Training guidelines for coaches and physical education teachers
Safe and healthy tennis techniques for children

I. Introduction

Tennis is a fun and exciting sport that can provide numerous physical and mental benefits for kids. In this introduction, we will explore the importance of tennis and physical education trainings, including the skills and techniques involved, the health enefits of playing tennis, and how kids can develop their athleticism and sportsmanship through the sport. Besides tennis trainings, strength and conditioning trainings has been a huge part of the elite game for generations. The main purpose of the program is to increase the people playing tennis around the world. Tennis is an amazing sport for kids and grownups as it allows everyone to express themselves individually and as a part of a team.

Coaches and physical education teachers play a critical role in teaching tennis to children in a way that promotes their overall well-being. This involves incorporating safe techniques, recognizing potential injuries like back pain or spinal issues, and emphasizing exercises that support both physical and mental health. By following the guidelines, coaches and physical education teachers can ensure that children learn tennis in a safe, enjoyable, and health-focused environment. Regular monitoring for signs of back strain and incorporating core-strengthening exercises will foster long-term physical well-being while enhancing children's skills on the court.

II. Tennis techniques and exercises for safety and health

- Warm-up and stretching

To prepare the body fot the upcoming training session, the players should always warm-up properly, focusing on the major muscle groups worked during the session. Joints should be well mobilized and body temperature should be raised. Start by increasing body temperature with a slow jog or rope skipping. Warm up the joints by moving each one through its full range of motion. Next perform a complex of dynamic stretching exercises which will further help increase the range of motion of the joints and stretch the muscles allowing them to become more elastic, reducing the risk of injury. Finally perform a complex of dynamic drills to increase the heart rate and prepare the body for the upcoming training load. Studies show that a well-structured, sport-specific warm up protocol can decrease the rate of injuries and increase sport performance.

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- Tennis strokes technique and biomechanics

A well-built tennis stroke technique is an essential part of the player's learning process. A beginner can hit up to 500 shots in a single one-hour session on average. Performing such a high volume of repetitions, using a bad technique may drastically increase the chances of joint or spinal injury. The benefits of having a good technique are:

- Decreased risk of muscle and joint injuries.
- Better efficiency during shot execution, using less energy to produce higher shot quality.
- Improved quality of the shot. More power, control and accuracy.
- High shot quality even in high-fatigue state of the body.

A major part of developing a good technique is understanding the principles of biomechanics in each tennis shot. Coaches can use the word "BIOMEC" to assist in the process of developing a well-built shot technique.

1. Balance

- B-Balance: A stable stance and wide base of the legs helps the player to have balance while hitting the stroke allowing him to transfer all his bodyweight into the shot, resulting in higher power output of the shot. Having well developed core muscles further assists in maintaining balance while performing dynamic shots, when the body is in motion during shot execution.

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2. Inertia

- I-Inertia: Inertia plays a significant part in tennis in general. Tennis players often have to overcome inertia to initiate a movement (start the racket follow-through, start running, decelerate) or use the inertia when transferring the bodyweight into the shot or maintaining speed when sprinting. The coach should know some factors that influence inertia in different ways. Racket weight, surface type, type of ball, physical capabilities of the player to initiate and stop a certain movement.

3. Opposite force

- O-Opposite force: As stated in Newton's third law: for every action there is an equal and opposite reaction. In a tennis stroke, the major part of power production starts from the ground up. That's why during preparation bending the knees and loading the legs before starting the swing is essential for a powerful and fast shot.

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4. Angular momentum

- M- Momentum: Developing a good timing on when to start preparation to when to start the forward swing to hit the ball can play a huge role in the quality of the shot. Using the right rhythm during shot execution can create such momentum that the speed and power of the shot can cost minimal energy wasted from the player. We can observe two types of momentum. Angular and linear momentum. Example of linear momentum is the forward movement of the arm during a slice, the vector of force is applied in a linear direction. Example of angular momentum is the rotation of the trunk during forehand stroke, where the force is applied around the body axis.

5. Elastic energy

- E-Elastic energy: Just like a resistance band, our muscles are elastic and when stretched under tension and quickly released (contracted), they produce high power and speed output. Tennis players can use this to their advantage in many ways, but the major one is shoulder turn during the shot. By performing shoulder turn in the shot preparation, trunk muscles are being stretched under tension and when they contract, the body rotates fast into the shot generating high levels of force, increasing the speed of the ball.

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6. Co-ordination chain

- C- Co-ordination Chain: A well-timed technique execution uses the kinetic chain of the body to transfer the force from the ground through the legs, core, arm, racket and finally the ball. Using the body's kinetic chain to its maximum capacity requires high level of body awareness and coordination. Usually, it takes long time to develop high efficiency of kinetic chain coordination

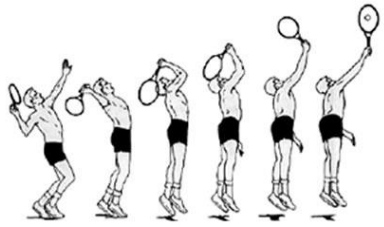

Figure 1 Different phases of the tennis service motion.

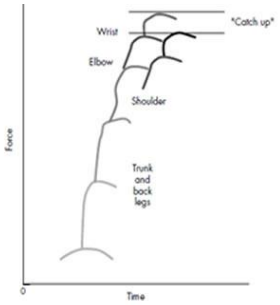

Figure 3 Schematic illustration of the kinetic chain theory.

Factors to consider when building the player's technique:

- Grip selection - too extreme of a grip can cause excessive strain on the elbow and wrist, causing an injury
- Weight of the racket - if the player is not well-developed physically, a heavier racket can cause serious injury on the elbow and the forearm musculature.
- Height of the athlete - longer athletes might have more difficulty going low on the low balls, because of their long legs, especially those with weak leg musculature.

III. Exercises to support overall well-being

There are 5 physical qualitites that make up the athletism and physical preparedness of the player.Strength, Speed, Endurance, Flexibility, Coordination. If developing a well-rounded athlete is a priority, the coach should incorporate a mix of exercises for each quality to ensure each of them is progressing. Here are examples of exercises for each of the mentioned physical qualities:

- **Strength**: the two major functions and benefits of developing the strength of the athlete are better performance overall regarding power, speed and rate of force development. Also the better developed muscular system will decrease the risk of serious injury during physical activities. We can put the exercises in three major groups: Lower body, upper body and core.

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✓ **Lower body**

1. Bodyweight squat: develops the quadraceps and adductor muscles, which play a major role in the movement and change of direction of tennis.
2. Hip bridge: working the gluteus and hamstring muscles, usually tennis players develop a lot stronger quadraceps compared to the hamstrings, which can be problematic in long-term risk of injury
3. Side lunge: Due to the fact that the majority of movement in tennis is lateral, it is important to incorporate exercises in the frontal plane of movement. That is why the side lunge should be a big part of the exercise selection when it comes to tennis.
4. Bulgarian split-squat: very rarely do tennis players work with both legs simutaneously, most of the time players are off balance and should have enough single-leg strength to withstand the stress put on the joints.
5. Calf raises: the calf muscles are the spring of the lower body. A powerful calf muscle can help the player jump higher and push harder on the steps of sprints.

✓ **Upper body**

1. Push ups: develop the pectoral and triceps muscles, which get activated during every shot from the baseline. Stronger chest muscles can help with powerful arm abduction creating that “snapping” efect during the shot.
2. Banded back row: using a band as resistance we can train the back muscles which are often neglected, hence not developed enough creating an uneven development between the anterior and posterior chain as mentioned with the quadraceps and hamstrings.
3. Banded shoulder press: with the high range of motion in the shoulder joint during playing, the joint can become unstable and the risk of shoulder dislocation or tissue injury is becoming higher. Stronger shoulder musculature can prevent greatly that risk.

✓ **Core**

1. Sit up: Flexing the trunk occurs bassicaly every time a player is serving. Having strong abdominal muscles not only keeps the trunk tight and helps with injury prevention, but also greatly assists in generating power and speed in all of the main tennis strokes.
2. Banded trunk rotations: in every forehand and backhand trunk rotation is a major component for an effective shot. Training this specific motion and getting stronger obliques, can help with shot power and speed.
3. Back extensions: because tennis is primarily using the anterior chain of the body, the spine and spinal erectors can become weak and stretched, which as

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mentioned above can creat muscle imbalances, increasing the injury risk, making the player's posture worse.
Out of all the exercises listed above, the highest priority should be put on the core muscles exersices. A well-developed core musculature can aid in injury prevention, creating a more effective kinetic chain and withstanding huge training loads and stress put on the body.

- **Speed:** The ability to perform repetitions at fast pace or for as little time as possible. Usually when we talk about speed we refer to the running aspect of the sport. Being able to quickly run from point A to point B, to accelerate quick from a dead stop or change of direction. The development of speed requires a good base of strength in the lower body so that the legs can withstand the stress put on the joints during runing and jumping.
    - Sprinting: the best way to get a better and faster sprint is to actually do the specific movement. Linear sprint, lateral sprint using variations of crossover steps, sprints from different starting positions.
    - Plyometrics: Jumping can help in developing the stretch-shortening cycle, which grealy affects the components of tennis movement such as sprinting, decelerating and changing direction.
    - Change of direction: on average a tennis player changes direction 4 times in a single point. That is why it is essential to practice technique and perform drill on changing direction in multiple planes.

- **Endurance:** primarily we focus on muscular endurance and cardio-respiratory endurance.
    - Muscular endurance is the ability of the muscles to perform repetitions for an extended period of time without decrease in performance. One of the ways to develop muscular endurance is by just performing high-repetition sets when doing strength exercises.
    - Cardio-respiratory endurance refers to the ability of the heart, lungs, and blood vessels to supply oxygen to working muscles during sustained physical activity. The player can develop a good CR endurance by performing a low-intensity jog or rope jumping for a longer period of time or performing high-intensisty speed exercises for a short period of time or using an interval method.

- **Flexibility:** having flexible muscles can be beneficial when pefrorming motions that reach extreme ends of range of motion in the joints. Muscle fiber and tendon strains or tears can be avoided if the musculature is flexible enough to

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withstand the extreme ranges of motion during play. Some exercises for developing flexibility include:
1.Hamstring stretch
2.Quad stretch
3.Pectoralis stretch
4. Abdominals stretch(Cobra)
5. Adductor Stretch
6. Calf stretch

- **Coordination:** Coordination takes a big part in sports in general but more so in tennis. Having multiple factors that the player has to focus on, such as:positioning of the opponent, upcoming ball, time needed to prepare before the ball has to be hit, thinking about the components of the stroke technique, means that the demand of multitasking in a short period of time is high. The coach can add hand-eye coordination drills in the warm-up of the player to prepare him for the training session. Those drills should have multiple stimuli coming at once, so that the player can coordinate different parts of the body, doing different things at the same time to achieve the goal of the exercise.

IV. Developing tactical knowledge in players

After building a solid base of skills and the ability to maintain a rally, a player can start incorporating tactical situations in order to be more effective during competitive points. Here are some points to help the coach better understand and build effective tactical exercises.

- Tactical situations: there are five major tactical situations that we encounter on the court:
  - Serve +1: When the player starts the rally with serve and recieves a second shot afterwards.
  - Return +1: When a player's first shot is a return and then recieves a second shot afterwards.
  - Rally from the baseline: when both players rally from the baseline
  - Playing at the net: When the player is at the net, playing against his opponent who is at the baseline.
  - Playing against a player at the net: When the player is at the baseline, playing against a player who is at the net.

- Tactical phases: there are three tactical phases that occur during the rally
  -Neutral phase: when both players rally with the same speed and intensity and there is no clear player taking the advantage.

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- Attacking phase: when a player is dominating the point, being in an offensive position, having the advantage.
- Defensive phase: when a player is in a difficult position, having to defend the point and not having the advantage in the point.

- Tactical intentions: during each shot a player should have an idea or intention on what kind of shot should be played. Here are the three tactical intentions during a shot:
  - Staying: when in defensive situation or in a difficult situation, the majority of the time a player can "stay" in the rally by executing a high percantage shot, high above the net and close to the middle of the court to prevent the risk of making an error and losing the point.
  - Taking advantage: when in a neutral or attacking phase, the player can play the shot with the intention ot take advantage and not necessarily hitting a winner. This can be achieved by increasing the speed of the ball, playing with a wider angle shot or by playing a deeper ball.
  - Finishing: when in attacking position or at the net, the player can hit the ball with intention to hit a winner or to force a mistake from the opponent.

By combining all of the above mentioned factors, the coach can have "endless" possibilities for creating a drill, fitting the player's needs. These drill can be done either with a basket or with two players playing against each other.

V. Recognizing and addressing back pain or spinal issues

- Observation on and off-court

Coaches and parents should keep track of the child's daily activities and regularly monitor the state of the child's body. Some activities such as sitting for an extended period of time playing video games or studying can cause poor posture and weak posterior muscles that support a healthy back. Going to school with heavy backpack is another problem that should be considered, because this is constant daily load on the back for the majority of the year. It is recommended that the ahtlete goes through a physiotherapist testing and monitoring once or twice a moth so that any possible problem regarding not only the back but different parts of the body can be prevented and acted upon. As mentioned above, correct technique movements during sport activities are mandatory for healthydevelopment of the child and reducing the risk of injury.

- Strenghtening the core muscles

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A big part of our bodyweigth is beared by our core and legs. By strengthening the core muscles (abdominals, obliques, adductors, spinal erectors), the children can withstand the daily physical demands put on the body and not have to worry about posture problems or injuries.

- Stretching for flexibility and injury prevention

Incorporating strethcing can help maintaing flexibility in the spine and prevent tightness and risk of injury. Some exercises include lat stretch, child's pose, cobra, etc. Regular work with a physiotherapist is still recommended, so that the prescribed exercises fit exactly the needs of the child.

VI. Teaching mental and emotional well-being through tennis

- **Building mental qualities through tennis**
  - Motivation: Almost every activity, especially in sport is deemed to fail if there is no motivation behind doing it. In tennis playing against other players, trying to achieve a sertain goal or result, trying to overcome difficulties help develop motivation within the children.
  - Concentration: tennis is not an easy sport, there are a lot of factors that a child has to focus on and also has to take decisions in a split second. This proccess forces a player to be concentrated for long periods of time if succeeding is a priority. In modern days, children have a small attention span and have a difficult time concentrating over a long period. By playing certain games or drill, the coach can help the player develop a good base of concentration and also progress it through time.
  - Emotional control: Emotional control is a difficult task not only for children but also for adults. In a dynamic sport such as tennis where the momentum of the game can change in a matter of seconds, there is no time for a lot of emotions. The nature of the game encourages players to stay calm and collected during a big part of the match or a training session. This not only helps the player on, but also off-court.
  - Control of thoughts: The fast-changing pace of tennis games demands full concentration before and during each point. This once again forces the player to filter and control his thoughts during the match. All the negative toughts should be controled and the mind should be clear and focused before the start of each point.
  - Independence: Because tennis is a singles sport (except for tennis doubles). Players have no teammates on the court. They play the game on their own, which gives them opportunities to take independent decisions, take actions and deal with the consequenses of their actions.

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- **Encouraging social connections and teamwork**
  By being in a group or playing games and drills with a partner, the children can form friendships, they can learn how to be leaders, how to have good sportsmanship. Introverted children can make new friends through tennis and all the activities around the sport. Playing doubles can form a bond between partners and make them understand the principles of teamwork and how to achieve success by creating a plan and working together.

VII. Key characteristics that coaches and physical education teachers have to posses to effectively teach safe and healthy tennis to children

7. 1. Knowledge of safe techniques and injury prevention

- Understanding of tennis biomechanics

Coaches must have a strong grasp of the technical aspects of tennis movements (e.g., forehand, backhand, serving) to teach correct postures and avoid common mistakes that could lead to injuries, particularly in areas like the back and knees.

- Injury prevention strategies

A deep knowledge of how to prevent injuries, such as lower back pain or muscle strain, is essential. This includes teaching proper warm-ups, conditioning exercises, stretching routines, and cool-downs. Coaches should also be able to recognize early signs of injury, particularly spinal issues.

- Age-appropriate drills

They should design drills and exercises that are safe and developmentally suitable for children's physical and cognitive levels, taking into account factors like agility, balance, and coordination.

7. 2. Effective communication skills

- Clear instructions

Coaches must communicate complex techniques in a simple and engaging way that children can easily understand. Visual demonstrations and using fun language or metaphors (e.g., “big nose” for follow-through posture) help children grasp concepts.

- Positive reinforcement

Encouraging children to focus on their improvement, effort, and teamwork promotes a healthy learning environment. Giving constructive feedback in a supportive manner helps children stay motivated and safe.

- Adaptability

Different children learn at different paces, so the ability to adjust teaching methods and tailor sessions to individual needs is important to ensure both safety and effective learning.

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7. 3. Leadership and organization

- Classroom management

Managing large groups of children requires clear structure and leadership to keep them engaged, focused, and safe during drills. A good coach ensures proper child-to-coach ratios and manages the time between exercises to avoid fatigue or confusion.

- Maintaining safety protocols

Coaches should create a safe environment, ensuring the court is free of hazards, the equipment is age-appropriate, and there are sufficient rest breaks during sessions.

7. 4. Physical conditioning and fitness knowledge

- Understanding physical development

Coaches must be knowledgeable about physical fitness principles, especially regarding children's muscle development and endurance. This includes implementing conditioning exercises like agility training and core strengthening to support tennis movements and reduce injury risk.

- Adaptation to fitness levels

Recognizing each child's fitness level and adjusting intensity, duration, and difficulty of drills accordingly is important to maintain safety and long-term health.

7. 5. Awareness of psychosocial and mental health benefits

- Focus on overall well-being

Tennis has psychosocial benefits, such as boosting confidence and teamwork. Coaches should integrate these elements into lessons, ensuring children not only develop physically but also mentally and emotionally.

- Mindfulness and stress management

Introducing activities that promote mindfulness (such as concentration games) and helping children manage their emotions during competitive situations can help reduce stress and anxiety, creating a balanced approach to physical and mental well-being.

7. 6. Empathy and patience

- Understanding individual differences

Coaches should be empathetic, understanding that children have different learning abilities and physical capacities. Patience is critical when dealing with varying skill levels, ensuring that no child feels left behind or pressured beyond their limits.

- Fostering a safe emotional environment

Creating a supportive atmosphere where children feel safe to make mistakes and ask for help encourages a healthy learning environment, both physically and mentally.

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VIII. Physical conditioning through exercises

The comprehensive concepts and aspects of conditioning allow the development of children's motor skills from a very early age, and even 5-year-olds can start a targeted training process. As the field of conditioning has evolved dramatically over the years, it is no longer only associated with lifting weights and running around the stadium for hours. Teenagers can work on their coordination, learn the technique of basic motor skills (running, jumping, throwing, catching, etc.) and build a rich sports culture. The earlier a child becomes part of the training process, the more productive the development process would be at a later stage of his sports career.

Physical preparation is one of the main factors in improving technical components in tennis. The development of the spatial orientation and coordination, as well as the rhythmicity of the competitor, will play an essential role in the positioning and execution of the shot at the best possible moment. Improving strength in the lower parts of the body will lead to a significant increase in the explosive speed, which will help the speed of the ball after that the impact to be significantly.

Physical conditioning exercises can help strengthen muscles, joints, and ligaments, reducing the risk of injuries on the tennis court. Stronger muscles provide better support for joints during twisting movements or sudden stops on the court. Below are described several basic exercises.

1) Dead bug

In a supine position, arms are extended toward the ceiling. Hips and knees are flexed at 90°. Slowly slide one leg forward until full extension and bring the opposite arm down toward the ground. Repeat with the other leg and arm.

Beginner: 2 sets of 8-10 repetitions, twice per week.

Intermediate: 3 sets of 10-15 repetitions, three times per week.

Advanced: 3 to 4 sets of 12-20 repetitions, four times per week.

2) Superman with shoulder circles (weitghted)

In a prone position with extended arms next to the head. Bring the legs and arms up, maintaining gorund contact only with the torso. Bring the arms behind the back, making a â€œcircleâ€. After touching both hands, bring them back to the starting position and repeat. For increased difficulty, a pair of dumbbells is added to the exercise.

Beginner: 2 sets of 5 repetitions, twice a week.

Intermediate: 3 sets of 8 repetitions, twice per week Advanced: 3 sets of 10 repetitions, three times per week.

3) Lat stretch

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Stand in front of a wall, bend the body at 90Â°. Keep the spine neutral and try to bring the head as far down as possible, surpassing arm level so that the back muscles are stretched. Beginner: 1 set of 20 second hold, twice per week. Intermediate: 2 sets of 30 second hold, three times per week.
Advanced: 2 sets of 45 second hold, three times per week.

4) Banded back row

In a seated position with extended legs, attach a band to your feet. Bring the scapulas together and pull the band toward the torso. Then in a slowed and controlled manner, return to the starting position until full extension of the arms. Beginner: 2 sets of 6-10 repetitions with light band. Twice per week Intermediate: 3 sets of 10-12 repetitions with medium band. Three times per week. Advanced: 3 sets of 10-15 repetitions with heavy band. Three times per week.

5) Neck extension with a band

Attach a band to the back of the head and grab the two ends of the band whit extended arms in front of the head. Bring the head back creating resistance against the band. Bring the head back slow and controlled.
Beginner: 2 sets of 5-8 repetitions with light band, once per week. Intermediate: 2 sets of 8-10 repetitions with light band, twice per week. Advanced: 3 sets of 10-12 repetitions with light band, three times per week.

6) Superman with shoulder circles

In a prone position with extended arms next to the head. Bring the legs and arms up, maintaining ground contact only with the torso. Bring the arms behind the back, making a “circle”. After touching both hands, bring them back to the starting position and repeat.
Beginner: 2 sets of 5 repetitions, twice a week.
Intermediate: 3 sets of 8 repetitions, twice per week Advanced: 3 sets of 10 repetitions, three times per week.

7) Cat cow

In a quadruped position, slowly flex the spine as much as possible, bringing the chin towards the chest. Then slowly extend the spine as far as possible. Try to look up in the furthest point of spine extension.
Beginner: 2 sets of 10 repetitions, three times per week.
Intermediate: 3 sets of 10 repetitions, four times per week.
Advanced: 3 sets of 15-20 repetitions, four to five times per week.

8) Plank

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In a prone position, bring the whole body up, while making ground contact with the toes of the feet and the forearms. Hold this position for a certain amount of time. Keep the abdominal muscles tight and keep the spine neutral. Beginner: 2 sets of 30-40 seconds, three times per week.
Intermediate: 3 sets of 45-60 seconds, three times per week.
Advanced: 3 sets of 60-80 seconds, four times per week.

9) Keeling side plank with hip abduction (Banded)

Lie on the side with knee and forearm making ground contact. Bring the torso up. While holding this position, bring the upper leg up. Bring it down slowed and controlled and repeat. For increased difficulty, put a band on the thighs. Repeat on the other side.
Beginner: 2 sets of 20 seconds per side, three times per week.
Intermediate: 3 sets of 30-45 seconds per side, three times per week.
Advanced: 3 sets of 50-70 seconds per side, three times per week.

10) Quadruped reach and rotate

In a quadruped position, bring on arm below the torso and reach as far as possible, then bring the arm back and extend it toward the ceiling trying to go as far as possible again. Try to focus on rotating the spine as much as possible in both directions.
Beginner: 2 sets of 10-12 repetitions, twice per week.
Intermediate: 2 sets of 15-20 repetitions, three times per week.
Advanced: 3 sets of 15-20 repetitions, three times per week.

11) Pectoralis stretches

Stand next to a wall and place one arm on the wall at 90Â° at the elbow and shoulder. Bring the body forward and rotate a little bit to the side so the pectoral muscles are stretched. Hold this position for a certain amount of time.
Beginner: 1 set of 10-15 second hold on both sides, three times per week.
Intermediate: 2 sets of 20 second hold on both sides, three times per week
Advanced: 2 sets of 30 second hold on both sides, four times per week.

12) Oblique stretch

Stand next to a fence or a Swedish wall. While standing sideways from the wall cross both legs and grab the wall with one arm below the head and one arm overhead. Bend the torso so that one side of the abdominal muscles are stretched. Hold this position for a certain amount of time.
Beginner: 1 set of 10-15 second hold on both sides, twice per week. Intermediate. 2 sets of 20 second hold on both sides, three times per week.
Advanced: 2 sets of 30 second hold on both sides, three times per week.

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