The squat is a basic exercise in many weight programs. It is used mainly for the development of the quadriceps (vastus medialis, vastus lateralis, vastus intermedius and rectus femoris), although the hip extensors (gluteus maximus and hamstrings), and trunk extensors (erector spinae, multifidus, rotatores, inter-spinales, levatores costarum, thoracis, cervicis and capitis) are very active in many individuals who perform the squat.¹ (see figure 1) Many other muscle groups are electrically active during the movement, acting as stabilizers for the ankle, knee and hip joints, as well as the spinal vertebrae.² The squat is basically a deep knee bend performed with weight on the shoulders. Studies have shown that most successful lifters have the following techniques in common when lifting for maximum weight:

1. Slow velocity in reaching the full squat position, which limits bounce at the end of the squat.
2. Keep trunk as nearly erect as possible with the knees steady.
3. Keep hips forward and level, not directed backward during ascent.

Safety factors regarding the squat cannot be over-emphasized. Two spotters must be used whenever the lift is performed. The supervisor or coach must check for adequate back and lower body flexibility before teaching the exercise, because poor quadriceps and achilles flexibility will result in a compensatory forward-bending, which predisposes the back to strain.

In assuming a starting position, the lifter stands with his center of gravity as directly as possible under the center of gravity of the bar. This allows for better stability in applying force directly in line with the center of gravity later in the lift. “Economy of effort is assured when the force is applied in line with the object’s center of gravity in the desired direction of motion.”²

Next the lifter grips the bar with the palms facing forward to maintain placement of the bar in the horizontal position across the shoulders. The palm forward position is the best anatomic position because it keeps the elbows back, and insures a forward directed force, holding the bar against the back of the neck, which is extended throughout the lift. The bar rests on the shoulders to allow the resistance to be distributed over a large supporting surface.

Once the bar is positioned on the shoulders, the lifter moves away from the rack and takes a stance with the feet slightly wider than shoulder width apart and turned laterally approximately 30°. This increases the base of support and the stability of the lifter. “Stability is directly pro-

---

Figure 1

[Images of muscle anatomy labeled: Sartorius, Rectus Femoris, Vastus Lateralis, Vastus Medialis, Gluteus Maximus, Semitendinosus, Semimembranosus, Bicep Femoris]
Portion of the area of the base on which the body rests. 12

The descent, or eccentric (lengthening contraction) phase, is slow, because a fast downward velocity requires a large force to overcome momentum, and often accounts for a bounce at the full squat position. A slow descent decreases the bounce, since less force is used to stop the bar, and more force is used to raise the bar. In order to exert the least amount of horizontal force, and the greatest amount of vertical force, the lifter should stop when the thighs are aligned just below parallel. 2

Vertical force should be exerted at a constant speed, directly in line with the center of gravity of the bar, with sufficient magnitude to overcome the inertia of the bar. The upward, or concentric (shortening contraction) phase, begins with a downward push from the ankles, which act as second class levers, favoring force. The force exerted against the ground results in upward movement, in accordance with Newton's third law, "For every action there is an equal and opposite reaction."

During the squat, the thigh behaves as a third class lever. The knee is the fulcrum, the resistance point is where the line of gravity intersects with the thigh, and the line of quadriceps force lies between the resistance and fulcrum. 3 Because a third class lever favors speed, rather than force, the ascent phase is most efficient when done rapidly, with constant velocity.

Extension of the ankle and knee occur simultaneously so the force from the second class lever at the ankle is transferred to the knee and adds to the force exerted by the quadriceps. The speed from the third class lever and the force combined from the lever at the ankle contribute to a most efficient lifting pattern.

The quadriceps are stronger than the back muscles and they should be used to produce most of the force in order to reduce the chance of injury to the back. Keeping the trunk as erect as possible increases the thigh torques, however, a slight lean of the trunk must be used to keep the center of gravity in line with the base of support (Figure 2). A common error of novice lifters is to exaggerate forward lean of the trunk, which displaces the weight forward of the line of center of gravity, and compromises stability (Figure 3). Thus, proper technique allows for the best use of the athlete's strength, in addition to insuring safety.

References

Bradley County Central

[From page 46]diting program. As mentioned earlier the appearance and overall atmosphere of the facility is important in motivating the athletes toward the hard work of weight training. Each athlete's work-out is individualized by the use of a daily progression chart which enables the athletes to progress toward individual and team goals. Another motivating force is the participation of athletes in inter-school powerlifting meets. This helps to maintain a competitive spirit in the off-season. Probably the single most important aspect of motivation is the staff's positive attitude, supervision, and organization of the strength and conditioning program. This program and philosophy of the staff and school administration, along with the dedication of the athletes, has enabled Bradley County Central High School to maintain an 80% overall winning average for the past six years.

The following is a list of accomplishments of our athletic teams over the past five years:

Football - two conference championships, three bowl championships, two district championships, two state playoffs, one region championship, 1976 Tennessee state AAA Champions with a record of 13-0.

Basketball - (Girl's) - four conference championships, three district championships, two region championships, 1976 Tennessee state AAA Champions, 1976 National Champions.

Basketball - (Boy's) - four conference championships, two district championships, one region championship, one region runner-up, two state playoffs.

Baseball - four conference championships, two district championships, one region championship, one region runner-up, two state playoffs, 1980 Tennessee state AAA Champions.

Volleyball - three conference championships, three district championships, three regional runner-up three playoffs.

Track (Boy's & Girl's) - two conference championships, for years district, region and state qualifiers.

Cross Country (Boy's & Girl's) - two conference championships, one conference runner-up, three years district and region qualifiers.

Tennis (Boy's & Girl's) - two conference championships, two years district qualifiers.

Wrestling - three years district and region qualifiers.

Softball - first year program, 8-5 record, district qualifier.

Golf - two conference championships, two district championships, four years district qualifier, three years region qualifiers, one year state qualifier.