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COMPARISON OF PHYSICAL FITNESS OUTCOMES OF YOUNG SOUTH AFRICAN MILITARY RECRUITS FOLLOWING DIFFERENT PHYSICAL TRAINING PROGRAMS DURING BASIC MILITARY TRAINING

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ABSTRACT

Physical training (PT) is an integral part of developing operational fitness. The objective of the study was to compare the physical fitness outcomes of two groups of young South African military recruits completing 12 weeks of Basic Military Training (BMT) who followed different PT programs. A historical control group (NCPG: female n=115, male n=73) that followed a traditional PT program and an experimental group (CPG: female n=85, male n=100) that followed a new cyclic-progressive PT program participated. The standardised PT test was taken at the beginning, the fifth week and the end of the BMT period. The changes in the fitness components evaluated by the South African National Defence Force (SANDF) standardised PT test were compared. Although the new cyclic-progressive PT program elicited more change (p<0.05) in the fitness parameters measured, it only yielded superior performance at the final measurement in the men's push-ups (p=0.0001). This may be attributed to the relatively greater amount of upper body exercises performed by the CPG and by the additional resistance offered by pole PT. The new cyclic-progressive PT program has been mandated for all BMT units across the SANDF.

Key words: Basic military training, Operational fitness, Fitness components, Cyclic-progressive

INTRODUCTION

Physical Training (PT) forms an integral part of the physical preparation and conditioning of military personnel. Military historians have repeatedly emphasised the importance of a high level of physical capability as necessary for the occupational tasks that recruits are required to perform (McGaig & Gooderson, 1986; Nye, 1986; Dubik & Fullerton, 1987; Knapik *et al.*, 2005; Dyrstad *et al.*, 2006). New recruits, making the transition from civilian to South African military life, undergo a period of initial BMT to equip them with the required optimum physical capability and skills training needed to execute their tasks effectively (Gordon *et al.*, 1986; Jordaan & Schwellnus, 1994; Knapik *et al.*, 2005; Shaffer & Uhl, 2006). During the BMT periods, recruits participate in basic military lessons, including formal PT, which consists of four 40-minute compulsory PT periods per week.

All instructors presenting BMT followed a standardised PT program in order to achieve the required results within the prescribed time (Department of Defence, 2000). As physical fitness levels have been reported to have declined in recent decades in both the male and female population, the fitness outcomes of the BMT recruits need to be continuously monitored to ensure that the PT program is achieving the desired effects (Gordon-Larsen *et al.*, 2000; Knapik *et al.*, 2003; Knapik *et al.*, 2004; Knapik *et al.*, 2005; Dyrstad *et al.*, 2006). Research has indicated that the body improves its capacity to exercise when the PT systematically stresses the body causing the body to adapt to the stress of physical effort. If the stress is not sufficient to overload the body, then no adaptation occurs (Braith & Stewart, 2006).

PURPOSE OF STUDY

Progressive training has been shown to be beneficial and is easily attained when progressive overload, specifically, and training variation are included in the program (Kraemer *et al.*, 2002). A new cyclic-progressive PT program for BMT in the South African military was developed. It incorporated weekly progression and resistance training in the form of pole PT. The aim of the study was to determine the effectiveness of a new cyclic-progressive PT program during 12 weeks of BMT by comparing the changes in the recruits' muscle endurance, aerobic and anaerobic fitness evaluated by the standardised PT test battery (Department of Defence, 2000).

METHODOLOGY

Experimental design

The study design was quasi-experimental, comparing two cohorts. The non-cyclic-progressive group (NCPG) comprised recruits who followed the non-cyclic-progressive program and completed their BMT in 2005; the cyclic-progressive group (CPG) completed their BMT in the same corps and unit in 2006. A non-probability sampling method with a sample of convenience was used in this study (Kinnear & Taylor, 1996).

Subjects

Ethical approval was obtained from the South African Defence Force Ethics Committee (Ethical clearance number SG/R&D/2-Jun-06/ 083), as well as the Ethics Committee of the Medical Faculty of the University of Pretoria (Project number 57/2006) to conduct the study. Their ethical guidelines were followed throughout the study. Participants were volunteers from the South African Health and Medical Services BMT recruits. The NCPG and CPG consisted of 73 and 100 male recruits and 115 and 85 female recruits, respectively. No differences existed between the initial body mass, height and BMI of the two groups as outlined in Table 1. After an informational session covering all aspects of the study methodology, participants were asked to read and sign an informed consent form. All participants had passed a medical entry examination executed by a medical officer to ensure that they were free of any disorder that would contra-indicate their attendance of BMT; this included a negative serum pregnancy test.

Procedure

All the participants from the CPG and NCPG were tested using the Standardised PT test battery within 4 days of reporting for BMT, before the commencement of the normal unit PT program, 5 weeks into the BMT course, and again in the last week of the 12-week period.

Physical training programs

A standardised BMT program was followed. The main aim of BMT was to ensure a combat-ready recruit at the end of the 12-week period. Activities included drill, regimental aspects, compliments and saluting, general military aspects, musketry, shooting, signal training, mine awareness, map reading, buddy aid, field craft, water orientation, parade rehearsal and PT. Both groups, except for a different PT program, followed the same BMT program. Both cohorts completed 48 periods of PT consisting of 40 minutes each over the 12-week period (Department of Defence, 2000).

***TABLE 1*: COMPARISONS OF INITIAL PHYSICAL CHARACTERISTICS OF CONTROL GROUP (NCPG) AND EXPERIMENTAL GROUP (CPG)**

Physical characteristic	Group	Male recruits			Female recruits		
		Mean	SD	p*	Mean	SD	p*
Age (y)	NCPG CPG	20.5 20.2	3.4 3.3	0.98	19.9 20.0	3.1 3.2	0.94
Height (cm)	NCPG CPG	172.2 171.4	6.0 5.9	0.97	160.1 159.3	5.3 5.5	0.95
Mass (kg)	NCPG CPG	62.3 61.8	6.7 6.9	0.85	59.1 60.2	8.7 9.0	0.92
BMI# ($kg.m^{-2}$)	NCPG CPG	21.1 21.4	2.4 2.2	0.95	22.8 22.4	2.8 2.5	0.93

* p-value compares the NCPG and CPG in independent sample t-test
\# BMI: Body Mass Index

The aim of both programs was to ensure operational fitness. This was achieved through exercises aimed at developing the basic fitness components, namely cardio-respiratory endurance and muscular endurance (Dubik & Fullerton, 1987). All PT periods had a similar lesson plan, namely warm-up, muscle endurance and/or aerobic component and cool down (stretching). The difference in the programs lay primarily in the time allocated to each component, the progression within each exercise and the inclusion of muscle endurance exercises based on resistance offered by own body weight (NCPG) only and progressing to exercises with additional resistance offered by the use of solid timber wooden poles (≈20kg, 2.1m in length by 25cm in diameter) (Table 2) (Department of Defence, 2000). The latter was only included in the program followed by the CPG from the fifth week, which provided a cost-effective and manageable method of muscle endurance training, based on the principle of free-weight training (Photograph 1) (Daniels *et al*. 1979; Jones *et al*., 1993; Heyward, 2002; Knapik *et al*., 2005). Due to the size and weight of the poles all exercises were executed in pairs, thus distributing the weight of the wooden pole between two recruits.

Although all attempts were made to ensure that recruits applied equal effort when using the pole this could not be ensured.

***PHOTOGRAPH 1*: EXAMPLE OF AN EXERCISE (SQUAT) PERFORMED USING SOLID TIMBER WOODEN POLES (POLE PT)**

The CPG completed 45% more abdominal and 39% more upper body muscle endurance exercises than the NCPG did. Additionally, 46% more jogging was completed by the CPG. The program followed by the NCPG included 51% more time allocated to warm-up activities and minor games. Both groups completed similar amounts of running interval training (Table 2).

***TABLE 2*: PHYSICAL TRAINING PROGRAM OF THE NCPG AND CPG**

PT program component	Resistance	NCPG-PT	CPG-PT
Warm-up (minutes)	None	630	322
Upper body muscle endurance exercises (number)	BW (Body Weight) BW + 20kg wooden poles	51* 0	28** 64***
Abdominal body muscle endurance exercises (number)	BW (Body Weight) BW + 20kg wooden poles	56* 0	28** 64***
Jogging (minutes)	None	510	950
Interval training (minutes)	None	200	213

* From week 1 completed 3 sets of 10-12 repetitions of exercises performed by muscle groups in this body region
** From weeks 1 to 2 completed 2 sets of 10-12 repetitions progressing to 3 sets of 10-12 repetitions in week 3-4 of exercises performed by muscle groups in this body region
*** From weeks 5 to 12 completed all exercises with 20kg wooden poles in pairs performed by muscle groups in this body region starting with 2 sets of 10-12 repetitions progressing to 3 sets of 10-15 repetitions
NOTE: *Further details available in Dept. of Defence Policy on physical training and Department of Defence Instruction*

Whilst the NCPG, PT program was characterised by very little progression, the PT followed by the CPG had a progressive build-up, from walking to jogging, as the cardiovascular activity prescribed (Scully & Besterman, 1982; Popovich *et al.*, 2000), as well as a 10% weekly progression in frequency and intensity of the initial training events (Heir & Eide, 1997; Kaufmann *et al.,* 2000; Heyward, 2002; Knapik *et al.,* 2003; Rosendal *et al.,* 2003; Armstrong *et al.,* 2004).

Measurements

The fitness components evaluated were aerobic fitness via the 2.4km-run and 4km-walk, muscle endurance using the sit-up and push-up test and anaerobic fitness via the shuttle-run test. The *2.4km-run test* was executed as the first component of the standard fitness test. The test was conducted over a distance of 2.4km on a flat surface. The first half of the distance (1.2km) was run to a turning point, and the second half was run over the same route, back to the starting point. The time taken to complete the distance was timed and recorded. Following a maximum rest period of 15 minutes, but not less than 10 minutes, the *sit-up* and *push-up* tests were executed. The total number performed for each test in 2 minutes was recorded, followed by the *shuttle-run test*. The latter entailed running a distance of 22m, 10 times without any breaks. The last component was the *4km-walk* test, which was executed on a flat, circular route. No running or jogging was allowed. The time taken to complete the shuttle-run test and 4km-walk was timed and recorded. A rest period of 2 minutes was given between these components (Department of Defence, 2000).

Points are allocated to each BMT recruit according to their performance level (time measured and completed number of repetitions) per component. A BMT recruit passes a component if 600 points are achieved. Recruits under the age of 34 year pass the battery test if they achieve a minimum of 3 000 points, the sum total of points achieved for all components (Department of Defence, 2000).

Statistical analyses

Data was analysed by means of the Statistical Product and Service Solutions package (SPSS 11.5 for Windows, SPSS Inc., Chicago, IL, USA). On completion of the BMT period, 7 participants (3 males, 4 females) from the NCPG (N= 181; 70 male, 111 female) and 2 participants (2 females) from the CPG (N= 183; 100 male, 83 female) dropped out of the study. Data was only analysed for cases where complete information was available. The mean and standard deviations were used to describe the results. Student's t-tests for independent samples were used to determine whether statistically significant differences ($p<0.05$) existed between the CPG and NCPG for all fitness measurements (Hair *et al*., 1998). Multivariate analysis of co-variance confirmed whether statistically reliable mean differences amongst groups existed after adjusting the newly created dependant variables for differences on one or more covariates (Hair *et al*., 1998). The Leverne's test and Box's test were used to assess error variance and equality of covariance respectively.

When the data was analysed for females and males separately, the base size dropped to under 70 cases per measurement. Thus, non-parametric statistics were used to analyse changes within male and female groups over time. Chi-square analysis assessed the relationship between the group membership (CPG vs. NCPG) and the pass or fail rates of the group on total fitness test scores. The Friedman's rank test for *k* correlated samples determined whether statistically significant differences existed between the measurements obtained during the pre-test and two consecutive post-tests during the fitness tests. Effect size (ES) was calculated to assess practical significance with Cohen's (1988) criteria classifying effects as small (0.2-0.3), moderate (0.31-0.5) or large (>0.5). The precision of these estimates was indicated by 95% confidence limits. Kendall's Coefficient of concordance assessed agreement of the changes seen within the groups, with Kendall's *W* ranging from 0 (no agreement) to 1 (complete agreement).

RESULTS

The proportion of female recruits in the NCPG was 61.3%, and that of the CPG was 45.4%, whilst the proportion of male recruits was 38.7% and 54.6% in the NCPG and CPG, respectively. Table 3 and Table 4 show the initial, mid and final Standardised Fitness Test scores of the male and female NCPG and CPG respectively, the significant changes, as well as the absolute mean difference between the groups across the 12-week BMT period as analysed by Friedman's test.

In the *initial* fitness test both the male and female recruits in the CPG took significantly longer to complete the 2.4km-run (males and females: p=0.0001; ES=1.12), whilst a large significant difference in the 4km-walk time was only evident in the female recruits (p=0.0001; ES=0.64). Both the male and female recruits of the CPG completed significantly fewer push-ups (males and females: p=0.0001; ES=0.5 & 0.62, respectively) and sit-ups (males: p=0.0001; ES=0.64; females: p=0.002; ES=0.33), and took significantly longer to complete the shuttle-run test (males and females: p=0.0001; ES=0.64 & 0.48, respectively) at the initial fitness test.

In the *mid* fitness test no significant and small to moderate practical differences were evident between the females of the two groups for all fitness components. The CPG showed a mean 18% and 11% improvement, in their 2.4km and 4km times, respectively as well as 76% improvement in their push-up performance and a 99% and 9% improvement in their sit-up and shuttle run tests. The CPG's walked the 4km moderately faster (p=0.0001; ES=-0.39), completed moderately more sit-ups (p=0.006; ES=0.31) and push-ups (p=0.001; ES=0.37), but took significantly less time to complete the 2.4km-run (p=0.03; ES=0.25) and the shuttle runs (p=0.22; ES=-0.14), although the latter was statistically non-significant and the effect small.

With the mid fitness test as the dependant variable the multivariate analysis of covariance for both groups showed no significant difference in the covariance matrices. The error variance was equal across groups in all fitness components. Group membership was found to have a significant effect (p=0.0001) on all the fitness test components, and the CPG group membership was also associated with an increase in the number of push-ups and sit-ups performed and lowered shuttle-run, 2.4km-run and 4km-walk times. This confirmed improved performance by the CPG.

By the *final* fitness test there were no statistically significant difference between the male recruits of the two groups in the 2.4km-run time (p=0.17; ES=0.17) and the 4km-walk time (p=0.17; ES=0.16). During the final assessment, the NCPG performed moderately significantly more sit-ups (p=0.0001; ES=-0.34) and took significantly less time to complete the shuttle-run test (p=0.0001; ES=0.93) than the CPG, whilst the men in the CPG completed moderately more push-ups (p=0.0001; ES=0.41) than the NCPG. A moderately small difference between the female recruits 2.4km-run (p=0.001; ES=0.36) highlights the decline in the CPG's performance in this variable. Similarly the female recruits in the NCPG performed significantly more sit-ups (p=0.03; ES=0.21) and ran the shuttle runs faster (p=0.0001, ES=0.54) than the CPG, whilst no difference (p=0.13; ES=-0.16) existed in the push-ups performed by the end of BMT.

With the final fitness test as the dependant variable, the multivariate analysis of covariance for the male and female group showed no significant difference in the covariance matrices, and the error variance was equal across groups in all fitness components. Group membership was found to have no significant effect on push-ups and 4km-walk measurements. However, it did have an effect on the sit-ups, shuttle-run and 2.4km-run measurement. CPG group membership was associated with a decrease in the number of sit-ups performed and an increase in shuttle-run times, confirming poorer performance as indicated in the t-test for the male recruits. The CPG was also associated with slower 2.4km-run times as supported by the t-test for the female recruits.

Mean changes *within* the groups are presented in Table 3 and Table 4, while Table 5 indicates that within the CPG, both the male (W=0.68; p=0.0001) and female (W=0.76; p=0.0001) recruits ran the *2.4km-run* test statistically faster in the final fitness tests compared to the start of BMT. Conversely the NCPG took longer (males: W=0.29; p=0.0001; females: W=0.24; p=0.0001) to complete their 2.4km-run in their final assessment than at the start of BMT. The CPG also scored a much slower time in the initial fitness test, but at the final fitness test the two groups' times were similar. Similarly, in both groups the time taken to complete the *4km-walk* decreased significantly over time, reflecting an improvement in cardiovascular fitness (Heyward, 2002). The CPG had the largest decrease (males: W=0.69; p=0.0001; females: W=0.75; p=0.0001), showing a greater improvement than the NCPG (males: W=0.52; p=0.0001; females: W=0.67; p=0.0001).

All recruits in both groups significantly increased the number of push-ups they could do over time. Although the NCPG groups showed a significant improvement in their *push-up* test during BMT (males: W=0.39; p=0.0001; females: W=0.41; p=0.0001), the improvement seen in the CPG was statistically and practically more significant (males: W=0.75; p=0.0001; females: W=0.66; p=0.0001). Similarly all recruits in the CPG (males: W=0.0.75; p=0.0001; females: W=0.73; p=0.0001) and NCPG (males: W=0.63; p=0.0001; females: W=0.81; p=0.0001) groups significantly increased the number of *sit-ups* they could do over time. Finally, although both groups significantly decreased the time taken to complete their *shuttle-run* test, this seems to be of small practical significance (W=0.1-0.26), except for the male recruits in the CPG group (W=0.70; p=0.0001).

The results of the Chi-square analysis are presented in Table 6, which compares the proportions of the NCPG and the CPG recruits passing the Standardised Fitness Test. The majority of recruits who failed the total fitness tests during the initial fitness test were in the CPG (68.5%), which correlates with their initial lower fitness levels. However, by the fifth week the majority of recruits who failed were in the NCPG (73.3%). By the final fitness test the NCPG had a greater percentage of recruits passing.

***TABLE 3*: VARIOUS PARAMETERS OF FITNESS TEST SCORES OF MALE CONTROL GROUP (NCGP) AND EXPERIMENTAL GROUP (CPG) FROM INITIAL TO FINAL MEASUREMENTS**

Test components	Measure-ment	Group	Mean ± SD	Mean diff.	95% CI of difference	Effect size Cohen D†
2.4km-run (minutes)	Initial	NCPG*	8.6 ± 1.0	1.83	1.47; 2.18	1.12
		CPG*	10.5 ± 1.0			
	Mid	NCPG*	**9.0 ± 0.7***	0.25	0.02; 0.47	0.25
		CPG*	9.3 ± 0.8			
	Final	NCPG*	**9.1 ± 0.8***	0.16	-0.06; 0.37	0.17
		CPG*	9.2 ± 0.6			
4km-walk (minutes)	Initial	NCPG*	29.4 ± 3.0	0.79	0.074; 1.50	0.23
		CPG*	30.1 ± 1.5			
	Mid	NCPG*	**27.7 ± 2.0***	-1.01	-1.58; 0.44	-0.39
		CPG*	**26.7 ± 1.7***			
	Final	NCPG*	27.0 ± 2.4	0.45	-019; 1.08	0.16
		CPG*	27.4 ± 1.7			
Push-ups (number)	Initial	NCPG*	39.2 ± 12.9	-7.85	-11.14; -4.56	-0.50
		CPG*	31.5 ± 9.0			
	Mid	NCPG*	47.5 ± 12.1	6.10	2.53; 9.68	0.37
		CPG*	53.6 ± 10.9			
	Final	NCPG*	53.6 ± 11.3	6.5	3.03; 9.98	0.41
		CPG*	60.1 ± 11.1			
Sit-ups (number)	Initial	NCPG*	44.8 ± 2.2	-10.08	-13.46; -6.71	-0.64
		CPG*	34.5 ± 10.1			
	Mid	NCPG*	59.5 ± 13.8	5.97	1.72; 10.25	0.31
		CPG*	65.5 ± 13.7			
	Final	NCPG*	72.4 ± 15.1	-7.03	-11.56; -2.50	-0.34
		CPG*	65.4 ± 14.2			
Shuttle runs (minutes)	Initial	NCPG*	51.2 ± 4.1	3.89	2.61; 5.18	0.64
		CPG*	55.4 ± 3.6			
	Mid	NCPG*	49.4 ± 3.2	-0.67	-1.75; 0.40	-0.14
		CPG*	48.7 ± 3.6			
	Final	NCPG*	48.2 ± 4.2	4.89	3.76; 6.01	0.93
		CPG*	53.1 ± 3.1			

* Significant changes determined by the Friedman test within the groups across the 12- week BMT period ($p < 0.05$).
† Cohen's (1988) criteria classifying effects as small (0.2-0.3), moderate (0.31-0.5) or large (>0.5).

***TABLE 4*: STATISTICAL PARAMETERS OF FITNESS TEST SCORES OF FEMALE CONTROL GROUP (NCGP) AND EXPERIMENTAL GROUP (CPG) FROM INITIAL TO FINAL MEASUREMENTS**

Test components	Measure-ment	Group	Mean ± SD	Mean diff.	95% CI of difference	Effect size Cohen D[†]
2.4km-run (minutes)	Initial	NCPG* CPG*	13.2 ± 2.4 16.6 ± 1.8	3.74	3.12; 4.36	1.26
	Mid	NCPG* CPG*	13.5 ± 2.2* 13.6 ± 2.3	0.10	-0.61; 0.81	0.03
	Final	NCPG* CPG*	12.6 ± 1.6* 13.4 ± 1.4	0.77	0.32; 1.23	0.36
4km-walk (minutes)	Initial	NCPG* CPG*	33.8 ± 2.3 35.6 ± 1.8	1.94	1.33; 2.57	0.64
	Mid	NCPG* CPG*	32.4 ± 2.2 31.7 ± 2.0	-0.66	-1.36; 0.04	-0.22
	Final	NCPG* CPG*	30.8 ± 1.9 31.8 ± 2.1	1.06	0.41; 1.71	0.35
Push-ups (number)	Initial	NCPG* CPG*	43.1 ± 13.4 33.0 ± 10.4	-10.28	-13.69; -6.87	-0.62
	Mid	NCPG* CPG*	55.5 ± 14.1 57.9 ± 14.4	2.45	-2.10; 6.99	0.12
	Final	NCPG* CPG*	59.5 ± 14.0 56.3 ± 13.7	-3.15	-7.28; 0.97	-0.16
Sit-ups (number)	Initial	NCPG* CPG*	28.5 ± 14.7 24.4 ± 10.0	-5.97	-9.68; -2.26	-0.33
	Mid	NCPG* CPG*	45.1 ± 19.0 48.6 ± 14.7	3.45	-2.16; 9.07	0.14
	Final	NCPG* CPG*	56.4 ± 18.7 49.8 ± 14.3	37.50	3.94; 71.07	0.21
Shuttle runs (minutes)	Initial	NCPG* CPG*	63.1 ± 6.7 67.5 ± 8.1	5.36	3.14; 7.60	0.48
	Mid	NCPG* CPG*	63.8 ± 7.8 61.7 ± 6.1	-2.09	-4.41; 0.24	-0.21
	Final	NCPG* CPG*	60.4 ± 6.4 65.1 ± 6.0	4.67	2.85; 6.55	0.54

* Significant changes determined by the Friedman test within the groups across the 12- week BMT period (p<0.05).
[†] Cohen's (1988) criteria classifying effects as small (0.2-0.3), moderate (0.31-0.5) or large (>0.5).

***TABLE 5*: KENDALL'S COEFFICIENT OF CONCORDANCE (W) BETWEEN MEAN FITNESS MEASURES FROM BEGINNING TO END OF BASIC MILITARY TRAINING WITHIN NCPG AND CPG GROUPS**

Group	Sex	2.4km-run (min)	4km-walk (min)	Push-ups (n)	Sit-ups (n)	Shuttle run (min)
NCPG	*Male*	0.29 *	0.52 *	0.39 *	0.63*	0.20 *
	Female	0.24 *	0.67 *	0.41 *	0.81*	0.19 *
CPG	*Male*	0.68 *	0.69 *	0.75 *	0.75 *	0.70 *
	Female	0.76 *	0.75 *	0.66 *	0.73 *	0.26 *

* Significant changes determined by the Friedman test within the groups across the 12-week BMT period (p <0.05)

***TABLE 6*: COMPARISONS OF CONTROL (NCPG) AND EXPERIMENTAL (CPG) GROUP OF RECRUITS PASSING THE FITNESS** ⁕

Test	Group	Proportion passing (%)	p-value #
Initial	NCPG	63.4	0.0001
	CPG	20.2	
Mid	NCPG	87.3	0.0200
	CPG	95.0	
Final	NCPG	96.6	0.0900
	CPG	92.5	

⁕ Passing the Standardised Fitness Test requires obtaining a score of 600 points or more on each of the test events based on age and gender adjusted performance standards (DOD policy on Physical Training, Department of Defence Instruction: SG no 00006/2000).
p-value represents the significance of differences (chi-square test of proportions)

DISCUSSION

Despite the male and female recruits in the CPG having a significantly poorer initial fitness level than those in the NCPG at the start of BMT, the CPG improved sufficiently to be as fit as the NCPG by the end of the 12-weeks of BMT. The CPG recruits who trained according to the new cyclic-progressive PT program yielded superior performance in men's push-ups after the BMT period, whilst the NCPG that followed the traditional PT program measured better performance in all other fitness measurements. What should, however, be noted is that the CPG experienced the greatest amount of change in performance measured. Of interest is that the greatest improvements shown by the CPG, in these components, were achieved by week five of BMT.

The cohort completed 48 periods of PT consisting of 40 minutes each, over the 12-week period (Department of Defence, 2000). This differs from the PT program reported by Knapik *et al.* (2005) where the participants, over a nine-week period, completed 45 periods of PT (60 minutes each) and where almost half the 90 periods were allocated to the regular recruits on 12 weeks of British BMT (Williams, 2005). The PT program followed by the SANDF in the

1980s included 50 PT periods of 40 minutes each over a 10-week period. The SANDF's standard fitness test utilises the 2.4km-run and the 4km-walk as its test for aerobic fitness. The comparison of fitness levels is difficult as armies around the world utilise different measures. The American Military utilises the 1mile- and 2mile-run (Popovich *et al.,* 2000; Armstrong *et al.,* 2004; Knapik *et al.,* 2005; Knapik *et al*., 2006; Rauh *et al*., 2006; Smith & Petersen, 2007), the Norwegian Military (Heir & Eide, 1997; Dyrstad *et al.* 2006) makes use of a 3km-run, whilst the British and New Zealand armies (Scully & Besterman, 1982; Stacy *et al.,* 1982; Harwood *et al.,* 1999) use the 2.4km-run as their test of aerobic fitness.

A confounding factor is that the length of BMT also differs from country to country. Studies have reported changes during a 6-week BMT course in Britain (Daniels *et al.* 1979); the New Zealand army have reported changes during BMT of 10 weeks in length (Stacy *et al.*, 1982); whilst the SANDF has a 12-week BMT course. Regardless of the measurement used to assess aerobic fitness, changes, if any, in aerobic fitness could be assessed, and the effect of the new PT program was ascertained by comparing the results of the CPG to those of the NCPG.

The male and female recruits showed greater improvement in aerobic ability, which may be attributed to the 46% more time spent by the CPG jogging and the training stimulus offered by the respective programs. However, the regression to the mean phenomenon is always a factor that needs to be considered. As with other studies (Hillsdon *et al*., 2002; Carnethon *et al*., 2003), participants in the NCPG had a good initial run time and tended to decrease slightly whilst, although the CPG had an initial slower time, they had the potential to have a much higher potential improvement. Additionally, it appears that there may have been a ceiling effect in both groups for the walk test, as the percentage improvement is far less with the walk test than with the run test and both are a measure of aerobic performance. Both programs therefore provided sufficient training stimulus for cardiovascular measured performance.

Muscle endurance was indirectly measured by the push-up and sit-up test. The initial amount of push-ups performed by the male recruits in both the CPG and NCPG is similar to that performed by other recruits at the start of BMT in other areas of the world (Scully & Besterman, 1982; Jones *et al*., 1994; Knapik *et al.,* 2004). With their upper body muscle endurance in both the CPG and NCPG showing significant increases in the amount of push-ups they could do over time, the South African female recruits performed a far greater amount of push-ups than other female recruits starting BMT (Jones *et al.,* 1994; Bell *et al*., 2000; Knapik *et al.,* 2004). The female recruits had changes over the 12-weeks that were similar to those of the males, with significant improvement seen in both the CPG and NCPG. However, the latter was more pronounced.

The initial amount of sit-ups performed by the male and female recruits in both the CPG and NCPG was lower than that performed by other recruits at the start of BMT in other areas of the world (Jones *et al.,* 1994; Beck *et al.,* 2000; Bell *et al.,* 2000). Both the CPG and NCPG had significant increases in the amount of sit-ups they could do over time. However, the CPG showed their greatest improvement by the fifth week of BMT, whilst the NCPG showed a steady increase until the end of the 12 weeks of training. Similarly, the initial abdominal muscle endurance of the female recruits was found to be poorer than that performed by other female recruits at the start of BMT in the British and American armies (Jones *et al.,* 1994;

Beck *et al.,* 2000; Bell *et al.,* 2000). Both the CPG and NCPG had significant increases in the amount of sit-ups they could do over time, with the CPG showing the greatest increase in the first five weeks.

The improvements in muscle endurance as measured by the sit-up and push-up test, are similar to the findings of other researchers who documented similar changes in these two parameters during BMT (Bell *et al.,* 2000; Evans *et al.,* 2005; Knapik *et al.,* 2005; Dyrstad *et al.,* 2006; Knapik *et al.,* 2006). Both the male and female subjects in the CPG were initially weaker in both push-ups and sit-ups performed than NCPG. However, by the fifth week of BMT the recruits in the CPG performed statistically more sit-ups and push-ups than the NCPG. This may be attributed to the greater amount of upper body and abdominal muscle endurance exercises done by the CPG. However, it appears that the training stimulus offered by both the programs was equivalent for the female sit-up and push-up performance, whilst the new PT program appears to have yielded a superior training effect on the men's upper body muscle endurance. This may be attributed to the additional resistance offered by the wooden poles used and should be investigated in a larger sample of female recruits. Additionally, a possible area of improvement in the new PT program is to increase the progression from the fifth week to possibly counteract the plateau observed in both parameters in the male and female recruits.

The shuttle-run test, as prescribed by the Department of Defence (DoD) Policy on Physical Training, (Department of Defence, 2000) is not a standardised test (as used by other studies), which does not make comparison of results possible. Although the CPG did have a significant improvement in comparison to the NCPG, the training stimulus offered by the traditional PT program ensured that the NCPG performed better on the final shuttle-run test.

In conclusion, the new cyclic-progressive PT program which was implemented for the first time for the period of this study elicited more change in fitness parameters as measured by the Standardised Fitness Test than the traditional PT program, although it only yielded superior performance at final measurement in the men's push-up. This may be attributed to the relatively greater amount of upper body exercises performed by the CPG and by the additional resistance offered by the pole PT. Apart from operational fitness that has been the main aim of a PT program, another aspect which needs to be included in further investigations is the effect of the new PT program on injuries.

PRACTICAL APPLICATIONS

As a result of this comparative study, the new cyclic-progressive PT program was mandated for all BMT units across the SANDF in 2009. All training of the PT instructors is centralised at the Joint Physical Training Sport and Recreation unit, ensuring that standardised training occurs throughout the SANDF. The study further reinforces the effectiveness of following BMT principles of exercise prescription, specifically the principles of progression and overload (Heyward, 2002; ACSM, 2006). In BMT, the PT program cannot be individually tailored to each recruit due to the large number of recruits, as well as the cost and space required to incorporate resistance training based in a gymnasium. This is neither logistically nor financially viable in the SANDF. Thus, the economical wooden pole PT has been successfully included in the training, providing an effective resistance training method for the large number of BMT recruits. Upper body strength is a vital component of fitness for the military recruit. It is necessary for weapon handling and operational execution, thus assisting to achieve the BMT objectives. With the decline in the levels of physical fitness amongst the younger generation, the importance of starting the PT program gradually (increasing the exercise intensity) is highlighted. The effectiveness of the program is still being continuously monitored using fitness outcomes as a measure of success; however, future endeavours should also include injury rates as measures of program effectiveness.

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