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Review

Impact of Resistance Training on Body Composition and Cardiovascular Endurance in Adult Females

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Abstract: Resistance training (RT) has long been recognized for its ability to enhance muscular strength, but a growing body of evidence shows that RT also improves body composition and cardiovascular endurance in adult females across a wide range of ages and fitness levels (An et al., 2024; Ramos-Campo et al., 2022; Lopez et al., 2022). The purpose of this study is to examine the relationship between structured RT programs and measurable changes in fat mass, lean body mass, and cardiorespiratory fitness in women aged 18–65 years. Using a mixed-methods approach, this investigation integrates quantitative measures of body composition and cardiovascular endurance with qualitative insights into participant adherence and motivation. Data were drawn from randomized controlled trials, longitudinal cohort studies, and cross-sectional investigations that assessed the effects of RT alone or in combination with aerobic modalities. Key findings indicate that RT elicits significant reductions in total body fat and visceral adipose tissue, enhances lean muscle mass, and improves indicators of cardiovascular endurance, such as maximal oxygen uptake (VO_2max) and submaximal heart rate recovery (Wewege et al., 2022; Wang et al., 2024). Moreover, circuit-based RT and combined high-intensity interval plus RT interventions appear especially effective in producing dual improvements in body composition and cardiorespiratory capacity (Ramos-Campo et al., 2021; Wang et al., 2024). These results highlight the importance of incorporating resistance exercise into public health recommendations for adult women.

Keywords: resistance training, body composition, cardiovascular endurance, adult females, VO_2max

Introduction

Background

Physical inactivity and excess adiposity remain significant public health challenges for women worldwide. Epidemiological data consistently link increased fat mass with heightened risks of cardiovascular disease, type 2 diabetes, and all-cause mortality (Paluch et al., 2024). Although aerobic training has traditionally been promoted as the primary exercise modality for cardiovascular health, accumulating evidence demonstrates that resistance training (RT) provides comparable—or even superior—benefits for improving both **body composition** and **cardiorespiratory fitness** (An et al., 2024; Lopez et al., 2022).

RT involves the repeated application of external loads (e.g., free weights, resistance machines, elastic bands) to induce muscular contraction, resulting in strength and hypertrophic adaptations. Beyond muscular strength, RT has been shown to increase resting metabolic rate, reduce visceral adipose tissue, and enhance glucose regulation (Wewege et al., 2022; Shaw et al., 2010). Recent guidelines from the American Heart Association underscore RT as an essential component of comprehensive cardiovascular disease prevention strategies for both men and women (Paluch et al., 2024).

Literature Review

Effects of Resistance Training on Body Composition

Multiple systematic reviews and meta-analyses demonstrate that RT produces significant reductions in fat mass while preserving or increasing lean muscle mass in women of various age groups (Lopez et al., 2022; Wewege et al., 2022). For example, Benton et al. (2011) reported that middle-aged women engaging in RT three times per week experienced measurable decreases in body fat percentage and increases in fat-free mass within 12 weeks. Similarly, Ransdell et al. (2021) documented consistent improvements in body composition, muscle strength, and functional fitness in women aged 45–80 years across a decade of intervention trials. Importantly, these positive outcomes are not restricted to high-frequency training; even once-weekly circuit-based programs have demonstrated significant reductions in fat mass and improvements in VO_2max (Menz et al., 2021).

RT may also counteract age-related sarcopenia, which is particularly relevant for women given the accelerated decline in estrogen after menopause. Khalafi et al. (2023) observed that postmenopausal women engaging in structured RT experienced significant improvements in lean mass and reductions in fat mass, highlighting the modality's role in attenuating the metabolic consequences of aging.

Resistance Training and Cardiovascular Endurance

While aerobic training is classically associated with cardiorespiratory improvements, a growing body of research shows that RT alone can enhance VO_2max, ventilatory threshold, and submaximal exercise performance (An et al., 2024; Ramos-Campo et al., 2021). For instance, Fernandez-Lezaun et al. (2017) found that older adults improved their cardiorespiratory fitness through RT without concurrent endurance exercise. Circuit-based RT, which involves minimal rest between exercises, is particularly effective for simultaneously stimulating muscular and cardiovascular systems (Ramos-Campo et al., 2022). Wang et al. (2024) further reported that combining high-intensity interval training with RT elicited greater improvements in VO_2max than high-intensity intervals alone in young overweight women.

Mechanistically, RT may improve cardiovascular endurance by enhancing stroke volume, improving endothelial function, and reducing arterial stiffness (Gardner & Poehlman, 1997; Paluch et al., 2024). Furthermore, RT increases total skeletal muscle mass, which serves as a metabolic sink for glucose and fatty acids, thereby indirectly supporting cardiovascular health (Lopez et al., 2022).

Comparative Efficacy of Resistance and Aerobic Training

A key question in exercise science is whether RT can match or surpass aerobic training in improving cardiorespiratory fitness. An et al. (2024) conducted a meta-analysis comparing aerobic and resistance training and concluded that while aerobic training typically produces slightly larger gains in VO_2max, RT still yields clinically meaningful improvements in cardiorespiratory function, particularly when structured as circuit training. Ho et al. (2012) further demonstrated that combined RT and aerobic interventions lead to additive benefits in cardiovascular risk factor reduction.

Research Gaps and Rationale

Despite the growing literature, several gaps remain. Many studies have focused on older populations, leaving uncertainty about RT's effects in young and middle-aged women. Others have small sample sizes or short intervention durations, limiting generalizability (Ramos-Campo et al., 2022; Benton et al., 2011). Moreover, the mechanisms linking RT-induced body composition changes to improvements in cardiovascular endurance require further exploration.

Given these gaps, this study aims to provide a comprehensive synthesis of the evidence on the **impact of resistance training on body composition and cardiovascular endurance in adult females**, integrating findings across different age groups and training modalities.

Research Questions and Hypotheses

This investigation is guided by the following research questions:

1. Does participation in structured RT programs significantly reduce body fat percentage and increase lean body mass in adult females?

2. Does RT independently improve indicators of cardiovascular endurance (e.g., VO_2max, submaximal heart rate recovery) in this population?
3. Are circuit-based or combined RT interventions more effective than traditional RT in eliciting concurrent improvements in body composition and cardiorespiratory fitness?

Based on current evidence, the hypotheses are:

- **H1:** Resistance training will significantly decrease fat mass and increase lean body mass in adult females.
- **H2:** Resistance training will improve cardiovascular endurance metrics, even in the absence of dedicated aerobic exercise.
- **H3:** Circuit-based and combined RT protocols will produce greater dual benefits than traditional RT alone.

Significance of the Study

This research carries both scientific and public health relevance. First, it addresses the underrepresentation of women in exercise science literature, offering gender-specific insights into training adaptations (Ransdell et al., 2021). Second, it informs exercise prescription guidelines by clarifying the extent to which RT can serve as a standalone intervention for improving cardiovascular health and body composition. Finally, by identifying the most effective training modalities, this study provides practical recommendations for clinicians, fitness professionals, and policymakers seeking to combat the dual epidemics of obesity and physical inactivity in adult female populations.

Methodology

Research Design

This study adopts a **mixed-methods design** to investigate the effects of resistance training (RT) on body composition and cardiovascular endurance in adult females. The primary quantitative component follows a **12-week randomized controlled trial (RCT)** format, while a complementary qualitative component captures participant experiences and adherence patterns through structured interviews. Mixed-methods designs are recommended for exercise science research because they allow the integration of objective physiological measurements with contextual behavioral data, thereby enhancing both internal and external validity (An et al., 2024; Ramos-Campo et al., 2022).

The intervention compares three exercise modalities:

1. **Traditional Resistance Training (TRT)** – progressive overload with free weights and machines.
2. **Circuit Resistance Training (CRT)** – continuous RT performed with minimal rest to elevate heart rate (Ramos-Campo et al., 2021).
3. **Control Group (CG)** – no structured training beyond normal daily activity.

This design permits evaluation of RT's independent effects on body composition and cardiovascular endurance, and enables comparisons between circuit and traditional formats.

Participants

A total of **120 adult females** (age 18–65) will be recruited from community fitness centers and university wellness programs. Participants will be stratified into three age cohorts (18–30, 31–45, 46–65) to explore potential age-related differences in training responses (Ransdell et al., 2021; Khalafi et al., 2023). Inclusion criteria include:

- Body mass index (BMI) between 20 and 35 kg/m^2,
- No participation in regular resistance training within the last 6 months,
- Medical clearance for vigorous physical activity.

Exclusion criteria comprise cardiovascular disease, uncontrolled hypertension, orthopedic injuries that preclude RT, or metabolic disorders requiring pharmacological treatment (Paluch et al., 2024). Written informed consent will be obtained from all participants prior to enrollment.

Sample size calculations were performed using G*Power software based on effect sizes reported in previous meta-analyses (Wewege et al., 2022; Lopez et al., 2022). Assuming a medium effect ($f = 0.25$), an alpha of 0.05, and 80% power, 36 participants per intervention arm are required. To account for attrition, 40 participants will be assigned to each group.

Randomization and Blinding

Participants will be randomly allocated to TRT, CRT, or CG using a computer-generated block randomization schedule. Allocation will be concealed by sealed opaque envelopes prepared by a researcher not involved in data collection. Because of the nature of exercise interventions, participant blinding is not feasible; however, outcome assessors and data analysts will remain blinded to group allocation to minimize measurement bias (Ramos-Campo et al., 2022).

Intervention Protocols

Traditional Resistance Training (TRT)

TRT participants will complete **three sessions per week** on non-consecutive days for 12 weeks. Each session will include:

- **Warm-up:** 5 minutes of light cycling or treadmill walking,
- **Exercises:** 8–10 multi-joint and single-joint movements (e.g., squats, bench press, lat pulldown, shoulder press, leg curl),
- **Sets/Repetitions:** 3 sets of 8–12 repetitions at 60–75% of one-repetition maximum (1RM),
- **Rest Periods:** 90 seconds between sets.

This protocol follows recommendations from the American College of Sports Medicine for novice and intermediate adults (Paluch et al., 2024).

Circuit Resistance Training (CRT)

CRT participants will perform **three weekly sessions** of circuit training incorporating the same exercises as TRT, but organized into continuous circuits with **30–45 seconds rest** between stations. Intensity will be set at 50–65% of 1RM to allow sustained effort. Each session will last approximately 45 minutes. Circuit-based RT has been shown to produce simultaneous improvements in muscular strength, body composition, and VO_2max (Ramos-Campo et al., 2021; Menz et al., 2021).

Control Group (CG)

Control participants will maintain their usual lifestyle and will be offered a free 12-week RT program after study completion.

Outcome Measures

Body Composition

Body composition will be assessed at baseline and post-intervention using **dual-energy X-ray absorptiometry (DXA)**, which provides accurate measurements of total fat mass, lean mass, and regional fat distribution (Lopez et al., 2022). Waist circumference and waist-to-hip ratio will also be recorded to evaluate central adiposity (Shaw et al., 2010).

Cardiovascular Endurance

Cardiorespiratory fitness will be evaluated through **maximal graded exercise testing** on a cycle ergometer to determine **VO_2max** (Fernandez-Lezaun et al., 2017; Wang et al., 2024). Secondary measures include resting heart rate, systolic and diastolic blood pressure, and heart rate recovery at 1 and 3 minutes post-exercise.

Strength and Functional Fitness

Although not primary outcomes, maximal strength (1RM for squat and bench press) and functional fitness (e.g., timed sit-to-stand test) will be measured to provide a comprehensive picture of training adaptations (Benton et al., 2011; Ransdell et al., 2021).

Qualitative Data

Semi-structured interviews will be conducted with a purposive sample of 20 participants across intervention groups to explore motivational factors, perceived barriers, and subjective health changes. Interviews will be audio-recorded, transcribed verbatim, and analyzed thematically.

Data Collection Procedures

Baseline testing will occur during Week 0, and post-testing will occur during Week 13. All assessments will be conducted in a temperature-controlled laboratory after an overnight fast of at least 8 hours. Participants will be instructed to avoid vigorous physical activity and caffeine for 24 hours before testing to reduce variability (An et al., 2024).

Training sessions will be supervised by certified strength and conditioning specialists to ensure adherence and correct exercise technique. Attendance will be recorded, and compliance will be defined as participation in at least 85% of scheduled sessions.

Data Analysis

Quantitative data will be analyzed using **SPSS 29.0**. Descriptive statistics (mean ± SD) will summarize baseline characteristics. A **two-way repeated measures ANOVA** will test the effects of group (TRT, CRT, CG) and time (pre, post) on primary outcomes. Post-hoc Bonferroni adjustments will be applied for multiple comparisons. Effect sizes will be reported as partial eta squared (η^2). An alpha level of 0.05 will be used to determine statistical significance.

For qualitative data, transcripts will be coded inductively by two independent researchers using NVivo 12 software. Themes will be developed through iterative discussion until consensus is reached. Triangulation with quantitative findings will enhance credibility.

Ethical Considerations

This study will adhere to the **Declaration of Helsinki** and has received approval from the Institutional Review Board of [University Name]. All participants will provide written informed consent after receiving detailed information about study aims, procedures, and potential risks. Emergency medical equipment and trained personnel will be present during all exercise sessions. Participants will be free to withdraw at any point without penalty.

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