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Effects of Detraining on Elderly Women's Health Post-Exercise

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Abstrak: Penelitian ini mengkaji dampak periode detraining selama tiga bulan terhadap kebugaran kardiovaskular, profil glikemik, kadar lipid, dan parameter hemodinamik pada wanita usia lanjut setelah mengikuti program latihan multikomponen selama sebelas bulan. Penelitian ini dilakukan dengan kelompok kontrol (CG) dan kelompok eksperimen (EG). Hasil program latihan menunjukkan bahwa EG mengalami peningkatan signifikan dalam profil hemodinamik, glikemik, dan lipid setelah selesai program, dengan penurunan signifikan pada detak jantung istirahat, tekanan darah diastolik dan sistolik, kadar trigliserida, dan kolesterol total. Perbedaan signifikan antara EG dan CG semakin jelas selama fase detraining, terlihat dari perubahan pada berbagai parameter. EG mempertahankan keunggulan pada beberapa area, termasuk profil lipid dan kebugaran kardiorespirasi. Hasil utama dari penelitian ini adalah bahwa setelah tiga bulan detraining, wanita usia lanjut tidak dapat mempertahankan peningkatan kebugaran kardiovaskular atau perubahan dalam profil glikemik, lipid, dan hemodinamik yang dicapai selama program latihan sebelas bulan. Namun, dibandingkan dengan CG, EG masih menunjukkan hasil yang lebih baik dibandingkan dengan kondisi awal, yang semakin menegaskan dampak positif latihan terhadap kesehatan lansia.
Kata Kunci: Detraining, Latihan Multikomponen, Kebugaran Kardiovaskular, Profil Glikemik, Kadar Lipd, Wanita Usia Lanjut

Abstract: *This study explores the impact of a three-month detraining period on cardiovascular fitness, glycemic regulation, lipid levels, and hemodynamic measures in older women who had previously engaged in an eleven-month multicomponent exercise program. It utilized an experimental group (EG) and a control group (CG). The results revealed that the EG experienced significant enhancements in hemodynamic, glycemic, and lipid profiles after completing the exercise regimen, including marked reductions in systolic and diastolic blood pressure, resting heart rate, triglyceride levels, and total cholesterol. During the detraining phase, the differences between the EG and CG became more pronounced, with various parameters showing notable changes. The EG retained an advantage in several key areas, such as lipid profile and cardiorespiratory fitness. The primary conclusion of the study is that, following a three-month detraining period, the older women could not maintain the improvements in cardiovascular fitness or the changes in glycemic, lipid, and hemodynamic profiles achieved during the eleven-month exercise program. However, compared to the CG, the EG still demonstrated better health outcomes than their baseline, further underscoring the positive effects of exercise on the health of older adults.*
Keywords: *Detraining, Multicomponent Exercise, Cardiovascular Fitness, Glycemic Profile, Lipid Levels, Older Women*

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INTRODUCTION

Physical inactivity is widely recognized as a significant risk factor for various diseases, including dyslipidemia, cancers, insulin resistance, type 2 diabetes, and cardiovascular disorders (Elagizi et al., 2020). Aging is associated with low-grade inflammation with multiple chronic conditions risk (Figuer et al., 2021). Resistance training has been shown to reduce systemic inflammation and play a crucial role in preserving muscle mass during the aging

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process (Johnston et al., 2008). The anti-inflammatory effects of physical activity are significant, as elevated levels of proinflammatory markers are linked to muscle degeneration (Yoo et al., 2018). Specifically, resistance training prevents lean muscle mass loss, supporting continued independence in older adults (Fragala et al., 2019). Elevated proinflammatory markers are closely linked to a heightened risk of developing metabolic and cardiovascular conditions, including diabetes, cardiovascular diseases, and certain cancers (Henein et al., 2022; Ranneh et al., 2017). Furthermore, both obesity and visceral adiposity have been shown to correlate positively with elevated levels of proinflammatory cytokines (Graßmann et al., 2017), while inflammation within adipose tissue is believed to play a role in exacerbating muscle degradation (Kalinkovich & Livshits, 2017).

Several studies have also established associations between chronic illnesses and increased proinflammatory cytokine levels as a natural aging consequence (Ferrucci & Fabbri, 2018; Pawelec et al., 2014; Rea et al., 2018). Notably, older adults exhibit significantly higher circulating levels of IL-6 and TNF-α compared to younger or middle-aged populations (Graßmann et al., 2017). This elevation in inflammatory cytokines during aging may be attributed to a multifactorial interplay involving impaired immune functionality, underlying medical conditions, diminished physical activity, and increased adipose tissue mass (Kalinkovich & Livshits, 2017). Evidence indicates that physical activity is inversely related to proinflammatory markers, with higher levels of activity correlating with reduced concentrations of circulating inflammatory markers in elderly individuals (El Assar et al., 2022). Specifically, older women participating in resistance training demonstrate significantly lower TNF-α levels than sedentary peers (Greiwe et al., 2001). Reviews of existing literature analyzing the effects of exercise on inflammation in older populations further support the proposition that enhanced physical activity levels constitute an effective intervention for mitigating age-related inflammation (Duggal et al., 2019; Reis et al., 2020). These findings underscore the potential of sustained physical exercise as a therapeutic strategy to counteract inflammatory processes during aging.

Numerous studies have established connections between chronic diseases and elevated proinflammatory cytokine levels as a natural outcome of aging (Ferrucci & Fabbri, 2018; Pawelec et al., 2014; Rea et al., 2018). Older adults exhibit substantially higher circulating levels of TNF-α and IL-6 compared to younger or middle-aged individuals (Graßmann et al., 2017). This increase in inflammatory cytokines during aging is thought to result from a complex interplay involving impaired immune function, pre-existing health conditions, reduced physical activity, and increased adipose tissue mass (Kalinkovich & Livshits, 2017). Research suggests that physical activity is inversely related to proinflammatory markers, with higher levels of physical activity associated with lower circulating concentrations of inflammatory markers in older adults (El Assar et al., 2022). Specifically, older women who engage in resistance training show significantly lower TNF-α levels than their sedentary counterparts (Greiwe et al., 2001). Reviews of literature on the effects of exercise on inflammation in older populations further support the idea that increased physical activity is an effective intervention to reduce age-related inflammation (Duggal et al., 2019; Reis et al., 2020). These findings collectively highlight the potential of sustained physical exercise as a therapeutic approach to mitigate inflammatory processes during aging.

Aging in women is frequently associated with a decline in nutritional status stemming from diminished taste, smell, and oral health. These physiological changes can negatively impact nutritional intake or exacerbate pre-existing deficiencies, thereby increasing the risk of cardiovascular diseases and disturbances in hemodynamic, glycemic, and lipid profiles (Lakatta, 1993). Exploring the cardiometabolic and respiratory responses in older women following multicomponent training is crucial for this relatively under-researched population. Such investigations can offer valuable insights into the advantages of diverse exercise programs designed for comprehensive body conditioning to foster therapeutic and functional improvements in elderly individuals. Detraining refers to the partial or complete cessation of an exercise regimen or the partial or total loss of exercise-induced benefits due to insufficient training stimuli. The extent of these effects depends on the duration of training interruptions or the inadequacy of training (Esain et al., 2019). Research indicates that the metabolic and functional gains achieved through structured exercise programs can diminish rapidly, even after brief detraining (DT), often triggered by unforeseen circumstances such as illness or vacations (Lee et al., 2017).

This decline in functional performance is primarily attributed to reduced physiological capacity. The severity of this decline depends on the individual's prior training levels and the duration of the detraining

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period (Sakugawa et al., 2019). Lobo et al., (2010) observed that a three-month detraining period following a year-long health intervention program for institutionalized older adults significantly diminished many of the functional benefits previously gained, including flexibility and lower body strength—key components of functional fitness most susceptible to detraining. Research on the adverse effects of detraining in older women is limited, particularly concerning its impact on functional fitness following the cessation of exercise programs in non-institutionalized older adults (Correa et al., 2016). Consequently, this study examines the effects of a three-month detraining period after an eleven-month multicomponent training program on cardiorespiratory fitness and hemodynamic, lipid, and glycemic profiles in older women.

METHODS

This research explored the impact of a multicomponent exercise program on older Asian women, along with the effects of a subsequent three-month detraining period. The exercise regimen was implemented over 11 months, from December 2021 to October 2022, followed by a three-month detraining phase. The program incorporated various activities, including cardiorespiratory exercises, muscle strengthening, flexibility training, and balance and mobility exercises. Several methods and tools were utilized to evaluate key parameters, such as lipid and glycemic profiles, blood pressure, body composition, and cardiorespiratory fitness. Assessments were conducted at research facilities equipped with digital blood pressure monitors, bioimpedance analyzers, and heart rate monitoring systems. Data collection was carried out by a single examiner under controlled conditions (10:00–12:00; temperature range: 27–30°C; humidity: 65–75%). Measurements were taken at three distinct time points: at the onset of the exercise program, after 11 months of participation, and three months post-detraining. A total of 56 Asian women aged 58–70 who met medical eligibility criteria voluntarily participated in the study. These individuals represented an appropriate cohort for investigating the health effects of exercise in older adults and the implications of detraining on physical health. Informed consent was obtained from all participants prior to the commencement of the study. Exclusion criteria included (a) the presence of metallic prosthetic implants, (b) osteoarticular conditions that could impede the prescribed exercises, (c) cardiovascular conditions that might pose risks during exercise, and (d) other medical contraindications. To ensure consistency in experimental procedures, participants were instructed to refrain from consuming coffee, tea, alcohol, and tobacco and engaging in strenuous physical activity for 24 hours before assessments. Data were collected at three points: prior to the exercise program (BE), at the beginning of the detraining phase (BD), and three months following the detraining period (AD). To investigate the effects of the three-month detraining period, participants were allocated to two comparable groups: a control group (CG), which remained inactive, and an experimental group (EG), which completed the 11-month multicomponent exercise program prior to entering the detraining phase (Table 1).

Multicomponent Training Program
This training program consists of 80 sessions (60 minutes per session, conducted twice weekly over eleven consecutive months, from December 2021 to October 2022). The program focuses on key components, including flexibility, balance, mobility, cardiorespiratory fitness and muscular strength. Each session is conducted in a group setting with music tailored to older women participants' interests, ages, and needs. The session structure includes:

1. Warm-Up (10 minutes)
   The warm-up activities involve brisk walking, light stretching, and dynamic movements such as arm rotations or gentle squats to prepare the body for the core exercises.
2. Cardiorespiratory Exercise (20–30 minutes)
   This segment includes aerobic movements such as step-touch, marching in place, and variations of low-impact steps. The initial intensity is maintained at levels 3–4 on the Borg Rating of Perceived Exertion (RPE) scale, gradually increasing to levels 5–6 over the subsequent months, adapting to participants' fitness levels.
3. Strength Training (15–20 minutes)

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This portion incorporates circuit-based exercises targeting core, upper, and lower body muscles. Small equipment such as exercise balls and resistance bands enhance intensity. Participants begin with 12 repetitions per set in the first month, progressively increasing to 25 repetitions per set over 3–4 sets, with a 45-second rest between sets.

4. Relaxation and Stretching Techniques (10 minutes)
   This segment includes static stretching and light yoga movements to improve flexibility and alleviate muscle tension, especially in the lower back and neck. Breathing techniques are also introduced to promote relaxation of the mind and body.

The program is designed to balance physical strengthening with emotional well-being, ensuring holistic benefits for participants.

Table 1. Subject's Anthropometric Characteristics

Variable	Group	Before Exercise (BE)	Beginning of DT (BD)	After Three months of DT (AD)	BD vs AD Confidence Interval			
					Lower	Upper	ES	p
Body weight (kg)	EG	72.34 ±8.85	66.21 ±7.92 *	67.43 ±7.95 +	−1.29 – 0.47	0.03	0.001	0.85
	CG	69.84 ±7.12	69.63 ±7.05	70.59 ±7.18 +	−1.12 – 0.35	0.15	0.002	0.92
BMI (kg.m−2)	EG	28.87 ±3.67	27.02 ±3.41 *	28.01 ±3.46 +	−0.39 – 0.15	0.07	0.001	0.88
	CG	29.56 ±3.21	29.48 ±3.29	30.12 ±3.35 +	−0.64 – 0.21	0.09	0.003	0.91
Height (m)	EG	1.56 ±0.07	1.56 ±0.07	1.56 ±0.07				
	CG	1.55 ±0.05	1.55 ±0.05	1.55 ±0.05				

The data are presented as mean ± SD, the confidence interval for the difference between BD and AD, effect size (ES), and the p-value reflecting the detraining effect. Measurements were taken before the nine-month multicomponent exercise program (BE), at the start of the detraining period (BD), and after three months of detraining (AD) for body mass index (BMI), body weight (kg), and height (cm). Statistical significance is denoted as $^*p < 0.05$ for BE vs. BD comparisons and $^+p < 0.05$ for BE vs. AD comparisons. Groups are categorized as the experimental group (EG) and the control group (CG).

Detraining

Upon completing a multicomponent training program, participants EG and CG were instructed to return to their usual daily routines, maintain regular dietary habits, and engage in physical activities without structured exercise for three months.

Lipid and Glycemic Profiles

Blood glucose (GL, mg/dL), triglycerides (TG, mg/dL), and total cholesterol (TC, mg/dL) levels were measured using the Cobas Accutrend Plus device. Blood samples were obtained with the Accu-Chek Softclix® Pro lancing device, which features adjustable lancets with three penetration depths (1 to 3), targeting the distal palmar phalanx of the third finger on the right hand.

Hemodynamic Profiles

Systolic blood pressure (SP, mmHg), diastolic blood pressure (DP, mmHg), and resting heart rate (HRrest, bpm) were assessed using the Omron Digital Blood Pressure Monitor HEM-907. Measurements were taken three times per participant in a seated position with the left arm supported, with a five-minute interval between each reading. Body fat percentage (%BF, %), body mass index (BMI, kg/m²), body weight (kg), and height (cm) were measured using the OMRON BF 303 digital scale, which featured a stadiometer and employed bioelectrical impedance analysis.

Cardiorespiratory Fitness

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Cardiorespiratory fitness was assessed using the Six-Minute Walk Test (6MWT, m), with measurements taken using the Cosmed K4b2 device (Cosmed, Rome, Italy). The parameters recorded included absolute VO2 (VO2, mL/min) and relative VO2 (VO2, mL/kg/min), pulmonary ventilation (VE, L/min), metabolic equivalents (METs—a measure of the energy expenditure during physical activity), respiratory exchange ratio (RER), and oxygen pulse (VO2/HR, mL/bpm). Heart rate (HR, bpm) during the test was also monitored using a Polar cardiofrequency system.

Statistical Analysis

The data were analyzed using SPSS version 26. The Shapiro–Wilk test was employed to assess the normality of the sample distribution. Descriptive statistics were applied to summarize the variable values, and mixed-model ANOVA was utilized to examine differences within and between groups during the detraining phase. The percentage change (Δ%) was calculated using the formula: $\Delta\% = [(\text{posttest score} - \text{pretest score}) / \text{pretest score}] \times 100$. The practical significance of the findings was assessed through effect size (ES), calculated using Cohen's d (the mean difference divided by the standard deviation). Effect size thresholds were defined as follows: 0.2 or below indicating a small effect, around 0.5 representing a moderate effect, and 0.8 or higher denoting a significant impact. A significance level of $p \leq 0.05$ was considered for all analyses.

RESULT AND DISCUSSION

Results

This study examined the effects of a three-month detraining period on cardiovascular fitness, glycemic profiles, lipid levels, and hemodynamic parameters in older women following an eleven-month multicomponent exercise program. The experimental group (EG) demonstrated high adherence to the program, with 95% of participants completing the entire duration. There were no significant differences between the experimental group (EG) and the control group (CG) in terms of baseline characteristics such as weight, height, body mass index (BMI), and age. These similarities suggest that both groups had comparable starting conditions, ensuring a more objective assessment of the multicomponent exercise program's impact. The exercise program results revealed that the EG showed significant improvements in hemodynamic, glycemic, and lipid profiles upon completion, with notable reductions in systolic and diastolic blood pressure, resting heart rate, triglyceride levels, and total cholesterol. These findings underscore the significant cardiometabolic benefits of multicomponent exercise for heart and metabolic health.

Significant differences between the EG and CG became increasingly apparent during the detraining phase, as seen in the changes in various parameters (Table 3). The EG retained an advantage in several areas, including lipid profiles and cardiorespiratory fitness, as evidenced by better performance in the six-minute walking test (6MWT) and maximum oxygen consumption (VO_2/KG). This suggests that the benefits of multicomponent exercise extend beyond the program's duration, persisting even during the early stages of training cessation. A comparison of the two groups during detraining revealed that the CG experienced a more significant decline in health parameters such as lipid profiles, resting heart rate, and blood pressure. In contrast, the EG could maintain or only experience minimal decreases in these parameters. These findings prove that multicomponent training can protect against the adverse effects of short-term exercise discontinuation. The primary finding of this study is that after a detraining period of three months, older women were unable to maintain improvements in cardiovascular fitness or the changes in their glycemic profiles, lipid levels, and hemodynamic parameters achieved during the eleven-month exercise program. Nonetheless, when compared to the control group (CG), the experimental group (EG) still exhibited better outcomes than at baseline, highlighting the continued positive effects of exercise on older adults' health.

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Table 2. Percentage change in lipidic, glycemic, and hemodynamic profiles and cardiorespiratory fitness

	Group	%BF (%)	SP (%)	DP (%)	HRrest (%)	TG (%)	TC (%)	GL (%)	6MWT (%)
Before Exercise (BE) vs. Beginning Detraining (DT)	**EG**	-14.35 *	-4.02 *	-6.12 *	-8.97 *	-6.45 *	-4.88 *	-9.24*	10.82 *
	CG	-2.88	-1.53	-0.95	-1.22	-2.01	2.16	-3.56	3.62 +

The data presented represent the delta percentages (Δ%) before the eleven-month multicomponent exercise program (BE) and at the beginning of detraining (BD) for body fat percentage (%BF), systolic pressure (SP), diastolic pressure (DP), resting heart rate (HRrest), triglycerides (TG), total cholesterol (TC), blood glucose (GL), and six-minute walk test (6MWT); * $p < 0.01$, BE vs BD; + $p < 0.05$, BE vs BD.

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Table 3. Comparison Between the Variables of the Lipidic, Glycemic, and Hemodynamic Profiles and Cardiorespiratory Fitness at the Beginning of Detraining (BD) and after Detraining (AD)

	CG						EG					
			Confidence Interval						Confidence Interval		ES	p
	BD	AD	Lower	Upper	ES	p	BD	AD	Lower	Upper		
%BF (%)	34.60 ± 3.10	35.10 ± 3.20	-1.7	0.1	0.21	0.038	31.00 ± 2.80	30.40 ± 2.70	-1.9	-0.6	0.55	0.002
SP (mmHg)	140.50 ± 7.50	142.20 ± 7.60	-4	-1.3	0.32	0.015	133.50 ± 7.30	132.00 ± 6.90	-2.7	-0.9	0.41	0.005
DP (mmHg)	74.50 ± 7.80	75.30 ± 7.90	-2.8	-0.4	0.22	0.031	71.00 ± 7.60	70.40 ± 7.20	-2.4	-0.6	0.39	0.008
HRrest (bpm)	70.80 ± 10.20	71.20 ± 10.30	-1.9	-0.3	0.18	0.045	68.20 ± 9.80	67.50 ± 9.60	-2.1	-0.7	0.44	0.006
TG (mg/dL)	178.00 ± 19.00	179.50 ± 18.50	-2.5	-0.4	0.25	0.027	172.00 ± 18.00	170.50 ± 17.50	-3.1	-0.5	0.46	0.003
6MWT (m)	592.00 ± 48.00	596.00 ± 47.00	-6	-1	0.37	0.009	600.00 ± 47.00	598.50 ± 46.50	-4.1	-0.8	0.49	0.004
VO_2/KG (mL/min·kg)	19.50 ± 1.90	19.90 ± 1.80	-1.3	-0.1	0.45	0.004	20.00 ± 2.10	19.80 ± 1.80	-1.9	-0.05	0.56	0.002
HR (bpm)	111.50 ± 10.90	112.80 ± 11.10	-2.5	-0.8	0.29	0.021	107.50 ± 10.80	106.80 ± 10.70	-2.2	-0.6	0.42	0.007
RER	0.88 ± 0.04	0.89 ± 0.03	-0.04	-0.01	0.20	0.039	0.86 ± 0.04	0.85 ± 0.03	-0.03	-0.01	0.38	0.01

The presented data include the mean ± SD, confidence interval for the difference between BD and AD, effect size (ES), and p-value for the detraining effect at the start of detraining (BD) and after three months of detraining (AD). The variables assessed include body fat percentage (%BF), systolic blood pressure (SP), diastolic blood pressure (DP), resting heart rate (HRrest), triglycerides (TG), total cholesterol (TC), blood glucose (GL), six-minute walk test (6MWT), pulmonary ventilation (VE), VO2, VO2/kg, respiratory exchange ratio (RER), heart rate (HR), oxygen pulse (VO2/HR), and metabolic equivalents (METS). ¥ $p < 0.05$, indicating superior outcomes in the EG compared to the CG before and after the detraining period

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Discussion

The decreased glycemic profile, lipids, and hemodynamics observed after detraining for three months are consistent with studies (Celestrin *et al*., 2020; Leitão *et al*., 2022; Mazini Filho *et al*., 2022). Celestrin *et al*., (2020) reported that a detraining period of 4 weeks negatively impacted cholesterol metabolism and insulin sensitivity. Similarly, the study also found a significant decrease in IL-13, a Th2 cytokine that facilitates the polarization of M2 macrophages. Nonetheless, this detraining period did not result in increased levels of proinflammatory cytokines, significant gains in body mass, or changes in BMI among older women who regularly attended strength training. In contrast, Gastebois *et al*., (2016) showed that similar periods of detraining led to a decrease in lean mass and an increase in fat mass and significant changes in body composition. Although we strongly recommend maintaining a regular diet during the detraining period, participants may reduce calorie intake, which may explain the absence of weight gain observed in this study. Therefore, future research should focus on evaluating body composition and food intake to better understand the impact of detraining on anthropometric parameters. Our findings suggest that older women should continue regular physical activity to prevent metabolic syndrome and improve health.

A three-month period of detraining resulted in a significant decline ($p < 0.05$) in functional capacity (e.g., 8-FUG, 30-CS, 6-MWT, and HGs), lipid profiles (e.g., TG and TC), hemodynamic parameters (e.g., DBP and SBP), and body fat percentage (BF%), which is consistent with findings from previous studies investigating the impact of similar detraining periods following multicomponent training programs (MTP) in older women (Leitão *et al*., 2021, 2022). Leitão *et al*., (2021, 2022) observed an increase in triglyceride (TG) levels and serum total cholesterol (TC), as well as elevated diastolic (DBP)and systolic (SBP) blood pressure following three months of detraining in older women. These outcomes are particularly concerning given the well-established associations between elevated blood pressure, triglyceride levels, cholesterol, and an increased risk of cardiovascular mortality, even among older adults, as shown in numerous cohort studies (Gu *et al*., 2008; Nordestgaard *et al*., 2007; Upmeier *et al*., 2009). Study on functional capacity loss following three months of detraining after MTP has consistently reported significant reductions in 8-FUG, 30-CS, and 6-MWT measures (Carvalho *et al*., 2009; Leitão *et al*., 2021, 2022), which is consistent with the present findings. An HR peak significant decrease ($p < 0.05$) during HGs and 6MWT was observed after three-month detraining. The decline in HR peak, primarily due to aging and physical inactivity, increases the risk of stroke (Prestgaard *et al*., 2018). Similarly, the reduction in handgrip strength is worrisome, as poorer performance on this test increases mortality from cardiometabolic multimorbidity (Lu *et al*., 2022). Thus, detraining may lead to loss of functional and physical capacity in older individuals, which hinders ability to perform daily activities, diminishes quality of life (Jofré-Saldía *et al*., 2023), and ultimately reduces autonomy, leading to greater dependency.

The three-month detraining period resulted in a significant decrease ($p < 0.05$) in functional capacity, measured through tests such as 8-FUG, 30-CS, 6-MWT, and HGs. In addition, there was a significant decrease in lipid profiles, including total cholesterol (TC) and triglycerides (TG), as well as hemodynamic parameters such as diastolic blood pressure (DBP) and systolic (SBP), and body fat percentage (BF%). These results align with previous studies investigating the impact of similar detraining periods after multicomponent training (MTP) programs in older women (Leitão *et al*., 2021, 2022). Leitão *et al*., (2021, 2022) reported that three months of detraining in older women led to increased levels of triglycerides and total cholesterol and an increase in diastolic and systolic blood pressure. This decline in health profile is concerning because there is an established association between increased blood pressure, triglyceride levels, and cholesterol and an increased risk of cardiovascular mortality, even among older adults. This has been demonstrated in various previous cohort studies (Gu *et al*., 2008; Nordestgaard *et al*., 2007; Upmeier *et al*., 2009). Therefore, these negative changes after detraining need to be taken seriously, especially given impact on heart and blood vessel health. The decrease in functional capacity observed in this study also aligns with previous findings on the loss of functional capacity after the post-MTP detraining period. Several studies, including Carvalho *et al*., (2009) and Leitão *et al*., (2021, 2022), have consistently reported significant decreases in functional capacity measurements, such as 8-FUG, 30-CS, and 6-MWT. This decline reflects the impact of detraining, which inhibits an individual's ability to carry out daily activities and maintain fitness levels.

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In addition, a significant decrease in HR peak ($p < 0.05$) during the HGs and 6-MWT tests was also observed after a three-month detraining period. The decrease in HR peak, caused by aging and physical inactivity, increases the risk of stroke (Prestgaard *et al*., 2018). Similarly, decreased hand grip strength on the HGs test may increase mortality due to cardiometabolic multimorbidity (Lu *et al*., 2022). This decrease in physical capacity leads to a reduction in the autonomy of the individual, which can increase dependence on others and decrease quality of life (Jofré-Saldía *et al*., 2023). The detrimental effects of detraining on cardiorespiratory fitness can lead to a decline in functional capacity, potentially impacting older adults' cognitive function, and positively associated with preserving cognitive function over six years through exercise, suggesting that maintaining fitness may help slow mental decline in older individuals. A reduction in cardiorespiratory fitness can negatively affect autonomy and overall quality of life, emphasizing the importance of replacing sedentary behaviors with more active lifestyles. Multicomponent exercise programs have positively affected older women's health and quality of life, raising the risk of cardiovascular diseases and reducing functional capacity (Coetsee & Terblanche, 2015; Esain *et al*., 2019; Sakugawa *et al*., 2019). This highlights the value of multicomponent exercise programs in mitigating age-related health declines and avoiding detraining periods.

The detrimental impact of the detraining period on cardiovascular fitness can lead to a decrease in functional capacity, potentially affecting cognitive function in older adults. This decline in cardiovascular fitness can increase the risk of mental decline, which was revealed in several studies showing a positive association between physical fitness and the maintenance of cognitive function over six years through exercise. Thus, maintaining physical fitness is very important in slowing down mental decline in elderly individuals. A decline in cardiovascular fitness can also affect autonomy and overall quality of life. This emphasizes the need to replace sedentary behavior with a more active lifestyle to improve the quality of life in old age. Exercise programs that include various physical components, such as strength, endurance, balance, and flexibility training, have been shown to positively impact older women's physical and psychological health, helping them maintain autonomy and a better quality of life. Multicomponent exercise programs can reduce age-related health decline and avoid periods of detraining, which can contribute to an increased risk of cardiovascular disease and decreased functional capacity (Coetsee & Terblanche, 2015; Esain *et al*., 2019; Sakugawa *et al*., 2019).

CONCLUSION

The study found that a three-month detraining period notably diminished cardiovascular fitness, functional capacity, and metabolic health in older women who had previously engaged in a nine-month multicomponent exercise program. These findings are consistent with existing literature, which suggests that detraining contributes to the deterioration of lipid profiles, hemodynamic parameters, functional capacity, and an increased risk of cardiovascular diseases. Despite these adverse effects, the exercise group exhibited better health outcomes than sedentary individuals, underscoring the beneficial impact of regular physical activity. These results emphasize the significance of maintaining an active lifestyle to mitigate age-related health deterioration, suggesting that older adults should continue regular exercise to maintain functional capacity, reduce cardiovascular risk, and enhance overall quality of life. Future research should incorporate dietary assessments and body composition measurements to further investigate the comprehensive effects of detraining on physical health. The study does have several limitations. A primary limitation was the absence of nutritional assessments before, during, and after the detraining period, which could have impacted variables such as body mass, cytokine levels, LPS levels, and HOMA-IR. Additionally, the unequal sample sizes between the experimental and control groups may have affected the statistical power of the results. The lack of stringent monitoring of physical activity during the detraining period may have influenced proinflammatory cytokines and metabolic parameters. However, notable changes were observed in some measures after detraining, indicating that participants likely refrained from physical activity during this period. Future studies should explore the effects of factors such as calorie intake and diet quality on body composition and metabolic health during detraining. Furthermore, research should involve a broader range of exercise programs with longer durations, more robust experimental designs, and larger, balanced sample sizes to strengthen the validity of the findings. Future investigations could also examine various exercise types and their effects on additional physical and cognitive outcomes. This study has contributed to understanding the impact of multicomponent exercise on cardiovascular health and metabolism in older women. The findings

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provide evidence that while the benefits of such exercise may diminish following a detraining period, multicomponent training offers long-term benefits, particularly in maintaining lipid profiles, blood pressure, and cardiorespiratory fitness. The study underscores the importance of regular physical exercise in preventing the decline of cardiovascular health and overall bodily function in older adults. Based on these findings, it is recommended that older women participate in regular multicomponent exercise programs to enhance their quality of life and reduce the risk of cardiometabolic diseases. Programs that incorporate muscle strength, cardiorespiratory fitness, balance, and flexibility should be encouraged. It is also essential for individuals already engaged in such programs to maintain their physical activity habits, as even short-term cessation can result in substantial declines in health parameters.

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