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Physical Activity and Sedentary Behavior in Middle-Aged Women: Is It Menopause Stages or Symptoms That Matter?

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ABSTRACT

Background and Aims: Menopause induces symptoms such as hot flashes, depression, and anxiety, which impair quality-of-life. Regular physical activity (PA) seems to be a favorable non-pharmacological approach to mitigate consequences of menopause. However, studies showed that middle-aged women reduce PA participation, possibly due to menopausal stage transition or symptoms. This study aimed to evaluate the association of menopausal stage and symptoms severity with PA and sedentary time in women.

Methods: An online study was conducted among pre-, peri-, and postmenopausal women. Menopausal symptoms were evaluated using Menopausal Rating Scale, Hospital Anxiety and Depression Questionnaire, Insomnia Severity Index, Hot Flash-Related Daily Interference Scale, and newly developed Anxiety and Depressive Interference Scales. Moderate-to-vigorous PA (MVPA) time (during work, transport, and leisure-time) and sedentary time were assessed using the Global Physical Activity Questionnaire. Clusters were created using scores from all questionnaires assessing symptoms. Nonparametric MANCOVA, Kruskal–Wallis test, and Dunn post hoc were used to compare MVPA and sedentary time between groups.

Results: A total of 462 women completed the questionnaire, and three clusters representing low, moderate, and severe symptoms were identified. No significant differences between menopausal stages for MVPA and sedentary time were found. However, a significant effect ($p = 0.018$) was found across clusters. Regarding PA domain only, leisure-time MVPA differed among clusters ($p = 0.02$). Women experiencing moderate-to-severe symptoms had lower levels of leisure-time MVPA compared to women with mild symptoms ($p < 0.05$).

Conclusions: These findings indicate that women experiencing moderate-to-severe symptoms are also likely to have lower levels of PA during leisure-time independent of their menopause stages.

1 | Introduction

A woman's life is divided into three major periods (reproductive, perimenopausal, and postmenopausal) during which hormonal changes can alter her behavior and quality-of-life [1, 2]. Menopause is an important step in the female reproductive aging process, characterized by the cessation of ovarian hormone secretion and menstruation. In the years preceding menopause, women experience increased variability in menstrual cycle length, with more frequent occurrences of very long or very short cycles, followed by 12 months of amenorrhea that marks the onset of postmenopausal years. This poorly understood phase, the duration of which can vary from woman to woman, is referred to as "perimenopause" [1] and is associated with a variety of

physiological, psychological, and social changes that can significantly affect women's quality-of-life [3]. It is notable that "menopausal" symptoms (observed during peri- and postmenopause) affect over 80% of women, with approximately one-third experiencing severe symptoms [4]. Among these, vasomotor symptoms, such as hot flashes and night sweats, are the most prevalent, impacting 60%–80% of women for 5–10 years [5]. Additionally, anxiety, depression, and sleep disturbances are frequently reported during this period of life, with prevalence rates of 45%–50%, 30%–45%, and 60%–80%, respectively [6–8].

In middle-aged women, regular physical activity (PA) has emerged as a promising non-pharmacological intervention to enhance quality-of-life and mitigate the adverse effects associated with declining ovarian hormone levels [9]. Empirical evidence suggests that regular PA during the menopausal transition can improve cardiovascular health, minimize fat mass gain, prevent muscle mass loss, maintain bone density and balance, enhance mood, and alleviate depressive symptoms [10]. Additionally, a systematic review with meta-analysis has shown that PA program improved vasomotor symptoms severity [11]. Moreover, elevated levels of sedentary behavior are correlated with higher mortality rates among older women, whereas lower sedentary time is associated with enhanced quality-of-life [12, 13]. Therefore, increase PA and decrease sedentary behavior are particularly crucial in middle-aged women to ensure healthy aging.

Unfortunately, middle-aged women tend to reduce substantially their PA levels [14, 15], which exacerbates the adverse body changes associated with estrogen decline. For instance, a recent French survey on the effect of women's life transitions on PA and sedentary behavior revealed that 32% of women decreased their PA duration, 36% reduced their PA frequency, and 36% increased their sedentary time during the menopausal transition [16]. Furthermore, research indicates that women who experience early menopause (before the age of 45) exhibit lower levels of PA compared to those who undergo menopause between the ages of 45 and 55 [17]. The adherence of middle-aged women to regular PA results from a complex interplay of biological, social, and psychological factors [18, 19]. Notably, animal studies have demonstrated that fluctuations in estrogen levels can influence PA through central neural pathways, involving dopamine and/or serotonin release [20]. The modulating effect of estrogen on PA levels has also been observed in studies involving pre- and postmenopausal women [18, 21, 22], although this phenomenon has not been found systematically [23, 24]. However, these results suggest that the progressive decline in estrogen levels observed during ovarian aging may contribute to the reduction in PA. Similarly, the presence of menopausal symptoms (such as depressive symptoms or sleep disorders) may also negatively impact the adherence to a healthy lifestyle in which PA is a behavior of paramount importance [25, 26]. Moreover, these findings have also been observed in other populations experiencing these symptoms [27, 28]. Consequently, hormonal changes and menopausal symptoms may alter motivation to PA practice, particularly for leisure-time PA, which is more related to intrinsic elements (such as enjoyment and satisfaction) compared to PA related to work or transport, which is often driven by extrinsic factors [29–31]. Although previous studies have already been conducted on the relationship between menopausal symptoms and PA and sedentary levels, it is noteworthy that studies on this topic have been mainly conducted in Asia or America [32–34], with only one study done in European countries to our knowledge [35]. In these countries, the ethnic, cultural, and socioeconomic characteristics of the middle-aged women may influence the relationship among the different variables under study.

The purpose of this cross-sectional study was to compare the PA levels and sedentary behavior across menopausal stages (premenopausal, perimenopausal, and postmenopausal) in women living in French-speaking European countries. Additionally, the study aimed to determine whether the adherence to PA and lower sedentary time in peri- and postmenopausal women could be associated with the severity of menopausal symptoms.

2 | Materials and Methods

2.1 | Study Design

In this study, an anonymous self-administered online survey was conducted according to the CHERRIES checklist [36]. This cross-sectional study was approved by the data protection authority of the University of Poitiers (no personal data, cookies, or IP addresses were recorded).

The survey used the *Sphinx Declic Online* website platform and was distributed online via social networks (*Facebook and Twitter*), flash codes in local newspapers in Poitiers, and posters at Poitiers University [37]. The study was conducted between March 2023 and December 2023, required voluntary participation, informed consent for data processing, and took approximately 15 min to complete.

2.2 | Sample Size Calculation

The sample size was calculated on the basis of the populations of women between 40 and 60 years old in France, Belgium, and Switzerland (8.88, 1.53, and 1.31 million, respectively) [38–40]. Using the Yamane formula with a 5% margin of error, the estimated sample size population required for this study was $n = 400$ participants.

2.3 | Population

Inclusion criteria were as follows: (a) female population, (b) between 40 and 60 years of age, (c) not using hormonal contraception, and (d) living in France, Switzerland, or Belgium.

First, participants were divided into three groups (premenopausal, perimenopausal, postmenopausal) according to menopausal stages based on the *Stage of Reproductive Aging Workshop* (STRAW) criteria [2], as described in Figure 1.

Second, to investigate the association between menopausal symptoms and PA levels, perimenopausal and postmenopausal women were pooled together and classified into clusters based on the intensity of menopausal symptoms and their impact on quality-of-life, which were assessed only in these populations, as described in 2.5 Statistical Analyses.

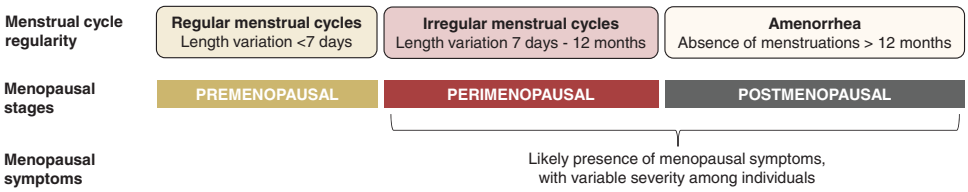

FIGURE 1 | Menopausal stages classification according to self-reported menstrual cycle regularity.

2.4 | Questionnaire

2.4.1 | Population Characteristics

Data collected included age, body mass index (BMI), presence of cardiometabolic pathology (such as cardiomyopathy, hypertension, arrhythmia, and diabetes mellitus) (yes/no), number of children, educational level (secondary education/high school graduate/bachelor's degree/master's or doctoral degree), ethnicity (Caucasian/other), daily alcohol and tobacco consumption (yes/no), and hormonal replacement therapy (HRT) use (yes/no).

2.4.2 | Menopausal Stages

Women were divided into three groups according to their self-reported menstrual cycle regularity, based on the STRAW criteria (Figure 1). Premenopause was defined in women with regular menstrual cycles (STRAW −4 and −3); perimenopause in women with irregular menstrual cycles (STRAW −2 and −1); and postmenopause in women with more than 12 months of amenorrhea (STRAW +1 and +2) [2, 41].

2.4.3 | Menopausal Symptoms Intensity

Menopausal symptoms were evaluated using different validated questionnaires, exclusively among peri- and postmenopausal women.

The Menopause Rating Scale (MRS) is a questionnaire composed of 11 items rating the severity of menopausal symptoms from 0 (no symptoms) to 4 (very severe), divided into three domains: somatovegetative symptoms, urogenital symptoms, and psychological symptoms. This questionnaire is validated in French [42].

The Hospital Anxiety and Depression Scale (HADS) is used to screen for depressive and anxiety disorders. It consists of 14 questions, scored from 0 to 3. It provides two scores ranging from 0 to 21, quantifying two dimensions: anxiety (HAD.A) and depression (HAD.D). According to its original authors, for both subscales, a score below 7 indicates an absence of symptoms, between 8 and 10 indicates doubtful symptoms, and above 11 indicates definite symptoms. Developed by Zigmond and Snaith in 1983, it has been validated in French [43, 44].

The Insomnia Severity Index (ISI) consists of seven questions, all scored on a 5-point Likert scale (from 0 to 4). The total score on the questionnaire provides an assessment of sleep disturbance in the absence of insomnia (score 0–7), subthreshold insomnia (score 8–14), moderate severity insomnia (score 15–21), and severe insomnia (score 22–28). This questionnaire is validated in French [45].

2.4.4 | Quality-of-Life Impact of Menopausal Symptoms

The quality-of-life impact of menopausal symptoms was also assessed exclusively among peri- and postmenopausal women, using several questionnaires.

The impact of hot flash symptoms on quality-of-life was assessed using the Hot Flash-Related Daily Interference Scale (HFRDIS). This scale evaluates the impact of the presence of vasomotor symptoms on nine daily life activities. The last item assesses the impact of these symptoms on overall quality of life. This scale consists of 10 items, all scored from 0 (no impact) to 10 (completely interferes). The HFRDIS, developed in 2001 by Carpenter et al., has been recently validated in French [46, 47].

The impact of anxiety and depressive disorders on quality-of-life was assessed using two modified versions of the HFRDIS model, in which "hot flash" was replaced with "anxiety" or "depressive" to develop two questionnaires, named ARDIS and DRDIS, respectively. The consistency of each version was calculated, indicated strong reliability (Cronbach's $\alpha = 0.98$ and McDonald's $\omega = 0.98$ for both ARDIS and DRDIS). Additionally, their scores are correlated with the HADS questionnaire (ARDIS and HAD.A: rho = 0.48, $p < 0.001$; DRIDIS and HAD.D: rho = 0.69 $p < 0.001$). These data are available in the Supporting Information section.

2.4.5 | PA and Sedentary Time

Levels of PA and sedentary time were assessed using the Global Physical Activity Questionnaire (GPAQ), a tool that allows to evaluate the moderate-to-vigorous PA time (MVPA) and the sedentary time during a classic week. This 16-item questionnaire is designed to assess levels of PA in 3 domains: time of MVPA spent at work, during transport, and during leisure-time. An additional domain is included to assess sedentary time. Originally developed by the *Word Health Organization* for interviewer administration, it has been validated in French for self-administration [48–50].

2.5 | Statistical Analyses

Data were presented as median, interquartile range (IQR), and percentage (%). The Kolmogorov Smirnov test was used to determine data distribution normality, which indicated non-normality distribution for all variables. Between-group differences were tested using the Kruskal–Wallis test for continuous variables and the chi-squared test (χ^2) for data percentages.

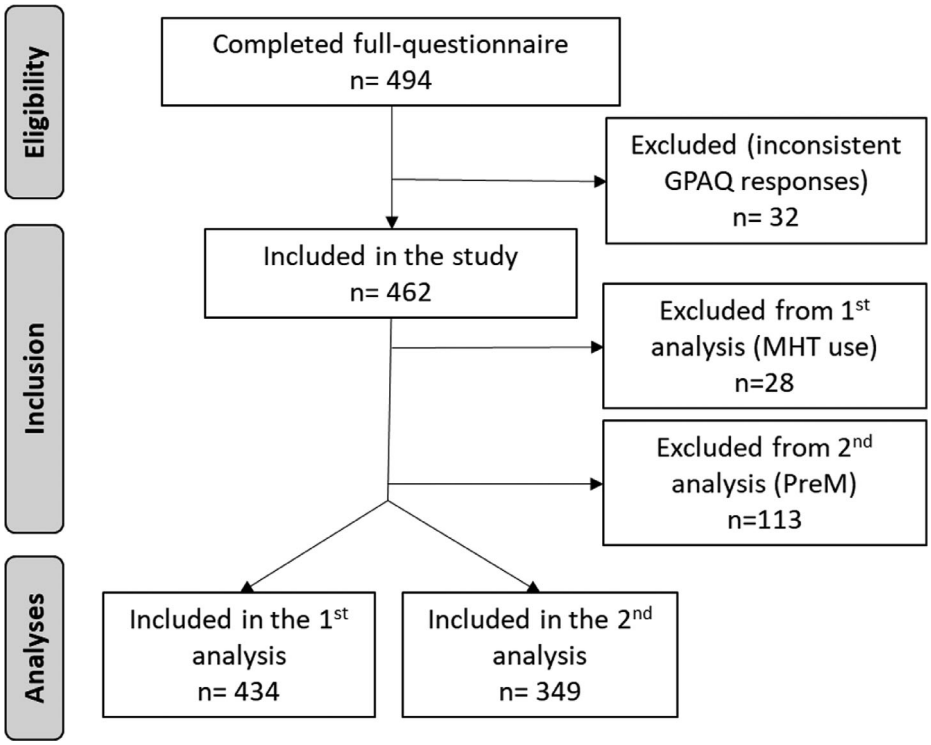

FIGURE 2 | Flow chart of study participant recruitment. First analysis: effect of menopausal stages on physical activity level and sedentary time; second analysis: effect of menopausal symptoms severity on physical activity level and sedentary time. GPAQ, Global Physical Activity Questionnaire; MHT, menopausal hormone therapy; PreM, premenopausal.

A hierarchical cluster analysis using scores from questionnaires assessing menopausal symptoms intensity (MRS, ISI, HAD.A, HAD.D) with their quality-of-life impact (HFRDIS, ARDIS, DRDIS) was performed using Ward's method with squared Euclidean distance as the criterion.

Two multivariate analyses were conducted to determine the influence of (a) menopausal stage or (b) menopausal symptoms severity (intensity and quality-of-life impact) on PA and sedentary time. The two nonparametric multivariate analyses were controlled for the population characteristics (i.e., age, BMI, child, cardiometabolic disease, HRT use, educational level, ethnicity, daily alcohol, and tobacco consumption). When the MANCOVA showed significant differences, the Kruskal–Wallis test and Dunn's post hoc analysis with Bonferroni correction were performed.

Hierarchical cluster analysis was conducted using IBM SPSS Statistics software (version 27.0.1.0), and all statistical analyses were performed using R Studio (version 4.4.0), with the "vegan" and "dunn.test" packages.

3 | Results

A total of 494 women completed the full questionnaire, but 32 participants were excluded due to inconsistencies in their responses at the GPAQ questionnaire, leaving a final amount of 462 women included in the study. For our first analysis of the association between menopausal stages and PA and sedentary time, we decided to exclude women taking menopausal hormone therapy (28 responders) to ensure homogeneous hormonal status in our postmenopausal group (as it is only prescribed for postmenopausal women in these countries). The flow chart of study participant recruitment is presented in Figure 2.

3.1 | Association Between Menopausal Stages and PA and Sedentary Time

3.1.1 | Population Characteristics

The *STRAW* criteria classified 113 women as premenopausal, 115 as perimenopausal, and 206 as postmenopausal. The characteristics of the population, classified by menopausal, stage are shown in Table 1.

3.1.2 | Menopausal Stages and PA and Sedentary Time

The MANCOVA showed no effect ($F = 0.3412$, $p = 0.742$) between menopausal stages and MVPA at different domains and sedentary time (Table 2).

3.2 | Association Between Menopausal Symptoms and PA and Sedentary Time

3.2.1 | Population Characteristics

Three clusters of symptoms severity (intensity and quality-of-life impact) were defined across peri- and postmenopausal women

TABLE 1 | Population characteristics for each menopausal stage.

	PreM $n = 113$	PeriM $n = 115$	PostM $n = 206$	Statistic p value	Post hoc
Age (years)	45 (7)	50 (3)	55 (5)	$H = 222.05$ **$p < 0.001$**	PreM < PeriM < PostM*
BMI (kg/m^2)	25.1 (7.8)	23.9 (6.5)	24.2 (6.6)	$H = 1.62$ $p = 0.44$	—
Child (n)	2 (1)	2 (2)	2 (2)	$H = 10.72$ **$p = 0.005$**	PreM ≠ PeriM** PreM ≠ PostM**
CardioM (n, %)				$\chi^2 = 9.10$ **$p = 0.011$**	PreM ≠ PeriM*
Yes	7 (6)	10 (9)	28 (14)		
No	106 (94)	105 (91)	178 (86)		
Daily tobacco (n, %)				$\chi^2 = 1.48$ $p = 0.477$	—
Yes	12 (11)	16 (14)	32 (16)		
No	101 (89)	99 (86)	174 (84)		
Daily alcohol (n, %)				$\chi^2 = 0.17$ $p = 0.916$	—
Yes	9 (8)	8 (7)	17 (8)		
No	104 (92)	107 (93)	189 (92)		
Ethnicity (n, %)				$\chi^2 = 0.09$ $p = 0.955$	—
Caucasian	107 (95)	108 (94)	195 (95)		
Other	6 (5)	7 (6)	11 (5)		
Education (n, %)				$\chi^2 = 17.78$ **$p = 0.007$**	PreM ≠ PeriM* PreM ≠ PostM**
Secondary education	2 (2)	14 (12)	21 (10)		
High school graduate	9 (8)	15 (13)	33 (16)		
Bachelor degree	51 (45)	53 (46)	87 (42)		
≥Master degree	51 (45)	33 (29)	65 (32)		

Note: Data were presented as median (IQR) and percentage (%). Between-group differences were tested using the Kruskal–Wallis test and Dunn's post hoc test for continuous variables and the chi-squared test for categorical data.

Bold indicates $p < 0.05$.

Abbreviations: BMI, body mass index; CardioM, cardiometabolic disease; NS, non-significant; PreM, premenopausal; PeriM, perimenopausal; PostM, postmenopausal.

*$p < 0.05$.

**$p < 0.01$.

($n = 349$). After calculation, 147 women were classified as having "mild" symptoms, 145 as having "moderate" symptoms, and 57 as having "severe" symptoms. The population characteristics of each cluster of symptom intensity are shown in Table 3, and the symptom intensity scored from all questionnaires are shown in Figure 3.

3.2.2 | Menopausal Symptoms and PA and Sedentary Time

The MANCOVA revealed a significant effect ($F = 5.182$, $p = 0.02$) across clusters concerning MVPA at different domains and sedentary time. Regarding specifically the domain of PA, only leisure-time MVPA showed differences among clusters ($H = 7.449$, $p = 0.02$). Specifically, women experiencing moderate-to-severe symptoms had lower levels of leisure-time MVPA compared to women with mild symptoms (mild: 120 (240) versus moderate: 60 (195), $p = 0.04$; low: 120 (204) versus severe: 7 (180), $p = 0.03$). However, the difference in leisure-time MVPA between the moderate and severe symptom groups was not statistically significant (Table 4 and Figure 4).

4 | Discussion

The objective of this cross-sectional study was to compare the levels of different PA domains and sedentary time in middle-aged women depending on their (a) menopausal stages and (b) the severity of menopausal symptoms. A total of 462 women took part in the survey. Our analysis revealed no difference in MVPA domains or sedentary time across different menopausal stages. However, once aggregating peri- and postmenopausal cohorts and categorizing them into three distinct clusters based on the severity of menopausal symptoms, we found that women experiencing moderate-to-severe symptoms exhibited lower levels of leisure-time MVPA compared to those with lower symptoms.

TABLE 2 | Effect of menopausal stages of physical activity level and sedentary time.

	PreM $n = 113$	PeriM $n = 115$	PostM $n = 206$	MANCOVA
MVPA at work (min/week)	0 (0)	0 (0)	0 (0)	$F = 0.341$ $p = 0.742$
MVPA transport (min/week)	45 (180)	0 (205)	50 (265)	
MVPA leisure-time (min/week)	68 (200)	80 (222.5)	77.5 (210)	
Sedentary time (min/week)	3360 (2310)	2940 (1470)	2940 (2056)	

Note: Data are presented as medians and interquartile ranges; MANCOVA, Kruskal–Wallis test and Dunn's post hoc analysis with Bonferroni correction were performed.

Abbreviations: MVPA, moderate-to-vigorous physical activity; PreM, premenopausal, PeriM, perimenopausal; PostM, postmenopausal.

*$p < 0.05$.

TABLE 3 | Population characteristics for each cluster of symptoms severity.

	Mild $n = 147$	Moderate $n = 145$	Severe $n = 57$	Statistic p value	Post hoc
Age (years)	53 (7)	54 (6)	53 (5)	$H = 0.85$ $p = 0.65$	—
BMI (kg/m^2)	22.8 (6.7)	24.7 (6.0)	24.2 (6.6)	$H = 11.59$ $\mathbf{p = 0.003}$	Mild < moderate* Mild < severe*
Child (n)	2 (1)	2 (1)	2 (2)	$H = 7.34$ $\mathbf{p = 0.025}$	Mild ≠ severe* Moderate ≠ severe*
CardioM (n, %)				$\chi^2 = 9.08$ $\mathbf{p = 0.011}$	Mild ≠ severe* Moderate ≠ severe*
Yes	17 (12)	16 (11)	15 (26)		
No	130 (88)	129 (89)	42 (74)		
MHT use (n, %)				$\chi^2 = 2.43$ $p = 0.297$	—
Yes	8 (5)	15 (10)	5 (9)		
No	139 (95)	130 (90)	52 (91)		
Daily tobacco (n, %)				$\chi^2 = 1.62$ $p = 0.446$	—
Yes	24 (16)	20 (14)	12 (21)		
No	123 (84)	125 (86)	45 (79)		
Daily alcohol (n, %)				$\chi^2 = 1.08$ $p = 0.584$	—
Yes	14 (10)	11 (8)	3 (5)		
No	133 (90)	134 (92)	54 (95)		
Ethnicity (n, %)				$\chi^2 = 1.71$ $p = 0.426$	—
Caucasian	139 (95)	139 (96)	52 (91)		
Other	8 (5)	6 (4)	5 (9)		
Education (n, %)				$\chi^2 = 32.38$ $\mathbf{p < 0.001}$	Mild ≠ severe* Moderate ≠ severe*
Secondary education	9 (6)	13 (9)	15 (26)		
High school graduate	19 (13)	20 (14)	14 (25)		
Bachelor degree	61 (42)	68 (47)	22 (39)		
≥Master degree	58 (39)	44 (30)	6 (10)		

Note: Data were presented as median (IQR) and percentage (%). Between-group differences were tested using the Kruskal–Wallis test and Dunn's post hoc test for continuous variables and the chi-squared test for categorical data.

Bold indicates $p < 0.05$.

Abbreviations: BMI, body mass index; CardioM, cardiometabolic disease; MHT, menopausal hormone therapy; PreM, premenopausal; PeriM, perimenopausal; PostM, postmenopausal.

*$p < 0.05$.

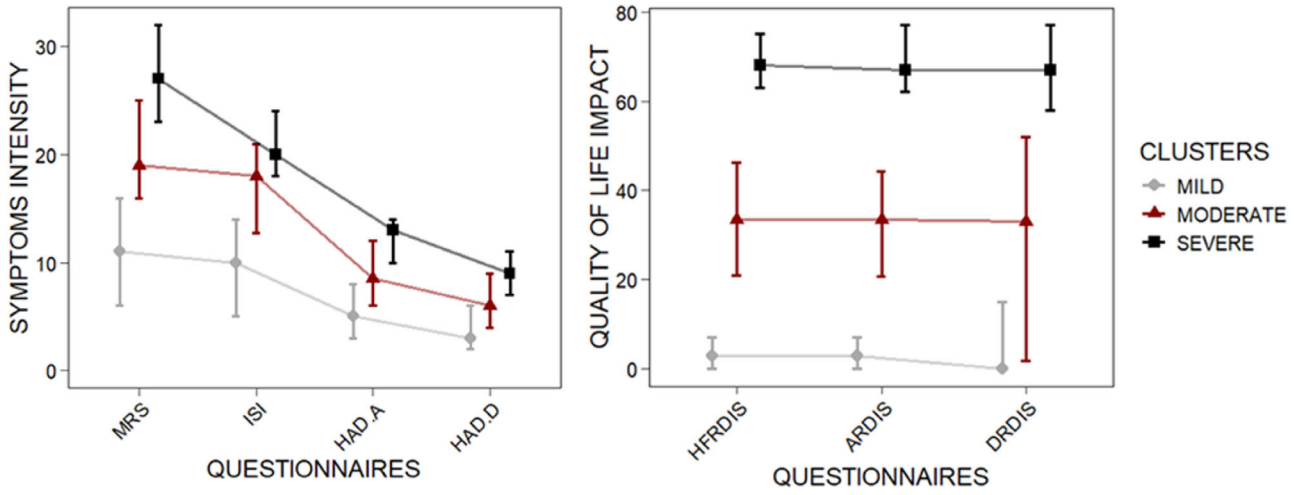

FIGURE 3 | Profiles of each cluster of symptoms severity (mild, moderate, severe). Data are presented as medians and interquartile ranges. Symptoms severity (intensity and quality-of-life impact) is represented in different graphics due to the use of different scales. ARDIS, anxiety-related daily interference scale; DRDIS, depression-related daily interference scale; HAD.A, hospital anxiety scale; HAD.D, hospital depression scale; HFRDIS, Hot Flash-Related Daily Interference Scale; ISI, insomnia severity index; MRS, menopause rating scale.

TABLE 4 | Effect of menopausal symptoms severity on physical activity level and sedentary time.

	Mild $n = 147$	Moderate $n = 145$	Severe $n = 57$	MANCOVA	Kruskal–Wallis	Post hoc Dunn
MVPA at work (min/week)	0 (0)	0 (0)	0 (0)	$F = 5.182$ $\mathbf{p = 0.019}$	$H = 1.63$ $p = 0.44$	—
MVPA transport (min/week)	100 (275)	0 (210)	0 (210)		$H = 3.18$ $p = 0.20$	—
MVPA leisure-time (min/week)	120 (240)	60 (195)	7 (180)		$H = 7.45$ $\mathbf{p = 0.02}$	Mild vs. Moderate: $\mathbf{p = 0.04}$ Mild vs. Severe: $\mathbf{p = 0.03}$ Moderate vs. Severe: $p = 0.76$
Sedentary time (min/week)	3220 (1995)	2940 (2100)	2730 (1680)		$H = 4.36$ $p = 0.11$	—

Note: Data are presented as medians and interquartile ranges. MANCOVA, Kruskal–Wallis test and Dunn's post hoc analysis with Bonferroni correction were performed.

Abbreviation: MVPA: moderate-to-vigorous physical activity.

To the best of our knowledge, the current study is among the few that investigate menopausal stages, as well as the severity of menopausal symptoms and their associations with PA domains and sedentary time. Unlike previous studies, our research focuses specifically on MVPA, as this intensity level is recommended for middle-aged women aiming to maintain good health during aging (cf. World Health Organization recommendations). This focus is particularly significant, as a recent longitudinal study involving over 11,000 middle-aged women demonstrated that adherence to PA guidelines (MVPA time) over a 15-year period is associated with improved health-related quality-of-life [9].

4.1 | Menopausal Stages and PA Participation

Our initial hypothesis was that the varying concentrations of estrogen typically observed across distinct STRAW stages (pre-, peri-, and postmenopause) might influence the levels of PA in women. This hypothesis was based on the possible impact of estrogen concentrations on PA. Indeed, the existing scientific literature, particularly animal studies, indicates that circulating estrogens have a beneficial impact on female PA levels [20, 22]. Indeed, estrogen receptors are found in many body tissues, including the brain, where this hormone is thought to play a role in the pleasure associated with PA, particularly through its effect on serotonin and dopamine secretion [20]. In the context of our study framework, we excluded women who were using hormonal contraception or undergoing menopausal hormone therapy, with the aim of exclusively recruiting individuals with natural ovarian function. The goal was to create groups with uniform hormonal status, although this is always challenging due to the large inter-individual variation in hormone levels, particularly in perimenopausal women [1]. Nevertheless, we have presumed that premenopausal and perimenopausal women included in our study would exhibit elevated estrogen levels relative to their postmenopausal counterparts [51]. Our findings indicate, for the first time, that there is no discernible variance in behavioral patterns concerning MVPA across different domains

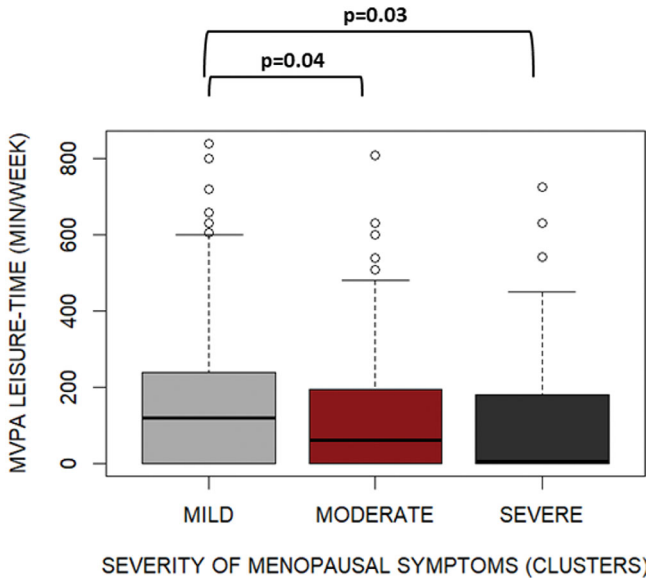

FIGURE 4 | Effect of menopausal symptoms severity on leisure-time participation. Dunn's post hoc test with Bonferroni correction was performed. MVPA, moderate-to-vigorous physical activity.

and sedentary tendencies with menopausal stages. These results differ from those of Dąbrowska-Galas et al. [35], who showed a higher prevalence of high PA levels in the postmenopausal group compared to premenopausal and perimenopausal women [35]. However, in their study, the postmenopausal group had a higher level of education than the other groups, which may have influenced the results, unlike our study, which controlled for this factor.

4.2 | Menopausal Symptoms and PA Participation: The Causal Loop Dilemma

Previous cross-sectional studies showed that women who practiced regular PA had significantly lower menopausal symptoms than inactive women [32, 35], [33, 34, 52]. However, the link between PA and menopausal symptoms severity remains unclear, showing doubts about its causality.

Several interventional studies conducted in recent years have demonstrated the relevance of PA as a non-pharmacological intervention for menopausal symptoms. For instance, Liu et al., in their meta-analysis, showed that PA can reduce the intensity of hot flashes, especially by improving thermoregulatory control [11, 53]. Similarly, low to moderate intensity PA has been shown to effectively decrease anxiety and depressive symptoms, as insomnia severity [54, 55].

Although PA appears to have beneficial effects on menopausal symptoms, the relationship may also be bidirectional, with symptoms adversely affecting PA participation. A 20-year prospective study of 55,395 middle-aged women from the Nurses' Health Study cohort reported that women experiencing more severe symptoms were more likely to lead long-term unhealthy lifestyles, including physical inactivity [26]. These findings are in-line with the *Scottish Action for Mental Health* report on menopause, PA, and mental well-being, which indicated that around 70% of symptomatic women feel that their mood changes (anxiety, depressive) and sleep problems negatively impacted their capacity to engage in PA [25]. These findings are consistent with a recent systematic review that found menopausal symptoms to be an intrapersonal barrier for women throughout the menopausal transition. [56]. Thus, we can hypothesize that when severe menopausal symptoms such as anxiety, depressive symptoms, fatigue induced by sleep disorders are present, they can undermine women's confidence in their ability to engage in PA. In fact, McAndrew et al. found that exercise self-efficacy mediated the relationship between increased PA levels and lower menopausal symptoms, suggesting that a lack of self-efficacy affects confidence, making menopausal symptoms a barrier that can lead to low confidence in one's ability to exercise [57]. This fact reinforces the idea that this population should be encouraged and given special attention to promote PA and reduce sedentary time.

4.3 | Strengths and Limitations

The principal strength of our study is the exhaustive and relevant evaluation of menopausal symptoms. We used several questionnaires with good psychometric proprieties (MRS, HADS, ISI, HFRDIS), all validated in French language. Although we developed the ARDIS and DRDIS questionnaires, we also demonstrated theirs strong consistency (Supporting Information section). We therefore distinguish our work from the studies using the Kupperman Menopausal Index Scale to assess menopausal symptoms, as its relevance has been questioned in several studies [58–60].

In addition, because we found correlations between all the scores of these different questionnaires (Supporting Information section), we decided to profile symptomatic women, by creating clusters based on symptom severity. This clustering approach allows for a more nuanced understanding of the relationship between menopausal symptoms intensity and their impact on quality-of-life.

Our study has several limitations. The cross-sectional design precludes tracking changes in PA levels over time and cannot establish causal relationships between variables, including the potential bidirectional nature of the association between menopausal symptoms and PA levels. Moreover, unmeasured confounders, such as the presence of pathology that limits the ability to practice PA (e.g., long COVID, history of stroke), as well as factors like educational level, socioeconomic status, cultural normal, access to healthcare, or motivation could also influence certain associations by acting as barriers or facilitators to PA practice. For example, women in the "severe symptoms" cluster had lower educational levels than those in the "mild" or "moderate" clusters, where higher education is often correlated with better health knowledge, higher income, and greater access to healthcare, potentially leading to higher PA levels and better overall health [61]. To mitigate these potential confounding effects, we conducted an MANCOVA adjusting for assessed covariates.

Furthermore, to enhance clarity, reduce completion time, and participant burden, the menopausal symptom intensity (MRS, HADS, ISI) and quality-of-life impact (HFRDIS, DRIDIS, ARDIS)

questionnaires were not displayed to premenopausal women and were only completed by peri- and postmenopausal participants. This choice was supported by pilot testing ($n < 10$) and the understanding that menopausal symptoms mainly arise during STRAW stages −2 to +2. However, emerging evidence suggests that some women in the late reproductive stage (STRAW −4 to −3) may already experience early symptoms [62], which our design did not capture. Thus, potential symptom-PA associations in this group were not captured, limiting the generalizability of our findings to earlier reproductive stages. In addition, the question on the use of MHT was restricted to postmenopausal women, in-line with current guidelines in France, Belgium, and Switzerland, which recommend its use only at this stage. This may limit comparability with countries where MHT can be prescribed earlier, in the perimenopausal period. Subsequently, nearly 95% of participants were of Caucasian, raising concerns about the representativeness of the target population. Indeed, ethnicity influences the type and the severity of menopausal symptoms, with Caucasian women often reporting a higher prevalence of psychosomatic symptoms than their counterparts of other ethnicities [63]. Finally, probably due to our recruitment methods (dissemination via social media, and QR codes featured on posters and in newspapers) that explicitly stated the aims of our study, 65% of women reported meeting PA recommendations (≥150 min of MVPA per week), which is higher than the European average for middle-aged women [64]. Consequently, our results may not be generalizable to other populations. Participation bias may also have occurred if the length of the questionnaire discouraged women, although the use of conditional display reduced participant burden by showing only questions relevant to previous responses. Future studies should adopt a methodological approach that includes inactive populations by modifying the recruitment process, particularly by blinding participants to the specific study objectives and tailoring the dissemination strategy, to reduce recruitment and participation bias.

In addition, the GPAQ questionnaire used to assess PA and sedentary time may be questionable. In our study, we excluded 32 participants due to inconsistencies in their responses (e.g., women reporting >35 h/week of MPVA at work, or >12 h/day of total MVPA). Although validated for self-administration in French [50], a more recent study showed that its reliability and validity appeared to vary with the educational level [65]. In our study, 62% of the excluded women had a low educational level (≤high school graduation), suggesting that the questionnaire may need to be adapted to better assess of PA levels in this population. Therefore, employing device-based methods to monitor PA levels in middle-aged women may prove more suitable and reliable in future studies.

4.4 | Implications for Practice

Moderate-to-severe menopausal symptoms are significantly associated with lower levels of leisure-time MVPA, regardless of menopausal stage. These findings highlight the importance of addressing menopausal symptom severity to increase PA levels in middle-aged women. Future research should explore strategies to increase leisure-time PA in women with moderate-to-severe menopausal symptoms and examine the role of tailored interventions.

5 | Conclusions

Women with moderate-to-severe symptoms are more likely to have lower levels of PA during leisure-time. Further research is needed to better identify women at risk of decreasing their PA levels during the menopausal stage transition, enabling improved management of menopausal disorders. It is essential to consider these issues in follow-up consultations to ensure comprehensive care and support for maintaining PA levels in this population.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supplement File: lim270037-sup-0001-SuppMat.docx