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SOME OBSERVATIONS ON WEIGHT-TRAINING*

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**This material was presented as a demonstration in an indoor gymnasium.*

INTRODUCTION

Weight-lifting is a heavy resistance weight-bearing action, demanding high explosive power and the ability to hold great loads momentarily under control. Maximal efforts are employed against extreme resistances. It is at these intensities that stresses on the articuloskeletal system are greatest. Correct techniques must be employed to minimise strain at body sites of greatest vulnerability — the knee, back and wrist.

The knee is vulnerable especially at initiation of the lift before the quadriceps contract forcefully. The back experiences high strain levels, the force on a lumbo-sacral disc exceeding 1000 kg in the investigations of Morris et al (1961). The intra-abdominal pressures induced alleviate the load on the spine to an extent. Frequently the annular fibrosis ligaments are strained. At the wrist deterioration may occur due to hyperextension associated with repetitive lifting and holding weights overhead.

Breathing must not be suspended during the moment of extreme exertion. With the breath held and the epiglottis closed, the chest is compressed and intrathoracic pressure rises. The Valsalva manoeuvre operates, resulting in a reduced venous return to the heart and consequent rapid drop in blood pressure with possible loss of consciousness.

CONVENTIONAL WEIGHT-TRAINING EXERCISES

From a battery of lifts recognised by the British Amateur Weightlifters Association some have been adopted over the last two decades in the training of athletes. Mostly the lifts have been modified to comply with individual requirements. Attendant risks can be demonstrated in a sample of typical exercises.

Arm and shoulder work

1. *Bench press* — particularly employed by rugby forwards, swimmers and weight-throwers. Two spotters should be used for safety and the bar should not be taken in too high near the throat. The grip must be sufficiently wide as not to jeopardise security, since 40 kg can lacerate the facial bones from half a metre's fall. A chest full of air should provide a rigid base from which the weight can be pushed vertically. The performer exhales as the weight ascends and inhales during its descent.

The athlete may concentrate on eccentric contractions in lowering the load, the barbell being lifted for him by assistants. This overcomes the training limitations of performing only uni-directional work and allows heavier loads to be handled.

2. *Overhead press* — an inflated chest should act as a platform as the weight is pressed vertically from the chest or behind the neck until the arms are fully extended. In teaching the technique light pressure at the scapulae can prevent swaying or a mirror can provide visual feedback. Dumb-bells permit working along the line of action of the specific competitive performance.

3. *Rowing* — is performed from an upright or bent-forward posture. Unskilled subjects tend to get more erect with succeeding repetitions in bent-forward rowing. Appropriate use of a mirror or exerting pressure lightly on the upper back can prevent accentuation of the lordotic curve.

4. *Overarm pulls* — weights lifted should not be unduly heavy. A mild flexion of the arms is recommended to reduce strain on the shoulder joint. Correct timing of breathing is important, inhalation occurring as the weight descends and exhalation as the load is taken up.

5. *Curls* — performed with barbells or with one or two dumb-bells. Elbow flexion is implicated. Care is needed with heavy loads so the lordotic curve is not overemphasised.

Large muscle-group work

1. *Sit-ups* (trunk curls) — the load on the abdominals in a sit-up from supine lying can be increased by holding a loaded barbell or disc on the chest or behind the neck. An assistant can hold the athlete's ankles to facilitate the action. In the early stages of training permitting mild flexion at the knees will avoid straining the hip extensors.

2. *Squats* — foam rubber or a towel can be used to alleviate pressure on the cervical vertebrae from a loaded barbell. This exercise has been much criticised as causing knee joint degeneration from strain on the patellar bursae (e.g. Adams, 1973). During deep knee bending without attendant weights the patello-tendon force has been calculated by Reilly and Martens (1972) to reach 7.6 times body weight, a value considerably increased when heavy weights are employed. Performance of partial squats is advised, though full squats at much less frequent intervals can provide maximum overload.

Maintaining stability may constitute a problem. Elevation of the heels by means of an inclined board can assist balance or the heels may remain flat on the floor to widen the base of support within which the body's line of gravity may safely shift. Another procedure is to use a steel rack to limit bar movement in the sagittal plane.

3. *Power cleans* — attention to technique is needed in the initial lifting movement. The relative demerits of the derrick lift and the knee action have been much discussed (e.g. Whitney, 1962). Lifting with the back straight prevents the spine being turned into a cantilever with subsequent spinal strain. Appropriate coaching of correct head positioning is required. As the forces on the spine are a function of the distance the load is from it in the same plane, the weight should be kept close to the body while being lifted.

4. *High pulls* — involve basically similar gross muscular action to the power clean. Work output can be increased by rising on to the toes to complete the lift, demanding additional coordination.

5. *Squat-jumps* — good coordination is essential to avoid overbalancing on landing after jumping with loaded barbell supported on the shoulders. A cushion underneath the bar helps to reduce jarring.

6. *Bench step-ups* — resistance additional to body weight is provided by a weighted barbell on the shoulders. The bench height should be compatible with the stature of the individual, otherwise a quadriceps tear is a risk. With unduly heavy weights the stepping rhythm may be disrupted with consequent danger of overbalancing and injury.

ALTERNATIVE RESISTANCE TRAINING METHODS

Isometrics

Body segments or stable external objects provide resistance. Specially designed isometric racks are used in indoor gymnasia. The scrummaging rack used outdoors by rugby forwards is a further example.

Claims once attributed to isometric training have recently been qualified considerably (Hettinger, 1971). Isometric training effects may not appreciably assist dynamic performance. Further the concomitant compression of the vascular bed with occlusion of blood supply to the muscles under tension and the resultant rise in blood pressure make isometrics unsuitable for many sedentary individuals.

Isokinetics

Describes the form of exercise permitted by machinery with the facility to adapt resistance to the force applied. Training programmes using isokinetic machines were found superior to isometric regimes and to typical progressive resistance programmes (Thistle et al, 1967).

The weight-thrower can simulate the pattern of muscular action of his event using isokinetic apparatus. Accessory equipment can be attached to the machine to accommodate specificity training for a range of sports.

Multi-station apparatus

Designed to reduce injury risks in strength training and organisational problems in team circuit training. Resistance is supplied alternately by body weight, weighted stacks and isokinetic machines. Safety factors are inherent in the design of each station which accommodates a range of physiques and capacities. The apparatus allows variation of muscle groups between stations.

CONCLUSIONS

The use of heavy weights in resistance training demands correct teaching of lifting techniques. Most injuries occur when heavy weights are lifted and most back injuries occur when spinal flexion is permitted. This is manifested in the relatively much larger proportion of injuries in male than in female athletes using weight-training, females tending to operate at intensities permitting greater safety margins. Special care should be given to young athletes to prevent undue over-exertion in lifting.

Safety considerations should override all others where large groups are involved. This may require more careful programming of the gymnasium timetable. Spotters and weight-racks should be used where appropriate. A suitable surface is needed, most lifting exercises being conducted from rubber mats. Appropriate footwear is necessary to provide sufficient frictional contact with the floor. In most cases the orthodox multi-purpose gymnasium shoe is inadequate.

Frequently athletes do not continue their weight-training once their competitive season has commenced. The effect of strength training gradually disappears when training is terminated, in accordance with the principle of reversibility. In general the loss will be at about one-third the rate of acquisition. Injuries are frequently sustained when weight-training is recommenced without any allowance for strength loss in the interim.

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