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PHYSICAL ACTIVITY AND HEALTH

A Pilot 6-Week Lifestyle Intervention in Women Aged 50+ in Ireland

RESEARCH

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ABSTRACT

Introduction: The deleterious effects of ageing and inactivity are compounded by the menopause which typically occurs in females aged 50+. The menopause is associated with unfavourable changes in body composition including decreased skeletal muscle mass, bone density and increased adipose tissue. This study aimed to determine the effects of a 6-week community-based intervention on nutrition knowledge and physical, metabolic, and cardiovascular health of women aged 50+ years.

Methods: Nineteen participants (57 ± 6 years, 32.4 ± 7.2 kg/m^2) completed the intervention consisting of 2 hours of aerobic training (home-based / participant led), 2 hours of concurrent training (instructor led) and one 60-minute health workshop per week. General nutrition knowledge was assessed using an adapted validated questionnaire. Body weight, body mass index (BMI), body composition and waist circumference were measured pre and post intervention. Lower body strength endurance and cardiovascular endurance were assessed using sit-to-stand and 6-minute walk tests respectively. Point-of-care testing determined fasting glucose and lipid profile.

Results: There were significant reductions in body weight (–2.2 ± 2.0 kg, $p < 0.01$), BMI (–0.9 ± 0.8 kg/m^2, $p < 0.05$), percent body fat (–1.1 ± 0.5%, $p < 0.05$), waist circumference (–2.4 ± 0.5 cm, $p < 0.05$) and fasting glucose (–0.6 ± 0.8 mmol/L) post intervention. General nutrition knowledge score (5.8 ± 0.05, $p < 0.05$), 6-minute walk test (Mdn = 82.5, IQR = 49.5, $p < 0.05$) and sit-to-stand performance increased (11.5 ± 4.5 repetitions, $p < 0.05$) significantly.

Discussion: This intervention successfully improved body weight, BMI, body fat percent, waist circumference, fasting glucose, general nutrition knowledge, cardiovascular fitness, and lower body strength of participants. Metabolic health improved with a trend towards improved cardiovascular health.

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INTRODUCTION

Ageing elicits negative physiological adaptations in body composition, muscle strength, aerobic fitness, and cardiometabolic health (Janssen and Ross 2005). The ageing process is exacerbated by physical inactivity, which accelerates sarcopenia, leading to increased risk of frailty, falls, poor physical health, mental health, quality of life and early mortality (Chodzko-Zajko *et al.* 2009). The deleterious effects of ageing and inactivity are compounded by the menopause which typically occurs in females aged 50+ (Gold 2011). Menopause induced reductions in oestrogen are associated with lower bone density (Finkelstein *et al.* 2008). Additionally, the menopause is associated with unfavourable changes in body composition including decreased skeletal muscle mass and increased adipose tissue (Clegg *et al.* 2017). Importantly, abdominal body fat accumulation is evident, which is associated with increased risk of elevated blood pressure, fasting glucose levels and dysregulation of the lipid profile (Clegg *et al.* 2017). There is also evidence to suggest that the reduced oestrogen levels in this population further increase the risk of developing cardiometabolic diseases including type 2 diabetes (T2DM) and cardiovascular diseases (Clegg *et al.* 2017).

Physical activity (PA), plays a crucial role in healthy ageing and this is particularly true for inactive females during and after the menopause (Chodzko-Zajko *et al.* 2009). The physiological adaptations that occur in response to training are specific to the type of training undertaken. Aerobic training improves body composition, visceral adipose tissue, lipid profile, blood pressure, cardiovascular health, insulin sensitivity and metabolic health (Chodzko-Zajko *et al.* 2009). Weight bearing aerobic training also positively affects bone mineral density in postmenopausal women (Kemmler *et al.* 2020). Importantly, aerobic training increases cardiovascular fitness, which is an independent predictor of health and is associated with reduced risk of cardiometabolic diseases (Chodzko-Zajko *et al.* 2009). Resistance training increases muscle mass, muscle strength, muscle endurance and muscle power (Chodzko-Zajko *et al.* 2009). Resistance training is effective in ameliorating age and inactivity related sarcopenia, improving balance, reducing risk of frailty and falls and the morbidity and mortality that is associated with same (Chodzko-Zajko *et al.* 2009). Resistance training also plays a crucial role in increasing bone mineral density by positively stressing bone building osteoblasts (Kemmler *et al.* 2020). These adaptations are important for all adults for healthy ageing but are particularly important for post-menopausal women who experience profound bone loss and high prevalence of osteopenia and osteoporosis following the loss of oestrogen in menopause (Kemmler *et al.* 2020). The physiological adaptations that occur in response to aerobic and resistance training improve overall physical health, mental health, functional independent living, and quality of life, which is particularly evident when comparing trained older adults to their age-matched untrained counterparts (Chodzko-Zajko *et al.* 2009). These adaptations are important for all adults but are crucial for women who experience additional menopause induced threats to bone health, muscle health, cardiovascular health, and metabolic health. Both forms of training should be incorporated into interventions for women over 50 years of age to yield maximum benefits for participants.

Nutrition plays a crucial role in healthy ageing and the management of menopausal symptoms (Hagey and Warren 2008). Evidence-based strategies such as reducing saturated fat intake and replacing with unsaturated fats, reducing caffeine and alcohol intake, and increasing the consumption of plant-based foods as practised in the Mediterranean diet have been shown to ameliorate menopausal symptoms (Noll *et al.* 2021). However, Irish research indicates that middle-aged and older adults (males and females) unfavourably consume diets high in fat, saturated fat, salt, sugar, and sub optimally consume fruits, vegetables, protein, and dietary fibre (Kehoe *et al.* 2021, Hone *et al.* 2020). These nutrition behaviours have implications for the health status of this population and health promotion interventions for this cohort are warranted. Therefore, community-based interventions which incorporate multimodal PA and focus on augmenting nutrition and health knowledge, may increase self-efficacy to adopt and maintain health behaviours that confer significant benefits for middle-aged and older women. There are limited interventions which aim to specifically promote the health of females aged 50+ in the literature. The aim of this study is to determine the effects of a 6-week community-based intervention on nutrition knowledge and on the physical, metabolic, and cardiovascular health of women aged 50+ years living in Laois, Ireland. We hypothesise that there will be improvements in cardiovascular fitness, strength, lipid profile, blood glucose and nutrition knowledge in the participants post intervention.

METHODS

STUDY DESIGN

This study employed a pre-test post-test study design using quantitative data from a 6-week aerobic and concurrent training and health education intervention. Participants attended one private and one group testing session pre and post intervention.

PARTICIPANTS

Females aged 50+ years living in Laois, Ireland were invited via True Fitness and Laois Sports Partnership social media channels including Facebook and Twitter to participate in a 6-week community-based lifestyle intervention from 14th January 2019 – 21st February 2019. Ethical approval was obtained from the Institute Research Ethics Committee at the Institute of Technology Sligo. All participants were provided with a detailed participant information sheet and written informed consent was obtained prior to participation in this research. Participants completed a health history and screening form.

6-WEEK INTERVENTION

The intervention (Figure 1) consisted of 2 hours of aerobic training (home-based/participant led), 2 hours of concurrent training (instructor led) and one hour of health education per week and was developed by a multidisciplinary team consisting of a clinical exercise physiologist, qualified exercise strength and conditioning instructor, nutritionist, and registered dietitian.

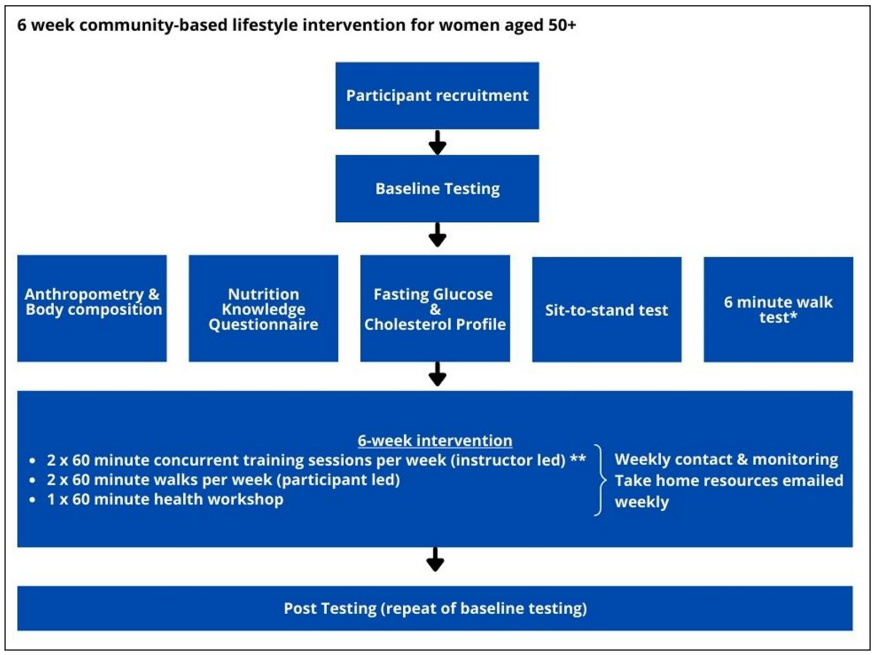

Figure 1 Stages of the 6-week intervention for women aged 50+ years. * These tests were completed in a group setting and participants did not need to fast or avoid strenuous activity before these tests were completed. ** The concurrent training sessions were designed and monitored by a clinical exercise physiologist to ensure safety due to the clinical conditions in the group.

PRE AND POST TESTING PROCEDURES

Participants were asked to fast for 12 hours and not to do any strenuous physical activity 24 hours prior to private pre and post testing. This involved taking a fasted blood sample (40 ul) from the participants index finger using a lancing device and capillary pipette. Fasting blood glucose and lipid profile ((total cholesterol (TC), high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol and triglycerides)) were assessed using a One Touch glucometer and the CardioChek Professional Analyser (BHR Pharmaceuticals Limited). Blood pressure was measured using an electronic blood pressure monitor (Medicare Lifesense A2) after each participant had been seated with legs uncrossed for 10 minutes. Anthropometric measurements were taken following the World Health Organisation STEPwise Approach to Surveillance physical measurement guidelines for arm, chest, waist, abdomen, and hips (World Health 2011). Body composition, body weight (kg), body fat percentage and lean muscle tissue (kg) was estimated using a Tanita Innerscan Segmental Body Composition Monitor (BC545). Participants were asked to remove footwear and socks before body composition analysis and height measurements. BMI was calculated by dividing total body weight in kilograms by height in meters squared (World Health Organisation, no date).

A nutrition knowledge questionnaire was adapted from a validated questionnaire (Kliemann *et al*. 2016) to suit an Irish population. Questions specific to the health education workshops were also added to assess nutrition knowledge pre and post intervention (Additional File 1). Questionnaires were scored to indicate complete answers. The maximum possible score was 28 with a higher score indicating greater nutritional knowledge.

The group testing sessions involved measuring aerobic fitness using the 6-minute walk test (Lipkin *et al*. 1986) and lower limb strength endurance using the 60-second sit-to-stand test (Bohannon 2012). Prior to both tests, clear instructions were verbally communicated, and participants had an opportunity to ask questions.

DATA ANALYSIS

IBM SPSS Statistics version 24 was used to statistically analyse the data. Normality of data was determined using the Shapiro-Wilks test where a normal distribution was established at $p > 0.05$. Paired samples t-tests were used to assess the impact of the 6-week intervention by comparing the mean differences between pre and post test results for parametric data sets. The Wilcoxon Signed Rank test was used to assess median differences between pre and post non-parametric data sets. Statistical significance was established at $p < 0.05$.

RESULTS

Twenty-four participants were recruited for this study. Nineteen participants (57 ± 6 years, 32.4 ± 7.2 kg/m^2) completed the intervention to give an adherence rate of 79.2%. The baseline health history questionnaire identified several clinical conditions including back pain (n = 10), hypertension (n = 6), high total cholesterol (n = 5), joint disorders (n = 5), asthma (n = 3), muscle injuries (n = 2), bone disorders (n = 2) and type 2 diabetes mellitus (n = 1).

PHYSICAL CHARACTERISTICS

Post intervention there were significant reductions in total body weight, BMI, body fat percent, arm, chest, waist, abdominal and hip circumferences (Table 1). Based on baseline BMI, 26.3% (n = 5), 10.5% (n = 2) and 63.2% (n = 12) of participants were classified as having healthy weight, overweight or obesity respectively. BMI classification remained the same post intervention, however there were less participants classified as obese class 3 post intervention (15.8% pre vs 10.5% post) (data not shown). Lean muscle mass increased however this was not statistically significant. There were less participants classified as being abdominally obese as determined by waist circumference from pre (84.2%, n = 16) to post intervention (84.2%, n = 15). Performance in the 6-minute walk test and sit-to-stand test increased significantly post intervention (Table 1).

	PRE-TEST	POST-TEST	Δ CHANGE (+/–)	SIGNIFICANCE/ p-VALUE
Weight (kg) n = 19	83.5 (±18.8)	81.3 (±18)	–2.2 (±2)	$p < 0.05$*
Body fat (%) n = 18**	42 (±6.9)	40.9 (±6.4)	–1.1 (±1.5)	$p < 0.05$*
Lean muscle (kg) (Mdn, IQR) n = 18**	(44.1, 11)	(45.4, 11.1)	(+1.3, 1.7)	0.37
BMI (kg/m^2) n =19	32.4 (±7.2)	31.5 (±6.9)	–0.9 (±0.8)	$p < 0.05$*
Arm (cm) n = 19	35.2 (±4.6)	34.4 (±4.3)	–0.8 (±0.9)	$p < 0.05$*
Chest (cm) n = 17***	108.7 (±13.9)	106.6 (±12.8)	–2.2 (±1.8)	$p < 0.05$*
Waist (cm) n = 19	95.6 (±14.0)	93.2 (±13.5)	–2.4 (±2.5)	$p < 0.05$*
Abdomen (cm) n = 19	107.4 (±16.2)	104.8 (±16.6)	–2.6 (±2.9)	$p < 0.05$*
Hip (cm) n = 19	107.3 (±11.2)	104.5 (±10.3)	–2.8 (±2.5)	$p < 0.05$*
Waist:Hip ratio n = 19	0.9 (±0.1)	0.9 (±0.1)	0 (±0.03)	0.7
6-minute walk test (m) (Mdn, IQR) n = 16****	(600, 80)	(680, 200)	(+82.5, 49.5)	$p < 0.05$*
Sit-to-stand (repetitions) n = 16****	39.3 (±8.0)	50.8 (±12.5)	+11.5 (±8.9)	$p < 0.05$*

Table 1 Mean (±SD) or median (Mdn), Interquartile range for physical characteristic results pre and post the six-week intervention in women aged 50+ years.

Values expressed as mean ± standard deviation for parametric data sets or Mdn and IQR for non-parametric data sets, * Indicates statistical significance $p < 0.05$, ** The Tanita Innerscan Segmental Body Composition Monitor (BC545) did not provide body fat or lean muscle mass data for one participant during post-testing, *** Two participants abstained from the chest measurement, **** Three participants in total were unable to attend the pre-testing (n = 1) or post testing (n = 2) sessions.

CARDIOVASCULAR AND METABOLIC CHARACTERISTICS

Post intervention there were no changes in LDL cholesterol. Minor reductions were reported for total cholesterol, HDL cholesterol, triglycerides, and TC/HDL ratio, however these changes were not statistically significant. A significant reduction in fasting glucose was reported post intervention (Table 2).

Table 2 Cardiovascular and metabolic characteristic results of the six-week pre-test post-test intervention in women aged 50+ years (n = 19).

	PRE-TEST MEAN (SD)	POST-TEST MEAN (SD)	Δ CHANGE (+/–)	SIGNIFICANCE/p-VALUE
Total Cholesterol (mmol/L)	5.1 (0.9)	4.8 (0.8)	–0.3 (0.6)	0.07
LDL cholesterol (mmol/L)	1.7 (0.5)	1.7 (0.4)	0 (0.6)	0.2
HDL cholesterol (mmol/L)	2.8 (0.7)	2.6 (0.7)	–0.2 (0.2)	0.6
Triglycerides (mmol/L)	1.3 (0.5)	1.1 (0.5)	–0.2 (0.4)	0.1
TC/HDL ratio	3.1 (0.7)	2.9 (0.7)	–0.2 (0)	0.5
Glucose (mmol/L)	6.2 (0.8)	5.6 (0.4)	–0.6 (0.8)	$p < 0.05$*

NUTRITION KNOWLEDGE

The mean (standard deviation) general nutrition knowledge score at baseline was 13.8 (3.2). This increased significantly to 19.6 (3.2) post intervention ($p < 0.05$). General nutrition knowledge increased for 78.6% of questions (n = 22), did not change for 7.1% (n = 2) of questions and decreased for 14.3% (n = 4) of questions (Table 3). All participants could identify correctly what one serving of cooked rice/pasta was pre and post intervention. Post intervention, all participants knew what one serving of fruit was, the recommended total blood cholesterol level, if a person should consider taking a vitamin D supplement and that there is an increased loss of calcium from bones during the menopause (Table 3). There was a decrease in knowledge about a serving of vegetables, if diet has a role in bone health, the nutrients associated with bone health and if there is a slow loss of calcium from ageing bones.

Table 3 Questions answered correctly from the General Nutrition Knowledge questionnaire pre and post the 6-week intervention (n = 18)*. * One person who completed the intervention did not complete the General Nutrition Knowledge questionnaire post intervention, ** 17 participants responded to this question.

QUESTIONS FROM THE GENERAL NUTRITION KNOWLEDGE QUESTIONNAIRE	ANSWERED QUESTION CORRECTLY PRE INTERVENTION N (%)	ANSWERED QUESTION CORRECTLY POST INTERVENTION N (%)
How many servings are recommended daily for fruit, vegetables, and salad?	10 (55.6)	15 (83.3)
What is 1 serving of fruit?	4 (22.2)	18 (100)
What is 1 serving of vegetables?	9 (50)	6 (33.3)
If a person has two glasses of fruit juice in one day, how many of their fruit and vegetable servings would this count as?	6 (33.3)	9 (50)
How many servings are recommended daily for wholegrain breads, pasta, potatoes, rice?	4 (22.2)	6 (33.3)
What is 1 serving of cooked rice/pasta?	18 (100)	18 (100)
What is 1 serving of bread?	7 (38.9)	14 (77.8)
How many servings are recommended daily for cheese, milk, and yoghurt?	6 (33.3)	8 (44.4)
What is 1 serving of dairy?	7 (38.9)	12 (66.7)
Which types of dairy foods are recommended to consume?	11 (61.1)	14 (77.8)
How many servings are recommended daily for meat, poultry, fish, eggs, beans, and nuts?	5 (27.8)	10 (55.6)
What is 1 serving of eggs?	3 (16.7)	9 (50)
What is 1 serving of unsalted nuts and seeds?	2 (11.1)	7 (38.9)
Which fats/oils are recommended for health in small amounts?	13 (72.2)	15 (83.3)

(Contd.)

QUESTIONS FROM THE GENERAL NUTRITION KNOWLEDGE QUESTIONNAIRE	ANSWERED QUESTION CORRECTLY PRE INTERVENTION N (%)	ANSWERED QUESTION CORRECTLY POST INTERVENTION N (%)
What types of fat are recommended that people should eat less or not eat less of?	5 (27.8)	7 (38.9)
What are the alcohol guidelines for men and women in Ireland?	2 (11.1)	6 (33.3)
What is a standard drink?	11 (61.1)	14 (77.8)
Understanding food labels	7 (38.9)	10 (55.6)
Sources of sugar on food labels	8 (44.4)	11 (61.1)
Factors that impact cholesterol levels	4 (22.2)	9 (50)
Are there different types of cholesterol?	14 (77.8)	14 (77.8)
What is the recommended total blood cholesterol level? **	13 (72.2)	17 (100)
Does diet have a role in bone health?	18 (100)	17 (94.4)
What nutrients are associated with bone health?	1 (5.6)	0 (0)
Is there a slow loss of calcium from our bones as we age?	17 (94.4)	16 (88.9)
Should a person consider taking a vitamin D supplement if they have low sunlight exposure and/or eat low amounts of oily fish, cereals, red meat, and eggs?	17 (94.4)	18 (100)
During the menopause is there an increased loss of calcium from the bones?	15 (83.3)	18 (100)
Practical tips to deal with menopause symptoms	11 (61.1)	13 (72.2)
Total score out of 28, mean (SD)	13.78 (3.19)	19.56 (3.24)

DISCUSSION

This study evaluated the impact of a 6-week community-based aerobic training, concurrent training and nutrition education intervention on the nutrition knowledge and physical, metabolic, and cardiovascular health of a cohort of women aged 50+ years in Ireland. The main findings were improvements in general nutrition knowledge, body weight, BMI, body fat percent, arm, chest, waist, abdomen and hip circumferences, cardiovascular fitness, lower body strength and fasting glucose.

Irish representative data indicates that 52% and 81% of women aged between 45 and 64 years are living with overweight and obesity respectively (Department of Health, 2019). Data from the Irish Longitudinal Study on Ageing indicates that one in two people aged ≥50 years have a substantially increased waist circumference with a higher proportion of females (56%) living with abdominal obesity than males (48%) (Leahy *et al*. 2014). Abdominal obesity is a predictor of excess visceral adipose tissue and is associated with an increased risk of high blood pressure, high fasting blood glucose levels, type 2 diabetes mellitus, and other chronic conditions including lower back pain and arthritis (Han *et al*. 2006). This study found significant reductions in body weight, BMI, percent body fat and waist circumference post intervention. There was a reduction in the number of women classified as obese class 3 post intervention. This could have important implications at a population level where a one unit decrease in BMI has the potential to result in 28 less cases of chronic disease per 1,000 women in Ireland (Kearns *et al*. 2014). Our results may also have important implications for women during and post menopause who experience unfavourable changes in body composition, increased abdominal body fat accumulation, and elevated risk of cardiometabolic ill health during this time (Clegg *et al*. 2017).

Physical activity plays an important role in functional healthy ageing (Chodzko-Zajko *et al*. 2009). Aerobic activity improves cardiovascular health, metabolic health, functional and cognitive capacity, and quality of life (Chodzko-Zajko *et al*. 2009). However Irish research indicates that only two-thirds of adults aged ≥50 years in Ireland engage in low or moderate levels of aerobic physical activity and that participation decreases significantly among females with advancing age (Cooper *et al*. 2020). Our study showed a significant increase in distance walked in the

6-minute walk test post intervention. This increase in cardiovascular fitness is associated with improved physical health, mental health, and quality of life (Chodzko-Zajko *et al*. 2009). The data pertaining to participation in resistance training for adults 50+ years in Ireland is scarce, but what is available suggests that participation in strength training is poor, which has serious implications for healthy ageing, particularly for women during and post menopause (Cooper *et al*. 2020). We report a significant increase in sit-to-stand ability post intervention. This is an important finding, particularly in women of this age, since increased leg strength protects against sarcopenia and frailty in addition to increasing bone mass and reducing risk of osteopenia and osteoporosis which is prevalent in this population (Fiatarone *et al*. 1990). While there was no significant increase in lean muscle mass post intervention, the increase that was observed has important clinical implications for this population. Women respond very well to intervention but are more likely to report barriers to physical activity participation including caring roles and body objectification (Verhoef *et al*. 1992, Fredrickson and Roberts 1997). Therefore, interventions that specifically target women's needs and that are delivered in a safe environment are important.

In Ireland, middle aged and older male and female adults unfavourably consume diets high in fat, saturated fat, salt, sugar, and sub optimally consume fruits, vegetables, protein, and dietary fibre (Kehoe *et al*. 2021, Hone *et al*. 2020). These lifestyle behaviours have implications for the health status of this population group and health promotion interventions for this cohort are warranted. While nutrition knowledge is not the sole determinant of food choice, recent research from Italy has shown that those with higher adherence to dietary guidelines are more likely to have a higher nutrition knowledge score (as determined by an adapted version of the Nutrition Knowledge questionnaire)(Bonaccio *et al*. 2013). There was a mean improvement in nutrition knowledge scores of almost 6 (13.8 (3.2) to 19.6 (3.2)) over our six-week intervention which could lead to improvements in overall dietary quality. However, it should be noted that knowledge of some questions decreased. This is something that should be explored further in a larger scale longer duration study.

LIMITATIONS

This study has limitations. There were only 24 women recruited (with 19 completing the six-week intervention) however, this was dictated by the space available for training and workshops. Habitual physical activity levels prior to engagement in this study, which may impact outcomes of this study were not measured in participants. The length of the intervention may have been too short to allow for significant changes in cholesterol profile to be detected. Follow-up is important to determine if improvements are sustained. Finally, the use of a point of care device to assess fasting glucose and lipid profile has inherent limitations.

CONCLUSION

This research indicates that women aged 50+ responded positively to a women-only community-based lifestyle education and physical activity intervention. Community-based lifestyle interventions for females aged 50+ years should at least incorporate a combination of aerobic and resistance exercise in addition to nutrition and health education workshops to improve cardiometabolic health.

ADDITIONAL FILE

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

- **Additional File 1.** Adapted General Nutrition Questionnaire used to assess nutrition knowledge in this study. DOI: https://doi.org/10.5334/paah.195.s1

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COMPETING INTERESTS

The authors have no competing interests to declare.

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