

Effects of Repetitive Strain/Stress Injury on the Human Body

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Abstract—This review describes some of the effects of repetitive strain/stress injury (RSI) on the human body especially among computer professionals today that spend extended hours of prolonged sitting in front of a computer day in and day out. The review briefly introduces the main factors that contribute to an increase of RSI among such computer professionals. The review briefly discusses how the human spinal column and knees are mainly affected by the onset of RSI resulting in poor posture. The root and secondary causes and effects of RSI are reviewed. The importance and value of the various breathing techniques are reviewed in an attempt to alleviate some of the effects of RSI. The review concludes with a small sample of suggested office stretches and poses geared towards at reducing RSI follows in this review. Readers will learn about the effects of RSI, as well as ways to cope with it. A better understanding of coping strategies may lead to well-being and a healthier overall lifestyle. Ultimately, the investment of time to connect with oneself with the poses and the power of the breath would promote a well-being that is overall healthier thus resulting in a better ability to cope/manage life stresses.

Keywords—Health, wellness, repetitive, chairs.

I. INTRODUCTION

RSI is a generic term often used to describe discomfort and pain felt in muscles, nerves and tendons that often develop with prolonged repetitive movement of the same body parts, eventually leading to an overuse of those body parts.

RSI is on the increase due to prolonged use of technology without taking appropriate breaks [1]. This includes using the computer or sitting in a confined space for an extended period of time. As a result, many individuals deal with RSI only when the pain and discomfort in the body becomes unbearable and often at times leading to surgery.

A. Chairs and the Spinal Column

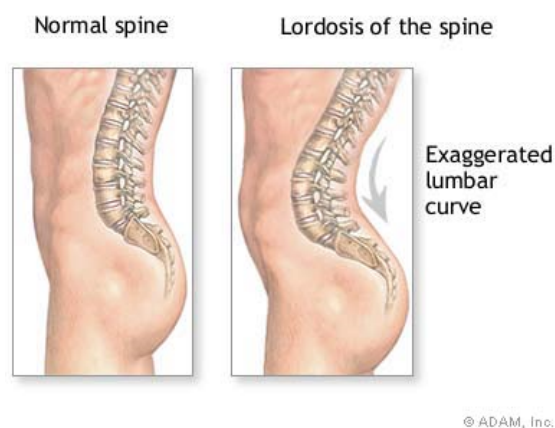
Sitting long hours on chairs often causes stress on the spinal column leading to low back problems. Sitting increases the risk of chronic heart problems such as heart disease, diabetics, some form of cancers and mental health [23]. It is obvious that less sitting and more moving on the whole would result in a better health, therefore, where possible, human beings should engage in every opportunity to stand [19]. This effect is compounded if a steering wheel or a computer is placed in front of us in a tight space thus restricting movement of the low back, hips, pelvis and legs. Another good example of long hours of restrictive sitting would be on long haul flights. The end result of sitting long hours in a restricted space with poor

ergonomic design is tight hips and leg muscles primarily often caused by reduced mobility of the hip socket. Over time, this puts a stress on the smaller and vulnerable sacroiliac and lumbar vertebrae of the spinal column when these are not primarily designed for this purpose. The result is that back injuries occur as these muscles try to support our poor seated posture [1]. Thomas Jefferson and Ben Franklin use stand up workstations [20]. Research suggests 60-75 minutes a day of moderate intensity activity to combat the risk associated with prolong/excessive sitting [21]. There are numerous benefits to our overall health, minds and bodies of standing more and sitting less [22].

B. Poor Posture

Poor posture is often tied to prolonged sitting in a space where the ergonomic design aspects were not taken seriously. This is where the natural curves of a normal spine are affected causing spinal irregularities.

Poor posture often leads to either lordosis which is excessive inward curve of the spine often affecting the lumbar vertebrae of the spinal column. Normal spine is shown in Fig. 1 (a) [3]. Lordosis is excessive outward curve of the spine, shown in Fig. 1 (b) [3].



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Fig. 1 (a) Normal (b) Lordosis [3]

A third abnormal curving of the spine either to the left or right is scoliosis, which causes the spine to curve abnormally into an “S” or “C” shape as shown in Fig. 2 [5].

C. Good Posture

Good posture could be defined as seating in a manner that the effort needed to work at computer is the least. A checklist that identifies proper seating to achieve good posture is to ensure feet: flat on the floor; knees: directly over feet, bent at

right angles; pelvis: rocked forward; low back: arched in; upper back: rounded naturally; shoulders, arms relaxed by the side; neck: arched in, relaxed, supported by spine; head: gently balanced on top of spine [15], [24].



Fig. 2 Scoliosis [5]

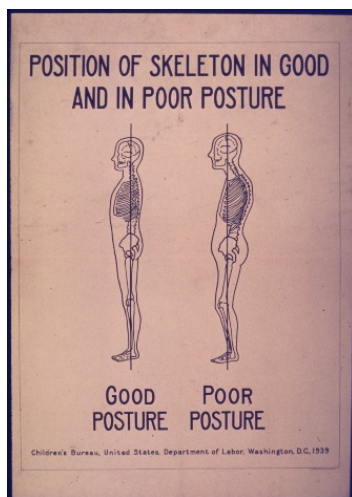


Fig. 3 Good Posture vs Poor Posture [31]

II. RSI

The knees and the spine are often the most injury prone areas of the human body. It is in the present age of computers that the continual over usage of the arms and hands are fully exposed causing RSI. A myriad of physical complaints arises from RSI often to do with severe neck and shoulder tension to tendonitis and carpal tunnel syndrome. This is attributed mainly to several factors. Sitting extended long hours in a chair that is not ergonomically designed often times hunched over a keyboard, performing the repetitive movement of both the small and large muscles of the upper body in order to manipulate the keyboard and mouse, put the nervous system into another layer of stress [1]. Computer-related injuries are often attributed due to poor sitting postures and poor design of workplace environment especially design of desk and chair [16].

A. Population Affected

RSI predominately affects those who perform repetitive tasks often noticed in production line workers (including packers), those playing musical instruments, computer work of some sort, carpentry, sewing, etc. Tools that are used for an extended period of time, day in and day out continuously over several years into decades could also bring about an RIS [10].

B. Overcoming Computer RSI

Balancing computer time with regular short healthy self-care breaks by implementing office stretches has proven to be a solution to combating computer RSI, boosting energy and balancing mood [1].

One of the self-care breaks that have shown and proven to be effective is by doing certain yoga and Pilates poses, stretches, breathing exercises and meditation practices regularly at work stations [1]. The focus of the poses chosen for this review is on developing the components of a healthy seated posture and also working on improving the tone, flexibility and blood circulation in the muscles of the upper body. This would eventually lead to improved mobility in the joints [1].

To gain maximum benefit, Blaine suggest that these office stretches to be done throughout the work day lasting anywhere from 10 to 20 minutes at a time on a regular basis [1]. Blaine suggests that a focused computer free yoga practice either before or after work or both would promote a healthy musculoskeletal and nervous system due to the prolonged computer use [1].

The proper design of the workplace to reduce RSI through the science of ergonomics can be very helpful. In Canada, workers are protected against RSI through Federal and Provincial law and guidelines for the employer to prevent RSI [14].

C. Causes and Effects of RSI

A breakdown of the causes and effects of RSI, in particular computer related RSI is briefly summarized below [2] [11].

Root Causes

1. Working in one position for years.
2. Millions of repetitions
3. Work intensity
4. Aging and loss of tissue resilience
5. Physiology and anatomy
6. Ergonomics
7. Personality

Resulting in the following:

Initial Results

1. Fatigue
2. Slouching postures
3. Muscle tension
4. Chest compression

Resulting in the following:

Secondary Results that Become Causes

1. Compensation and overloading

2. Inflammation and swelling
3. Abrasion and irritation
4. Loss of sleep

Finally resulting in the following:

Ultimate Results

1. Pain
2. Numbness
3. Anxiety or depression

III. BREATH

A. Importance of Breath

The most important thing humans do each day is to breathe. Humans could survive maybe a hundred days without food, a hundred hours without water, but not even a hundred seconds without taking a breath [4].

Feeling energized or exhausted, emotional or numb often depends primarily on the quality of breath. According to most yogis, breath is the life force or prana. The result of constant shallow breathing causes semi-consciousness. Lack of oxygen can be responsible for headaches, fatigue and lack of mental alertness [4].

The upper portion of the lungs, which most people are limited to using with each breath, is only one third of our lung capacity, and has the least number of alveoli (the exchange point for oxygen and carbon dioxide) [4].

Less oxygen to fuel our cells has many negative effects; the most obvious is to try to function on a minimal quantity of air. Our brain starts to read this as “normal”, and this form of shallow breathing then becomes a habit [4].

The primary muscles of respiration – the intercostal muscles, the abdominal muscles, and the diaphragm – are specially designed for the work of taking 24,000 breaths each day. The secondary muscles of respiration – the pectorals, as well as the muscles of the shoulder and neck – are designed for emergency breathing. When these muscles are overused, they become very tight and tense. This shallow, chest breathing is very common and goes hand-in-hand with the stress response [4].

B. Inspiration and Expiration

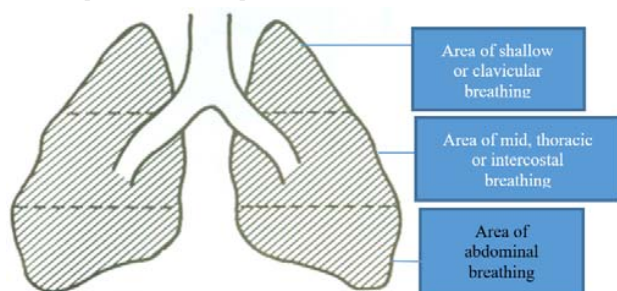


Fig. 4 Inspiration and Expiration [4]

C. Inspiration/Inhalation

Inspiration involves the contraction of the main inspiratory muscle, the *diaphragm*, which moves downwards creating a vacuum that draws air in. Forced inspiration will use

additional muscles such as sternocleidomastoid and pec minor [4].

Inhalation is a result of the contraction of the intercostal muscles (the muscles between the ribs) and the diaphragm [4].

D. Expiration/Exhalation

Expiration occurs when the diaphragm relaxes, resulting in a natural recoil of the chest wall and lungs which moves air out of the lungs. Forced exhalation will use additional muscles such as the abdominals [4].

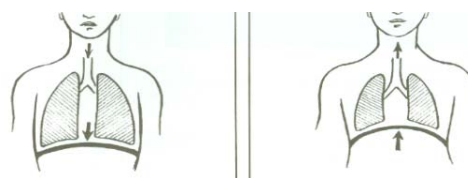


Fig. 5 True diaphragmatic breathing [4]

Comparing the lungs to a triangle, or bell-shaped organ, it can be seen that deep abdominal breathing is the most efficient as it uses the largest part of the lungs [4]. Diaphragmatic breath has numerous benefits. The top three are: effects on abdominal organs, effects on energy and awareness and effects on nervous system [13].

E. Abdominal and Complete Breath

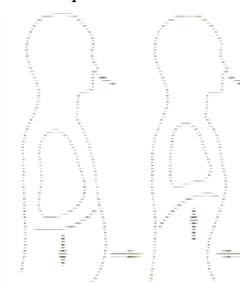


Fig. 6 Abdominal Breath [4]

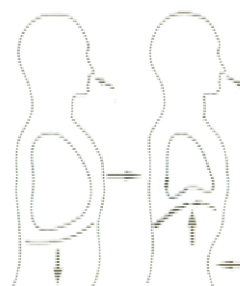


Fig. 7 Complete Breath [4]

You should lie in a relaxed position with eyes closed and should breathe in and out through the nose. Place your left hand on your abdomen and your right hand on your chest. You should isolate the bottom part of your lungs by moving only your abdomen while inhaling. The left hand on your chest does not move [4]. This is the **Abdominal Breath**.

The abdomen moves only during inhalation and exhalation.

If this is difficult at the beginning, try to actively push the abdomen out during inhalation, as though *pulling* the air into your lungs. On exhalation, pull abdomen in as though *pushing* the air out of the lungs [4].

F. The Complete or Yogic Breath

The complete [9] breath combines all three levels of breathing, i.e. Abdominal, Thoracic (using the intercostal to expand the ribcage) and the Clavicular where the shoulders and collarbone are raised [4].

The sequence of performing the Yogic complete breath is as follows:

Inhalation

The process of inhalation begins by inhaling slowly and to bring awareness to the expansion and rise of abdomen initially, followed by the expansion and rise of ribcage and finally the expansion and rise of chest.

Exhalation

The process of exhalation involves to exhale slowly and bring awareness to the contraction and fall of chest, followed by the contraction and fall of ribcage and finally the contraction and fall of abdomen [9].

I. Physical Benefits of True Breathing

During inhalation, the diaphragm descends; it gives a light massage to the internal organs. The abdominal breath has many benefits. There is a better availability of oxygen to the body's cells and therefore function better, both physically and mentally. Focused breathing acts like a sedative on the nervous system, and stabilizes the heart's rhythm. The breathing exercises can also strengthen the immune system by reducing stress, help to reduce cravings and increase energy levels [4]. One will experience a very immediate, positive effect on the emotions from this breath practice [4].

J. Breath and Prana

Pranayama can be split into two words. Basically, Prana is a Sanskrit word signifying life force and ayama signifying extending or stretching. Put together "pranayama" translates to the control of life force [18].

Prana is much more than mere breath; it is the power behind and within the breath. It is the vital force in every being, a cosmic energy that pervades the whole universe. The Chinese recognize it as Chi [4].

Prana can be "directed" to different areas of our body to promote healing. Prana is energy. By releasing unnecessary tension, "prana" or energy will flow more freely through the body, keeping the physical body in balance. Tension, tightness and stress all inhibit the free flow of energy or prana [4].

Breathing process within us can take place consciously via the will power of the mind and unconsciously, i.e. automatically. The yogic breath is called pranayama breathing practice. Pra signifies constant and movement. Hence prana is a life force which is in constant motion [6] [8].

There are numerous different pranayama and breathing techniques that involve some degree of expansion

(lengthening), contraction (shortening), holding (retaining) the breath in a multitude way, yet the baseline of all yogic breathing is to create and sustain an even and smooth balance breath rhythm and more importantly to apply this skill to everyday living [8].

IV. SUGGESTED OFFICE STRETCHES/POSES

A small sample from the list below, as Mohd describes, is valuable for promoting a healthy overall posture. Additionally, it is beneficial to take short breaks away from the computer to unplug. All of these yogic poses listed below bring awareness to the breath and release tension in the joints and muscles [4].

A. Quiet Mountain (Tadasana)

- Aligns the spine
- Improves posture through awareness

You should stand with your feet hip distance apart and your arms by your side. Spread your fingers and toes, and feel the vertical alignment of your spine. At the same time, you should gently stretch the crown of your head towards the ceiling. Take a moment to feel that you are grounded and breathe with awareness [4].

B. Tall Mountain (Powerful Pose)

- Aligns the spine
- Strengthens the legs and shoulders

You should start Tall Mountain pose in Quiet Mountain pose and allow your knees to bend towards floor. While inhaling the participant lifts both of their arms until the hands are shoulder-width distance apart, with the palms facing in, feeling their spine lengthen, while at the same time their chest opens and expands. Settle into the position during exhalation and feel the energy radiating between the palms of your hands. Preferably you should use a strong prana breath [4].

Modifications:

- Avoid hypertension if there is a lower back concern.
- Modify arm position for neck and upper back concerns.
- Knees slightly bent at the knee joint, so as to prevent locking.
- If discomfort felt in the knees, take the hips back so that knees are behind the toes.

C. Upward Stretch (Power Moves)

- Lengthens and lifts
- Wakes up and energizes the body

The participant starts by standing in Quiet Mountain pose. While inhaling, the participant lifts both of their arms, (hands and shoulder-width apart, palms forward) above their head feeling their spine lengthen, inclines slightly backwards [4].

Modifications:

- Avoid hypertension if there is a lower back concern.
- Modify arm position for neck and upper back concerns.
- Tighten the glutes to protect the lower back.

D. Chair (Utkatasana)

- Strengthens the legs, glutes, spine and shoulders
- Open the chest

The participant starts by standing in Quiet Mountain pose.

Start to inhale and sweep your arms up and take your hips into a “squat” position. Reach your arms up and breathe, feeling strong and lifting up through your pelvic floor, lengthening your spine at the same time [4].

Modifications:

- Modify arm position for neck and upper back concerns.
- Decrease the angle at the knees if necessary.

E. Chest Expansion

- Opens the chest
- Strengthens the spine

Bring your hands up in line with your chest, push your palms out and feel the stretch in your arms. Bring your arms behind your back and clasp your fingers. Take your shoulders blade towards each other and lift your chest. Take a moment in this position to breathe deeply. Now flex forward at your hips, pushing your arms high. Let go and hang from your hips [4].

F. Progression

- Stand with feet about a foot apart.
- Place one leg forward slightly, bending the other, or keeping it straight, and bring head to knee.

Modifications:

- Place hands on the lumbar region of the back.
- Avoid head down position for those with hypertension.
- Avoid overextending the neck and shoulders for neck and upper back concerns.

G. Head to Knees or Standing Forward Bend (Uttanasana)

- Strengthens the feet
- Stretches the hamstrings
- Stimulates digestive system

Rotate your pelvis to an anterior tilt and flex forward at your hips during exhalation. Keep your back straight, and lengthen your spine. Bring your hands down to the floor on each side of your feet. The tips of your fingers are in line with the tips of your toes. Do not hyperextend your knees. Allow your body to do the work moving deeper into the posture during your exhalation [4]. Bend your knees and bring your chest to rest on your thighs, during exhalation and start to straighten your legs. When your chest begins to separate from your thighs, stop the forward bend. Increase the depth of the stretch gradually [4].

Modifications:

- Allow the hands to slide down the legs to support the lower back. Pull belly button to spine.
- Keep the knees soft to relieve tension in low back and hamstrings.
- Avoid head down position for those with hypertension.

H. Variations on Standing Forward Bends

The participants lengthen their spine from their lower back, reaching their tailbone towards the ceiling. The participants use their breath to settle into the posture. Hands may be placed around the ankles using light pressure to pull the body deeper [4].

Modifications:

- Allow the hands to slide down the legs to support the lower back. Pull belly button to spine.
- Keep the knees soft to relieve tension in low back and hamstrings.
- Avoid head down position for those with hypertension.

I. Wide Leg Standing Forward Bend (Prasarita Padottanasana)

- Opens the hips and groin.

The participant spreads their legs wide and allows their upper body to hang from the hips. They then reach the tailbone towards the ceiling, lengthening through the spine. Throughout the pose they breathe and hold the posture effortlessly [4].

J. Lateral Triangle (Trikonasana) (Power Moves)

- Strengthens the spine
- Stabilizes legs and torso
- Improves digestion

The participants step to their side, feet just wider than shoulders, their arms reaching to their sides. The participant takes a breath to center and feel their lines of energy. On their exhalation, stretching their right arm up and allow their left hand to slide down their left leg towards their knee inclining to the left. The participant visualizes standing between two boards keeping their body in one plane, and sinking deeper on their exhale. The participant performs this stretch a couple of times with their breath leading the movement in and out, and then reaching and holding the pose for a count of two or three breaths. Repeat with other side [4].

K. Extended Triangle

- Stretches the feet, calves, hamstrings and groin.

From the **Triangle pose**, the participant allows their right hand to reach to their left leg, while twisting the torso. The right-hand rests on the floor, on the inside of the foot. The left hand extends up towards the ceiling. The participant turns their head to look at this hand, and feels the line of energy connecting both hands. The participant holds the pose and breathes deeply, allowing their chest to open as their left shoulder pushes back. Repeat with their other side [4].

Modifications:

- Avoid over twisting if there is a lower back concern.
- Modify arm position for neck and upper back concerns.
- Avoid head down position for those with hypertension.

L. Reverse Prayer Pose (Pashchima Namaskarasana):

- Strengthens the wrist tendons
- Opens up chest
- Promotes digestion
- Promotes better breath
- Loosens tight shoulder muscles
- Eases neck pain

The participants stand with their feet one inch apart. Hands relax alongside body. With soft knees, the participant raises their arms behind their back, joining their palms and fingers together and pointing them downwards. The participant

inhales and turns their fingertips inwards towards their spine. The participant stays in this pose for a minute before coming out of the pose in the reverse order [4]. This is an excellent pose for stretching and opening tight wrists and hands, often caused by spending long hours on the keyboard [28].

M. Wrist Stretch

- Improves range of motion

The participant extends their left arm fully. Their palm should be facing away. They then pull the palm back with their right hand and hold the pose for 10 seconds. The participant then flexes their hand downwards, so that the palm faces towards them. The pose is repeated with the other arm [2].

N. Breaks

One of the most difficult aspects of maintaining one's recovery is the challenge of filling break times with activities other than typing. One easy solution is to use breathing exercises to add some variety. The participants use their break time to perform about a dozen abdominal breathing repetitions [2]. In fact, taking breaks is a reward for finishing a task or part task [27].

O. Exercises Sitting on a Chair

Many simple exercises can be performed while sitting on a chair to release tension. Seated does not mean no movement or motion. Some of these exercises are highlighted below [2].

- Pelvic tilts: Rolling pelvic backwards as in flattening lower back against chair and then forward to neutral position. This can help to alleviate low back stiffness.
- Rolling slowly, their head in circles.
- Shrugging the shoulders up and down and then rolling them in circles, first forward and then backwards.
- Holding hands behind their back of the chair and stretching the chest muscles.
- Moving feet with simple leg exercises, involving heels.
- Stretching fingers at regular intervals.

V. CONCLUSION

To reduce and prevent the effects of RSI, it is critical and vital that computer-free time is built into the work day routine [2]. The small sample of poses highlighted in this review is tools for promoting consciousness and awareness through mindfulness practice on a regular basis in order to reap its plentiful benefits. RSI can be minimized by understanding and applying the fundamental principles of good positioning especially seating, standing and bending [17].

A few simple small changes in office equipment setup and work habits would save months or years of pain and agony that might result in disability [12].

The key to alleviating RSI and to counter the effects of sitting long hours on chairs is to incorporate such poses and stretches on a regular basis, and by taking regular breaks away from the computer. In essence, prevention is of utmost importance rather than curing the pain after several years of performing the same task over and over, day in and day out

[1].

Apart from alleviating RSI, there are other benefits to be gained by following such a regime on a regular basis, the routine. It offers a unique stress management system, alternating between physical exertion and deep relaxation, which trains the nervous system to turn off the stress response [1].

Investing in an adjustable computer desk which would allow to alternate between standing and sitting would reduce or eliminate short- and long-term effects on overall health and body. Sitting most of the work day especially can have an effect from head to toe [29]. The Department of Ergonomics at Cornell University reports that 90% more pressure is exerted on your back when sitting compared to standing [30].

Yoga is simply a practice of awakening to each moment and discovering what emerges [7]. A long-neglected self will find even the simplest poses challenging and painful. It is through yogic poses the reunion of the mind, body and spirit begins. It is through mindful practice that the awakening within oneself begins to trigger. It is analogous to the first water coming out of the pipe that is not sparkling clear [8].

Making a conscious effort to focus on the three types of breathing techniques (mentioned above) on a regular basis can improve one's overall well-being. Ultimately, the breath is the life force of human being.

As the saying goes, prevention is better than cure. However, it is challenging to convince young healthy workers or their managers to prevent RSI.

One of the best super simple RSI prevention strategy for computer is to "tame your time and stop using it" as described by Tim [25]. It is best to establish a healthy relationship with the computer so as to prevent RSI [26].

The use of computers without question is definitely going to be a way of life for the future. Preventing RSI from happening in the first place by incorporating appropriate RSI programs starting at preschool cannot be over emphasized.

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