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 different 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.[1] 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[2] 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[3] 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[4]. 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.[5] 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.[6]

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 sometimes mistaken for this abdominal wall muscle and long term damage could cause respiratory illness or require hip replacement. The third and fourth section includes the transversalis fascia and parietal peritoneum.[6-7] 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 attach the cotyloid notch to the fovea on the femur.[8]

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.[9] 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. 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.[10] 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.[8] Common causes for hip pain are genetic inheritance, traumatic motor vehicle accidents, or osteoarthritis.[8]

Age, genetics, and injuries are usually culprits for osteoarthritis. Another cause of iliopsoas hip snap syndrome is the presence of an accessory strip of the psoas major or extra muscle.[10] 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.[11] 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[12] 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[10] or fibrosis and requires a physician performing the Thomas test and Ober or hula hoop test for an accurate diagnosis.[13]

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.[9] 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[14]. 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.[9] 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[15] 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 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 rises to meet the required work before shortening.[16] A more accurate description of the biomechanics used during the ollie includes the rear support leg

moving in hip and 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 diagonally with the direction of the board. The front leg is used to control the board and is used less to support the jump motion. When considering pushing the board to increase speed, the front support leg is engaged in an isotonic exercise while the swing leg's hamstrings are lengthening eccentrically and the quadriceps are shortening concentrically to propel the board forward and might result in different sized muscles.[17]

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.[17] The muscular fibers in the legs used to perform different motions vary from horizontal to vertical similar to the description in the latissimus dorsi.

To circumnavigate the observed muscle imbalances, performing different depth squats similar to those measured in[17] 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.[18] 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.[19] 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.

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.[20] They cite several papers claiming that knee valgus is associated with lower leg injuries and non-contact ACL injuries with rapid direction changes or rotation from abnormal knee or hip angles arising from upper leg muscle imbalances. An example is rapid external tibial rotation straining the MCL, reducing Golgi tendon organ feedback and

leading to ACL injury when returning to neutral. Their background asserts that leg muscle imbalance of more than 15% significantly increases injury rates and 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 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[21] 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. Spinal and pelvic rotation through hip flexion and adduction from body weight distribution asymmetry and reduced oblique activity are symptoms but not the actual cause of the issue.

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.[22] Muscle imbalance observed in this study 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 toward the toes of both feet, similar to wearing high heels. The ankle is in an eversion 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.[23-24] 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 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 in front of the calf which are inflamed in correspondence to overuse of the gastrocnemius or soleus muscles.[25]

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.[26] 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.[27]

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.[28]

After muscle injury or damage from exercise, myofibroblasts secrete a variety of cytokines such as the Transforming Growth Factor beta 1 (TGF-β1). 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-β1 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.[28] When Type I collagen accumulates in the interstitial matrix of the newly constructed basement membrane ECM, an exhaustive list of interleukins including IL-1β, IL-6, IL-13, IL-17 and IL-33 are recruited to the site for repair signaling.[29-31]

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).[28]

Inflammation - Fibroblast Reduction

The literature review on fibroblasts[28] 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. Complicated organic chemistry is reviewed in one study 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. There are several garlic anti-cancer properties and anti-inflammatory cytokines such as TRAIL, IL10, and TGF-β 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.[32]

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.[33]

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.[33]

Inflammation - Fibroblasts and Neurobiology

Neuroscience Third Edition Chapters 1-5[34] 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.[34]

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.[34]

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.[34]

The neurobiology textbook[34] 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. One study[35] 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. Another study[31] lists several materials such as bacteria, fungus, and cytokines that initiate the TH17 inflammation response and are enhanced in high salt concentrations. Decreasing Nitric Oxide production increases hypertension and agrees with additional research by Kendall and Feghali-Bostwick.[28] Availability of cellular water would most likely decrease and lead to muscular scarring if repeated long term but isn't explicitly stated.

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[29-31] increases the risk along with a condition called Dupuytren's disease that limits finger movement that produces similar immobilization. Ten patients out of 20 patients that were sampled during an unrelated arthroscopic shoulder surgery found elevated adhesive proteins.[36] The specific vascular cell adhesion molecule was VCAM-1 or cluster of differentiation[26] 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.[37] 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.[38] Another study on gymnasts found that greater hip flexion was associated with reduced GRF[39] but it would be a jump to conclusions to say that greater GRF automatically leads to more injuries since gymnasts produce more GRF[40] 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.[41]

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.[42] 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.[43] 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.[44] The authors cite another study that found bodily mechanics are adjusted at greater heights implying more leg flexion.

Athletes in a study[45] that displayed unstable posture while landing predicted a second anterior cruciate ligament (ACL) injury. 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.[46] 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[47] 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[48] and is analogous to landing on a skateboard with an inwardly directed rear knee.

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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 followed by psychological observations. The final section includes notes without the pain scale while weight lifting from November 2024 to April 2025 and skateboarding and longboarding during the following summer.

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 stance 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.[49]

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[50] such as 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.[26] 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.

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

Energy expenditure was estimated using computer software for all 100 days of the study period. Resting metabolic rate (RMR) was calculated using the Mifflin-St. Jeor equation at 2200 kilocalories (kcal) per day without exercise.[51] Two methods were employed to find kcal ingested and used. The first method finds one number to summarize daily kcals for the entire dataset with tabular software. RMR is combined with daily kcal ingested and an exercise scale with a value of '0' indicating no unessential movement, '1' burning 1-250, and '2' rounding at 500 calories. The second method does the same thing with Python using a complete kcal out scale for the exercise activities and also constructs a per day data visualization accompaniment. Kcal burned is difficult to accurately quantify without specialized equipment and information was extracted from a calories burned website.[52]

Diet information specifically was included in a table with columns that were identical to Chapter 11. They included information tracking the date, kcal, 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 estimated on a 0-2 exercise scale. Distance longboarding is difficult to estimate since the speed varies between walking and bicycling speeds depending on damage to the wheel bearings shape and lubricant. Familiarity with the terrain also reduces caloric expenditure since less effort is spent determining efficient routes over variable road conditions. One day longboarding five miles took 90 minutes while a cleaned board went 11.5 miles in the same time. 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.[53]

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.[53]

Post data collection notes

Lower leg

Medical history includes a partially torn talofibular ligament and it was uncertain if the lateral ankle sprain had lasting issues since there was audible noise anteriorly while rotating the foot. Posterior tendon popping during ankle rotation began with skateboarding tricks near the lower medial 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 dorsiflexion muscles caused anterior inflammation but the same medial popping was not observed on the left ankle dorsiflexion muscles while kicking with the left leg. Audible noise continued after ball kicking cessation and was ruled out as the cause. After the 2024 data collection period ended for the pain charts, effort was extended in 2025 to use the left leg with switch skateboarding, longboarding, and ball kicking. These activities resulted in identical anterior left ankle sound while the anterior right ankle ceased. Cross leg sitting with the right ankle underneath the left knee causes ankle inversion and results in similar posterior 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.[21]

Right soleus muscle soreness 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 following school organized 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 front left leg is forced to step backwards off the board. Failing switch heelslides displayed a pronounced weight falling forward by standing on the toes and identical overcorrecting by stepping off and backwards with the right front leg. An equivalent muscle observation occurred during switch FS 180s when raising the stronger rear anterior left leg off the board, resulting in unintentionally quarter flipping the board counterclockwise on landing. Failing to move the right front leg fast enough from switch pop shove its rotated the

board clockwise and is evidence of weaker or less coordinated right quadriceps. The muscles used in this movement are the sartorius to rotate the thigh laterally and pectineus to adduct.[9]

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 Casper 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. 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 longer standing heel and toeslides with the intention of improving both ankle dorsiflexion and 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.

Quadriceps, hamstrings, and gluteus, back squats

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 while exhausted and is

partially caused by weaker left abductor and right adductors. Squat technique was improved through rolling the hips and gluteus posteriorly to limit knee snapping. Strategies 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 lateral right thigh muscles are inflamed, the inflexible IT band framework snaps over the lateral epicondyle of the femur. Similar snapping was eventually observed with the vastus intermedius and rectus femoris around the patellar from a combination of exhaustion and seasonal temperature variation. 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 indicating stronger left anterior muscles compared with the right leg.

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. When resuming weightlifting during the 2025-2026 winter, the internet suggested to improve back squat technique by using a narrower grip and pulling the bar into the trapezius with more forward chest lean and posterior flexed shoulders. Increased strength and flexibility along with improved squat form eliminated knee pain and decreased audible noise. The inclusion of cardiovascular conditioning initiated the return of knee snap and supports gait related deformity while running from hyperextending the right knee. The right leg also displayed chaffing after incline hill running compared with left leg chafing when the right leg was consciously lifted higher on the same route on a later date. Sole concentration on limiting hyperextension on the right knee leads to the aforementioned left iliopsoas snap from Chapter 11.

Right lower back pain occurred during heavy weighted and forward leaning powerlifting back squats in 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. This information could also be used to support the idea for 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.

Quadriceps, hamstrings and gluteus, longboarding and skateboarding

Physical therapy recommended lateral leg raise exercises in 2009 and right stanced longboard pushing from 2014-2016 eliminated right lower back soreness but forced more pressure onto the vastus lateralis while resuming exercise in 2020. A similar weight lifting exercise for the gluteus medius is single leg step ups. The lateral knee attachment destabilizes the patellar when the vastus lateralis and gluteus medius 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 primary weight lifting exercise for legs changed from back squats in 2006-2011 to light weight front squats in 2014-2016, significant effort was spent on olympic style squat clean from 2011-2013 and resulted in right lower back pain indicating that longboarding was the difference. 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 gluteous 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.

IT band snap and lateral knee pain is related to underused gluteal muscles and is referred unofficially on the internet as Dead Butt Syndrome (DBS). Posterior rotated pelvis sometimes occurs while sitting for long periods during a desk job and reduces gluteus medius strength. Gluteus maximus strength also decreased significantly which reduced lower back muscle tension but allowed the pelvis to rotate unconsciously causing lower lateral quadricep pain and skateboard ollies overworked these muscles. Learning the ollie in early 2024 resulted in lateral quadricep and gluteous inflammation with reduction attempts by stretching the IT band through cross leg bends pulling the popliteus. Regular stanced backside 180 ollies were difficult because the skateboard is landing switch and blind to landing the front right foot. The excessive jumping attempts in August 2024 during this trick led to an overdeveloped lower bicep femoral muscle. Lower limb stability from downhill longboarding is helpful for rotational ollies. 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. The November-February 2024-2025 back squat period noted increased popliteal snap over the posterior lateral condyle of the femur similar to the lateral quadricep noise.

The primary form of exercise and transportation from 2017-2021 was walking and muscle imbalance contributed to right knee pain since the femur rotates medially and hyperextends the leg. Sedentary desk job sitting relaxes the gluteous muscles leading to lower back pain or knee pain and sitting with cross legs can lead to muscular asymmetry.[21] Prescribed

medication during this period caused immobilization during sleep and side resting by unconsciously facing away from heat or cooling air flow would exacerbate the already overworked right leg from poor stride mechanics. While viewing historical and current televised sports to observe knee valgus while turning and landing, it was observed the players sat with knees and feet open though it might be from chair proximity. Anecdotally, amateur athletes in school are witnessed sitting with a variety of orientations while not being recorded.

Extensive regular stance distance longboarding from 2014-2016 increased right bicep femoris strength and attempting heelslides developed the posterior or magnus adductor. Longboard slides increase adductor strength for BS or FS 180 skateboarding ollies by reasoning of heelslides pushing the board perpendicular to the road with hip extension and toeslides pulling the board against the road with hip flexion. A similar weight lifting exercise is weighted side lunges depending on the foot position and ankle flexion or extension. After extensive longboarding near the end of 2025, the thighs were more muscularly balanced and the external hip rotators were more involved in the 180 rotations. The left posterior was sore after landing regular stance tricks and partially explains the left rear leg lifting off the tail when performing switch stance tricks. It was noted that standing for a significant part of the day accumulated soreness in the right lower back and hip muscles instead of the right lateral lower vastus lateralis. The concept is important since stretching the hamstrings with standing bends by posteriorly rolling shoulders produces lower back pain instead of bowing the head that strains the lateralis and trapezius resulting in neck or head pain.

Head and neck

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 through skateboarding (*Figure 24*). Head and neck pain originates from stress and dehydration (*Figure 26* and *Figure 27*) and is well documented in the participant's medical history. The origins during skateboarding were from jumping and landing with the rhomboids rolled forward into the latissimus dorsi while looking at the board but there are several other sports that primarily have the neck and head down. Traditional olympic and powerlifting techniques to strengthen upper back and chest muscles helped to correct posture, however head pain emerged from excessive forward lean while exercising the posterior muscles. Nutrition is essential to avoid unnecessary head pain and proves challenging since extensive muscle rebuilding molecules and water accumulate in the gluteus medius, obliques, and abdominis rectus rendering traditional pound weighing for health subjective.

There are several activities that are seemingly unrelated to skateboarding whose purpose is either resting, mental distraction, or gentle movement. 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 almost exclusively rely 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.

One example of an advantage for learning anatomy through self-experimentation included discovering the left lower posterior serratus and anterior facing oblique were less flexible than their counterparts as judged by sitting split leg side bends which would not have been apparent without spending extensive time finding ways to reduce leg inflammation. Balancing the middle torso through exercising the serratus with front squats, pullups, and hanging crunches impeded respiratory function while inflamed but eventually improved efficiency as measured by a decreased one mile time. Although distance endurance improved from spacing short walks and longboarding throughout the day along with skateboarding or running, the observation lends evidence to increased lung capacity by improving an abnormal forward leaning posture from skateboarding. Exercising the anterior torso after skateboarding also improved superficial cues that might otherwise lead to overexercising and burning out.

Another positive about obsessing is watching professional skateboard videos who seem to land with arms flexed down compared with amateurs who flail their arms. Improving upper body muscular endurance through traditional weight lifting and juggling variations increased overall body coordination. A secondary benefit from the winter weight lifting in 2024 and 2025 was reduction of the likelihood of a skateboard-induced catastrophic back injury from falling. Back squats and pullups increased isometric deltoid and back muscles with front squats and anterior deltoid and pectoralis isotonic strength with decline pushups, incline press, shoulder press, and split jerk. Limiting exercise time and improving muscular balance between anterior and posterior neck supporting muscles alleviated most neck and head pain. These methods are nearly identical to a previous successful weight loss attempt with muscular balance achieved from weightlifting, longboarding, and substituting rugby instead of skateboarding. This paper would not exist without a masters degree.

Results

Exercise information was recorded for 100 days from July 22nd until October 29th and data analysis includes graphs using Python's matplotlib library. There was a four day collection gap from August 22nd to the 25th and one on September 6th. The first handful of charts are heatmaps that chronicle the frequency and duration of activity by weekday and time. Four bar graphs display 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 pain scale from Chapter 11 was used to track muscular soreness and the ensuing figures average five days of observations. More charts compare pain observations with one day forecasts estimated by a human. Predictions were not recorded for 17 days with the majority happening in the first two weeks because most of the exercises were related to stretching the already sore legs. A line graph to visualize the average number of daily activities before an abnormal pain record were included for 3, 5, 7, 10, and 30 days before the event and another chronologically visualizes the information for individual events. The final display includes kcal eaten, burned, and the resulting deficit.

Exercise Schedule

The exercise schedule was separated into five heatmaps to discern behavioral patterns useful in avoiding soreness. The first figure displays the frequency of activity for the seven days of the week compared with time set in two hour blocks. The next visualizes the average daily minutes spent on eight of the most frequently occurring activities organized by weekdays. The

third likewise categorizes the data by weekday, instead substituting the frequency of activities for daily minutes. The fourth swaps two hour time blocks instead of weekdays for activity frequency. The final heatmap chart summarizes the total hours for each activity by weekday.

The first heatmap groups activity frequency for weekdays and time segments recorded at time of completion. Most of the activities took place between 0900 and 1300 regardless of the day of the week and agrees with the text notes. 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*).

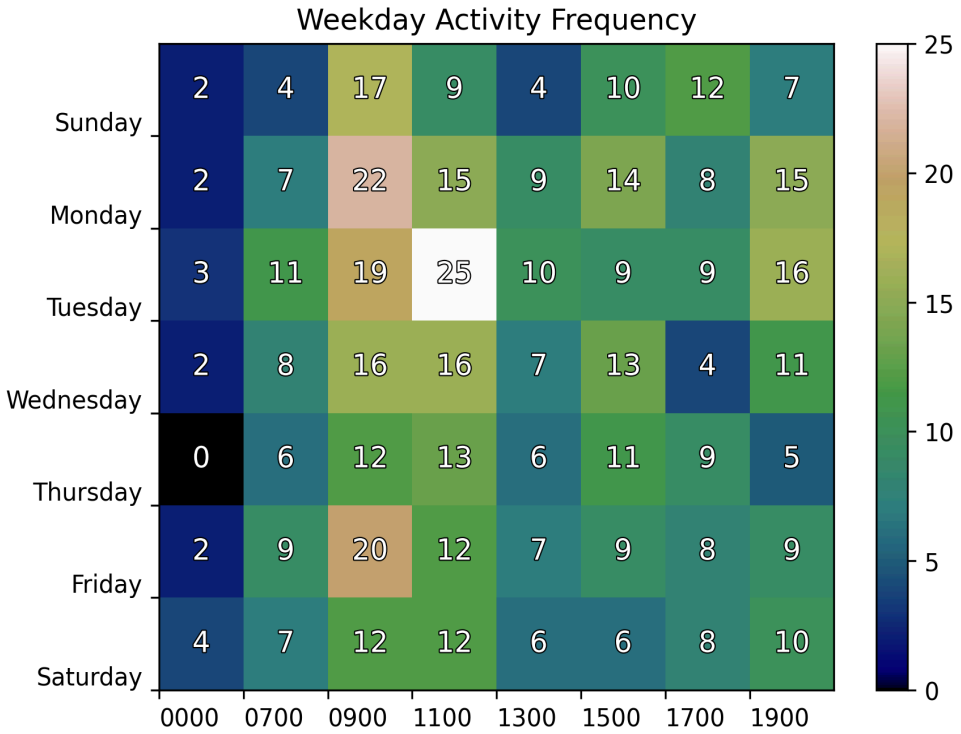

Figure 1: The total number of activities for the study period categorized by day of the week.

The next heatmap lists eight of the top most commonly repeated activities by the weekday. 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. Working on this paper had higher daily average minutes on Friday and Saturday. Lower daily minutes were recorded for longboarding on Monday, juggling on Thursday, and running on Thursday through Saturday (*Figure 2*).

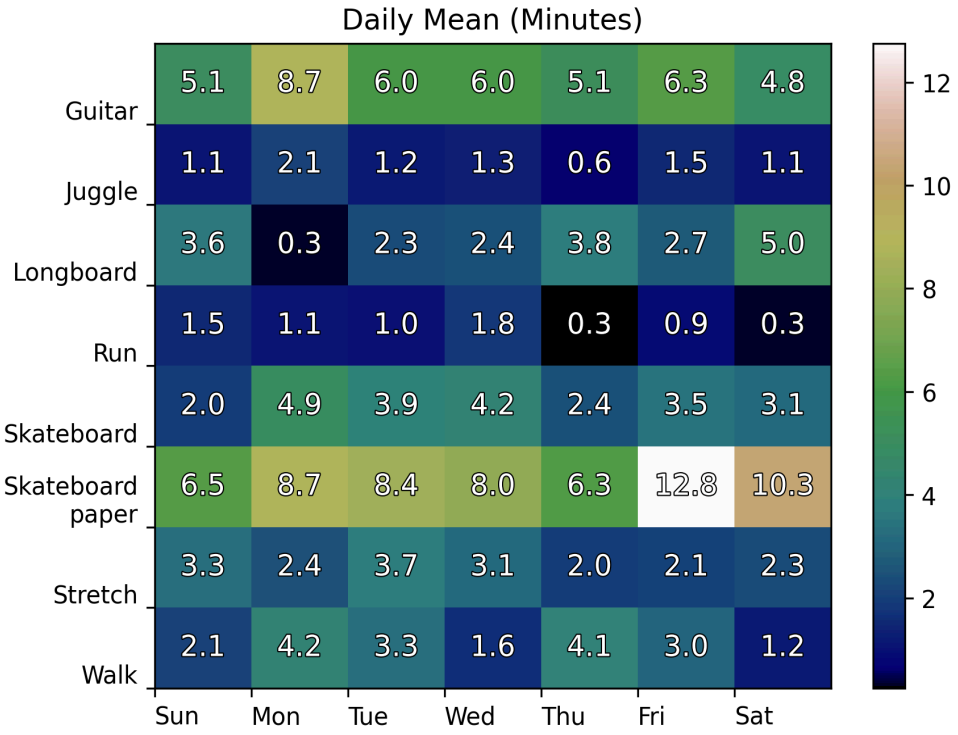

Figure 2: Average minutes spent on each activity by the day of the week for the top eight values.

The eight most frequently occurring activities were also categorized into the frequency for each weekday. The chart indicates that resting activities were performed several times more often than skateboarding. Guitar and stretching were no and low movement activities that were

consistently completed at a greater rate than other categories with stretching periods occurring the most on Tuesday. Guitar specifically was practiced 24, 23, and 21 times on Monday, Tuesday, and Friday and stretching had high values of 15 and 20 on Monday and Tuesday respectively. Although the previous figure revealed greater average daily time spent on this paper on Friday and Saturday, attempts were consistent across the days of the week. Skateboarding had higher values on Monday, Wednesday, and Friday while longboarding was primarily a Saturday activity that had only one attempt on Monday. Running had lower attempts than any category with one attempt on Thursday and Saturday. Walking mostly occurred on Monday, Tuesday, and Thursday (*Figure 3*).

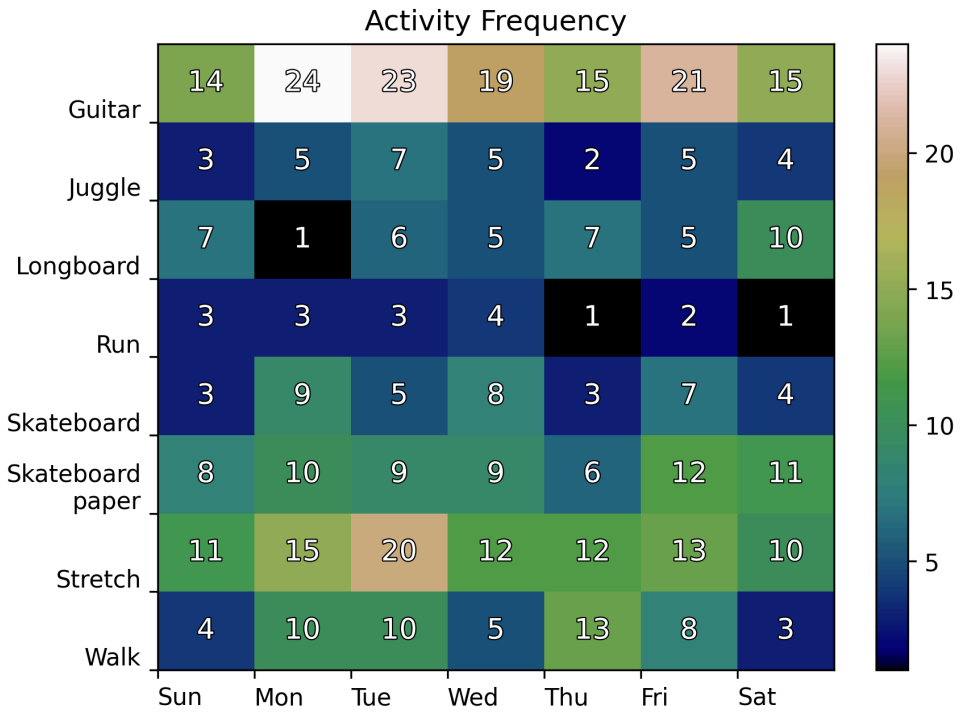

Figure 3: The frequency of activities for the day of the week.

Activity frequency for the primary activities was categorized by the time of day. Skateboarding almost always occurred between 0900 and 1300 with activity values of 14 and 8. There were only 2 records outside this time window. Longboarding usually was completed in the 1100-1300 time slot with 9 values. This paper was worked on from 0700 to 1100 and had values of 23 and 21. Stretching mostly happened throughout the afternoon with specific values of 22 and 23 at 1100 and 1900. Guitar activity frequency peaked at 0900 and Juggling nearly always occurred at 1500. Running had values ranging between 0 and 5 (*Figure 4*).

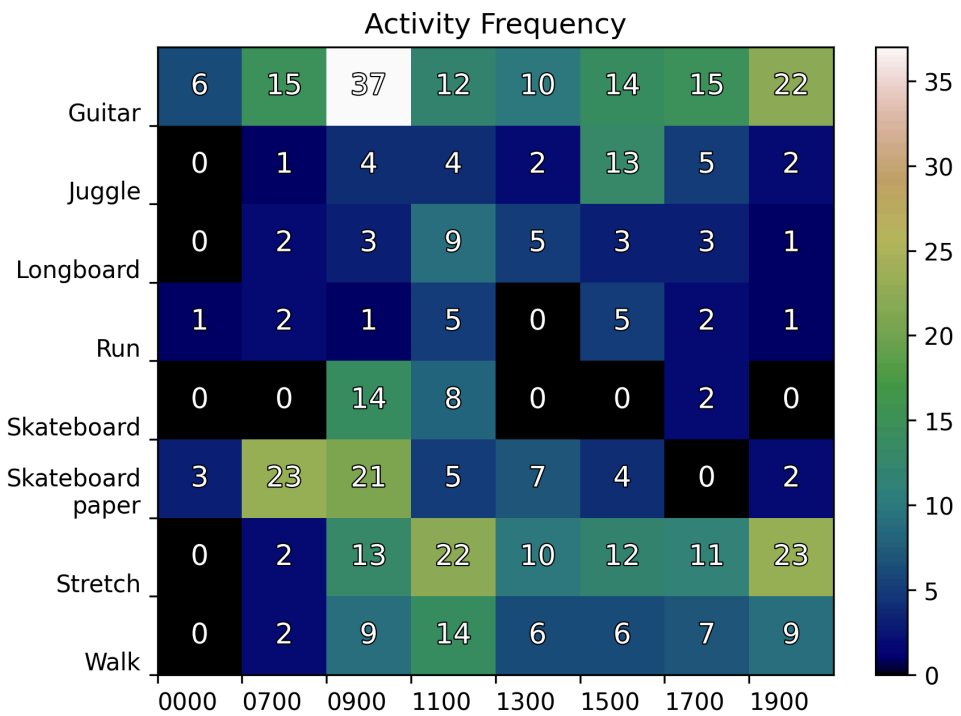

Figure 4: The frequency of activities for the time of day.

The final heatmap displays cumulative hours for prevailing activities categorized by weekdays. Playing guitar and working on this paper were two activities that acquired the most hours throughout the week. Guitar was played for 14.5 hours on Monday and this paper was

worked on for 21.2 hours on Friday and 17.2 hours on Saturday. Skateboarding and stretching usually occurred Monday through Wednesday. Longboarding had 0.5 hours on Monday and provided a less intense board related exercise with more hours in the second half of the week. Walking accumulated between 5 and 7 hours on Monday, Tuesday, Thursday, and Friday. Two of the least practiced events were juggling consistently ranging between 1.0 and 3.5 while running had low values of 0.4 and 0.5 on Thursday and Saturday (*Figure 5*).

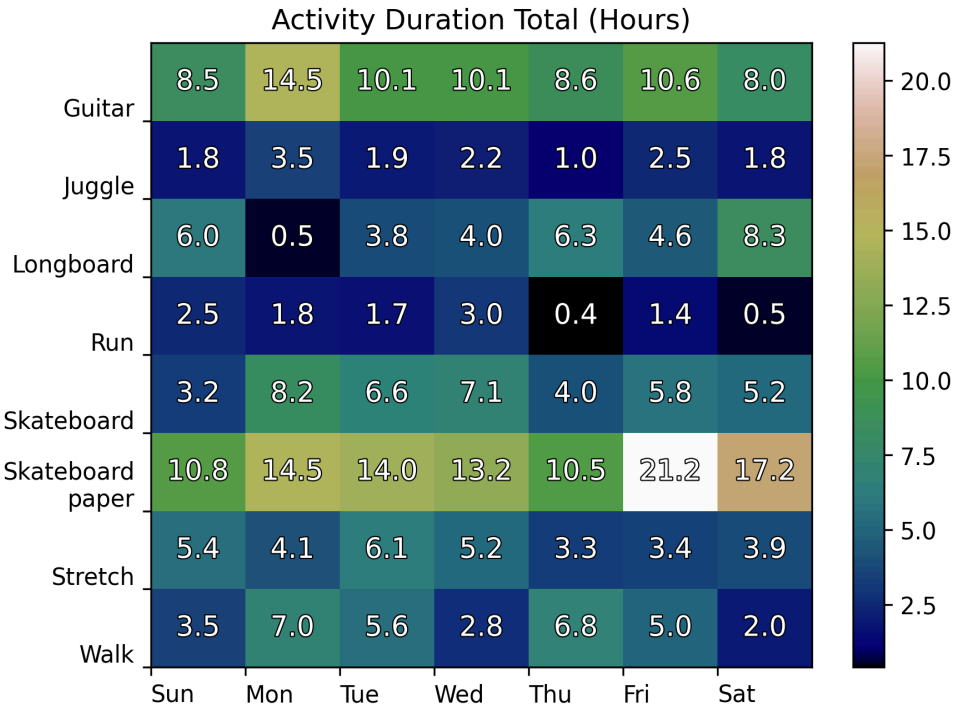

Figure 5: The total duration of activities for the day of the week.

Activity duration by hour is summarized for the eleven most common activities. No movement exercises such as performing analytics for this paper and practicing guitar received most of the cumulative hours with 102 and 70 hours respectively. The most time costly exercises for inflammation reduction was walking at 33 hours, followed by stretching with 31, and

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*).

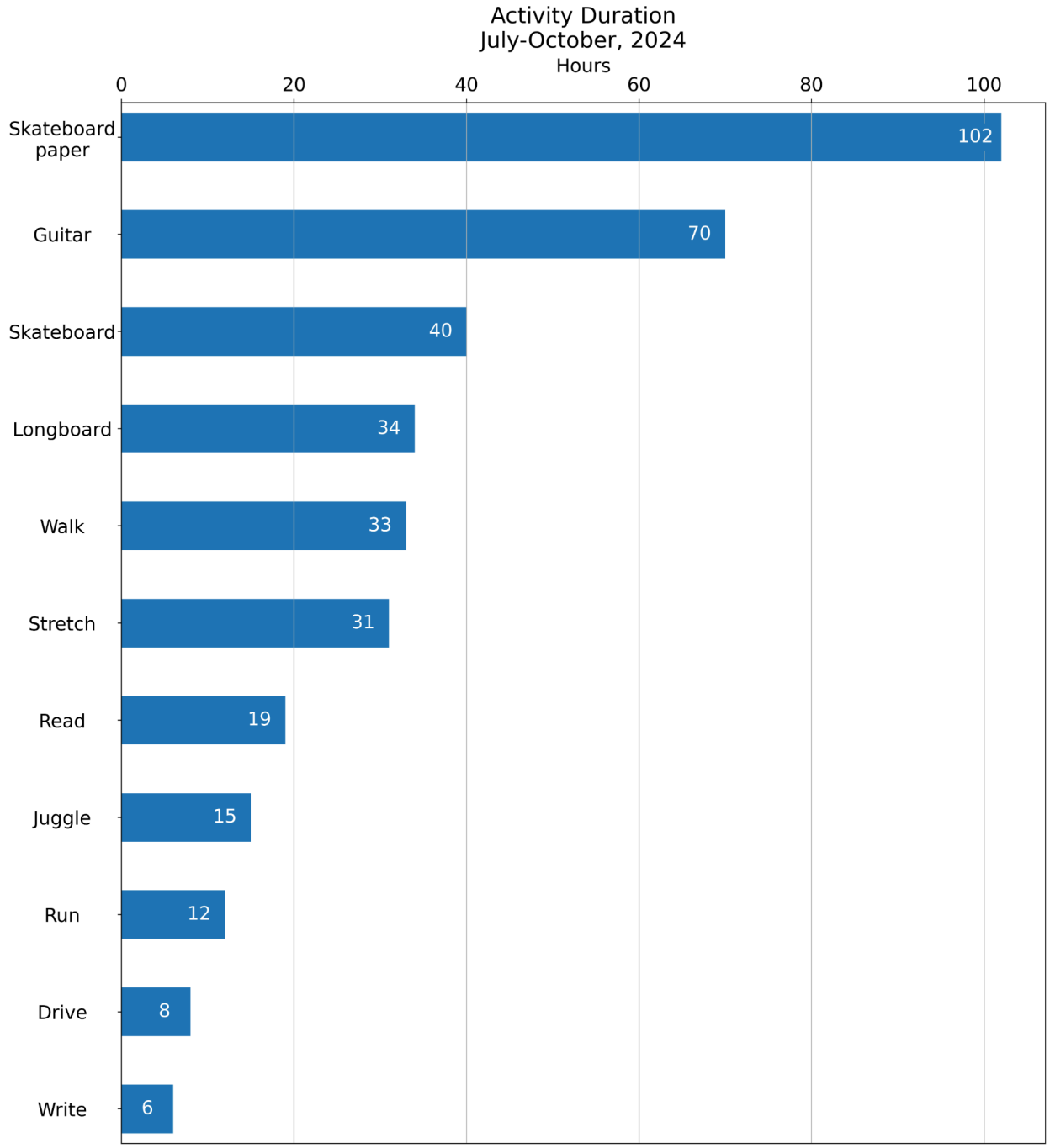

Figure 6: The total amount of time spent on the top 11 activities in hours.

Activity frequency was also calculated for the top eleven activities. Guitar was the most frequently occurring topic at 131 plays and is over double the next most frequent no movement activity with academic research for this paper at 65 events. Stretching was the most frequently occurring low movement exercise with 93, walking occurred 53, juggling had 31, and core exercises at 18. High intensity cardiovascular exercises included longboarding with 41 events, skateboarding at 39, and running at 18. Reading and writing not related to academic research occurred 14 and four times in the study period and there were two long driving events (*Figure 7*).

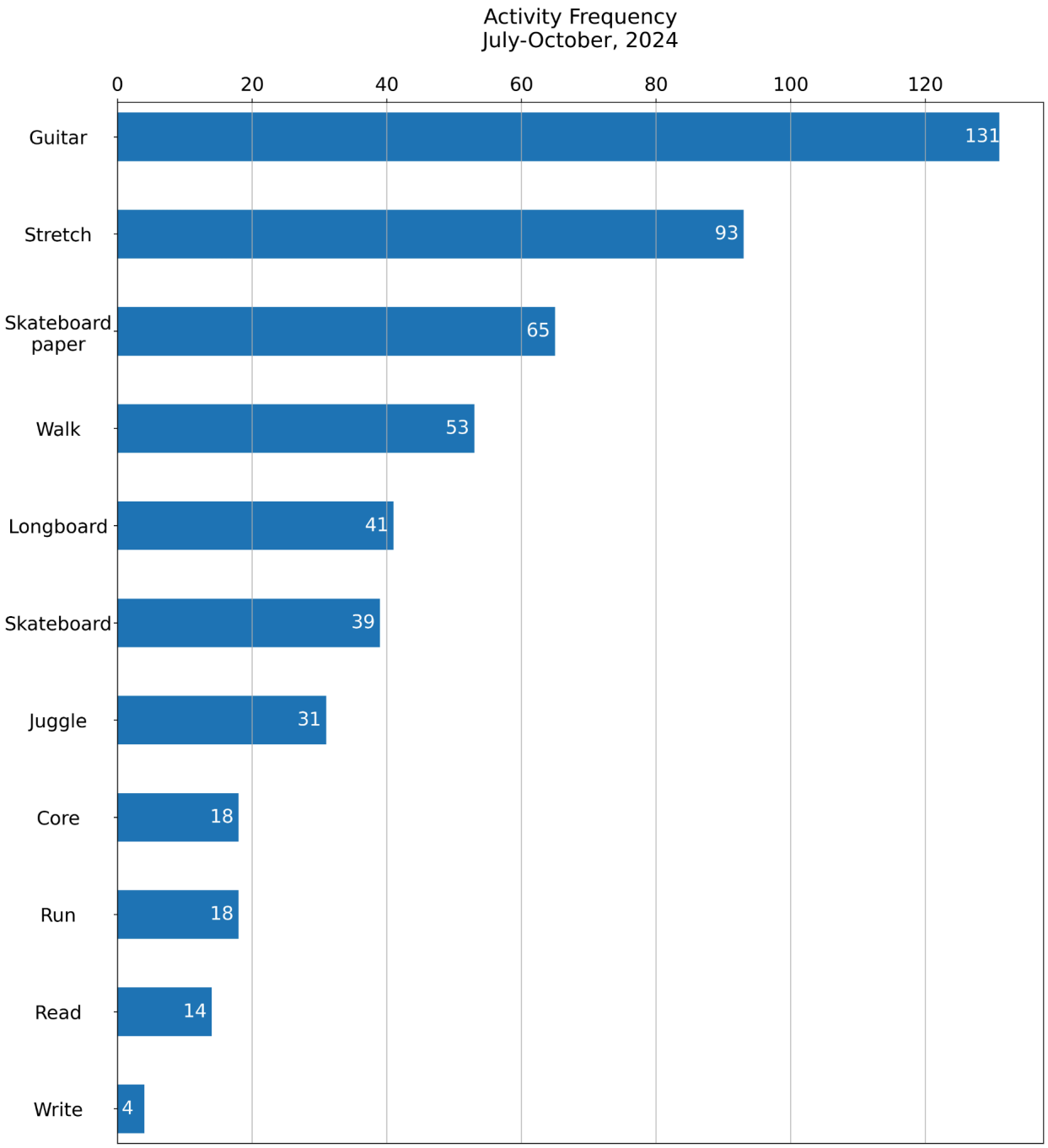

Figure 7: The total amount of times the top 11 activities were performed.

The next bar graph displays the average amount of time in hours spent on each activity when it was performed. The longest daily average event was taking a break and drinking beer with 5.0 and driving at 3.88 hours and is misleading since those two activities were only recorded three times throughout the study period. Drinking beer and not moving is an anomaly that warrants mention since active recovery for inflammation reduction either proceeds or immediately follows typical alcohol patterns. This 100 day record keeping period indicates 7 days of binge drinking or more than 4 servings at one time, one day of excessive binge drinking, and two seven day windows that exceeded over 14 drinks indicating low phases of alcoholism. The length of driving time is included to explain the early September headache episode. The next longest time spent per session was academic research for skateboarding at 1.56 hours. Guitar was not in the top ten despite amassing a significant amount of daily minutes since practice was short and frequent. Walking, stretching, and juggling were also absent despite appearing repeatedly on the previously listed top activity frequency charts. Writing and reading took 1.5 and 1.34 hours on average yet were not often performed. Skateboarding, watching skateboarding videos, hiking, and longboarding were typically hour long events (*Figure 8*).

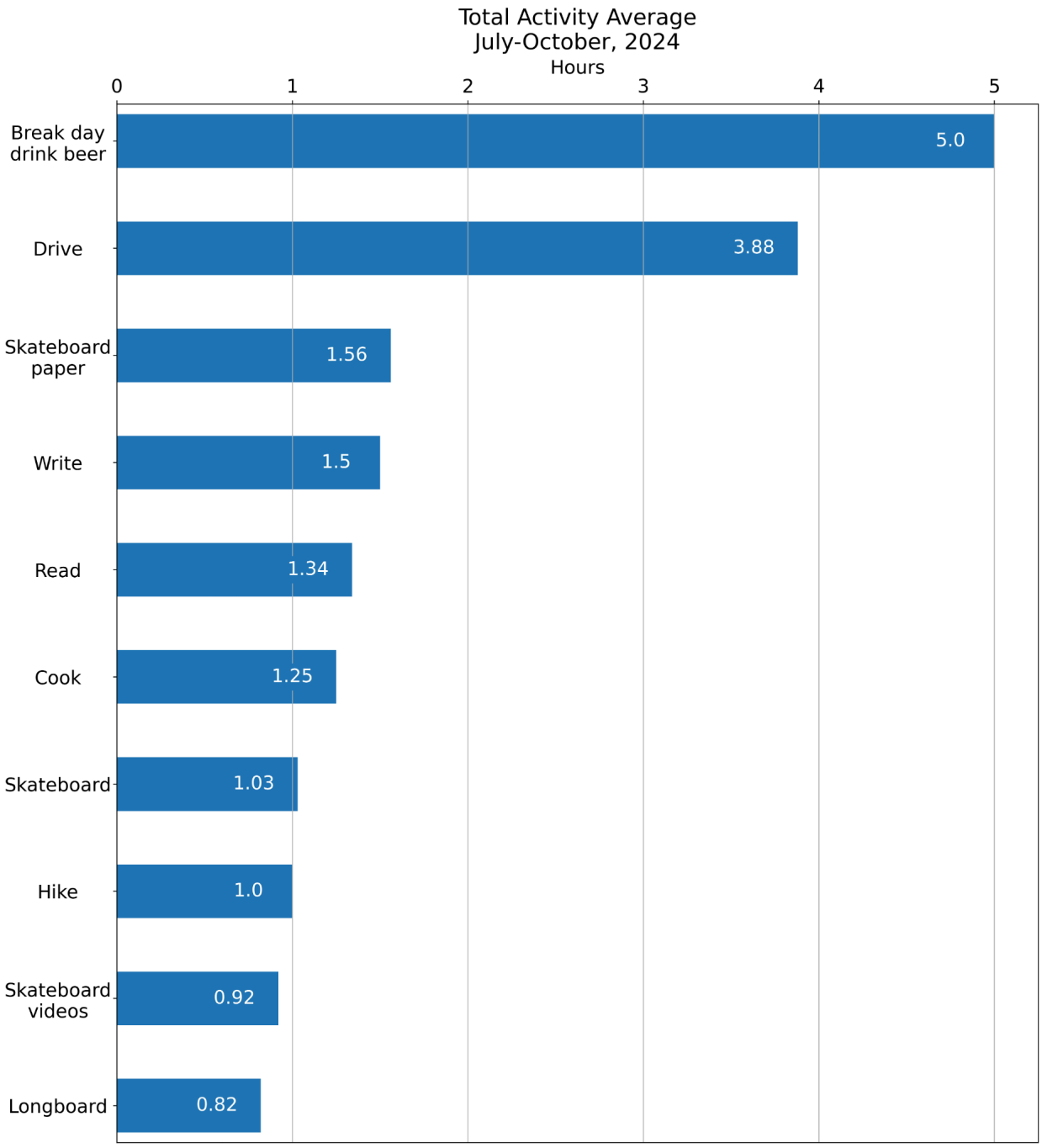

Figure 8: The average amount of time in hours spent on an activity when it was performed.

The average daily time spent on each activity combines the frequency and the length of the study period. The skateboard paper was worked on for 61 minutes per day compared to skateboarding with 24 and longboarding with 20. Guitar had the second most minutes with 42. Walking and stretching had 20 and 19 average daily minutes. Reading included content not from social media comments and news or related to skateboarding articles averaged 11 minutes per day. Juggling averaged 9 minutes, running summated 7, and driving accrued 5 minutes per day (*Figure 9*).

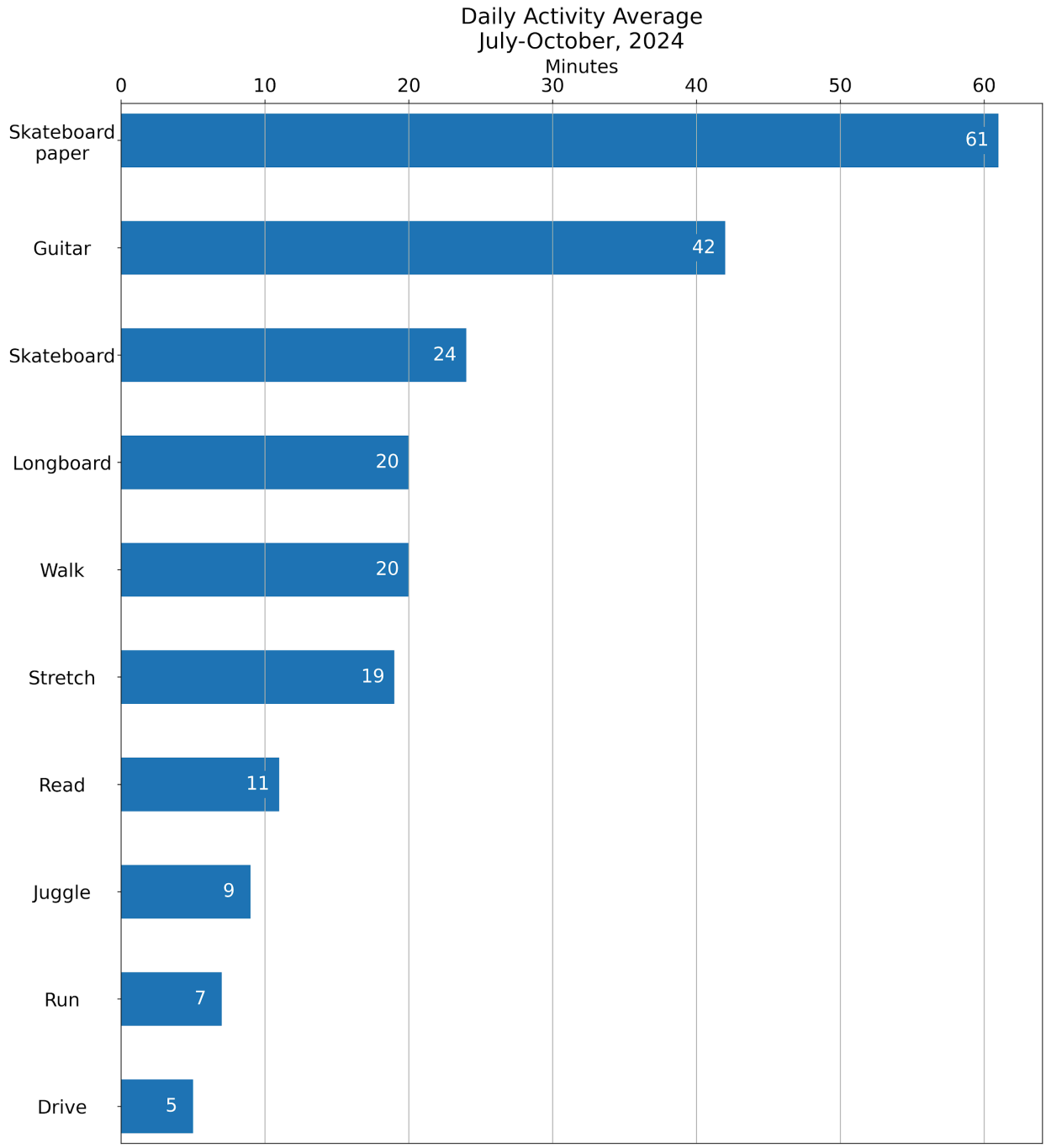

Figure 9: The average amount of time spent daily on each activity in minutes.

Graphs document the study period's activity frequency, time of day, and weekday. The five heatmaps and four barcharts support a skateboarding oriented exercise schedule completed

seven days of the week between 0700 and 1100. Skateboarding typically took place in the morning while inflammation reduction events were sporadically included throughout the rest of the day. Guitar and academic research consumed most of the time regardless of the day. Stretching and guitar were the most frequently occurring activities everyday while events like academic research, walking, and skateboarding had secondary values and is mostly supported by information from the daily activity total hour chart with academic research for this paper having irregularly larger total hours. Average duration when an activity was performed clarified low frequency tertiary events like alcohol use and long drives. Documented time directly supporting skateboarding took 4-5 hours per day from 0900-1900 while estimated time cooking and eating from one week of exhaustive recording accumulated 1-3 hours.

Pain Charts

The perception of pain was recorded on an arbitrary scale to identify weak areas while skateboarding. The 1-5 scale is identical to the previous chapter and groups specific muscles into 17 general areas with the exception of knee pain which was categorized as quadriceps pain. Specific information was recorded for the head, neck, shoulders, biceps, triceps, trapezius, latissimus dorsi, lower back, chest, abdominals, groin, gluteus, quadriceps, knees, calves, ankles, feet, and stamina. Hamstrings were rarely sore from skateboarding and are included in text summaries. Stamina was also recorded on the same scale to estimate exhaustion. These ten bar charts had values that were averaged every five days. The first two graphs display body areas that had consistently high pain values. The next five plots summarize 14 selected general areas into body regions on the same graphs for 'Head', 'Upper Back', 'Core', 'Upper Legs', and 'Lower Legs'. The 'Arm' graph for 'Biceps', 'Triceps', and 'Chest' are not individually included because there is no discernible difference between the values. The next two graphs compare the three categories for 'Upper Body' and three for 'Lower Body' on the same grids. The final line chart encapsulates the 17 categories from six broader regions through averaging into two lines representing 'Upper Body' and 'Lower Body' to compare with stamina.

Skateboarding from May through July and reducing inflammation caused groin pain to peak in early August. Deviating pain values coincide with a break from skateboarding and the substitution of using muscles differently with moderate running, lifting, and stretching. The highest five day pain value average was 3 and occurred from August 1st to the 5th. The outside temperatures were unusually scorching and the return to skateboarding was limited to a small indoor carpeted area. Text notes indicate sore hamstrings on July 30th and 31st after running and

lifting. The cause of groin pain was from underutilizing the upper quadriceps and hamstrings while skateboarding, overcorrecting during recovery in July, and relying on the small hip muscles to land tricks on carpet. The sore upper thighs from typically unused muscles had a difficult time recovering from dehydration and resulted in reduced hip flexion. The remaining period was unremarkable for groin pain (*Figure 10*).

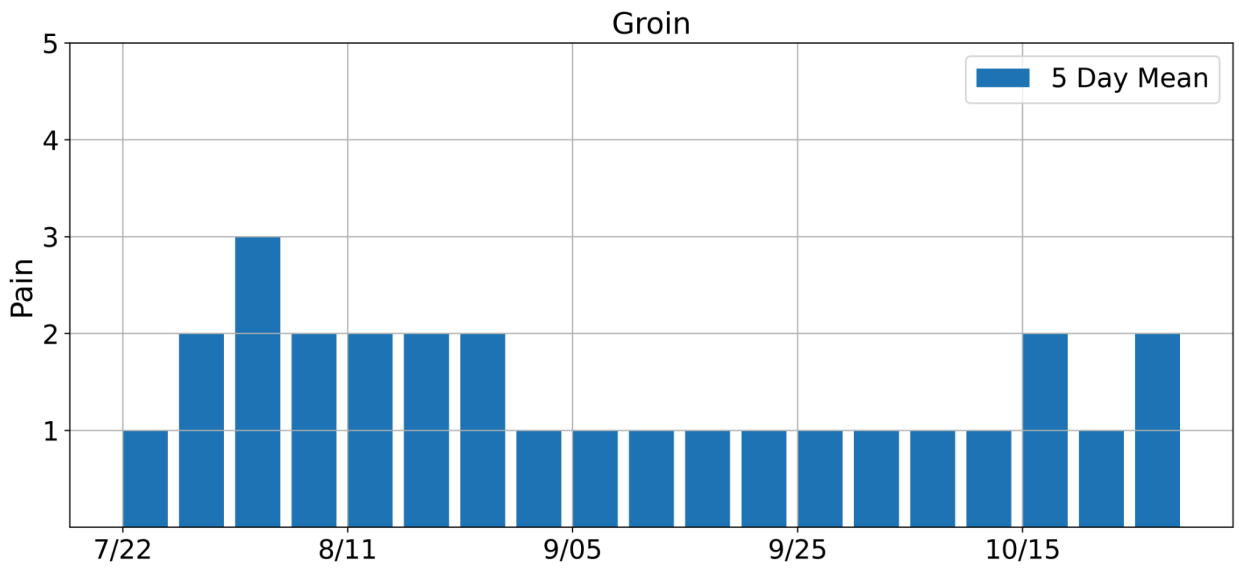

Figure 10: Five day averages for groin pain.

Quadricep soreness emerged before the data record period and forced the brief respite. This pain was initially apparent in the right lower lateral vastus lateralis with five day scale averages between 2 and 3 for the first month of data collection. This pain was reduced in the second and third five day averages after the cessation of skateboarding. Upper quadricep pain appeared after running in the third average bar. Skateboarding resumed outside on August 5th and lower quadricep pain returned on the seventh. Lower lateral quadricep pain was consistently

moderate for the remainder of the month except from September 7th through the 18th when a short intermission occurred (*Figure 11*).

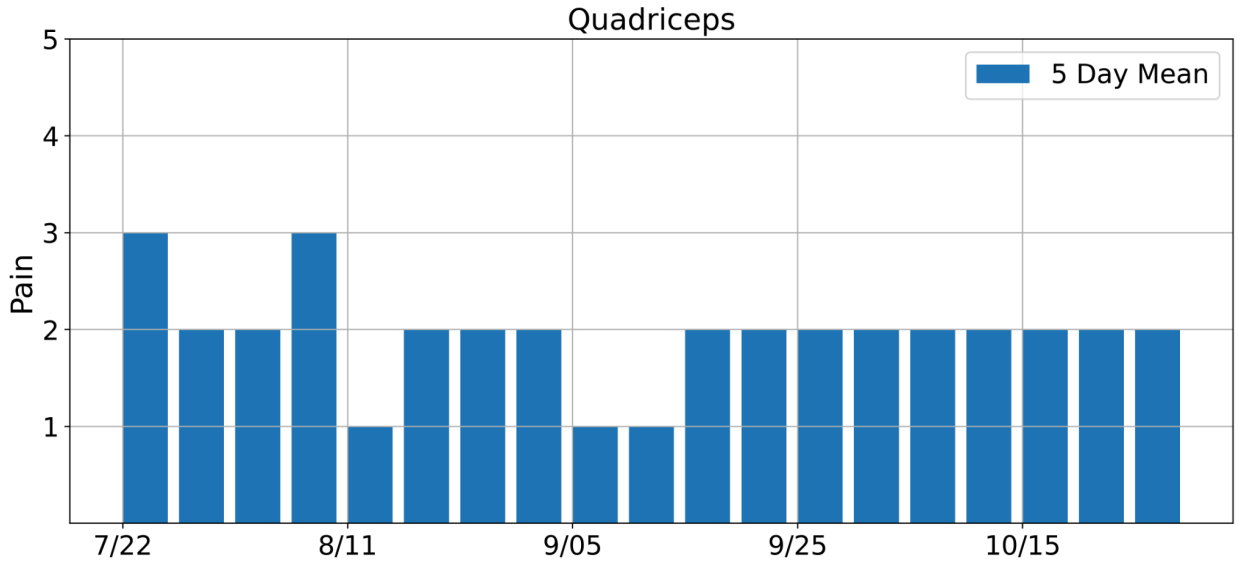

Figure 11: Five day averages for quadriceps pain.

The generalized muscle groups were further conglomerated into six classes and compared. 'Neck' and 'Head' pain lines were drawn on the 'Head' graph. There was greater neck pain at the end of July that was reduced from resting. The same posterior neck muscles were again sore starting August 25th and ending September 3rd. Both of the abnormal pain values were after several weeks of skateboarding. The beginning of September also had an episode of severe head pain after driving several hours for an overnight family wedding followed by neck pain. Head pain returned for the section around September 25th. All three periods of head and neck pain can be ascribed to inefficient hydration and nutrients (*Figure 12*).

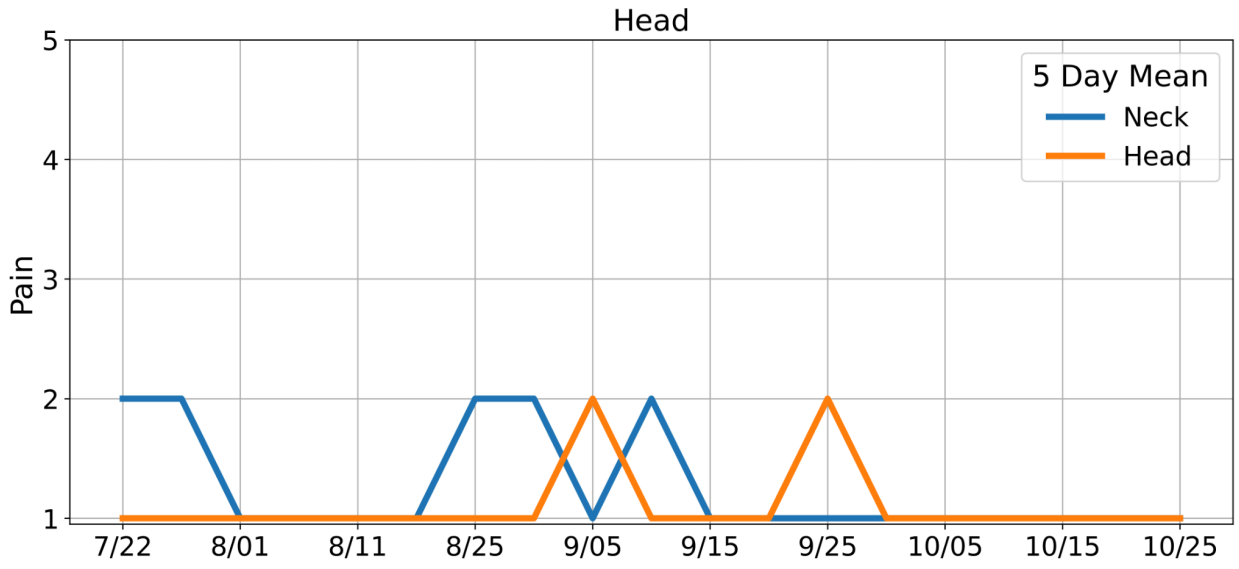

Figure 12: Pain for the head and neck were compared in the 'Head' category.

The graph for 'Upper Back' contains information for five-day averaged 'Latissimus Dorsi', 'Trapezius', and 'Shoulders' pain. The first spike for elevated pain in the shoulder and trapezius muscles occurred in the second five day average at the end of July and was from extended hours juggling to enjoy the summer weather. The second higher shoulder soreness period happened in the middle of August from learning five ball juggling while reducing lateral quadricep pain from skateboarding. The final abnormal pain was recorded after September 15th for trapezius and is from forward leaning posture while walking and longboarding as an alternative exercise while the right lower quadricep pain was subsiding. Head or neck pain followed the second and third trapezius soreness events but not the first event because the leg muscles were too exhausted to perform other exercises (*Figure 13*).

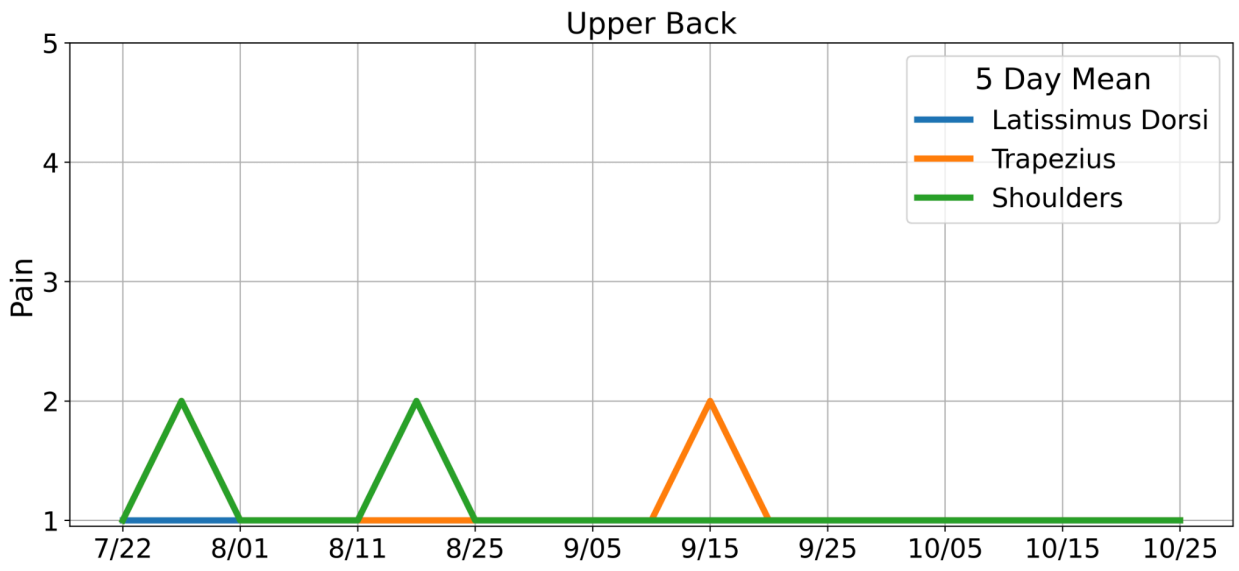

Figure 13: Muscles for the 'Upper Back' included the shoulders, latissimus dorsi, and trapezius.

The next graph combines information regarding the 'Core' separated into the abdominals and lower back. Lower right back pain was documented in the participant's medical history as multifidus soreness from exercising but back pain did not appear during the data collection period. The left anterior torso experienced pain the first period of September and originated from successive incidents. The board erroneously rotated 90 degrees toeside during a switch frontside 180 at the end of August resulting in a hard fall on a truck and bruising the right gluteus medius. The left core was overworked in subsequent longboarding, walking, and stretching events. Left core pain retreated during the driving induced head pain respite and returned as lower abdominal pain between September 10th and 15th after running. More lower abdominal soreness was experienced for the October 15th and 25th average while running and longboarding (*Figure 14*).

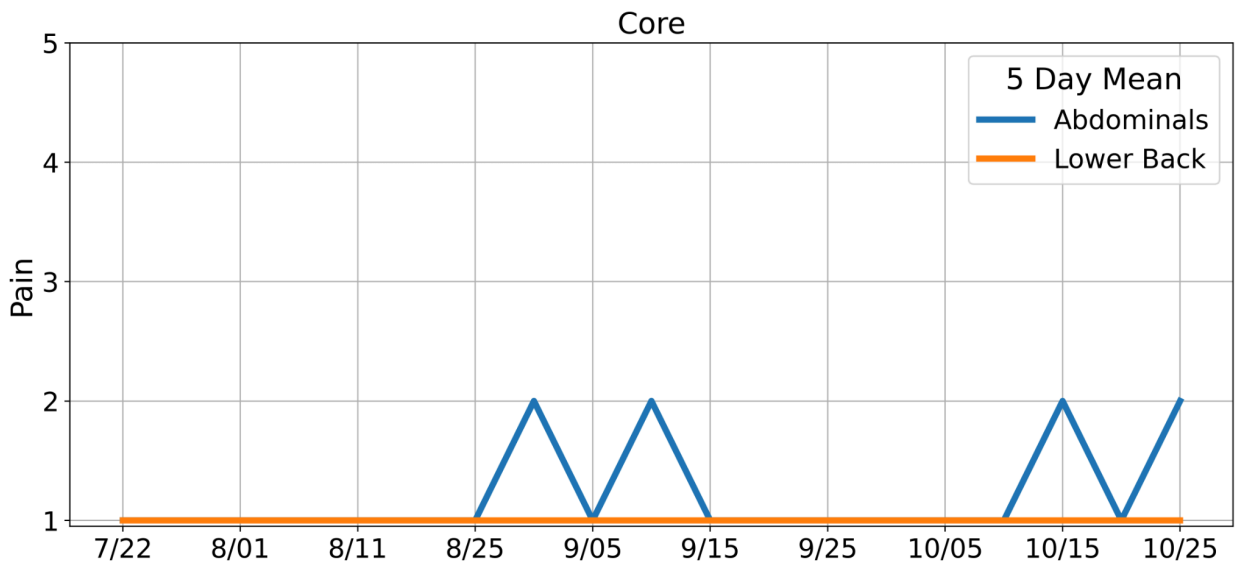

Figure 14: Pain for 'Core' included abdominals and lower back muscles.

The charts for 'Upper Legs' includes averages for knees, quadriceps, gluteus, and groin. The higher pain values in the first two weeks was preceded by unrecorded skateboarding. Chapter 11 categorized lower quadriceps pain as knee pain and was changed to more accurately reflect anatomy. Lower lateral quadricep pain continued through the middle of August before withdrawing the first two weeks in September. Quadriceps pain reemerged in the middle of September and was perceptible the remainder of the study period while skateboarding. Groin and gluteus pain are observed while lifting weights in the first recovery period. The last two averaged anterior hip pain records occurred at the end of October while practicing left stanced heelslides and running (*Figure 15*).

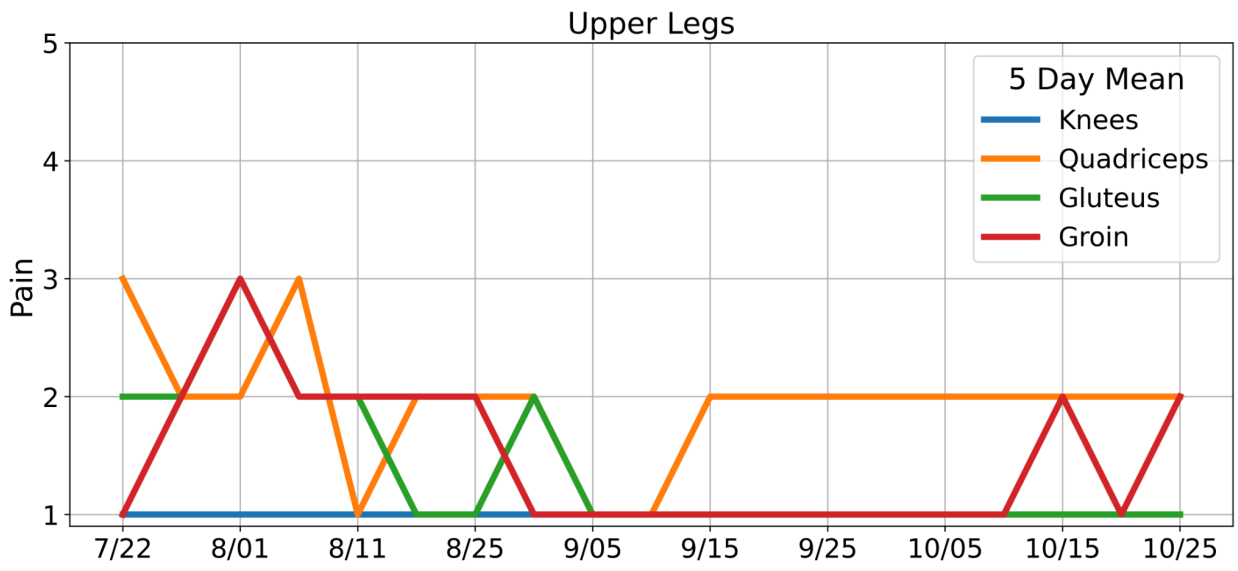

Figure 15: The muscles for the groin, gluteus, quadriceps, and knees compared in 'Upper Legs'.

The 'Lower Legs' category included muscles in the calves, ankles, and feet. The pain scores for feet had one abnormal value on August first and are from walking, running, and learning the kickflip. Ankle and calf pain also emerged at the end of September from a 7.2 mile run. Experimenting with different stride and arm mechanics to conserve energy led to unintentional lower leg pain. Gastrocnemius and soleus pain returned in the last five day period of October from switch stanced longboarding and walking. None of the daily values for lower legs were above two indicating low pain (*Figure 16*).

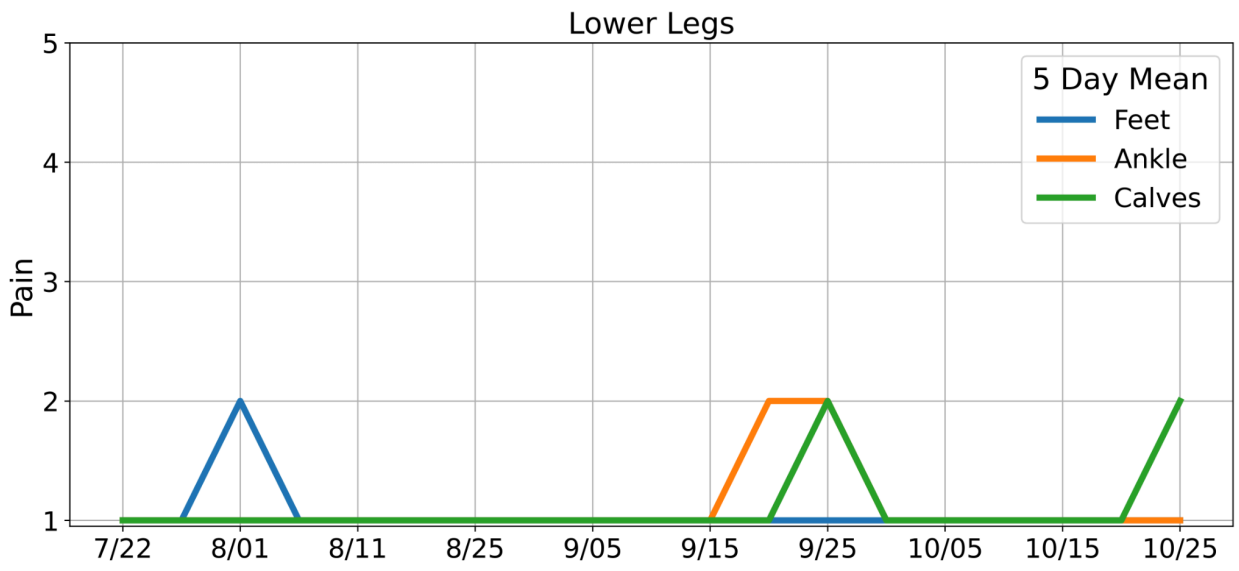

Figure 16: The muscles for Calves, ankles, and feet compared in 'Lower Legs'.

The 'Upper Body' graph includes five day averages for the headers in *Figures 12* and were used to define categories that were averaged allowing comparison of 'Head' and 'Upper Back' muscle pain groups. The individual pain graph comparing triceps, biceps, and chest was left out since there was little variation but they were generalized as 'Arms' in *Figure 17*. The three categories experienced elevated pain the last week of July and varied as different muscles were rehabilitated. There was a long period of 'Head' pain from the middle of August to the middle of September caused by exercise and dehydration from inadequate nutrition. The middle of August and September experienced two individual elevated pain records. There was higher neck pain on September 25th from moderate temperature induced running with text notes indicating inflammation throughout the body. There was reduced pain from the middle of September until the end of October from limited juggling and skateboarding practices (*Figure 17*).

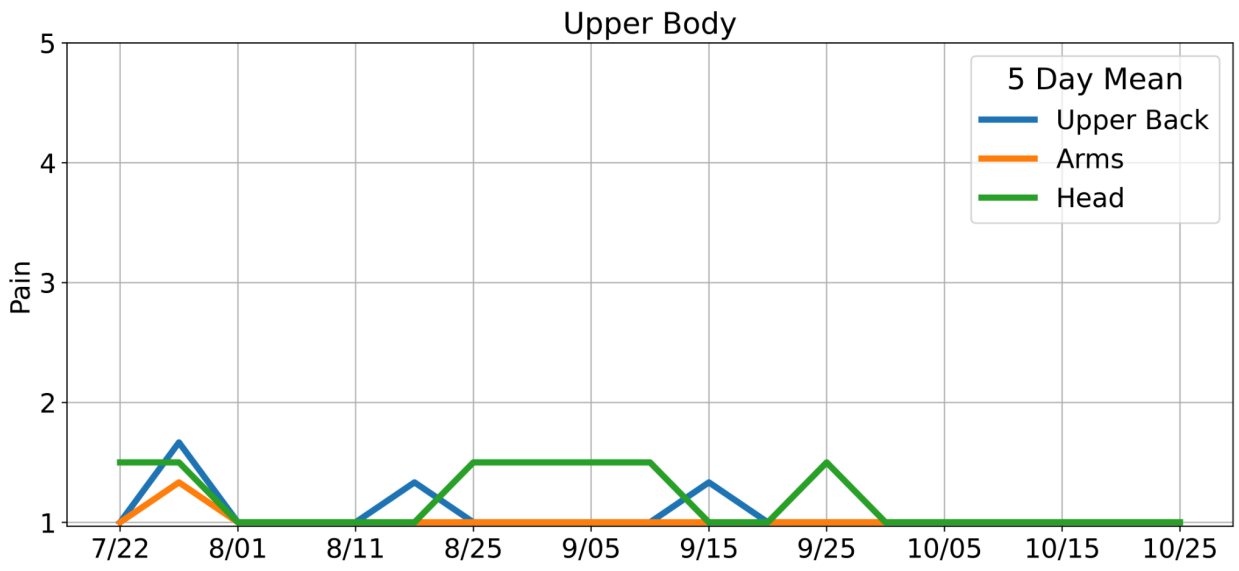

Figure 17: The averages for the muscles in upper back, arms, and head for the 'Upper Body'.

The 'Lower Body' graph also averaged the five day mean values for *Figure 14* through *Figure 16*. The 'Lower Legs' category was more painful from the start of the study period in July until early September and was diminished from dehydration induced head pain. The primary cause was right lower anterior abductor muscles which were again sore from the middle of September until the end of the study period. Both categories for 'Lower Leg' and 'Core' pain were from running and subsequent abdominal exercises. There were three instances of 'Lower Leg' spikes on August 1st, September 20th through the 30th, and October 25th. Amplified 'Core' pain was apparent starting September 1st and the 10th from gluteus bruising and following over reliance on the opposite muscles while recuperating. The torso was also sore on October 15th. All three categories experience heightened values on October 25th and beyond from the anticipation of cold weather, overuse, and barometric pressure anomalies (*Figure 18*).

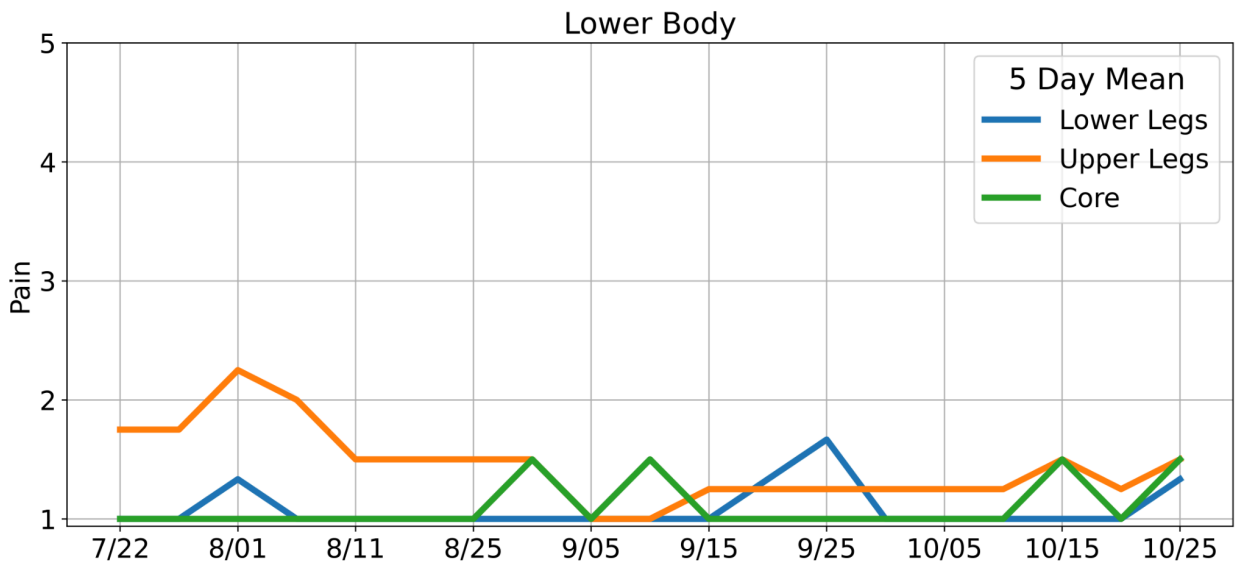

Figure 18: The 'Lower Body' compares the averages for the core, upper legs, and lower legs.

The categories for 'Upper Body' and 'Lower Body' were further coalesced to compare with stamina on the same chart. Stamina was variable from the start of the data collection until the end of September when it remained constant. *Figure 19* is included to find overuse patterns but the only discernable observation was high pain and less stamina at the start of the study. There were high values for stamina at the end while pain also increased. The second data collection was intended to find specifics about the causes of exhaustion from high pain and the generalized chart provides unspecific answers.

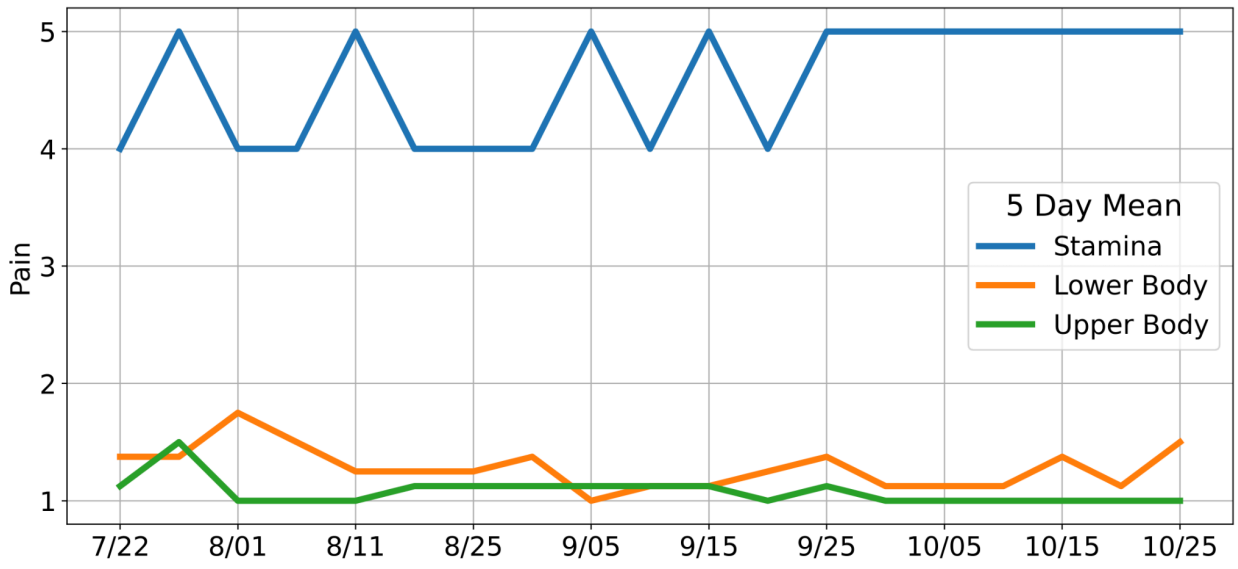

Figure 19: The pain chart compares the averages for upper and lower body with stamina.

Muscular soreness patterns were unearthed by recording pain values for several months while learning fundamental skateboard tricks. Head pain was observed on two instances and originates when the entire body is overused with inadequate fluid intake. Shoulder pain was caused by errant rotator cuff movements while juggling. Lower quadriceps pain caused overcorrecting from running and lifting resulting in groin and core pain from differently angled use. Alternating foot positioning during running led to unintentional lower leg pain. Longboard heelslides stretched the lower legs but inflamed the hip and upper quadricep muscles. Cycling through different exercises prevents boredom and allows for systematic training.

Pain Prediction

One day forecasting predictions were performed each night for the 17 categories to measure the effectiveness of the exercise regiment through estimating the next day's pain. This was recorded to save time through effective preventative stretches. The categories selected for inclusion were 'Head', 'Neck', 'Abdominals', 'Groin', 'Quadriceps', and 'Gluteus'. These body areas are observed because they were exercised the most and had a variety of values. Traditional classification metrics to evaluate the predictions included *Accuracy*, *Precision*, *Recall*, and *F1 Score*. Erroneous prediction values and the accompanied observation are magnified through legend scaling while correct predictions are minimized. Each point is plotted in contrast to the five day averages in the previous figures.

The value for 'Head' pain *Accuracy* had a value of 0.78 indicating above average effectiveness at predicting whether there would be head pain. Previous 'Neck' or 'Trapezius' pain is an indication of following head pain and explains the accuracy. The value for *Precision* was 1.0. The value for *Recall* was 0.99. The value for *F1 Score* was 0.99. These results indicate low false positives and false negatives (*Figure 20*).

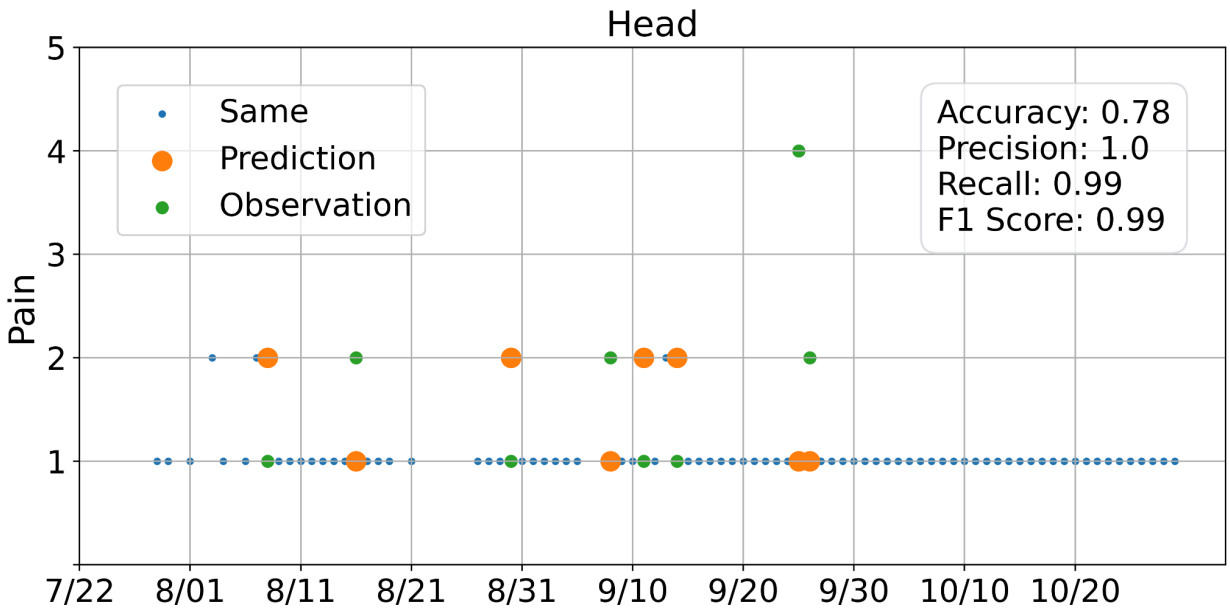

Figure 20: Prediction and observation accuracy report for head pain.

'Neck' pain had below average prediction accuracy with a score of 0.68. The value for *Precision* was 1.0. The value for *Recall* was 1.0. The value for *F1 Score* was 1.0. These results indicate no false positives or negatives. The chart displays a variety of over and under predictions compared to the observations, the most striking of which are under-predictions before two episodes of perceptible head pain during September (*Figure 21*).

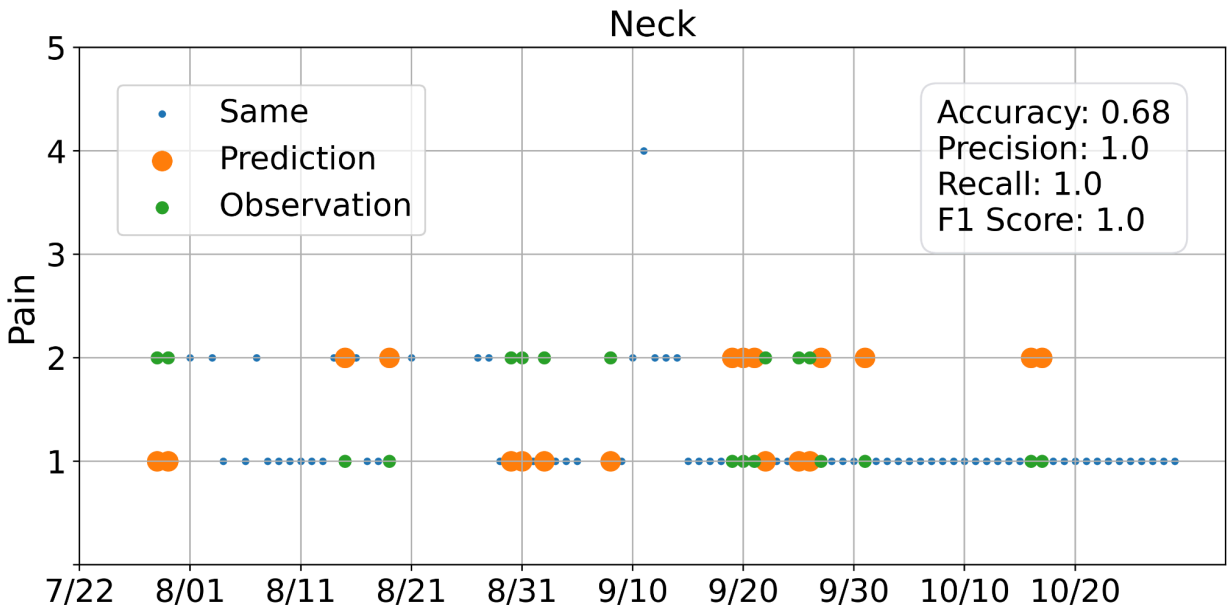

Figure 21: Prediction and observation accuracy report for neck pain.

'Abdominal' pain had below average prediction accuracy with a score of 0.71. The value for *Precision* was 1.0. The value for *Recall* was 0.97. The value for *F1 Score* was 0.99. These results indicate almost no false positives or negatives. The lower left abdominal had an unpredicted high pain value of four on August 31st from stretching and overcorrecting after a fall developed a large contusion on the right gluteus medius. Running gait mechanics were experimented on in the days before September 13th with the feet rotated more forward instead of pointing the toes outward and resulted in lower oblique soreness (*Figure 22*).

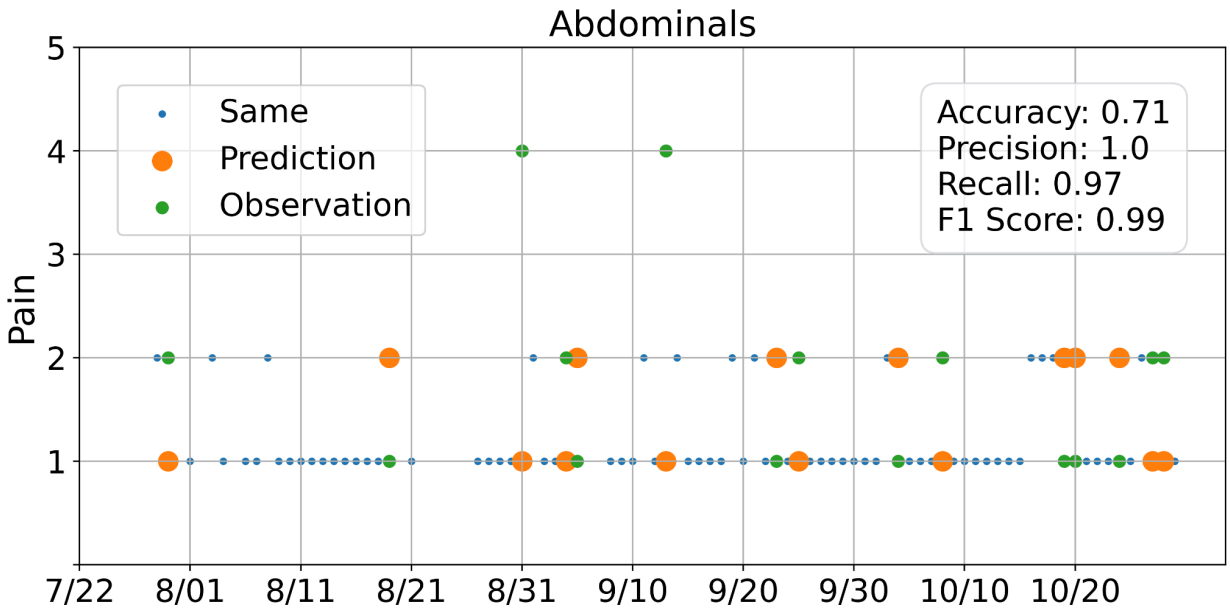

Figure 22: Prediction and observation accuracy report for abdominal pain.

'Groin' pain had below average prediction accuracy with a score of 0.65. The value for *Precision* was 0.97. The value for *Recall* was 0.97. The value for *F1 Score* was 0.97. These results indicate very low false positives or negatives. The groin experienced pain from running, switch pushing, and heelslides for several days starting October 16th (*Figure 23*).

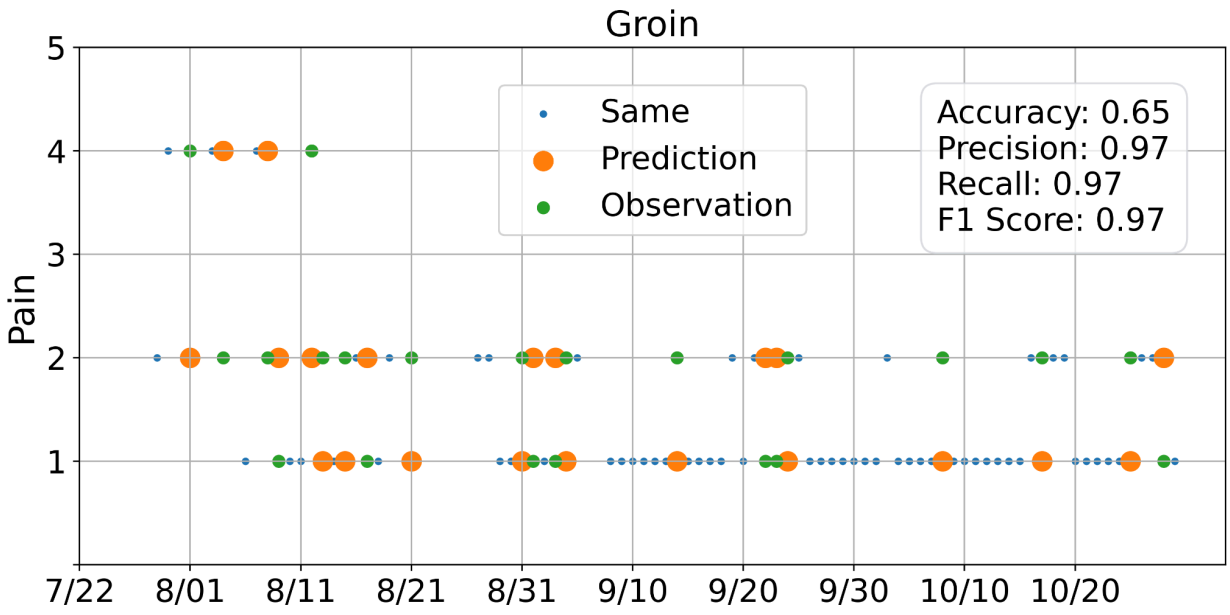

Figure 23: Prediction and observation accuracy report for groin pain.

'Quadricep' pain had low prediction accuracy with a score of 0.59. The value for *Precision* was 0.95. The value for *Recall* was 1.0. The value for *F1 Score* was 0.98. These results indicate very low false positives or negatives. The quadriceps experienced several instances of unexpected pain from October 16th through the 25th from overuse (*Figure 24*).

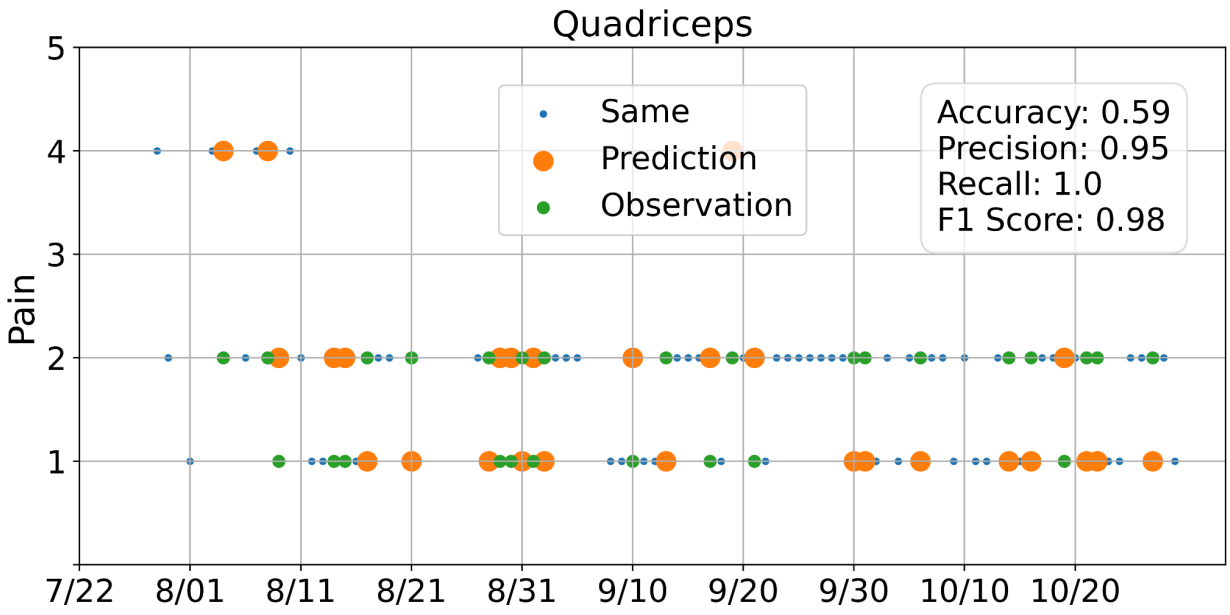

Figure 24: Prediction and observation accuracy report for quadricep pain.

'Gluteus' pain had below average prediction accuracy with a score of 0.68. The value for *Precision* was 1.0. The value for *Recall* was 0.99. The value for *F1 Score* was 0.99. These results indicate very low false positives or negatives. The middle of August had unanticipated gluteus medius pain while learning regular stanced BS 180s from August 10th through the end of the month. The return to skateboarding September 18th after time off included regular stanced pop shove its and BS 180s on both legs and gluteus medius pain was observed the following day. More gluteus pain was predicted on October 17th after a week of switch stanced heelslides but was not observed (*Figure 25*) and text notes indicate sore calves, hamstrings, and shoulders.

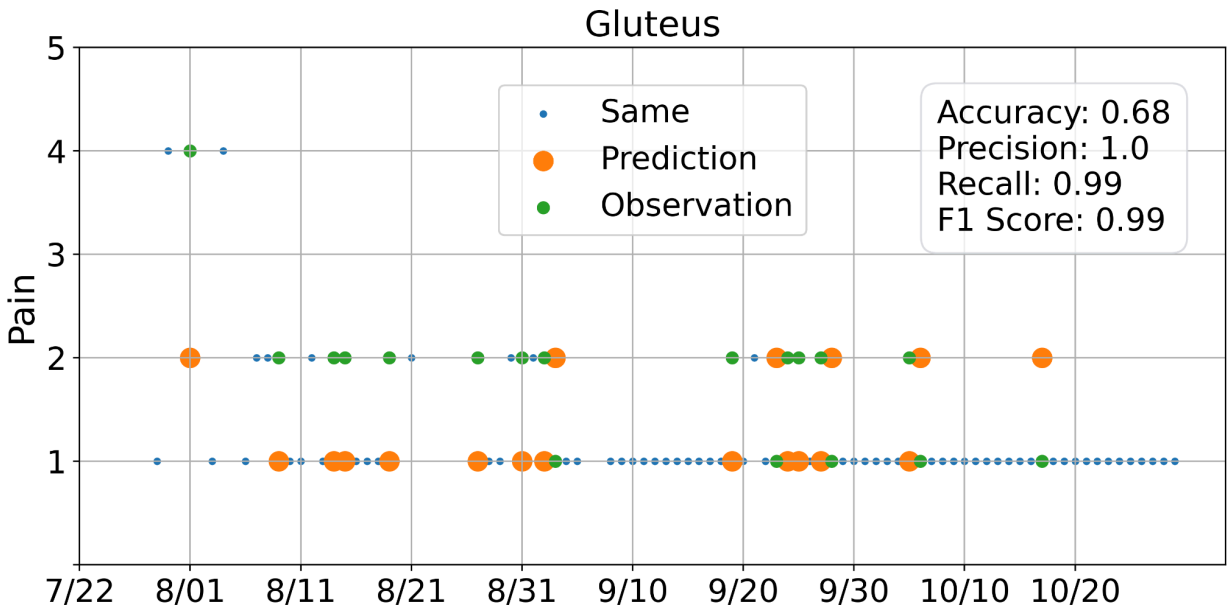

Figure 25: Prediction and observation accuracy report for gluteus pain.

Human prediction achieved between moderate or bad accuracy scores and several muscle groups were not included. The accuracy score for 'Head' pain was the highest yet the manual predictor missed both of the two debilitating events. The 'Neck' had more instances of pain and the values sometimes appeared with headaches but had bad accuracy predicting episodes. Forecasting abdominal pain was also below average and guessing groin pain was abysmal yet both are associated with running and longboarding. Prediction accuracy for the quadriceps and gluteus were also below average but it was discovered that BS 180s increases gluteus medius soreness. All of the predictions were good at avoiding false positives and negatives.

Activity Frequency Before Pain

One idea for the cause of more painful bodily parts was the number of activities before an event. The first ten days of observations were not included to allow backtracking. The first chart averages the number of daily activities prior to a notable painful event and is compared with no pain and the entire dataset. The dimensionality of the mean is expanded for time in the next chart that lists each painful event with 3, 5, 7, 10, and 30 days of average daily prior activities. Notable pain and stamina events were classified as values over or under three. The final chart compares kcal intake and expenditure to analyze diet, activity, and muscular soreness.

Average daily activities before an event were plotted by the number of days in reverse. There were 52 higher pain values with decreasing counts as the number of 'Days in Reverse' increased. The category for three days in reverse had a value of 6.5 average daily activities before 14 painful events. The value for the five days in reverse bin was 6.3 and had 12 events. The mean daily activities for seven days in reverse was 5.9 for a count of ten. The next included activities for ten days before and had a value of 6.1 for nine events. 30 days in reverse had a smaller amount of events at seven but had a greater daily average number of activities with 6.7. No pain and the rest of the data averaged between 5.1 and 5.3 mean daily activities before an event. Muscular soreness transpired when one or two more activities than normal were completed for the 95 days of record.

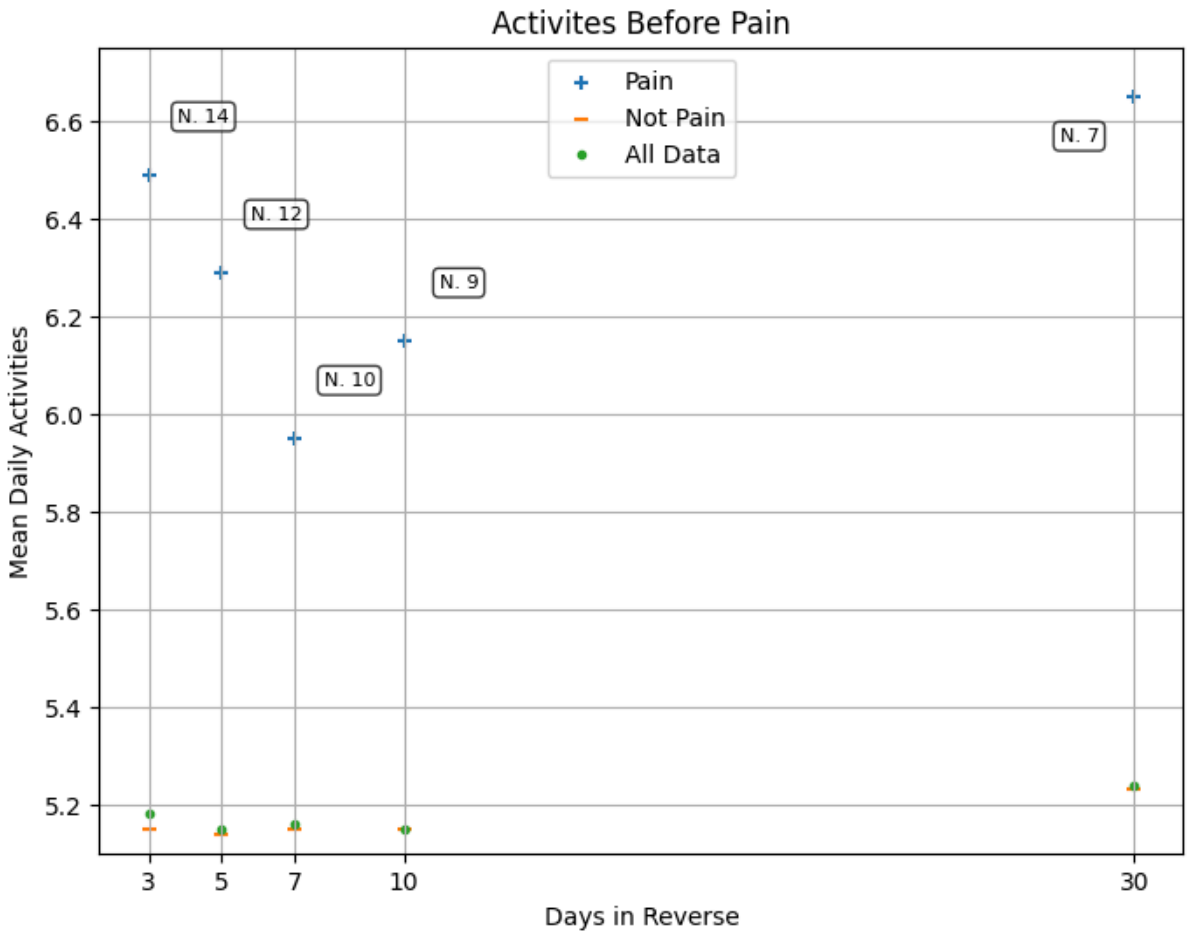

Figure 26: The average number of activities before an abnormal pain record depending on the number of days in reverse compared with no pain. The amount of high pain records is included.

The specific dates and especially sore body parts are listed chronologically. The first seven records do not have complete 'Days Before Pain'. Backtracking determined that the starting ten days of pain and activity observations would be removed since leaving out the first 30 days eliminated half of the high pain events. There were three days that had two elevated body area values on August 4th, 7th, and September 13th. Two of these days included stamina as the other abnormal entry. Elevated soreness was the cause of initiating this second data collection. August 4th observed low stamina (Stm) and high gluteus (But) pain and had 5.75

daily average activities from the previous three days. The next two values were on August 7th for quadriceps (Qua) and groin (Gro). Both had three day values of 5.75 compared with five days values of 6.00. More quadricep pain was experienced on the 10th with a three day average of 6.30, five day average of 6.45, and seven day average of 6.00. The average daily activities before groin pain on August 12th were between 5.75 and 6.00 for all the categories except for 30 days in reverse. The final incomplete category occurred on August 29th for Stamina with the highest three day mean at 8.00, five day at 7.40, and ten day at 7.25.

The remaining dates have the full 3, 5, 7, 10, and 30 days in reverse. High abdominal (Abs) soreness happened on August 31st with categories for 3-10 reverse days averaging around 7.00 activities before the event while 30 day soreness was closer to 6.00. Pain in the head (Hea) took place September 7th and was the only date that had higher activities 30 days prior at 5.60 compared with the other four classifications. It was also the only day that had values below the dataset's mean of 5 activities since it was overnight travel for a family wedding. The effect of several days with low daily activities was apparent in the remaining five pain events with ten and seven day means near the dataset mean. Stamina and abdominal pain on September 13th in particular had elevated activities three days before the event with a value of 7.60 (*Figure 27*).

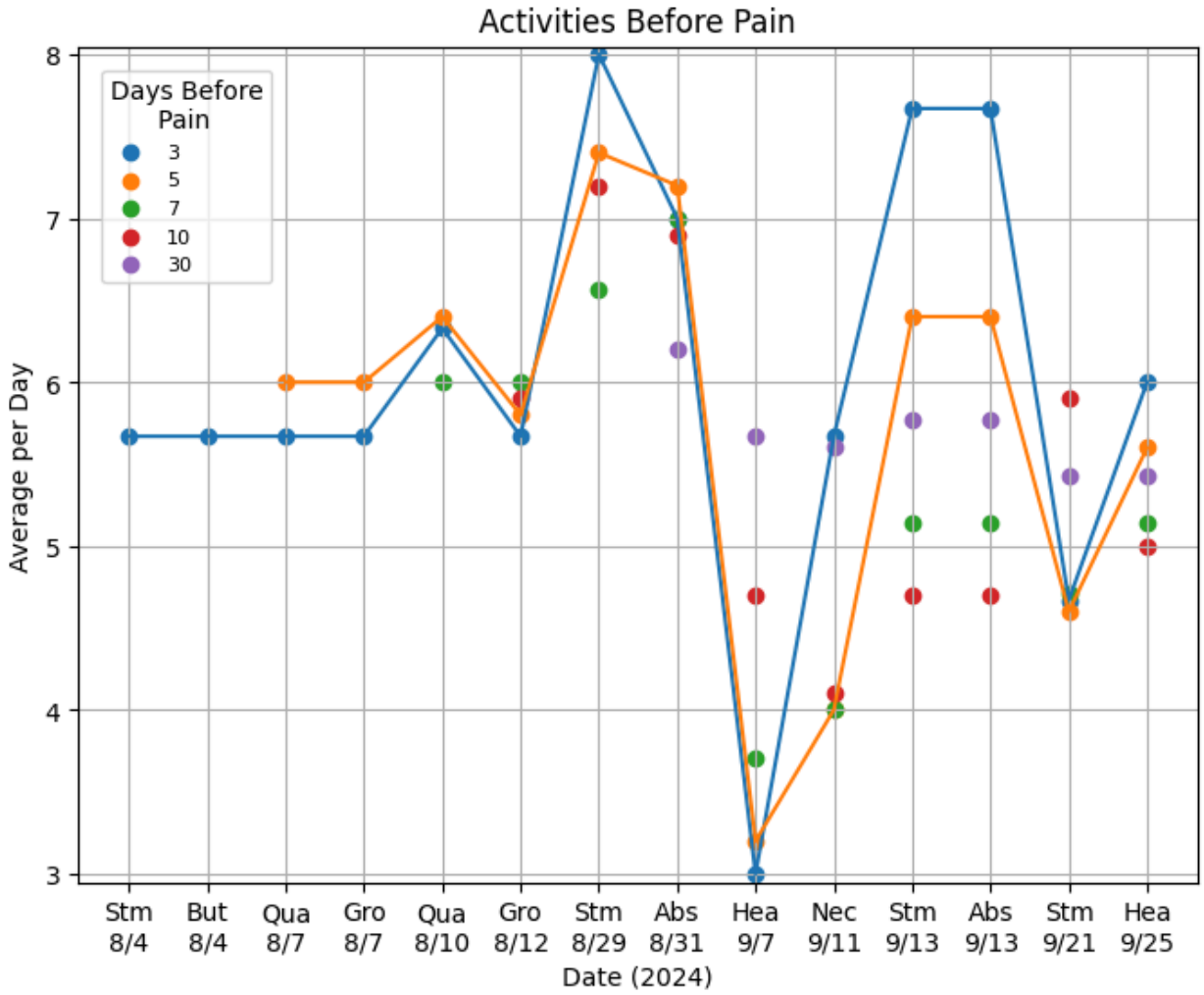

Figure 27: The average number of activities per day before every abnormal pain record.

The final graph charts kcal eaten, calories used for exercise, and the net difference. Energy budgeting partially explains pain. The energy deficit was estimated using a RMR of 2,200 kcal per day by several equations. Spreadsheet software estimated that the average daily amount of food consumed throughout the study was 2,422 kcal. The average amount of calories used for exercise was 315 kcal per day for a net loss of 3.62 pounds. The second method used Python and an energy unit burned per minute list for each of the exercises. The average daily kcal ingested agrees with the spreadsheet at 2,422 kcal but found the average amount used in

exercise every day was 652 for a loss of 13 pounds. The difference between the methods is either generalization in the first or overestimating energy burned per minute in the second. The daily calculations were averaged about every five days for the data points. Exercise consistently used between 500 and 750 calories with several outliers at 1000 and 250.

The first five days averaged eating about 3,000 calories while using about 500 for recovery efforts for a gain of 250 excess calories. This was the only entry with a net kcal gain. The next several five day averages had values around 750 calories burned by reducing diet intake. The next ten days had lower average calories lost from eating more. August 15th through the 19th had an unusual energy deficit at over 1,000 kcal burned mostly from diet while exercise remained constant. The next ten days had losses between 250 and 500 kcal. There was less exercise for the period on September 5th with no deficit while recovering from head pain. Elevated temperature and humidity decreased hydration efficiency and driving for five hours impeded fluid intake. The remaining data collection had two additional decreases in food intake. One occurred from September 10th through the 25th leading to another head pain event on September 25th. The other occurred from October 15th through the 29th and resulted in high lower lateral quadricep pain after the study period.

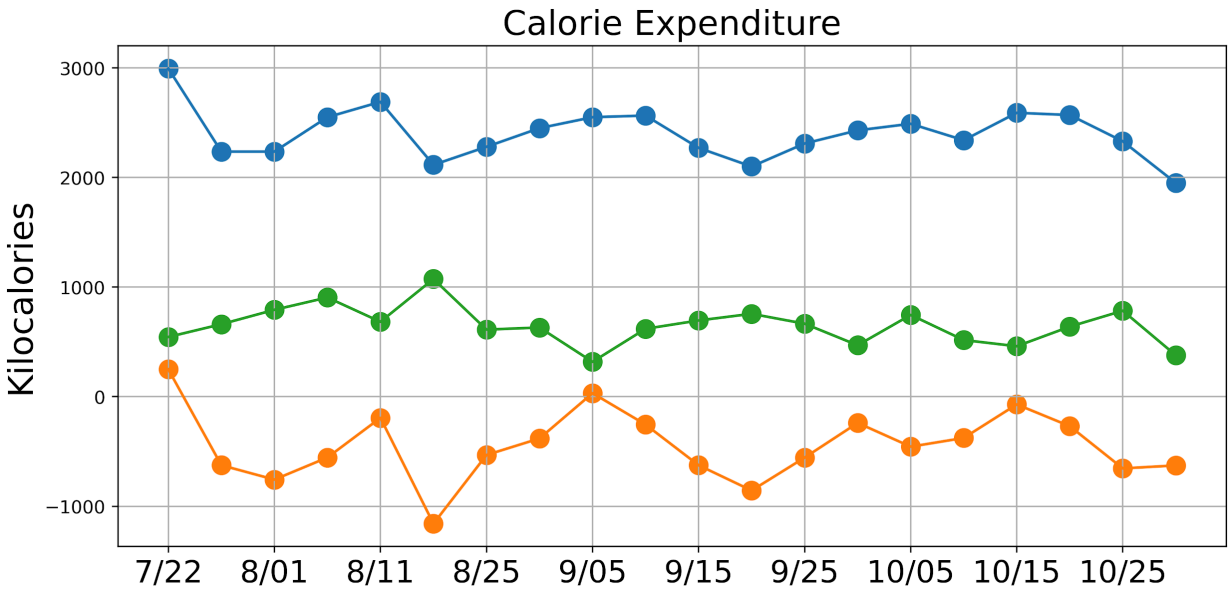

Figure 28: Five day average for kcal eaten (blue), kcal used directly through exercise (green), and the resulting deficit estimating RMR at 2,200 kcal per day.

Comparing the number of activities before pain with energy consumed and expended reveals behavioral patterns. The energy budgeting for three weeks before September 7th (*Figure 28*) while learning BS 180s partially explains higher soreness during this period (*Figure 27*). Average daily activities immediately before the first high head pain were lower than most of the dataset from outliers (*Figure 26* and *Figure 27*). The second observed head pain was different from climate induced dehydration. The intermediate time scale for calorie expenditure identified patterns of high exercise and moderate food intake followed by low exercise and high food intake.

Examination of the daily collected information through charts provides visual trends to explain the text notes and more accurately describes the purpose of inflammation reduction activities. The heatmaps and bar charts summarize activity frequency by time and weekday. Secondary hobbies consumed more hours than skateboarding. Muscles consistently worked were

accurately categorized through the pain graphs. Exploring non-parametric statistics available to the public disclosed their subjective nature and human prediction models had accuracy issues. The average number of daily activities before painful events was higher 3-5 days ahead. Caloric deficit resulted in several intervals of unpleasant bodily discomfort. Muscular recovery efficiency improved from several months of skateboard training but needed four months of traditional weight lifting and four months of switch skateboarding to correct exaggerated right lateral leg muscles. Future efforts combine lower leg, medial, and upper posterior exercises to avoid muscular imbalance.

Discussion

Knee pain emerged from imbalances between ankle supination and pronation, thigh abduction and adduction, and gluteal muscles during athletics and skateboarding was used to identify and correct the issues. Extensive data collection about activity scheduling, muscular soreness, and food intake led to increased understanding of hydration strategies. Irrespective of ankle sprains, audible distal medial ankle noise continued after ball kicking cessation and was ruled out as the cause. The right gastrocnemius and soleus was consistently sore after extended periods of walking, running, and lifting while dehydrated and is posture related. Weight during back squats shift from center to right in the descending leg flexion phase and from right to left in the extension phase indicating weaker left posterior abductors and right anterior adductors. Right lower back pain emerged from high school athletics and was reduced from longboarding but reappeared while mostly walking. Head and neck pain originates from both exercising or mental strain combined with a lack of nutrient instigated dehydration, mental stress, or muscular imbalance.

There are several unrelated activities that assist skateboarding. More evidence for greater left anterior and right posterior leg strength mismatch 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 multifidus pain while exercising from right limbed throwing, kicking, and swinging. The left hip also has greater anterior vascular definition.

The intention of collecting data for 100 more days was to find a statistical relationship between activities, nutrition, and observed pain[54] to mathematically predict debilitating soreness

to improve skateboard ability. Hydration was cemented as important to avoid muscle soreness leading to training disrupting headaches. Hydration difficulties emerged after training since water is eventually unappetizing and diet strategies from school athletics to induce thirst were utilized. Nutrition was a focus in the year following this data collection with phases of ingesting enough potassium to remove excess salt and water from post-workout protein recovery meals without raising blood sugar from excessive carbohydrates. Dieting is a billion dollar industry since social standing depends on appearance and was avoided as the focus of this study. Combining the subjective pain scale with objective measurements through non-parametric statistics resulted in low confidence and strategies to reduce inflammation requires individual awareness. Specific anatomy terms were learned with reasoning behind training regiments from athletics.

Right anterior and posterior ankle snapping emerged while skateboarding and right footed ball kicking. To test if the right ankle was damaged from previous ankle sprains, left footed ball kicks were practiced and produced similar left anterior ankle snapping while the right anterior noise ceased. Right posterior medial ankle noise continued indicating a lack of muscular balance. Since right soleus muscle soreness occurred prior to a minor ankle injury, the right medial snapping ankle was from poor walking and running form. Strengthening the ankle muscles was performed with Casper stalls and rolling the ankle into the skateboard during manuals. Medial lower leg strength also increased while practicing downhill longboarding.

Right lower back pain unfolded while learning back squats in 2009-2013. Left gluteus medius strength and flexibility improvements partially rectified the issue through rest and physical therapy in 2009 and was mostly rectified with regular stanced distance longboard pushing from 2014-2016. Gluteus and hamstring to quadricep muscle imbalance was addressed

from November 2024 to February 2025 with back squats and freeweight leg exercises. Squat form improved by rolling the hips and gluteus posteriorly to limit knee snapping. An article discovered in the middle of 2025 supports these methods since the cause of knee valgus can be attributed to lower limb muscular asymmetry (132). Weight imbalance was observed for back squats near exhaustion overrelying on the right gluteus medius in the descent and the left quadriceps abductors and right hamstring adductor in the ascent. Left lower back pain was observed while squatting with a mirrored technique and supports the stronger left anterior to right posterior leg strength theory for the origins of right lateral knee pain. Squat form was modified to limit this effect by using less weight, narrowing the grip, and pulling the bar into the trapezius to force forward lean and gluteus use.

Longboard pushing and heelslides from 2014-2016 contributed to abductor and adductor imbalance that was exaggerated while working a desk job and mostly walking for exercise from 2017-2021. Right knee pain emerged in early 2022 while working a physically moving night shift job. Knee pain became more apparent while increasing jogging distance from one to 15 miles during 2022 but was minimized while regular stance downhill longboarding from 2023-2024. The lack of right adductor balance caused irregular stride and accelerated the knee issue by rotating the femur and hyperextending the leg. Rear leg adductor strength was further exposed while learning regular stance ollies in 2024 and accentuated the existing right lower vastus lateralis pain. Similar left knee snapping was revealed while learning switch ollie tricks and observing the rear left leg lifting off the board's tail lends extensive evidence to stronger left anterior muscles. Stretching the lateral leg muscles was the initial method of reducing inflammation and colloquial terms such as Dead Butt Syndrome led to further concentration on reducing the anteriorly rotated pelvis that emerged while sitting for long periods with low

exercise. Greater right anterior and left posterior leg muscles accumulated from pushing the longboard switch from 2024-2025. Right anterior adductor strength increased in 2025 from pulling the board perpendicular to the road during regular stance downhill longboard toe slides and runs conversely to the overdeveloped right posterior adductor from sweeping the leg forward in the first half of the heel slide. Muscular use is mimicked with freestyle skateboard tricks such as switch stanced Casper stalls and 5050 truck stands or traditional weight lifting exercises like lateral lunges.

Pain around the right skull's frontal bone originates from the posterior neck and is a result of either muscular exhaustion or mental strain while sitting extensively. Although nutrition was not thoroughly addressed, imbalance between nutrients leads to head pain from low hydration decreasing muscular elasticity or vitamin deficiencies disrupting efficient function resulting in the accumulation of smooth or skeletal muscle repair molecules. Skateboarding rolls the shoulders anteriorly and causes different muscular development between the chest and upper back leading to head pain. The effect is converse to back squats or pull ups that roll the shoulders posteriorly causing identical head pain. Dehydration from inadequate post-exertion macro or micro nutrient intake is the primary cause of head pain and stems from uncontrollable secondary issues such as lack of time to prepare meals at rigid school or work scheduling making extensive exercise monetarily unaffordable or too mentally exhausting for long-term enjoyment. There are several low movement activities as determined by demographic that assist in providing a mental reprieve from athletics while retaining responsiveness to adequately nourish and stretch. The participant's hobbies that were especially applicable to this skateboarding self-experiment included enjoying general exercise, software development to learn mathematical and science fundamentals for accurately identifying bodily failures, and guitar to increase wrist strength and

coordination. Juggling is useful for neck pain reduction with arm coordination, rotator cuff movement, and casual hamstring bends while collecting dropped objects.

Excessive documentation while skateboarding had several disadvantages such as increasing the amount of time obsessing about irrelevant details and decreasing time to relax. Using computer science fundamentals to perform data analysis provided a hiatus from skateboarding but is markedly different from learning microbiology for nutrition, neurobiology, or the medical terms for muscular anatomy. Abstracted mathematical concepts using C syntax are more closely related to operational efficiency research and revealed applied mathematical methods to understanding the musculoskeletal, nervous, and digestive systems. 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 have undesired effects.

Conclusions

Right knee pain is from hyperextending the leg in motion due to several muscular imbalances starting with right lower back pain from learning to squat, continuing with longboarding induced quadricep and hamstring mismatch, and originating while primarily walking. Since right lower back pain emerged near the end of 2025 after pushing switch, it

would make sense to resume regular longboard pushing using the isometrically engaged left support leg to strengthen the gluteus medius, yet regular stanced ollie tricks are a second concentric quadriceps exercise for the right leg immediately after pushing regular stance. Overuse is one reason lower quadricep pain was experienced from 2020-2025. Knee pain disappeared after downhill longboarding in 2025 and alternating between regular and switch tail and heel slides would retain balanced muscular development at all lengths to continue learning skateboard tricks.

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 energy. In this context, computer hardware is similar to a sandbox for the brain and nervous system 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.

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