International Journal of EXERCISE SCIENCE

Technical Note

EmpowerHER: A Pilot Study to Increase Physical Activity and Strength Through Powerbuilding

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ABSTRACT

International Journal of Exercise Science 17(8): 750-767, 2024. Engaging in empowering exercise develops movement competency (MC) and strength and supports physical health, mental well-being, and quality of life. Powerbuilding combines powerlifting and bodybuilding to increase physical activity (PA), MC, and strength. To our knowledge, powerbuilding has not been explored as an exercise intervention. This pilot study investigated the impact of an eight-week powerbuilding intervention on women's PA, MC, strength, and empowerment. Eighteen women aged 25.1±9.8 with no powerbuilding experience participated in the intervention, meeting three times weekly for one hour. PA and MC were assessed pre- and post-intervention. Three-repetition maximum (3-RM) tests in the squat, bench press, and deadlift were completed in weeks one and eight of the intervention. Data were checked for normality; the Wilcoxon signed-rank test was used for non-normally distributed data. The McNemar test was used to analyze differences in dichotomous variables. Effect size was calculated and interpreted as follows small (r=0.1, d=0.2, ω=0.1), medium (r=0.3, d=0.5, ω=0.3), and large (r=0.5, d=0.8, ω=0.5) Total PA ([$t(17)$=3.52, p=0.003, d=0.83]) and participants who met the PA guidelines (Z=6.13, p=0.008, ω=0.82) increased significantly from pre- to post-intervention. Participants' MC scores improved significantly from pre- (24.3±3.5) to post-intervention (29.5±2.5; [$t(17)$=10.04, p<0.001; d=2.37]). Significant increases in strength were observed (squat [Z=-3.73, p<0.001, r=0.88], bench press [Z=-3.73, p<0.001, r=0.88], and deadlift [$t(17)$=16.41, p<0.001; d=3.87]). Empowerment in exercise scores averaged 56.3±6.6 (on a scale of 5-65). The intervention significantly increased total PA, improved MC, increased strength, and facilitated empowerment. Women's participation in powerbuilding may enhance their quality of life.

KEY WORDS: Resistance training, empowerment theory, movement competency, powerlifting

INTRODUCTION

Recently, empowering women and girls to achieve gender equality has become a global priority across various sectors, including health and wellness. Empowerment is a multidimensional construct that describes how individuals gain influence over outcomes and events of importance (28). Empowerment occurs at the individual, interpersonal, and community levels and varies between individuals (28). Individual-level empowerment is fostered through skill acquisition, leading to self-efficacy, autonomy, and motivation (22, 23). Increasing accountability, competition, and a sense of community at the interpersonal level may also increase feelings of

empowerment (33). Community-level empowerment can be facilitated through shared values and common goals (28).

In recent years, many have looked to physical activity and sports to empower women through community building, skill acquisition, increased independence, and resistance to traditional gender stereotypes (8, 22, 23). Participation in empowering exercise may have implications that extend beyond exercise into other areas of life (35). For example, an individual who feels strong in the gym might feel more capable at work. Thus, applying empowerment theory constructs to an exercise intervention could improve intervention and post-intervention adherence to exercise through increased self-efficacy, autonomy, motivation, competition, sense of community, shared goals, and values.

As a subset of physical activity, exercise is a planned, structured, and repetitive effort to improve physical fitness (2). Exercise is typically performed in an individual's spare time and includes sports, group fitness classes, recreational walking, running, and resistance training. Exercise and physical activity can improve physical literacy (i.e., the understanding to assume accountability to engage in lifelong physical activity and exercise) and movement competencies (i.e., the ability to perform basic human movements such as the squat, hinge, row, etc.) (37). The current United States physical activity guidelines include 150 minutes of moderate-intensity (75 minutes of vigorous-intensity) aerobic activity and at least two days of muscle-strengthening exercises involving all major muscle groups weekly (11).

Women are less likely than men to meet the physical activity guidelines (11). Over 50% of women report meeting the aerobic guidelines only, while 24.3% meet the muscle-strengthening guidelines only (27). However, only 20.9% of women in the United States meet the aerobic and muscle-strengthening portions of the physical activity guidelines (27). Barriers to meeting the muscle-strengthening guidelines among women include gender role expectations, low self-efficacy to perform resistance training, and fears of excess muscularity (1, 31). At the same time, muscle-strengthening activities like resistance training are particularly beneficial for women (18).

Resistance training is positively linked to improved physical performance, movement control, walking speed, functional independence, cognitive abilities, and self-esteem (13). Resistance training may also benefit chronic pathologies, decrease bone loss, and mitigate age-related sarcopenia (13, 18). Moreover, evidence from our research suggests that resistance training is more empowering than other types of physical activity (36). While women's reasons for exercise participation vary, empowering exercise may increase physical activity participation since empowerment can improve self-efficacy, develop competence, and increase motivation (36).

Exercises traditionally regarded as male-dominant, including resistance training, ice hockey, powerlifting, and martial arts, are often categorized as more empowering than traditionally female-dominant exercises like dance and aerobic exercise (8, 9, 38). Similarly, exercise that increases body functionality (i.e., everything the body is capable of doing, including physical

capacity) facilitates women's physical activity participation (38). Activities that require physical strength have also been shown to facilitate feelings of empowerment (8, 36, 38). Resistance training-based exercise, like powerbuilding, increases physical strength and promotes muscular development, yet powerbuilding's effects on strength and empowerment have not yet been explored.

Powerbuilding is a hybrid form of resistance training performed in a gym setting that combines powerlifting and bodybuilding elements to increase strength and promote a muscular physique (7). Powerlifting's three primary lifts are the barbell back squat, bench press, and deadlift (6). These movements, often called "the big three," are complex, multi-joint exercises that are performed to increase strength by performing a low number of repetitions. On the other hand, bodybuilding utilizes single-joint movements to increase muscular size and definition, usually by performing a higher number of repetitions (14). Powerbuilding training is structured around each of the big three movements. Thus, a powerbuilding protocol has a squat day, bench press day, and deadlift day. Bodybuilding exercises are integrated into each day, focusing on the same muscle groups (i.e., on squat day, lunges are performed; on bench press day, triceps exercises are performed, etc.) (7). Despite powerbuilding's popularity among gym-goers, there is a dearth of scientific literature describing it as a distinct training methodology with unique benefits, especially for women.

Given that powerbuilding builds strength and body functionality, it seems logical that powerbuilding might also increase women's and girls' empowerment in exercise. While the concept of combining strength and hypertrophy training may not be new, the specific application of powerbuilding as its own training methodology among untrained women is novel. Therefore, this pilot study examined the effects of an eight-week powerbuilding intervention on women and girls' physical activity engagement, strength, and empowerment. The intervention was hypothesized to increase participants' physical activity and strength relative to baseline and foster empowerment in exercise. The secondary study aims were to examine the intervention's effects on participants' health, fitness, physical literacy, and ability to perform basic human movements. Similarly, these metrics were hypothesized to improve relative to baseline.

METHODS

This pilot study used a single-group repeated measures (pre/post) design to examine changes in physical activity, health (i.e., cardiovascular function, body composition, and waist circumference), fitness (i.e., three-repetition maximum [3-RM] attempts in the squat, bench press, and deadlift), basic human movement competencies (i.e., squat, lunge, hinge, push, pull, brace, and rotate), physical literacy, and empowerment in exercise. The intervention lasted eight weeks, including 24 one-hour workouts and an online educational component. All intervention workouts were structured similarly, including a standardized warm-up, workout instruction, and a powerbuilding-based workout. The optional educational component was delivered online to reinforce concepts related to participants' feelings of empowerment in exercise.

Testing and exercise sessions were supervised by trained exercise professionals, with most coaches having one or more certifications: Certified Personal Trainer, CrossFit® Level 1 and 2 Coaches, and Certified Strength and Conditioning Specialist. Before the intervention began, all participants met with researchers to sign an informed consent/assent and complete the pre-intervention physical activity, health, physical literacy, and basic human movement competency measures. The intervention began approximately one week later, and 3-RM data were collected for the squat, bench press, and deadlift. During the last week of the intervention, final 3-RM data were collected. All participants were invited back to the lab the following week, where they completed the same measures from pre-intervention and the Empowerment in Exercise Scale (26).

Participants

A convenience sample of 20 girls and women aged 13-46 volunteered to participate in the study, and 18 completed 80% of the study sessions and were included in the analyses. A priori power analysis was impossible as this was the first study to use powerbuilding as an applied exercise intervention. Previous applied exercise intervention studies have used a similar number of participants (16, 24). Moreover, resources were limited, and only two dedicated women coaches were available. To keep the coach-to-participant ratio 1:10 (or better), participants were limited to 20 individuals. Participants were recruited through recruitment flyers containing a link to a screening survey. Flyers were distributed by email, in university newsletters, on university bulletin boards, and through the researcher's social media accounts. Interested individuals completed a screening survey to ensure they met the following inclusion criteria: 1) self-identified as female, 2) were at least 13 years old, 3) had no self-reported powerbuilding or powerlifting experience, 4) were free from injury, 5) passed the physical activity readiness screener (PAR-Q) (39), and 6) indicated availability for at least 19 (>80%) of the 24 study sessions. Participants were encouraged to enroll with an eligible friend or family member (i.e., in a dyad). However, participants who enrolled independently were placed into a dyad for the study's duration. Pairing individuals was deliberate and designed to encourage interpersonal-level empowerment constructs (e.g., accountability, competition, sense of community). Informed assent/consent was obtained from all participants and their parents or guardians if they were under 18. The study protocol was approved by the institutional review board IRB#11380. The research adhered to ethical guidelines set forth by the editorial board for the International Journal of Exercise Science (34).

Protocol

Instruments and measurements: Researchers recorded each participant's age, height, and body mass in the initial meeting. After participants removed their shoes, height was measured to the nearest centimeter using a Charder stadiometer (model H.M. 200P). Body mass, body fat percentage (BF%), fat mass (FM), and fat-free mass (FFM) were measured using a Tanita (TBE310) bioelectric impedance analysis (BIA) scale. Mass was measured in kilograms. The BIA equipment used in this study demonstrates strong concurrent validity and reliability when compared to DEXA (32), the gold standard (DEXA; $r = 0.94$; $p < 0.001$). Body mass index (BMI)

was calculated according to standard procedures (40). Waist circumference was measured three times according to standard procedures (17) with a flexible tape to the nearest tenth of a centimeter and averaged. Cardiovascular function was assessed using an Omron BP78510 series monitor. Resting heart rate and blood pressure were measured after the participant had been seated comfortably for at least five minutes; the measurement was repeated three times, with one minute between each according to standard procedures. The three measurements were averaged and recorded.

Physical activity was measured using the Past-Week Modifiable Activity Questionnaire (PWMAQ). This interviewer-administered assessment records participants' physical activity frequency and duration during the past seven days. Thirty-eight activities and an "other" activity space are listed. Each activity's corresponding MET value is multiplied by the duration of the weekly activity in hours. A total physical activity score is calculated by summing MET hours per week across all activities. To determine if an individual met the physical activity guidelines, the number of days the participant did muscle-strengthening activities (e.g., calisthenics/toning exercises, strength/weight training) was tallied, and then corresponding MET hours were subtracted from the total physical activity score. Activities with a corresponding value less than 3.0 were also subtracted from the total since light-intensity physical activity does not count toward meeting the guidelines. The resulting value represented MET hours spent performing aerobic activity. Since 7.5 MET hours per week corresponds with 150 minutes of moderate to vigorous aerobic activity, individuals with scores ≥7.5 MET hours met the aerobic portion of the guidelines (11). If an individual indicated they participated in muscle-strengthening activities at least twice weekly, they met the muscle-strengthening portion. Participants who did ≥7.5 MET hours of aerobic activity and two more days of muscle-strengthening activities fully met the physical activity guidelines. Participants were dichotomized into two groups for each portion (e.g., aerobic, muscle-strengthening, both) of the guidelines. The PWMAQ is a valid and reliable measure of leisure time physical activity among women and adolescents (29).

The PLAYself questionnaire was administered to measure physical literacy. This questionnaire evaluates self-perceptions of physical literacy in four sub-sections: environment, physical literacy self-description, relative ranking of literacies, and fitness (3). The PLAYself was designed to measure physical literacy in children seven and older and is valid and reliable in children and adolescents. The physical literacy self-description subsection aims to determine self-efficacy related to participation in physical activity. It consists of 12 questions, scored on a four-point Likert scale (i.e., not at all true = 0, not usually true = 33, true = 67, and very true = 100); one question was reversed scored. The total score was out of 1,200. Since no measure of physical literacy exists for adults, the 12-question physical literacy self-description subsection of the PLAYself questionnaire was adopted and scored according to standard procedures (3). The physical literacy self-description subsection has been shown to have good reliability with moderate-to-strong item-total correlation among young adults (19) and acceptable internal consistency in this study (pre-intervention $\alpha = 0.89$, post-intervention $\alpha = 0.71$). An additional question, "My level of fitness enables me to do all the activities I choose," was piloted in the

physical literacy questionnaire section as a stand-alone question, which was scored independently of the PLAYself questions but on the same scale (i.e., out of 100).

Movement competency was measured at both time points by assessing participants' ability to complete a bodyweight squat, forward lunge, push-up (or modified push-up), suspended bodyweight row, hinge, plank/brace, and standing rotation (37). Each movement was demonstrated before the participant was instructed to perform ten repetitions at both time points. The first five repetitions were video recorded from the front view, and the subsequent five were recorded from the side view with an Apple iPad. For the plank/brace movement, participants were instructed to hold the plank for as long as they could, and the time was recorded in seconds. Approximately 30 seconds of plank footage was recorded, and the front and side views were captured. An Apple iPad was used to record all participants. Three researchers with physiology and biomechanics expertise independently scored each movement from one (poor) to five (ideal), and all scores were added together to obtain a total score. The agreement among raters' pre-intervention scores was good, 0.85 (95% CI: 0.68-0.94). Post-intervention agreement was acceptable, 0.70 (95% CI: 0.34-0.88) (20). The total scores were averaged to obtain each participant's total score. Assessment protocols and scoring criteria were conducted according to recommendations from previous research (37).

The Empowerment in Exercise Scale (EES) is a 13-item self-assessment to assess physical education class outcomes (26). The EES aims to capture aspects of empowerment, such as individuals' perceptions of their ability to control and change their physical and psychological well-being and contextual transference (26). This scale has demonstrated strong internal consistency ($\alpha = 0.89$) in previous research (26) and this study ($\alpha = 0.87$). The EES wording was modified slightly for our study. Originally, the EES asked," As a result of participating in this physical education class," then asked 13 questions such as "…my confidence to do physical activities/exercises on my own has increased," and "…my knowledge of this activity has increased." For our study, we changed "physical education class" to "exercise intervention" in the directions. The subsequent questions remained the same. The EES was answered on a five-point Likert scale ranging from 1 (does not describe my feelings) to 5 (clearly describes my feelings). The total score ranges from 5 to 65, where higher scores indicate more empowerment in exercise.

Strength was tested using a 3-RM in the squat, bench press, and deadlift. All participants adhered to the following protocol after they became familiar with each lift at the familiarization session and again at the end of the intervention (week eight). A light warm-up weight was estimated (i.e., a weight the participant felt they could easily lift for 6-8 repetitions) and lifted for 6-8 repetitions. The participant rested for 2-4 minutes. A warm-up weight was estimated by adding 5-10% to the light warm-up weight and was lifted for 5-7 repetitions. Participants rested for 3-5 minutes. A near maximum weight was estimated, again by adding 5-10% of the warm-up weight and lifted for 4-6 repetitions followed by 3-5 minutes of rest. Weight was increased again in the same fashion and lifted for 3 repetitions. If the attempt was successful, 5-10% of the previous attempt's weight was added, and after 3-5 minutes, another 3-RM was attempted. If

the attempt was unsuccessful, the weight was decreased by 2.5-5%, and after 3-5 minutes of rest, another 3-RM was attempted. The procedure continued until the participant could no longer lift the weight with proper form for three repetitions. This protocol was adapted from previous literature (15).

Exercise Protocol: Exercise sessions were held on Mondays, Wednesdays, and Fridays and focused on the squat, bench press, and deadlift. The first three sessions were familiarization sessions where participants completed each lift's initial 3-RM. The 3-RM attempts were completed on different days after comprehensive instruction for each movement (i.e., squat instruction and testing on the first day of the intervention, bench press on the second day, and deadlift on the third day). Three to five coaches were present at each session to facilitate the goal of having novice participants complete the 3-RM protocol.

Each familiarization session included complete and thorough demonstrations of each lift and verbal instruction to ensure participants were comfortable performing the movement. On the squat testing day, five coaches worked with groups of four participants. Four performance points were emphasized (12, 15), but as participants had never performed powerlifting, repetitions were counted even if the participant could not achieve all four performance points. They were: 1) the entire foot maintains contact with the ground; 2) the lumbar curve is maintained; 3) the knees track with or slightly in front of the toes; and 4) the hips descend below parallel. Three coaches worked with groups of six or seven on the bench press day. Five points of performance were emphasized, and most participants achieved them. The five performance points were: 1) the hands are placed slightly wider than shoulder width; 2) the head, shoulder blades, and buttocks maintain contact with the bench, and the feet maintain contact with the floor; 3) the elbows track closely to the body; 4) the bar contacts the chest; and 5) the bar is pressed straight back into the starting position (12, 15). On the deadlift day, participants were divided into five groups and worked with four coaches. Six performance points were emphasized: 1) the lumbar curve of the spine is maintained; 2) weight is placed in the heels; 3) the shoulders are slightly in front of the bar in the set-up; 4) the bar maintains contact with the legs during the movement; 5) the hips and shoulders rise at the same rate until the bar clears the knees; and 6) the hips are open, legs straight, and the chest is up at the top of the movement (12, 15).

The following 18 sessions were structured similarly and included a standardized warm-up, workout instruction, and a powerbuilding-based workout where primary lifts (i.e., squat, bench press, and deadlift) were followed by accessory lifts (i.e., lunge, push-up, ring row, side plank, etc.). Progressive overload, a fundamental resistance training principle shown to increase strength, was implemented following an undulating pattern where the primary lifts' tonnage varied from 1,080 to 2,080 (6). An "as many reps as possible"-style repetition scheme for time was implemented for accessory lifts (e.g., one minute of push-ups followed by one minute of rest, repeated three times). Additional accessory exercises were added to the program in week four to ensure all participants exercised for the prescribed one-hour period.

Coaches and participants worked collaboratively to create an empowering, supportive environment. Coaches focused on helping participants improve their exercise technique and performance using positive and constructive feedback. Exercise execution with proper form was prioritized over lifting as heavy as possible, empowering participants to push beyond their comfort zones. At the same time, participants paired up at the intervention's onset and remained in the same pair throughout the intervention, creating trust and accountability. Participants worked together. One participant in the pair would spot the other, and then they would switch. The study's design was deliberate in this way, as we hoped working in pairs would provide encouragement and create a sense of community.

Table 1. Overview of the optional educational component.

Intervention Week	Lesson 1	Lesson 2	Discussion Board Topic
Week 1	Overview and welcome.	Tracking your workouts.	While we have gotten to know each other briefly this week in the gym today, please tell us a little more about you. What is your name and preferred pronouns? Where are you from? What is your favorite food? Why did you sign up for the intervention? Anything else you want to share?
Week 2	Why resistance training?	What is a growth mindset?	Please share a time when you were scared or nervous to do something but did it in any way. It could be something involving an audience, sports, school, etc. It could be something small or big. What was it that made you nervous, and how were you able to go through with it?
Week 3	Vacuuming is physical activity?	Why you should care about your mindset.	Reflecting on this week's topics, reflect on how you can change a specific physical activity behavior from negative to positive. For example, you may recall that increasing physical activity through active transport is beneficial, but maybe you don't like walking to and from class. You can change your mindset from "I don't like walking to class" to "Walking to class is good for me, and by walking, I am increasing my overall physical activity."
Week 4	Creating tiny habits.	Knowledge check.	This week, we learned about how Tiny Habits can have a big impact on behavior change. If you are comfortable sharing, please tell us about a Tiny Habit you plan to implement. If not, please share your overall impression of Tiny Habits.
Week 5	Why SMART goals are so smart!	What is self-regulation?	This week, I want you to think about SMART goals and self-regulation to create two SMART goals: one for the end of the intervention and one for eight weeks later.
Week 6	Why nutrition matters.	The mind-muscle connection.	This week, you learned about the importance of eating well. You also had the opportunity to focus on the mind-muscle connection in the gym. What do you think about the mind-muscle connection? When you focused your attention on the muscles as they fired, did you feel stronger? The same? Will you continue to use the mind-muscle connection throughout the intervention?
Week 7	What is relapse?	Relapse prevention.	This week, we learned all about relapses and relapse prevention. I want you to think about the high-risk situations you are likely to encounter in the coming weeks or months.

			What are they? What plans can you have in place to deal with those situations?
Week 8	Reconnecting with long-term goals.	Take home messages.	Please take a moment to reflect on the following: 1) What was your greatest success since starting the intervention? 2) What challenges have you faced that have been difficult to overcome? If you want to congratulate each other or have any suggestions for overcoming your peers' challenges, feel free to comment on each other's posts.

Educational Component: The researchers created an educational component to complement the exercise intervention. The online educational component was available to participants via Canvas (Instructure, Salt Lake City, UT). It was designed by researchers trained in empowerment and educational frameworks to provide information about the physical, mental, and social benefits of resistance training. Topics included growth mindset, self-regulation, creating tiny habits, goal setting, and more. A weekly discussion post allowed participants to reflect on each week's lessons in and outside the gym. Participants completed a knowledge check at the intervention's midpoint to gauge their interaction with the content. Content is summarized in Table 1. Though participation in the educational component was not required, 15 participants engaged with the educational content during the intervention.

Statistical Analysis

Data were analyzed using SPSS Version 27 (IBM, Armonk, NY). Means ± standard deviations were calculated for complete data. All data were screened for normality using the Shapiro-Wilk test (25). Non-normally distributed data were analyzed with the Wilcoxon signed rank test, and normally distributed data were analyzed with paired-sample t-tests. Dichotomized variables were analyzed using the McNemar test. The effect size was calculated using Cohen's r, Cohen's d, or Cohen's ω and interpreted according to the following: small (r = 0.1, d = 0.2, ω = 0.1), medium (r = 0.3, d = 0.5, ω = 0.3), and large (r = 0.5, d = 0.8, ω = 0.5) (5, 21). Statistical significance was set at $p \leq 0.05$.

RESULTS

Eighteen participants completed the intervention. Participants' average age was 25.1 ± 9.8. Eleven participants indicated white ethnicity, three were multi-racial, two were Hispanic, Latina, or Spanish origin, one was black or African American, and one was American Indian. Education varied widely among participants. Twenty-two percent (n = 4) had less than a high school diploma, 11.1% (n = 2) had a high school degree or equivalent, 27.8% (n = 5) had some college but no degree, 5.6% (n = 1) had an associate degree, 16.7% (n = 3) had a bachelor's degree, 5.6% (n = 1) had a master's degree, 11.1% (n = 2) had a doctorate or professional degree. The majority (72.2%) of participants were single. Seven participants (38.9%) were students, one was self-employed, five (27.8%) were employed part-time (i.e., working up to 39 hours per week), and five (27.8%) were employed full-time (i.e., working 40+ hours per week).

Participants' physical activity is shown in Table 2. Total physical activity increased significantly from pre- to post-intervention ($t(17) = 3.52$, $p = 0.003$). Aerobic physical activity did not change

significantly from pre- to post-intervention (Z = -0.21, p = 0.83). Similarly, the number of participants who met the physical activity guidelines' aerobic portion did not change significantly from pre- to post-intervention (Z = 0.00, p = 1.00). Participants who met the muscle-strengthening guidelines increased significantly from pre- to post-intervention (Z = 12.07, p < 0.001). Eight participants met the physical activity guidelines at the end of the intervention, representing a significant increase in the number of individuals who met the guidelines from pre- to post-intervention (Z = 6.13, p = 0.008).

Table 2. Changes in physical activity (Mean ± SD).

Variable	Pre-Intervention (n = 18)	Post-Intervention (n = 18)	Effect Size (Cohen's *d*, *r*, or ω)
Total Physical Activity (MET Hours)	16.5 (10.3)	24.5 (8.0)**	d = 0.83
Aerobic Activity (MET Hours)	11.8 (11.8)	10.7 (8.5)	r = 0.05
Muscle-Strengthening Activity (Days)	0.83 (1.8)	3.0 (0.0)**	r = 0.70
Meets Aerobic Portion Only (n)	8	7	ω = 0
Meets Muscle-Strengthening Only (n)	4	18***	ω = 0.82
Meets Both (n)	0	8**	ω = 0.58

** Significantly different from pre-intervention (p < 0.01), *** significantly different from pre-intervention (p < 0.001)

Cardiovascular function (i.e., blood pressure and resting heart rate) did not change significantly from pre- to post-intervention (see Table 3). Paired-sample t-tests showed that participants' waist circumference significantly decreased from pre- to post-intervention ([$t(17)$ = 3.03, p = 0.008]), where the intervention's effect size was large (d = 0.72). However, there were no other significant changes in height, weight, body fat percentage, or body mass index (see Table 3). Weight and BMI may have increased due to increased muscle mass among participants.

Table 3. Changes in health measures (Mean ± SD).

Variable	Pre-Intervention (n = 18)	Post-Intervention (n = 18)	Effect Size (Cohen's *d*)
Systolic Blood Pressure (mmHg)	110.7 (11.1)	109.6 (9.8)	0.13
Diastolic Blood Pressure (mmHg)	76.3 (9.4)	75.0 (8.5)	0.16
Resting Heart Rate (bpm)	82.4 (9.0)	79.7 (8.0)	0.36
Height (cm)	159.9 (6.4)	160.0 (6.1)	0.15
Weight (kg)	65.0 (16.8)	65.6 (16.8)	0.33
Body Fat (%)	29.4 (11.3)	29.4 (11.0)	0.01

Body Mass Index (kg/m²)	25.3 (5.7)	25.5 (5.7)	0.33
Waist Circumference (cm)	78.3 (14.3)	75.5 (14.4) **	0.72

** Significantly different from pre-intervention ($p < 0.01$).

Physical literacy composite scores did not change significantly from pre- (741.8 ± 165.2) to post-intervention (784.5 ± 117.7; $t(17) = 1.85$, $p = 0.08$), but the intervention did elicit a small effect on physical literacy ($d = 0.44$). When questions were analyzed individually, a statistically significant change ($Z = -1.89$, $p = 0.05$) was observed for "Being active is important for my well-being," thus demonstrating the intervention's effect on participants' perceptions of physical activity for well-being. Significant differences in participants' pre- (53.4 ± 29.6) to post-intervention (61.2 ± 23.8) scores were not observed for the stand-alone question, "My level of fitness enables me to do all the activities I choose." However, this score increased on average, and a medium effect size was observed ($Z = -1.50$, $p = 0.14$, $r = 0.35$).

Participants' basic human movement score improved significantly from pre- (24.3 ± 3.5) to post-intervention (29.5 ± 2.5; [$t(17) = 10.04$, $p < 0.001$; $d = 2.37$]), where participants' movement competence improved. Additionally, all participants significantly improved their plank hold time (measured in seconds) from pre- (67.3 ± 21.2) to post-intervention (82.4 ± 25.5; [$t(17) = 3.74$, $p = 0.002$; $d = 0.88$])

On average, participants reported high empowerment in exercise resulting from the intervention (56.3 ± 6.6). Scores on the EES ranged from 40 to 65, and six scores were over 60.

Three-repetition maximums increased significantly for the squat ($Z = -3.73$, $p < 0.001$), bench press ($Z = -3.73$, $p < 0.001$), deadlift ($t(17) = 7.31$, $p < 0.001$]), and three lift 3-RM total ($Z = -3.72$, $p < 0.001$) (see Table 4).

Table 4. Changes in 3-RM (Mean ± SD).

Variable	Pre-Intervention (n = 18)	Post-Intervention (n = 18)	Effect Size (Cohen's *d* or Cohen's *r*)
Squat 3-RM (kg)	40.4 (22.6)	66.9 (16.9)***	$r = 0.88$
Bench press 3-RM (kg)	29.8 (9.5)	36.2 (9.3)***	$r = 0.88$
Deadlift 3-RM (kg)	55.7 (17.8)	75.9 (18.6)***	$d = 1.72$
Three lift 3-RM total (kg)	125.9 (49.9)	179.0 (44.8)***	$r = 0.88$

*** Significantly different from pre-intervention ($p < 0.001$).

Data were extracted from Canvas to gauge participants' overall engagement with the online course content, including discussion board posts and knowledge check completion. Fifteen (83.3%) participants accepted the course invitation for the intervention's educational component. Three participants did not accept the course invitation despite completing the

intervention. Among the 15 who accepted the course invitation, the average time spent interacting with the course content across the eight weeks was 79.3 ± 307 minutes. Of the eight weekly discussion boards, week one was completed by 11 participants (61.1%), weeks two, three and four were completed by nine (50%), week five was completed by six (33.3%), weeks six and seven were completed by four (22.2%), and week eight was completed by five (27.8%). The average posting rate on discussion boards was 39.6%. The week four knowledge check was completed by eight participants (44.4%).

DISCUSSION

This pilot study examined the effects of an eight-week powerbuilding intervention on women and girls' physical activity engagement and empowerment. The main findings reveal that participants significantly increased physical activity and 3-RM in the squat, bench press, deadlift, and the three lift 3-RM total, supporting our primary hypothesis. Notably, our powerbuilding intervention increased participants' muscle-strengthening days and the number of participants fully meeting the physical activity guidelines. Moreover, increasing the number of muscle-strengthening days did not significantly decrease participants' engagement in aerobic activity. Some elements of our second hypothesis were also supported. Participants reported high levels of empowerment in exercise, significantly improved movement competence, and an increased appreciation for the importance of being active in relation to well-being.

Physical activity increased, meeting the physical activity guidelines increased, and strength improved significantly in our study. While our structured program was designed to increase strength and physical activity, it is critical to note that the efficacy of physical activity interventions to increase physical activity is mixed (30). A recent meta-analysis revealed that total and vigorous physical activity did not increase significantly between intervention and control groups post-intervention (30). Similarly, research examining a walking intervention's ability to increase physical activity found that only light-intensity physical activity behavior increased due to the intervention (4). Given the evidence, we believe exercise modality, especially empowering exercise, is essential in increasing physical activity. Our participants signed up for a powerbuilding training program and were motivated to complete it despite having no experience. Our carefully constructed program addressed barriers to resistance training participation, such as powerbuilding. For example, we provided equipment and specific knowledge about powerbuilding, which influenced participation (1, 31). We addressed topics such as developing a growth mindset and self-efficacy in our educational component since both have been shown to influence resistance training and physical activity participation (10). While we cannot pinpoint with certainty why total physical activity increased in our study, our intervention supported participants to complete the muscle-strengthening portion of the guidelines. It seems likely that the empowering nature of powerbuilding participation combined with the educational component and a supportive intervention community promoted physical activity participation.

Participants in our study significantly increased the amount of weight they lifted and improved their basic human movement competency from pre- to post-intervention. We relied on evidence-based principles of resistance training to elicit training adaptations to increase strength (6). Our results align with previous resistance training research aimed at increasing strength in untrained individuals (6). For example, previous research in untrained individuals demonstrates improvements in the squat, bench press, deadlift, and three lift total following nine weeks of traditional and flexible daily undulating periodization (6). Basic human movement competency and plank hold time improved significantly from pre- to post-intervention since the powerbuilding movement patterns practiced during the intervention are similar to the movements performed in the basic human movement tests (i.e., performing squats reinforces the movements pattern of the bodyweight squat, performing deadlifts reinforcing movement patterns of the hinge). These results suggest that powerbuilding improves overall movement competency. It should be noted that previous research describes basic human movement competency improvements following high-intensity functional training and weight training classes (16).

Previous research suggests that some forms of exercise are more empowering than others (36). Certainly, powerbuilding defies gender norms by promoting physical strength and muscular development. Similarly, previous research has shown that women's participation in exercise typically considered male-dominant is more empowering than traditionally female-dominant exercise (8, 9, 36, 38). Although some work has explored the relationship between women's participation in strength-based sports and physical activity participation, this study adds insight into how powerbuilding and empowerment increase women's and girls' physical activity and strength (38). Previous research has highlighted empowerment's multidimensional nature, noting that empowerment occurs at the individual, interpersonal, and community levels (28). The current study endeavored to foster empowerment among participants by providing personalized exercise training (based on pre-intervention 3-RM testing) to increase self-efficacy, autonomy, and motivation. The intervention's deliberate pairing of participants created accountability, competition, and a sense of community in a supportive environment. Indeed, participants shared the common goal of increasing their physical activity through powerbuilding.

At the study's conclusion, participants reported high levels of empowerment in exercise. All participants improved their 3-RMs in the squat, bench press, and deadlift. These individual-level improvements in strength may be closely related to high levels of empowerment in exercise. Notably, the EES was completed after post-intervention strength testing. Therefore, we postulate that individual feelings of strength are related to empowerment in exercise. This line of thinking aligns with previous research that suggests that women's physical strength is closely related to feelings of empowerment (36, 38). Moreover, we created a sense of community through supportive coaching and dyadic and group training; a sense of community increases physical activity engagement (16).

Several strengths and limitations should be considered. To our knowledge, this is one of the first studies to rely on powerbuilding training to increase physical activity among women and girls. Study participants engaged in muscle-strengthening activities three times per week, which helped them meet the physical activity guidelines. Large effect sizes were observed across the study's primary outcome variables as physical activity and strength increases were observed. Large effect sizes paired with statistical significance suggest the intervention was adequately powered and highly influential in producing the observed changes. We provided an educational component to help reinforce the benefits of physical activity while providing tools to overcome common barriers to physical activity. While engagement with the educational component could have been higher, the modules can be tested in future studies to promote empowerment and physical activity-related outcomes. Empowerment theory constructs guided the intervention, and participants shared that they appreciated our efforts to foster empowerment individually, among partners, and within the intervention community in the educational component's discussion boards. Our sample, encompassing women aged 13 to 46 from diverse demographic backgrounds, participated in the study, making it relatively representative. We also had a low attrition rate (10%) and no reported injuries, which is notable for an applied exercise intervention. Lastly, our well-trained research team meticulously supervised and verified each workout session.

There were several limitations to the study. Our sample size, while representative, was small; only 18 women and girls completed the study. As a pilot study, a control group was not utilized. Physical activity was assessed using an interviewer-administrated tool, which may have led to over- or under-reported physical activity behaviors. However, our data align with national-level data. Future studies should include objective measurements of physical activity. The empowerment in exercise scale is only designed to be used after an intervention. Thus, we were unable to measure changes in empowerment. Considerations to reduce participant burden may be considered study limitations. For example, the length of the intervention was limited to eight weeks, which may not have been long enough to elicit physiological exercise adaptations. We did not control participants' dietary and sleep habits, which could have affected our results. Lastly, we did not control for hormone fluctuations due to participants' menstrual cycles, which could have affected exercise capacity and performance. Future studies should explore strategies for minimizing participant burden while maximizing results.

This pilot study lays the groundwork for future powerbuilding research, especially among women. The data obtained from this study offers valuable insight since significant changes in physical activity and strength, a low attrition rate (10%), and no injuries were observed. Effect sizes for the study's primary variables were large, suggesting adequate power. Future researchers can use this information to inform sample size calculations for adequately powered studies, ensuring sufficient statistical power to detect meaningful effects. Methodological insights—implementing dyadic and group training, creating a supportive environment, and utilizing women coaches– offer practical insights for researchers who aim to bridge the sex data gap in exercise science. Researchers can leverage this information to refine study protocols and optimize data collection procedures for enhanced efficiency and accuracy. By sharing our pilot

study data and insights transparently, we aim to advance research in sports and exercise science and empower future researchers to build upon our work effectively.

In conclusion, this pilot study is the first to use powerbuilding to increase physical activity among women and girls. Our findings are significant considering how few women and girls meet the physical activity guidelines, especially the muscle-strengthening portion (11, 27). It provides preliminary evidence demonstrating how involvement in powerbuilding improves health, movement competencies and increases empowerment. This study represents a first step toward developing powerbuilding exercise interventions grounded in theory to increase physical activity among women and girls, and it is valuable in bridging the sex data gap in sports and exercise science research.

ACKNOWLEDGEMENTS

The authors would like to thank the participants for their participation in this research. As the first land-grant institution established under the 1862 Morrill Act, we acknowledge that the state of Kansas is historically home to many Native nations, including the Kaw, Osage, and Pawnee, among others. Furthermore, Kansas is the current home to four federally recognized Native nations: The Prairie Band Potawatomie, the Kickapoo Tribe of Kansas, the Iowa Tribe of Kansas and Nebraska, and Sac and Fox Nation of Missouri in Kansas and Nebraska. Many Native nations utilized the western plains of Kansas as their hunting grounds, and others – such as the Delaware – were moved through this region during Indian removal efforts to make way for White settlers. It's important to acknowledge this, since the land that serves as the foundation for this institution was, and still is, stolen land. We remember these truths because K-State's status as a land-grant institution is a story that exists within ongoing settler-colonialism, and rests on the dispossession of Indigenous peoples and nations from their lands. These truths are often invisible to many. The recognition that K-State's history begins and continues through Indigenous contexts is essential.

This project received a small ($1,500) research grant from the Central States chapter of the American College of Sports Medicine. None of the authors have any conflict of interest.

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