‘MenoWell’: A Pilot 6-Week Novel, Online, Multimodal Exercise and Health Education Programme for Women in All Stages of Menopause Living in Laois, Ireland

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ABSTRACT

Introduction: Perimenopausal and post-menopausal women experience a myriad of physical, endocrine, and psychological changes, which may negatively impact their wellness. Menopause education and positive lifestyle behaviours may enhance women’s experience during this transition. Our aim was to examine the efficacy of ‘MenoWell’, a 6-week online menopause-specific multimodal exercise and health education intervention, on physical performance, menopausal symptoms, wellbeing, and physical self-efficacy in this population in Laois, Ireland.

Methods: Twenty-three female participants (51.3 ± 5.6 years, n = 11 perimenopausal, n = 12 post-menopausal, n = 15 with no musculoskeletal issues or clinical conditions, n = 8 with musculoskeletal issues and/or clinical conditions) completed a 6-week online multimodal exercise (2*40-minute/week) and health education (1*40-minute/week) intervention. Pre- and post-testing of physical performance was conducted. Online questionnaires examined baseline menopause knowledge and education (Menopause Knowledge and Education Questionnaire) and changes in menopausal symptoms (Menopause Rating Scale), wellbeing (World Health Organization Five Wellbeing Index), physical activity participation (Single-Item Measure Physical Activity Participation Question) and physical self-efficacy (Modified Perceived Physical Activity (LIVAS: Lichamelijke Vaardigheden Schaal) questionnaire). Paired samples t-tests and Wilcoxon signed rank tests examined changes pre- and post-intervention.

Results: Most participants did not feel informed about menopause. Post-intervention, there were significant improvements in sit-to-stand ($p < 0.001$, $\eta^2 = 0.81$), sit-and-reach ($p < 0.001$, $\eta^2 = 0.49$), box press-up ($p < 0.001$, $\eta^2 = 0.73$), 6-minute walk test ($p < 0.001$, $\eta^2 = 0.56$), menopause symptoms ($p < 0.001$, $\eta^2 = 0.76$), wellbeing ($p = 0.003$, $\eta^2 = 0.36$), and physical self-efficacy ($p = 0.011$, $\eta^2 = 0.27$). No significant change was observed for physical activity participation and bilateral single leg balance ($p > 0.05$).

Discussion: A substantial lack of awareness and knowledge surrounding menopause exists in Ireland. Only 6 weeks of online, evidence-based, time-efficient (2 hours per week) and menopause-specific multimodal exercise and health education significantly improved physical performance, menopausal symptoms, wellbeing, and physical self-efficacy in perimenopausal and post-menopausal women. Thus, a widespread rollout of women-specific multimodal exercise and health education programmes to inform and prepare women is recommended.

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1. INTRODUCTION

In Ireland, there has been an increase in life expectancy, which is 83.4 years for women (CSO, 2020). The average age in Ireland for a woman to reach menopause is 51 years (DOH, 2022). Thus, an increasing number of women in Ireland will experience the menopausal transition and live a substantial proportion of their lives post-menopause, and many will seek advice regarding menopausal symptoms and the management of the same (Talaulikar & Davies, 2022). There are three stages of natural menopause; perimenopause (the variable length of time when symptoms of the menopause are present but menstrual periods have not stopped completely for 12 consecutive months), menopause (a specific point in time that is retrospectively diagnosed as the absence of menstrual periods for 12 consecutive months) and post-menopause (the time after menopause, when menstrual periods have ceased for over 12 consecutive months).

Menopausal symptoms can be severe and have a huge impact on a woman's life. In brief, menopausal symptoms include abnormal bleeding, vasomotor symptoms (i.e., hot flushes and night sweats), heart discomfort, sleep disturbances, genitourinary syndrome, sexual problems, mood disturbances, cognitive dysfunction, and joint and muscle pain and discomfort (Geraghty, 2022). Many of these symptoms may begin in perimenopause, which can begin as early as the late thirties and has a median length of 4–8 years (Delamater & Santoro, 2018; Snyder et al., 2015), meaning that a large proportion of women experience a lengthy and problematic time of hormonal change that can have a negative impact on their daily lives. In addition, the physiological changes that occur with ageing and the menopause result in numerous unfavourable adaptations including the loss of muscle mass, strength and function (i.e., sarcopenia), loss of bone mass and increased incidence of osteopenia and osteoporosis, increased cardiovascular and metabolic risk (e.g., insulin resistance, high blood pressure, high cholesterol, type 2 diabetes mellitus (T2DM), and cardiovascular disease), and other adaptations that markedly and negatively impact women's physical health, mental health, wellbeing, and quality of life (Geraci et al., 2021; Larsson et al., 2019; Pérez-López & Chedraui, 2017; Sipilä et al., 2020). These physiological adaptations are further exacerbated by physical inactivity, sedentary behaviour, and poor nutrition. Therefore, it is imperative that women are provided with simple, time-efficient, and evidence-based information and lifestyle advice on how they can optimise their health before, during, and after the menopausal transition. Participation in regular multimodal exercise and the optimisation of nutrition and dietary practices are essential to reduce the risk of non-communicable diseases and to promote health during female ageing (Cano et al., 2020; Garber et al., 2011). Multimodal exercise, incorporating aerobic, strength, flexibility, and balance training, has well-established benefits for overall health and can ameliorate the physiological adaptations with ageing and the menopause (Cooper et al., 2021; Hoeger et al., 2019). More specifically, multimodal exercise plays a key role in the prevention, treatment, and management of sarcopenia, osteopenia, osteoporosis, and cardiometabolic risk and is important for preserving functional capacity and the ability to perform activities of daily living, decreasing the risk of falls, and reducing tension, stress, and anxiety (Faigenbaum, 2017; Garber et al., 2011; Hoeger et al., 2019). Evidence-based dietary recommendations include increasing intakes of varied plant-based foods such as wholegrains, vegetables, fruits, unsalted nuts and reducing intakes of salt, sugar, saturated fat, trans fat, and alcohol (Cena & Calder, 2020; Fekete et al., 2022; Piepoli et al., 2016; Soleymani et al., 2019). Additionally, consuming adequate protein, vitamin D, and calcium is important for the prevention of sarcopenia and osteoporosis, particularly post-menopause (Rizzoli et al., 2014).

Currently, many women do not feel prepared for menopause and are unaware of how the associated physiological adaptations will affect their lives (Kracht et al., 2022). Furthermore, menopause is commonly referred to as a 'taboo' topic and some women do not consider talking to medical professionals about the menopause to be a positive experience (Kracht et al., 2022; Macpherson & Quinton, 2022). While the benefits of multimodal exercise and a healthy balanced diet are numerous, it is important that women are provided with the knowledge and skills to engage in healthy lifestyle behaviours that suit their home and work environments, particularly because perimenopause and post-menopause occur at a time in a woman's life when she is often actively engaged in family upbringing and/or care, as well as part-time or full-time employment or other commitments, to help overcome barriers and increase perceived benefits of behaviour change and the confidence to implement them (Arlinghaus & Johnston, 2018; Monteleone et al., 2018).

To our knowledge, the impact of a combined online multimodal exercise and health education intervention has not been examined in this cohort previously. The purpose of this research study was to determine the efficacy of 'MenoWell', a 6-week online menopause-specific multimodal exercise and health education intervention, on cardiorespiratory fitness, upper- and lower-body muscular strength and endurance, flexibility, bilateral single-leg balance, menopausal symptoms, physical activity participation, perception of physical abilities, and subjective wellbeing in perimenopausal and post-menopausal women living in Laois, Ireland.

2. METHODS

STUDY DESIGN

This one-group pretest-posttest design study was conducted between May and July 2023, after obtaining ethical approval by Dublin City University's research ethics committee (REC2023/072). The study was designed and delivered by a team of clinical and/or exercise physiologists, a phase IV cardiac rehabilitation specialist, a registered associate nutritionist, experienced exercise instructors, and a certified athletic therapist. The study was split into four main phases: recruitment, pre-testing, a 6-week intervention, and post-testing (Figure 1).

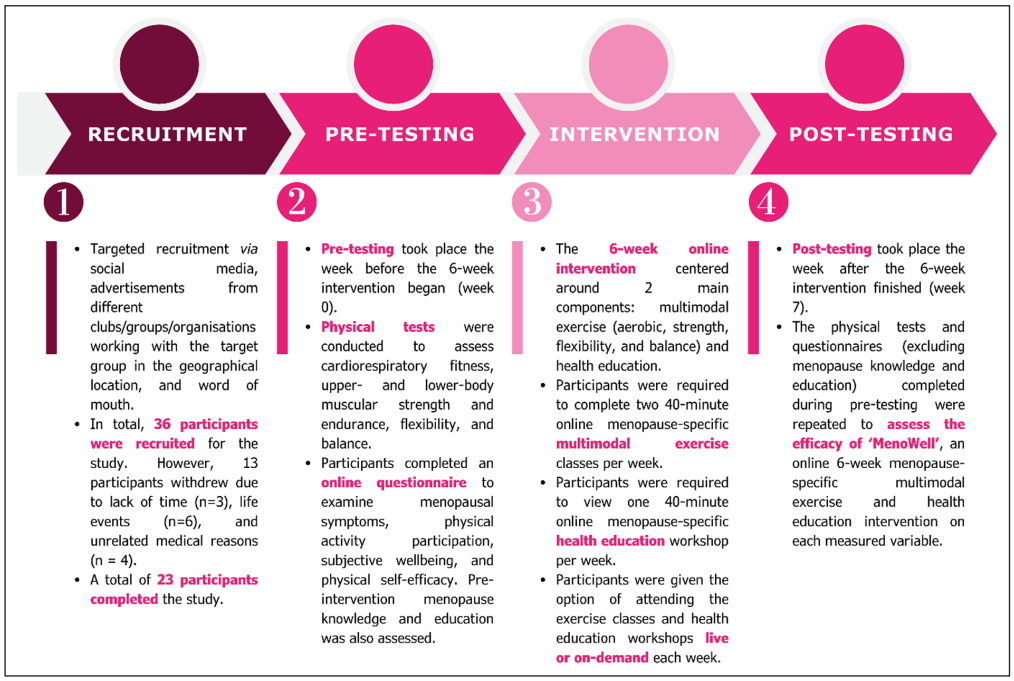

Figure 1 Overview of the study design.

RECRUITMENT

Females aged between 35–70 years who were perimenopausal or post-menopausal and living in County Laois in Ireland were recruited *via* social media, advertisements from different clubs/groups/organisations working with the target group in the geographical location, and word of mouth. Eligible participants were asked to read a plain language statement, complete a physical activity readiness questionnaire (PAR-Q+), and sign an informed consent form. Medical clearance, from a registered General Practitioner (GP), was required for individuals who answered 'yes' to any of the questions asked in the PAR-Q+. Participants with musculoskeletal issues or clinical conditions (including, but not limited to, osteopenia, osteoporosis, back pain, joint pain, arthritis, high blood pressure, high cholesterol, T2DM and cardiovascular disease) were included in the study because of the common prevalence of same in this population and the beneficial role of multimodal exercise in the prevention, treatment and management of these conditions. The multimodal exercise classes, as well as the tests selected to assess physical performance, considered this clinical exercise prescription (e.g., extended warm-up, extended cool down, exercise intensity education, and appropriate adaptations and progressions to different exercises). Exclusion criteria was the presence of unstable angina and heart failure.

PARTICIPANTS

Thirty-six participants were recruited. However, 13 participants withdrew due to lack of time (n = 3), life events (n = 6, e.g., family bereavements and holidays), and unrelated medical reasons (n = 4). In total, 23 participants completed the study. Participants received on-going support throughout each phase of the study in the form of biweekly emails, text messages and phone calls, if required.

TESTING

Physical Tests

Physical performance pre- and post-testing took place in a community multipurpose hall the week before (week 0) and week after the 6-week intervention (week 7). A 15-minute warm up was first completed. The physical tests were performed in a group-setting in the following order during both sessions: (1) Bilateral Single Leg Stance Eyes Closed Balance Test; (2) Sit-to-Stand Test; (3) Sit-and-Reach Test; (4) Box Press-Up Test; (5) Six-Minute Walk Test (Figure 2). A 5-minute cool down was performed at the end of the testing session.

Figure 2 Images of the Bilateral Single Leg Stance Eyes Closed Balance Test **(A)**, Sit-to- Stand Test **(B)**, Box Press-Up Test **(C)**, and the Six-Minute Walk Test **(D)**.

Bilateral Single Leg Stance Eyes Closed Balance Test: This test measures static balance ability and was adapted from Springer et al. (2007). Participants were instructed to cross their arms over their chest, stand on their left leg first, with the right leg raised slightly forward so the heel of their right foot was at the level of the toes on the left foot and close their eyes. The tester used a stopwatch to measure the number of seconds the participant was able to stand on one leg. The time commenced when the participants raised their foot and closed their eyes. The time ended when a participant (a) touched the floor with their raised foot, (b) touched the wall with their raised foot, hands or shoulder, or (c) the maximum time of 30 seconds had elapsed. Participants were given two trial runs of 5 seconds each before the actual test was performed. The test procedure was then repeated while standing on the right leg, with the left leg raised.

Sit-to-Stand Test: The 60-second sit-to-stand test is a measure of lower body muscular strength and endurance (Strassmann et al., 2013). It captures the number of times a participant can stand up and sit down on a sturdy chair, without armrests, continuously for 60 seconds. To fully stand up, the legs must be in a straightened position (i.e., knees fully extended) and to sit down, the chair must be touched by the buttocks. Participants folded their arms across their chest to prevent assisted use of the arms. Participants were instructed to complete as many sit-to-stand repetitions as possible for 60 seconds at a self-paced speed. Participants were informed when 30 seconds and 15 seconds were remaining. The total number of repetitions of the sit-to-stand movement in 60 seconds was recorded.

Sit-and-Reach Test: This test measures flexibility of the hamstring muscles and, to a lesser extent, flexibility of the lower back muscles (Hoeger et al., 2019). Participants sit on the floor in an upright and straight position, with the legs fully extended and the bottom of their feet against the sit-and-reach box (Novel Products Inc., Montana, United States). Participants were then instructed to stretch forward, without letting the knees lift up and avoiding any jerking

movements and push the indicator as far as possible along the box. The tester noted the number of centimetres (cm) reached, and then the test was repeated twice, allowing for a total of 3 attempts. The highest score of the 3 attempts was then recorded.

Box Press-Up Test: The box press-up test assesses endurance of the muscles in the upper body. To start, participants were in a prone position, with their knees under the hips and hands pointing forward under the shoulders, on an exercise mat. The upper body and head are kept in a straight line. Participants were instructed to bend their elbows and bring their chin towards the mat (the down position) and then push up from the mat by fully extending the elbows (the up position). Participants then performed as many press-ups as possible within 60 seconds at a self-paced speed and the total number of repetitions was recorded.

Six-Minute Walk Test: The six-minute walk test is a simple and appropriate field-based test for the assessment of cardiorespiratory fitness (Dourado et al., 2021). Participants were instructed to walk, jog, or run the maximum distance possible in six minutes up and down a 20-metre straight course, indicated by plastic cones, on a flat indoor surface. Verbal encouragement was given, and they were informed of the time remaining after every minute. The total number of repetitions of the 20-metre course was recorded and then the total distance covered in metres (m) was calculated.

Questionnaires

Participants completed an online questionnaire on Qualtrics (Seattle, Washington, United States), before and after the 6-week intervention (week 0 and week 7, respectively). This questionnaire included (i) Menopause Rating Scale (MRS), an 11-item subjective and validated questionnaire concerning the presence and severity of somatic, psychological, and urogenital symptoms experienced by women in different stages of the menopause (Heinemann et al., 2003); (ii) Single-Item Measure (M1) Physical Activity Participation Question, used to determine the frequency of physical activity participation in the previous 7-day period (Milton et al., 2011); (iii) World Health Organization Five Wellbeing Index (WHO-5), a 5-item questionnaire which is a self-reported measurement tool of current mental wellbeing (WHO, 1998); (iv) Modified Perceived Physical Activity (LIVAS: Lichamelijke Vaardigheden Schaal) Questionnaire, a 10-item questionnaire used to assess perceptions of physical abilities in comparison to people of the same age (Ryckman et al., 1982; Zelle et al., 2016). For baseline only, participants completed the Menopause Knowledge and Education Questionnaire, a 5-item questionnaire to determine previous sources and thoughts of information on the menopause (Harper et al., 2022). All questionnaires can be found in Supplementary File 1.

THE 'MENOWELL' INTERVENTION

Multimodal Exercise Classes

Participants completed two 40-minute online age- and ability-appropriate, menopause-specific multimodal exercise classes per week. Participants could attend two live online exercise classes per week hosted *via* Zoom (Zoom Video Communications, California, USA), or complete two weekly specified pre-recorded exercise classes hosted on a private on-demand library on the EduFIT website, or a mixture of live and on-demand exercise classes to suit their own schedules. The exercise classes were all delivered by trained exercise instructors and included a 10-minute warm up and 5-minute cool down. An example of the structure of a multimodal exercise class incorporating aerobic, strength, flexibility, and balance exercises can be found in Figure 3. The exercise instructors demonstrated three versions of each exercise (1, beginner; 2, intermediate; 3, advanced) and participants were continuously advised to choose the version of the exercise that was most appropriate for their current functional ability and level of fitness (e.g., taking the press-up strength exercise as an example, level 1 was a wall press-up; level 2 was the box press-up; and level 3 was the modified press-up). In this way, all participants completed a strength exercise, involving the same muscle groups but a version that was appropriate to their ability. Participants received an online education workshop on exercise intensity before commencing the intervention and had colour-coded intensity cards, provided at the pre-testing session, at every live online exercise class. The green, orange, and red cards reflected specific rates of perceived exertion (RPE); 9 – 12, 13 – 17, and 18 – 20, respectively (Borg, 1982). At various intervals during the live online exercise classes, participants were asked to hold up their colour-coded intensity cards to show their RPE at that time. All participants were asked to perform the multimodal

exercise classes at a self-assessed moderate intensity. All live online exercise classes were monitored by a member of the research team. Participants communicated with the research team at the end of every week which two specific exercise classes they had completed. This was particularly important when a participant could not attend a live exercise class and thus replaced it with an on-demand exercise class.

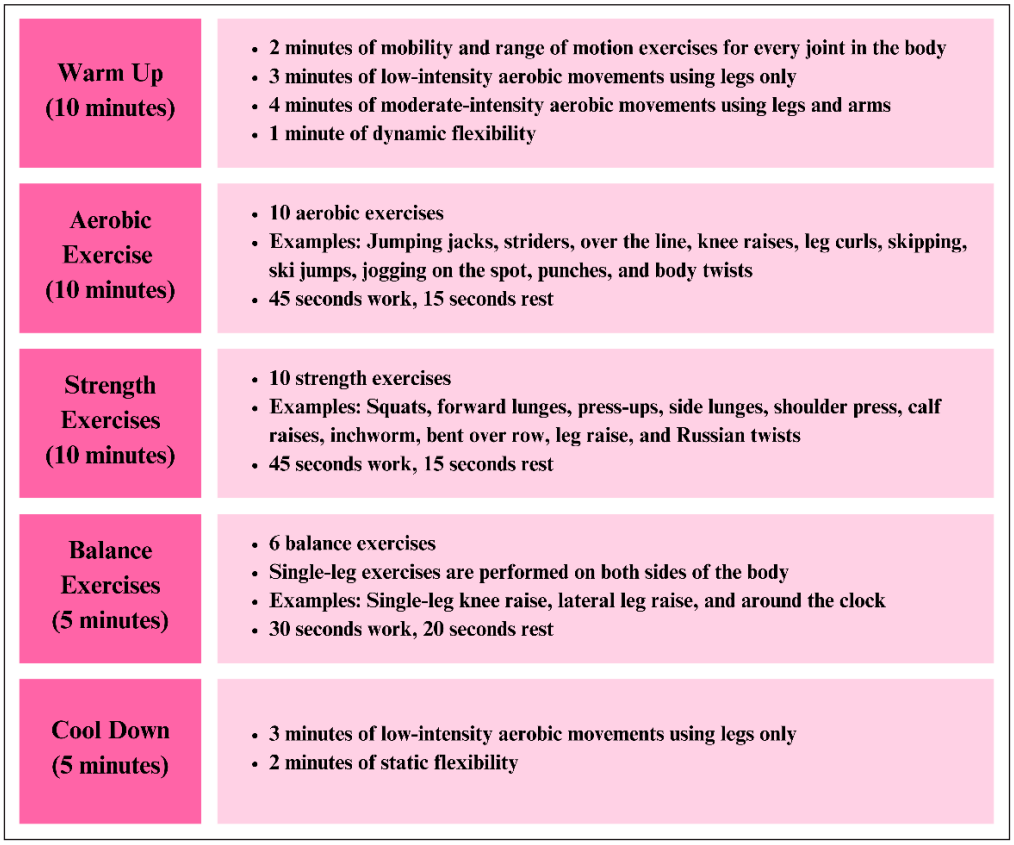

Figure 3 An example of the structure of a multimodal exercise class in the 'MenoWell' programme.

Health Education

Participants were required to complete one 40-minute menopause-specific health education workshop per week, held either live on Zoom or the recording was viewed in the on-demand library. The health education workshops were delivered by clinical and/or exercise physiologists and a registered associate nutritionist. The topics covered in the health education workshops are displayed in Table 1. Participants were provided with the opportunity to ask questions and encouraged to send any additional questions *via* email. Take-home resources including workshop notes, workouts, and recipes were provided to participants *via* email and hosted on the on-demand library, and infographics containing the main points of each workshop were shared on social media.

Table 1 Overview of the menopause-specific health education content.

WEEK	HEALTH EDUCATION WORKSHOP CONTENT
1	Muscle Matters in Menopause
2	Nutrition for a Healthy Menopause
3	Healthy Hearts in Menopause
4	Building Bone in Menopause
5	Sleeping Soundly in Menopause
6	S.E.L.F. Care in Menopause

Statistical Analysis

Statistical analysis was performed using SPSS 28.0 (IBM Corp., Armonk, NY, United States) with a 0.05 significance level. Firstly, descriptive statistics were completed with frequencies, means, and standard deviations reported where appropriate. Normality was assessed and all data were normal except for balance on the right and left legs. Paired samples t-tests were conducted to examine

variables pre- and post-intervention for all normal data. Effect sizes were calculated as eta squared (η^2) and classified as small effect (0.01), moderate effect (0.06) and large effect (0.14) (Cohen, 1988). For balance on the right and left legs, a Wilcoxon signed rank test was completed. Effect sizes were also calculated and classified as small (r = 0.1), medium (r = 0.3) and large (r = 0.5).

3. RESULTS

Participants reported a mean age of 51.3 ± 5.6 (36–66) years. Participants were either perimenopausal (47.8%, n = 11) or post-menopausal (52.2%, n = 12). The majority of participants reported having no musculoskeletal issues or clinical conditions (65.2%, n = 15), while others reported having one or more musculoskeletal issues or clinical conditions (34.8%, n = 8) (Table 2).

Table 2 Reported musculoskeletal issues and clinical conditions.

PARTICIPANT	REPORTED MUSCULOSKELETAL ISSUES AND CLINICAL CONDITIONS
1	Dystonia (one arm)
2	Underactive thyroid
3	Type 2 diabetes mellitus
4	Asthma, previous myocardial infraction, and high cholesterol
5	Back pain, high blood pressure, and high cholesterol
6	Post-ovarian cancer treatment
7	Asthma
8	Anaemia

The majority of participants were not taught about menopause at school (95.5%) (Table 3). At 40, most participants felt not informed at all about perimenopause/menopause (68.2%). Many participants started to look for information on perimenopause/menopause as their symptoms started (45.5%), or a long time after their symptoms started (40.9%). Participants previously sourced information on the menopause primarily from healthcare professionals (72.7%) and friends (68.2%). Participants believed that information on menopause should be taught in the doctor's surgery (68.2%) and school (59.1%).

Table 3 Menopause knowledge and education questionnaire results (n = 22).

QUESTIONS	ANSWERS	% (n)
Were you taught about menopause at school?	Not at all	95.5 (21)
	Some basic information	4.5 (1)
	Very detailed information	0.0 (0)
How informed did you feel about perimenopause/menopause at 40?	Not informed at all	68.2 (15)
	Some knowledge	27.3 (6)
	Very informed	4.5 (1)
	Not sure	0.0 (0)
When do you think menopause should be taught?	Doctors' surgery	68.2 (15)
	School	59.1 (13)
	Apps such as period trackers & fertility apps	45.5 (10)
	University	27.3 (6)
	Pregnancy	22.7 (5)
	Contraception clinic	18.2 (4)
	Other	13.6 (3)
When did you start to look for information on perimenopause/menopause?	As my symptoms started	45.5 (10)
	A long time after my symptoms started	40.9 (9)
	Before I had symptoms	13.6 (3)
	I have not looked for any information yet	0.0 (0)

(Contd)

QUESTIONS	ANSWERS	% (n)
Have you looked for information about the menopause in any of these ways?	Health professionals	72.7 (16)
	Friends	68.2 (15)
	Social media	54.5 (12)
	Official websites	54.5 (12)
	Podcasts	36.4 (8)
	Other websites	31.8 (7)
	Documentaries	27.3 (6)
	Scientific literature	22.7 (5)
	Magazines	22.7 (5)
	Films & TV programmes	22.7 (5)
	Books	18.2 (4)
	YouTube	4.5 (1)
	Newspapers	4.5 (1)

A statistically significant improvement, with a large effect size, was observed for the sit-to-stand test ($p < 0.001$, $\eta^2 = 0.81$), sit-and-reach test ($p < 0.001$, $\eta^2 = 0.49$), box press-up test ($p < 0.001$, $\eta^2 = 0.73$), 6-minute walk test ($p < 0.001$, $\eta^2 = 0.56$), MRS ($p < 0.001$, $\eta^2 = 0.76$), WHO-5 ($p = 0.003$, $\eta^2 = 0.36$), and LIVAS ($p = 0.011$, $\eta^2 = 0.27$) (Table 4). No statistically significant change was observed for M1 and single-leg balance on either leg ($p > 0.05$).

VARIABLE	MEAN ± SD PRE	MEAN ± SD POST	p-VALUE	EFFECT SIZE
Sit-to-stand test (reps)	27.4 ± 4.5	34.7 ± 5.4	**<0.001***	Large $\eta^2 = 0.81$
Sit-and-reach test (cm)	23.2 ± 6.9	26.9 ± 7.7	**<0.001***	Large $\eta^2 = 0.49$
Box press-up test (reps)	26.2 ± 5.5	36.9 ± 8.9	**<0.001***	Large $\eta^2 = 0.73$
6-minute walk test (m)	645.7 ± 101.1	691.7 ± 94.7	**<0.001***	Large $\eta^2 = 0.56$
MRS	16.6 ± 7.3	11.0 ± 5.0	**<0.001***	Large $\eta^2 = 0.76$
M1	3.8 ± 1.8	4.2 ± 1.2	0.26	Moderate $\eta^2 = 0.06$
WHO-5	13.4 ± 3.9	16.3 ± 2.9	**0.003***	Large $\eta^2 = 0.36$
LIVAS	26.2 ± 4.5	29.1 ± 5.9	**0.011***	Large $\eta^2 = 0.27$
Single leg balance: Left (s)	7.9 ± 6.0	8.7 ± 7.8	0.05	Medium r = 0.40
Single leg balance: Right (s)	12.0 ± 9.6	8.8 ± 7.0	0.72	Very small r = 0.07

Table 4 Pre- and post-intervention mean, standard deviation, p-value and effect size for all tested variables (n = 23 for all tested variables, apart from the sit-and-reach test which has n = 22).

Abbreviations: *statistical significance; SD, standard deviation; Reps, repetitions; Cm, centimetres; M, metre; S, seconds; MRS, menopause rating scale; M1, single-item measure physical activity participation; WHO-5, World Health Organization Five Wellbeing Index; LIVAS, Lichamelijke Vaardigheden Schaal or perceived physical activity; η^2; Eta squared.

4. DISCUSSION

The key findings of this pilot study show that 'MenoWell', a 6-week online menopause-specific multimodal exercise and health education intervention, significantly improved cardiorespiratory fitness, upper- and lower-body muscular strength and endurance, flexibility, menopausal symptoms, perception of physical abilities, and wellbeing in perimenopausal and post-menopausal women. Thus, this 6-week novel, evidence-based, female-specific, inclusive, easily accessible, and time-efficient online intervention promotes the adoption of healthy lifestyle habits and improves physiological health, physical self-efficacy, and wellbeing, which in turn contributes to improvements in menopause symptoms and overall health in ageing women. To our knowledge, this is the first time the efficacy of a menopause-specific online multimodal exercise and health education intervention has been examined in women in all stages of menopause.

Menopause is a significant and unique life event in a woman's life. It impacts physical and mental health, as well as the personal, social, and work lives of women (Kracht et al., 2022; Monteleone et al., 2018). Most participants in the current study did not feel informed at all about perimenopause or menopause before 40 years of age. Additionally, they started to look for information about

perimenopause or menopause either when their symptoms started or a long-time after their symptoms had started. These findings are in agreement with those reported by Harper et al., (2022), and highlight that many women are unaware of the symptoms or physiological changes that occur with menopause and female ageing before becoming perimenopausal. This may have negative consequences on their experience of menopause, as they may not recognise that the symptoms they are experiencing are menopause-related, may avoid seeking treatment, or may not possess the practical tools to effectively manage their symptoms, as well as their lifelong health, as they may not be aware of importance or how to sustain positive lifestyle behaviours which can support functional healthy ageing in women. Accordingly, a large number of participants in this study believe that menopause education should be provided in doctor's surgeries or schools, suggesting that information on menopause should be more widely and freely available. It is important to note that this questionnaire did not include the option of 'work' as an opportunity to receive menopause education. Many women will experience menopause while in paid employment, and depending on the severity of menopause symptoms, this may lead to increased rates of sickness absence and decreased functional productivity, which in turn leads to increased indirect costs for the employer (D'Angelo et al., 2022; Oude Hengel et al., 2023). It may also provoke some women to consider reducing their working hours, changing jobs, or turning down additional roles and responsibilities, or leaving the workforce (D'Angelo et al., 2022). Hence, menopause-specific, evidence-based health education may be pivotal for employers and employees to support ageing women struggling with menopause symptoms at work and to provide a positive, inclusive, and flexible working environment to retain these women in employment. Participants mainly sourced menopause information from health professionals, followed by friends, social media, and official websites. As a first point of contact, health professionals need to be aware of the most up-to-date evidence-based guidelines for menopause care to make sure women are offered sufficient advice to make informed decisions and feel supported throughout and after the menopausal transition. Women are often anxious and overwhelmed by menopausal symptoms and visiting a health professional can be a stressful experience, particularly if there is limited time available (Dintakurti et al., 2022). Hence, a multidisciplinary approach for the management of menopause may be considered best practice, as GP's can provide individualised hormonal or non-hormonal treatments and exercise physiologists and registered nutrition/dietetic professionals can offer simple, practical, effective, evidence-based lifestyle behaviour advice and support. Informal sources of support, i.e., friends and social media, are not considered as reliable sources of information on the menopause and therefore, seeking information from reliable sources must be encouraged.

The loss of estrogen which accompanies the cessation of menstruation is often associated with an array of physical and psychogenic symptoms which impair a woman's health-related quality of life (Ali et al., 2020; Briggs & Kovacs, 2015). However, there is substantial variation in the presence and severity of these symptoms between different women. A quantitative measurement of the impact of menopausal symptoms on a woman's health-related quality of life can be obtained using the validated MRS questionnaire. Women reporting a total MRS score of >16 indicates a severe impact on quality of life (Blümel & Arteaga, 2017). We report a significant reduction in the total MRS score after 'MenoWell', from a mean score of 16 to 11. This finding has clinical significance as the lower the total MRS score, the less detriment menopausal symptoms have on a woman's health-related quality of life. Additionally, a woman experiencing less menopausal symptoms may require less visits to their local GP or pharmacy and reduce work and/or commitment impairments. In line with this, we found a significant increase in subjective psychological wellbeing, a positive dimension of mental health which was accessed by the WHO-5 index, and positive self-efficacy beliefs, quantified using the LIVAS questionnaire, following 'MenoWell'. Subjective psychological wellbeing is an important determinant of perceived quality of life (Sischka et al., 2020). The WHO-5 index encompasses questions based on positive mood, vitality, and general interest. It is possible that higher scores of subjective psychological wellbeing reported by participants in this study following 'MenoWell' are reflective of increased knowledge of key topics related to women's health and the menopause, enhanced feelings of empowerment and control, increased motivation and mood, experiencing fewer menopausal symptoms, and feeling fitter, stronger, and more energised. Additionally, higher subjective psychological wellbeing may be related to reduced fear and feelings of negativity which commonly surround menopause. Self-efficacy, which is based on the theory of social learning, is described as an individual's beliefs about their capability to perform a particular behaviour or task (Bandura, 1977). Physical self-efficacy is considered a predictor of the adoption and maintenance of physical activity (Zelle

et al., 2016). Individuals with high physical self-efficacy are more likely to initiate and sustain engagement in physical activity (Zelle et al., 2016), which will have a positive impact on physical wellness. Participants in this study reported higher physical self-efficacy following 'MenoWell', which may be due to increased knowledge of the importance and specific exercise prescription of multimodal exercise for health, as well as the benefits and practical recommendations for reducing sedentary behaviour, receiving clear and correct technique-driven instructions in the live online exercise classes and pre-recorded exercise videos, improved confidence to complete multimodal exercise at an intensity which is most suitable for them, having access to an on-demand library of exercise videos to encourage participants to meet weekly exercise recommendations (e.g., extra balance exercise for participants who have frailty or osteoporosis), and achieving higher scores in their physical test assessments post-intervention. Previous studies have reported fewer menopausal symptoms and improved sleep quality, vitality, emotional and mental health in menopausal-aged women following at least 12 weeks of aerobic, concurrent (aerobic and strength) or trimodal (aerobic, strength, and flexibility) exercise training, with and without sporadic health education (i.e., once a month for 6 months), or 12 weeks access to women-specific health information resources, with and without health professional support (Anderson et al., 2015; Aparicio et al., 2021; Baena-García et al., 2022; Dąbrowska et al., 2016; Mansikkamäki et al., 2012). To the author's knowledge no previous published interventions combined multimodal exercise, incorporating the four health-related components of fitness, and health education for ageing women. We have shown that 'MenoWell', a 6-week menopause-specific online multimodal exercise and health education intervention can improve menopausal symptoms, physical self-efficacy and wellbeing in a shorter period of time.

Concomitant to menopausal symptoms, there are multiple deleterious physiological adaptations which occur as result of the hormonal changes in menopause and female ageing. These negative physiological adaptations are associated with increased cardiovascular and metabolic risk and incidence of chronic non-communicable diseases including obesity, cardiovascular disease, T2DM, and the metabolic syndrome. Sarcopenia is a progressive skeletal muscle degenerative disorder, leading to detrimental losses in muscle strength, muscle quality and/or quantity, and physical performance, thereby increasing the likelihood of functional impairment, physical disability, falls, fractures, and mortality (Buckinx & Aubertin-Leheudre, 2022; Cruz-Jentoft et al., 2019). Sarcopenia begins at 30 years of age, with decrease in muscle mass of around 3–8% per decade but is accelerated by the combined impact of menopause and ageing due to hormonal changes, namely the estrogenic decrease (Buckinx & Aubertin-Leheudre, 2022). Postmenopausal osteoporosis is also a common skeletal disorder, caused by an imbalance of bone formation and bone resorption, leading to a progressive loss of bone tissue and increased risk of fractures (Calleja-Agius & Brincat, 2015). The loss of ovarian function with menopause causes rapid bone loss, with the maximum rate of loss occurring during the first 5 years following the end of menstruation (Geier & Benham, 2022). In order to ameliorate these physiological changes, particularly preserving muscle mass and bone mass, as well as optimal physical health, cardiometabolic health, mental health, functional capacity, and independence, young women in addition to perimenopausal and postmenopausal women must understand the importance and practical application of multimodal exercise, nutrition, and other healthy lifestyle behaviours for the management of menopausal symptoms and the prevention or management of sarcopenia, osteoporosis, chronic disease, morbidity, and early mortality.

We found, performing two live and/or on-demand 40-minute online multimodal exercise classes per week for a period of 6 weeks significantly improved cardiorespiratory fitness, upper- and lower-body muscular strength and endurance, and flexibility in perimenopausal and postmenopausal women. Cardiorespiratory fitness is an independent predictor of all-cause and cardiovascular disease mortality, meaning that the higher an individual's cardiorespiratory fitness, the lower the risk of non-communicable chronic diseases and mortality from all-causes and cardiovascular disease, irrespective of age, body composition and other risk factors (Fardman et al., 2021; Garber et al., 2011; Hoeger et al., 2019). As menopause is a period of elevated cardiovascular risk, improving cardiorespiratory fitness is extremely important for ageing women. We also found a significant increase in the total distance covered in the 6-minute walk test demonstrating that cardiorespiratory fitness can be increased by engaging in 'MenoWell'. Other pivotal components of health-related physical fitness are muscular strength and endurance. Together, these are key indicators of current health status and functional capacity and predictors of mortality in healthy and clinical populations (Strassmann et al., 2013). Muscular strength and endurance,

as well as the preservation or improvement of muscle and bone mass and function, can be achieved through progressive resistance or strength training (Hoeger et al., 2019) which was a key component of this multimodal exercise training intervention. There was a significant increase in the number of repetitions performed in the press-up test and sit-to-stand test highlighting a substantial improvement in upper- and lower-body muscular strength and endurance, respectively, in perimenopausal and postmenopausal women following 'MenoWell'. We report a significant increase in the average score of the sit-and-reach test post-intervention, implying that lower back and hamstring flexibility improved after 'MenoWell'. This result has important implications for everyday life as lower-back and hamstring flexibility is required for a multitude of activities of daily living, for example bending over to pick up shopping bags or bending over to tie shoelaces. Additionally, as joint and muscle pain and stiffness can increase post-menopause as a consequence of declining estrogen levels (Geier & Benham, 2022), improving flexibility can help to relieve chronic pain and discomfort, improve posture and gait, and enhance wellbeing and quality of life (Hoeger et al., 2019). A recent study in women aged 50+ years in Ireland reported improved aerobic fitness and lower-body strength and endurance following a 6-week hybrid (online/onsite) intervention of aerobic training (2 hours/week), concurrent training (aerobic and strength, 2 hours/week), and health education (1 hour/week) (Cooper et al., 2022). Of note, similar adaptations were found in our study with only a combined total of only 2 hours, compared to 5 hours of multimodal exercise and health education per week for 6 weeks. Comparisons with other interventions focused on training one (aerobic), two (aerobic and strength), or three (aerobic, strength, and flexibility) components of fitness in ageing women is hindered by the lack of post-intervention analysis of physical performance (Aparicio et al., 2021; Baena-García et al., 2022; Dąbrowska et al., 2016; Mansikkamäki et al., 2012).

Despite significant improvements in cardiorespiratory fitness, muscular strength and endurance, and flexibility, we found no significant changes in single-leg balance on the right or left leg, when measured with the 30-second single-leg stance eyes closed balance test. The balance exercises incorporated in the exercise classes in this programme were performed with eyes open to reduce the risk of falls in the home environment. Maintaining balance requires the integration of the visual system, vestibular system, and proprioception to provide information on body position and movement to the central nervous system (Steinberg et al., 2023). Hence, the ability to sustain balance is challenged significantly when visual input is removed (i.e., the eyes are closed). On reflection, in this case, the single-leg stance eyes closed balance test was not specific to the training performed (eyes open) and this may have contributed to non-significant change in bilateral single-leg balance. Therefore, it is possible that improvements in single-leg balance may have been identified following 'MenoWell' if a validated and reliable single-leg stance eyes open balance test had been utilised and this must be considered for future studies.

While we did not examine changes in menopause-specific health literacy, the 'MenoWell' health education workshops focused on key areas that are important for women in all stages of menopause including maintaining and developing muscle mass and strength, protecting bone mass and cardiovascular health, and prioritising sleep hygiene, healthy nutrition, and self-care. The health education workshops were designed to empower women with the knowledge and practical skills they need to adopt and maintain evidence-based and effective lifestyle behaviours to support physical health, mental health, and wellbeing within a positive and motivating environment and having the opportunity to ask questions. This approach is supported by a previous study reporting that women actively engaged and were comfortable receiving online menopause-specific health education and felt supported when learning about menopause with other women (Kracht et al., 2022). Tailored (i.e., population-specific) health education, to increase awareness and develop or improve practical skills, is a core component of positive behaviour change and long-term maintenance of same. Participants need to understand why the information included in the health education workshops is pertinent to them and how to take this information and practically implement it in their daily lives to achieve desired health outcomes, which are key components to improving self-efficacy (Arlinghaus & Johnston, 2018). As an example, the first health education workshop of 'MenoWell' focused on providing information and magnetic resonance imaging (MRI) scans of menopause and female ageing-induced changes in skeletal muscle mass, specifically the loss of muscle mass and muscular strength and endurance (i.e., sarcopenia), and the deleterious health implications of same (e.g., prediabetes, T2DM, frailty, falls etc.). Subsequently, participants were educated on the frequency, intensity, time, and type of resistance training that should be performed each week to attenuate sarcopenia and provided with nutritional recommendations and sample

recipes to ensure ageing women are consuming adequate amounts of protein each day to mitigate sarcopenia and to stimulate muscle protein synthesis after resistance training. By providing health education in this manner, fewer potential barriers to behaviour change will be identified and participants' real or perceived ability to make changes to their daily lives to improve their overall health and wellbeing will be positively impacted.

The findings and the implications arising from this pilot study should be considered with respect to the limitations. Firstly, this was a one-group pretest-posttest design study with no control group, and therefore, we suggest that a randomised controlled trial be conducted. Secondly, the sample size in this pilot study is small and was further reduced by numerous drop-outs throughout the intervention, due to personal reasons and seasonal interferences as the intervention was conducted in the summer months. As this was an initial pilot study, it is critical that future studies include a larger sample size that satisfies the statistical power of the experiment. Thirdly, the results of this pilot study are specific to women living in Ireland. Hence, 'MenoWell' should be performed internationally as the findings may not be generalisable to other populations in different countries.

5. CONCLUSION

The results of this pilot study demonstrate a lack of awareness and knowledge of perimenopause and post-menopause in midlife women living in Ireland and highlight the need for increased availability and accessibility to reliable and evidence-based information, particularly in advance of the menopausal transition (i.e., women aged 30 years and older). The key findings of 'MenoWell', a 6-week novel, online, home-based, and time-efficient (2 hours in total of participant time per week) menopause-specific multimodal exercise and health education intervention, show that cardiorespiratory fitness, upper- and lower-body muscular strength and endurance, lower-back and hamstring flexibility, menopausal symptoms, subjective wellbeing, and physical self-efficacy were significantly improved in perimenopausal and post-menopausal women living in Laois, Ireland. These findings corroborate the need for the future rollout of accessible and inclusive women-specific multimodal exercise and health education programmes, based on the most up-to-date scientific research, to enhance menopause-specific knowledge particularly on menopausal symptoms and chronic diseases associated with menopause and female ageing, to promote the adoption and maintenance of simple, practical, and positive lifestyle behaviours, and to support and achieve optimal physical, mental, emotional, social, and occupational wellness for midlife and older women.

DATA ACCESSIBILITY STATEMENT

The data supporting the findings of the current study are available from the corresponding author on reasonable request.

ADDITIONAL FILE

The additional file for this article can be found as follows:

- **Supplementary File 1.** Pre- and post-testing questionnaires. DOI: https://doi.org/10.5334/paah.296.s1

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COMPETING INTERESTS

DC, KW, and RK are employed by EduFIT Limited. SO'C has no competing interests to declare.

AUTHOR CONTRIBUTIONS

All authors had access to the data used in this study and take responsibility for the integrity of the data. The study was designed by DC, KW, and RK. SO'C was responsible for data analysis. All authors were responsible for the interpretation of the data and preparation of the manuscript and were involved in the critical review for important intellectual content. Approval of the final manuscript was given by all authors.

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