Online Circuit Training Increases Adherence to Physical Activity: A Randomized Controlled Trial of Men with Obesity

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ABSTRACT

KESHAVARZ, M., M. SÉNÉCHAL, and D. R. BOUCHARD. Online Circuit Training Increases Adherence to Physical Activity: A Randomized Controlled Trial of Men with Obesity. *Med. Sci. Sports Exerc.*, Vol. 55, No. 12, pp. 2308–2315, 2023. **Purpose:** This study aimed to examine adherence to the weekly physical activity guidelines (≥150 min of aerobic activities at moderate-to-vigorous intensity and two or more sessions of strength training (yes or no)) and health outcomes during the COVID-19 pandemic for men living with obesity, 46 wk after being offered an online muscle-strengthening circuit program for 12 wk. **Methods:** Sixty men (age ≥19 yr) living with obesity (body fat percentage ≥25%) were randomly assigned to the intervention group ($n = 30$) or the control condition ($n = 30$) for 12 wk. The intervention group was offered an online circuit training, three sessions per week, whereas the control group received a website helping them to reach the physical activity guidelines. Adherence to the weekly physical activity guidelines was evaluated 46 wk after enrolling in the program using a heart rate tracker (Fitbit Charge 3) and an exercise log. Health outcomes (e.g., anthropometrics, body composition) were measured at baseline and after 12, 24, and 46 wk. **Results:** The intervention group had higher adherence to physical activity guidelines at 46 wk (36.8%) than the control group (5.3%; $P = 0.02$). However, no difference in health outcomes was observed between participants in the intervention group compared with the control group after 12, 24, and 46 wk. **Conclusions:** Increasing adherence to exercise in men living with obesity is challenging. The proposed program increased adherence to the physical activity guidelines after about a year for men living with obesity; however, more studies are needed to understand how to improve health outcomes when following an online delivery exercise program in this population. **Key Words:** MALE, STRENGTH TRAINING, OBESE, HOME BASE

The prevalence of adults reaching the physical activity recommendations in developed countries is low and contributes to many chronic conditions such as obesity (1). There is an international consensus that adults should perform a minimum of 150 min of moderate-to-vigorous aerobic activities per week and a minimum of two sessions of muscle-strengthening activities to reap multiple health benefits (2,3). However, adherence is poor and even worse in specific groups. For example, 14.3% of adults living with obesity reach these guidelines compared with 25.0% of their lean counterparts (4). Although obesity prevalence is high for both men and women, it has increased more in men than women over the last decades (5), but less research has focused on determining how to increase the level of physical activity for men and avoid the health consequences of obesity. Thus, more knowledge and strategies are needed in this specific population (6).

Although muscle-strengthening activities are recommended for both men and women, evidence shows that men are more likely to engage in such activities than women throughout their lifetime, partially because of the masculine features of muscle-strengthening activities (7–9). Focusing on muscle-strengthening activities could be a potential strategy for men with obesity to increase adherence due to advantages such as: 1) greater absolute strength (10) over lean individuals and 2) lower rate of perceived exertion over aerobic activities and high self-worth during such activities (11).

Among the methods of performing muscle-strengthening activities, circuit training takes less time than traditional activities and can target outcomes typically associated with aerobic activities by sustaining a high heart rate (12). Our research group previously showed that adults living with obesity spend, on average, 92.5% of their time during a strength circuit training at moderate aerobic intensity (heart rate reserve ≥40%) (13).

Given that a muscle strength circuit program can lead to reaching both components of the physical activity guidelines, it is important to test the long-term adherence to such a program and its health benefits. To increase long-term adherence, the main barriers to regular activity must be targeted (14). The

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Submitted for publication February 2023.
Accepted for publication June 2023.

0195-9131/23/5512-2308/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0000000000003270

main barriers to exercise for adults included lack of time, costs (15), and transportation (15). In addition, people living with obesity report other barriers, such as the need for a minimum level of fitness (10), or technical skills (16), being ashamed of their bodies (17), and the lack of gender-specific programs (18). Offering a program in the home specific for men living with obesity could meet all these barriers, especially during the global COVID-19 pandemic that caused lockdowns, social interaction limitations (19), and fitness centers closure (20).

The primary objective of this study was to test if an online muscle-strengthening circuit program offered for 12 wk led to a greater proportion of men living with obesity adhering to the two components of the physical activity guidelines compared with the control group, 46 wk after baseline. The second objective was to test if participants in the intervention group would improve selected health outcomes such as anthropometric measures, body composition, and metabolic profile (resting heart rate, blood pressure, lipids/glucose) and look if participants in the intervention reduce their barriers to exercise compared with the control group. It was hypothesized 1) that the online muscle-strengthening circuit program could lead to a minimum of 25.0% of men living with obesity adhering to the two components of the physical activity guidelines and 2) that the online muscle-strengthening circuit program would improve health outcomes.

METHODS

Study design. The study was a parallel randomized controlled trial (Clinical Trial Number NCT04680455) comparing men living with obesity who were offered an online-based muscle-strengthening circuit program for 12 wk or a control condition (online resource to exercise on their own). Participants were randomly assigned in a 1:1 ratio to either the intervention or the control condition. Assessments were performed at baseline, 12 wk (postassessment), 24 wk, and 46 wk. All participants were given an approved consent form (REB No. 2020-008), and a signature was obtained before participation. The baseline assessment started in September 2020, and the last follow-up assessment took place in December 2021.

Sample size calculation. Sample size calculation was done based on the anticipated change in the proportion of individuals living with obesity to achieve the same proportion of their lean counterparts meeting the two components of the physical activity guidelines. It was hypothesized that the proportion of men living with obesity who meet physical activity guidelines in the intervention group would increase to 26.3% at 36 wk after intervention (21) compared with a 0% increase for the control group. The alpha level and power of analysis were set at 0.05 and 80%, respectively, considering a dropout rate of 30% in each group. A total of 23 people per group were required; therefore, we recruited 30 per group.

Recruitment. Recruitment was done through flyers at the university and through Facebook. The focus was that this program was only offered to men, free, performed at home without specialized equipment. Participants were eligible if they 1) characterized themselves as men; 2) 19 yr or older; 3) living with obesity, defined as having a body fat percentage greater or equal to 25% (22) confirmed by a BodPod measurement (COSMED, Rome, Italy) at the baseline visit; and 4) had access to the Internet at home to perform the online program. Participants were excluded if they reached the two components of the physical activity guidelines (150 min of moderate to vigorous aerobic activities + two sessions of muscle-strengthening activities per week) (22) as measured by a heart rate tracker (Fitbit HR charge3, Fitbit, San Francisco, CA) (23) and an exercise log over 7 consecutive days. Men were also excluded if they reported any condition (e.g., severe knee arthritis) that could impact their ability to perform the program or take medications impacting heart rate (e.g., β-blockers).

Randomization. Randomization was done after obtaining informed consent from all participants and once the eligibility was confirmed. Participants were randomly assigned to either the intervention or control group to obtain a ratio of 5:5 for every 10 participants. A person who had no role in the study did the randomization. Computer-generated random numbers created the randomization sequence via SPSS software 22.0. Allocation was done by a research assistant not involved in this project.

Intervention. Participants in the intervention group were asked to exercise three times per week while performing four basic bodyweight exercises in a circuit manner for 12 wk with a total of 24 of 36 sessions supervised online via the Microsoft TEAMs platform. Participants were supervised three times per week for the first 4 wk, then two times per week for the next 4 wk and one time per week for the remaining 4 wk. This strategy was used previously to increase participant autonomy before they started the unsupervised phase (24). At each session, participants performed the four prescribed exercises (squats, tricep dips, lunges, and push-ups) for 45 s each, then switched immediately (15 s) to the next exercise, followed by 1 mi of rest at the end of each circuit (Fig. 1). The circuit was repeated until the time was up (50 min). Modifications were made if a participant had restrictions that prevented him from performing an exercise. Instructors monitored the attendance for each session.

The program was offered in different weekly periods to accommodate different work schedules. If a participant missed a session, there were plenty of opportunities to participate in another session. Sessions could have up to four men in a single session. Before starting the 12-wk intervention, each participant received a personal in-person session explaining the exercises. Participants were eased into the program by completing 120 min of exercise in week 1, 150 min in week 2, and 180 min in the following weeks.

Participants allocated to the control group received an online exercise resource for a 12-wk workout plan covering fitness components required to reach both components of the weekly physical activity guidelines on their own (25). Before starting the program, each participant received a session explaining the Gold's-gym workout plan (https://www.goldsgym.com/12-week-transformation/) as a resource for

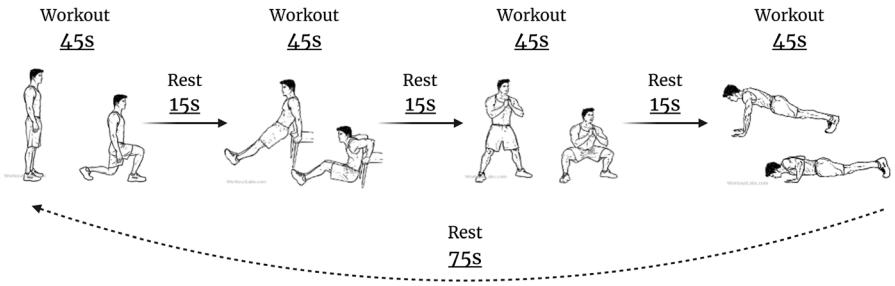

FIGURE 1—Online muscle-strengthening circuit program.

men in this group to reach the national physical activity guideline. No supervision was offered, and no contact was permitted between the research team and participants from this group besides scheduling the assessment sessions.

Primary outcome. Adherence to the physical activity guidelines 46 wk after baseline was the primary outcome (yes/no). It was also captured after 12 and 24 wk. To be considered as meeting both components of the physical activity guidelines, a participant needed to accumulate a minimum of 150 min of aerobic activities at moderate to vigorous intensity (≥40% of heart rate reserve) (26) tracked by a validated Fitbit charge 3 (27) on the nondominant wrist and report a minimum of two sessions of muscle-strengthening activities (days, duration, setting) over 7 consecutive days. Once participants returned the Fitbit, heart rate data were extracted using the Fitbit Javascript platform (https://dev.fitbit.com/) and recorded every 5 s. For the aerobic portion, a minimum of 4 d with a minimum of 10 $h \cdot d^{-1}$ in each of these days were required to be considered for analysis. For the muscle-strengthening portion, the logbook must be filled out for 7 consecutive days.

Secondary outcomes. In addition to the main outcome, secondary health outcomes were measured at baseline and at 12, 24, and 46 wk. These included anthropometrics, blood pressure, and resting heart rate. They were all measured following the Canadian Society for Exercise Physiology protocols, if applicable (28). Body fat percentage (%) and muscle mass (kg) were estimated using the BODPOD (COSMED; error ±1%–2.7%). Body mass index was calculated by a person's weight in kilograms divided by height in meters squared ($kg \cdot m^{-2}$) (29). Fasting lipid and glycemic profiles were measured at the fasting level using finger-prick blood samples and analyzed via an automated analyzer (2300 StatPlus analyzer; Yellow Springs Industries, Yellow Springs, OH). Fasting was considered abstaining from all food and beverages, except water, for at least 12 h before the blood draw.

At baseline, participants reported age, household income (≤$100,000), and education level (college or higher). Because the program was offered online, participants' comfort level with technology was measured using the Functional Assessment of Currently Employed Technology Scale questionnaire (30), with a score ranging from 0 to 50, and scores of +35 are classified as comfortable with technology. Cardiorespiratory fitness was evaluated using a modified version of the Balke and Ware treadmill test (31). Briefly, after 1 min of continuous walking (3.4 mph), the grade was increased to 7.0%, progressively increasing by 1.0% every minute thereafter until 15.0%. If the participant was not fatigued, the grade was maintained at 15.0%, and the speed increased by 0.5 mph each minute until volitional fatigue. The exchange of oxygen, carbon dioxide, and participants' heart rate were continuously gathered using a TrueOne 2400 Metabolic Cart and a Polar FT1 heart rate monitor (Polar, Kempele, Finland). The Exercise Benefits/Barriers Scale was used at baseline and again after the intervention to determine individuals' barriers perception to regular exercise. The Exercise Benefits/Barriers Scale is a validated questionnaire (32), and the total score ranges from 43 to 172, with a higher score showing less barriers to exercise (32). Finally, to assess fidelity of the exercise program, the average intensity during an exercise session was captured at week 6 during a session. Participants were instructed to measure their radial pulse according to the American College of Sports Medicine protocol (33).

Statistical analysis. Shapiro–Wilk and Levene's tests were performed to test for normality and equality of variances among variables of interest. Data are presented as average ± SD, whereas categorical data are presented as *n* (%). Chi-square tests and independent-sample *t*-tests were used to assess differences in categorical and continuous variables between the two groups, respectively. Wilcoxon signed rank and Friedman tests (categorical variables) and paired *t*-tests (continuous variables) were used to determine the significant changes in the studied outcomes within groups at different time points (baseline, 12 wk, 24 wk, 46 wk). A *P*-value of 0.05 was used as a threshold for statistical significance. Statistical analyses were performed using SPSS version 22.

RESULTS

A total of 132 individuals were screened, and 57 were excluded because they did not meet one of the inclusion criteria (Fig. 2). Therefore, 75 participants completed baseline assessments, from which 15 were excluded because they were either meeting physical activity guidelines ($n = 8$), were not meeting a minimum of 25% of body fat (n = 5), or declined to participate in the study ($n = 2$). Finally, 60 participants were randomly assigned to the intervention group ($n = 30$) and control condition ($n = 30$), from which 11 dropped out in both groups by the end of the last follow-up (46 wk). As a result, 19 in each group were analyzed. No significant difference was observed between participants in the intervention group who dropped

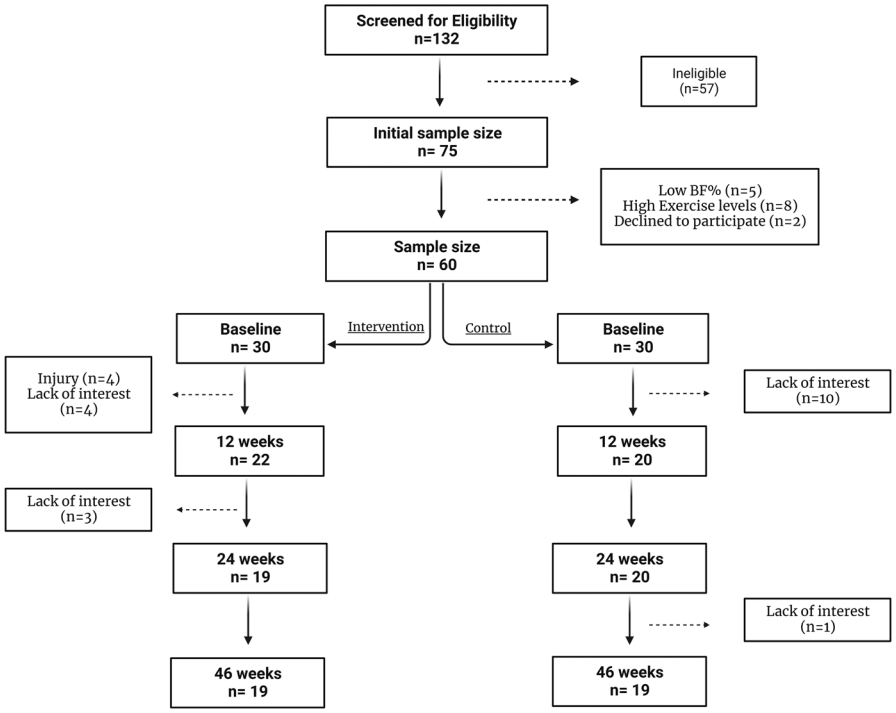

FIGURE 2—Participant flowchart.

out of the program (n = 11) and those who completed it (n = 19) on baseline measures, except for meeting aerobic guidelines where none of the participants met them for the group who did not complete the trial compared with 36% for the group who completed the trial (P = 0.005).

Baseline data for the study sample are presented in Table 1. The average age of participants was 41.7 ± 11.4 yr. The majority of the participants (74.5%) reported a yearly household income equal or less than $100,000, and the majority (91%) had a college or university degree. The average body fat percentage was 35.4% ± 5.8% at baseline. A third of the sample (31.6%) met the aerobic guidelines at baseline, whereas 7.9% met the muscle-strengthening activity guidelines. All participants were classified as comfortable with technology, with a score of 35 or more for all participants and an average of 44.3 ± 4.9 out of 50. The average score regarding the self-perceived barriers to exercise participation was 131.6 ± 12.9 out of 172.

Of the 24 supervised sessions, participants who completed the trial attended an average of 22.8 ± 1.3 sessions, or 95%, during the active phase of the intervention. The average intensity during an exercise session, captured at week 6, was 48.0% ± 5.8% of heart rate reserve. Participants in the intervention group significantly reduced their barriers to exercise after 12 wk of being exposed to the circuit program

TABLE 1. Baseline characteristics of participants (N = 38).

	Control (n = 19)	Intervention (n = 19)	Control (n = 19)
Age, yr	42.0 ± 12.7	41.4 ± 10.1	42.0 ± 12.7
Annual household income (≤$100,000)	5 (27.8)	4 (22.5)	5 (27.8)
Education (college or higher)	16 (85.3)	19 (100)	16 (85.3)
Body mass index, kg·m^{-2}	29.2 ± 3.8	28.6 ± 3.0	29.2 ± 3.8
Overweight (25.0–29.9 kg·m^{-2})	15 (50)	23 (76.6)	
Obesity level 1 (30.0–34.9 kg·m^{-2})	8 (26.6)	4 (13.3)	
Waist circumference, cm	112.2 ± 10.6	111.8 ± 10.3	112.2 ± 10.6
Body fat, %	34.9 ± 6.1	35.8 ± 5.7	34.9 ± 6.1
Muscle mass, kg	67.9 ± 8.4	64.6 ± 6.9	67.9 ± 8.4
Resting heart rate, bpm	71.8 ± 11.5	76.0 ± 8.6	71.8 ± 11.5
Cardio-respiratory fitness, mL·kg^{-1}·min^{-1}	37.9 ± 9.2	36.8 ± 7.1	37.9 ± 9.2
Systolic blood pressure, mm Hg	130.7 ± 10.1	128.3 ± 12.7	130.7 ± 10.1
Diastolic blood pressure, mm Hg	85.5 ± 6.2	80.4 ± 18.8	85.5 ± 6.2
High-density lipoprotein, mmol·L^{-1}	1.0 ± 0.2	1.1 ± 0.1	1.0 ± 0.2
Triglyceride, mmol·L^{-1}	1.6 ± 0.7	1.6 ± 0.8	1.6 ± 0.7
Glucose, mmol·L^{-1}	5.6 ± 1.0	5.6 ± 0.6	5.6 ± 1.0
Meeting aerobic criteria of the PA guidelines	6 (31.6)	6 (31.6)	6 (31.6)
Meeting muscle-strengthening criteria of PA guidelines	3 (15.8)	0 (0)	3 (15.8)
Comfort with technology (0–50; more = better)	40.9 ± 5.0	44.3 ± 4.9	40.9 ± 5.0
Benefits/barriers to exercise (43–172; more = better)	129.5 ± 10.4	133.7 ± 14.9	129.5 ± 10.4

Data are presented as n (%) or average ± SD.
PA, physical activity.

($P = 0.039$), with a greater change in the intervention group compared with the control group ($P = 0.021$).

Participants in the intervention group had significantly higher adherence to both components of physical activity guidelines (150 min of aerobic activities + ≥2 sessions of muscle-strengthening) compared with the control condition at 12 wk (intervention vs control, 56.6% vs 5.0%; $P = 0.001$), 24 wk (intervention vs control, 38.9% vs 10.5%; $P = 0.031$), and 46 wk (intervention vs control, 36.8% vs 5.3%; $P = 0.021$). See Figure 3.

A higher proportion of participants in the intervention group reached the minimum guidelines for muscle-strengthening activities (≥2 sessions per week) compared with the control group at 46 wk (intervention vs control, 36.8% vs 5.3%; $P = 0.021$). The proportion of participants who reached aerobic guidelines (≥150 min of physical activity per week) was not significantly different between the two groups at 46 wk (intervention vs control, 73.7% vs 57.9%; $P > 0.05$; intervention vs control, 254 ± 172 vs 255 ± 287 min).

All secondary outcomes data are presented in Table 2. No significant difference at any of the time points was observed between intervention and control groups ($P > 0.05$). However, there was a significant reduction in waist circumference in the intervention group at 12 wk (108.5 ± 11.4; $P = 0.001$), 24 wk (108.1 ± 11.8; $P = 0.006$), and 46 wk (108.3 ± 13.1; $P = 0.009$) compared with their baseline measures (111.8 ± 10.3), whereas the numbers for the control condition were only significant at 24 wk (106.8 ± 12.2; $P = 0.041$) and at 46 wk (104.6 ± 12.1; $P = 0.005$) compared with their baseline (112.2 ± 10.6). There was also a significant reduction in resting heart rate in the intervention group at 12 wk (68.1 ± 10.3; $P \leq 0.001$), 24 wk (65.6 ± 8.7; $P \leq 0.001$), and 46 wk (66.0 ± 7.4; $P \leq 0.001$) compared with baseline measures (76.0 ± 8.6). Similar results were observed for the control condition, with a significant reduction at 12 wk (68.0 ± 9.0; $P = 0.023$), 24 wk (64.8 ± 9.1; $P \leq 0.001$), and 46 wk (67.1 ± 10.9; $P = 0.005$) compared with baseline measures (71.8 ± 11.5). Again, there was no significant difference between the two groups at measured time points ($P > 0.05$). No significant change was observed for lipid profile, anthropometrics, and body composition compared with baseline values in neither group.

DISCUSSION

The online muscle-strengthening circuit program led to a significant increase in adherence to both components of physical activity guidelines among men living with obesity about a year after being offered the program. Following the program, the perceived barriers were reduced in the intervention group compared with the control group. However, only the resting heart rate and the waist circumference reduced significantly for the intervention group, and the improvements were not superior compared with the control group.

Epidemiological studies suggested that meeting both components of the physical activity guidelines (aerobic and strength activities) reduce the risk of many chronic conditions more than meeting each of these individually (34,35). The proposed online muscle-strengthening circuit program led to a very high attendance rate (95%), with almost 37% of participants still meeting both components of the physical activity guidelines after 46 wk. It might seem like a huge drop, but even if only 37% of the sample is meeting both components of the physical activity guidelines after 34 wk of follow-up, this percentage is higher than what is observed in the community for people not living with obesity (33%) and people living with obesity (29%) (21). This high attendance rate, which is higher than usually reported (36), could be related to the fact that the program addressed many barriers to regular exercise reported by men living with obesity, such as lack of time and need for transportation (15), and weight stigma by exercising at a private space (37) in addition to COVID-19 restrictions (38).

These findings are supported by the fact that barriers to physical activity were reduced significantly by the end of the 12-wk intervention. Addressing the perception of lacking time to exercise is important because it is the most reported reason

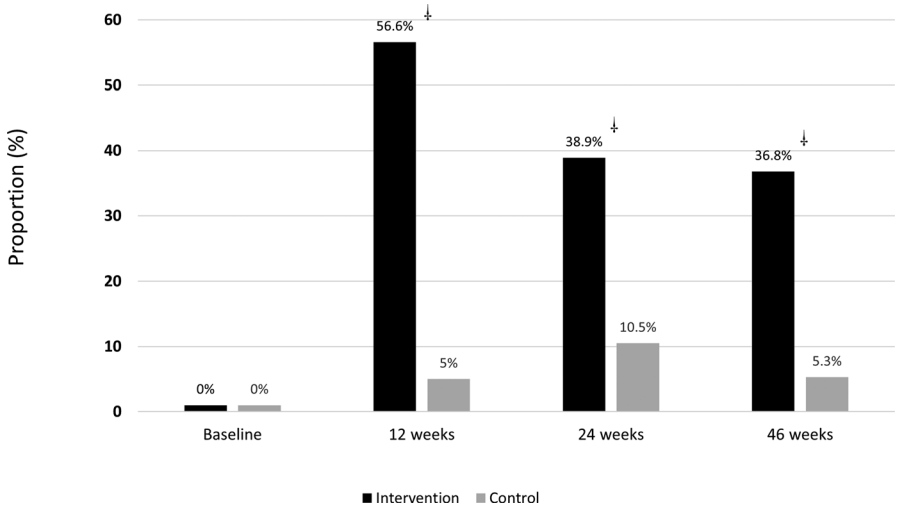

FIGURE 3—Chi-square results on the proportion of participants reaching both components of physical activity guidelines. †Significant difference between groups.

TABLE 2. Measured outcomes before and after the program.

	Control				Intervention			
	Pre	12-wk	24-wk	46-wk	Pre	12-wk	24-wk	46-wk
BMI, kg·m^{-2}	29.2 ± 3.8	27.9 ± 3.4	27.5 ± 3.5	27.2 ± 3.2	28.6 ± 3.1	28.6 ± 3.1	28.5 ± 3.3	29.0 ± 4.1
Weight, kg	105.1 ± 15.1	100.5 ± 13.8*	98.8 ± 14.0*	97.4 ± 13.2*	101.3 ± 13.2	101.4 ± 13.5	100.9 ± 14.2	100.5 ± 15.6
Waist circumference, cm	112.2 ± 10.6	109.8 ± 114	106.8 ± 12*	104.6 ± 12.1*	111.8 ± 10.3	108.5 ± 11.4*	108.1 ± 11.8*	108.3 ± 13.1*
Body fat, %	34.9 ± 6.1	34.1 ± 6.8	32.5 ± 7.8	32.2 ± 6.8	35.9 ± 5.7	35.6 ± 6.1	35.5 ± 5.7	35.4 ± 6.3
Muscle mass, kg	67.9 ± 8.4	65.8 ± 7.2	65.8 ± 6.9	65.4 ± 7.1	64.6 ± 6.9	64.9 ± 6.5	64.9 ± 6.9	64.1 ± 6.6
Resting heart rate, bpm	71.8 ± 11.5	68.0 ± 9.0*	64.8 ± 9.1*	67.1 ± 10.9*	76.0 ± 8.6	68.1 ± 10.3*	65.6 ± 8.7*	66.0 ± 7.4*
Systolic BP, mm Hg	130.7 ± 10.1	127.2 ± 126	129.4 ± 134	129.2 ± 13.7	128.3 ± 12.7	127.3 ± 12.1	131.7 ± 12.5	131.8 ± 15.0
Diastolic BP, mm Hg	85.5 ± 6.2	83.6 ± 7.3	84.4 ± 8.3	81.8 ± 10.1	80.4 ± 18.8	81.8 ± 6.3	84.3 ± 6.6	86.1 ± 12.3
HDL, mmol·L^{-1}	1.0 ± 0.2	1.0 ± 0.1	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.1	1.0 ± 0.1	1.1 ± 0.1	1.2 ± 0.8
Triglyceride, mmol·L^{-1}	1.6 ± 0.7	1.3 ± 0.7	1.6 ± 0.8	1.4 ± 0.7	1.7 ± 0.9	1.5 ± 0.6	1.8 ± 1.0	1.4 ± 0.8
Glucose, mmol·L^{-1}	5.6 ± 1.0	5.3 ± 0.5	5.4 ± 0.7	5.5 ± 0.7	5.7 ± 0.6	5.7 ± 1.0	5.6 ± 0.7	6.0 ± 0.9

Data are presented as average ± SD.
*Significant change compared with baseline.
BMI, body mass index; BP, blood pressure.

among all adults (39). For example, Collins et al. (40) found that, among the 947 participants exercising for 6–8 months, 40% of participants reported lack of time as the reason for dropping out. By removing the time required for transportation from and to a fitness facility throughout the online muscle-strengthening circuit program, it possibly contributed to a high proportion of men still meeting the two components of the physical activity guidelines after 46 wk.

Although successful in increasing the proportion of men living with obesity to reach the two components of the physical activity guidelines, participants in the intervention group failed to improve most measured health outcomes compared with baseline and the control group. Among the measured health outcomes, only waist circumference and resting heart rate were significantly improved within 46 wk, but in both groups. Reducing waist circumference and resting heart rate are important factors in reducing the risk of cardiometabolic diseases and premature death (36) and were observed in the intervention group. The fact that no differences were observed between groups could be explained by the fact that the proportion of participants who reached aerobic guidelines was not significantly different between the two groups at 12 wk (intervention vs control, 57.9% vs 33.3%; $P > 0.05$), 24 wk (intervention vs control, 89.5% vs 68.4%; $P > 0.05$), and 46 wk (intervention vs control, 73.7% vs 57.9%; $P > 0.05$). In a meta-analysis by Reimers et al. (41), it was reported that endurance exercises are the most effective to decrease resting heart rate and other health outcomes as opposed to resistance activities, yoga, and recreational sports. Future studies using the online muscle-strengthening circuit program should consider selecting outcomes associated with muscle-strengthening activities such as muscular strength, endurance, and power.

As far as the other health outcomes measured, body weight, body composition, and other metabolic outcomes were not significantly improved after the 12-wk intervention. Meta-analyses exploring the efficacy of exercise, with and without a controlled diet, on weight outcomes for people living with obesity indicated that physical activity without controlled diet results in modest weight loss (42,43). Similarly, systematic reviews have shown that regular exercises could improve metabolic profile in patients with metabolic diseases (44,45); but are not as effective for healthier individuals (46). Despite not meeting both components of the physical activity guidelines, it is possible that the sample was too young, too active, or too healthy at baseline to observe significant health improvements during the intervention. For example, participants in the circuit study were middle-aged adults (average age, 41.7 yr) and not completely inactive at baseline (31.6% meeting the aerobic component of the physical activity guidelines), with a metabolic profile within norms. Moreover, because of the mode of exercise, it is possible that the resistance training program did not lead to the expected energy expenditure, as proposed by Cadieux et al. (47) during sessions to induce significant physiological changes. In addition, this study was conducted in the early phases of the COVID-19 pandemic. It is possible that participants' behavior, including eating habits (48), sleeping hours (49), work, and social and leisure time activities (50), were not controlled in this study.

Limitations. Although the current study provides insight into a program that led to an exceptional adherence to physical activity guidelines in men living with obesity, some limitations need to be acknowledged. First, the initial sample size was calculated based on the primary outcome, and therefore, the analysis for secondary outcomes was subjected to statistical errors and less power in analysis. No control was done for energy intake for both groups or other life activities. The FitBit Charge 3 used to capture the aerobic component of the physical activity guidelines using the heart rate may have presented possible errors, such as responding to changes in activity and conditions (51). Also, only supervised sessions were considered for the attendance rate; therefore, the attendance is unknown from the nonsupervised sessions during weeks 5 to 12. It is important to note that the sample was not representative, as most participants were White Caucasians. In addition, to be included in the study, men had to live with obesity according to a body fat percentage cutoff. It is possible that different findings could have been observed if another metric such as body mass index or waist circumference was used. Finally, the study was conducted during the global pandemic of COVID-19. As a result, some amendments to the original plan were made. First, many participants did not accept wearing the mask once during follow-up visits. As a result, this measure is only available at baseline. Also, the goal was to follow

participants for a full year (52 wk after enrollment), but the follow-up time was reduced to avoid another wave of COVID-19 predicted after the holiday period. As a result, a follow-up at 46 wk was conducted.

CONCLUSIONS

This novel online muscle-strengthening circuit program significantly increased the proportion of men living with obesity meeting both components of physical activity guidelines 46 wk after enrollment. Although this is good news because it is hard to motivate men living with obesity to be regularly active, the health benefits normally associated with completing the physical activity guidelines were not improved. Future studies should select outcomes related to muscle-strengthening activities and focus on measuring oxygen consumption/energy expenditure of the circuit program to have a better picture of the impact of the circuit program on health outcomes.

This project was funded by the Heart and Stroke Foundation of New Brunswick. The authors declared no professional relationships with companies or manufacturers who will benefit from the results of the present study. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation. The results of the present study do not constitute endorsement by the American College of Sports Medicine. Trial registry: Clinical Trial No. NCT04680455.

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