MOTOR COORDINATION IN THE ITALIAN PRIMARY SCHOOL: TEACHING RELEVANCE AND AVAILABILITY OF ANOCHIN'S THEORETICAL MODEL

Antinea Ambretti[1], Gaetano Raiola[2] and Maurizio Sibilio[1]

[1] Department of Educational Sciences, University of Salerno, Italy
[2] University of Salerno, Italian Federation of Volleyball FIPAV, Italy

Review paper

Abstract
The 2007 National Guidelines for the curriculum of the Italian primary school require the achievement of the motor abilities and motor coordination to be one of the main goals for the development of the skills at the end of the primary school. Anochin's theoretical model provides an overview of the motor coordination, based on 5 analyzers which can identify a teaching method centered on the development of both gross motor and up-motor skills. Anochin's remarks are rich of possible teaching ideas which are consistent with the Italian school system. They might also be a topical theoretical support to choose and use the motor evaluation tests in the Italian primary school, in order to evaluate the coordination and its constituent elements.

Key words*: teaching, programs, primary school, motor evaluation tools, coordination, tests*

Introduction

In 2009, the American College of Sports Medicine (ACSM) updated their position stand titled Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults (Donnelly et al., 2009). The position stand reports that 66% of adults are affected by overweight and obesity, which puts them at increased risk for numerous chronic diseases. The new recommendations conclude that moderate intensity physical aerobic activity (3-5.9 METS) of at least 150min/week is needed to prevent weight gain and reduce chronic disease risk factors. A dose effect of physical activity likely exists, with greater weight loss and enhanced prevention with doses of moderately intense aerobic physical activity of approximately 250-300 min/week (~2000 kcal/week) (Donnelly, et al., 2009). Despite the recommendation of moderate intensity, some populations such as those in post-operative rehabilitation or elderly might be unable to withstand longer duration at a moderate intensity level. Thus, any mode of exercise that could increase the intensity of exercise while maintaining the same external workload could possibly be advantageous to such populations. One such alternative is blood flow restriction training, which involves decreasing blood flow to a working muscle, by application of a wrapping device, such as a blood pressure cuff(for reviews please see (Loenneke & Pujol, 2009, 2010; Loenneke, Wilson, & Wilson, 2010; Manini & Clark, 2009; Wernbom, Augustsson, & Raastad, 2008). Evidence indicates that this style of training can provide a unique, beneficial mode of exercise in clinical settings, as it produces positive training adaptations equivalent to the physical activity of daily life (10-30% of maximal work capacity) (Abe, Kearns, & Sato, 2006). Treadmill walking with moderately restricted blood flow has previously demonstrated an increase in maximal oxygen consumption (VO2MAX) (Park et al., 2010) and increases in both skeletal muscle hypertrophy and strength (Abe, et al., 2006; Ozaki, Miyachi, Nakajima, & Abe, 2011). In addition, Ozaki et al. (2011) found that 10 weeks of blood flow restricted treadmill walking in the elderly (~66 years) at 45% heart rate reserve produced not only increases in muscular size and strength but also increased carotid arterial compliance. It is hypothesized that blood flow restriction training induces skeletal muscle hypertrophy through a variety of mechanisms (for a review please see (Loenneke, Wilson, et al., 2010)), however the mechanisms are still under investigation. Low intensity walking is a mode of exercise that is commonly prescribed to increase physical activity. This coupled with the aforementioned walking studies provides the rationale for the current investigation to determine if VO2 could also be elevated with a practical means to restrict blood flow. Additionally energy expenditure (EE) was investigated to see if restricting blood flow increases the caloric cost of low intensity aerobic exercise. The blood flow restriction stimulus often used in the research is applied by a KAATSU Master Apparatus, which limits the practical application in that very few individuals can gain access to such equipment or they lack the skill to correctly operate the device. Elastic knee wraps have previously been investigated as a blood flow restriction stimulus with resistance training (Loenneke et al., 2010; Loenneke, Kearney, Thrower, Collins, & Pujol, 2010); however the effects with aerobic exercise are currently unknown.

Material and methods

Elastic knee wraps (76 mm wide) were used to test the hypothesis that restricting blood flow to the proximal portion of the legs would result in changes in VO2, EE, and heart rate (HR). Elastic knee wraps were used because they are easy to obtain, inexpensive, and practical.

Tension was purposely not measured, as there is a need to observe how a stimulus would work in a field setting.

Participants
Ten healthy men and women (age=21.4 (1.42) years, height= 170.14 (9.95) cm, body mass= 77.26 (17.86) kg) participated in a randomized crossover study consisting of 2 trials separated by at least 6 days and no more than 8 days, thus no dramatic changes in their metabolism could be expected during the ~1 week time period of the study. Participants had no known symptoms of impaired endothelial function or known risk factors for cardiovascular or metabolic disease. Participants were permitted to train their leg musculature as usual up to 48 hours before each testing trial. Participants were asked to abstain from alcohol consumption for 24 hours before each test, abstain from caffeine for 12 hours prior, and participants were also required to fast four hours prior to testing. Although not controlled for, participants were advised to maintain their habitual dietary practices throughout the week. Participants were informed about the procedures and potential risks of the tests before their informed consent was obtained. The universities institutional review board approved this protocol, which was written in accordance with standards set by the Declaration of Helsinki.

Exercise Testing
Participants attended the human performance laboratory on 2 separate occasions. The first meeting consisted of randomization to either the blood flow restricted (BFR) or control (CON) group. The second meeting consisted of completion of the opposite trial. In addition, testing was performed at the same time of day under both conditions to control for any possible diurnal variation. Exercise consisted of five 2-min bouts of walking at 75 m/min on a treadmill with a one minute rest period following each exercise bout. This protocol was chosen because it has been previously used in the literature (Abe, et al., 2006). BFR and CON trials were conducted in exactly the same manner with the only difference being the application of elastic knee wraps (Harbinger Red-Line, 76 mm wide) to the upper thighs, as described and depicted by Loenneke and Pujol (2009). Knee wraps were applied by the same investigator to maximize intra-rater reliability. The BFR stimulus was applied immediately before exercise, remained on throughout the rest periods, and was removed following the final bout of exercise. VO2 was determined with the Vista Mini-CPX model 17670 using Turbofit v. 4.0 software (VacuMed, Ventura, CA), which was calibrated using manufacturer guidelines prior to each testing session. Energy expenditure (EE) was calculated using the caloric equivalents for the non-protein respiratory exchange ratio (RER) values for each liter of oxygen used. Heart rate (HR) was measured using a T31 Transmitter to a FS1 wrist attachment manufactured by Polar Electro (Polar Electro USA, Lake Success, NY).

Following proper fitting of the correct sized face mask, participants were asked to stand on the treadmill for 10 minutes to allow for acclimation to breathing with the gas collection mask on. This was done to ensure that subjects gas values represented resting conditions. All subjects' gas values reached steady state by 4 minutes. Once a steady state breathing pattern was observed, baseline VO2, EE, and HR 30 second average values were recorded and subsequently recorded upon completion of each 2 minute exercise bout, prior to the rest period.

Statistical analysis
Data were analyzed using PASW Statistics 18 with all variability represented using notation that is in accordance with the Scientific Style and Format for standard deviation (SD) (Council of Science Editors. Style Manual Committee., 2006). Baseline measurements from both days were used to determine the intra-class correlations (ICC) of VO2, EE, and HR, which was used in the calculation of the standard error of the measurement (SEM) (SEM= SD?1-ICC). The minimal differences (MD) for VO2, EE, and HR needed to be considered a real change was calculated from the SEM (MD= SEM x 1.96 ?2). VO2, EE, and HR levels were analyzed using repeated measures analysis of variance (ANOVA) to determine significant differences between BFR and CON at an alpha level of 0.05. When significance was found, paired sample t-tests were used to determine pair-wise differences with a Bonferroni corrected alpha of 0.007 to control the family-wise error rate. The effect size for each pairwise comparison was calculated using Cohen's d (d= [(BFRmean-CONmean)/SD]).

Results

Table 1 presents mean VO2, EE, and HR values following each individual bout of exercise for both BFR and CON. VO2 was significantly higher with BFR over CON (p=0.001). Post hoc analysis found differences with exercise bouts 2-5 but no significant differences at baseline, after the first bout, or 3 minutes post exercise. The significant differences found with VO2 exceeded the MD following all exercise bouts (>0.1 l/min) and Cohen's d test found that the BFR had a large effect for all bouts of exercise compared to CON (range of 0.90-2.00). EE was significantly increased with BFR over CON (p=0.001).

Post hoc analysis found differences for exercise bouts 2-5 but no significant differences at baseline, after the first bout, or 3 minutes post exercise. The MD to be considered real was exceeded (>0.5 kcal/min) for all exercise bouts and Cohen's d test found that the BFR had a large effect for all bouts of exercise compared to CON (range of 0.98-2.05). HR was significantly elevated with OCC compared to CON (p=0.001) and exceeded the MD to be considered real with every time point except baseline (>11 bpm). Cohen's d test also found a large effect of BFR at every time point except baseline (range of 1.11-1.53).

Table 1. Mean Values of oxygen consumption (V02), energy expenditure (EE), and heart rate (HR) following low intensity walking with blood flow restriction (BFR) and without (CON). *indicates a significant difference between BFR and CON (p = 0.007)

	VO2 (l/min)				
	BFR	CON	Mean Dif.	p value	Cohens d
Pre	0.3 (0.1)	0.3 (0.1)	0	0.591	-0.2
1st	1.0 (0.2)	0.9 (0.2)	0.1†	0.02	0.9
2nd	1.1 (0.2)	0.9 (0.2)	0.2†	.001*	2
3rd	1.1 (0.2)	0.9 (0.1)	0.2†	.001*	1.5
4th	1.1 (0.2)	0.9 (0.2)	0.2†	.001*	1.76
5th	1.1 (0.2)	0.9 (0.1)	0.2†	.002*	1.33
Rec	0.3 (0.1)	0.3 (0.1)	0	0.508	-0.16

EE (kcal/min)					
	BFR	CON	Mean Dif.	p value	Cohens d
Pre	1.4 (0.4)	1.5 (0.4)	-0.1	0.626	-0.14
1st	5.0 (1.3)	4.5 (1.1)	0.5†	0.013	0.98
2nd	5.4 (1.3)	4.4 (0.8)	1.1†	.001*	2.05
3rd	5.7 (1.2)	4.4 (0.8)	1.3†	.001*	1.57
4th	5.6 (1.3)	4.5 (1.0)	1.1†	.001*	1.83
5th	5.3 (1.3)	4.3 (0.4)	1.0†	.001*	1.43
Rec	1.6 (0.4)	1.6 (0.6)	0	0.862	-0.05

HR (bpm)					
	BFR	CON	Mean Dif.	p value	Cohens d
Pre	73 (9)	72 (9)	1	0.638	0.15
1st	118 (16)	98 (13)	20†	.007*	1.19
2nd	118 (14)	96 (10)	22†	.001*	1.53
3rd	123 (17)	98 (12)	25†	.004*	1.2
4th	128 (21)	98 (11)	30†	.005*	1.15
5th	128 (25)	98 (11)	30†	.006*	1.11
Rec	112 (19)	92 (12)	20†	.005*	1.16

† indicates exceeding the minimal differences to be considered real. All values are expressed as means ± SD

Discussion

The current study was the first to investigate the effects of knee wraps as a mode of restricting blood flow with an activity of daily living such as walking. This study demonstrated that knee wraps produce significant increases in VO2, EE, and HR over exercise without elastic knee wraps at the same absolute workload. Although significance was seen between groups, the physiologic relevance of such a small change is unknown. Nevertheless, subjects were able to tolerate blood flow restricted walking with elastic knee wraps, thus providing a foundation for future research. The current findings are in agreement with Abe et al. (2006) who found a significant increase in VO2 and HR with low intensity blood flow restricted walking.

The exercise protocol used in this study was similar to Abe et al. (2006) (five 2-min bouts) except for the treadmill speed and blood flow restriction stimulus used. This investigation used a speed 75 m/min whereas 50 m/min had been previously used. In addition, the blood flow restriction stimulus used in this study was via knee wraps as opposed to the KAATSU Master Apparatus used in the Abe study. Despite difference in speed between studies, the overall intensity of exercise was still maintained at a relatively low level. This elevated oxygen requirement for exercise may be related to the increased electromyographic (EMG) activity of the leg muscles seen with blood flow restricted exercise (Moore et al., 2004; Takarada, Nakamura, et al., 2000; Takarada, Takazawa, et al., 2000). This increased recruitment likely occurs from the reduction in oxygen and subsequent metabolic accumulation, during blood flow resistance restricted exercise. Both reduced oxygen and metabolic accumulation can increase fiber recruitment, mechanistically speaking, through the stimulation of group III and IV afferents which may cause inhibition of the alpha motorneuron, resulting in an increased fiber recruitment to maintain force and protect against conduction failure (Yasuda et al., 2010). This is the first investigation with blood flow restriction of any kind, to quantify EE from an exercise bout and demonstrates that the EE is elevated over CON when knee wraps are applied to the proximal portion of the legs prior to an activity of daily living such as walking. This indicates that utilizing knee wraps requires more energy to complete exercise of a given workload, than exercise with no blood flow restriction. Although the overall increase in caloric expenditure was small, it was considered a real increase based on the reliability of our measurements. Additionally, the increases in HR with blood flow restriction are consistent with previous research, attributed to the decreased venous return (Sumide, Sakuraba, Sawaki, Ohmura, & Tamura, 2009). Although increases in muscle hypertrophy, strength, and endurance capacity have been observed with blood flow restricted walking, the application of this type of training is limited by the high cost and technical skills needed to operate pneumatic tourniquets. Thus, a need exists for a more practical way to restrict blood flow (e.g. elastic knee wraps). Future research should focus on both the acute and chronic effects of knee wraps as a mode of practical blood flow restriction for aerobic exercise. Seven out of ten participants in this study self-reported being aerobically trained (mean 125 min/wk, range of 120-300 min/wk), so it is plausible that the current aerobic status of our participants buffered a response that might be more evident with a less active population. In addition, the effects of continuous walking, rather than the five 2 minute intermittent bouts used in this study should be investigated. Furthermore, although it has been thought that the increased oxygen requirement is due to elevated EMG activity; this study did not measure EMG activity so the degree of muscle activity with practical blood flow restriction is unknown.

Previous research with elastic knee wraps has shown elevated perceptual responses (RPE and Pain) with blood flow restricted resistance training (Loenneke, Balapur, et al., 2010; Loenneke, Kearney, et al., 2010). Perceptual responses were not measured with the current study, but future investigations should quantify that response, because previous reports have shown a relationship between perceptual responses and stress hormones levels (Adler, 2000; Borg, 1998). It remains unknown if this relationship exists with practical blood flow restricted aerobic exercise, and further examine what, if any limitations this may present in its application. Investigations should also be completed with the elderly to determine if this is in fact a beneficial mode of exercise for that population.

In conclusion, this is the first study to investigate the effects of practical blood flow restricted aerobic exercise finding significant increases in VO2, EE, and HR with blood flow restriction compared to CON, despite both walking at the same absolute workload. These results provide proof of concept that restricting blood flow provides a mode of increasing the intensity of both aerobic and resistance training, however caution should be applied until long term studies are conducted to determine if subtle changes in metabolism result in significant physiologic adaptation. The need for an affordable, effective means to receive the benefits of blood flow restriction training exists, thus the need for further research in the field of practical blood flow restricted exercise.

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MOTORIČKA KOORDINACIJA U TALIJANSKOJ OSNOVNOJ ŠKOLI: ZNAČAJ NASTAVE I UPOTREBLJIVOST ANOHINOVOG TEORIJSKOG MODELA

Sažetak

U 2007. Nacioalni Vodič za kurikulum talijanske osnovne škole zahtijevao je postizanje motoričkih sposobnosti i motoričke koordinacije kao glavnih ciljeva razvoja vještina na kraju osnovne škole. Anohinov teorijski model omogućava pregled motoričke koordinacije, temeljen na 5 analizatora koji mogu identificirati nastavnu metodu centriranu na obje – veće motoričke a i nad-motoričke vještine. Anohinova zapažanja su bogata mogućim nastavnim zamislima koje su sukladne talijanskom školskom sustavu. Oni također mogu biti tematska teorijska potpora za izbor i korištenje testova motoričke evaluacije u talijanskoj osnovnoj školi, u skladu s evaluacijom koordinacije i njenih konstitutivnih elemenata.

***Ključne riječi**: nastava, program, osnovna škola, evaluacija motorike, koordinacija, testovi*

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Correspondence to:
Prof.Maurizio Sibilio, PhD
University of Salerno
Department of Educational Sciences
Via Ponte Don Melillo. 84084 Fisciano, Italy
Phone: 0039 089964416
E-mail: msibilio@unisa.it