INTERNATIONAL JOURNAL OF
-EXERCISE SCIENCE-

Original Research

A Flexible Training Approach to Improving Concurrent Training Outcomes in Remote Trainees

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Abstract

International Journal of Exercise Science 18(8): 43-55, 2025. https://doi.org/10.70252/UXRY5820 This study aimed to evaluate the effectiveness of a flexible, trainee-driven training program in improving concurrent training outcomes for individuals training remotely. The study employed a repeated-measures, parallel group design with 18 participants randomized into either a control group with fixed workouts or an experimental group with flexible workout selection based on perceived readiness. Participants were recreationally trained at baseline. Over a 16-week period, both groups completed assessments of strength and endurance, including deadlift, push-ups, and a two-mile run. The results indicated no significant difference in overall fitness improvements between the two groups, with both showing meaningful progress in strength and endurance measures. However, adherence rates were notably lower in the flexible group as the study progressed, potentially due to decision fatigue. Statistical significance was set at $\rho \leq 0.05$, with main effects of time showing significant improvement in fitness scores across all groups. The findings suggest that while flexible programming offers similar benefits to traditional fixed programs, it may require strategies to maintain adherence over longer periods. Practical applications include the potential for flexible training to be used effectively in remote settings, particularly for populations like military personnel with varying access to fitness resources.

Keywords: Remote training, Army Combat Fitness Test, strength, aerobic performance

Introduction

Taking part in a combined exercise program composed of both resistance training and aerobic training is well-known to confer a number of health benefits including reduced cardiovascular disease risk and overall improved quality of life.[1] Additionally, there are a variety of team sport athletes, and tactical athletes who benefit from the unique adaptations elicited through combined resistance training and aerobic training. For example, soldiers in the Army, Army Reserves, and Army National Guard are now required to complete the Army Combat Fitness Test (ACFT) which consists of both assessments of maximal strength and aerobic capacity.[2]

Adequate training stress must be balanced with adequate recovery to promote ideal training adaptations and prevent nonfunctional overreaching or overtraining in trainees of all types.[3] For trainees pursuing concurrent training goals, this balance is just as important, if not more so than for trainees pursuing strength or endurance goals in isolation. Adaptations to training have been shown to differ between trainees on similar training programs for endurance outcomes[4-6], hypertrophy and strength outcomes[7], as well as concurrent training outcomes.[8] Differences in outcomes may be partly explained by lifestyle factors that are not typically controlled in training studies, such as nutrition and life stressors, but are also influenced by genetic factors.[9] These differences in responses to training may result in the overtraining or undertraining of trainees who are given identical training programs, especially in the context of concurrent training where endurance training has the potential to attenuate strength, power and hypertrophy improvements if weekly training volume is not adequately managed for each trainee.[10-11] The difficulty of individualizing programming is compounded in the context of remotely trained individuals. Without real-time feedback, coaches have limited ability to make proactive adjustments to an trainee's program based on real-time readiness indicators. Novel methods of individualizing concurrent training programs for remote trainees are needed.

Several methods of training individualization in both resistance training and aerobic training currently utilize objective and subjective measures of readiness and fatigue. The rating of perceived exertion (RPE) is a subjective measure that is used in both pursuits to guide load prescription and progression, performance prediction, and to track progress over time. Although RPE and repetitions in reserve (RIR) scales for resistance training[12-14] and RPE scales for aerobic training[15] are available, both have similar aims in quantifying the subjective load of training to drive programming adjustments. Objective measures in resistance training, such as barbell velocity, have also been explored as a way to match load and volume prescriptions to daily readiness.[16-18] When directly compared, objective autoregulation methods seem to be superior to their subjective counterparts in the improvement of strength and power outcomes.[19]

Heart rate variability, perceived recovery, and heart rate-running speed index have been successfully implemented as a means to individualize progression in endurance training using a flexible training model.[20] There is a scarcity of research examining the use of similar strategies in concurrent training outcomes, however, similar concurrent performance benefits have been observed with varying training intensity distributions when external workloads are matched[21], implying that encouraging greater flexibility within a trainee's training program may be beneficial if intensities and volume can be matched to daily readiness.

Even in training scenarios where objective methods of autoregulation have been shown to be more effective, many of the objective methods commonly used to individualize training require specialized equipment and a high level of monitoring and adjustment by a coach, or advanced knowledge from the athlete themselves, necessitating a low coach to trainee ratio. However, organizations such as the military typically require approaches that can effectively train hundreds or thousands of personnel with a small team of strength and conditioning professionals. Many Army units, particularly Reserve and National Guard units, lack access to a dedicated strength and conditioning coach. Therefore, autoregulation strategies for a flexible training model that is primarily driven by the trainee are needed. Allowing trainees greater autonomy in workout selection based on their perceived readiness has been shown to achieve neutral to positive performance benefits when compared to traditional fixed programming.[22-24]

This greater autonomy lends itself to more effective training of remote trainees, who do not typically have the ability to report many of the common objective measurements of fatigue such as HRV, hormonal markers, or bar velocity. Subjective measures of fatigue and well-being have been shown to be effective as a standalone assessment of trainee readiness[25], which can be used to enable trainees to self-select their workouts. Additionally, smartphone applications can be an effective means of delivering physical activity programming for a variety of goals including concurrent training performance.[26] A remotely-delivered flexible training program would require an trainee to complete a subjective self-assessment of preparedness prior to each training session, the results of which would drive their workout selection for that day. The purpose of the present study is to evaluate the effectiveness of an trainee-driven flexible training program in improving muscular strength and endurance, and aerobic endurance outcome measures.

Methods

Participants

A power analysis conducted with G*POWER 3.1 (Universitat Kiel, Germany) determined that 18 participants were needed in the present study for a power of 0.8, with a Cohen's d effect size = 1.5 to correspond with the upper threshold for a moderate effect size in recreationally trained athletes[27], and an $\alpha = 0.05$. Initial recruitment yielded 50 participants, however, only 18 participants began the study.

This study was carried out in full accordance with the declaration of Helsinki as well as the ethical standards of the *International Journal of Exercise Science*.[28]

Subject characteristics are presented in Table 1. There was a total of 18 total subjects (10 male, 8 female). Running experience was quantified as the average number of miles per week a subject had engaged over the previous three months. Resistance training experience was quantified as the average number of weekly resistance training sessions engaged in in the previous three months.

Table 1. Participant Demographics.

Age (years)	36.3 ± 7.6
BMI (kg/m^2)	27.4 ± 3.9
Run Experience (miles per week)	7.7 ± 6.2
RT Experience (count per week)	3.1 ± 1.9

Subjects in the non-military cohorts were recruited through social media, and subjects in the Army National Guard cohort were recruited through coordination with their Master Fitness Trainer office. Exclusion criteria were injuries that would limit completion of a training program involving running and full-body resistance training. All participants provided written informed consent prior to participation and the protocol received approval from the Institutional Review Board at Liberty University and secondary review by the Army Human Research Protection Office.

Protocol

This study sought to evaluate the effectiveness of a flexible training structure in the improvement of concurrent training outcomes in remote trainees. To test this hypothesis, a repeated-measures parallel group design was used with two experimental conditions. The control group received workouts in a traditional manner; specific workouts completed on fixed days (CON). The experimental group (FLEX) was given designated running and resistance training days, but could choose which running or resistance training session to complete within each 2-week microcycle. For example, on the first resistance training day in a microcycle, subjects in the flexible group could choose from four resistance training sessions. On the following resistance training day in that microcycle, they could choose from the remaining 3 workouts. The workouts were identical between groups, with the only variation being the added flexibility given to subjects in the FLEX group. Participants in both groups could complete their workouts at any time of day as their schedule permitted.

At the beginning of the study, subjects were randomized into either the CON training group or the FLEX training group. The training program consisted of a standardized 3-week familiarization period during which participants became accustomed to the training software and reporting requirements, followed by 16 weeks of training. Both the familiarization period and the intervention period consisted of 2 resistance training sessions and 3 running sessions per week. Every four weeks both groups completed assessments of 3-repetition maximum deadlift (DL), a 2-minute pushup test (PU), and a 2-mile run (2MR). These assessments were chosen to replicate three of the events in the Army Combat Fitness Test that could be easily completed and reported in a remote training environment.

The intervention was run with three distinct cohorts based on subject availability, including one cohort composed of full-time Army National Guard members. The procedure was identical for all three cohorts, and the compiled data from each cohort is presented.

This study used a parallel group design, in which the control group (CON) was the group that completed each workout on specifically assigned days. The intervention group (FLEX) had fixed resistance training or run days but could choose the specific resistance training or run sessions based on their perceived readiness. Participants in the FLEX group were required to complete each session in each microcycle (6 running sessions, 4 resistance training sessions). There were 2 hard resistance training sessions in each microcycle (RPE 8-10) and two easier resistance training sessions (RPE 6-7) so that participants could choose based on their perceived readiness. Table 2 describes how many sessions participants in the FLEX group could choose from in each 2-week microcycle.

During weeks 1-3 both groups completed the same 3-week familiarization period which consisted of 3 weekly running sessions and 2 weekly resistance training sessions. The purpose of this period was to familiarize the participants with the training software being used (TeamBuildr, LLC, Landover, MD) and get the subjects accustomed to the nature of the training program. Participants were also provided with instructions on how to properly implement an RPE scale for their resistance training workouts. During the third week of the familiarization period, participants conducted initial assessments of DL, PU, and 2MR. During weeks 4-17, participants were split into either the CON or FLEX group. The CON group completed the assessments again every four weeks for a total of five assessments. The FLEX group completed the assessments every other microcycle but could choose when in the microcycle they completed their assessments. During weeks 18 and 19, both groups were put on the same peaking block and conducted final assessments at the end of week 19. The FLEX group did not have the option to choose workouts during this period.

Table 2. FLEX Group Choice Matrix.

Day	Session Type	Week 1	Week 2
Monday	RT	4 choices	2 choices
Tuesday	Run	6 choices	3 choices
Wednesday	Rest	Rest	Rest
Thursday	Run	5 choices	2 choices
Friday	RT	3 choices	1 choice
Saturday	Run	4 choices	1 choice
Sunday	Rest	Rest	Rest

Participants received their workouts and logged workout details in the TeamBuildr application. This study was conducted entirely virtually. All participants in the study completed workouts and assessments remotely. There were no scheduled meetings or in-person contact times, but researchers were available to answer any individual questions posed by the participants.

Prior to each training session, participants completed a performance readiness survey that asked about prior night sleep (hours) and overall readiness to perform physical activity on a 1-100 visual analog scale. Participants in the FLEX group were instructed to choose workouts based on their rating of perceived readiness.

Resistance training workouts consisted of compound and isolation movements using barbells and dumbbells, with general and movement specific warm-ups prescribed before each session. Each workout consisted of 2-3 compound barbell movements (deadlift, back squat, bench press, split squats, overhead barbell press) followed by 2-3 accessory exercises with dumbbells or bodyweight (rows, pushups, single arm press, planks, lateral raises). Every microcycle consisted of 2 hard sessions (RPE 8-10) and 2 easier sessions (RPE 6-7). Participants were instructed to input weights used for each movement during each workout. Participants were instructed to progress their weight selections as they adapted to training to remain in the prescribed RPE ranges. Each testing week contained a resistance training testing day where the deadlift and pushup were tested, and a run day where the 2-mile run was tested. Training days and testing days contained identical general and movement specific warm-ups. The remaining days in the testing week were low in volume and intensity to facilitate periodic deloading periods. Participants were asked to remain consistent throughout the entirety of the program in regards to their deadlift implement (straight bar or trap bar).

Running sessions were prescribed in a time-based manner (i.e., "complete 25 minutes of running at an easy pace" or "10 minutes of an easy pace, 6x30s strides with 2 minutes rest in between sets, 10 minutes easy pace cool down"). Participants were instructed to log miles completed for each running workout.

At the completion of the study, all data from the assessments were exported from the TeamBuildr application. Raw scores for each event (DL, PU, 2MR) were converted to t scores, and summed to obtain a total fitness score (TFS) for each participant at each assessment.

Statistical Analysis

Statistical analyses were performed with IBM SPSS Statistics Version 29. A priori statistical significance was set to $p \leq 0.05$. All data are presented as mean ± standard deviation unless otherwise specified. Cohen's f statistic and partial eta squared are reported for the primary outcome (TFS). Due to an increase in dropout rates as the study progressed, sub-group analyses were conducted based on the participants that completed two, three, four, or five assessments. Two-way repeated measures ANOVAs were conducted for each sub-group to analyze the effect of time and group on concurrent training adaptations (TFS). Two-way repeated measures ANOVAs were also conducted on each assessment measure (DL, PU, 2MR) to analyze the effect of time and group on specific strength or running outcomes. Significant main effects of group or time were followed up with one-way repeated measures ANOVAs to further identify where differences occured

Results

Two Assessments (4 weeks of training)

In subjects that completed two assessments (n = 18), there was no statistically significant group by time interaction, ($F^{16,23} = 1.774$, $p = 0.202$, partial $\eta 2 = 0.100$). The main effect of time did show a statistically significant difference in mean TFS, ($F^{16,23} = 18.674$, $p < 0.001$, partial $\eta 2 = 0.539$). The main effect of group showed that there was not a statistically significant difference in TFS between groups ($F^{16,23} = 0.098$, $p = 0.759$, partial $\eta 2 = 0.006$). At the group level, there was a main effect of time in CON ($F^{16,4} = 6.866$, $p = 0.034$, partial $\eta 2 = 0.495$), and in FLEX ($F^{16,29} = 33.817$, $p <$ 0.001, partial $\eta 2 = 0.790$).

Three Assessments (8 weeks of training)

In subjects that completed three assessments (n = 16), there was no statistically significant interaction between the intervention and time on TFS, ($F^{15,11} = 2.269$ $p = 0.112$, partial $\eta 2 = 0.139$). The main effect of time showed a statistically significant difference in mean TFS, ($F^{15,11} = 16.37$, $p < 0.001$, partial $\eta 2 = 0.539$). Pairwise comparisons revealed a difference between TFS1 and TFS2 (M = 10.1, SE = 2.8 au, $p = 0.003$) but not between TFS2 and TFS 3 ($p = 0.06$). The main effect of group showed that there was no statistically significant difference in TFS between groups ($F^{16,1}$ $= 0.516$, $p = 0.485$, partial $\eta 2 = 0.036$). At the group level, there was a statistically significant effect of time on TFS for the CON, ($F^{15,1} = 8.469$, $p = 0.004$, partial $\eta 2 = 0.547$). Pairwise comparisons revealed differences between TFS1 and TFS2 (M = 14.0, SE = 5.5 au, $p = 0.038$), between TFS1 and TFS3 (M = 16.9, SE = 4.9 au, p = 0.01) but not between TFS2 and TFS 3 (p = 0.193). There was a statistically significant effect of time on TFS and for FLEX ($F^{15,1}$ = 17.89, p < 0.001, partial η2 = 0.719). Pairwise comparisons revealed differences between TFS1 and TFS2 (M = 6.3, SE = 1.3 au, p = 0.002), between TFS1 and TFS3 (M = 7.8, SE = 1.8 au, p = 0.003) but not between TFS2 and TFS3 (p = 0.09).

Four Assessments (12 weeks of training)

In subjects that completed four assessments (n = 8) there was a statistically significant interaction between the intervention and time on TFS, ($F^{9,28}$ = 4.374 p = 0.003, partial η2 = 0.422). The main effect of group showed that there was a statistically significant difference in TFS between groups ($F^{16,18}$ = 13.09, p = 0.01, partial η2 = 0.686). There was a group difference at TFS3 favoring CON (M = 22.1, SE = 4.8 au, p = 0.004) and TFS4 favoring CON (M = 21.8, SE = 4.6 au, p = 0.003) but no difference at TFS1 (p = 0.1) and no difference at TFS2 (p = 0.06). The main effect of time showed a statistically significant difference in mean TFS, ($F^{9,28}$ = 21.66, p < 0.001, partial η2 = 0.783). Pairwise comparisons revealed a difference between TFS1 and TFS3 (M = 10.7, SE = 1.9 au, p = 0.002), between TFS1 and TFS4 (M = 15.5, SE 1.7 au, p < 0.001), between TFS2 and TFS4 (M = 9.0, SE 2.2 au, p = 0.006), and between TFS3 and TFS4 (M = 4.4, SE 0.9 au, p = 0.003). There was a statistically significant effect of time on TFS for CON ($F^{9,29}$ = 12.847, p = 0.001, partial η2 = 0.811). Pairwise comparisons revealed significant differences between TFS1 and TFS3 (M = 16.7, SE = 3.7 au, p = 0.02), between TFS1 and TFS4 (M = 20.9, SE = 3.4 au, p = 0.009), and between TFS2 and TFS4 (M = 12.7, SE = 3.9 au, p = 0.049), but there was no difference between other time points. There was a statistically significant effect of time on TFS and for FLEX ($F^{9,29}$ = 14.137, p < 0.001, partial η2 = 0.825). Pairwise comparisons revealed significant differences between TFS1 and TFS3 (M = 4.8, SE = 1.5 au, p = 0.04), between TFS1 and TFS4 (M = 9.3, SE = 1.9 au, p < 0.001), and between TFS3 and TFS4 (M = 4.6, SE = 1.0 au, p = 0.02), but there was no difference between other time points.

Five Assessments (16 weeks of training)

In subjects that completed five assessments (n = 5) there was no statistically significant interaction between the intervention and time on TFS, ($F^{24,10}$ = 2.074, p = 0.147, partial η2 = 0.409). The main effect of time showed a statistically significant difference in mean TFS, ($F^{24,10}$ = 7.781, p = 0.002, partial η2 = 0.722). Pairwise comparisons revealed significant differences between TFS1 and TFS4 (M = 15.6, SE = 2.5 au, p = 0.008), between TFS1 and TFS5 (M = 18.9, SE = 2.4 au, p = 0.004), between TFS3 and TFS4 (M = 6.1, SE = 1.0 au, p = 0.01), between TFS3 and TFS5 (M = 9.3, SE = 1.1 au, p = 0.003), and between TFS4 and TFS5 (M = 3.3, SE = 0.6 au, p = 0.01). There was a statistically significant effect of time on TFS for CON ($F^{24,30}$ = 7.379, p = 0.009, partial η2 = 0.787). Pairwise comparisons revealed significant differences between TFS1 and TFS4 (M = 22.8, SE = 3.8 au, p = 0.03), between TFS1 and TFS5 (M = 28.9, SE = 3.7 au, p = 0.02), between TFS3 and TFS5 (M = 12.3, SE = 1.4 au, p = 0.01), and between TFS4 and TFS5 (M = 6.1, SE = 0.6 au, p = 0.01), but there was no difference between other time points. There was a statistically significant effect of time on TFS and for FLEX ($F^{24,24}$ = 24.852, p = 0.004, partial η2 = 0.961). Pairwise comparisons revealed significant differences between TFS1 and TFS4 (M = 8.4, SE = 0.5 au, p = 0.04), between TFS3 and TFS4 (M = 5.9, SE = 0.02 au, p = 0.002), but there was no difference between other time points. The main effect of group showed that there was not statistically significant difference in TFS between groups ($F^{16,9} = 5.533$, $p = 0.1$, partial $\eta 2 = 0.648$).

Event-Level Measures

Tables 3-6 present the results at the event-level for each subgroup.

Table 3. Deadlift Results (kg) for Each Subgroup.

Sub-Group	n	DL1	DL2	DL3	DL4	DL 5
2 Assessments (Fixed)	8	86 ± 39	102 ± 39*	-	-	-
2 Assessments (Flex)	10	89 ± 25	97 ± 26*	-	-	-
2 Assessments (all)	18	87 ± 31	99 ± 31*	-	-	-
3 Assessments (Fixed)	8	86 ± 39	102 ± 39*	100 ± 36*	-	-
3 Assessments (Flex)	8	87 ± 28	95 ± 28*	97 ± 25*	-	-
3 Assessments (all)	16	87 ± 33	98 ± 33*	98 ± 30*	-	-
4 Assessments (Fixed)	4	81 ± 26	95 ± 34	89 ± 25	95 ± 26*	-
4 Assessments (Flex)	4	82 ± 19	90 ± 16	89 ± 12	91 ± 16*	-
4 Assessments (all)	8	82 ± 21	93 ± 25	89 ± 18	93 ± 20*	-
5 Assessments (Fixed)	3	91 ± 20	105 ± 34	97 ± 25	105 ± 21*	116 ± 16*
5 Assessments (Flex)	2	95 ± 3	99 ± 2	95 ± 3	102 ± 0	102 ± 0
5 Assessments (all)	5	93 ± 14	103 ± 24	96 ± 17	104 ± 15**	110 ± 14*

DL = Deadlift *= Difference from baseline ** = Difference from previous assessment † = Difference between groups

Table 4. Push-up Results for Each Subgroup.

Sub-Group	n	PU1	PU2	PU3	PU4	PU5
2 Assessments (Fixed)	8	32 ± 13	40 ± 15*	-	-	-
2 Assessments (Flex)	10	27 ± 20	31 ± 23*	-	-	-
2 Assessments (all)	18	29 ± 17	35 ± 20*	-	-	-
3 Assessments (Fixed)	8	32 ± 13	40 ± 15*	45 ± 15*	-	-
3 Assessments (Flex)	8	21 ± 17	25 ± 20*	26 ± 20*	-	-
3 Assessments (all)	16	27 ± 16	33 ± 19*	35 ± 20*	-	-
4 Assessments (Fixed)	4	38 ± 10†	47 ± 14†	54 ± 8†*	56 ± 9†	-
4 Assessments (Flex)	4	15 ± 12†	17 ± 11†	18 ± 12 †*	19 ± 13†*	-
4 Assessments (all)	8	26 ± 16	32 ± 20	36 ± 22	38 ± 22	-
5 Assessments (Fixed)	3	33 ± 7†	45 ± 17	52 ± 8†	54 ± 10†	52 ± 12†
5 Assessments (Flex)	2	8 ± 3†	10 ± 4	10 ± 4†	12 ± 2†	11 ± 1†
5 Assessments (all)	5	23 ± 15	31 ± 23	35 ± 24	37 ± 25	35 ± 24

PU = Push-up *= Difference from baseline ** = Difference from previous assessment † = Difference between groups

Discussion

The primary goal of this study was to evaluate whether providing trainees with increased autonomy through workout selection, based on subjective readiness, would result in greater concurrent training adaptations compared with a traditional fixed programming approach.

While the results indicated that this increased autonomy did not result in greater improvements, the ability to obtain similar results while allowing for greater autonomy is a valuable finding.

Table 5. Two Mile Run Results for Each Subgroup.

Sub-Group	n	2MR1	2MR2	2MR3	2MR4	2MR5
2 Assessments (Fixed)	8	21.9 ± 10.9	19.1 ± 5.4	-	-	-
2 Assessments (Flex)	10	20.8 ± 3.8	19.54 ± 3.2*	-	-	-
2 Assessments (all)	18	21.3 ± 7.6	19.4 ± 4.2	-	-	-
3 Assessments (Fixed)	8	21.9 ± 10.9	19.1 ± 5.4	18.7 ± 5.2**	-	-
3 Assessments (Flex)	8	20.1 ± 2.9	19.3 ± 2.5	18.9 ± 2.7	-	-
3 Assessments (all)	16	21.0 ± 7.8	19.2 ± 4.1	18.8 ± 4.0**	-	-
4 Assessments (Fixed)	4	19.9 ± 5.0	18.6 ± 4.6	18.3 ± 4.8 *	18.2 ± 5.3*	-
4 Assessments (Flex)	4	19.7 ± 3.3	19.8 ± 3.4	19.5 ± 3.4	18.6 ± 3.1 *	-
4 Assessments (all)	8	19.8 ± 3.9	19.2 ± 3.8	18.9 ± 3.9	18.4 ± 4.0*	-
5 Assessments (Fixed)	3	21.1 ± 4.7	19.8 ± 4.6	19.3 ± 4.7*	19.2 ± 5.0	18.8 ± 4.2*
5 Assessments (Flex)	2	20 ± 5.7	19.6 ± 6.0	19.3 ± 5.7*	18.8 ± 5.4	18.4 ± 4.8
5 Assessments (all)	5	20.7 ± 4.7	19.7 ± 4.6	19.3 ± 4.7*	19 ± 5.0*	18.7 ± 4.2*

2MR = Two mile run *= Difference from baseline ** = Difference from previous assessment † = Difference between groups

Table 6. Adherence by Subgroup.

Sub-Group	n	Average Sessions Completed	% of Assigned Sessions
2 Assessments (Fixed)	8	9.9 ± 2.0	66%
2 Assessments (Flex)	10	10.3 ± 3.7	69%
2 Assessments (all)	18	10.1 ± 3.0	67%
3 Assessments (Fixed)	8	19.3 ± 3.4	64%
3 Assessments (Flex)	8	18.3 ± 8.5	61%
3 Assessments (all)	16	18.9 ± 6.2	63%
4 Assessments (Fixed)	4	31.3 ± 5.2	70%
4 Assessments (Flex)	4	19.3 ± 14.3	43%
4 Assessments (all)	8	25.3 ± 11.9	56%
5 Assessments (Fixed)	3	43.3 ± 8.9†	72%
5 Assessments (Flex)	2	17.5 ± 2.1†	29%
5 Assessments (all)	5	33 ± 15.5	55%

† = Difference between groups

Our findings are consistent with previous research demonstrating the overall efficacy of a structured remote training program for improving combined strength and endurance outcomes.[26] The authors found practically meaningful improvements in Army Combat Fitness Test performance after a 12-week virtual exercise program. Another study[29] employed high-intensity interval training with college students during COVID-19 lockdowns to improve pushup repetitions, in which there were significant increases in total pushup-capacity.

The present study provides support for a flexible training approach providing similar improvements in concurrent training outcomes for recreationally trained individuals when compared to a traditional approach. While this is the first study to our knowledge that evaluates this training strategy for concurrent training, the event-level measures of strength and aerobic capacity may be compared to existing literature. The DL results indicate that improvements between groups were similar at each time point, which confirms earlier findings from Walts and colleagues[22] and by Colquhoun and colleagues[24], but does not replicate the large differences found in the study by Mcnamara & Stearne, which found significantly greater improvements in a flexible non-linear weight training program.[23] The PU results began to demonstrate between-group differences in the 4 assessment sub-group. However, these differences seem to be a result of the higher scoring participants in the FLEX group dropping out at greater rates than the CON group, as there were between-group differences at PU1 for this subgroup which carried over to the subsequent time points.

The 2MR results demonstrated similar endurance improvements between groups, indicating that the level of individualization provided by the flexible approach was not sufficient to elicit greater adaptations than the control group as seen in the study by Nuuttila and colleagues[20] which used nocturnal heart rate variability, perceived recovery, and heart rate-running speed index to individualize training load progression.

Both approaches were effective in improving overall fitness as measured by TFS, however, group differences were observed in the 4 Assessment sub-group where CON outperformed FLEX at time points 3 and 4. This difference in performance can be largely explained by declining adherence rates in the FLEX group compared to the CON group as the study length progressed. Adherence in the FLEX group fell to 43% of total prescribed sessions compared to 70% in the CON group in the 4 assessment sub-group, which corresponds with 12 weeks of training. It is possible that the cognitive burden of choosing sessions for an extended period may have resulted in decision fatigue, causing lower adherence. Additional research into this aspect of trainee-driven flexible remote training programs is needed, as the existing literature on flexible programming is exclusively in person where adherence is presumably affected to a lesser extent.

The primary limitation of this study is the self-reported nature of the data, which is an inherent obstacle in remote training in general. Future research could utilize methods such as video submissions, automated reminders, and scheduled progress reviews participants to enhance and confirm adherence, although this would increase the effort required from the participants and practitioner. An additional limitation in this study was the accurate quantification of adherence. Some participants, particularly in the FLEX group, continued to log results for the assessments but logged very few workouts between assessment periods. It is difficult to ascertain whether these participants truly did not complete workouts between assessment periods or if they simply did not enter data into the application.

Another limitation is the lack of blinding which may also have introduced bias, although the nature of the study made blinding unfeasible. In terms of generalizability, conducting an assessment every 4 weeks may pose limitations, in that it is more frequent than real-world military settings. Additionally, it is possible that such frequent assessments may have produced undue accumulation of fatigue throughout the program that may have affected the results.

Future research on this topic should focus on identifying athlete characteristics (experience, training status, etc.) that predispose them to thrive in a program with more or less autonomy. Additionally, strategies to increase oversight in remotely-trained individuals should be explored while balancing practitioner burden.

Acknowledgements

Authors declare no conflict of interests. The authors wish to thank the subjects for their invaluable contribution to the study.

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