Chapter 12 : Anatomy for Skateboarding II

Skateboarding analysis with more data and a summary of anatomy information from June-December, 2024.

Introduction

This second chapter on learning kinesiological functions relevant to skateboarding begins by reviewing the anatomical terms and directions used to describe the body. These descriptions are primarily derived from the National Institute for Health's National Library of Medicine's Stats Pearls online resource and continues with articles on knee valgus, personal ankle snap, and inflammation. The methods section covers the study period along with bodily observations reexamining a lower back overuse injury sustained during school athletics. Text notes are translated into several sections based on month and activity to chronicle progress and injuries sustained while skateboarding, longboarding, and running along with efforts to minimize inflammation through juggling, walking, and calisthenics. Besides calories intake and body weight, nutrition was recorded identically as the previous chapter in subjective categories. The participant was on state funded healthcare for the duration of the study.

Graphics were constructed in the results to include information for the exercise schedule. The subsection includes length of time and frequency sorted by hour and weekday during the previously listed activities. Total number of hours for each activity, frequency count, average length of activities, and average minutes spent per day on each activity was summarized for the entire time period. The pain chart is first visualized with five day averages on the observed

values to examine specific and abnormal body parts. The body parts were further aggregated into general areas until upper body, lower body, and stamina were displayed in one chart. Observed values and and next day predictions were compared using traditional classification metrics for accuracy, precision, recall, and F1-Scores. Average number of activities before erroneous pain values were sorted by days in reverse and by the day of the event using an implementation of merge sort. The conclusions review how to improve training for more enjoyable practice and recovery.

Background

Although the study's participant had played sports for decades, limited academic information is apparent while reading physiological articles and navigating basic terminology (88). To identify names of the specific sore muscles, appropriate articles are separated into upper body and lower body to find the cause of left internal hip snap. Muscle imbalance and causes of knee valgus are then examined to more effectively evaluate the risks of fundamental skateboarding movements and discover the root cause of right knee snapping. Anatomy and injuries along the anterior and posterior ankle are also included because of ankle snapping. Another section reviews information on the chemical reactions causing inflammation and methods of safely reducing chronic accumulation of fibroblasts before finally reviewing studies on injuries related to the landing phase. Statistics used to evaluate the pain charts are reviewed later in the section and cover time series representations as described more in depth in chapters 0-10.

Upper Body and Abdomen

Beginning superiorly and moving distally, the calvaria and skull base are composed from four sections of bones whose nominal descriptions are included because muscular attachment roughly corresponds to the names of their bone origins and attachment. The frontal is the anterior coronal junction between the two parietal bones, which connect inferiorly with the temporal bone, occipital bone, and with the back lambdoid. The temporal section includes the sagittal which defines the anterior and posterior axis between the aforementioned parietal bones before arriving at the occipital or posterior skull. The intracranial fosse includes the anterior, mid, and posterior cranial that forms the internal cavity holding the brain. There are 14 mirrored bone pairs in the face. Fontanelles are soft spots in the skull that close at various ages in human development from age 0-60. A common skull complaint includes temporomandibular (TMJ) disorders and should be properly evaluated by a medical professional (85) but was personally observed during periods of dry air and static electricity inducing jaw clenching during sleep.

Moving inferiorly supporting the skull, the neck is anatomically divided into the anterior triangle with four primary areas and the posterior section with two areas. The phrenic nerve traverses the spine at Cervical (C) C3, C4, and C5 to control the diaphragm, respiration, and neck infrahyoid muscles. A compressed ansa cervicalis nerve by these hyoid muscles can change the pitch or accent of vocal intonations (84) presumably by increasing oxygen intake. The shoulder or glenohumeral joint attaches to the axial skeleton through the sternoclavicular joint. Muscles that support arm movement and function include the rhomboids, trapezius, deltoid, and several rotator cuff muscles. Biceps brachii is technically not a shoulder muscle but originates from the glenoid labrum. As previously described, a left acromioclavicular (AC) joint sprain increases the

risk for subacromial bursitis and overhead movements should be carefully orchestrated (83). The Latissimus dorsi attaches in front of the trapezius' lower six vertebrae, Thoracic (T) T6- Sacrum (S) 5, the posterior iliac crest, several lower ribs, and the external oblique. The main function is pulling motions and assists in respiration. The upper muscle fibers are horizontally aligned while the lower fibers are vertical and are relevant to the different types of free weight lifts used to target each section of the muscle (82). Despite having access to dumbbells for bent or upright rows to exercise the vertical portion of the muscle, exercising the overhead pulling muscles proved challenging without a dedicated bar for chin ups.

Each of the 12 ribs are connected to the posterior thoracic spines via tendons and the muscles of the back are divided into three categories. The first category is called the superficial and include the previously mentioned trapezius which attaches to C7-T12 and the clavicle, along with the latissimus dorsi that attaches to T7 - Lumbar (L) 5, sacrum, and iliac crest. Additional muscles include the levator scapula that support the posterior neck and the minor and major rhomboids that attach at C7-T1 and T2-T5 respectively. The second category is called the intermediate group and is responsible for respiration with attachments to the ribs. The first muscle is the serratus posterior inferior at C7-T3 and 2-5 ribs and the serratus posterior superior attaching to the T11-L3 and 9-12 ribs. The third group refers to the deep muscles and includes more neck supporting muscles such as the splenius. Additional spine supporting muscles are the intrinsic erector spinae muscles. The lateral muscle includes the iliocostalis, the largest is the longissimus, while the spinalis runs medially. The transversospinalis bends at the back posteriorly when bilaterally contracted and refers to the semispinalis in the cervical and thoracic sections, multifidi that spans the entire spine, and rotatores that are the deepest back muscles (81).

Anterior to the back, the abdominal wall is composed of several muscles and inflexible fascia to support the upright torso characteristic of humanoid posture. The first is known as the campers and scarpas fascia. The next section is the anterolateral muscles and refers to the internal and external oblique, transverse and rectus abdominis, and pyramidalis which are innervated between T7-T12. The posterior muscles of the abdominal wall include the psoas major that attaches at T12, from L1-L4, the iliacus, and finally to the lesser trochanter of the femur. The quadratus attaches the iliolumbar ligament and iliac crest to the twelfth rib and L1-L4 via superomedial positioning and is inelastic since its primary function is to connect the legs to the torso and assist in posture. Exercise induced lower back pain is often mistaken for this abdominal wall muscle and long term damage could cause respiratory illness or require hip replacement leading to death or significant disability. The third and fourth section includes the transversalis fascia and parietal peritoneum (70, 109, 110). Learning more about the specificity of neck, shoulder, and back muscular location was hoped to decrease the severity of headaches through modifying sleeping and exercise habits. Specifically forcing side or back sleeping, increasing indoor humidity, and icing the right trapezius were strategies derived from these readings used to reduce muscular inflammation caused headaches. The landing phase of skateboarding tricks requires synchronization between leg squats and upper body flexed in a lower, centered position to retain balance while absorbing the Newtonian forces and avoid rapid accumulation of muscular overuse.

Hip and Upper Leg

As described in the previous chapter, internal Iliopsoas (IP) hip snap was identified in the left leg and warranted further investigation to discover methods for greater muscular balance induced athletic longevity. The femur bone connects to the pelvis via a ball and socket joint between the femur head and the acetabulum whose labrum provides a cartilage collar that regulates pressure, synovial fluid, and load transmission. The joints transverse axis facilitates hip flexion and extension, the longitudinal allows rotation, and the sagittal assists in abduction and adduction. The Capsular ligaments connect the pelvis to the femur and include the iliofemoral which attaches the anterior inferior iliac spine to the intertrochanteric femur crest and prevents hyperextension. The pubofemoral prevents excessive abduction and extension while the ischiofemoral prevents excess extension in contrast to the iliofemoral. The ligamentum teres attaches the cotyloid notch to the fovea on the femur (71 Bony Pelvis and Lower Limb, Hip Joint).

The muscles that are primarily responsible for hip flexion are the psoas major and the iliacus with help from the pectineus, rectus femoris, and sartorius (74 - Thigh muscles). The psoas is used in stabilizing the spine during sitting and standing and is relevant since the subject was a former power lifter. The psoas major attaches to the lower vertebrae through the pelvis to the small trochanter of the femur and the psoas minor exists anterior of the major psoas and occurs in 60% of people. The iliac fossa merges with the large psoas muscle tendon at the Femur's trochanter and a common injury is iliopsoas bursitis (76 Bony Pelvis and Lower Limb, Iliopsoas Muscles).

221	71, 76	In kicking, the plant foot primarily engages the extension gluteal and hamstring muscles -> switch kicks shortened the bicep femoris and contributes to the back of knee snapping. The hip

		extension on regular skateboarding ollies is identical and explains the consistently returning knee pain throughout 2024.
222		Soccer kick: plant leg - flexion hip or thigh into air (no resistence) extension hip or thigh counterweights body and swing leg isometrically and would be the muscles used the most. Illiopsoas
		snapping (IS) on the left leg is most likely caused by punting and kicking footballs using the primary leg during recess and organized practice and additional psoas major muscle is listed as
		a cause of IS.

20250725	R calf used to cramp after rugby 15s or football and I wonder if it's L leg forward lunges motion and subsequent L hip snap related. Since I skate R, the L forward lunge would be the default
	movement in rugby rucking or football blocking. The L psoas is used in hip flexion and was cramping during intentional slightly dehydrated rest several days after alternating leg split jerk and is
	consistent with the previous weeks observation of struggling to rotate the flexed hip during either stanced skateboard 180s. Push regular to strengthen L gluteous medious and split jerk with R
	leg forward to strengthen R hip flexors.

The sartorius attaches from the iliac spine to the medial tibia and flexes and rotates the thigh laterally which is a motion used in skateboarding by the front leg during the FS and BS 180. The pectineus connects the pubis to the lesser trochanter of the femur and adducts and flexes the front legs thigh during the pop shove it (74 - Thigh muscles, 73 Anterior Hip Muscle Image). Extension muscles include the gluteus maximus and hamstrings while the tensor fascia latae and gluteal medius or minimus allows medial rotation. Muscles used for lateral rotation include the obturator, quadratus femoris, gemelli, gluteus maximus, sartorius, and piriformis (71, 75 Bony Pelvis and Lower Limb, Gluteus Maximus Muscle (Image), 72 Posterior Hip Muscle (Image)). (71 Bony Pelvis and Lower Limb, Hip Joint) also lists common causes for hip pain such as genetic inheritance, traumatic motor vehicle accidents, or osteoarthritis. Age, genetics, and injuries are usually culprits for osteoarthritis. (76 Bony Pelvis and Lower Limb, Iliopsoas

Muscles) lists another cause of iliopsoas hip snap syndrome as the presence of an accessory strip of the psoas major or extra muscle. The participant's left hip snap could have been caused by either using one foot during football kicks, imbalanced powerlifting squats, or a combination of activities primarily relying on one muscle group over several years during adolescence.

When the layperson is embarking on a new exercise program and uses Google for answers about the origins of their hip pain, one suggestion is anterior inferior iliac spine (AIIS) avulsions. This is a serious injury that occurs when the rectus femoris muscle pulls a portion of bone away from its attachment on the iliac or pelvis and is typically a result of overuse during sprinting or kicking activities that require explosive hip flexion (104 Anterior Iliac Spine Avulsion Injury). Activities that could induce this injury include soccer, track, or karate but could arise from several dozen sports that vary over geographical distribution, seasonality, or demographic information which is why basic Google defaults on suggesting several semi-serious injuries. AIIS is not to be confused with the less serious pulled leg muscle or more serious dislocation, stress fracture, or bone cancer (103 Avulsion Fractures) and you should probably stop doing that exercise for a few days or see a doctor if the pain persists. IP hip snap is also called coxa sultan and includes both internal or external snapping. The most common is external extra-articular iliotibial (IT) snap when the IT band or gluteus maximus snaps over the femur's greater trochanter during hip flexion and rotation as a result of muscular instability around the femur’s joint. Causes include either imbalanced hip muscles (76) or fibrosis and requires a physician performing the Thomas test and Ober or hula hoop test for an accurate diagnosis (105 Understanding and treating the snapping hip).

Knee extension muscles at the patella are located in the quadriceps and include the vastus lateralis, medious, and intermedius as well as the rectus femoris anteriorly (74 Bony Pelvis and

Lower Limb). The vastus lateralis absorbs most of the weight at the end of the swing phase during walking or when the heel strikes the ground. The muscle is especially used while descending stairs or hills as documented during the previous chapter and paleofemoral pain is commonly attributed to mismatched strength between the lateralis and medius (80 Bony Pelvis and Lower Limb, Vastus Lateralis Muscle). The muscles used in adduction are located on the interior of the thigh and include the longus and brevis. The gracilis medially rotates the tibia while the magnus is considered both a hamstring and adductor. Other hamstrings include the long and short bicep femoris and the semitendinosus and semimembranosus that functions to extend the thigh and medially rotate the tibia (74 Bony Pelvis and Lower Limb, Thigh Muscles). The femur bone and muscles are innervated proximally by the obturator and femoral nerve and their associated branches. The distal nerves include the femoral, obturator, fibula, and tibial. Piriformis syndrome occurs when inflamed hip abductor muscles compress nerves (77 Bony Pelvis and Lower Limb, Femur (bone)) but is redundant since any rapidly swollen muscles compress the nerves and cause pain or tingling sensation. It requires significant force to break the femur and a more likely significant lower limb injury while flat ground skateboarding is broken feet or toes from overuse or ankle sprains from awkward landings.

Knee Valgus and Muscle Imbalance

Skateboarding movements are muscularly asymmetrical when performing only regular or switch stanced tricks. In kinesiology studies, the support leg refers to the primary limb used while the swing limb is either guiding or striking. Eccentric muscle contraction indicates lengthening of the muscle until the desired force exceeds the amount produced by the muscle in

contrast to concentric where the muscle lengthens to meet the required work before shortening (**111**). A more accurate description of the biomechanics used during ollie includes the rear support leg moving in knee flexion to a ¾ depth squat using an eccentric rectus femoris and vastus lateralis of the quadriceps and a concentric hamstring bicep femoris before transferring weight into knee extension with concentric quadriceps and eccentric hamstrings to jump upwards and laterally with the forward direction of the board. The front positioned swing leg is used to control the board and is not used as much to support the jump motion. Conversely when considering pushing the board to increase speed, the front support leg is engaged in an isometric exercise while concentrically activating the swing leg muscles to propel the board forward and might result in different sized muscles (34).

One study from Brazilian and Australian researchers examined strength asymmetry and hamstring to quadriceps ratios during concentric and eccentric muscle contractions. A small sample of professional skateboarders was included and found non-significant differences between limb muscle strength for isometric versus dynamic knee extension and for traditional hamstring to quadricep measurements. They cite several sources that report knee side to side strength asymmetry during movements greater than 10% increase the likelihood of injury. This lateral knee asymmetry was below the 10% value, however hamstring to quadricep concentric and eccentric ratios were abnormal indicating possible muscle imbalances (34). The muscular fibers in the legs used to perform different motions vary from horizontal to vertical similar to the description in the latissimus dorsi. Different depth squats might lead to a differently sized bicep femoris distally compared with proximally, increasing the potential for injury. This is probably one of the reasons why lower quadricep pain is experienced since ¾ squat skateboard jumps do

not engage the proximal hamstrings and gluteus muscles in the same direction as full depth squats.

To circumnavigate the observed muscle imbalances, performing different depth squats similar to those measured in (34) might be necessary. If athletic and muscular improvement are the goal with no interest in skateboarding, an alternative method would be to use a weight room where plyometric ladder footwork would be similar to skateboarding dog walks, box jumps analogous to waist high ollies, and full depth bodyweight jump squats are comparable to full squat hippie jumps. Another study from U.S. institutions of higher learning measured dominant versus non dominant leg strength in both powerlifters and field jumpers. They found that powerlifters had less asymmetrical leg imbalances than the jumpers (33). More research compared powerlifters with non powerlifters muscle imbalances and posture found that horizontal shoulder adduction and knee extension was slightly stronger amongst the lifters. Pectoralis minor length was also significantly shorter but they found no abnormalities in posture measurements (35). Both studies had small sample sizes under the 30 required for more robust statistical answers. People that have gained financial stability to concentrate on skateboarding have achieved muscular balance but it might be harder for amateurs because the level of involvement increases dramatically between casually pushing for transportation and performing ollie related tricks. To avoid catastrophic injury from muscular imbalances, it is essential to work on both switch and regular stanced tricks and perform leg exercises that use a full range of motion. One way to accurately track exercises are mobile applications such as spreadsheets or fitness watches.

From the stationary videos in the previous chapter on skateboarding anatomy, knee valgus is easily avoided during stationary ollies. However, it was concerned that slight knee

valgus would emerge while performing moving ollie related tricks to retain balance. In lieu of studies with adequate samples examining skateboarding knee valgus, research using 2D video to analyse basketball player's knee and ankle angle in two leg vertical jump and one leg forward step up tasks found no difference with two legs but significant difference using the dominant versus non-dominant limb (55). They cite several papers claiming that knee valgus is associated with lower leg injuries **(3-6,8 in their paper)** and non-contact ACL injuries with rapid direction changes or rotation from abnormal knee or hip angles **(9-11 in text**) arising from upper leg muscle imbalances (**19 in text**). An example is rapid external tibial rotation straining the MCL, reducing Golgi tendon organ feedback and leading to ACL injury when returning to neutral. **3, 8, and 24 in text** assert that leg muscle imbalance of more than 15% significantly increases injury rates and **25** indicates that a stronger gluteus medius supports more control in the landing phase of the jump since increased medius timing reduces knee valgus and would probably reduce non-contact ACL injury risk.

Lower back pain had been a problem during high school athletics and continuing into college before a medical induced three year break with minimal activity made the issue unnoticeable. Back pain resumed with exercise and was reduced by strengthening the gluteus medius as previously suggested in high school by medical doctor recommended physical therapists. Several years passed before skeletal-muscular development returned to facilitate learning skateboarding tricks. While resting lower quadricep soreness between skateboarding, significant time was spent researching information for this textbook and one idea emerged in examining the long term effect of sitting posture on the previously mentioned lower back and IT band pain. One study examined people sitting in various positions with and without lower back pain by using a 3D motion capture system and gluteal pressure force plates to measure trunk

flexion and pelvic obliquity angle. They found that patients with back pain had lower trunk flexion angles and greater gluteal asymmetry while cross sitting. Numerous studies in their literature review support that spinal and pelvic rotation through hip flexion and adduction from body weight distribution asymmetry and reduced oblique activity are symptoms **(8 - in text)** but not the actual cause of the issue (51).

Since lower back pain on the right side was reduced from strengthening the gluteus medius and the lower quadricep pain was on the same side, it stood to reason that knee soreness could be exacerbated by long periods of resting with asymmetrical posture induced by cross legged sitting after skateboarding. Since prolonged knee flexion sitting has the potential to increase patellofemoral pain syndrome or damage the underlying kneecap cartilage, researchers used band weight and EMG electrical activity to measure differences in the vastus medialis and lateralis muscles during step up activity after floor sitting in the cross leg, side, and in a chair. After cross leg sitting, they found that vastus medialis activity increased during the descending phase and both muscles were used more during the ascending portion (54). Muscle imbalance as observed in this study and supported by their literature review has the potential to decrease knee stability.

Foot and Ankle

The squat and ensuing jump portion of the skateboarding ollie requires weight to be positioned distally toward the toes of both feet, similar to wearing high heels. The ankle is in an everted position while placed on the tail of the board, rotates to a normal position while striking the ground, then to a non-weight bearing inverted position briefly before returning to neutral

during the airborne phase and subsequent landing. This places enormous strain on the lower leg and foot, particularly the fibularis or narrow lateral lower leg compartment and excess fluid can accumulate causing reduced blood flow. Characteristic signs include pain, tingling, loss of feeling, low pulse, or paralysis and are usually caused by overuse. They are associated with 13-34% of leg injuries. Skin discoloration is also possible but this superficial symptom is not to be confused with dead skin from dry air. The lateral compartment also assists in plantar flexion of the muscles located at the bottom of the foot (53, 78). The foot is described as containing 29 muscles, with 10 extrinsic originating outside the foot and crossing the ankle for attachment support in various foot bones. The most prominent muscle in foot movement is the tibialis anterior, which originates superior-laterally of the tibialis and attaches to the medial foot. There are nine compartments for muscles in the foot with varying descriptions of division depending on the study. Tom, Dick, and Harry attach to the bottom of the foot and are non-technical terms used to refer to the three tendons that originate posterior of the tibia and beneath the soleus' achilles tendon's attachment to the calcaneus or heel, which is inflamed in correspondence to overuse of the gastrocnemius or calf muscles (79).

There are three categories for lateral leg compartment syndromes stemming from ankle instability, increasing in severity from peroneal tendonitis, subluxation, and tendon tears vertically over the fibula (106). South Korean neurosurgical researchers examined the similarities of common peroneal nerve palsy foot drop induced from squatting or cross legged sitting that is prevalent in south-east asian cultures compared with lower back or lumbar induced foot drop. More accurate identification is important to avoid unnecessary spinal surgery. By examining a small cohort in retrospect that were diagnosed with peroneal nerve palsy, the patients were categorized based on the squatting, cross leg, or sitting position that induced the

diagnosis. Sitting cross leg inverts the ankle and strains the tibialis posterior indicating a lateral leg compartment neuropathy, rather than weak hip abductor strength characteristic of back pain originating foot drop (52).

Inflammation - Fibroblasts

Besides the risk of injuries sustained from falling, skateboarding presents the potential for long-term muscular scarring from overuse justifying investigation into the biological mechanisms behind repair. Fibroblasts are the basis for connective tissues that generate proteins involved in forming the extracellular matrix (ECM) scaffolding in muscle and organ repair. Materials involved in muscle repair include structural proteins such as fibrous, collagen, and elastin, adhesive proteins with laminin and fibronectin, and ground substance proteins with glycosaminoglycans separated into hyaluronan and other glycoproteins. Fibroblasts typically originate from the area closest to the muscular damage. Myofibroblasts are derived from precursor cells in response to damage and don't exist in healthy muscles. Monocytes and fibrocytes are less active precursors to fully active fibroblasts and circulate the body via the vascular system that transports material such as white blood cells in lymph fluid for immune responses. Epithelial, endothelial, and pericytes are organ specific and vascular smooth muscle cells are found in artery or vein fibrosis (61).

After muscle injury or damage from exercise, myofibroblasts secrete a variety of cytokines such as the Transforming Growth Factor beta 1 (TGF-SS1). A specific cause of chronic inflammation or fibrosis in the skin or lungs is overexpression of the Insulin-like Growth Factor Binding Protein-3 (IGFBP-3) induced by TFG-SS1 in mediating the induction of

proteoglycan tenascin-C (TN-C). This glycoprotein is composed of one or more carbohydrate or sugar chains that are covalently bonded to share negatively charged subatomic particles called electrons (61). When Type I collagen accumulates in the interstitial matrix of the newly constructed basement membrane ECM, an exhaustive list of interleukins including IL-1SS, IL-6, IL-13, IL-17 and IL-33 (62, **67, 68**) are recruited to the site for repair signaling.

Other signaling molecules include prostaglandins or lipid compounds that induce swelling while making nerve endings sensitive and leukotrienes that are produced by white blood cells. Eicosanoid leukotrienes are a specific type of lipid mediator involved in inflammation whose imbalance in lung cells leads to fibrosis or scarring by disrupting apoptosis of fibroblastic cell removal. Immune cells such as macrophages assist in ECM scaffolding on ground surfaces using the viscous substance proteoglycans to form a pathway for nutrient flow, cell migration during immuno or fibroblast responses, and intercellular communication independent of blood vessels. The final stage of muscle recovery is called angiogenesis where fibroblasts release endothelial cells to construct new blood vessels in a mechanism called vascular endothelial growth factor (VEGF) (61).

Inflammation - Fibroblastic Reduction

The literature review on fibroblasts (61) does not include skeletal muscle biological details and instead covers several therapies for fibroblast reduction in organs and cancer related illnesses. There are several food substances that have been proposed to reduce inflammation. Garlic has historically been used as a medicinal food additive and has been suggested as an anti-cancer substance with increased immune effects. (56) reviews complicated organic

chemistry to identify the molecular compounds that might be responsible for anti-inflammatory properties. Vacuolar enzyme alliinase arises from a damaged garlic clove that induces an elimination reaction resulting in allicin or an anti-microbial sulphuric compound used by the plant in defense. Allicin degrades into a secondary sulfide. The studies that investigated garlic anti-cancer properties identified several anti-inflammatory cytokines such as TRAIL, IL10, and TFG-SS that promote apoptosis depending on the microbiome. The tone of the conclusion indicates that the authors suspect increased water intake is the likely cause of reduced inflammation.

Another study reviewed the anti-inflammatory effect of the *Cinnamomum verum* (*C. verum*) bark extract cinnamon in a laboratory environment. The cinnamon was prepared by grinding *C. verum*, incubating the powder with hot water in a rotavapor, and extracting with a centrifuge. Ethanol was added to the mixture and heated before filtering and returning to a rotavapor for evaporation. The final cinnamomum extract was freeze dried for storage. To simulate human gastrointestinal digestion, several phases were designed with chemical compositions similar to biological reality. The oral phase consisted of water and salt and the gastric phase was composed of swine pepsin, calcium chloride, and the previously described oral mixture. The pH was modulated with hydrogen chloride to replicate the acidic environment of the stomach. The final intestinal simulation phase consisted of the previously described gastric content with added porcine bile and porcine pancreatin to obtain trypsin. Calcium chloride and water were also included before the digested material was acidified and preserved with protease inhibitors (57).

Anti-oxidants were measured using the Folin-Clocalteu method to measure radiance absorption with a UV spectrophotometer and modified by raising the alkalinity with sodium

carbonate. The amount of polyphenol in the samples was measured with a chromatographic separation device and the identification of target bioactive molecules with a spectrometer. Cancerous human colorectal cells were obtained to test the anti-inflammation properties of cinnamon in an intestinal barrier model through several assessments. After statistically comparing the results of the laboratory conditions, the authors concluded that the beneficial properties of cinnamon were maintained after digestion (57).

Inflammation - Fibroblasts and Neurobiology

Neuroscience Third Edition Chapters 1-5 include background information on electricity and neuron signaling. Nerves in the human body have several categories such as the central nervous system which is composed of nerves that are found in the brain and spinal cord. The peripheral nervous system includes the sensory nerves found throughout the rest of the body. The somatic nervous system controls voluntary musculoskeletal appendages such as walking and touch. The autonomic system controls smooth muscles and cardiac function with subcategories that include the sympathetic nervous system for increased adrenal and heart function and the parasympathetic that reduces heart rate. Neural circuits are the synaptic connections between neurons that perform a specific task, for example the myotatic spinal reflex or the knee jerk reaction that extends the leg. Circuits have afferent nerves that carry information to the brain and efferent neurons that carry information away from the brain.

Neurons are not good conductors of electricity for signaling compared with metal wires because they are composed mainly of pure water. Efficiency gains are increased between the brain, spinal cord, and the rest of the body with the term action potentials where ions are

transferred with the addition and subtraction of elements such as sodium (NA), potassium (K), chloride (Cl), and Calcium (Ca). Much of this information was discovered through early electrophysiological studies using millimeter diameter tubes and voltmeters measuring two dimensional electrical transfers on deceased octopus neurons. More recent noninvasive radiographic techniques use Magnetic Resonance Imagery (MRI). Important early discoveries include the Nernst and Goldman equations based on the element and Faraday electrical constants to predict electrical potential by elements crossing a neuron membrane. The Hodgkin-Huxley mathematical equation further details how ionic currents flow with neuron membrane depolarization changes and improves prediction accuracy for action potentials based on NA and K. The elements form a positive feedback loop that is regenerative until neuron membrane equilibrium is reached. The mathematical relationship to calculate current flow depends on change in voltage at a location, e base of natural logarithms, and length of the constant axon which varies on the resistance/capacitance of plasma membrane, intracellular axoplasm, and extracellular medium.

The transfer of information can be summarized beginning with external stimuli contacting the somatic sensory system through receptors at the dermatological organ innervated by cells forming a dorsal root ganglion. Somatotopy is the topographical mapping of nerves that relay information to the spinal cord to the structures of the forebrain responsible for those particular functions. Parallel pathways are the separation of specialized nerve cell axons that process specific inputs like temperature, pain, pressure, etc. Examining nerves closely reveals the synaptic cleft or the space outside cells that transfers molecules to reach other cells as well as electrical gap junctions with pre and postsynaptic current connectors. The neuron axon reads the signal at the next site of synaptic interaction and can measure over a meter long such as the

spinal cord to foot. Neuroglia are structures that are analogous to scaffolds supporting neurons and astrocytes that regulate chemistry for signaling. Myelin forms a sheath around most axons like those found in muscles for increased speed and precision in the topographical mapping of bodily sensations to the spinal cord and brain. Schwann cells generate myelin in the peripheral nervous system and oligodendrocyte generates myelin in the central nervous system. Myelin are not found in gray matter in the outer neurons of the brain that share information and presumably allow for dissipating energy and hallucinations. Microglial cells remove debris from damaged neurons.

Myelination provides an electrical insulation layer of glial membranes to increase conductance speed. Nodes of Ranvier are the gaps in myelin wrapping along the axon which dissipate electricity and action potentials are required to continue the signal propagation. Ligand-gated ion channels are activated by extracellular processes like glutamate as opposed to membrane potential changes and receive intercellular messaging from other cyclic nucleotides like cAMP or cGMP. Transient Receptor Potential (TRP) are ion channels that respond to temperature and mediate inflammation or membrane deformation that responds to changes in the plasma membrane. One ion channel gate opening theory revealed by three dimensional imaging is that depolarization causes the helix structures to rotate in a mechanism similar to a spiral staircase conveyor belt. The voltage sensor reveals that cytoplasm moves through the membrane to block the space between walls opened by depolarization.

The neurobiology textbook illuminates several methods to increase athletic performance and the most helpful was avoiding muscle damage through limiting nerve damage. Since NaCl also is used in speeding up signaling in the nervous systems, it might stand to reason that chemically inducing an adrenal response with large quantities of caffeine or salt might produce

improved performance. (65) found repeated activation of the autonomic system nerve C1 in the medulla oblongata reduces the adrenal protective effect in short term lung injury without affecting noradrenal or plasma levels using chemogenetic tools. (68) lists several materials such as bacteria, fungus, and cytokines that initiate the TH17 inflammation response and is enhanced in high salt concentrations. Decreasing Nitric Oxide production increases hypertension and agrees with (61). Availability of cellular water would most likely decrease and lead to muscular scarring if repeated long term but isn't explicitly stated.

33, 34, 35 - relates to muscular imbalance

66,67- is 3d, mostly covered in the previous section

Landing Injuries

Frozen shoulder is a fibroblast disorder that is caused by shoulder surgery, arm fracture, diabetes, or other disease and occurs in people with limited shoulder movement. Chronic accumulation of inflammation cells and cytokines as described in the previous sections (62, 67, 68) increases the risk along with a condition called Dupuytren's disease that limits finger movement that produces similar immobilization. (63) sampled patients during an unrelated and elected arthroscopic shoulder surgery and found elevated adhesive proteins in 10 people who had frozen shoulder compared with the 10 that did not. The specific vascular cell adhesion molecule was VCAM-1 or cluster of differentiation 106 and is found in endothelial cells. These issues warrant mention since the participant experienced five years of minimal quadricep movement while taking anti-psychotics and working in an office job. The accumulation of fibroblasts in the

vastus lateralis from inactivity might have produced pain described in Chapter 11 in a similar method.

The most visible events for the public to observe skateboarding is through television sponsored competitions such as the X-Games and Olympics which feature ramps and landing areas with synthetic vinyl or smooth wood covering specifically designed for easy assembly. Compared to cement or concrete streets and permanent outdoor skate parks, ground reaction forces (GRF) would be reduced at event or indoor park surfaces (112). GRF gauges landing impact by using a baseplate to measure Newtonic forces and is a common measurement in research on kinesiology landings. Formal studies available on skateboarding injuries were locked behind paywalls at the time of this writing and two sports with similar mechanics were analyzed. Basketball lower limb movements are comparable to skateboarding when the head is looking down while dribbling and injuries are more thoroughly covered to warrant inclusion. Gymnastic injuries are reviewed since “sticking the landing” is similar to skateboarding with minimal foot adjustments while landing on a platform post-acrobatic maneuver.

Hip, knee, and ankle flexion angle are related to injury since greater GRF are produced depending on landing. One study compared landings with low versus high knee flexion angle and found greater Newtonic forces in the ankle plantarflexors when the knee was rigid. The hip and knee muscles absorbed more in the soft or knee flexion landing (117). Another study on gymnasts found that greater hip flexion was associated with reduced GRF (120) but it would be a jump to conclusions to say that greater GRF automatically leads to more injuries since gymnasts produce more GRF (122) as a result of the sport's technique. Asymmetry between limbs on landing was also examined between injured and non-injured gymnasts and found no difference between the two groups (121).

While learning skateboarding tricks it was suspected that lapses in concentration from fatigue or external distractions would lead to injuries. Researchers from James Madison and George Mason Universities found increased landing GRF and greater hip, knee, and ankle plantar flexion occurred while the participant was tired (116). Since greater fatigue increases impact and decreases lower limb landing angles, exhaustion might also lead to more injuries. Another study on recreational basketball players examined vertical jump, landing form with an observer's scoring system, and the player's perception of physical exhaustion before and after a game. Higher fatigue, worse landing technique, and lower vertical jump were observed, however their discussion indicates that metanalysis reviews on the subject are too inconclusive to state that fatigue was the only variable. Possible explanations are adopting protective stances to limit bodily harm (127). The baseplate method with leg angle was investigated for different footwear cushions' effect on basketball landings from various heights. The researchers found no interactions between shoe cushion and height and that the participant's perception of shoe comfort and quantitative force had low categorical statistical relationships (128). The authors cite another study that found bodily mechanics are adjusted at greater heights implying more leg flexion.

Athletes in (115) that displayed unstable posture while landing predicted a second anterior cruciate ligament (ACL) injury within the study's population. Another study on athletes after ACL injuries demonstrated limb asymmetry in landing regardless of quadricep strength when compared to a control group. They also found increased trunk flexion and decreased knee flexion as compensatory movements for the increased scar tissue (126). Knee valgus loading is a risk for ACL injuries and this inwardly directed knee movement was observed while constraining the plant-side arm during run and cut motions in football and lacrosse (118) and is

relevant for skateboarding since the rear leg demonstrates knee valgus while jumping. Australian researchers investigated body kinematics during landing after catching a ball and found increased knee valgus on the support leg (124) and is analogous to landing on a skateboard with an inwardly directed rear knee.

Methods

Over the course of learning skateboarding tricks during 2024, there were four periods of intense exercise followed by recovery. The pain scale from Chapter 11 was continued and extended to include a one day prediction. Bodily observations are noted with more detail regarding medical history. The primary activity for each era is chronologically summarized for skateboarding in June and July, recovery in July and August, more skateboarding in August and September, September to October recovery, October skateboarding, and ending with October recovery. Nutritional notes are included before ending with psychological observations.

Study Period

While writing the Python package as described in Chapters 8-10 that parses and implements several data summary functions, it was discovered that more information would need to be collected in addition to the pain charts displayed in Chapter 11 for a robust sample to use parametric statistics. Additional data was collected for 100 days from July 22nd until October 29th 2024 in an identical table format and includes manually estimated one day forecasting. The climate for the upper midwest states where this experiment took place during the spring is

typically humid with moderate temperatures and rainfall. The summers are drier with temperatures ranging from 80-95 fahrenheit while the fall gradually becomes colder with long stretches of rain.

Bodily Observations

Towards the end of the second intense exercise era during the data gap, it was observed in textual notes that on June 27th the right lower spinae was sore and was thought to have originated from excessive skateboarding. This area was consistently sore during high school powerlifting and in college while performing the squat, power clean, and playing football or rugby. In 2009 doctors took X-rays and found no spinal misalignment and noted that it was multifidus pain. Physical therapy was recommended with exercises to strengthen the gluteus medius and intrinsic external hip rotators. A chiropractor increased blood flow to the area with alignments and noninvasive electroshock therapy and the pain was reduced by resting and stretching.

June and July Skateboarding

Perceived duration of the skateboarding sessions during the unrecorded summary data period ranged from one to two hours and typically occurred in the late morning and early afternoon between 0900 and 1300. Observational notes included a warm up and guideline for gradually progressing into more complicated maneuvers. The indoor section of the warm up took 10 minutes and included dynamic movements with 5-10 meters of high knees, butt kickers, high

knee karaoke, lunges, lateral lunges, and 2-4 sprints at increasing speed. Once toeside and heelside primo were mastered, more complicated freestyle tricks like rail ¾ flip out and the old school kickflip were learned with less consistency. At least one regular or switch ollie was done indoors before leaving.

Once outside, stationary ollies and tricks that needed to be worked on were practiced for five to ten minutes. While moving, 2-4 regular or switch stanced frontside and backside turns were performed before an equal amount of multidirectional nose and tail pivots. Regular manuals were occasionally held up to 10 meters depending on muscular soreness. If several ollies were anticipated, moving squats and hippie jumps were done to get a feel for the board until gradually higher and faster moving ollies were achieved. The primary goal during this period was to successfully jump up a curb and was accomplished both regular and switch stanced during a period of low muscular soreness in early July. Ollieing off a curb is significantly easier with one to two meter distances achieved. Frontside 180s were then performed until pushing home after dehydration and exhaustion rendered practice useless. Switch stance was much more difficult and not performed with consistency. Several bruises accumulated from falling on different occasions. Once back inside, abdominal work was performed with a yoga ball for pike-ups, oblique twists, leg raises, and crunches. It was thought during these months that inflammation in the vastus lateralis, intermedius, rectus femoris, and tensor fascia latae (TFL) destabilized the distal illio-tibial tract tendons attached to the lateral knee and resulted in pain characteristic of Illio-Tibial Band Syndrome (ITBS), as described in previous chapters. Recovery focused on reducing ITBS by stretching the TFL, gluteus medius, quadriceps, hamstrings, and posterior lower legs. ITBS was eventually eliminated through strengthening the gluteus from traditional weightlifting during the next winter and is beyond the information collected for this chapter.

Upper body exercises included handstands, pushups, tricep extensions, bicep curls, and barbell rows and were performed every one to two weeks with some regularity.

The usual setting was at a local college ½ mile away from the domicile and was selected because of the presence of security cameras and vehicles to ensure property destruction would not be blamed on the participant. This was the location until being kicked out when the student athletes began returning. The real reason might be because ollie trick audio frequency is too similar to gunshots which would decrease the efficiency of an automated security system. In early July, temperatures reached nearly 100 with heat index and forced practice inside to avoid further muscular damage. Technique practice included toeside to heelside rail to ¾ flip out and were performed until landing on the bottom of the new board broke it at the nose and carpet was probably the issue. The steepness of the nose and tail along with modifying the nose for more length are thought to have contributed to the destruction. One stationary kickflip was landed on the larger board with an additional one or two foot drags after several days of attempts. Ability progressed from having difficulty ollieing at the end of April to doing regular and switch frontside and backside reverts, ollies up and off curbs, toe and heelside primo, manuals and regular frontside 180 and shove its.

In late June, 2024, the left gluteus medius, maximus, biceps femoris, gastrocnemius, soleus, and calcaneal tendon were sore from overuse while switch manualling. A freestyle skateboarding injury from doing primo to build foot muscles included the accidental removal of a foot callus while contracting the lateral head on the flexor hallucis brevis muscle. The direct cause was a haphazardly tied shoelace and sliding foot along a ¾ foot length shoe insert and is probably related to the later observed popping sound of several tendons during ankle rotation. The remedy included 3 days of stretching during a varying barometric pressure induced weather

event where over an inch of rain fell in 12 hours. It might be more difficult for a person in a desert or experiencing severe drought to notice the built up muscular tension without the characteristic joint pain that emerges during shifts in barometric pressure from precipitation events.

June and July Longboarding

In addition to skateboarding, distance longboarding was haphazardly performed with the intention to improve cardiovascular endurance and reduce weight. After an hour of skateboarding, the participant pushed regular and switch for five miles over one hour on the wider skate deck as described in Chapter 11. A moderately sloped one half mile hill whose sidewalk runs parallel to a highway was used to practice balance at speed shifting from riding on tail to nose wheels over cracks in rapid succession. That technique was included to improve the skater's comfort moving the board in an ollie motion at speed and assisted in identifying an improved foot position towards the nose.

June and July Miscellaneous Exercises

Occasional juggling and running occurred during off days to improve hand, foot, and eye coordination and build more cardiovascular endurance. Juggling practice is a good way to actively stretch without overexerting inflamed muscles since bending to pick up dropped balls is a frequent occurrence. Experimenting with running form for more endurance by using smaller muscles at varying times contributed to runners' knees or lower quadriceps tendonitis. During the

late afternoon and night, more thorough stretches were performed to alleviate muscle soreness and focused on lateral muscles with straight leg cross stance, cross leg bend, sitting twists, lying leg raises, and knee twists as described in several websites (https://health.clevelandclinic.org/it-band-stretches).

The dry indoor air and continually electrified nervous system from excessive wind dried skin while skateboarding led the participant to lay in the more cold and humid basement. The lateral pelvic tilt issue was partially addressed from exercises found through websites such as (https://www.conorharris.com/blog/the-best-resource-on-the-internet-for-fixing-lateral-pelvic-til) deep primo stance squats, and focussing on leg stability while resting. The isometric exercises described on the internet are of dubious source since they are from blogs but are consistent with physical therapy recommendations from previous visits with credentialed professionals. Having a background in organized sports at a university is helpful and it is essential to not mindlessly perform exercises while exhausted to alleviate pain as recommended from programs on social media feeds. As mentioned in the previous chapters on statistics, these websites or applications use unsupervised machine learning and are making probability assumptions from the data collected through electronics including Google searches, messaging, and attention paid to watching recommended content.

July and August Recovery

Around July 17th, a harder fall over an uneven sidewalk elevated from a tree root occurred. The palm road rash was annoying and included scapholunate tendon stiffness in the morning after sleeping. The pain was alleviated by massaging the palmar hand and posterior

wrist and temporarily caused a stoppage of upper body exercises while the wound healed. Several days later, tweezers reopened the wound and removed several fragments of rock that aided in healing and prevented permanent scar tissue from forming. There was no loss of handgrip strength and no swelling which indicated there were no fractures. Moisturizing the wound resulted in a minimal scar tissue that disappeared completely within three months.

Near the middle of July, significant right leg ITBS pain returned and forced complete cessation of skateboarding and exercises ensued similar in methodology to the stretches and walking recorded in May. Another issue emerged during this time when one of the peroneal tendons began snapping over the lateral malleolus (19). It is most likely from a slightly pronated ankle during the extension and jump from the ¾ squat phase during ollie related tricks, manuals, and pushing the longboard switch. The right lateral leg muscle volume increased significantly from fluid while the upper posterior muscles were unable to provide consistent stabilization on the knee during exercise.

From July 17th to August 4th 2024, data thoroughness issues were discovered with the first dataset and it was decided to collect 100 more days of information. A typical day schedule starting on July 22nd until skateboarding resumed included working on this paper's code from 800-1000, practicing guitar from 1000 until 1100, walking, stretching, or longboarding for 15 to 30 minutes, and resting several hours before juggling from 1700 until 1730 with more guitar and stretching. Graphics for this information are included in the results. The palm lacerations made typing, guitar, juggling, and general hand use difficult for several days until skin gradually closed the wound. Soreness persisted in the palmar scapholunate tendon until full recovery on August 21st. Awareness of pain in both the ITBS and palm had several peaks and troughs. Hourly data

was not included but palm soreness peaked in the morning after sleeping and ITBS peaked several hours after recovery exercises.

20250801 - Tranquilizers immobilize a person during sleep -> sitting for extended periods increases knee pain from relaxed gluteous muscles -> sleeping on one side increases knee pain in the opposite
leg, AC or heat vent results in sleeping facing away from the direction of air.

The last debilitating period of right lateral lower quadricep pain ended on July 29th but a period of extremely high temperatures and humidity that began July 27th through August 5th prohibited outside skateboarding. Instead emphasis was placed on controlling calorie and alcohol intake with moderately intense basement skateboarding.

July 28th was spent building up to the ollie kickflip by practicing getting into primo, ¾ flips, rail to rail flip, and old school flips. At least one of the layers of plywood was broken when landing on the backside of the board but went unnoticed. On July 29th a rail to rail and ¾ flip out was landed but there were several upside down board stomps. The following day was spent on single leg squats, romanian deadlifts, and lunges which initiated severely sore gluteus for several days. On July 31st, the legs were tired and landed several times on the upside down board and practice stopped when the board was broken entirely. The lack of board movement on carpet while incorrectly landing the flip along with the high angle of the nose and tail are thought to be the major issue. August 1st was spent attempting regular stanced kickflips on the wider board and the next day was spent attempting switch kickflips to no success.

August 3rd a stationary kickflip was finally landed and another where the foot touched the ground. From longboarding everyday during the summer in 2015 until 2016 and landing basic shove its to a period of relatively little skateboarding from 2017-2022, it took seven months

of focusing specifically on landing a kickflip to have the necessary aerial board control to progress through basic ollies, front and backside 180's, and pop or frontside shove its. One issue while learning the kickflip was that the backfoot habitually moves to the posterior from incorrect practice and can be rectified by practicing stomping on the rear leg using a fingerflip instead of unnecessarily inflaming the rear quadriceps with a full ollie and flip. August 7th and 10th were spent nailing two truck holes into the broken board and sanding the jagged edge without power tools to repurpose the material as a freestyle board.

August and September Skateboarding

August 5th a replacement board arrived and practice resumed concentrating on BS 180s and was a reminder that stationary tricks on carpet are easy compared with performing while moving. The next day a hypothesis was formed that injuries occur more frequently and faster after skating for longer than one hour and are explored further in the results. Additional notes describe BS 180 attempts and it was initially thought that transferring weight from the left to right foot as the feet switch front and back was causing difficulty fully rotating and landing the trick. This problem was remedied by moving the front left big toe onto the medial screw furthest from the body and the right kick foot forward on the tail to prevent it from moving backwards and off while landing. The other issue was landing rigid and falling forward, caused by the transfer of momentum into the board which continued moving while the torso stopped and was fixed over the next few days by concentrating on landing with bent knees. The difficulty of this trick is not being able to see the right foot landing on the board because the torso and head are facing backwards to maintain a centered balance which is where hand eye or hand foot muscle

coordination is helpful. Downhill longboarding standing tailslides assisted in learning this trick the following summer.

August 13th the right bicep femoris was sore from under rotating BS 180s by 10-20 degrees and landing with inward knee flexion or valgus. From August 15th to the 21st, focus shifted to longboarding and recovering full use of the lateral hamstrings. An interesting left gluteus medius bruise was accumulated on August 19th while practicing switch FS 180s because poor rear foot guidance allowed the board to roll counter clockwise 90 degrees and land almost primo, throwing the skater off balance and landing on the side of the wheel. The observation of low switch board control lends evidence to greater left anterior to right posterior leg strength. Attempts to increase blood flow to the site of internal contusion included mule kick poses and moved the fibroblastic material into the quadratus and erector spinae lower back muscles. A data gap exists between August 22nd and 25th on the pain scale but text notes indicate short 45-60 minute BS 180 practices with two days of rest between sessions. The 27th was a major success landing 10 out of the attempted 35 BS 180s. The following two days were spent practicing switch frontside 180s before falling on the gluteus medius.

Skateboarding practice resumed for BS 180s on September 9th with the addition of upper body work. A new strategy was developed to avoid 7-20 day long recovery times after skating every day. Since skateboarding is more similar to box jumping in plyometrics than to running, overuse injuries happen at a more frequent rate when done in excess. The length of practice was shortened with five minutes spent warming up without a skateboard and 10 minutes on turns, hippie jumps, and stationary ollies before concentrating on a single trick for 30 minutes. Shin guards, knee pads, and longboard gloves were used more regularly to avoid injury and for warmth. The shin guards were too constricting and cut off blood circulation to the left peroneus

longus, indicating that the calf muscle increased in volume since purchase in March. High percentage landing of BS 180s was achieved by September 18th and indicated adequate proficiency. It was decided that moving pop shoves were the next trick to practice. On September 24th, stationary switch BS 180s and moving switch FS 180s along with fast turns were practiced to develop the opposite muscles.

August and September Miscellaneous Exercises

Longboarding also occurred as an alternative to skateboarding on less intense exercise days with practice focusing on switch manuals along with regular BS body varial 180s and BS tail reverts to acquire skills related to ollie BS 180. Duration lasted from 30-60 minutes but less distance was covered than in June and July. Juggling was again practiced throughout to stay active and avoid sitting all day and progressed from 100 four ball catches to eight five ball catches by progressing 3 ball claps, four ball flashes, and five ball flashes. This proved difficult to maintain while researching this paper and learning skateboarding, thus juggling three and alternating kicking the tennis ball every rotation was conducted. Handstands improved to single handstand pushups for balance and significant time was spent on core exercises one to two times per week throughout both months. Very little time was spent on upper body exercises besides push ups and handstands. Since flexibility had increased to perform the front splits after several weeks, the side split variations were attempted four times by flexing the adductors and resulted in significant gracilis, magnus, longus, and vastus medialis soreness forcing the project to be abandoned. Technique was also incorrect since attempting the side splits without pelvis rotation anteriorly or posteriorly results with the femur's greater trochanter stopping at the pelvis bone.

Between good weather and excitement from landing moving pop shove its, on September 18th 7.2 miles were run at a moderate pace and resulted in several days of low stamina and an annoying blood blister that developed on the second distal phalange. The right foot unconsciously rotates laterally while tired from running, however during this long run attention was paid to keeping the foot parallel to direction which forced the first phalange to jut lateral into the second distal causing the blister. This lends further evidence to muscle imbalance being the cause of ITBS. Low nutrients and exhaustion induced lower body muscle twitching. The next day the anterior tibialis, peroneal longus, gluteus medius, TFL, abdominal obliques, spinae erector, bicep femoris and adductors were significantly sore and a severe headache developed.

September and October Recovery

A resting period started August 30th and continued until September 8th with short runs, walks, and long stretches. Running was performed periodically from September 2nd through the 12th as an alternative to longboarding to avoid aggravating muscles in the peroneal tract and the swollen lateral quadriceps and revealed muscular weaknesses by exposing lower core and muscle imbalances. Walking with infrequent jumping also occurred and distances for both activities ranged from one to three miles. On September 6th a debilitating headache with nausea episodes occurred after driving four hours for a family wedding with the probable culprit being inclement weather, electrified and tired body from overuse, and high salt diet induced trapezius inflammation which was remedied by eating fast food, ice cream, and water. It is concerning that two incidents of severe head pain occurred within two weeks and it is probable that motivation to excessively exercise during pleasant weather before the severe cold of winter was an influencing

factor. Ragweed pollen is also high during this time and might induce symptoms similar to a cold. Another short resting episode occurred from September 25th until October 6th with minor exhaustion induced delusions. The primary complaint was general lower body and core inflammation and it was thought that improvement in switch board control by practicing downhill longboarding heelslides would help muscle coordination for switch skateboarding.

October Skateboarding

Regular stanced skateboarding practice resumed on October 7th with successful completion of all the tricks except the pop shove it. The next two sessions were spent practicing pop shoves to marginal success before realizing the significance of the muscle mismatch between the right and left lateral quadriceps, TFL, and gluteus medius. It was also noticed that landing pop shove its increased vastus medialis and intermedius soreness. Landing primo was the primary issue and was caused either by not lifting the front foot off the nose fast enough hitting the now forward facing tail and rotating it along its axis similar to a kickflip or a tired back leg over kicking, sending the nose rapidly upwards into the front foot. It was thought that the issue stemmed from a lack of right leg adductor control from not doing left heel slides similar to poor tail foot switch stanced ollie board control, besides overall lower leg inflammation. The actual problem was the rear leg too far off the tail during rotation, resulting in reduced board control.

For three skateboarding practices starting October 18th, switch ollies and FS 180s were practiced with conscious attention paid to guiding the board with the rear foot. Muscular soreness followed by inclement weather characteristic of the upper midwest prohibited further outside skateboarding. It was again noticed while performing switch FS 180s without a board

that the torso was positioned too far forward or backwards indicating that the left leg is unaccustomed to the movement. An interesting effect of the skateboard analogous to kinesiology is the thermal expansion of the bearings and trucks with the rapidly changing temperature and humidity where they are stored in the basement during the fall. The cold basement would contract the metal from the bearings or truck bushings onto any residual moisture from the humidity making them stick and sound funny.

September and October Longboarding

Between September 26th and October 19th, there were eight switch downhill longboarding sessions to improve balance and board control for performing switch FS 180s while moving. Luckily the geography of this study is within a river valley with easy access to several low traffic and well paved hills for practice but similar efforts could be performed in a parking garage. Downhill longboarding was entirely unneeded yet it provided a mental changeup from practicing the same skateboarding motions ad nauseum. Walking uphill also uses the gluteous and hamstring muscles to support motion in a forward direction, rather than angularly while skateboarding. Longboard sliding also stretches the lower leg muscles and exercises the upper leg muscles. During this time significant effort was also placed on pushing the longboard switch and performing body varials and tail reverts. Pushing in reverse was also experimented with to improve foot and brain awareness when landing backside tricks.

September and October Miscellaneous Exercises

Upper body exercises were performed once during this month and induced the aforementioned dorsal scapular nerve entrapment from scar buildup in the shoulder. Stretches targeted the levator scapulae, scalene, and rhomboid muscles. Since more complicated skateboarding tricks increase exhaustion of small supporting muscles and decrease time spent practicing before falling, it was thought that performing a cardiovascular exercise such as running would increase stamina. The weather was good from September 18th until the 27th and five moderately distanced runs were performed but also created soreness in the supporting ankle and knee tendons. A boardless five stair jump landed with a slight rear leg valgus and was still inflamed two weeks after the attempt, confirming the idea that attempts should be kept below the waist until more aptitude was achieved.

The weather rapidly became more variable by the end of October and more attention was paid to why spinning to the left was more natural compared with right spinning. Martial arts was practiced from ages 5-12 and placed emphasis on building muscular coordination in all four limbs. Baseball and golf during this time only used the participant's right limbs. Moderate time was spent punting and place kicking during recess and in football and probably contributed to muscle imbalance. From middle school through high school, each spring was spent spinning to the left in the track and field events shot put and discus and is more likely the cause of increased left spin ability. Not being able to guide the board as effectively with the rear left foot in switch ollie spins is probably the main cause and right direction spinning mimicking track and field throws occurred during October. There were around ten of these exercises with duration from 10-30 minutes.

October Recovery

The longboard, wide skateboard, and traditional skateboard gear were cleaned and the highly detailed pain chart, nutrition information, and exercise schedule tables ceased tracking by the end of the month. The left leg muscular coordination was improved during the last few weeks of inclement weather by kicking a rugby or tennis ball with the left foot. Cardiovascular endurance was improved by longboard pushing in the switch stance. The next few months were spent healing the quadriceps through building strength and volume in the gluteus and hamstring muscles.

Nutritional Observations

Diet information was included in a table with columns that were identical to Chapter 11. They included information tracking the date, calories, weight, and alcohol servings. There were also summarized categorical fields for observed weather at the time of skateboarding with humidity and temperature based entirely on the entity's perception. Exercise intensity was binned into three numbers with 0 indicating no calories burned, 1 being 1-250, and 2 being greater than 250 and was estimated by using online calculators (https://www.calculator.net/calories-burned-calculator.html).

Longboarding calorie estimation is variable since it's related to lubricant, bearing damage, bearing shield removal allowing the accumulation of dust, and amount of jumping or sliding
to misshape the wheels and bend the bearings. Longboarding 11.5 miles in 1.5 hours through similar terrain and time as it took to longboard 5 miles with
non-greased bearings although this might be from increased experience pushing more efficient lines with smoother pavement, hills, and dodging traffic through predicting and

not having to stare at the ground. Pushing at night helps since you'd have to remember good routes or maybe from several years of increased time in the same place.

Salt, fat, carbohydrate and protein was estimated on a low to high scale of one to five with the highest number being an arbitrary opinion on the amount of micro or macronutrient consumed. Body weight was measured every one to two weeks and varied from 190-195 pounds. The inconsistency is because weight gain or loss was not the goal of this data collection period and more to provide a reminder to eat more or less calories. Losing weight might reduce muscular volume and increase the risk for catastrophic injury while losing excessive fat would decrease padding to absorb physical force during hard falls.

From the Neurobiology and Anatomy textbook, considerable time was spent describing cellular absorption and release of elements such as the role of K forcing NA from cells to speed up the transfer of information to the brain through nerves. A possible strategy would be to eat salt and wait several hours to pass through the stomach and transfer to inflamed areas before consuming potassium foods to increase the evacuation of minerals to expedite muscular recovery. One example during this experiment included mild hypernatremia or high blood salt level and alkaline mouth from consuming excessive salt and not enough water after exercise leading to more consumption of potassium and drinking more water. This had three effects and included highly acidic or foul smelling leftover food, urinating every 30 minutes for several hours, and hyponatremia or low salt induced mild dehydration after exercising the next day. The physical evidence of these conditions included observing the foods consumed, bodily bloating, and dry mouth with sensitive teeth. Stomach is usually acidified by drinking beer, which would not happen if calorie reduction through alcohol cessation occurred and could potentially impact tooth decay.

The textbook was specifically describing nerve signals but the superficial level understanding of dietary sciences and cellular biology could be applied to consuming large amounts of protein and carbohydrates to immediately assist in muscle repair after exercise followed by fiber to aid in digestion. Lack of knowledge in sports nutrition or tabular record keeping meant that tracking micronutrients might take more mental energy and be detrimental for athletic performance. The options include hard coding each food, writing a web scraping program, or using a 3rd party application and would all require excessive time transferring information to usable formats for analysis and are beyond the scope of this chapter. Ignoring economic constraint, it is hard to not eat enough on a traditional western diet since there are a lot of carbohydrates, protein, or fat and most of the micronutrients take care of themselves without obsessing. There were two outlier situations that required extra nutritional attention several years ago. The first was having to commute to a job 5 miles or more by walking, longboarding, or using public transportation, requiring additional calorie intake. During a separate period I was also a vegetarian which requires more planning to eat enough protein and B12 vitamins. The main issue in the subject's diet is a lack of fiber and not eating voluminous low calorie foods like vegetables and fruits.

Psychological Observations

Attempting to combine skateboarding as a supplemental training exercise without dedicated guidance for a youth sport such as football or rugby would prove difficult because of the regularity of the organized schedule. Muscles in the lateral leg compartment become overdeveloped while skateboarding and more established plyometric exercises such as box

jumps, ladders, and sled pulls more evenly build coordination. Fatigue probably increases the risk of concussions since lack of energy decreases awareness while playing sports and is incidentally supported by my own experience trying to both play a sport and perform academic research. The easy accumulation of severe bruises and sprains performing even basic tricks could be debilitating for youth sports where time missed is perceptively longer. Almost everyone's organized competitive athletic career ends after high school and future nostalgia for the last few years is more important for an individual's psyche than tangible wins or faster marks.

Pain Statistics

Pain was estimated by the participant on a low to high scale between 1 and 5 at the end of the day for 17 body parts along with stamina to estimate energy levels. Predictions were also made for the following day. Subjective pain data groups specific muscles into common terms such as 'Head' or 'Quadriceps' and was recorded for the same time period in an identical format as Chapter 11. The body parts include feet, ankles, calves, knees, quadriceps, gluteus, groin, abdominals, lower back, latissimus dorsi, trapezius, shoulders, chest, triceps, biceps, neck, and head. Hamstrings were rarely sore and pain was not tracked for easier recording. Text notes specifically address when hamstrings were sore and the exercise that caused the pain. Gluteus and lower back pain are analogous since the hamstrings are easily stretched and fibroblasts accumulate in the weaker gluteus minimus, hip muscle like the iliopsoas, and spinae erector of the lower back.

Classification metrics in evaluating predictions for statistics attempt to estimate performance and one common method is using true and false positives and negatives along with

several equations. In this study, true positives indicate predictions where the body part was going to be sore and the next day that muscle was in pain. True negatives predicted no soreness and there was no next day pain. False positives predicted soreness when there was none and false negatives predicted no soreness and the muscle was sore. The first equation is *Accuracy* and combines the number of correct sore or not sore predictions divided by the entire number of predictions. *Accuracy* fails to provide an adequate summary if the predictor always assumes that the body part is sore (true positives) and the muscle is sometimes not sore (true negatives) since the score would still be high. Since hamstrings were left out because they were assumed to be not sore, *Accuracy* is a poor metric for evaluating this body part and this study relies on the text notes as record for both the exercise cause and abnormal soreness (https://www.geeksforgeeks.org/machine-learning/metrics-for-machine-learning-model/) (https://developers.google.com/machine-learning/crash-course/classification/accuracy-precision-recall).

Another summary equation is *Precision* that minimizes the number of times the predictor incorrectly guessed next day soreness where there was none (false positives) by dividing the number of correct sore predictions (true positives) divided by the sum of true positives and incorrect sore predictions (false positives). *Recall* measures the number of times no soreness was predicted and the muscle was sore (false negatives) through dividing the true positives by the sum of true positives and the number of times the prediction identified no soreness and the muscle was sore (false negatives). A high recall score of 1.0 would indicate zero false negatives. *F1 Score* averages *Precision* and *Recall* by multiplying those metrics in the numerator, the addition in the denominator, and multiplying that number by two (https://www.geeksforgeeks.org/machine-learning/metrics-for-machine-learning-model/)

(https://developers.google.com/machine-learning/crash-course/classification/accuracy-precision-recall).

Explain the reverse graph equations

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asdgjl;asgjlkga

Post data collection notes

After the data collection period, effort was extended in 2025 to left leg or switch skateboarding, longboarding, and ball kicking and resulted in identical left ankle sound while the right ankle ceased. One specific exercise that stretches the right anterior lateral lower leg to counteract the pronated ankle and subsequent knee valgus jump during regular stanced ollies included regular stanced caspar stalls. Another similar exercise leveraged during this period was rolling the ankle supine and forward into the board during moving skateboard manuals as suggested by internet video blogs to learn the kickflip. These movements are similar to modern physical therapy techniques such as squatting or jumping from a bosu ball. In the middle of 2025 near the end of the study and after the majority of the data collection period, an article suggested the cause of knee valgus can be attributed to muscular imbalance between the gluteus maximus, adductors or abductors, hip rotators, and foot pronators and supinators (132). Greater right anterior leg muscles were accumulated from pushing the longboard switch in 2024 and gluteus imbalance was addressed from November 2024 to March 2025 with back squats and freeweight

leg exercises. Minimal basement skateboarding occurred from February to March 2025 and focused on keeping the left back leg on the board while switch ollieing. Outdoor skateboarding started at the end of March until November 2025 in a two to one switch to regular stanced schedule. The end of May included a skateboarding break where 20 miles of running were logged in five days and a loud synovial fluid or inflamed tendon over bone noise occurred in the left lateral dorsal peroneal ankle muscle suggesting more attention should be paid to ankle flexibility. Switch downhill longboarding practice began in ernest progressing from small carves at the end of May, 2025 to long standing heel and toeslides with the intention of improving both ankle dorsiflexion and proximal left adductor to right abductor symmetry.

Medial leg soreness on both legs was observed after an extended period in 2025 and switch heelslides are not consistently smooth returning parallel downhill throughout the last half of the heelslide in a similar manner from lack of experience. The end of November in 2025 also noted a sore left soleus from standing and that regular stanced tailslides increased right hallucis extensor soreness.

Results

Scheduling information was recorded for 100 days from July 22nd until October 29th and data analysis includes graphical displays from Python's matplotlib library. The first graph in a series of heatmap charts bins the total number of activities for the day of week and the time of completion. Another displays the daily average time spent on each activity in minutes and the

next two categorizes the frequency of activities for each day of the week and the time. The last heatmap displays the total number of hours for all the activities for the days of the week. Four bar charts were developed and displayed the total number of hours for each activity, total frequency, average number of hours spent on a task at one time, and average number of minutes spent on a task for every day. The graphical charts average every five days of observations and selected body parts with abnormal measurements are included with the intent of finding patterns of overuse. The information is further filtered into general areas such as 'Upper Back' and 'Core' to view the information on the same graph. Another series compared those groups on the same graph in 'Upper Body' and 'Lower Body' before the averages of those values were amalgamated into one visual. More graphs compare pain observations with one day forecasted human predictions. A line chart to visualize the average number of daily activities before an abnormal pain or normal record were included for 3, 5, 7, 10, and 30 days before the event and the final graph displays this information for individual events and chronologically.

Exercise Schedule

As described in the methods from the text notes, most of the exercise activities took place between 0900 and 1300. The days that had consistently larger values included Sunday through Wednesday with peak times on Monday at 0900 with 22 total activities in the study period and Tuesday at 0900 and 1100 with 19 and 25 respectively. Friday also had a value that was similarly active with 20 events. Monday and Tuesday evenings between 1900 and 1159 had 15 and 16 total activities. Between midnight and 0700 there were almost no activities and the time between 1300-1700 had values mostly around 6-9 with a handful of outliers (*Figure 1*). Two activities that

were performed consistently regardless of the day of the week included Guitar and working on this Skateboard paper. Skateboarding, walking, and stretching were also performed continually.

Figure 1: The total number of activities for the study period categorized by day of the week.

Figure 2: Average minutes spent on each activity by the day of the week for the top eight values.

The nominal activity chart (*Figure 3*) indicates that resting activities were performed several times greater in frequency than actually skateboarding. Writing this paper provided a conscious no movement activity. Skateboarding almost always occurred between 0900 and 1300 and the paper was worked on from 0700 to 1100. Guitar activity frequency peaked at 0900 and Juggling nearly always occurred at 1500 (*Figure 4*). Analytics or literature reviewing material for this paper and playing the guitar consistently had the most cumulative hours while juggling was performed evenly regardless of the weekday. Skateboarding and stretching usually occurred Monday through Wednesday while longboarding provided a less intense board related exercise the second half of the week (*Figure 5*).

Figure 3: The frequency of activities for the day of the week.

Figure 4: The frequency of activities for the time of day.

Figure 5: The total duration of activities for the day of the week.

Activity duration is summarized below with low movement exercises such as performing analytics for this paper and practicing guitar receiving most of the cumulative hours with 102 and 70 hours respectively. The most time costly light exercises used for inflammation reduction was walking at 33 hours followed by stretching with 31 and with juggling at 15. Over the four months, 40 hours were spent skateboarding and 34 longboarding. Other cumulative hours for resting events included reading, driving, and writing with 19, eight, and six hours (*Figure 6*).

Figure 6: The total amount of time spent on the top 11 activities in hours.

Guitar was also the most frequently occurring topic at 131 plays and is over double the amount of times as academic research for this paper at 65 (*Figure 7*). The information is more evident in *Figure 8* where research was typically performed 1.56 hours per event while guitar

session length was not in the top ten despite accumulating the most daily average minutes at 79 a day, almost twice the amount of attention as paid to research (*Figure 9*). Stretching was the second most frequently occurring activity at 93, walking with 53, and juggling at 31 (*Figure 7*) though none of these appeared on the longest average duration per event (*Figure 8*). Reading and writing occurred 14 and four times in the study period and long driving events occurred twice (*Figure 7*) even though these topics landed in the top five longest average events with 1.34, 1.5, and 3.88 hours per event respectively (*Figure 8*). Only reading had an average daily amount with eight minutes. An hour was spent stretching each day, almost half an hour was spent walking, and 19 minutes on juggling (*Figure 9*).

Figure 7: The total amount of times the top 11 activities were performed.

Figure 8: The average amount of time in hours spent on an activity when it was performed.

Figure 9: The average amount of time spent daily on each activity in minutes.

Pain Charts

The perception of pain was recorded almost exactly as the previous chapter by grouping specific muscles into general areas, with the exception of knee pain categorized as quadricep pain. The medical history includes previous multifidus pain in the lower back from technique breakdown near the end of intense exercising. Specific values are included graphically for the groin and quadriceps in *Figure 10* and *11*. Groin pain peaked in late July and early August and coincided with a break from skateboarding and the substitution of using muscles differently with moderate running and lifting. Quadricep pain emerged before the data record period and was apparent in the lower lateral vastus lateralis. Soreness was reduced by the middle of August. Specific information was not included for the head, neck, shoulders, biceps, triceps, trapezius, latissimus dorsi, lower back, chest, abdominals, gluteus, hamstrings, knees, calves, ankles, feet, and stamina.

Figure 10: The five day average for groin pain.

Figure 11: Quadriceps pain for the study period. Distal anterior lateral quadricep muscular pain was categorized as 'Knee' in the previous chapter but 'Quadriceps' in this chapter.

The generalized muscle groups were further conglomerated into five classes and compared on the same graph. The neck and head were compared in the 'Head' graph with high neck pain in the middle of July that was reduced from resting. Neck pain emerged at the end of August after several weeks of consistent skateboarding and was immediately followed by head pain after driving for several hours to a family wedding. A similar event (*Figure 12*) occurred at the end of September following continuous skateboarding and is preceded by 'Upper Back' pain in the shoulders, trapezius, and latissimus dorsi (*Figure 13*). Head pain is from lack of active rest, followed by excessive concentration and dehydration. *Figure 14* compares five day continuous averages for abdominal and lower back classified as 'Core' and coincides with running and core exercises from the text notes.

Figure 12: Pain for the head and neck were compared in the 'Head' category.

Figure 13: Muscles for the 'Upper Back' included the shoulders, latissimus dorsi, and trapezius.

Figure 14: Pain for 'Core' included abdominals and lower back muscles.

The charts for 'Upper Legs' included averages for knees, quadriceps, gluteus, and groin with the quadricep muscles around the knee instigating additional record keeping. Lower quadricep pain continued from the end of July into the middle of August and reemerged after three weeks of skateboarding in the middle of September. The knee category did not have high pain scores similar to the previous chapter after more information was illuminated that fibroblasts were accumulating in the quadriceps from overuse and misaligning the tendons around the patellar. Gluteus and groin pain began in early August with the inclusion of weight lifting and running (*Figure 15*) and might be the origin of lowering knee adjacent pain through correcting posture. The 'Lower Legs' category included muscles in the calves, ankles, and feet. The pain scores for feet had one abnormal value around August first and are related to learning the kickflip. Ankle and calf pain emerged at the end of September and could be attributed to mild temperatures increasing the walkability of the environment or the rapid changes in air pressure from humidity (*Figure 16*).

Figure 15: The muscles for the groin, gluteus, quadriceps, and knees compared in 'Upper Legs'.

Figure 16: The muscles for Calves, ankles, and feet compared in 'Lower Legs'.

The five day running averages for the headers in *Figure 12* through *Figure 16* were used to define categories that were averaged allowing comparison of 'Head', 'Arms', and 'Upper Back' muscle pain groups. As noted in the text summaries earlier, the duration of skateboarding

ranged from 45 to 120 minutes and impacted muscular soreness with a long period of 'Head' pain from the middle of August to the middle of September. Exercise intensity from the middle of September until October indicated improved pacing since there were only two days where pain became debilitating (*Figure 17*). Since arms were rarely focused on during the recording period and never sore, the muscle repair scaffolding energy waste might circulate and heap together in the muscles stressed from lowered head and forward slumped shoulders. Besides sustained irregular posture while squatting in a sport, elevated salt and dehydration from intense exercise is also a contributing factor. The 'Upper Legs' were sore throughout because they are used in nearly every direction besides straight forward and backwards (*Figure 18*). Upper body and lower body are compared with stamina with the intention of finding statistical relationship (*Figure 19*), however the subjectiveness of the scale reduced confidence in non-parametric statistics.

Figure 17: The averages for the muscles in upper back, arms, and head for the 'Upper Body'.

Figure 18: The 'Lower Body' compares the averages for the core, upper legs, and lower legs.

Figure 19: The pain chart compares the averages for upper and lower body with stamina.

Manual Pain Prediction

One day forecasting predictions were performed each night for all of the categories to measure the effectiveness of the exercise regiment through rating the next day's pain. This was recorded to save time through effective stretches. The value for 'Head' pain *Accuracy* had a value of .78 indicating above average effectiveness at predicting whether there would be head pain or not. The metrics for *Precision*, *Recall*, and *F1 Score* were 1.0, .99, and .99 indicating low false positives and false negatives (*Figure 20*). 'Neck' pain had below average prediction accuracy with a score of .68 but had no false positives or negatives (*Figure 21*). 'Abdominals' pain prediction accuracy had an average score of .71 and low false positives or negatives (*Figure 22*). 'Groin', 'Quadriceps', and 'Gluteus' pain had below average values of .65, .59, and .68 indicating poor predictive accuracy but had low false positives and negatives (*Figure 23*, *Figure 24*, and *Figure 25*).

Figure 20: Prediction and observation accuracy report for head pain.

Figure 21: Prediction and observation accuracy report for neck pain.

Figure 22: Prediction and observation accuracy report for abdominal pain.

Figure 23: Prediction and observation accuracy report for groin pain.

Figure 24: Prediction and observation accuracy report for quadricep pain.

Figure 25: Prediction and observation accuracy report for gluteus pain.

Activity Frequency Before Pain

type or rigor - B1 has 0,1,2 calories out for each day, A1 has length of activity duration.

One hypothesis for the cause of more painful bodily parts was the number of activities before an event. The average number of daily activities prior to a notable painful event regardless of type or rigor was averaged and compared visually with both no pain and the entire dataset. Notable pain or stamina events were classified as values over or under three. There was also a four day collection gap from August 22nd to the 25th and one on September 6th. The first ten days were not included because muscular soreness was primarily in the legs from overuse while skateboarding during a period of no data collection. Since there were 18 categories for pain

including stamina and 85 days of usable information, there were 1530 total pain records with erroneous counts of 14, 12, 10, 9, and 7 for the days prior categorized as 3, 5, 7, 10, and 30 'Days in Reverse'. The 3 days in reverse bin had an average of 6.5 average daily activities, 5 days had a value of 6.3, and 7 days had 5.95. The categories for 10 and 30 days in reverse had values of 5.95 and 6.65 respectively (+). The average daily activities for days that did not have pain (-) and the entire data set including duplicates for the extra days in reverse (.) for the five 'Days in Reverse' ranged between 5.15 and 5.25 (*Figure 26*). The dimensionality of the daily prior activities is expanded in *Figure 27*.

Figure 26: The average number of activities before an erroneous pain record depending on the number of days in reverse compared with no pain. The amount of high pain records is included.

The specific dates and sore body parts are listed chronologically. The first seven records do not have information for several categories of days in reverse. The first two records started on August 4th and only have three days in reverse, the next two records do not have categories over five days in reverse, and the fifth record only has 3, 5, and 7 previous data. The sixth and seventh records do not have information for 30 days in reverse. Since this is half of the pain events, more focus should be paid toward 3 and 5 days in reverse that had similarly high daily averages compared with 7 and 10. The 30 reverse days category had low pain events because it is over a

third of the dataset and was subjective to outlier weeks with high or low activity. 'Head' pain on September 7th had almost half of the previous daily average activities prior to the events in every category except for the 30 days in reverse. One reason is because there was little attempt to remove accumulated repair material and the abnormally long driving activity (*Figure 27*).

Figure 27: The average number of activities per day before every abnormal pain record.

Discussion

<INTRO PARAGRAPH LIST THE MAIN POINTS>

Knee pain emerged from imbalances between ankle supination and pronation, abduction and adduction, and gluteal muscles during athletics and skateboarding was used to identify and correct the issues.

0) Irrespective of ankle sprains, audible distal lateral ankle noise continued after ball kicking cessation and was ruled out as the cause indicating stronger left anterior muscles compared with the right leg.

1) The right posterior lower leg is consistently sore after extended periods of walking, running, and lifting while dehydrated.

2) Back squat shifts from center to right in the leg flexion phase and from right to left in the extension phase indicating weaker left posterior abductors and right anterior adductors.

3) Longboard pushing and heelslides as the primary exercise from 2014-2016 contributed to abductor to adductor imbalance while primarily walking from 2017-2019.

4) Lower back pain was significantly reduced by strengthening the left gluteus medius with regular stanced distance longboard pushing from 2014-2016.

More evidence for greater left anterior and right posterior leg strength imbalance includes posterior lower leg pain after skateboarding, lifting the left leg off the board during switch ollie tricks, rotating the right leg laterally while running, and medically documented lower right back or multifidus pain while exercising from right limbed throwing, kicking, and swinging. The left hip has greater superficial vascular definition.

- L no foot truck stall to reduce lifting the rear left leg off the board on switch ollies.

Conclusion: Since lower back pain emerged near the end of 2025 after pushing switch, it would make sense to resume regular longboard pushing. Knee pain disappeared after switch stance

downhill longboarding in 2025 and alternating between regular and switch tail and heelslides would retain balanced muscular development to continue learning skateboard tricks.

Medical history includes a partially torn talofibular ligament anterior of the peroneal compartment on the right leg from the participant's view, but tendon popping during ankle rotation began with skateboarding tricks near the distal section of the calcaneal tendon. Tom, Dick, and Harry and in particular the flexor hallucis longus are implicated tendons from overuse inflammation causing audible posterior ankle noises. Kicking the rugby ball with the right ankle extensors caused inflammation but the same anterior popping was not observed on the left ankle extensors while kicking with the left leg. Audible noise continued after ball kicking cessation and was ruled out as the cause indicating stronger left anterior muscles compared with the right leg. Cross leg sitting with the right ankle underneath the left knee causes ankle inversion and results in similar ankle popping when feet are reversed. While sitting in a chair, the left ankle unconsciously moves on top of the right knee, placing weight on the left buttocks (51). Strengthening the lateral supine ankle muscles was performed with caspar stalls and rolling the ankle into the skateboard during manuals.

Right soleus muscle soreness also occurred after weight lifting squats although this effect might be gait related since walking and running was consistently performed as inflammation reduction (*Figure 9*) for the hamstrings and the same posterior lower limb soreness was noted after school American football and rugby matches. Walking and running in partially melted snow or ice illuminated exaggerated lateral hip movement imbalance. Right medial posterior lower leg is the failing point while longboarding during the last half of lengthy regular stanced heelslides and the left leg is forced to step backwards off the board. Lower body pain reduction was the primary focus of longboarding since skateboarding anteriorly rotates the

pelvis, lengthening the quadriceps and reducing hamstring flexibility. Shortened anterior or posterior lower leg muscles would pull the patellar bone forward or backwards and lengthen thigh muscles and the November-February 2024 back squat period noted increased popliteal snap over the posterior lateral condyle of the femur similar to quadricep noise. One reason listed on the 13th of August in 2024 was over developed lower bicep femoral muscle from BS 180 practice. Stretching the IT band with cross leg bends to reduce lateral quadriceps and TFL inflammation would also pull the popliteus. The alternative lower leg muscle is either a strained plantaris which is more painful and debilitating than observed or the gastrocnemius was entrapping a nerve near the fibular head. Posterior lower leg soreness also developed after extensive downhill longboarding in November 2025.

While learning to push the longboard for transportation in 2014 the right vastus lateralis strength increased and regular stance heelslides from 2015 to 2016 overdeveloped the right posterior adductor. The primary form of exercise and transportation from 2017-2019 was walking and muscle imbalance contributed to right knee pain since the femur rotates medially and hyperextends the leg. Regular heelslides overdeveloped the right posterior adductor, it would follow that toeslides would increase posterior abductor strength for BS or FS 180 skateboarding ollies by reasoning of pushing the board perpendicular to the road on heelslides and pulling the board against the road on toeslides. A similar weight lifting exercise is weighted side lunges depending on the foot position and ankle flexion or extension but these were abandoned because the cold climate only allows longboarding for 6 months and more attention was needed to rebuild the posterior muscles during the winter. Longboarding could be a warm weather or economic replacement for snowboarding since most small to midsize cities are located within river valleys and drivable distance to hills and large megatropolis have indoor parks.

20250515 - When failing on the L heel slide, weight falls too far forward resulting in flexed ankles (standing on toes) and overcorrecting by stepping back. It is similar to last year when landing
primo during L FS 180 and is probably from weaker R TFL, quadriceps, and obliques compared with R hamstring, glute, and lower back opposite muscles. Similar failure during L pop shuv its
where the board lands primo with grip tape facing outward when physically exhausted since the R anterior lower limb muscles are too slow raising the foot out of the way of the rotating board.

High weight and low repetition backsquats in late 2024 displayed a slight weight shift from center to right during leg flexion and right to left in extension and is partially from weaker left abductor and right adductors. Techniques to improve the ollie revealed an increase in rear leg posterior adductor strength during knee flexion in the descent and anterior abductor strength during knee extension or jumping. When the gluteus is either underutilized or sore from exercise, the left quadricep snaps near the knee while lengthening during the eccentric descent portion of the squat and the right quadricep snaps during the concentric ascent portion when the muscle shortens. This information could be used to support the stronger left quad to right quad or less left leg flexibility than right leg flexibility because the right posterior muscles are used more during exercise. A shortened posterior gluteus and hamstring group rotates the pelvis backwards, increasing quadricep flexibility while recovering but producing noticeable snaps.

20260116 - stretching the hamstrings with the shoulders rolled back makes the hips sore but with the shoulders the lats, trap, and neck or head also get sore.
R leg was very chaffed after running uphill trails. Raised R leg higher instead several days later and L leg is chaffed now, more evidence for L leg quadricep overdevelopment.

20250905, 208	**74 includes sartorius to rotate the thigh laterally and pectineus to adduct as in both 180s and shuvit.**

The IT band is an inflexible framework for the previously listed lateral upper muscles and assists in pulling the knee laterally when the TFL and lateral quadriceps increase in volume to use fibroblasts to repair torn myocytes. This results in the characteristic IT band snap which is the IT snapping over the lateral epicondyle on the distal section of the femur. Similar snapping was eventually observed with the vastus intermedius and rectus femoris around the patellar.

Right lower back pain occurred during heavy weighted and forward leaning powerlifting back squats during school that relied on the stronger right gluteal muscles to complete the lift. Muscle imbalance theory partially caused by squatting is supported by performing back squats with slight weight shift onto the left leg and forward to use the gluteal and hamstring muscles, resulting in identical left lower back muscular soreness.

20251201 - The L posterior is tired from landing R tricks and explains L back leg lifting off the tail when tired. Left lower back more sore than right after standing for two days, R then L skateboarding, and running. Probably also gait related since significant attention was spent alternating weight shifted onto the R or L leg while standing.

20250905, 208	External hip rotators are more involved during 180 movements and are more relevant to R knee and L hip snap than either leg adductor or abductor muscle imbalance. Once the 180 movement

20250801 - Since standing for a significant part of the day, muscular soreness has accumulated in the lower back instead of the lateral distal knee. Lower back pain is documented medically since
teenage athletics during powerlifting and later during middle distance sprints, longboarding, and rugby. Presumably continuing athletics while sore would result in knee or hip surgery later in
life regardless of sitting or standing and it is impossible to perform skateboarding tricks while sore.

20251004 - The origin of today's lower back soreness is overuse from impending cold weather with sore R posterior leg from L longboarding and tailslides, R adductor from R tailslides, and anterior
superiorly directed chest and shoulders respectively during hamstring stretches.

Physical therapy and chiropractic recommended lateral leg raise exercises in 2009 reduced lower back and hip soreness and were repeated sporadically but forced more pressure onto the vastus lateralis while resuming exercise in 2020. A similar weight lifting exercise is single leg step ups and pushing a longboard or skateboard also exercises the gluteus medius. The lateral knee attachment raises the patellar when the moderately sized tensor fasciae latae (TFL), gluteus medius, and vastus lateralis from the quadriceps are inflamed from overuse. While learning to push the longboard for transportation in 2014, the left gluteus medius muscle size increased and reduced lateral hip movement and right lower back pain. Although the main weight lifting exercise for legs changed from low repetition and heavy back squats from 2005-2011 to light weight front squats while longboarding in 2014-2016, significant effort was spent on olympic style squat clean from 2011-2013 that injured the lower back identically to heavy back squats. Carves and slides downhill using a longboard builds upper adductor and gluteus strength that is necessary to balance the overdeveloped lower and lateral thigh muscles. Walking uphill builds gluteal and upper hamstring muscle fibers in a direction that is avoided by skateboarding alone and results in less soreness compared with squat related weight lifting. Lower limb stability is similar to rotational ollies.

Head and neck pain is thought to originate from stress and dehydration (*Figure 26* and *Figure 27*) and is well documented in the participant's medical history. Although not addressed extensively in this paper, nutrition is essential to avoid unnecessary head pain and proves

challenging since extensive muscle accumulates in the gluteus medius, obliques, and abdominis rectus rendering traditional pound weighing for health subjective. The origins during skateboarding were from jumping and landing with the rhomboids rolled forward into the latissimus dorsi while pointing the head down to look at the board but there are several other sports that primarily have the neck up and head down. Traditional olympic and powerlifting techniques to strengthen upper back and chest muscles helped to correct posture, however head pain emerges from excessive forward lean while exercising the posterior muscles.

20251211 - AI suggested to pull the bar into the back when searching for chest technique suggestions, forward chest lean with posterior flexed shoulders and gluteous with a narrow grip and bar pull
eliminated knee snap. The forward lean was enough to limit knee snapping on low weight since the shoulders were rarely posteriorly flexed during 7 months of skateboarding but not enough
while squatting heavier weights. Rolling the hips and gluteous posteriorly limited knee snapping during the two previous years of squatting. Observations supports increased posterior muscular
flexibility and strength. Or it was the pace of the mile before which was faster on Sunday/Monday low rep squats than Thursday higher rep same weight squat -> supports improper gait related
R iliopsoas soreness -> evidence against that theory is knee snapping continued at warmup weight without bar pulling on Thursday. A third theory is rapid muscle adaptation and growth since
the legs were still sore into Thursday and required body part specific warmup. Also the R knee started caving at the end of jump squats indicating muscle memory while tired

The left lower posterior serratus and oblique is inflexible as judged by sitting split leg hamstring bends.

Watched skateboarder's arms and Huston seems to land with arms flexed down compared with other professionals who flail their arms. It might be a result of computer effects.
Center of balance would be improved however and lends additional evidence for 3 and 4 ball hand foot juggling to increase coordination as well as learning more arm or neck anatomy.

February 2025

Started building R muscles for switch kickflip with broken nose board. Focused on forward, non flailing arms (crab pose) and landing by squeezing arms in front and down with

activated glutes for a centered 3/4 squat.

20251208 - Itchy middle respiratory tract might be from shallow breathing from serratus anterior inflammation.

The IT band snap and lateral knee pain is related to underused gluteal muscles and is referred unofficially as Dead Butt Syndrome (DBS). Forward rotated pelvis occurs while sitting for long periods during a desk job and reduces gluteus medius strength which is a muscle that was overworked during skateboarding. Gluteus maximus strength also decreased significantly which reduced lower back muscle tension and pain but allowed the pelvis to rotate forward unconsciously causing distal, lateral quadricep pain. One possible explanation for higher head pain prediction accuracy (*Figure 20*) compared with the other body parts is more thorough knowledge about what causes head pain compared with lack of experience exercising the lateral quadriceps (*Figure 24*). ITBS is revealed at a younger age to soccer, basketball, and American football skill positions though it increases risk for knee injury. Debilitating lower back pain from powerlifting or linemen positions is alleviated from gluteus medius physical therapy and is analogous to ITBS. Building gluteal muscles first would probably decrease injury risk in adolescent skateboarders but overdeveloping might lead to blind dependence on the butt.

There are several activities that are seemingly unrelated to skateboarding whose purpose is either resting, mental distraction, or gentle movement and could be replaced with an exhaustive list depending on the user's demographic. One cause is that skateboarding without guidance is an intense exercise that requires mentally aware recovery to reduce inflammation through stretching. The athletics that the participant was accustomed to had well defined exercise and recovery regiments for muscles that are not used as prominently. Ollie tricks rolls the

rhomboids forward stressing the trapezius and almost exclusively relies on rarely exercised directionally aligned muscle fibers in the vastus lateralis and gluteous medius. Guitar is a no movement event helpful for building mental stamina for details, increases hand strength, and rotates the front arm in an isometric position opposite the downward palm facing orientation while ollieing.

SKATEBOARD ABILITY IMPROVEMENTS FROM EXCESSIVE DOCUMENTATION

RL heel and tailslides improved 180 ollies and short board shuvs or no complies increased shuv it
consistency. Board feel increases with 180 turns and reverts and found flip tricks depended on building front leg
adductor coordination and rotating the back foot forward scaled with speed. Side achievement 1) increasing
endurance with spacing short walks or runs, longboard pushes, and injury prevention with excessive stretching

2) 18 pack looks like a gut when eating 3000 calories/day while burning ~1000

and the inattentive could be fooled into skateboarding injuries from unnecessarily extensive cardio for superficial
reasons. Specifically regarding warm weather land board sports as it relates to sports training, distance
longboarding and mild carves for endurance is beneficial for large muscularly built people while street skating
increases muscular volume and physical fortitude for lean athletes more accustomed to running or sprinting.
Weight loss in general is dependent on medical constraints, geographic availability (mountain biking, swimming,
etc.) and finding enjoyment in an affordable activity. 3) L guitar and downhill longboarding ability increased in half
the time by avoiding the painful mistakes learned while using the right hand. For example, playing chords with
inefficient finger shapes leading to unnecessary soreness, baseball sliding on the L leg when falling on out of
control R heelslides, or occasional overuse while learning R ollie and FS180.

FROM THE NEUROBIOLOGY LITERATURE REVIEW

Chapters 0-10 in this book thoroughly summarized transfers of large volumes of energy in Earth Science at a scale where the reader would be unable to cause damage while increasing attention to detail needed to understand electricity signals with information systems. Computer hardware can be analogically thought of as an imitation of nearly anything that requires electricity. In the current context, computer hardware is similar to a sandbox for the brain in an effort to prevent unwanted permanent damage from unregulated biological laboratory experiments. Commercially available computers or networks are not accurate enough to provide consistent statistical answers at any scale and are a learning device.

FROM THE METHODS

The implications for exercise forecasting has the potential for disastrously long lasting bodily injuries when applied to consuming media where behavior modifications are inserted. Applying elite Olympic style psychological motivation to normal people is annoying and can lead to mental instability. It is therefore essential that extensive statistics classes from a graduate school in the social sciences would be a prerequisite before undertaking any experimental behavior modification regiment without guidance from exercise scientists and other trained professionals. Automated behavior modifications based on ephemeral social science information systems may have undesired effects.

FROM THE METHODS: PSYCHOLOGICAL OBSERVATIONS

Another issue with skateboarding is newly middle aged people taking skateboarding very seriously to recapture the youthful glory of participating in school sports. I suspect this is what happened at the turn of the millennium when effective marketing sold what is effectively difficult

rollerblading as a weight loss strategy to curb rising U.S. obesity. Delusions of grandeur were directed to hypercompetitive masculine stereotypes and resulted in superiority contests to see who could jump off the highest stair resulting in severely mangled limbs. Hometown heroes could also motivate people within the group to exercise until severe muscular damage occurred and $100 skinny jeans were worn once before becoming torn. By 2020 it became apparent that skateboarders are the worst demographic to market toward because they are loners that have no money. It is an effective exercise for the 20-50 demographic that moves between cities for work because the sport doesn't require extra equipment or people and carries over several skills from organized sports, besides occupying the long stretches of boredom by reading or rehabilitating imbalanced muscular pain during inclement weather. However, being preoccupied from moving continuously might distract an adult from missing important muscular maladaptations.

Within the context of skating's history, these physiological conclusions would take significantly longer to find before the internet and even longer before computerized library catalogs with some publicly available texts being outdated or graffitied. Having to physically transport yourself several miles to the library or hospital to ask a doctor without insurance would make this sport inaccessible for most people. One scenario would be delusions of grandeur by those who are otherwise academically unremarkable as newly energized athletes, leading to inflamed sense of ability. The satisfaction from efficiently solving math problems becomes addictive for young people after being told they were mediocre for decades and skateboarding's loose affiliation with late 20th century anti-establishment ideas might lead to cheating to gain entrance into higher academic institutions. The participant would have to be under regular observation by guardians or medical personnel to avoid catastrophic martyrdom.

I'm good enough to skate the ramp park features but 90% are unusable because I can't ollie. The bizzariety is that it takes at least 3 years of pushing to skate and presumably

another 3 years to learn ollies and grinds to even justify transportation and is the same for driving 45 minutes to the closest indoor park. By the time you've spent half a decade,
you would probably run out of money and would have to work, losing the skill to justify going to an indoor skatepark during the winter. Yet if you train a 12 year old,
they would be burned out on skateboarding and probably hate the sport because they associate it with childhood and school. The turn of the millennium skate culture with shows
such as Jackass probably also barred parents from investing. Analogously, I would play rugby with people my own age but they all live in cities, whose access is denied unless I take
tranquilizers to perform a mind numbing job, gaining several dozen pounds in weight and making the sport unenjoyable anyway.

If I worked service industry, I could afford more skateboard but I would lose healthcare and go more into debt with hospital bills when I eventually break a leg while tired from working
the benefitless job or software contracting.

Conclusions

After the data collection period ended, 6 months were spent focusing on back squats and pullups to reduce the likelihood of a skateboard-induced catastrophic back injury from falling. Ultimately increasing isometric deltoid and back muscles with front squats and short juggling periods and anterior deltoid and pectoralis isotonic strength with decline pushups, incline db press, db shoulder press, and bb split jerk while limiting exercise time, muscular balance between anterior and posterior neck supporting muscles alleviated most neck and head pain. These methods are nearly identical to previous similar weight loss and muscular balance

achieved with rugby, weightlifting, and longboarding instead substituting rugby with flat ground skateboarding and described in excruciating detail.

<todo>

It is my opinion that attempts to reduce exercise induced inflammation outside of the standard stretching, mild movements, or nutrition might lead to myocellular death by delaying the accumulation of fibroblasts to repair damage to cell walls and lead to permanent scarring of the muscle fibers.

References

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2. Knee side-to-side strength asymmetry and hamstring-to-quadriceps strength ratios in professional street skateboarding athletes

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8. The immunomodulation and anti-inflammatory effects of garlic organosulfur compounds in cancer chemoprevention

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14. Fibroblasts

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15. Repeated activation of C1 neurons in medulla oblongata decreases anti-inflammatory effect via the hypofunction of the adrenal gland adrenergic response

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16. Fibroblasts as novel therapeutic targets in chronic inflammation

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18. High dietary salt intake activates inflammatory cascades via Th17 immune cells: impact on health and diseases

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19. Peroneal Tendon Syndromes https://www.ncbi.nlm.nih.gov/sites/books/NBK544354/

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64 Fibroblasts - redundant

65 Repeated activation of C1 neurons in medulla oblongata decreases anti-inflammatory effect via the hypofunction of the adrenal gland adrenergic response - no full text

66 Fibroblasts as novel therapeutic targets in chronic inflammation

67 Structural biology of the IL-1 superfamily: Key cytokines in the regulation of immune and inflammatory responses

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Landing Injuries

112 Simulation of the Vertical Ground Reaction Force on Sport Surfaces during Landing

113 The effect of landing type on kinematics and kinetics during single-leg landings - no full text

115 Biomechanical Measures during Landing and Postural Stability Predict Second ACL Injury after ACL Reconstruction and Return to Sport - no full text

116 The Effect of Fatigue on Landing Biomechanics in Single-Leg Drop Landings - no full text

117 Effect of landing stiffness on joint kinetics and energetics in the lower extremity - no full text

118 Short-dependent variations in arm position during single-limb landing influence knee loading: implications for ACL injury - no full text

120 Greater lower limb flexion in gymnastic landings is associated with reduced landing force: a repeated measures study - no full text

121 Analysis of landing performance and ankle injury in elite British artistic gymnastics using a modified drop land task: A longitudinal observational study

122 Ground reaction forces among gymnasts and recreational athletes in drop landings

123 Biomechanical factors associated with injury during landing in jump sports - no full text - excessive might read the literature review sources

124 Whole body kinematics and knee moments that occur during an overhead catch and landing task in sport - no full text

126 Young athletes with quadriceps femoris strength asymmetry at return to sport after ACL reconstruction demonstrate asymmetric single-leg drop-landing mechanics - no full text

127 Evaluating the effects of match-induced fatigue on landing ability; the case of the basketball game

128 Kinetics and perception of basketball landing in various heights and footwear cushioning

42	Analyzing and Interpreting Data From Likert-Type Scales

89 Maybe you could make an index combining

calories burned and hours worked as an estimate of stress and estimate alcohol and calorie intake.

23	Kurtosis as Peakedness, 1905-2014 R.I.P.	Maintains that kurtosis is not a measure of peakedness of a distribution but rather a measure of existing outliers in a sample or propensity to produce more outliers in a population.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4321753/
		High measures of kurtosis (over 3) have heavy tails or outliers while under 3 would have lighter tails/outliers in the normal distribution.	https://www.itl.nist.gov/div898/handbook/eda/section3/eda35b.htm
		Cronenbach alpha coefficient - measures internal consistency among a survey	https://stats.oarc.ucla.edu/spss/faq/what-does-cronbachs-alpha-mean/
		ANOVA - ???	https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_hypothesistesting-anova/bs704_hypothesistesting-anova_print.html
		chi-test - categorical data	https://support.google.com/docs/answer/7004263?hl=en&ref_topic=3105600
24	A Language, not a letter: Learning Statistics in R, Chp 23: What is ARIMA	ARIMA is for data that is stationary or has variance, mean, and autocorrelation that does not change over time. This page provides historical backgrounds of the formula (not in depth).	https://ademos.people.uic.edu/Chapter23.html
25	NIST Engineering Statistics Handbook: 6.4.4.2. Stationarity	Briefly describes what stationarity is with two graphs and one equation.	https://www.itl.nist.gov/div898/handbook/pmc/section4/p

			mc442.htm
26	Penn State Stats 510: Section 4.1: Seasonal ARIMA models	Provides example calculations for the seasonal ARIMA model. SARIMA is used for data that has seasonal fluctuations and would be most applicable to yearly data. Maybe one could	https://online.stat.psu.edu/stat510/lesson/4/4.1
		apply the techniques to differences in >30 daily values in the same season but with values that differ during the time of day? That last part is speculation I haven't read too deeply.	
27	A Systematic Review of Time Series Classification Techniques Used in Biomedical Applications	Literature review on several hundred papers on deep learning for large, non parametric datasets. A combination of several algorithms performed exceptionally well in prediction tasks	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9611376/
		but the number of data points are in the several thousands. It is worth further investigation because of Gaussian Process Latent Variable Models which attempt to recognize patterns	
		by shape, thereby reducing dimensional complexity and computation power needed.	
28	Non-parametric inference	Defines non parametric as a group of statistical tests that use data with large and infinitely-dimensional models.	https://statistics.berkeley.edu/research/nonparametric-inference
29	Penn State Stats 462: Applied Regression Analysis. Lesson 10: Autocorrelation	For use in time series data when typical formulas fail to find any trends. The chapter includes many references to formulas and explanations.	https://online.stat.psu.edu/stat462/node/188/
30	UCLA Advanced Research Computing. Statistical Methods and Data Analytics. FAQ: What's with the different formulas for kurtosis?	Provides three formulas for kurtosis calculation.	https://stats.oarc.ucla.edu/other/mult-pkg/faq/general/faq-whats-with-the-different-formulas-for-kurtosis/
31	NIST Engineering Statistics Handbook: 1.3.5.11. Measures of Skewness and Kurtosis	Another referenced source for kurtosis and skewness formulas	https://www.itl.nist.gov/div898/handbook/eda/section3/ed

			a35b.htm
32	International Encyclopedia of Statistical Science. Skewness	Another college reference for skewness.	https://lbj.utexas.edu/sites/default/files/file/news/Skew.pdf