefficient; CI, confidence interval; OR, odds ratio; SE, standard error; ^a Model adjusted for age, menarche, and monthly regular menstruation.

women.

When we considered both health behaviours and classical cardiometabolic markers (i.e. ICH status) [4], the results showed that lower ST and higher values of CRF, upper-body flexibility, and lower-body muscular strength were associated with the presence of ICH status in perimenopausal women. There is strong evidence confirming the relationship of ST with increased CVD risk [1,35,36]. This could be plausible with different physiological mechanisms: i) a sedentary lifestyle, which implies fewer skeletal muscle contractions, may decrease the mitochondrial [37] and lipoprotein lipase activity of oxidative muscle [35], contributing to poor lipid and glucose metabolism, and expression of genes regulating inflammation in the vasculature; ii) the lipid overflow-ectopic fat model [36], which is related to the dysfunctional capacity of subcutaneous fat to store excess energy (as a consequence of excess caloric consumption and sedentary lifestyle); iii) aging and a sedentary lifestyle have also been related to endothelial dysfunction, hypertension, increased sympathetic nervous system activity, and arterial stiffness, and reduced blood flow, oxygenation, and perfusion in the muscles [5].

Numerous studies have highlighted the protective role of physical fitness components on cardiovascular health in women [5–9,37]. CRF has been shown to improve body composition, blood pressure, autonomic nervous system activity, glucose, and lipid profiles, inflammation state, and oxidative stress [7,6–9]. Regarding flexibility, a recent review [5] has suggested that skeletal muscle stretching decreases sympathetic nervous system activity and arterial stiffness. Previous studies have also highlighted the emerging potential role of flexibility on cardiometabolic health in women [8,9] and elderly people [38]. Among the different pathways linking muscular fitness with cardiometabolic disturbances, Wolfe [37] suggested that a higher energy expenditure associated with increased muscle protein turnover (consequence of greater muscle mass) might contribute to the prevention of obesity. Moreover, higher muscular strength has been related to lower total-abdominal adiposity, incidence of metabolic syndrome, insulin resistance, and chronic inflammation [6,8]. The findings also provided specific cut-offs for ST (< 460 min/day) and upper-body flexibility (≥ -3 cm), which were associated with a more favourable cardiovascular profile in perimenopausal women.

From a clinical point of view, the present findings might motivate clinicians to focus on more effective and specific CVD prevention programmes aimed at reducing sedentary behaviours, but also on improving CRF, flexibility, and muscular strength in perimenopausal women. Overall, the keystone of this message for clinical practice is that clinicians might identify more effectively perimenopausal women with adverse cardiovascular profiles using these additional simple instruments. Clinicians could ask women “How many hours/day do you usually spend sitting/lying/standing?”, or make women perform the back-scratch test during consultation. These simple tools only would require one measuring tape and 2 min. Such methods would be helpful for early identification of perimenopausal women with higher CVD risk. Therefore, these complementary tools have a great potential in clinical practice for justifiable reasons: i) the only equipment required is a

measuring tape, which is inexpensive; ii) the time needed to perform these tests is minimal; iii) these tests can be performed in consulting rooms; iv) the procedures for these tests do not require any special training. Hence, we strongly believe they might be easily implemented during consultations.

Some limitations need to be mentioned: (i) the study had a cross-sectional design, (ii) the study lacked a large sample size, (iii) the ICH score relied on the use of categorical variables and on the assumption that all indicated behaviours/factors contribute equally to the cardiovascular final score, (iv) the relatively healthy sample from the current study could have hampered the sensitivity in detecting some associations, and v) some authors have previously suggested that the Blatt-Kupperman Menopausal index presents some psychometric concerns, and includes few symptoms not currently considered key menopause symptoms (while omitting others) [39]. However, we would like to clarify that the results of this study were not affected by this variable. On the other hand, the main strength of the present study was the use of accelerometry to assess ST and PA levels. It is also noteworthy that we have used a large range of physical fitness tests in perimenopausal women. Moreover, to the best of our knowledge, the use of ST and fitness testing cut-offs as complementary tools for the identification of ICH status in perimenopausal women has never been explored. However, the modest sample size and the intermediate AUC values observed in this study suggest that the ability of ST, CRF, flexibility, and muscular strength for identifying the presence or absence of ICH status should be interpreted cautiously.

In conclusion, the findings suggest that reduced ST and greater values of CRF, upper-body flexibility, and lower-body muscular strength are associated with a more favourable cardiovascular profile in perimenopausal women. Including ST and flexibility as complementary ICH metrics might facilitate early identification of perimenopausal women with higher CVD risk. However, future large studies evaluating the usefulness of these proposed tools in perimenopausal women (before of being recommended and implemented in clinical practice) are warranted.

Contributors

Pedro Acosta-Manzano was responsible for the conception and management of the work, participated in the acquisition, analysis, and interpretation of data, contributed to the design of the study, drafted the manuscript, and reviewed the article for important intellectual content.

Víctor Segura-Jiménez was responsible for the conception and management of the work, participated in the acquisition, analysis, and interpretation of data, contributed to the design of the study, and reviewed the article for important intellectual content.

Irene Coll-Risco participated in the acquisition, analysis, and interpretation of data, contributed to the design of the study, and reviewed the article for important intellectual content.

Milkana Borges-Cosic participated in the acquisition, analysis, and interpretation of data, contributed to the design of the study, and

reviewed the article for important intellectual content.

José Castro-Piñero participated in the acquisition, analysis, and interpretation of data, and reviewed the article for important intellectual content.

Manuel Delgado-Fernández participated in the acquisition, analysis, and interpretation of data, and reviewed the article for important intellectual content.

Virginia A. Aparicio was responsible for the conception and management of the work, participated in the acquisition, analysis, and interpretation of data, contributed to the design of the study, drafted the manuscript, reviewed the article for important intellectual content, and was responsible for the direction of the study.

Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.

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Ethical approval

The study, performed in perimenopausal women, was reviewed and approved by the Ethics Committee for Research Involving Human Subjects at the University of Granada (Granada, Spain).

Provenance and peer review

This article has undergone peer review.

Research data (data sharing and collaboration)

Data will be made available on request. Anyone interested in discussing collaborative research should contact the corresponding author.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.maturitas.2018.11.015>.

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