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Association Between Severity of Menopausal Symptoms, Core Strength and Peak Expiratory Flow Rate in Perimenopausal Women: A Cross-Sectional Study

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ABSTRACT

Background: Perimenopause is a transitional reproductive stage associated with hormonal fluctuations, musculoskeletal symptoms, reduced physical activity and possible decline in respiratory function. Core muscles contribute to lumbopelvic stability and forced expiration; however, their relationship with menopausal symptom severity and peak expiratory flow rate (PEFR) in Indian perimenopausal women is not well established.
Aim: To find the association between severity of menopausal symptoms, core strength and PEFR in perimenopausal women.
Materials and Methods: A cross-sectional study was conducted among 268 perimenopausal women aged 41-48 years, selected by purposive sampling from a tertiary health-care hospital and Mahila Mandals. Women using hormone replacement therapy and those with chronic cardiopulmonary, metabolic, endocrine, neurological, urogynaecological, or oncological conditions were excluded. Menopausal symptoms were assessed using the Menopause Rating scale (MRS), core strength using a pressure biofeedback unit (PBU) and PEFR using a Mini-Wright peak expiratory flow meter. Pearson's or Spearman's correlation coefficients were applied according to data distribution.
Results: The mean age of participants was 45.2 ± 2.48 years. The mean total MRS score was 18.8 ± 7.41, indicating moderate symptom severity. Mean core strength was 3.69 ± 0.99 mmHg, and mean PEFR was 291.32 ± 59.76 L/minute. Core strength showed a strong positive correlation with PEFR (r = 0.546). Severity of menopausal symptoms showed weak negative correlations with core strength (r = −0.137) and PEFR (r = −0.130).
Conclusion: Core strength was positively associated with PEFR in perimenopausal women. Although menopausal symptom severity had only weak negative associations with core strength and PEFR, physiotherapists should consider core-stability and breathing assessment in community-based menopausal health programmes.

Keywords: Perimenopause, Menopausal symptoms, Core strength, Peak expiratory flow rate, Menopause Rating Scale

INTRODUCTION

Perimenopause, also known as the menopause transition or climacteric, is the period from the onset of menstrual irregularity until one year after the final menstrual period, and it marks the end of the reproductive years.[1,2] The age range considered perimenopausal in Indian women is 41 to 48 years,[3] and natural menopause occurs earlier in India than in many Western countries.[3,4] The prevalence and severity of menopausal symptoms vary with geographic, cultural and socioeconomic conditions,[5] and a systematic review suggests that physical symptoms predominate among Asian midlife women.[6]

Symptoms of the transition include vasomotor and somatic complaints such as hot flushes, night sweats, headache and joint and muscle pain, psychological symptoms such as anxiety, irritability and depressive mood, sleep disturbance, and urogenital symptoms.[6,7] These symptoms impair quality of life,[7,8] and the perimenopause has been described as a period of increased vulnerability to depression.[9,10] Musculoskeletal complaints, particularly low back pain, are also common, and low back pain is more prevalent in women than in men after the age of menopause.[11,12] Oestrogen influences skeletal muscle, for example by promoting myoblast growth,[13] so its decline may contribute to loss of muscle strength.

The core is described as a muscular box formed by the abdominal muscles anteriorly, the paraspinal and gluteal muscles posteriorly, the diaphragm superiorly and the pelvic floor and hip girdle muscles inferiorly.[14,15] The deep local stabilisers, notably the transversus abdominis and lumbar multifidus, stabilise the lumbar spine and pelvis, and altered activation of these muscles is observed in people with low back pain.[16,17] Reduced core strength may therefore contribute to the musculoskeletal complaints reported during the menopausal transition.

Sex hormones also influence respiratory health. Menopause has been associated with more respiratory symptoms and with accelerated decline in lung function,[18-20] and peak expiratory flow rate (PEFR) and other expiratory flow indices were lower in postmenopausal than in premenopausal women in earlier reports.[21,22] The abdominal muscles, of which the transversus abdominis is the deepest, are the principal expiratory muscles; they raise intra-abdominal pressure during forced expiration and so assist expiratory flow.[23,24] In healthy adults, transversus abdominis strength has been found to correlate with pulmonary function,[25] and a similar relationship has been reported between abdominal muscle strength and pulmonary function in people with low back pain.[26]

Despite these plausible links, little is known about core muscle function and expiratory flow in perimenopausal women. To our knowledge, only one small study of 61 women has examined them in relation to symptom severity, and it did not examine the relationship between core strength and PEFR.[27] Such information could help physiotherapists to include assessment of core muscle activation and expiratory flow in the care of women in the menopausal transition. The aim of this study was to determine the association among severity of menopausal symptoms, core strength and PEFR in perimenopausal women. The objectives were to describe symptom severity with the Menopause Rating Scale (MRS), core strength with a pressure biofeedback unit and PEFR with a peak flow meter, and to examine the association between core strength and PEFR and the association of each with the severity of menopausal symptoms.

MATERIALS & METHODS

Study design and setting. This cross-sectional study was conducted between August 2019 and March 2020 at a tertiary

care hospital and in community women's groups (Mahila Mandals) in Mumbai, Maharashtra. Permission was obtained from the institutions concerned, and the study was approved by the Institutional Ethics Committee of MGM College of Physiotherapy, Navi Mumbai. The purpose of the study was explained to all participants and written informed consent was obtained before assessment. Awareness lectures on perimenopause were given to groups of women in the community camps before data collection.

Participants. Women aged 41 to 48 years, the age range considered perimenopausal in Indian women,[3] who were willing to participate were recruited by purposive sampling. Women were excluded if they used hormone replacement therapy; had a chronic illness or a severe metabolic or endocrine disorder; were receiving chemotherapy or radiotherapy for cancer; had undergone uro-gynaecological surgery such as hysterectomy; had a neurological impairment or a congenital spinal condition; had been diagnosed with polycystic ovarian disease; or had a cardiopulmonary disorder. Women who did not complete the questionnaire properly or the assessment procedures were withdrawn from the analysis.

Sample size. The sample size was calculated with the formula $N = Z^2SD^2/L^2$,[28] where Z = 1.64 (90% confidence level), SD = 0.998 (standard deviation of core strength in a pilot study of 14 women) and L = 0.1 (precision). This gave a required sample of 268 women.

Menopausal symptom severity. Symptom severity was assessed with the MRS,[29] which has 11 items, each scored from 0 (no symptoms) to 4 (very severe symptoms), giving a total score of 0 to 44. The items form three subscales: somatic (hot flushes and sweating, heart discomfort, sleep problems, and joint and muscular discomfort; range 0 to 16), psychological (depressive mood, irritability, anxiety, and physical and mental exhaustion; range 0 to 16) and urogenital (sexual problems, bladder problems and dryness of the vagina; range 0 to 12). Total scores were classified as none or little (0 to 4), mild (5 to 8), moderate (9 to 15) and severe (16 or more).[29] The English version of the scale was used. Because most participants did not understand English, each item was read out by the investigator in the language best understood by the participant and the response was recorded.

Anthropometry. Height and weight were measured, and body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. BMI was classified using Asian criteria: underweight, below 18.5 kg/m²; normal, 18.5 to 22.9; overweight, 23.0 to 24.9; obese I, 25.0 to 29.9; and obese II, 30.0 or above.[30] Waist circumference was measured at the narrowest part of the torso between the xiphoid process and the umbilicus, and hip circumference at the maximal circumference of the buttocks, with the participant standing and using a flexible, inelastic tape applied without compressing the skin. The waist:hip ratio (WHR) was classified as excellent (below 0.75), good (0.75 to 0.79), average (0.80 to 0.85) or at risk (0.86 or above). [31,32]

Core strength. Core strength was assessed as transversus abdominis activation with the Stabilizer pressure biofeedback unit (Chattanooga Group, Hixson, TN, USA), a method with acceptable validity and reliability. [33-35] The participant lay prone with the inflatable bag placed between the anterior superior iliac spine and the umbilicus. The bag was inflated to 70 mmHg, the participant was asked to breathe deeply using the abdominal wall, and the pressure was readjusted to 70 mmHg. The participant then performed three contractions on the standardised command "Draw in your abdomen without moving the spine or pelvis", each held for 10 seconds, with readings taken at full expiration. The examiner palpated for movement of the spine or pelvis and observed for compensatory

strategies such as breath holding and rib elevation. Up to six practice attempts were allowed to avoid premature fatigue, and no feedback was given during data collection. The reduction in pressure from the 70-mmHg baseline was recorded for each contraction, and the mean of the three contractions was used in the analysis. A mean reduction of at least 4 mmHg, the lower limit of the range stated by the manufacturer, was defined as a successful contraction.

Peak expiratory flow rate. PEFR was measured in the sitting or standing position with a Mini-Wright peak flow meter.[36] After a maximal inspiration, the participant blew into the mouthpiece as quickly and as hard as possible without placing the tongue in front of the mouthpiece. Three attempts were made, a test with cough or sneeze was repeated, and the highest value (L/min) was taken as the best value. Values were also grouped into red (60 to 250 L/min), yellow (260 to 480 L/min) and green (490 to 900 L/min) zones.

Statistical Analysis

Data were entered in Microsoft Excel 2016 and analysed with IBM SPSS Statistics version 24. Continuous variables were summarised as mean ± standard deviation (SD) and categorical variables as number (percentage). Normality was assessed with the Shapiro–Wilk test ($p > 0.05$ indicating a normal distribution). Pearson's correlation coefficient was used for normally distributed variables (PEFR and total MRS score), and Spearman's rank correlation coefficient for associations involving core strength, which was not normally distributed. 95% confidence intervals (CI) were obtained by Fisher's z transformation for Pearson's coefficient and by bootstrap resampling with 5000 samples for Spearman's coefficient. A two-tailed p value below 0.05 was considered statistically significant.

RESULT

Of 268 women recruited, four were excluded because the assessment was incomplete, and 264 women were analysed. Participant characteristics are shown in Table 1. By Asian BMI criteria, 6 women (2.3%) were underweight, 53 (20.1%) were normal, 55 (20.8%) were overweight, 128 (48.5%) were in obese class I and 22 (8.3%) were in obese class II. The Waist-Hip Ratio was excellent in 9 women (3.4%), good in 41 (15.5%), average in 159 (60.2%) and at risk in 55 (20.8%).

Table 1: Characteristics of the participants (n = 264)

Variable	Mean ± SD	Range
Age (years)	45.2 ± 2.5	41 to 48
Height (cm)	156.1 ± 7.1	121.0 to 175.3
Weight (kg)	62.0 ± 9.9	35.0 to 104.0
BMI (kg/m²)	25.4 ± 3.7	14.3 to 38.1
Waist circumference (cm)	83.0 ± 10.6	61 to 118
Hip circumference (cm)	100.1 ± 10.0	78 to 123
Waist:hip ratio	0.83 ± 0.04	0.70 to 0.96
Core strength (mmHg)	3.69 ± 0.99	2.00 to 6.66
Peak expiratory flow rate (L/min)	291.3 ± 59.9	120 to 450
MRS somatic subscale (0 to 16)	6.0 ± 3.0	0 to 15
MRS psychological subscale (0 to 16)	8.8 ± 3.7	0 to 16
MRS urogenital subscale (0 to 12)	4.1 ± 2.4	0 to 11
MRS total score (0 to 44)	18.8 ± 7.4	1 to 40

BMI, body mass index; MRS, Menopause Rating Scale; SD, standard deviation.

The mean total MRS score was 18.8 ± 7.4 (median 19, range 1 to 40). By the conventional MRS categories, 8 women (3.0%) had none or little, 14 (5.3%) mild, 69 (26.1%) moderate and 173 (65.5%) severe symptoms. The distribution of each symptom is shown in Table 2. Joint and muscular discomfort was the most frequent symptom, reported by 253 women (95.8%) and rated moderate or worse by 214 (81.1%). Depressive mood, irritability, anxiety and physical and mental exhaustion were each reported by more than 90% of women (90.2% to 92.0%), and were rated moderate or worse by 68.9% to 75.4%. Hot flushes, heart discomfort, sleep problems and bladder problems were reported by 62.9% to 64.8%, and dryness of the vagina by 50.8%.

Table 2: Severity of individual menopausal symptoms on the Menopause Rating Scale, n (%) (n = 264)

Symptom	None	Mild	Moderate	Severe	Very severe	Moderate or worse
Somatic subscale						
Hot flushes, sweating	98 (37.1)	82 (31.1)	50 (18.9)	22 (8.3)	12 (4.5)	84 (31.8)
Heart discomfort	94 (35.6)	74 (28.0)	67 (25.4)	25 (9.5)	4 (1.5)	96 (36.4)
Sleep problems	93 (35.2)	57 (21.6)	61 (23.1)	42 (15.9)	11 (4.2)	114 (43.2)
Joint and muscular discomfort	11 (4.2)	39 (14.8)	85 (32.2)	94 (35.6)	35 (13.3)	214 (81.1)
Psychological subscale						
Depressive mood	26 (9.8)	47 (17.8)	87 (33.0)	67 (25.4)	37 (14.0)	191 (72.3)
Irritability	24 (9.1)	58 (22.0)	78 (29.5)	68 (25.8)	36 (13.6)	182 (68.9)
Anxiety	25 (9.5)	41 (15.5)	85 (32.2)	77 (29.2)	36 (13.6)	198 (75.0)
Physical and mental exhaustion	21 (8.0)	44 (16.7)	81 (30.7)	80 (30.3)	38 (14.4)	199 (75.4)
Urogenital subscale						
Sexual problems	40 (15.2)	38 (14.4)	79 (29.9)	78 (29.5)	29 (11.0)	186 (70.5)
Bladder problems	96 (36.4)	86 (32.6)	50 (18.9)	28 (10.6)	4 (1.5)	82 (31.1)
Dryness of vagina	130 (49.2)	62 (23.5)	44 (16.7)	23 (8.7)	5 (1.9)	72 (27.3)

Items are scored 0 (none) to 4 (very severe).

Mean core strength was 3.69 ± 0.99 mmHg (median 3.33; interquartile range 2.66 to 4.66). A mean pressure reduction below 4 mmHg, indicating an unsuccessful contraction, was seen in 137 women (51.9%); 122 women (46.2%) reduced the pressure by 4 to 5.9 mmHg and 5 (1.9%) by 6 mmHg or more. Core strength distribution is shown in Figure 1.

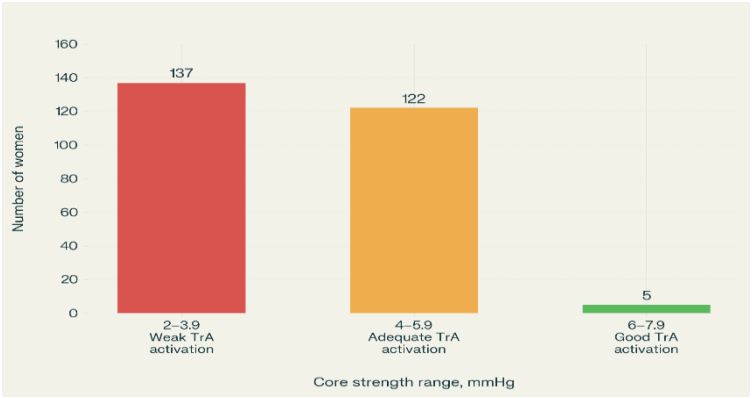


Figure 1: shows the distribution of core strength among perimenopausal females (n=264)

Mean PEFR was 291.3 ± 59.9 L/min; 78 women (29.5%) were in the red zone, 186 (70.5%) in the yellow zone and none in the green zone. Figure 2 shows the distribution of peak expiratory flow rate. 78 perimenopausal women were in the red zone (up to 250 L/min) & 186 in yellow zone (260–480 L/min) and no one was in the green zone.

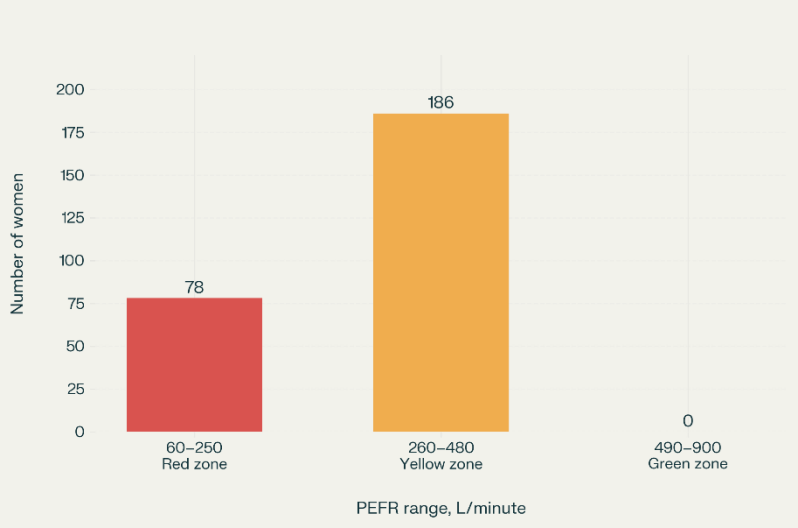


Figure 2: shows the distribution of peak expiratory flow rate among perimenopausal women

The Shapiro–Wilk test showed that total MRS score (W = 0.990, p = 0.056) and PEFR (W = 0.991, p = 0.116) were normally distributed, whereas core strength was not (W = 0.943, p < 0.001). Core strength was positively and moderately correlated with PEFR (Spearman rho = 0.55, 95% CI 0.44 to 0.64, p < 0.001; Table 3 and Figure 1). Total MRS score showed small inverse correlations with core strength (rho = −0.14, 95% CI −0.25 to −0.02, p = 0.026) and with PEFR (Pearson r = −0.13, 95% CI −0.25 to −0.01, p = 0.035).

Table 3: Correlations among core strength, peak expiratory flow rate and total Menopause Rating Scale score (n = 264)

Variables	Coefficient	Unadjusted (95% CI)	p	Adjusted for age and BMI	p
Core strength and PEFR	Spearman rho	0.55 (0.44 to 0.64)	<0.001	0.53	<0.001
Core strength and total MRS score	Spearman rho	−0.14 (−0.25 to −0.02)	0.026	−0.12	0.047
PEFR and total MRS score	Pearson r	−0.13 (−0.25 to −0.01)	0.035	−0.09	0.151

CI, confidence interval; PEFR, peak expiratory flow rate; MRS, Menopause Rating Scale; BMI, body mass index. Adjusted values are partial rank (Spearman) correlations controlling for age and BMI.

Spearman's correlation of PEFR with total MRS score was −0.11 (p = 0.079). After adjustment for age and BMI, the correlation between core strength and PEFR remained moderate (0.53, p < 0.001), that between core strength and total MRS score was −0.12 (p = 0.047) and that between PEFR and total MRS score was −0.09 (p = 0.151).

DISCUSSION

In this cross-sectional study of 264 women aged 41 to 48 years, core strength was moderately and positively correlated with PEFR and both measures showed weak inverse correlations with the severity of menopausal symptoms.

Most women were overweight or obese by Asian criteria, and one fifth had a Waist-Hip Ratio in the at-risk range. Increases in weight and waist circumference with age have been reported in Indian women and may reflect hormonal changes around the menopause.[3] Because the study had no comparison group, it cannot show whether body composition in these women differs from that of premenopausal women.

The mean total MRS score of 18.8 placed most women in the severe category of the scale. Joint and muscular discomfort was the most frequent complaint, reported by 95.8% of women and rated moderate or worse by 81.1%. Joint and muscle pain has repeatedly been reported as a leading complaint among Indian and Asian perimenopausal women, [6,37,38] and several contributing factors are plausible, including obesity, low physical activity and falling oestrogen levels, although none was examined here. A smaller study of 61 perimenopausal women reported a lower mean MRS score (15.1 ± 5.8), with somatic and psychological symptoms more common than urogenital symptoms and with sleep problems and joint discomfort the most frequent somatic complaints, which is in line with the present profile.[27] That study classified scores of 12 to 35 as mild to moderate and 36 or more as severe, so its categories cannot be compared directly with the conventional cut-offs used here. Psychological symptoms were also very common, in keeping with descriptions of the perimenopause as a window of vulnerability for depression; [9,10] however, because the MRS is self-reported and midlife stressors also influence mood and irritability, these symptoms cannot be attributed to the menopausal transition alone. Vasomotor symptoms were less often moderate or worse (hot flushes, 31.8%) than psychological and joint complaints. Reported prevalence of hot flushes in Indian studies varies widely, from 19% in Mumbai [39] to higher figures in northern India,[40] so the present findings fit within the regional variation. Urogenital symptoms were the least frequent, which agrees with evidence that vaginal dryness and other sexual symptoms become more prevalent later, in the postmenopause.[41]

About half of the women (51.9%) did not achieve a successful transversus abdominis contraction on pressure biofeedback. No reference values exist for perimenopausal women, and the pressure biofeedback unit assesses the ability to activate the muscle rather than overall core strength, so this finding should be interpreted cautiously. Muscle mass and strength decline with age, and oestrogen has trophic effects on skeletal muscle,[13] so weaker trunk muscle function could contribute to the high frequency of musculoskeletal symptoms, including low back pain, reported by women after the menopause. [11,12] The present design cannot confirm this, and without a premenopausal comparison group it is not possible to say that core weakness is specific to the menopausal transition. A smaller study reported a mean pressure biofeedback reading of 6.3 ± 2.6 mmHg, with most women above 6 mmHg,[27] which is considerably higher than here. That study, however, took a drop of 6 to 10 mmHg as a proper contraction, whereas the 4-mmHg threshold used here is the lower limit given by the manufacturer, so the values and thresholds of the two studies are not directly comparable.

The mean PEFR was 291 L/min, close to the mean of 309.5 ± 52.7 L/min reported in 61 perimenopausal women,[27] and no woman fell in the green zone. However, the zones used here were defined by absolute cut-offs and not as a percentage of predicted or personal best values, and the results should therefore not be read as evidence of airway obstruction. Lower lung function has been described after menopause, [18-20,22] and proposed mechanisms include effects of oestrogen and progesterone on airway and respiratory drive,[21] reduced thoracic bone density [21] and systemic inflammation,[18] but our design could not test these explanations.

The moderate positive correlation between core strength and PEFR (rho = 0.55) is biologically plausible. Forced expiration involves contraction of the abdominal wall, which reduces abdominal circumference,

raises intra-abdominal pressure and pushes the diaphragm upwards,[23,24] and transversus abdominis is recruited early as expiratory effort increases.[25] Our result is similar to the correlation of 0.51 between transversus abdominis strength and PEFR reported in healthy adults,[25] and agrees with reports of relationships between abdominal muscle activity or strength and expiratory flow or pulmonary function in elderly women and in people with low back pain,[23,26] and of high core strength and peak flow in Indian classical singers.[36] It should be noted, however, that both the pressure biofeedback task and peak flow are effort dependent and require the participant to follow instructions and make a maximal voluntary effort, so part of the correlation may reflect shared effort, technique or general fitness and not a direct mechanical link. The cross-sectional design also prevents conclusions about the direction of the association.

The correlations of core strength and PEFR with total MRS score were small. The coefficients of about −0.13 to −0.14 explain less than 2% of the variance in symptom score, the association of PEFR with symptom score was not significant with Spearman's coefficient. These associations should therefore be regarded as hypothesis generating. If real, they could reflect shared effects of oestrogen on muscle and lung, [13,20] or the reverse direction, in which women with more severe symptoms such as pain, fatigue and poor sleep are less active and perform less well on effort-dependent tests. A recent study of 61 perimenopausal women found inverse but non-significant Pearson correlations of MRS score with core strength ($r = -0.17$, $p = 0.18$) and with PEFR ($r = -0.25$, $p = 0.051$).[27] These coefficients are similar in direction and of comparable or somewhat larger magnitude than ours, and the difference in statistical significance probably reflects the much smaller sample (61 vs 264 women). Those authors suggested that a correlation might appear in women with severe symptoms or after the menopause.[27] In the present study, in which most women scored in the severe range by conventional cut-offs, the correlations remained weak, although differences in severity classification between the studies limit this comparison.

Strengths of the study include an a priori sample size calculation, standardised measurement protocols and the combined assessment of symptoms, core muscle function and expiratory flow in the same women. Several limitations should be noted. First, the cross-sectional design and purposive sampling limit causal inference and generalisability. Second, physical activity, occupation, parity and comorbid pain, which may influence both symptoms and muscle function, were not recorded. Third, PEFR was not expressed relative to predicted values. Fourth, the MRS was interviewer administered, and initial hesitation to answer questions because of social taboo in the community setting may have led to under-reporting of some symptoms.

In clinical practice, assessment of transversus abdominis activation and expiratory flow may be worth including in the physiotherapy evaluation of women in the menopausal transition, particularly those with musculoskeletal complaints. Earlier studies have examined the effect of abdominal muscle exercises on PEFR in postmenopausal women [42] and of core exercises on respiratory parameters.[43] Future trials should test whether core stabilisation combined with breathing exercises improves expiratory flow and reduces symptom severity in perimenopausal women, and should include physical activity, occupation, menstrual staging and a comparison group of premenopausal and postmenopausal women.

CONCLUSION

In this study of 264 perimenopausal women, menopausal symptoms were frequent and often severe, led by joint and muscular discomfort and psychological complaints, and about half of the women could not achieve a successful transversus abdominis contraction on pressure biofeedback. Core

strength was moderately correlated with peak expiratory flow rate whereas both measures were only weakly related to the severity of menopausal symptoms. Assessment of core muscle function and expiratory flow may be useful in physiotherapy for women in the menopausal transition, but longitudinal and interventional studies are needed to establish causality and clinical benefit.

Declaration by Authors

Ethical Approval: Approved by the Institutional Ethics Committee [MGM/COP/IERC/2018-19-7/97/2019]; written informed consent was obtained from all participants.

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