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ORIGINAL ARTICLE

Trajectories of mood and stress and relationships with protective factors during the transition to menopause: results using latent class growth modeling in a Canadian cohort

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Abstract The menopause transition is characterized by significant hormonal changes that may predispose women to psychosocial maladjustment. Prospective studies to date have focused primarily on negative mood states and show equivocal findings. The primary goal of this study was to identify patterns of change with respect to positive and negative mood states (vigor, depression, tension, and stress) over a 5-year period in a cohort of women undergoing the transition to menopause. A secondary aim was to determine whether the identified trajectories were associated with menopause status as well as baseline health-related and psychological characteristics. This longitudinal study observed 102 healthy Canadian women who were premenopausal at baseline (age 47–55 years). Analyses consisted of latent class growth modeling. Mood states were predominantly normal and stable, raising doubts regarding the notion that psychosocial distress is a common and natural occurrence during the transition to menopause. Neither time spent in perimenopause nor BMI had a significant influence on levels of mood indicators. However, higher scores on body image, self-esteem, and general health perceptions were predictive of more positive psychological outcomes over the 5-year period. Targeting improvements in self-perceptions may promote a healthier psychological adjustment during this natural transitional period in a women's lifespan.

Keywords Women · Menopause · Mood · Trajectories · Latent class growth modeling

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Introduction

Menopause is characterized by significant hormonal and psychosocial changes. During this natural transitional period, middle-aged women experience a progressive change in ovarian function and in hypothalamic–pituitary–adrenal axis activity that is often accompanied by a multitude of signs and symptoms that may be vasomotor, sexual, somatic, or psychological in nature (Soules et al. 2001; Poomalar and Arounassalame 2013). While the onset of menopause may predispose women to issues related to their well-being and quality of life (Hess et al. 2012), much of the literature on women's mental health during the transition to menopause has taken a disease-risk perspective, focusing on negative physical and mental health consequences. However, the medical community and psychiatric health care providers may be overpathologizing menopause, as the evidence regarding women's mental health during this period remains equivocal (Judd et al. 2012). Overall, there are gaps in the current knowledge base regarding how women, particularly those without any underlying medical conditions, experience the natural transition to menopause and whether they face fluctuations in their psychological health during this time.

Psychological health during the transition to menopause

Mood states have long been thought to serve as a good proxy of psychological health and well-being (Lyubomirsky et al. 2005;

Diener 2006; Guérin 2012). Although there is ongoing debate regarding whether different positive and negative mood states are merely poles along a single continuum (Russell and Carroll 1999), there is sufficient evidence from studies of general health, well-being, and quality of life to warrant the study of both positive and negative psychological dimensions (Dennerstein et al. 2002; Pressman and Cohen 2005).

During the transition to menopause, research has overwhelmingly focused on women's dysfunctional emotional experiences. Several studies have shown that women in perimenopause (i.e., immediately prior—up to 1 year after—menopause) are more likely to exhibit higher levels of depression, stress, and emotional distress than women in pre or postmenopause (Bromberger et al. 2001; Alexander et al. 2007; Tangen and Mykletun 2008; Bromberger et al. 2010). Conversely, Ward-Ritacco et al. (2015) revealed that the proportion of women aged between 55 and 64 years reporting high stress and depressive symptoms was minimal, finding instead that mean vitality scores were higher than 2005 normative values for both adults and women of this age category. In some longitudinal studies, psychological characteristics including anger, depression, perceived stress, and positive mood evaluations did not change over time in middle-aged women (Matthews et al. 1990; Dennerstein et al. 2002). In one study, negative mood states were actually found to decline over time irrespective of women's menopausal status (Dennerstein et al. 2000). There is also evidence of a certain chronicity to negative mood states, such that baseline levels of anxiety and depression for instance may impact the susceptibility to experience a worsening in psychological health during the transition to menopause (Bromberger et al. 2013).

In sum, the results of cross-sectional and longitudinal studies paint a mixed, albeit not altogether, morbid portrait of middle-aged women's psychological health during the transition to menopause. Still, there is a shortage of current prospective data, particularly in regards to positive psychological states. Moreover, to our knowledge, few studies have utilized complex analyses such as latent growth modeling to dissect natural patterns of change in different mood states over the course of this natural transition period.

The transition to menopause: individual variability

Furthermore, literature to date seems to suggest that not all women respond to, or experience, the transition to menopause in the same way. We know that patterns of mood states are subject to much variability between individuals and over time (Airila et al. 2013) and therefore it would be pertinent to try and classify women into a smaller number of clusters based on the mood states they experience over time. Specifically, more prospective research is needed among healthy women during menopausal years to determine unique patterns of positive *and* negative psychological changes over time and whether these patterns are tied to menopausal status. To this end, person-centered analytical techniques, such as latent class growth modeling, may be a compelling approach that can optimally represent individual heterogeneity in the evolution of psychological health over time.

There is some empirical research to support this perspective. One longitudinal study of Australian women over a 14-year period showed that vasomotor symptoms peaked in postmenopause, but several symptom clusters (e.g., somatic) were stable throughout mid-life (Mishra and Dobson 2012). Patterns of mood symptoms specifically were not examined by the authors. On the other hand, a similar study in a large British cohort aged between 48 and 54 years revealed that most women held a primarily flat trajectory of mild to moderate psychological symptoms, with only 10% of women experiencing very severe symptoms (Mishra and Kuh 2012). However, Mishra and Kuh (2012) consolidated various mental health measures into one broad psychological dimension, making no distinction between different mood outcomes including positive states. Furthermore, the investigators did not test whether there were any links between the symptom profiles and baseline personal characteristics that could influence psychological trajectories during the transition to menopause.

A healthy transition to menopause: risk and protective factors

The transition to menopause results from a complex interaction of internal (i.e., physiological, psychological) and external factors (i.e., social) factors which has led experts to consider a biopsychosocial perspective to understand women's symptoms and experiences (Dennerstein et al. 2002; Thurston et al. 2008). In this regard, it can be important to consider other health-related factors such as age and body mass index (BMI) that can interact with key hormonal and social changes and contribute to psychological health during this period. On the one hand, findings of age-related declines in stress and mood are not unanimous (e.g., Gold et al. 2000; Bromberger et al. 2003). There is evidence that age and BMI are positively related to heightened menopause symptoms, disrupted sleep patterns, as well as changes in lifestyle factors during the transition to menopause (e.g., physical activity), which in turn can have an effect on women's mood (Gold et al. 2000; Darling et al. 2012). There is some epidemiological data to support a strong association between BMI and common mental disorders (McCrea et al. 2012) while the SWAN study revealed that BMI was associated with significantly greater odds of a major depressive episode during annual follow-ups across the menopause transition (Bromberger et al. 2011). On the other hand,

the nature and extent of the association between BMI and *positive* mood indicators such as vigor or vitality are also unclear (Coakley et al. 1998; Ward-Ritacco et al. 2015), although higher BMI has been tied to issues such as body image disturbances which can precipitate feelings of stress and depression and influence overall psychological health (e.g., Ginsberg et al. 2016).

Indeed, how women feel about their body and themselves could serve as potential protective factors at the onset of the transition to menopause, but relatively few studies have been conducted on this topic (Tiggemann 2004). Existing evidence suggests that body dissatisfaction may be common in middle-aged women (Allaz et al. 1998), which could be particularly salient during premenopause, a period when low levels of satisfaction with one's body have been inversely associated with factors such as general self-esteem and mental health indicators (Webster and Tiggemann 2003; McLaren et al. 2003). Self-esteem is itself associated with depression and anxiety (Sowislo and Orth 2013). Specifically, low self-esteem can predict experiencing distress in relation to symptoms of menopause such as hot flashes and may be intricately related to overall health as well as perceived stress and mood during this transitional period (Hunter and Rendall 2007).

Still, research findings to date must be interpreted with caution, as there is significant variability in regard to the populations under study (i.e., overweight, smokers, chronic disease (s), etc.), with evidence that generally "healthy" women may experience an advantage when it comes to psychological health during the transition to menopause (Matthews et al. 1990; Judd et al. 2012). Therefore, it may also be worthwhile to examine women's perceived general health as an independent protective factor of changes in mood during the transition to menopause (Hess et al. 2012).

The present study

The primary purpose of this study was to use latent class growth modeling to identify patterns of change with respect to positive as well as negative mood states (i.e., vigor, depression, tension, and stress) over a 5-year period in a cohort of women undergoing the transition to menopause. A secondary purpose was to (a) explore whether the identified mental health trajectories were associated with menopause status, specifically time (in years) spent in perimenopause; and (b) determine the extent to which baseline (premenopause) health-related and psychological characteristics, namely age, BMI, body satisfaction, self-esteem, and general health perceptions, predict these trajectories. We hypothesized that number of years in perimenopause as well as higher age and BMI and lower body satisfaction, self-esteem, and health would predict less favorable trajectories.

Materials and methods

Participants and procedures

This study was conducted with a convenience sample of 102 healthy Canadian women enrolled in a 5-year longitudinal investigation of the menopausal transition. The larger project sought to document changes in body composition, cardiometabolic risk factors, and a wealth of psychosocial indices throughout this transition period (Abdulnour et al. 2012). All women were premenopausal during the recruitment phase of the study [i.e., two menstruations in the last 3 months, no increase in cycle irregularity in the 12 months before testing, and a plasma follicle-stimulating hormone (FSH) level of <30 IU/L (Soules et al. 2001)]. In addition, women were recruited between the ages of 47 and 55 years as it was expected that by the end of the study, most women would become postmenopausal. Additional inclusion criteria included the following: no surgically-induced menopause, nonsmoker, BMI between 20 and 29.9 kg/m^2, and self-reported weight stability (±2 kg) for at least 6 months prior to enrollment. Characteristics that provided grounds for exclusion were the following: (1) pregnancy or having plans to become pregnant, (2) medical problems such as cardiovascular and/or metabolic diseases with the potential to interfere with the primary outcome variables, (3) oral contraceptives' use or hormone therapy, (4) high risk for hysterectomy, and (5) history of drug and/or alcohol abuse.

Recruitment for this study consisted of community advertising and medical clinic referrals, primarily through posters in waiting rooms and descriptive pamphlets made available in physician offices. Out of a total of 314 women who responded to this recruitment strategy, 212 women were excluded based on ineligibility and/or refusal to continue with the protocol. Eligible women (n = 102) were invited to attend several screening and assessment visits at year 1 of the study (baseline) followed by annual in-person visits in years 2 to 5. In addition to annual body composition and physiological measurements, the women responded to psychosocial questionnaires as described below. For those women still experiencing regular menstrual cycles, annual measurements were consistently taken in the first 8 days of the follicular phase. Changes in menstrual cycles were monitored throughout each year of the study via telephone follow-ups and postcards and confirmed annually by the study physician. Women who reported no change in menstrual frequency were classified as premenopausal. Those who observed changes in menstrual frequency and/or no menstrual bleeding for 3 to 11 months were categorized as perimenopausal while those who reported 12-months of amenorrhea were classified as postmenopausal (Soules et al. 2001).

This study was approved by the appropriate hospital and university research ethics boards. All participating women

provided written informed consent. Further information regarding the study protocol, as well as other measurements and findings pertaining to cardiovascular factors and menopause-specific symptoms, are available elsewhere (Abdulnour et al. 2012; Abdulnour et al. 2016).

Measures

Demographics A short socio-demographic questionnaire inquired about women's age, race, marital status, employment, and income, among other lifestyle variables. Women's BMI was calculated as body weight (kilograms) over height (square meters) using measurements obtained each year using a BWB-800AS digital scale and a Tanita HR-100 height rod.

Mood and stress Three subscales of the Profile of Mood States-short form (POMS-SF) (Shacham 1983) in addition to the Perceived Stress Scale (PSS) (Cohen et al. 1983) were used to assess vigor, tension, depression, and stress. The POMS is a popular, reliable, and valid instrument to measure mood states. The questionnaire has been used extensively among adult women and it demonstrated good psychometric properties in a validation study with postmenopausal women (Wyrwich and Yu 2011). For the purposes of this study, participants were asked to indicate their level of agreement with 18 adjectives (6 items each for vigor, depression and tension) on a five-point scale ranging from 0 (not at all) to 4 (extremely). Responses to items were summed by subscale to provide total scores between 0 and 24 with higher values designating higher levels of the mood state. Estimates of reliability in this study were good for all subscales as revealed by alpha values ranging from .79 (depression year 4) to .95 (vigor year 5). The PSS-14 was used to evaluate women's experience of stress. The 14 items are rated on a five-point Likert-type scale from 0 (never) to 4 (very often) which are summed to derive a final score. The scale demonstrated good concurrent validity in this study (yearly Cronbach's alpha range: .87 to .90).

Self-esteem General feelings of self-worth were assessed using the Rosenberg Self-Esteem (RSE) Scale (Rosenberg 1965). The RSE is a validated instrument that is used in different populations and is frequently employed in studies with women (e.g., (Elavsky and McAuley 2007a). Using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), participants respond to 10 items that tap general or typical feelings about themselves. Ratings were summed to provide total scores ranging from 10 (low) to 40 (high). Cronbach's alpha coefficients each year indicated good internal consistency in this study (range: .86 to .90).

Body satisfaction Body satisfaction was assessed using the Body Esteem Scale (BES) (Mendelson et al. 2001). The BES consists of 23 items that measure general satisfaction with one's appearance along two dimensions: satisfaction with weight and attributions (evaluations attributed to others about one's body and appearance). Responses to items that include "My weight makes me unhappy" are scored on a five-point Likert scale from 0 (never) to 4 (always). Similar to previous research (Prichard and Tiggemann 2008), a sum of all 23 items was computed for an overall representation of women's satisfaction with their bodies. In this study, reliability values for the scale at each time point were high, with alpha's ranging from .89 to .93.

General health perceptions The Medical Outcomes Study Short Form Health Survey (SF-36) (Ware 1993) is a common measure of health-related quality of life (QOL) across different domains of functioning. We used the 5-item general health perceptions subscale of the SF-36 to obtain a global evaluation of women's own health. The original coding scheme was used whereby raw scores for each item were converted to a 0–100 range and then averaged, with low scores representing worse self-perceived health.

Statistical analyses

Prior to analysis, the data were entered into SPSS statistic 21 software (IBM Corp) and screened for severe violation of assumptions following established procedures outlined by Tabachnick and Fidell (2007). Descriptive statistics were computed, including intraclass correlations for mood variables.

Mood trajectories We used latent class growth modeling (Nagin 1999) to identify distinct mood/stress trajectories in this sample of women. Latent class growth analysis is a semiparametric approach that can detect subgroups of people (participants) that follow different patterns of change over time. This person-centered technique is ideally suited for longitudinal data, where applying a single set of parameters (intercepts, slopes) may not adequately characterize the data (Muthén and Muthén 2000; Nagin 2005). For this study, a series of latent class growth model analyses were conducted using the MPLUS 7.0 software. Maximum likelihood (ML) estimation was used, which is suited to account for possible non-normality and missingness of the data. We followed the steps suggested by Andruff et al. (2009) for testing the shape and number of subgroup trajectories. Specifically, a model was tested for each mood indicator wherein a latent intercept (e.g., year 1 vigor) followed by latent slope growth factors (i.e., change in vigor over 5 years) were specified. Models were fitted by testing linear and quadratic trends for each trajectory on consecutive models ranging from one to four classes. Linear parameters were retained while non-significant quadratic terms were removed.

Several criteria were used to determine the best fitting classification models for each mood indicator. We compared the

Akaike Information Criterion (AIC) as well as the Bayesian Information Criteria (BIC) whereby superior models demonstrate lower values. We also consulted the bootstrapped likelihood ratio test obtained using Tech 14 in Mplus. Significant results for this test are indicative that a model with *k*-classes is a better fit than one with (*k*-1) classes. We looked for entropy values closer to 1 and latent class probabilities >.8 (Geiser 2012). Lastly, and most importantly, we looked for parsimony and set a minimum group size of 10% similar to (Sabiston et al. 2013) given concerns about the replicability and interpretability of small trajectories and their utility in further analyses. For each mood indicator, participants' highest estimated posterior probabilities were used to assign them to a subgroup (Nagin 1999).

Trajectory predictors (covariates) Time spent in perimenopause was defined as the number of years recorded in this stage of menopause over the 5-year study period (continuous variable ranging from 0 to 4). Perimenopause was selected as the menopause status of interest in this study given evidence presented herein about the potential risk of psychological disturbances in perimenopause compared to pre and postmenopause. In addition, the size of the sample, in particular the low proportion of women in each status at given time points (e.g., few premenopause at year 5), precluded the use of complex time-varying covariate modeling of menopause status. In regard to health and psychological trajectory predictors, year 1 levels were used to maintain consistency, to optimize available data, and given that *all* women were premenopausal at this time.

To examine the effect of menopause status (i.e., time in perimenopause) as well as the impact of baseline (year 1) health and psychological predictors of latent class membership, the Mplus auxiliary (r3step) command was used. Otherwise known as the "Modal ML" method (Vermunt 2010), this three-step approach incorporates measurement error and produces less-biased estimates than traditional approaches. Moreover, the r3step command circumvents any impact from the predictor on the measurement model, thereby retaining original classifications (Asparouhov and Muthén 2014). Result estimates are presented as odds ratios with 95% confidence intervals (95% CI).

Results

Descriptives

Table 1 presents descriptive statistics for the main study variables. The average age at baseline (i.e., year 1) was 49.85 years (SD = 1.90). The women demonstrated a healthy BMI at year 1 which was maintained across time points. At year 2, two thirds of the women had reached perimenopause and half were still in perimenopause in year 4. By year 5, two thirds of the sample was in postmenopause and less than one fifth was still in premenopause. Over the course of the study, the average amount of time spent in perimenopause (across all participants who were perimenopause and postmenopause at year 5) was 1.97 years (SD = 1.06) with a range from 0 to 4. At baseline, general health perceptions were relatively high while self-esteem and body satisfaction were in the moderate to high range. Although not examined statistically in this study, values between years 2 and 5 suggest there may be a quadratic trend for general health and stability of self and body esteem over time. Scores for vigor were high and stable over the 5-year period. Stress perceptions scores were moderate and stable

Table 1 Descriptive statistics presented as *n* values, percentages (%), means, and standard deviations (SD)

	Year 1	Year 2	Year 3	Year 4	Year 5
N	102	96	95	90	91
Age	49.85 (1.90)	50.97 (1.92)	52.03 (1.91)	53.04 (1.91)	54.02 (1.89)
Menopause status					
Premenopause, *n* (%)	102	35 (36.5%)	19 (20.0%)	7 (7.8%)	4 (4.4%)
Perimenopause, *n* (%)	0	60 (62.5%)	59 (62.1%)	45 (50.0%)	26 (28.6%)
Postmenopause, *n* (%)	0	1 (1.0%)	17 (17.9%)	38 (42.2%)	61 (67.0%)
BMI (kg/m^2)	23.26 (2.22)	23.16 (2.35)	23.36 (2.41)	23.41 (2.70)	23.33 (2.70)
Mood indicators					
Vigor (0–24)	14.17 (3.97)	14.11 (5.12)	14.02 (4.69)	15.18 (4.14)	14.51 (5.28)
Depression (0–24)	2.45 (3.10)	2.54 (3.03)	2.29 (2.78)	2.06 (2.40)	2.13 (2.59)
Tension (0–24)	5.64 (4.60)	5.65 (4.04)	5.65 (3.91)	5.87 (3.93)	5.73 (4.55)
Stress perception (0–56)	19.30 (7.41)	19.67 (7.63)	19.75 (7.48)	18.64 (6.79)	19.56 (7.25)
General health perceptions (0–100)	83.88 (12.83)	82.43 (13.36)	85.03 (13.71)	84.30 (12.32)	81.91 (12.32)
Self-esteem (10–40)	23.55 (4.47)	23.30 (4.66)	23.87 (4.51)	23.44 (4.61)	23.68 (4.22)
Body satisfaction (0–92)	55.44 (9.06)	54.53 (9.20)	55.16 (9.74)	54.46 (10.25)	54.50 (9.92)

BMI body mass index

while tension and depression scores were fairly low and did not waver much from years 1 through 5. Intraclass correlations ranged from 0.45 (depression) to 0.61 (stress).

Mood trajectories

Growth models with one to four classes were tested for each mood indicator. Tables 2 and 3 provide a comparison of fit indices for the models tested. As there were no significant quadratic trends across models, for simplicity, only linear trends are presented. Figure 1 presents estimated and sample means for the final trajectories in the retained growth models.

For vigor, a two-class solution was deemed appropriate (model 1b; Table 2). Despite the higher fit indices and high entropy of the three-class model (model 1c), there were only seven participants in a low vigor class. The same observation was made for a four-class solution and therefore neither was retained for further interpretation. Based on final class counts and proportions based on estimated posterior probabilities, over half (63%) of participants belonged to a high vigor trajectory that increased significantly though not steeply over

Table 2 Latent class growth modeling results for vigor and depression

	Class 1	Class 2	Class 3	Class 4	AIC	SSBIC	BIC	Entropy	BLRT LR Δ
1. Vigor									
Model 1a *N*	99				2748.15	2744.21	2766.31	–	–
Intercept	14.07 (0.34)†								
Slope	0.19 (0.15)								
Model 1b *N*	*62*	*37*			2603.96	2598.33	2629.92	.836	150.183, $p < .0001$
Intercept	*16.27 (0.43)*†	*10.70 (0.72)*†							
Slope	*0.29 (0.14)**	*−0.05 (0.20)*							
Model 1c *N*	48	44	7		2563.45	2556.14	2597.19	.842	46.51, $p < .0001$
Intercept	16.74 (0.59)†	12.35 (0.80)†	8.31 (1.41)†						
Slope	0.41 (0.14)**	0.07 (0.16)	−0.82 (0.70)						
Model 1d *N*	22	41	31	5	2549.03	2540.023	2590.552	.792	20.424, $p < .0001$
Intercept	18.48 (0.59)†	14.98 (0.57)†	10.86 (0.90)	8.98 (1.74)					
Slope	0.27 (0.22)	0.25 (0.20)	0.25 (0.26)	−1.40 (0.57)*					
2. Depression									
Model 2a *N*	99				2274.17	2270.22	2292.33	–	–
Intercept	2.52 (0.24)†								
Slope	−0.11 (0.09)								
Model 2b *N*	*76*	*23*			2148.24	2142.62	2174.20	.865	131.92, $p < .0001$
Intercept	*1.40 (0.56)*†	*5.99 (1.12)*†							
Slope	*−0.04 (0.11)*	*−.35 (0.27)*							
Model 2c *N*	67	29	3		2086.54	2079.30	2120.273	.909	67.71, $p < .0001$
Intercept	1.18 (0.21)†	5.00 (0.62)†	7.82 (1.42)†						
Slope	−0.05 (0.07)	−0.37 (0.21)‡	0.65 (0.45)						
Model 2d *N*	65	28	4	4	2066.17	2107.69	2057.16	.919	26.37, $p < .0001$
Intercept	1.13 (0.21)*	3.96 (0.38)†	10.48 (0.97)†	8.02 (1.32)†					
Slope	−.05 (0.07)	−0.08 (0.17)	−2.13 (0.52)†	0.60 (0.41)					

Intercept and slopes (linear) are presented as estimates (standard errors of the estimate). Models a, b, c, d represent an increasing number of classes. Italicized model is retained for further analyses

AIC Akaike information criterion, *SSBIC* sample-size adjusted Bayesian information criteria, *BIC* Bayesian information criteria, *BLRT* bootstrap likelihood ratio test

*$p < .05$; **$p < .01$; † $< .001$; ‡$p < .10$

Table 3 Latent class growth modeling results for tension and perceived stress

	Class 1	Class 2	Class 3	Class 4	AIC	SSBIC	BIC	Entropy	BLRT LR Δ
3. Tension									
Model 3a *N*	99				2656.36	2652.419	2674.53	-	-
Intercept	5.62 (0.35)†								
Slope	0.05 (0.15)								
Model 3b *N*	*73*	*26*			2528.94	2523.31	2554.89	.859	133.42, $p < .0001$
Intercept	*4.15 (0.43)*†	*9.76 (2.41)*†							
Slope	*−0.02 (0.24)*	*0.09 (0.56)*							
Model 3c *N*	53	40	6		2469.60	2462.28	2503.34	.862	65.34, $p < .0001$
Intercept	3.26 (0.51)†	7.33 (0.52)†	15.29 (1.20)†						
Slope	−0.01 (0.16)	0.13 (0.22)	−0.61 (0.50)						
Model 3d *N*	34	42	5	18	2464.16	2455.15	2464.16	.789	11.44, $p = .01$
Intercept	2.10 (0.86)*	5.64 (0.59)†	15.75 (1.31)†	9.34 (1.18)†					
Slope	0.21 (0.29)	0.004 (0.24)	−0.66 (0.65)	−0.15 (0.43)					
4. Stress									
Model 4a *N*	100				2814.83	2810.95	2833.06	–	–
Intercept	19.46 (0.60)†								
Slope	−0.04 (0.25)								
Model 4b *N*	70	30			2683.19	2677.66	2709.24	.738	138.134, $p < .0001$
Intercept	16.19 (1.34)†	25.78 (5.77)†							
Slope	−0.12 (0.34)*	0.13 (0.64)							
Model 4c *N*	*48*	*41*	*11*		2624.97	2617.77	2658.84	.814	64.225, $p < .0001$
Intercept	*14.21 (0.82)*†	*22.21 (0.86)*†	*31.87 (2.29)*†						
Slope	*0.07 (0.25)*	*−0.15 (0.26)*	*−0.28 (0.84)*						
Model 4d *N*	45	41	10	4	2615.695	2606.85	2657.38	.812	15.273, $p < .0001$
Intercept	13.96 (0.84)†	21.57 (0.95)†	28.84 (3.17)	33.31 (3.13)					
Slope	0.09 (0.26)	−0.20 (0.26)	−0.68 (0.97)	0.72 (1.27)*					

Intercept and slopes (linear) are presented as estimates (standard errors of the estimate). Models a, b, c, d represent an increasing number of classes. Italicized model is retained for further analyses

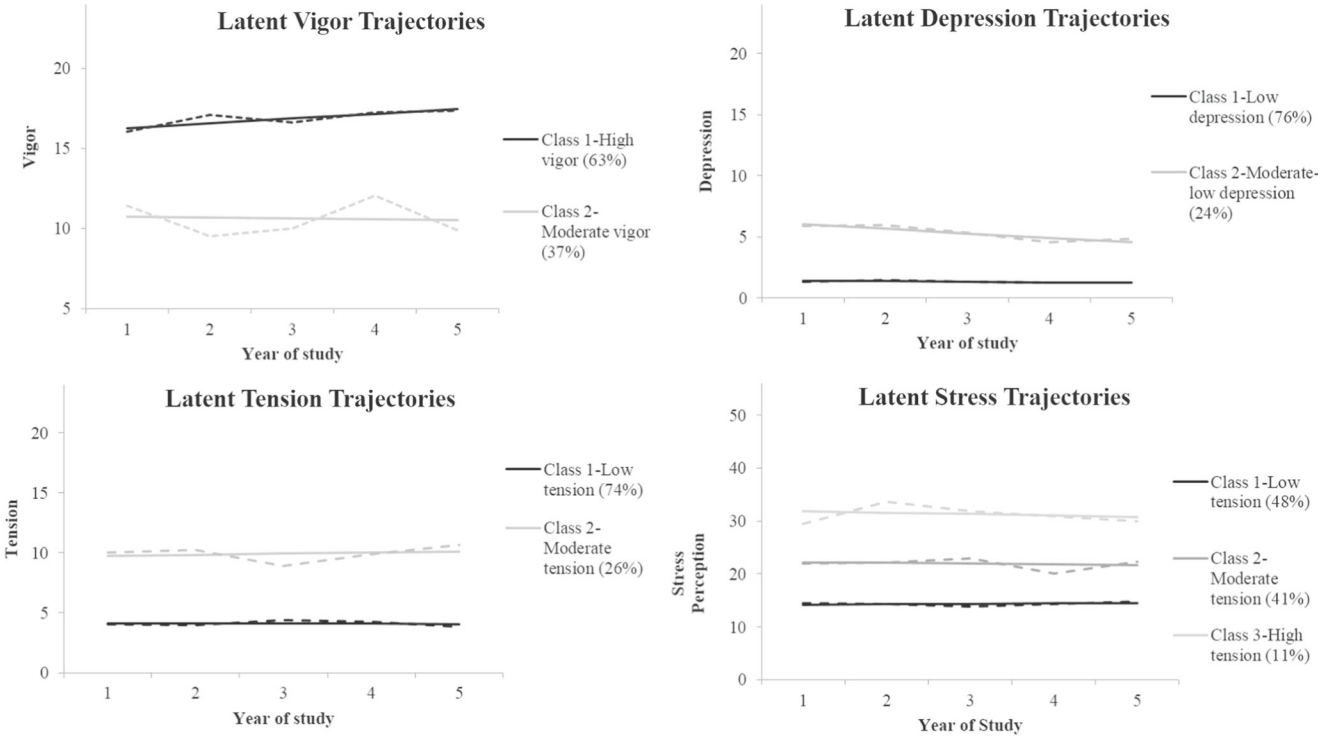
AIC Akaike information criterion, *SSBIC* sample-size adjusted Bayesian information criteria, *BIC* Bayesian information criteria, *BLRT* bootstrap likelihood ratio test

*$p < .05$; **$p < .01$; † < .001; ‡ $p < .10$

time (slope $p = .03$). The remaining 36% of the women started with moderate vigor in year 1 which was maintained into year 5 (slope $p = .82$) despite a significant drop in vigor by year 2 and a rise again in year 4.

Regarding depression, the size of the higher order classes, which were characterized by high and declining levels of depression, was too small to draw valid interpretations (models 2c-2d; Table 2). A two-class model (model 2b), which revealed a better fit than a single group model, was retained. The two main trajectories that emerged both showed relatively low scores for depression, the first which comprised three-quarters of the sample showed stable and nearly negligible levels of depression over time. The second trajectory was slightly higher in depression with scores that were likewise stable over time (slope $p = .19$); this cluster was labeled as mild depression for the purposes of this study.

For tension, although the three- and four-class models successively improved model fit, the negligible size of high tension trajectories ($n \leq 6$) again rendered interpretation and follow-up analyses difficult. The two trajectory model was retained (model 3b; Table 3). Final class counts revealed that the first trajectory represented a large group of women (74%)



Note. Dashed lines represent sample trajectory means; solid lines represent estimated trajectory means.

Fig. 1 Final trajectories for vigor, depression, tension, and stress perception over a 5-year observational period. *Dashed lines* represent sample trajectory means; *solid lines* represent estimated trajectory means

with low levels of tension that remained stable over time (p = .94). Women in the second trajectory showed moderate levels of tension with a slight drop in year 3, albeit the overall slope of the trajectory was not significant (p = .87) which indicates stability in regard to tension.

With respect to perceived stress, a three-class solution was retained (model 4c; Table 2) as it demonstrated significant improvement in model indices from a two-class solution. As shown in Fig. 1, all three trajectories were characterized by stable stress perceptions over 5 years. Almost half of the women (48%) belonged to a low-stress class, whereas 11% of women were classified as high stress. The remaining sample fell into a moderate stress trajectory that exhibited a small dip in stress levels in year 4 compared to years 3 and 5.

Trajectory predictors

Perimenopause Time spent in perimenopause was not significantly associated with trajectory membership for vigor, depression, tension, or stress. Specifically, results using the r3step method on the derived trajectories showed that number of years in premenopause was *not* significantly associated with belonging to the following: a higher versus a moderate vigor profile (OR = 1.15, 95% CI: 0.72–1.85, z = 0.59, p = 0.55); a lower depression trajectory (OR = 0.89, 95% CI: 0.50–1.60, z = −0.37, p = 0.71); and a lower tension profile (OR = 0.85, 95% CI: 0.50–1.46, z = 0.58, p = 0.56). Similarly, belonging to a high versus moderate stress (OR = 1.42, 95% CI: 0.62–3.28, z = 0.83, p = 0.40) or a high versus low stress trajectory (OR = 1.22, 95% CI: 0.56–2.67, z = 0.51, p = 0.61) was not predicted by time spent in perimenopause over the course of the study.

Health and psychological predictors (year 1) Odds ratios and confidence intervals for the logistic regression analyses using the r3step method on the derived trajectories are presented in Table 4. Age at the start of the study was not a significant predictor of trajectory classification across vigor, depression, and tension (p values >.05) with the exception of stress, whereby women who were older were more likely to be classified as following a course of moderate stress versus high stress (z = 2.05, p = .041). As can be seen in Table 4, the direction of the relationship between BMI and mood profiles was variable and did not reach statistical significance. General health perceptions were a significant predictor of latent trajectories. Specifically, women with better overall perceptions of health were at greater odds of being in the high vigor compared to the moderate vigor trajectory (z = 2.01, p = .044). They were also more likely to belong to the low depression group (z = 2.94, p = .003) as well as the low stress group (z = 2.72, p = .006).

Table 4 Odds ratios and 95% Confidence Intervals for associations between predictors measured at year 1 and latent class membership

	Vigor	Depression	Tension	Stress perception	
	High vigor (Class 1)	Low depression (Class 1)	Low tension (Class 1)	Low stress (Class 1)	Moderate stress (Class 2)
Age	0.88 (0.69–1.12)	0.99 (0.78–1.26)	1.11 (0.84–1.46)	1.23 (0.83–1.81)	1.51 (1.02–2.25)*
BMI	0.84 (0.67–1.05)	1.07 (0.83–1.38)	1.06 (0.83–1.29)	0.78 (0.52–1.16)	0.73 (0.46–1.17)
General health perceptions	1.04 (1.00–1.08)*	1.06 (1.02–1.10)*	1.02 (0.98–1.07)	1.08 (1.02–1.08)**	1.04 (0.98–1.11)
Self-esteem	1.06 (0.96–1.18)	1.26 (1.09–1.45)*	1.11 (0.99–1.26)	1.40 (1.09–1.79)**	1.14 (0.93–1.41)
Body satisfaction	1.06 (1.01–1.10)*	1.05 (1.00–1.05)*	1.04 (0.99–1.09)‡	1.09 (1.02–1.17)*	1.05 (0.98–1.12)

Vigor comparison class moderate vigor (class 2), *Depression comparison class* low depression (class 2), *Tension comparison class* moderate tension, *Stress perception comparison class* high stress (class 3)

*$p < .05$, **$p < .01$, ‡$p < .10$

Self-esteem was significantly associated with depression and perceived stress trajectories. In particular, women who reported higher levels of self-esteem at the start of the study (year 1) were more likely to belong to the low depression profile ($z = 3.12$, $p = .002$) and more likely to be classified as displaying low stress ($z = 2.65$, $p = 0.008$) and moderate stress (results not shown, OR = 1.22, 95% CI: 1.05–1.42, $z = 2.56$, $p = 0.01$) profiles compared to a high stress profile. Lastly, body satisfaction was a significant predictor of latent mood trajectories, with the exception of tension where this association approached significance (z = 1.670, $p = 0.095$). Notably, women who reported greater body satisfaction in year 1 of the study, when all were premenopausal, were more likely to follow a high vigor ($z = 2.312$, $p = 0.021$) and a low depression trajectory as well as a low compared to a high perceived stress trajectory ($z = 2.50$, $p = 0.012$).

Discussion

The current study is the first to use latent class growth modeling to examine prospective trajectories of positive and negative mood states in women going through the transition to menopause, with a secondary aim of identifying risk and protective factors during this natural transitional period. Our findings indicate that positive and negative mood states remain quite stable throughout the transition to menopause. In addition, the majority of our participants followed trajectories that were characterized by low levels of negative mood overall. Though exploratory, given the small size of this sample, our analyses revealed that time spent in perimenopause was not significantly related to mood profiles. We also found that participants who enter the menopause period at a younger age were more at risk of higher levels of stress. In addition, baseline levels of general health perception, self-esteem, and body satisfaction significantly predicted mood states over time, hinting at a potential protective effect.

On the one hand, our results diverge from those of other studies in the literature. Bromberger et al. (2013) showed that women with low anxiety in premenopause may be more susceptible to high anxiety during and after the transition to menopause while Tangen and Mykletun (2008) found that the perimenopause period resulted in higher depression and anxiety compared to premenopause. In our study, neither participants exhibiting higher nor lower initial levels of tension and depression showed higher levels in subsequent years. Moreover, although a longer perimenopause period may have resulted in a slightly higher likelihood of being classified in a higher tension cluster, the association was not significant. We also found that both trajectories that emerged for depression were relatively low and not associated with perimenopause duration, which contrasts with some evidence that the odds of clinical depression levels are much higher during perimenopause (Weber et al. 2014). On the other hand, our findings are consistent with those of Mishra and Kuh (2012) who identified four *stable* groups of menopause symptoms, including psychological symptoms, similar to the results of Mishra and Dobson (2012) who found stability across various symptom dimensions in mid-life women over 14 years. Similarly, our results compliment those of Matthews et al. (1990) who showed a null effect of the natural menopause transition on mental health consequences in healthy middle-aged women.

While the exclusion of conditions such as hypertension and diabetes in the Matthews et al. (1990) study as well as ours helped diminish possible medical confounds in regard to mood, it does not negate the impact of general health status on emotional functioning during the transition to menopause. Rather, we found that better general health perceptions going into the transition to menopause showed potential for being an important protective factor given they were related to higher vigor and lower depression as well as tension. Therefore, we agree with others that clinicians should be working to improve and preserve components of women's quality of life including general health prior to menopause rather than waiting for

symptoms to erupt in at-risk women (Hess et al. 2012). Such an approach may safeguard not only against some of the physical symptoms of menopause but also offer resilience vis-à-vis the many psychosocial factors (e.g., hassles, life stress, work satisfaction) which may impact mid-life women's well-being (Dennerstein et al. 2002; Gordon et al. 2016).

Indeed the various hormonal and social transformations that accompany the transition to menopause can become sources of distress (Darling et al. 2012). Nonetheless, the results of our study showed that over half of participants followed a high and steadily increasing profile for vigor, consistent with the suggestion that overall well-being may actually improve into the later stages of the transition to menopausal (Dennerstein et al. 2002). The stability of a moderate vigor trajectory, which was not influenced by age or time spent in perimenopause, also confirms previous findings and addresses a gap in research examining positive psychological factors over the course of the transition to menopause (Dennerstein et al. 2000).

Possible influences on the observed mood profiles abound, including a body of research linking levels of vigor and vitality as well as negative mood states during the transition to menopause with personal and lifestyle factors, including sleep and physical activity (Slaven and Lee 1997; Elavsky and McAuley 2007b). While physical activity levels were not examined in this study, a higher BMI was associated, though not significantly, with greater odds of being classified as high stress and low vigor. This lack of significance, which was also observed for depression and tension, is consistent with previous research (Han et al. 1998; Ward-Ritacco et al. 2015), yet it may be attributable to low variability for this variable as the majority of participants were of a healthy weight at the start of the study. Nonetheless, the findings are relevant from a Canadian perspective as it is estimated that at least 45% of Canadian women aged 40 to 59 years present with a normal weight (i.e., BMI range 18.5–24.9) (Statistics Canada 2014).

It could also be that women's own perceptions of their bodies and themselves during premenopause, rather than a scaled measure of weight, are particularly relevant for maintaining good psychological health during the transition. We showed that, consistent with the extent literature (e.g., Schneider et al. 2000; Sowislo and Orth 2013), higher self-esteem in premenopause was associated with minimal depression levels and low stress over a 5-year period. This suggests that preventive strategies aimed at improving menopausal women's emotional resilience should begin early and may be best targeted if imbedded within important life spheres such as work and leisure which can contribute to a sense of self-worth. Finally, we saw that higher body esteem predicted lower depression and stress profiles but also higher levels of vigor. As an understudied variable in this population (McLaren et al. 2003), satisfaction with body size and shape may offer protection for premenopausal women via feelings of energy and revitalization as they venture through this period of change.

Vigor specifically, as measured using the POMS, has been linked to indicators of more general well-being over several years (Airila et al. 2013). As a multidimensional measure of emotional functioning, the POMS is sensitive to changes in mood during the transition to menopause (Wyrwich and Yu 2011) and well suited to classify mid-life women into "risky" trajectories that may be precursors to more severe health problems. In addition, researchers have warned about the implications of subsyndromal or minor depression on health and quality of life during menopause (da Silva Lima and de Almeida Fleck 2007; Judd et al. 2012). Examining sub-optimal emotional functioning would be a viable avenue for clinical research as there is controversy about the true incidence of disorders such as depression during the transition to menopause, with accumulating evidence that only a minority of mid-life women actually experience morbid psychological symptoms (Freeman 2010).

Nonetheless, we are cautious in making assumptions about the mental health status of the participants in this study as the POMS remains a generalist tool rather than a comprehensive measure of mood disorder (Kerns and Okonkwo 2010). The lack of normative data makes it difficult to validate whether the difference between the two fairly low depression clusters is clinically meaningful, although five-point differences on the POMS were found to be statistically important in previous research (e.g., Davis et al. 2003). Still, in more at-risk groups of women, clinical levels of depressed mood may be best captured using clinician-administered tools (e.g., Beck Depression Inventory etc.; Beck et al. 1961). In addition, there is evidence that the rate of disorders like depression may be similar to that at other times in a woman's life (Judd et al. 2012) and that a history of depression may be a risk factor for emotional distress during the transition to menopause (Freeman 2010). History of mood and anxiety disorders was not controlled for in this study and should be acknowledged as a weakness.

As another limitation of this study, the influence of menopause status was examined indirectly through time spent in perimenopause, possibly missing certain nuances related to changes in other stages of menopause over time. In addition, we used chronological age at baseline as a predictor rather than the age at which the women achieved menopause (i.e., after 12-months of amenorrhea), which could provide a clearer indication of how clusters and mood changes relate to menopause specifically rather than the course of aging (Mishra and Dobson 2012). Similarly, only baseline levels of other predictor variables were examined. When examining risk and protective factors in future studies, accuracy may be improved by considering values in the final year of premenopause for *each* woman.

In addition, the size and socio-demographic diversity of this sample was small; therefore, statistically, the results need to be interpreted with considerable caution. Moreover, they may not be generalizable to all women transitioning to menopause. Certainly, a larger sample would strengthen the results

of latent trajectory analyses and may give rise to multi-trajectory models with more diverse and varying profiles that are a better fit to the data. Lastly, we cannot rule out the possibility that low variability in outcomes of interest in our sample could have contributed to stability across the variables over time. Given sample size is relatively small and based on convenience, future longitudinal research is needed to determine if these trajectories are replicable with large samples that are more diverse and representative of the population.

These weaknesses were offset by many strengths in this study, notably the use of valid and reliable measures, including the POMS, the SF-36 subscale for general health perception, and the gold-standard Rosenberg Self-Esteem Scale. In addition, as an understudied but sizeable proportion of the Canadian population, the participants in this study were healthy women (i.e., no underlying medical conditions and BMI < 30) which also helped minimize the influence of confounding health conditions (Hernandez and Nunez Rodriguez 2015). Finally, latent class growth analysis is underutilized in this area but its use was well suited for the goals of this study and it strengthened the internal validity of our results. Specifically, mixed findings in the literature suggest that psychological health, and mood in particular, is highly individualized during the transition to menopause; relying on average scores across samples, even in longitudinal designs, can obscure underlying individual variability (Mishra and Dobson 2012).

Future research should extend the findings of this study in regard to diversity, underlying mechanisms, and influences, as well as preventive and treatment strategies. We suggest that researchers replicate the results of this study with a diverse and more representative sample of Canadian women, namely with a more balanced representation of education level and SES as well as race and ethnicity in light of reports of ethnic differences in the rates of menopause symptoms (Gold et al. 2006; Green and Santoro 2009; Im 2009). In this regard, we did not examine vasomotor symptoms such as hot flashes in this study given noted limitations with this data in this cohort (Abdulnour et al. 2016). This shortcoming should be addressed in future studies as there is evidence that changes in mood may be related to the way women perceive these bodily reactions (Freeman 2010; Pérez-López et al. 2014). It would be important to examine how the experience of vasomotor symptoms above and beyond menopause status influences the stability of mood trajectories in a larger cohort. Moreover, recent evidence suggests that depressed mood during menopause may be related to an interaction between life stress and estradiol variability (Gordon et al. 2016), suggesting that future studies also integrate measures of hormonal fluctuations that will result in more multidimensional and sensitive profiling. In this regard, researchers may wish exploit techniques such as dual trajectory analysis (Nagin and Odgers 2010) whereby associations between these other variables and between mood states themselves may be examined.

Lastly, our findings have important implications for health practitioners. We found that a strong sense of self-esteem, body image, and positive perceptions of health may be protective against the development of psychological disturbances during the transition to menopause. Thus, identifying strategies designed to enhance these factors in middle-aged women may promote resilience and a healthier psychological adjustment through this natural period in women's lives.

Conclusions

Menopause is a period of significant hormonal and psychosocial transformation. However, the results of this study reveal stability in psychological health over a 5-year period in midlife women going through the transition to menopause. Protective factors such as good general health and positive self-perceptions should be cultivated ahead of the menopause period.

Compliance with ethical standards

Funding This study was funded by the Canadian Institutes of Health Research (Grant No. T 0602145.02).

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest Eva Guérin, Gary Goldfield, and Denis Prud'homme declare that they have no conflict of interest.

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