CIRCUIT TRAINING
- A Scientific Approach -

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Conventional Circuit Training

Circuit training has long been actively and enthusiastically promoted as both an effective and efficient means of developing 'general fitness'.

Participants attend circuit classes and fitness trainers prescribe circuit programs in the hope of developing reasonable levels of aerobic fitness, inducing fat loss, increasing strength, building muscle and improving 'muscle tone' all at the same time.

Conventional circuit programs attempt to provide general fitness training via a protocol of 15-60 second stations progressing in an order that changes the muscle groups utilised by alternating upper and lower body exercises or working muscle groups antagonistically.

The supposed 'logic' behind such a protocol is that 'by keeping the duration of exercises relatively short, and changing muscle groups utilised each time, excessive local muscular fatigue is prevented'. Furthermore, it is claimed that 'by keeping the duration of stations as short as possible, the intensity of work will be high enough for increases in strength and muscle mass'. Despite the very short duration spent on each station and the regular changing of muscle groups utilised each time, some proponents of conventional circuits have claimed that cardiovascular conditioning will occur due to what they call 'peripheral heart action' (the shunting of blood from one muscle group to another which is supposed to somehow tax the cardiovascular system).

This type of circuit training protocol and accompanying rationale is espoused by many trainers who genuinely believe they are prescribing an effective and efficient training regime. In recent years traditional circuit training concepts have been re-badged under the guise of **'metabolic conditioning'** and other supposedly innovative training systems. Unfortunately, conventional circuits and related 'metabolic conditioning' regimes are both **inefficient** and relatively **ineffective** in achieving general fitness goals and **the rationale behind these training systems is physiologically unsound**.

Aerobic Conditioning and Energy Expenditure.

The traditional approach to circuit training and more recent concepts in 'metabolic conditioning' are not as effective as suggested, and surprisingly inefficient with regard to training goals which most hope to achieve. Changing the muscle groups utilised from station to station and then only exercising for such short durations, is inappropriate when the aims include aerobic conditioning.

Aerobic metabolism responds slowly to increases in energy requirements and changes to the muscles being exercised. This response lag occurs both within central processes (the heart and major blood vessels) and peripheral muscle components (mitochondria, capillaries, aerobic enzyme activity etc), and it normally takes at least one to three minutes (providing one is well trained and well warmed up) for aerobic processes to be operating at anywhere near full efficiency at the new work level or within the new muscle groups being utilised.

During this period, **anaerobic** metabolic processes (primarily those associated with the lactic energy system) must meet much of the energy demand, resulting in rapid accumulation of lactic acid and causing muscular fatigue, thereby significantly reducing the average exercise intensity (whilst actually raising the perceived rating of exertion) at which the circuit workout can be carried out. As a result of this lowered average intensity, energy expenditure is significantly reduced.

It seems little wonder then, that while circuit training has generally produced small gains in **VO2 max** in sedentary persons (-1% to 17% over 10-12 weeks), these gains fall well short of the results normally achieved from more conventional aerobic training activities (10-35%).

Conventional circuit training will not induce any significant changes in aerobic fitness (VO2 max or anaerobic threshold levels) in aerobically trained individuals. **Oxygen consumption levels** achieved during conventional circuit training using predominantly pin-loaded machines, free weights or hydraulic equipment, are generally less than 40% of MVO2, despite very high levels of perceived exertion and fatigue (due to high lactic acid accumulation).

Such VO2 consumption and **energy expenditure** (approximately 5-7 cal/kg/hr) levels are only comparable to recreational walking (at approximately 6km/hr) and rate very poorly against levels of oxygen consumption and energy expenditure achieved in activities such as running, cycling or rowing (10-15 cal/kg/hr).
It is important to understand that the **heart rates** achieved during conventional circuit training provides a very poor indication of oxygen consumption. During circuit training sessions heart rates of 70%-80% of maximum tend to produce VO2 levels of only 25%-40% of MVO2. In comparison, conventional aerobic workouts which illicit the same heart rate response result in oxygen consumption levels of approximately 65-75% of maximum whilst the perceived level of exertion is actually lower.

Strength Benefits

Traditional circuit training and 'modern' 'metabolic conditioning' are also relatively ineffective and inefficient as a means of improving strength or lean body mass when compared to conventional resistance training methods.

While strength increases and hypertrophy may occur in previously sedentary individuals undertaking a circuit program, these changes are very small compared to the results which may be achieved from effective resistance training methods. Studies which have investigated conventional circuit training have generally found improvements in strength of only 5 - 25% over a period of 10-12 weeks whilst conventional resistance training programs have been shown to bring about improvements in the order of 50-200% in the same period of time.

Once again, individuals already engaging in resistance training will not experience significant changes by including circuit training. In fact, they may even incur a decrease in strength and lean body mass if circuit training is performed instead of more conventional resistance training methods.

Strength and muscle mass increases are dependent on the use of heavy loads and very high intensity work. However, the general nature of fatigue experienced during circuit training, due to moderately high blood lactate levels, precludes high intensity training.

Muscular endurance and lactic acid tolerance

Many trainers promote circuit training as a means of developing muscular endurance, which they believe to be of value in developing general fitness. As the development of lactic acid tolerance is an important factor in the development of muscular endurance, they therefore believe that this goal will be effectively met because circuit training brings about moderately high levels of lactic acid. Circuit training may in fact improve general systemic lactic acid tolerance, which is largely the ability to tolerate the psychological discomfort associated with fatigue. However, for the average gym participant, the true value of such an adaptation is questionable, especially if it is developed with training methods which compromise the development of more sought after physiological parameters such as strength, muscle mass, aerobic capacity and fat loss.

But what about middle or long distance athletes wishing to improve lactic acid tolerance? Wouldn't conventional circuit training at least be effective in achieving that goal? Unfortunately, it would not, simply because peripheral factors play a major role in developing lactic acid tolerance so this capacity is largely activity specific. As a result each athlete will have to train quite differently to bring about an improved lactic acid tolerance that is of value in their event. Central and psychological factors associated with lactic tolerance would however, be trained to some extent and may be of value to athletes training for sports which utilise a large number of muscle groups and require good general lactic acid tolerance (eg. rowing, wrestling, rugby).

Circuit Alternatives

Having examined the problems associated with the conventional approach to circuit training it is necessary to emphasize that it is certainly not a total waste of time. It is simply neither a very efficient nor effective means of achieving goals discussed above, relative to other training methods. Unfortunately, **conventional circuit training would seem to offer all the strength training benefits of an aerobic workout and all the aerobic benefits of a strength training workout**.

The good news is that circuit training can potentially be a very effective and enjoyable means of developing aerobic fitness specific to most muscles of the body, providing that some major changes are made to the type of equipment used, the sequencing of exercises and the duration spent at each station. Unfortunately, by attempting to make circuit training a more effective means of increasing strength and muscle mass all one ends up with is a conventional resistance training program.

It is important to understand that it is not possible to concurrently achieve optimal gains in strength, lean body mass, lactic power and aerobic fitness, as the optimal methods of training for each differ significantly. However, for those who wish to achieve reasonable gains at both ends of the scale concurrently, these goals are best achieved by having separate and specific programs for each. Obviously, a conventional resistance training program will more effectively bring about improvements in strength and lean body mass whilst aerobic programs will more effectively develop aerobic fitness. Resistance and cardiovascular training may be performed on alternative days, or even trained separately during the same session.

Effective Circuit Training for Aerobic Fitness

The primary function of circuit training for aerobic conditioning in the fitness center setting is to provide a mode of training with sufficient variety to ensure program adherence, to cater for as many people as possible, in as little space as possible, for as little cost as possible. Fortunately, these requirements can be met by an alternative form of circuit training, which is far more effective than the conventional circuits outlined above.

Protocol

Effective aerobic training in a circuit format simply requires longer duration stations with an exercise progression which uses the same muscle groups for as many consecutive stations as possible (given boredom and equipment constraints). Furthermore, when changing the muscle groups used, rather than simply jumping from predominantly lower body to upper body exercises, new muscle groups should be phased in via the use of full body exercises.

The more similar consecutive exercises are, the less important the duration of the stations. However, experience has been that stations of 3-20 minutes seem to provide the best compromise between effective aerobic conditioning and boredom prevention.

Workout Intensity

An initial problem in running a circuit class or prescribing a circuit program for people used to conventional circuits is that they often tend to go too hard too soon and find it difficult to last the duration of each station. A well designed cardiovascular circuit should in fact feel easier as the length of time spent at each station is increased. A circuit class or program of 20-45 minutes duration, if performed in a continuous manner at even effort, will be most effective if exercisers operate at intensities between their aerobic threshold (O2T) and anaerobic threshold (AnT).

In terms of perceived exertion, the ‘aerobic threshold’ occurs at the highest level of steady state exercise at which one still feels ‘comfortable’. The anaerobic threshold occurs at the highest level of steady state exercise at which: one still feels ‘only a little uncomfortable’; breathing is still regular, rhythmic and controlled, and; one can still talk properly but does not wish to hold a conversation.

Absolute heart rate levels are of no consequence in determining whether someone is exercising at the appropriate intensity. The appropriate heart rate will vary significantly between individuals (even of the same age and fitness level) and is dependent on a number of factors which the fitness instructor is not generally in a position to quantify.

Equipment Needs

The most appropriate equipment for cardiovascular circuit training is that which effectively works as many large muscle groups as possible and lends itself to this tends to motivate participants. At least some, if not most of the equipment should allow full body exercise, particularly when general cardiovascular conditioning and/or weight loss is the goal. Where it is not possible to use full body machines, equipment utilising major lower body muscle groups should generally be employed preferentially over upper body machines.

The employment of specific upper body and abdominal exercises will result in a reduction in total oxygen consumption and energy expenditure (especially in those untrained in these movements), but are of critical value in developing specific peripheral aerobic conditioning, which is arguably as important as the development of central (heart and lung) conditioning. This is obviously of prime concern for particular sports people, but is valuable to those seeking general fitness as well.

Conventional cardiovascular training ergometers are the most effective pieces of equipment to use in aerobic circuits. Equipment such as exercise cycles, steppers and treadmills, will effectively work the

large gluteal, quadricep and hamstring muscle groups of the lower body. Bionic (arm/leg) cycles, rowing ergometers and cross country ski machines are excellent full body machines which not only induce the highest oxygen uptake, but also allow effective 'phasing' between muscle groups. Kayak and swimming ergometers provide the most functional upper body training with kayak ergometers potentially inducing oxygen consumption and energy expenditure levels very close to many lower body ergometers.

Many non-equipment exercises such as free squatting, shuttle runs, skipping and step-ups can be used, although instructors should be aware that it may be difficult to keep participants motivated for the full duration of each station with some of these activities. Fitness Centre Owners/Managers should also be aware that activities such as skipping and shuttle runs are very expensive in terms of space utilised.

Free weights, pin loaded and many hydraulic machines are relatively ineffective in achieving cardiovascular training goals as they often do not work a large number of muscle groups and, more importantly, they do not lend themselves well to long durations of continuous activity.

A simple, but practical and highly effective circuit might utilise treadmills, bionic (am/leg) cycles, rowing ergometers, cycles and Nordic ski ergometers, repeated in series as many times as necessary to cater for class members.

Treadmill – Cycle – Row – Nordic Ski – Kayak/Swim or Upper Body Erg - Arm/Leg Cycle – Cardio/Versa Climber - repeat

Circuit Training for Aerobic fitness is simply a way of minimising the boredom that is potentially associated with training on cardiovascular ergometers for extended periods of time (20 - 90 minutes). It need not necessarily be carried out in a class format but can also be effectively performed via a system of **'express lanes',** or simply individually programmed according to the guidelines for effective training discussed here. As few as three or four different pieces of equipment can be used by each individual.

Resistance Training Circuits/Express Lanes

Whilst resistance and cardiovascular training can be executed separately with adequate effectiveness during the same workout, under no circumstances should one attempt to train both parameters simultaneously or even perform alternating 'strength' and 'aerobic' exercises.

It is not possible to perform effective resistance training in a continuous, non-stop manner within a conventional circuit format. Rest periods (approx. 1 to 2 minutes) between high intensity sets (close to maximal relative effort) must be provided so that the appropriate workout intensity can be maintained. If activity of some description is desired so as to satisfy some perceived notion of a requirement for 'workout flow' then stretching exercises may be prescribed as part of the circuit between sets.

The class can cater for twice as many people as there are pieces of resistance training equipment, with one person performing a set whilst their partner either rests, spots them or performs the prescribed stretch. Generally one or two sets per exercise of approximately 60-90 seconds should be performed with strict form (preferably with eccentric contractions of 4-10 seconds duration and concentric contractions of 2-10 seconds duration, performed without any pauses, under constant tension) to ensure the best possible benefit from the minimal number of sets performed and to negate the need for any warm-up sets. The full body workout should be performed only two to three times per week. One set should generally prove sufficient in express lane formats providing sets are performed to failure.

Pin loaded or pneumatic equipment are most appropriate for a circuit class or express lane format, hydraulic equipment is less effective because it only allows concentric contractions. Pin loaded machines should be user friendly, preferably side loaded with the full weight stack easily accessible by the user and half weight increment plates are desirable.

'Express Lane' formats are logistically a more efficient method of providing pre-set resistance training workouts in the fitness centre setting. Clients are not restricted to specific class times and are able to enter the express lane at any time of the day (even when the express lane is full, one or two new persons can enter the lane every one to four minutes). Furthermore, they provide a specific starting and finishing point, thereby overcoming potential problems with exercise order inherent in circuit formats. As few as four or five pieces of resistance training equipment are required for a single express lane. Two lanes of four pieces each (i.e. two different full body workouts with one exercise

per major set of bodyparts) allows for superior work flow to a single lane of eight pieces providing up to two exercises per body part. Clients can alternate express lanes from workout to workout to maximize variety. Separate upper and lower body express lanes are also an option.

If the absence of warm-up sets if of concern, you may wish to place two dual action cycles at the beginning of the express lane (assuming two people are entering the express lane at a time) to provide a general full body warm-up. Participants would exercise at a sub-anaerobic threshold steady state intensity for approximately 3 -5 minutes (i.e. the time it would normally take two people to complete two sets each on the resistance training stations.

In a circuit format all exercises should preferably be compound in nature. Express lanes provide more flexibility in this regard, although once again predominantly compound exercises are recommended so as to keep the total number of exercises required to a minimum.