**Objective.** To determine the effectiveness of exercise and/or nutrition interventions and to address body weight changes during the menopause transition. **Methods.** A systematic review of the literature was conducted using electronic databases, grey literature, and hand searching. Two independent researchers screened for studies using experimental designs to evaluate the impact of exercise and/or nutrition interventions on body weight and/or central weight gain performed during the menopausal transition. Studies were quality appraised using Cochrane risk of bias. Included studies were analyzed descriptively. **Results.** Of 3,564 unique citations screened, 3 studies were eligible (2 randomized controlled trials, and 1 pre/post study). Study quality ranged from low to high risk of bias. One randomized controlled trial with lower risk of bias concluded that participation in an exercise program combined with dietary interventions might mitigate body adiposity increases, which is normally observed during the menopause transition. The other two studies with higher risk of bias suggested that exercise might attenuate weight loss or weight gain and change abdominal adiposity patterns. **Conclusions.** High quality studies evaluating the effectiveness of interventions targeting body weight changes in women during their menopause transition are needed. Evidence from one higher quality study indicates an effective multifaceted intervention for women to minimize changes in body adiposity.

1. **Introduction**

Twenty-four percent of Canadians are obese and a further 37% are overweight using measured height and weight data from the 2007–2009 Canadian Health Measures Survey [1]. Further, over half (58%) of the Canadian women aged 40 to 59 years are considered overweight or obese [2]. Poor eating habits and physical inactivity contribute to the increasing prevalence of overweight and obese individuals [3]. The majority of middle-aged women do not regularly participate in exercise and/or fail to report healthy nutrition practices such as consuming five or more vegetables and fruits per day [4, 5]. Evidence also suggests a positive trend with aging and weight gain [1]. These trends mark the need to identify...
lifestyle interventions that address these healthy behaviours and their contribution to addressing midlife weight gain in women, to minimize the risks for obesity and related cardiometabolic complications.

In their midlife, women undergo the biologic transition into menopause. This menopause transition is divided into several stages and clinically has been categorized by international criteria developed to help assess women's reproductive stage [6]. The early menopause transition stage is specifically defined by menstrual cycles varying by seven or more days from regular cycles; the next stage is defined by intervals of skipped cycles or amenorrhea of at least 60 days. The third stage begins following the first year without menstruation and is defined as the end of perimenopause; which is then followed by a stage of early postmenopause and lasting up to six years. During the transition, women can experience vasomotor symptoms such as hot flashes and/or night sweats which may continue for five years or more years after the last menstrual period [7]. These symptoms typically occur in women ages 40 to 65 years [8] and are more prevalent in obese women [9, 10]. Other changes that occur during the menopause transition are changes in body composition and increase in abdominal fat mass as well as associated alterations in cardiometabolic risks due to hormone-related decreases in energy expenditure and fat oxidation [7, 11]. Health conditions (or problems) associated with central obesity in women include coronary heart disease, hypertension, type 2 diabetes, cancer, osteoarthritis, and gall bladder disease [12].

Lifestyle interventions to minimize gains in fat mass and changes in body composition and body fat distribution predominantly include exercise and healthy nutrition [13, 14]. Current guidelines recommend (a) assessing factors contributing to overweight (body mass index (BMI) 25–29.9 kg·m−2) and obesity (BMI ≥ 30 kg·m−2) in adults and (b) intervening with counseling and treatment of obesity [15]. Specific interventions include encouraging individuals to set realistic lifestyle goals, referral to weight loss programs, pharmacotherapy, or surgical interventions. Despite these guidelines, it is unclear what effect lifestyle interventions, such as exercise and/or healthy nutrition, have on weight gain, body composition, and/or body fat distribution in women, if performed specifically during the menopause transition stage. While systematic reviews of the literature evaluating interventions to prevent weight gain exist for more broadly defined populations, there are limited studies evaluating interventions for women during this critical midlife menopausal transition stage. Furthermore, the sequel of the menopause transition stage are often including increases in fat mass and abdominal adiposity and the associated risks of developing cardiometabolic complications are greater compared to the other periods in a women's life, when there are also significant hormone changes (e.g., menarche and pregnancy) [16].

Ultimately, this review was conducted to provide a synthesis of current evidence and identify gaps in the knowledge around effective exercise and nutrition interventions that address body weight and body composition changes in women specifically during the menopause transition stage. To date, only one known literature review on this topic exists and it was not systematic [17]. Further, it focused on the effects of hormonal changes on body weight and body composition during the transition to menopause [17].

The objective of this study was to determine the effectiveness of exercise and/or nutrition interventions on changes in body weight, body composition, and body fat distribution in women specifically during the menopause transition stage.

2. Methods

A systematic review was conducted using a protocol developed a priori according to the Cochrane Handbook for Systematic Reviews of Interventions [21] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [22]. Systematic reviews apply explicit methods to conduct an extensive search, select appropriate research studies, critically appraise the studies, and synthesize studies to answer specific questions [22, 23].

2.1. Comprehensive Search Strategy. The search strategy was developed collaboratively with an academic reference librarian (LAU) and researchers investigating the effect of menopause transition on body weight regulation (Table 1). Population, intervention, comparator, and outcome (PICO) [24] were used for developing the search strategy and focused on key words related to menopause transition, physical activity/exercise, and nutrition interventions (see Table 2). The search strategy was designed for Medline and adapted for EMBASE, CINAHL, AMED, PsycINFO, Global Health, and SPORTDiscus. Grey literature and hand searching were conducted by using included articles to look for related articles in PubMed and checking reference lists of included articles. During the screening process for inclusion/exclusion of studies, if the published information was unclear, authors were contacted by email with requests for additional details on their study.

2.2. Selection Process. Included studies evaluated exercise, or nutrition interventions targeting specifically women in the menopause transition stage and evaluated impacts on body weight and/or central and abdominal weight gain. The menopause transition is divided into several stages and clinically has been categorized by international criteria developed to help assess women's reproductive stage [6]. All intervention designs were included: randomized controlled trials (RCT's), crossover designs, case controlled studies, and pre-/post tests. Screening and selection of each of the included studies was conducted independently by two reviewers (JJ, SP; JJ, SB) using standardized forms and included three phases: (I) title screen; (II) abstract screen; and (III) full article screen, with screening decisions recorded.

For the level (I) title screen, the citation titles identified by the search strategy were reviewed to identify any studies about women and body weight and/or abdominal obesity during the menopause transition stage. Titles identified as “include” or “unsure” by any reviewer were retained for
### Table 1: Medline Search Strategy.

<table>
<thead>
<tr>
<th>Search Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) menopause/or perimenopause/or premenopause/(26010)</td>
</tr>
<tr>
<td>(2) &quot;perimenopause&quot;.ab,ti. (2638)</td>
</tr>
<tr>
<td>(3) &quot;peri-menopause&quot;.ab,ti. (216)</td>
</tr>
<tr>
<td>(4) &quot;premenopause&quot;.ab,ti. (12032)</td>
</tr>
<tr>
<td>(5) &quot;pre-menopause&quot;.ab,ti. (1186)</td>
</tr>
<tr>
<td>(6) climacteric.ab,ti. (3389)</td>
</tr>
<tr>
<td>(7) menopaus$.ab,ti. (29513)</td>
</tr>
<tr>
<td>(8) 1 or 2 or 3 or 4 or 5 or 6 or 7 (51438)</td>
</tr>
<tr>
<td>(9) Exercise/(52421)</td>
</tr>
<tr>
<td>(10) Physical Fitness/(18078)</td>
</tr>
<tr>
<td>(11) Exercise Therapy/(20391)</td>
</tr>
<tr>
<td>(12) exp Sports/(88445)</td>
</tr>
<tr>
<td>(13) Motor Activity/(60911)</td>
</tr>
<tr>
<td>(14) exercise$.ab,ti. (160690)</td>
</tr>
<tr>
<td>(15) yoga.ab,ti. (1081)</td>
</tr>
<tr>
<td>(16) (aerobics or &quot;physical therapy&quot; or &quot;physical activity&quot; or &quot;physical inactivity&quot;).ab,ti. (46541)</td>
</tr>
<tr>
<td>(17) (fitness adj3 (class$ or regime$ or program$)).ab,ti. (883)</td>
</tr>
<tr>
<td>(18) (walking or running or jogging or swimming or cycling or bicycling).ab,ti. (100485)</td>
</tr>
<tr>
<td>(19) (&quot;tai chi&quot; or &quot;tai ji&quot;).ab,ti. (526)</td>
</tr>
<tr>
<td>(20) &quot;physical training&quot;.ab,ti. (3882)</td>
</tr>
<tr>
<td>(21) dance$.ab,ti. (3061)</td>
</tr>
<tr>
<td>(22) sedentary behavior.ab,ti. (582)</td>
</tr>
<tr>
<td>(23) (physical adj3 (inactivity or activity or training)).ab,ti. (43594)</td>
</tr>
<tr>
<td>(24) (&quot;weight lifting&quot; or &quot;strength training&quot; or &quot;resistance training&quot; or &quot;circuit weight training&quot;).ab,ti. (4695)</td>
</tr>
<tr>
<td>(25) exertion.ab,ti. (8780)</td>
</tr>
<tr>
<td>(26) sports.ab,ti. (21251)</td>
</tr>
<tr>
<td>(27) &quot;lifestyle intervention&quot;.ab,ti. (1583)</td>
</tr>
<tr>
<td>(28) (&quot;cognitive behavioral&quot; and &quot;weight loss&quot;).ab,ti. (144)</td>
</tr>
<tr>
<td>(29) exp Diet Therapy/(35073)</td>
</tr>
<tr>
<td>(30) Nutrition Therapy/(556)</td>
</tr>
<tr>
<td>(31) (diets or diet or dieting).ab,ti. (194636)</td>
</tr>
<tr>
<td>(32) (diet$ adj (modif$ or therapy or intervention$ or stratag$)).ab,ti. (7935)</td>
</tr>
<tr>
<td>(33) (low calorie or &quot;calorie control&quot; or &quot;healthy eating&quot;).ab,ti. (3368)</td>
</tr>
<tr>
<td>(34) (nutrition$ adj2 (modif$ or therapy or intervention$ or stratag$)).ab,ti. (5810)</td>
</tr>
<tr>
<td>(35) or/9-32 (617979)</td>
</tr>
<tr>
<td>(36) body weight changes/or weight gain/(17952)</td>
</tr>
<tr>
<td>(37) Overweight/(5768)</td>
</tr>
<tr>
<td>(38) body mass index/or skinfold thickness/(58989)</td>
</tr>
<tr>
<td>(39) Waist Circumference/(1525)</td>
</tr>
<tr>
<td>(40) &quot;body weight&quot;.ab,ti. (119849)</td>
</tr>
<tr>
<td>(41) &quot;fat distribution&quot;.ab,ti. (3555)</td>
</tr>
<tr>
<td>(42) &quot;body composition&quot;.ab,ti. (16098)</td>
</tr>
<tr>
<td>(43) &quot;waist circumference&quot;.ab,ti. (7570)</td>
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<tr>
<td>(44) &quot;body mass index&quot;.ab,ti. (66808)</td>
</tr>
<tr>
<td>(45) &quot;skin fold&quot;.ab,ti. (1130)</td>
</tr>
<tr>
<td>(46) &quot;abdominal fat&quot;.ab,ti. (3072)</td>
</tr>
<tr>
<td>(47) &quot;adipose tissue&quot;.ab,ti. (32751)</td>
</tr>
<tr>
<td>(48) Hot Flashes/(1699)</td>
</tr>
<tr>
<td>(49) Vasomotor System/(8540)</td>
</tr>
<tr>
<td>(50) (flush$ or flash$ or sweat$).ab,ti. (44468)</td>
</tr>
</tbody>
</table>
Table 2: Criteria for study eligibility.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Included</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Perimenopausal women and early postmenopausal women during the transition to menopause and up to 6 years postmenopause (typical ages from 40 to 65) and BMI range from 20 to 40 kg·m⁻²</td>
<td>Premenopausal women (e.g., no menstrual irregularities) or more than 6 years postmenopausal</td>
</tr>
<tr>
<td>Intervention</td>
<td>Interventions including nutrition and/or physical activity (e.g., aerobic exercise such as running and biking) as the primary component</td>
<td>Intervention did not involve nutrition and/or physical activity as the primary component Excluded supplements, such as vitamins</td>
</tr>
<tr>
<td>Comparator</td>
<td>Any comparator</td>
<td></td>
</tr>
<tr>
<td>Outcomes</td>
<td>Body weight changes (e.g., weight changes, prevention of gain, and maintenance) and/or abdominal obesity</td>
<td>Primary outcome reports on bone density</td>
</tr>
<tr>
<td>Study Design</td>
<td>Experimental designs (e.g., RCT, interrupted time series, and pre-/posttest)</td>
<td>Nonexperimental designs (cohort study)</td>
</tr>
</tbody>
</table>

second level screening. For level (II) screening, abstracts were evaluated using the PICO inclusion/exclusion criteria (Table 2). Level (III) screening involved a full text review of each article using the standardized screening form. Consensus on differences was reached in a discussion with a third reviewer (DS).

2.3. Data Extraction and Analysis. Data extraction was conducted independently by two reviewers (JJ, SB) and using standardized forms. Collected data included characteristics of the intervention, characteristics of the study design, characteristics of the participants, and findings. The menopausal status of study participants was described based on the international STRAW+10 staging system’s stages of reproductive aging in women [6]. The Cochrane Collaboration Risk of Bias Tool was used to appraise study quality for the RCT’s [21, 25] and the Critical Appraisal Skills Programme (CASP) checklist was used for other study designs [26]. Differences in extracted data or appraisal ratings between the reviewers were resolved through discussion with consensus reached and reasons for decisions documented.

Given the heterogeneity of included study designs and few studies included, a descriptive analysis was conducted.

3. Results

Of the 3,564 unique citations identified, only 3 studies were eligible for inclusion (Figure 1). Of the 137 citations in full text review, 134 were excluded: III included women whose menopausal status was not explicitly defined as being specifically in the stage of menopause transition (e.g., menopausal status undefined, mixed pre-/peri-/postmenopausal), 7 were not experimental designs (e.g., editorials or summaries discussing evidence on the role of exercise, diet, and diet and exercise), and 16 examined other outcomes (e.g., bone health and quality of life) (in the appendix).

3.1. Characteristics of Included Studies. Included were two RCTs [18, 19] and one pre-/post study [20] published between 2003 and 2011 (Table 3). The number of participants ranged from 24 [19] to 535 [18]. The loss of participants due to study withdrawal or lost to follow-up was described in all three included studies [18–20]. Additionally, participants self-identified their menopausal status in all three studies. Participants from the five-year RCT ranged in age from 44 to 50 years at the start of enrollment for the five-year study [18]. The other two studies included women in varying menopausal stages; one reported baseline information for perimenopausal and postmenopausal women with ages ranging from 40 to 59 years of age, although the intervention and results were reported as separate perimenopausal and postmenopausal groups of women [19]. The other study identified women during the menopause transition (last menstruation ≥ 60 and ≤ 365 days) separately from premenopausal (last menstruation < 60 days) or postmenopausal women (last menstruation > 365 days) and resulted in a wider age range [20]. Quality appraisals of the RCTs identified one study with low risk of bias [18]. The other RCT provided insufficient detail to judge risk of bias for allocation concealment, blinding, and selective reporting of outcomes [19]. The pre-/post study had lower risk of bias but did not report adequate detail to judge risk of bias related to confounding factors, follow-up, and results [20].
### Table 3: Characteristics of included trials (N = 3).

<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Country</th>
<th>Design</th>
<th>Participants</th>
<th>Menopausal status (at time of recruitment)</th>
<th>Comparisons</th>
<th>Study quality rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simkin-Silverman 2003 [18]</td>
<td>USA</td>
<td>RCT</td>
<td>535 women (intervention = 260 control = 275)</td>
<td>Less than 3 months amenorrhea in past 6 months</td>
<td>Two phased dietary and behavioural program versus control for 54 months</td>
<td>6/6 criteria met (low risk of bias)</td>
</tr>
<tr>
<td>Ogwumike 2011 [19]</td>
<td>Nigeria</td>
<td>RCT</td>
<td>24 women completed full study (intervention = 13 control = 11)</td>
<td>Irregular menstruation that has not ceased entirely, in the past year</td>
<td>Circuit training program, 3 times/week versus control for 12 weeks</td>
<td>3/6 criteria met (unclear risk of bias)</td>
</tr>
<tr>
<td>Hagner 2009 [20]</td>
<td>Poland</td>
<td>Pre/Post</td>
<td>53 women</td>
<td>Final menstrual period: premenopausal &lt;60 days, perimenopausal ≥60 days, ≤365 days, and postmenopausal &gt;365 days</td>
<td>Nordic walking program (moderate intensity exercise) for 12 weeks</td>
<td>9/12 criteria met (lower risk of bias for cohort study)</td>
</tr>
</tbody>
</table>

RCT: randomized controlled trial.

### Table 4: Characteristics of intervention (N = 3).

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Dietary and physical activity</td>
<td>Physical activity</td>
<td>Physical activity</td>
<td>Physical activity</td>
</tr>
<tr>
<td>Group I: intervention</td>
<td>Group I: intervention</td>
<td>90-minute Nordic walking</td>
<td>3 times per week</td>
</tr>
<tr>
<td>Phase I:</td>
<td>(a) 10 station circuit consisting of muscular and cardiovascular endurance, flexibility, coordination, and abdominal and pelvic floor muscle exercises</td>
<td>(b) Target heart exercise rate was calculated for each woman at 60 to 80 percent of heart rate reserve</td>
<td></td>
</tr>
<tr>
<td>(a) Set weight loss goals</td>
<td>(c) 3 times per week on alternate days; grouped into one of three groups in the order of their baseline cardiorespiratory fitness</td>
<td></td>
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</tr>
<tr>
<td>(b) Eat low-fat foods (1300 kcal/day)</td>
<td></td>
<td>(d) 40- to 60-minute circuit exercises plus 10 minutes warm up/cool down</td>
<td></td>
</tr>
<tr>
<td>(c) Sessions for adherence to meal plan</td>
<td></td>
<td>Group 2: Control-assessment only</td>
<td>No control group</td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) 1000–1500 kcal/week physical activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Consultations to develop and adhere to physical activity routine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f) Self-monitoring and feedback on diet and physical activity</td>
<td></td>
<td>Reported at four weekly intervals for assessments (adiposity and flexibility)</td>
<td></td>
</tr>
<tr>
<td>Phase II:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Group meetings</td>
<td></td>
<td>Group 2: Control-assessment only</td>
<td></td>
</tr>
<tr>
<td>(b) Refresher programs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Increased caloric intake as weight goals met</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2: Control-assessment only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Phase I = 20 weeks</td>
<td>12 weeks</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td>Phase 2 = 48 months</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2. Characteristics of Interventions. Study interventions were exercise with diet or exercise only (Table 4). One study evaluated highly supported (i.e., coaching, education) caloric and dietary restrictions combined with exercise over 20 weeks, followed by ongoing and less intensive dietary and exercise interventions for another 48 months [18]. Another study evaluated a 12-week exercise intervention with participants randomly assigned to a circuit training program or control group [19]. The third study evaluated endurance exercise using a Nordic walking program over 12 weeks [20].

In the studies that utilized exercise as an intervention, participants were either not instructed in their dietary habits [19] or were asked to refrain from increasing their daily fat intake and to avoid changing their nutrition routines [20].
3.3. Characteristics of Outcome Measures. All three studies used different measures of adiposity and body fat distribution. One study focused predominantly on changes in BMI and waist-to-hip ratio [19]. The other studies measured overall gains and/or losses in body weight reported as BMI with percentage body fat [18] or total kilograms of fat [20]. Abdominal obesity was measured using waist circumference [18, 20] or waist-to-hip ratio only [19].

3.3.1. Combined Exercise and Dietary Intervention, RCT (n = 1). Compared to controls, participants randomized to an exercise and dietary intervention at 54 months were more likely to be at or below baseline weight (55% versus 26%) and experienced a decreased BMI and greater loss of percentage of body fat for all three follow-up measures, including decreased waist circumference ($P < 0.001$) [18]. While both intervention and control groups were found to have decreased waist circumference measurements at follow-up, the greater changes were measured in the intervention group [18]. The mean changes in body weight were $-0.2\text{lbs.} \approx -0.1\text{kg}$, SD = 5.2 kg) in the intervention group and $+5.2\text{lbs.} \approx (2.4\text{kg}, \text{SD} = 4.9 \text{kg})$ in the control group.

3.3.2. Exercise Only Intervention Only, RCT (n = 1). Participants randomized to circuit training significantly decreased the mean values of their waist-to-hip ratio ($P < 0.05$) between baseline and week 12, whereas those in the control group saw no significant changes over the 12-week follow-up period. Significant changes in BMI were not observed in either group ($P > 0.05$) [19] and attributed to the minimal changes in body weight for both groups during the 12 weeks of the study. Overall, participants randomized to a 12-week circuit training exercise program only decreased their waist-to-hip ratio.

3.3.3. Exercise Only Intervention, Pre-/Post study (n = 1). Compared to baseline, participants exposed to moderate endurance exercise over 12 weeks saw reductions in BMI, total body fat, and waist circumference ($P \leq 0.05$) [20].

4. Discussion

4.1. Summary of Main Results. This systematic review was focused on determining the effectiveness of exercise and/or nutrition interventions on mitigating changes in body weight, body composition, and body fat distribution in women specifically in menopause transition stage. Despite extensive searching of published and unpublished research, only three relevant studies were identified. Most studies were excluded due to poorly defining the menopausal status of study populations, lacking an intervention study, or lacking assessment outcomes related to body weight or body composition. The included studies described various study environments, participant characteristics, and interventions.

Of the three included studies, one higher quality trial with minimal risk of bias showed that compared to usual activities in the control group, women exposed to a program of combined exercise and caloric restriction dietary interventions for 54 weeks had improved body weight and reduced abdominal adiposity [18]. As well, significant reductions in waist circumference and body fat were maintained beyond four years. Despite using a less rigorous study design and having a shorter follow-up period, another study concluded that a Nordic walking program might reduce weight gain during the menopause transition stage [20]. Similarly, a study implementing a circuit training program found that the waist-to-hip ratio could be decreased with exercise, even while measures of BMI were not significantly influenced [19]. While limited in number, these studies suggest that exercise or both exercise and caloric reduction interventions may be able to disrupt the process and patterns of weight gain and change in body fat distribution during the menopause transition stage.

These findings are consistent with guidelines on the prevention and management of obesity that recommend lifestyle intervention as the first approach for preventing or treating obesity [27]. More specifically, lifestyle recommendations include regular exercise and a reduced-energy diet. These recommendations are supported by other studies addressing excess weight and obesity in middle-aged women and obese adults [28, 29]. The paucity of studies that have investigated the effects of lifestyle intervention on
weight, body fat, and body fat distribution specifically in women in the menopausal transition stage indicates that better designed studies are needed to support an evidence-based approach to managing and preventing women's body weight changes during this specific important life stage.

4.2. Periodic Clinical Measurements as an Intervention. Of the three included studies, only one study [18] suggested the potential impact of periodic clinical measurements as an intervention to attenuate weight gain during the menopause transition stage. Clinical measurements included weight, waist circumference, blood pressure, lipids, glucose, and level of physical activity and nutrient intake by questionnaire. Of note is that 26% of controls were at or below baseline weight at the 54-month visit and the group showed a significant decrease in waist circumference without being exposed to the intensive lifestyle intervention. Therefore, it is possible that the women in the control group may have been influenced by the periodic clinical measurements at 6, 18, 30, 42, and 54 months [18] and this is consistent with another study [30]. A longitudinal observational study attempting to document the effect of menopause transition in healthy nonobese premenopausal women found no significant weight gain after 5-year follow-up. In this study, there was no structured intervention other than that of yearly clinical measures of body weight, waist circumference, body composition, blood pressure, lipids profile, glucose, physical activity, and a food intake journal [30].

4.3. Reproductive Aging Is Poorly Defined in Studies. Selection of participants using self-reported menopausal status was described for all three studies and details on characteristics of participants were limited [18–20]. Participants included in the studies varied in age from 40 to 62 years and reproductive aging was understood as distinct from generalized physical aging. Of concern was the fact that many of the excluded studies examining weight gain in women from pre- to postmenopause did not describe menopausal status and failed to clearly define the reproductive stage of participants.

Reporting of the data in ways that obscure potential variability between women of different reproductive ages is an issue and has been previously identified as contributing to the development of less effective interventions for managing menopausal symptoms [31]. Criteria defining the stages of menopause can better situate studies examining effects of reproductive aging and help women and health professionals to effectively address issues, such as identification of critical stages for increased risk of adiposity. For this systematic review, the menopause transition stage was described based on the international STRAW+10 staging system's stages of reproductive aging in women[6].

Future studies could benefit from standard reporting of menopausal status using these internationally approved criteria.

Several factors have been shown to be influential during women's experience of menopause. While the prevalence of excess weight and obesity is high within the general population; population subgroups such as those with lower socioeconomic status have been identified as being at particular risk [32]. The findings of this systematic review indicate that a narrow segment of the population has been studied (i.e., predominantly white, middle-class women). Other key factors in reproductive aging (e.g., race, ethnicity, culture, geography, and socioeconomic status) are not prominent in the study of body weight changes during the menopause transition [31], despite longitudinal evidence that socioeconomic status is related to BMI, weight gain, and certain weight control practices within nationally representative samples of women [33]. One included study in this review identified this gap in the literature addressing diversity in research and reporting on women and changes in adiposity associated with menopause [19] and cited this as a rationale for their study. Indeed, the attrition rate for participants in the study was attributed to the socioeconomic structures limiting participation of women in their active lifestyles [19]. Hence, the findings of this systematic review highlight the need to ensure that consistent definitions are applied in defining reproductive aging stage, and that the characteristics of subpopulations of women are included as an integral part of research on interventions that target body weight, body composition, and body fat distribution during the menopause transition stage.

4.4. Limitations and Strengths. The potential limitations of this review included a lack of a standardized definition for the population of women in the menopause transition within the literature as described above; poor indexing of studies in databases; and the limited time frame (<26 weeks) over which two of the three studies were conducted. Given the poor indexing of studies in electronic databases, it is possible that some studies were missed; however, there is transparency in the extensive search strategy used. Sustained weight loss, up to and longer than one year, is considered a standard in studies of management of overweight and obesity [28]. However, only one of the three included studies was conducted for longer than one year with the other two studies being only 12-week duration. During study screening, sensitivity was favoured over specificity, resulting in larger numbers of studies screened and ultimately excluded. As well, the studies relied on self-reports by women on their menopausal status. Strengths of this review included the comprehensive search strategy which was developed in collaboration with an academic librarian, use of two independent reviewers at each screening stage, and the iterative and ongoing consultation with an interprofessional team of researchers having expertise in obesity, reproductive aging, and systematic review methodology.
5. Conclusions

Few studies have measured the effect of exercise and/or dietary interventions on women's body weight or body composition specifically during the menopause transition stage. Evidence from one large higher quality RCT indicates that women should exercise and eat a caloric restricted diet during the menopause transition stage to prevent weight gain and abdominal fat gain. The review also identified the need for use of common terminology for defining reproductive age of study participants as described by the STRAW+10 staging system [6]. Common terminology would facilitate synthesizing results across studies. Finally, further research should focus on more rigorous study methods using durations of one year or longer. Ideally, studies should be sensitive to the potential relationships between cultural norms, socioeconomic status, and body weight changes during the menopause transition stage. Subsequent results would be more likely to help women and their health professionals choose effective interventions for addressing changes in body weight and achieving a body composition defined by women and their care professionals as healthy.

Appendix

A. Reasons for Exclusion (Total n = 134)


As per M. Aubertin, E. T. Poehlman, and I. J. Dionne, in “Effect of regular physical activity on body composition in older women: independent of the type of exercise," Canadian Journal of Applied Physiology, vol. 28, no. pp. S28, 2003, the menopausal status was undefined, and participants were 50–70 years of age.


Y. W. Chen and P. Watson, in “The effects of an individualized diet and exercise program on body fat levels in Taiwanese females aged 40–60,” Proceedings of the Nutrition Society of New Zealand, vol. 27, pp. 107, 2002, recruited participants (women) who were 40–60 years of age and without details on menopausal status.


M. M. Cowan and L. W. Gregory, in “Responses of pre- and post-menopausal females to aerobic conditioning,” Medicine and Science in Sports and Exercise, vol. 17, no. 1, pp. 138–143, 1985, recruited two participant groups: one group of women had not had menses for 12 months or more (postmenopausal) and the other group had regular menses (“premenopausal”), with no additional details.


As per S. Faghhi, A. Abadi, M. Hedayati, and M. Kiniagii, in “The effect of the combination of restricted energy diet and low-fat milk or calcium supplement on iron status of premenopausal overweight or obese women,” Clinical Nutrition, Supplement, vol. 7, no. 1, pp. 238–239, 2012, the menopausal status was undefined: “menopausal women.”

As per K. Foster-Schubert, C. M. Alfano, and C. R. Duggan, in “Effect of diet and exercise, alone or combined, on weight and body composition in overweight-to-obese postmenopausal women Obesity, vol. 20, no. 8, pp. 1628–1638, 2012, the menopausal status was undefined: “postmenopausal women aged 50 to 75 years.”

As per C. M. Friedenreich, C. G. Woolcott, and A. McTiernan et al., in “Adiposity changes after a 1-year aerobic exercise intervention among postmenopausal women: a randomized controlled trial,” International Journal of Obesity, vol. 35, no. 3, pp. 427–435, 2011, the menopausal status was undefined: “postmenopausal women aged 50 to 74 years.”


As per G. Garnier, S. Garnier, I. Gaubert, and G. Auneau, in “Follow up of an active walking program on sedentary and moderately obese postmenopausal women,” Climacteric, vol. 14, pp. 73-74, 2011, the menopausal status was undefined: “women aged 60+/–5 years”.


J. S. Green, P. R. Stanforth, and T. Rankinen et al., in “The effects of exercise training on abdominal visceral fat, body composition, and indicators of the metabolic syndrome in
postmenopausal women with and without estrogen replacement therapy: The HERITAGE Family Study," *Metabolism, Clinical and Experimental*, vol. 53, no. 9, pp. 1192–1196, 2004, recruited participants, women with no menses for 3 months+ and 46–59 years of age, with no further details.


B. V. Howard, J. E. Manson, and M. L. Stefanick et al., in "Low-fat dietary pattern and weight change over 7 years: the women’s health initiative dietary modification trial," *Journal of the American Medical Association*, vol. 295, no. 1, pp. 39–49, 2006, reported no menopausal status, women 50–79 years of age.

A. J. Huang, L. L. Subak, and R. Wing, et al., in "Program to reduce incontinence by diet and exercise, investigators. An intensive behavioral weight loss intervention and hot flushes in women," *Archives of Internal Medicine*, vol. 170, no. 13, pp. 1161–1167, 2010, recruited participants, women with no menses 12 months+ and hot flashes, with no further details.


J. A. Lee, J. W. Kim, and D. Y. Kim, in “Effects of yoga exercise on serum adiponectin and metabolic syndrome factors in obese postmenopausal women,” *Menopause*, vol. 19, no. 3, pp. 296–301, 2012, recruited participants, “postmenopausal women (with absence of menses for one year+), 54.5+/-2.75 years and more than 36% body fat.”


P. J. Manns, D. P. Williams, C. M. Snow, and R. C. Wander, in "Physical activity, body fat, and serum C-reactive protein in postmenopausal women with and without hormone replacement," *American Journal of Human Biology*, vol. 15, no. 1, pp. 91–100, 2003, recruited participants, postmenopausal women (with no menses in the past year), 50–73 years of age.


H. S. Park and K. U. Lee, in “Postmenopausal women lose less visceral adipose tissue during a weight reduction program,” Menopause, vol. 10, no. 3, pp. 222–227, 2003, recruited “postmenopausal” women (with no menses for equal to or greater than one year), 57.6+/−7.2 years of age.


A. Zarneshan and K. Salehzadeh, in “Effects of combined selective aerobic moderate intensity exercises and soya intake on 17β-estradiol (biomarker of breast cancer) and obesity of obese postmenopausal women,” International Journal of Biosciences, vol. 2, no. 11, pp. 81–89, 2012, recruited participants, “menopausal” women, age of 49.6+/1.8 years, age in years 60.3+/−5.3 years, no reporting by menopausal age or defining menopausal age.


A.4. Not an Intervention Design (N = 7)

A.4.1. Evidence on the Role of Exercise (n = 2). Consider the following references.


A.4.2. Role of Diet (n = 1). Consider the following reference.


A.4.3. Other Issues Associated with Menopause (n = 4). Consider the following references.


A.5. Wrong Outcomes (n = 16)

A.5.1. Bone Health (n = 3). Consider the following references.


A.5.2. Quality of Life (n = 1). Consider the following reference.


A.5.3. Other Outcomes Unrelated to Study (n = 12). Consider the following references.


Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Authors’ Contribution

Janet Jull coordinated the review, conducted the study screening/selection, contributed intellectually during the study, and contributed to the writing of the final paper; Dawn Stacey and Denis Prud’homme conceived of the study, contributed intellectually during the study screening/selection, and contributed to the writing of the final paper; Sarah Beach, Stephanie Prince, and Joseph Abdulnour contributed
intellectually during the study screening/selection and contributed to the writing of the paper; Lee-Anne Uholz conducted the search of the literature, contributed intellectually, and reviewed the final paper. All authors reviewed and approved the final version of this paper.

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References


