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Poster 1

Transcutaneous Spinal Stimulation to Improve Locomotor Outcomes Following Spinal Cord Injury: A Systematic Review

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Background: Transcutaneous Spinal Stimulation (TSS) utilizes electrical current to stimulate Ia afferents at the posterior nerve roots. Activation of Ia afferents activates spinal circuits which brings motor neurons closer to threshold, allowing for greater voluntary motor activation. Physical therapists treating individuals with spinal cord injuries (SCI) have the opportunity to maximize their interventions by applying TSS with clinically available devices. Current systematic reviews summarizing TSS fail to include locomotor outcomes. Therefore, the purpose of this study was to summarize the effects of TSS on locomotor outcomes for individuals with SCI and make recommendations for future research. *Methods*: This review utilized the following databases: PubMed, Cochrane Registry, PEDro, Web of Science, CINHAL, and Embase using keywords, such as, “spinal cord injuries", “transcutaneous”, and “spinal cord stimulation”. A total of 327 articles were found through the initial search with 12 articles meeting the inclusion criteria after a three-step screening process. *Results*: Of the 8 articles that measured walking speed, 7 demonstrated improvements following TSS with 5 meeting MCID. Of the 6 articles that measured walking distance, 6 demonstrated improvements following TSS with 1 meeting MCID. Of the 3 articles which observed changes in gait kinematics, it is difficult to define improvements due to the lack of standardized values for gait kinematics. The same issues can be observed in the 2 articles which made observations utilizing the WISCI II, therefore it is difficult to make generalized statements for these outcome measures. *Conclusion*: Current research demonstrates that TSS has the potential to improve locomotor outcomes for individuals with SCI.

Conclusions are limited by small sample sizes with heterogeneous protocols for training, stimulation parameters, and outcome measures between studies. They are further limited by the fact that most studies only observed changes for participants with motor incomplete injuries, therefore the conclusions made can only apply to this population. Further research is warranted using larger sample sizes and control groups to determine the optimal stimulation parameters, and dosing for improved locomotor outcomes for individuals with SCI.

Poster 2

Altered Sensory Integration While Standing Improves Upper-Limb Sensorimotor Performance on a Robotics-Based Task with High Proprioceptive Feedback Demands

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Purpose/Hypothesis: Most upper-limb research focuses on discrete reaching-type tasks while participants are seated, however, many activities of daily living (ADLs) are dynamic, continuous, and occur while standing. While neurotypical young adults (NYAs) show reduced reaching times when seated compared to standing, the reduced speed in standing may allow for increased information processing and better control of the greater number of degrees of freedom in standing. With this in mind, it is unclear how posture affects sensorimotor control in different motor tasks with varying sensory demands. Here, we aim to assess the impact of posture (seated vs. standing) on sensorimotor control while manipulating visual feedback of the limb to understand the effects of posture and visual reliance on task performance. We also aim to characterize task-related activity associated with multisensory information processing using electroencephalography (EEG). We hypothesize that: 1) task performance in standing will be higher than task performance in seated, 2) there will be an increase in visual reliance in seated posture (seated NV - seated VS), and 3) there will be decreased visual information processing and increased proprioceptive processing when standing compared to seated.

Participants: 12 neurotypical, right limb dominant young adults, age 18-26 (10 female)

Materials and Methods: Participants were fitted with an EEG cap to be worn during the sensorimotor Continuous Target Tracking (CTT) task using a Kinarm End-Point lab robot (BKIN Technologies Ltd, Kingston, ON, Canada). Participants were asked to track a two centimeter diameter target as it followed one of nine circular trajectories at a consistent speed in both clockwise and counterclockwise directions. Performance error was represented by the average distance (cm) between the manipulandum and center of the target during each 10-second interval. Visual reliance was calculated by seatedNV - seatedVS. The study conditions were as follows: left upper extremity/right upper extremity, seated/standing, and vision (VS)/no vision (NV). Average error within each condition was measured along with 64-channel passive EEG during the task.

Results: We observed greater error in the NV condition compared to VS ($p < 0.001$). Further, we observed a significant improvement in CTT performance in standing NV condition compared to seated NV regardless of extremity ($p < 0.001$). Visual Reliance was significantly greater in seated compared to standing for the left ($p<0.01$) and right ($p<0.001$) limb during the CTT. Greater Visual Reliance when seated was significantly correlated with the reduction in error in standing compared to seated (standingNV - seatedNV) in the dominant right limb ($r=-0.81$, $p=0.0014$). Greater EEG alpha-band (7-

13 Hz) desynchronization in seated-NV compared to seatedVS. There was not an observable change in beta-band desynchronization between seated and standing conditions.

Conclusions: Contrary to prior findings of improved sensorimotor performance in discrete reaching-type tasks when seated (Berrigan et al.; Stewart et al.), we found significant performance improvement on the CTT when standing while vision of the limb was occluded (NV). We also found significantly greater visual reliance when seated compared to standing. It is possible that non-visual feedback processing is not as reliable in seated compared to standing. Standing offers greater potential proprioceptive information which is not necessary when visual information is available but is beneficial when vision occluded. This theory seems to be supported by the observation that those who rely more on visual information during seated task performance are those that seem to benefit the most from greater proprioceptive information provided when standing. Studies are ongoing in neurotypical older adults (50+ y.o.) and chronic stroke survivors as a part of a larger study using EEG & robotics to identify neural markers of proprioceptive deficit and altered visuo-proprioceptive integration that may contribute to impaired task performance.

Clinical Relevance: Determining the effects of multisensory processing and visual reliance during upper-limb tasks can help physical therapists optimize intact sensory components and improve motor learning for upper extremity tasks. In the future we may change posture or task demands in rehabilitation based on an individual's specific sensory deficits through more accurate measures of neural processing (EEG) to optimize functional skill learning and recovery.

Poster 3

Interactions Between Balance, Navigation, and Cognition in the Aging Brain

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Background: With advancing age, neurotypical older adults (OAs) demonstrate functional decline in a variety of physical,behavioral, and cognitive domains, decreasing an individual's personal independence and quality of life.. One of the earliest symptoms of aging-related cognitive decline is *impaired spatial navigation ability,* which is reflected in decreased activation in the hippocampus, the hub of navigation circuitry in human functional brain networks. However, prior literature shows aging-related functional decline in the hippocampus and increased recruitment of extra-hippocampal regions, specifically the striatum, which is primarily involved in balance ability, and the prefrontal cortex, which is typically responsible for executive function and higher-order cognition. Although aging-effects on navigational neural circuitry have been largely characterized , we currently lack a mechanistic understanding of how spatial navigation behavior relates to common clinical assessments indexing balance ability and executive function within individuals. Therefore, this study aims to investigate aging-effects on interactions between balance ability, navigational performance, and executive function within individuals to further inform future neurorehabilitative treatments for cognitive aging . , We hypothesize that OAs will demonstrate poorer performance on a battery of tasks assessing performance in these domains, in comparison to younger adults (YAs).

Methods: 21 neurotypical OAs (ages: 60+ years) and 23 neurotypical YAs (ages: 18-35 years) were recruited during the 2021-2023 academic years to complete a battery of assessments measuring aspects of balance ability, navigational performance, spatial cognition, and general cognitive function in isolation and in conjunction. Administered tasks focusing on these various domains with their associated primary outcome measures are listed below.

Outcome measures for the battery of participant assessments included: (1) distance walked on the Narrowing Beam Walking Test (NBWT) for balance ability, (2) Santa Barbara Sense of Direction Scale (3) completion time and distance traveled in a city-like virtual reality (VR) maze for navigational performance, (4) highest span reached on Corsi Blocks test and highest level reached on the Body Position Spatial Test (BPST) for spatial cognition, (5) completion time differences between Trails Making B and Trails Making A for set-shifting ability, an aspect of executive function, (6) completion time differences between the Timed Up and Go (TUG) and TUG-Cog tasks for dual-tasking ability, an additional aspect of executive function, and (7) Outcome measures were compared between OAs and YAs using unpaired t-tests and non-parametric tests where appropriate, to analyze between group differences.

Results: The Santa Barbara Sense of Direction scale results indicate that OAs demonstrated significantly higher self reported navigational abilities compared to YAs (p

= 0.03403). However, they demonstrated decreased naturalistic navigational abilities, as shown by significantly increased completion times (p = 6.316e-05) and distances traveled (p = 0.0007824) in the city-like VR maze. OAs also demonstrated decreased performance on tasks with increased executive function demands compared to YAs (TUG p = 2.626e-06; TUG-Cog, p = 2.129e-08; Dual Task Interference, p = 0.4932). Furthermore, OAs demonstrated decreased performance on tasks requiring short-term spatial memory and spatial awareness compared to YAs (Corsi Blocks, p = 0.001044; BPST, p = 3.049e-06). Lastly, OAs demonstrated lower performance scores on balance tasks compared to YAs (NBWT, p = 1.014e-06).

Discussion: Decreased performance of OAs on spatial navigation tasks is likely due to the increased competition for neural resources and may be responsible for subjective reports of increased instances of falls, difficulty navigating familiar environments, and attentional impairments in older adult populations. In future studies, it may be beneficial to investigate if OAs demonstrate worse performance on dual task interference tasks at higher challenge points to demonstrate these differences as they may be related to poorer performance on spatial navigation. In conclusion, we observed poorer performance on individual outcome measures for OAs as expected by typical aging. Based on the outcomes of our study, it may be concluded that older adults rely more heavily on extra-hippocampal structures for tasks related to navigation, balance, and attention.

Clinical Relevance: Our findings may guide clinicians' treatment with OAs participating in physical therapy by providing evidence-based aging-related differences based on outcome measures that can be utilized in a clinical setting. This can help therapists to create treatment plans and interventions that can target these functional declines in a preventative manner.

Poster 4

Safety and Feasibility of Functionally Integrated Tele-Exercise and Remote Monitoring in People with MS

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Multiple sclerosis is a neurodegenerative, autoimmune disease causing various sensorimotor and cognitive symptoms that contribute to reduced physical activity and quality of life. While studies demonstrate that physical activity and exercise can mitigate symptoms of those living with MS, individuals with MS encounter many barriers preventing them from engaging in physical activity and exercise. For example, people with MS report barriers such as reduced mobility, fatigue, decreased self-efficacy, and limited access to knowledgeable professionals that can limit their participation in physical activity and exercise. Tele-exercise has emerged as a potential way to address some of these barriers. However, some research suggests that lack of engagement in and adherence to tele-exercise regimens may contribute to variable outcomes, such as the lack of robust improvements in QOL reported in literature. Therefore, this study proposes to address the barriers to exercise in people with MS by integrating tele-exercise delivered through an online platform with cognitive behavioral therapy (CBT) coaching and state-of-the-art remote monitoring systems.

Poster 5

Chronic Pain, Mental Health, and Analgesic Use Among People with HIV: A Retrospective Study

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Purpose/Subjects: People with HIV (PWH) are at higher risk for experiencing trauma, mental health conditions and chronic pain than their HIV-negative counterparts.[1,2,3] This retrospective study aims to identify patients in an HIV clinical setting in an area of high HIV prevalence in Atlanta, Georgia, USA who have chronic pain, analgesic prescriptions, and/or mental health diagnoses. Metropolitan Atlanta was an ideal location for this study, as the burden of HIV disease is high: Atlanta is ranked 2nd in the nation for total number of new diagnoses of HIV for the year 2018, which is the most recent data available at time of authorship.[4] The complexity of HIV, mental health challenges, analgesic use and chronic pain demand a collaborative approach including a multidisciplinary care team and the patient.[5] Seeing persistent pain among PWH with a trauma-informed approach to care within the lens of co-occurring mental health diagnoses will allow us to better understand, treat, and sustain patients in life-saving HIV care.

Materials/Methods: This is a retrospective chart review from 2011 to present with a subset of data from 9/2020 - 9/2022. Data was collected from The Emory Center for AIDS Research (CFAR) HIV Disease Registry application at Grady Health System. In order to be considered in the study, participants had to be adults with HIV (>18 y/o), with a diagnosis of chronic pain, documented analgesic prescription and/or diagnoses of mental health conditions.

Results: From 2011-2022, 14.3% of all adults enrolled in the Ponce Center, had documented chronic pain, mental health diagnoses and analgesics prescribed. From 2020-2022, 5.3% of patients enrolled had all three variables documented.

Conclusion: PWH are disproportionately affected by persistent pain and mental health challenges.[1,2,3,5] Examining the intersection of these through the lens of collaborative approach of psychological support and pain management will allow us to better understand, treat and sustain patients in life-saving HIV care.

Clinical Relevance: Future research should focus on correlational analysis among these factors. Such research has the potential to move forward with development of focused assessment and treatment for PWH. Findings will be used to identify and create a screening tool for PWH with pain, analgesic use, and mental health needs that are candidates for interdisciplinary care including physical therapy and mental health resources in addition to primary HIV care.

Poster 6

Exploring the Opportunity to Simplify Documentation of Clinical Tools that Involve Patient Mobility

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Abstract: Objective: Determine if the Activity Measure for Post-Acute Care (AM-PAC) "6-Clicks" inpatient short form and Johns Hopkins - Highest Level of Mobility (JH-HLM) scale can substitute the mobility component of the gold standard quality metric tools.

Methods: Prospective, cross-sectional study, conducted at Johns Hopkins Hospital – Medical Campus located in Baltimore, MD between December 2022 – March 2023. Inclusion criteria included: >18 years old, admitted to one of the six acute care services: General Medicine 1, General Medicine 2, Cardiac, Oncology, Surgery, and Neurology. Two Physical Therapists (PTs) collected data on the mobility component for each quality metric tool at the initial Physical Therapy evaluation. Each PT was trained on implementation of each quality metric tool prior to data collection. A chi-squared goodness of fit test was conducted to assess fall risk. Then, a linear regression analysis was conducted to assess the relationship between Get Up and Go raw scores and AM-PAC T scores.

Findings: One hundred and thirty patients were included in the preliminary findings. Of the patients included, 56% were from the Cardiac service and 44% were from General Medicine 1, 2, and Surgery services. We evaluated the relationship between the AM-PAC and the mobility component of the Fall Risk Model, the Get Up and Go test "Rising From a Chair". The chi-squared goodness of fit test assessed statistical significance between the AMPAC data ranges and Get Up and Go scores. Overall correct categorization was 97.7%. The results of the linear regression analysis of the AM-PAC T scores and Get Up and Go raw scores indicate an inverse linear relationship.

Conclusion: The choice of a tool in a clinical context needs to reflect the purpose for which the tool is to be applied. If the purpose is to screen for fall risk populations, a tool is needed that is quick and easy to apply yet has strong correlation to the mobility component of a gold standard quality measure. The findings demonstrate evidence of an inverse relationship between scores of the AMPAC and the mobility component of the Fall Risk Model – Get Up and Go "Rising From a Chair." Therefore, the AM-PAC can be recommended as a substation for the mobility component of the Fall Risk Model to reduce redundancy in healthcare workflows.

Poster 7

Do Patient Expectations for Manual Therapy and Exercise Influence Patient Outcomes: A Systematic Review

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Background: Patient expectations are defined as an individual's beliefs regarding potential benefit of a treatment and his/her perceived likelihood of experiencing an anticipated effect,[1] which has been linked to levels of pain and recovery.[2] Current research shows patient expectations can moderate treatment effect and likelihood of a positive response to treatment.[3-7] This relationship has not been reviewed for expectations of specific interventions, such as manual therapy (MT) and exercise (EX) in physical therapy.

Purpose: The objective of this study is to investigate if patient expectations prior to application of MT or EX moderate an effect on pain and functional outcomes.

Method: A literature search was completed using MEDLINE, EMBASE, CINAHL, and Web of Science databases. Inclusion criteria were articles in English, subjects older than 18 years old, outpatient orthopedic setting, manual therapy or EX performed by licensed physical therapists, and patient expectations. Results were filtered via title/abstract screen, full-text review, and final data extraction; each with two independent reviewers and one reviewer as a tiebreaker. The quality of each study was evaluated by authors with the use of the Center for Evidence-Based Management (CEMB) Critical Appraisal of a Controlled Study.

Results: Of the 12 articles included in this study, eight associations were analyzed for MT and eight for EX, due to some articles studying both MT and EX or including multiple dependent variables. Eight of the 12 articles exhibited a relationship between patient expectations and outcomes. When breaking down the data, four of the ten MT analyses found an association (two for pain, two for function). Four of the eight EX analyses found an association (zero for pain, four for function).

Conclusion: The results suggest a potential association between expectations for treatment (MT and EX) and outcomes. However, this association may not be uniform between different intervention and outcome types. Patient expectations demonstrated a greater relationship with functional outcomes rather than pain, especially when analyzing EX. Additionally, it is important to consider that having the highest expectations pre-treatment does not necessarily correlate with more successful outcomes.[5] Given the methodological and statistical heterogeneity of these studies, conclusions should be interpreted with caution and future studies should focus on consistency in measuring expectation and outcome assessment.

Clinical Relevance: Patient expectations should be assessed due to its potential influence on pain and function outcomes. It is important for physical therapists to consider patient expectations of specific treatments and matching his/her desired treatment,[8] to optimize patient outcomes. Physical therapists should be mindful of how instruction and patient education[9] can influence pre-treatment expectations and therefore outcomes.

Poster 9

Understanding Key Feedback Principles to Maximize Motor Learning During Gait Rehabilitation Post-Stroke

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Significance: Stoke is a leading cause of serious long-term disability in the United States. Eighty percent of stroke survivors live with gait impairments, twenty-five percent of which have not improved despite intensive rehabilitation[1]. Motor learning is a fundamental process that plays an integral role in gait rehabilitation. Optimizing motor learning is essential for maximizing the effectiveness of gait rehabilitation programs and improving recovery of walking function post-stroke. The current literature focused on motor learning has some gaps which we attempt to highlight.

Objectives: Our project aims were to: 1) gain a broad understanding of the current evidence concerning motor learning that is applicable to gait rehabilitation in people post-stroke, 2) utilize knowledge gained from current research evidence to improve gait rehabilitation research study design and contribute to enhancing clinical outcomes.

Methods: A literature search was performed using PubMed and Research Rabbit. The review focused on motor learning in context of gait and biofeedback, and included perspective, review, and experimental studies.

Results: Recent evidence suggests that motor learning mechanisms can be categorized into four primary types: instructive, reinforcement, use dependent and sensorimotor[2]. These learning mechanisms provide a framework to help optimize motor learning. Examples of parameters that can be manipulated to enhance learning include type of feedback, practice session structure, frequency of feedback, dosage, and practice environment. We focused on optimizing the variable of feedback and evaluated research on the efficacy of biofeedback. From our literature review, we came to find that auditory, tactile or visual biofeedback are all beneficial.[3]
Our results for aim 2 showed that challenge point, feedback timing, and individualization of feedback are imperative to improve motor learning and skill acquisition[4]. We provided recommendations on how current biofeedback study paradigms in Kesar Lab can be altered to incorporate optimal practice and feedback parameters to maximize motor learning.

Summary: Overall, we found that there is a lack of current studies on how to optimize motor learning and feedback especially in the context of lower extremity and gait training tasks. Most research studies only utilize generalized feedback and do not individualize feedback to the learners' unique challenge point. Further studies are needed to systematically evaluate motor learning parameters for enhancing gait rehabilitation. We can utilize the current knowledge gained from biofeedback and motor

learning research, to create a refined study protocol to increase motor learning and develop clinical gait training strategies to treat post-stroke gait impairments[5].

Clinical Implications: Biofeedback applied considering challenge point, feedback schedules, and individualization, is beneficial to gait rehabilitation after stroke, and can be applied in clinical settings with low technology solutions. When considering tracking change and motor behavior in clinical settings, motor acquisition may not be apparent within session, however, over several treatments, we may observe retention of learning and improved gait performance.

Poster 10

Beta Band Frequency and its Implications in Motor Control in Patients with Parkinson's Disease

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Background & Purpose: Beta power is involved in movement & motor planning. Previous studies have shown increased beta power is related to suppression or resistance of movement. Parkinson's Disease (PD) patients show elevated beta power and have difficulty modulating beta with movement, which corresponds with motor deficits such as bradykinesia and hypokinesia, but little is known about the effects of balance training on the modulation of cortical activity. The purpose of this study is to examine changes in beta power within a single session of balance perturbations using a moving platform in both healthy older adults (HOAs) and patients with PD.

Subjects: 35 older adults were included in the study, 16 older adults with PD (age 69 ± 7, 4 female) and 19 HOAs (age 71 ± 6, 6 female).

Methods: This is a retrospective study with a single session for data collection. The two groups participated in up to 48 translational support-surface perturbations with varying timing, direction, and magnitude while recording electroencephalography (EEG). Raw data was divided into several time-bins immediately following the balance perturbations, with the 50-150 millisecond time bin being our focus because it is the time-frame when a balance reaction would be initiated. Perturbation-evoked beta power was compared across the session and between groups, and correlations with various clinical outcome measures were examined.

Results: Both groups showed a significant change in beta power from initial to final trials, with a decrease in the PD group ($p<0.01$) and an increase in the healthy old adults group ($p<0.01$). There is also a significant negative correlation between beta power and the Mini Balance Evaluation Systems Test (miniBEST) in the PD group. No other correlations with clinical outcome measures were found within this time bin.

Conclusions: We did not find change in beta to be a good biomarker for disease severity in PD, as it was not found to correlate with the UPDRS, a clinical assessment specifically designed to measure the severity of disease progression. However, our findings do suggest that beta modulation may be a good biomarker for balance ability in PD patients as higher baseline balance ability was found to be significantly correlated with a greater decrease in beta from the initial to final trials for individuals with PD. These are promising first steps in understanding implications of the modulation of beta during movement as it relates to altered levels of beta power in PD patients.

Clinical Relevance: During balance perturbation training in a safety harness with PD

patients, physical therapists might choose to focus specifically on applying perturbations in the posterior to anterior direction in order to maximize the beneficial effects they appear to have on improving modulation of beta. Backwards support-surface translations result in an anterior shift in center of mass, and would be similar to a more real-life situation in which a person gets bumped from behind in a crowd, or potentially slipping while walking on a slippery floor, causing them to lose their balance anteriorly.

Poster 11

DPThrive: A Mixed-Methods Analysis of a Novel DPT Student Well-Being Program

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Purpose: Graduate healthcare programs are academically strenuous, and new students are often unprepared for the increase in academic workload. This results in reported levels of elevated psychological, and subsequently physiological, stress the negative effects of which can be ameliorated. Higher stress and anxiety levels negatively affect academic performance by impairing learning[1], increasing psychological morbidities, and harming one's overall well-being[2]. Few studies have examined the influences of early intervention on well-being in first year Doctor of Physical Therapy (DPT) students, nor the long-term effects early intervention can have. The purpose of this study is to assess the long-term impacts of the DPThrive program on development of healthy lifestyle habits and subjective well-being in DPT students, and apply what is learned to further improve the current DPThrive program.

Subjects: Participants included five second-year DPT student volunteers obtained through voluntary response sampling of the Emory University DPT class of 2024. The students were previously a part of the DPThrive program as first-year students during the spring semester of 2022.

Methods: An uncontrolled, parallel mixed-methods trial study design utilizing electronic surveys for quantitative data and focused open-ended questions for qualitative data in order to assess the long term effects of DPThrive on habit formation and subjective well-being. Students participated in a 90-minute focus group to better understand DPT students' perceptions of the impact of participating in an 8-week goal setting and habit formation program on subjective well-being and habit strength patterns at a 8-month follow-up time period. Additionally, students completed a battery of surveys before and after the original study, and again 8 months after the conclusion of the program. Data was analyzed using a non-parametric repeated measures design for quantitative measures and thematic analysis with inductive coding for qualitative measures.
Results: There were multiple statistically significant ($p < 0.05$) differences found using Friedman tests for the quantitative data of financial well-being (FWB), $p = 0.042$; eudaimonic well-being (EWB), $p = 0.042$; GAD-7, $p = 0.039$; hours of sleep, $p = 0.034$; alcohol consumption, $p = 0.042$; and SHRI, $p = 0.043$. However, none were found statistically significant after the Bonferroni correction was implemented ($p < 0.017$) for differences between time points. Qualitative data through thematic analysis showed four emerging themes which included "Benefits of accountability from the program," "Social connection as a valuable component of the program," "The program enhanced understanding and exercising of self-compassion," and "The program promotes ongoing adaptation by supporting positive behavior change."

Conclusion/Implication: These findings collectively suggest that involvement in a peer-led, well-being program focused on goal setting and healthy habit formation may positively impact DPT student's well-being and lifestyle behaviors post-intervention. Further research is needed to determine the efficacy of a mixed-methods approach and its impact on habit formation programs for DPT student well-being.
Clinical Relevance: Early well-being intervention programs within DPT programs have the potential to aid in reducing burnout, improving coping mechanisms, and promoting a support system amongst colleagues.

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Poster 12

The Influence of Taking Students on Clinical Instructor and Clinical Outcomes in Physical Therapy

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Background: Previous literature acknowledges that taking physical therapy students during clinical rotations does not negatively influence clinical instructor (CI) productivity. Currently, there are gaps in the literature addressing the effects of student rotations on overall clinic productivity, and patient functional outcomes.

Purpose/Hypothesis: The present study assesses how taking students on clinical rotations influences CI and clinic productivity and patient functional outcomes. The hypothesis is if student physical therapists on their long-term rotations are involved in patient care, then the patient functional scores and clinic productivity will significantly decrease.

Subjects: Clinical instructors with full-time physical therapy students across 12 PT Solutions clinics in the United States during 2021 and 2022. 217 physical therapy students comprised of 13 first years, 94 second years, and 124 third years. The inclusion criteria were students in their long-term clinical rotations, who stayed at one clinic, and 1:1 student:CI ratio. Clinical rotations timespan varied between 4-16 weeks.

Methods: CI and clinic productivity was collected from the number of patients per day. Patient outcomes were measured from Focus on Therapeutic Outcomes (FOTO) total mean improvement scores, number of patients discharged, and the residual change in FOTO scores. Each variable was collected during the time periods: three months before clinical rotation, the months while the CI had a student, and three months following the clinical rotation. ANOVA and 2-factor T-Test compared productivity, FOTO, and Residual FOTO scores between each time period. FOTO scores were also compared between student years in their DPT (Doctor of Physical Therapy) program. A confidence interval of 95% and a p-value of 0.05 was used.

Results: There was a statistically significant decrease in CI productivity between the time periods during and following the students' rotation ($p < 0.001$), but not between the before or during time periods. ($p=0.489$). There was a statistically significant decrease in CI functional score between the time periods before and during the rotation ($p=0.02$) but not between the during and after time periods. There was a statistically significant decrease in CI residual FOTO score between the time periods before and during the students' rotations ($p =0.011$), but not between during and after time periods. No significant difference was found in clinic productivity, functional score, or residual score between before, during and after taking on a student ($p=0.922$, $p=0.526$, $p=0.419$).

Conclusion: Taking on students during their clinical rotations does not impact overall clinic productivity or patient functional outcomes. While there was a slight reduction in

CI FS and residual FOTO scores while the student was present, as well as a slight reduction in CI productivity after the students left, the differences are not clinically meaningful and do not impact patient recovery or business outcomes.

Clinical Relevance: Hosting a student has no impact on productivity or patient outcomes. However, having students may be beneficial for recruitment purposes for the company. Future studies should investigate the subjective experience of CIs to examine additional benefits of taking on students at their clinic.

Poster 13

Effectiveness of Remote Therapeutic Monitoring in Physical Therapy

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Background: With the COVID-19 pandemic, delivery of healthcare services, including physical therapy, had to transition to telerehabilition.[1]As clinics at Johns Hopkins Hospital (JHH) were only seeing post-operative patients, this led to the increased use of alternatives including remote therapeutic monitoring (RTM). RTM is defined as the use of a medical device to a patient's health or response to treatment using non-physiological data. From the increased use of alternative forms of therapy, CMS created a new CPT code for RTM. Though there has been some research utilizing RTM for neurologic conditions,[2] there is limited research using this with musculoskeletal conditions. Some research shows use of self-management applications with this population.[3]

Purpose: To examine the clinical effectiveness of RTM with non-surgical musculoskeletal conditions in rehabilitation practice and to examine the relationship between baseline factors and patient outcomes with the use of RTM

Subjects: Participants who were at least 18 years old with musculoskeletal related impairments. Information was provided to individuals regarding an alternative to traditional physical therapy services. One of two outpatient orthopedic surgeons within the JHH System provided access to a remote therapeutic monitoring program called Limber Health.

Methods: A retrospective cohort study was conducted looking at changes in PROMIS Physical Function and Pain Interference scores between the baseline and the 8-week mark after utilizing Limber Health self-management application. A 5-point change in PROMIS scores was considered minimally clinical important difference.[4-6]
For the data analysis, measures of central tendency and variation were used to describe patient demographics. Paired t-tests were used to examine the difference between baseline and 8-week PROMIS outcomes. Fisher exact tests were utilized to examine the difference in continuous data between those with and without a 5-point PROMIS change. Rank sums looked to examine the difference in categorical data between those with and without a 5-point PROMIS change.

Results: Approximately 50% of the cohort had incomplete data sets. There were 250 participants with complete data. For Pain Interference there was a significant change in all body regions except the hip pain group. There was significant change in Physical Function scores for those with shoulder and knee pain.
Conclusion: Although not significant, there is a positive trend of chronicity and level of education related to changes in Pain Interference. Due to the small sample size for the low back and hip categories, it is unclear if RTM is suitable for these groups even with

significant change for the low back group for Pian Interference.Some of the primary limitations of this study is that the Limber Health application did not stop collecting data on patients after the 8-week mark. There was limited information for the providers regarding patient adherence to the self-management application. It is also unknown if participants sought out traditional physical therapy services outside of utilizing Limber Health.

Clinical Relevance: RTM can be used as an alternative to traditional therapy services for individuals with non-surgical musculoskeletal conditions with low back, knee, and shoulder pain. This study can also inform future studies utilizing RTM.

Poster 14

Effects of Yoga on Patients Who Survived Strokes: Systematic Review and Meta-Analysis

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Background: Stroke is a leading cause of death globally with more than half of all survivors experiencing long-term disability. Rehabilitation after stroke may include physical, occupational, speech and psychological therapy to address the many deficits stroke survivors face. Yoga is a mind-body practice that addresses, strength, balance, coordination, mood, and cognition.[2,6,7]

Objectives: To assess the effects of yoga interventions on motor function, balance, strength, range of motion, quality of life, and depression or anxiety in adults after stroke.

Search Methods: We searched MEDLINE on PubMed and the Cochrane Central Register of Controlled Trials for randomized controlled trials (RCTs). We checked reference lists of included studies and relevant systematic reviews to identify additional studies.

Selection Criteria: RCTs of yoga interventions in adults with a diagnosis of ischemic or hemorrhagic stroke. Yoga interventions had to state they were yoga and include at least one of asana/postures, pranayama, mindfulness/meditation, or lifestyle modification.

Data Collection and Analysis: We uploaded search results to Covidence software for deduplication and study selection. Two authors independently screened the title and abstract of each study. Two authors then independently screened the full text of each potentially eligible study for inclusion. Disagreements were resolved by discussion. We extracted information from each included study, including key study characteristics, the risk of bias according to the Cochrane risk-of-bias tool, and numerical outcome data. Risk of bias and outcome data were extracted independently by two authors and discrepancies were resolved by discussion. We used standardized mean differences (SMDs) and 95% confidence intervals (CIs) to report outcomes and conducted meta-analyses when at least two studies had the same research question and available outcome data. We assessed the certainty of estimates using GRADE criteria.[5]

Main Results: We included three studies with 83 participants conducted between 2012 and 2014 in Australia and the USA. One study compared yoga plus exercise to exercise alone and two studies compared yoga to a waitlist control group. All studies were at high risk of bias for at least one domain. Compared to no exercise, at 8 or 10 weeks yoga improved quality of life (SMD 0.32, 95% CI -0.38, 1.02; n=47), hamstring range of motion (left - SMD 1.22; 95% CI -2.25, 62.47; n = 47; right - SMD: 1.52; 95% CI [4.69, 60.21]; n = 47), anxiety (SMD: -0.62; 95% CI [-15.35, 1.95]; n = 22); and depression (SMD: -0.65; 95% CI [-4.70, 0.50]; n = 22), but confidence intervals were wide due to small sample sizes and all estimates were uncertain due to risk of bias and imprecision.

Studies did not include any information on adverse events and did not mention any serious safety concerns.[1,3,4]

Authors Conclusions: The effects of yoga on functional mobility, quality of life, balance, strength, range of motion, anxiety, and depression after stroke are uncertain. More research should be done with larger sample sizes to determine whether yoga may be helpful after stroke.

Poster 15

Using Technology to Detect Erythema Across Skin Tones

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Purpose: The purpose of this study was to assess the quality of the ColorMeter DSM III and its effectiveness in detecting skin color changes in healthy adults.

Participants: A sample of 61 healthy adults (>18 years old) were recruited via convenience sampling in the local community.

Background: Pressure injuries (PIs) are prevalent complications for vulnerable populations. PI development especially concerns those with darker skin tones, who have higher risks of developing more severe, more frequent, and earlier PIs.[1] This is a major health disparity, as these individuals have the highest prevalence of stage 2 PIs, likely due to lack of early discovery.[2] The current standard for detecting skin damage is visual assessment for erythema. However, with darker skin tones, skin color changes and the ability to blanch are less visually detectable.

Methods: This study used the ColorMeter DSM III, a spectrophotometry device, with the Munsell Soil Color Chart and Pantone Skintone Guide, two objective tools for skin color measurement. Erythema was induced with a cupping device at the right arm. ColorMeter erythema values were obtained at pre-, immediately post-, and five minutes post-erythema induction. Additionally, melanin values were measured at five body regions. One-way ANOVAs and unpaired T-tests were performed (95% confidence interval and 0.05 significance level).

Results: Munsell Value decreased with increases in ColorMeter melanin measurements. Pantone Darkness Value showed a strong negative correlation with ColorMeter melanin (r = **-** 0.887, p < .001) and L* (lightness) values (r = **-** 0.900, p < .001). At the ulnar head, no significant difference existed between skin tone groups for erythema delta values from pre- to both immediately post- and five minutes post-erythema induction. At the arm, significant differences existed between light and both medium and dark skin tone groups from pre- to five minutes post-erythema induction (p = 0.001, 95% CI [0.04-0.37]). ColorMeter erythema measurements were generally unchanged by demographics or room conditions. Melanin content showed weak, positive relationships between body regions, but varies across an individual, especially for those with darker skin tones.

Clinical Relevance: This study assessed the quality of the ColorMeter DSM III and its effectiveness in detecting skin color changes after induced erythema across skin tones. Measurements from the Munsell Soil Color Chart and Pantone Skintone Guide can be related to ColorMeter L* and melanin values. ColorMeter measurements confirmed that

pressure removal reduces erythema towards baseline over time, which is associated with tissue healing in wound management.[3] Erythema changes were generally similar across skin tone groups. Previous literature notes that gender is not a PI development risk factor compared to older age and smoking;[4,5] however, this study found that demographics did not influence erythema. Additionally, differences in melanin may influence oxygen saturation readings in pulse oximetry across sensor locations.[6,7]

Conclusion: The ColorMeter DSM III effectively detects change in skin color with erythema induction, providing objective measurements for skin color changes across various skin tones. The ColorMeter DSM III may improve on current standards for detecting erythema. Ongoing research is needed to address this issue.

Poster 16

Feasibility of an In-Shoe Sensor to Deliver Propulsion Biofeedback during Gait

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Research Purpose: Post-stroke hemiparesis and diabetic peripheral neuropathy commonly result in reduced propulsion during gait, measured as anterior ground reaction force (AGRF). Reduced propulsion results in decreased step length and gait speed. The loadsol® is an in-shoe sensor that can provide clinical gait analysis and gait biofeedback. Our objective is to examine the feasibility of forefoot loadsol® biofeedback to increase AGRF in able-bodied participants.

Design Single-session experimental study.

Setting Motion Analysis Laboratory.

Subjects Seventeen able-bodied individuals (7 males, age = 26.5+-3.5 years, height = 1.70+-0.11 m, weight = 80.7+-25.8 kg).

Methods Participants walked on a split-belt instrumented treadmill with 3-sensor (hindfoot, midfoot, forefoot) loadsols® in both shoes. Following a baseline walking trial, loadsol® was used to provide auditory and haptic biofeedback with a 3-10% increase in unilateral forefoot plantar force.

Main Outcome Measures Peak forefoot loadsol® plantar force (N) and peak forceplate AGRF (N) were calculated for each gait trial. One-way ANOVAs with post-hoc t-tests were performed to compare baseline to biofeedback trials.

Results Auditory and haptic biofeedback induced significant increases in plantar force measured by the loadsol® (baseline = 694.6+-203.3, auditory = 753.8+-216.7, haptic = 758.3+-203.1, $p < .001$) and AGRF measured by the forceplate (baseline = 142.3+-57.4, auditory = 218.0+-139.8, haptic = 213.4+-135.3, $p < .001$). Feasibility was assessed using 5-point Likert-type scale where 1 indicated strongly disagree and 5 indicated strongly agree. Of 34 participants, 89.4% stated they understand the loadsol app, 98.8% said they understand biofeedback, and 97.5% stated they are likely to use this technology in their gait training.

Conclusions Both auditory and haptic biofeedback delivered by the loadsol® resulted in increased propulsion during gait, showing that the loadsol® may be a feasible device to modify gait in individuals with decreased propulsion.

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Poster 17

Young Adults with Stroke: A Scoping Review of Epidemiology, Sequelae, and Rehabilitation Needs

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Background: Worldwide, 80 million individuals have experienced a stroke in their lifetime, and 10% affecting young adults.[1, 2] Incidence levels of stroke in young adults continue to rise; 36% in people aged 35-44 and 27% in persons aged 18-34 between the years of 2003 and 2012.[3, 4] Observable racial and ethnic disparities in outcomes within YAS (Young Adult Stroke) population.[1, 3-6] This scoping review aims to synthesize the literature and summarize the epidemiological factors, clinical characteristics, and utilization of post-acute care services among YAS.

Methods: Peer-reviewed manuscripts from PubMed, PsycINFO, Web of Science, EMBASE, and CINAHL with search terms “young,” “stroke,” and “cerebrovascular accident” were retrieved. Studies between 2003-2021 and including individuals with stroke between 18-65 were included. Two reviewers independently screened each abstract and full-text article to adhere to PRISMA guidelines. The search yielded 11,858 articles; 5,097 were excluded as duplicates, and 3,491 articles were excluded during the title and abstract screening, leaving 2,347 articles to be considered in the full-text review. A total of 187 articles were included following the full-text review.

Results: The review included 1,093,366 YAS, ranging in age from 18 to 65 years. The mean age of YAS was 37 years (n=127 studies). The definition of young adults varied across studies, with 43% defining young adults as 18 to 50 years old, 26% using a range of 18-45 years old, and 12% defining young adults as 30-65 years old. The mean National Institutes of Health Stroke Scale (NIHSS) score was 6.6 (n=12 studies). The average mortality rate among YAS was 1.4% (n=19). The mean length of stay was 10 days (n=7). Minimal reporting of stroke incidence across racial groups found YAS were 61% white, 23% Black, 10% Hispanic, 5% other, 1% Asian/Pacific Islander, and less than 1% Native (n=14). Risk factors unique to YAS reported oral contraceptives (n=4), hyperhomocysteinemia (n=4), and patent foramen ovale (n=6). Post-stroke sequelae among YAS included impairments with motor, cognition (12%; n=21), anxiety (40%; n=7), and depression (40%; n=14). Functional outcomes were reported using a modified Rankin Score (mRS), where 58% of YAS had an mRS 0-2 and 42% had an mRS >2 (n=21). Unaddressed psychosocial needs led to feelings of fear and isolation. Lastly, post-acute care discharge disposition and return to work were reported, with 56% of YAS discharged home, and 63% of YAS returned to full-time work (n=19).

Conclusions: Unique risk factors, increasing incidence and prevalence, racial disparities, unknown etiologies, lack of understanding of fiscal impact, and outcomes all contribute to the importance of understanding YAS. Future studies including YAS, must

adequately describe their demographics and clinical makeup (racial/ethnic background, age stratification, etiology, unique risk factors) and develop and test interventions and services focused on YAS based on their unique needs and risk factors.

Clinical Relevance: The results of this study highlight the needs and deficits in care among YAS. Greater efforts must be made to overcome the barriers to rehabilitation and increase accessibility to all post-acute healthcare services.

Poster 18
Implementation of Video-Based Assessments for Evaluation of Gait and Dynamic Balanc

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Purpose: Physical therapists (PTs) frequently conduct evaluation of gait and functional mobility using clinical outcomes. Observational gait analysis is also commonly used to diagnose gait impairments. Video based gait data can improve the reliability of clinical observational gait analysis[1], however, there is a lack of accurate and clinically feasible methods to provide a quantification and interpretation of gait analysis that can be applied across all specialties. Motion capture, the current gold standard in gait analysis, is expensive, immobile, and requires expertise to use. Alternative video based assessment tools[2,3] are limited by lack of impaired gait datasets, being evaluated only in controlled settings, and not including dynamic gait assessments during standard clinical outcomes. The purpose of our study was to determine the feasibility of video motion-based capture to analyze the gait patterns of stroke survivors in a clinical setting. This study will utilize pose estimation via smartphone videos to distinguish various anatomical landmarks during gait[4], which was initiated in last year's DPT project to record outdoor overground walking in able-bodied individuals with a standardized background[5]. Here, we will analyze able-bodied individuals and stroke survivors during treadmill walking and in context of clinical outcome measures.

Subjects: An array of videos from 3 able bodied (AB) individuals (3 females, 25 years) were recorded during treadmill walking. These individuals were Emory University Doctorate of Physical Therapy students and knowledgeable of common neurologic gait impairments. Additionally, video data from 3 stroke survivors (males, 6 months post-stroke) were recorded during treadmill walking and clinical outcome measures.

Methods: Using iPhone cameras, frontal-sagittal and frontal plane videos were

recorded as participants completed the following clinical tests: 10-Meter Walk Test, Timed Up & Go test, 6 Minute Walk Test, Functional Gait Assessment, normal gait. Also, we collected videos of AB subjects mimicking 7 types of impaired gait patterns (vaulting, foot drop, antalgic, Trendelenburg, circumduction, crouch, and Parkinsonian). Videos were processed using OpenPose software to generate key point labels and resultant joint angles.

Results: In total, we collected 142 videos from the 6 participants, including 64 AB videos mimicking gait impairments on the treadmill, 8 AB participant videos performing clinical outcome measures, 35 treadmill gait videos of stroke survivors, and 35 videos of stroke survivors during clinical functional mobility outcomes. Videos were collected using smartphones and low-cost tripods, with guidelines informed by pose-estimation processing methods. Our preliminary analyses of labeled gait videos generated sagittal plane hip, knee, ankle joint angles, and kinematic trends aligned with the measured gait patterns (e.g. crouch, foot drop). Pose-estimation output videos showed moderate accuracy of anatomical key point labeling of our gait videos.

Conclusions: Our study suggests that video-based gait analysis is feasible in clinical settings including analysis of treadmill gait, overground walking, and during clinical functional mobility outcomes in less controlled non-laboratory environments. We also identified methodological recommendations and potential challenges to video-based gait analysis.

Clinical Relevance: The ability to quantify and objectively analyze gait impairments is crucial for physical therapy practice, and a prerequisite for developing tailored and efficacious gait intervention strategies. Obtaining and analyzing videos of gait in a busy non-optimal clinical environment with a physical therapist, other personnel, and equipment/furniture as potential barriers is important to facilitate the feasibility of quantitative gait analysis in clinical environments.

Poster 19
Functional Contributions of Motor Cortical Regions to Motor Skill Learning

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Purpose/Hypothesis: Sequence-specific learning is necessary for a wide variety of everyday tasks – from typing a sentence to tying shoelaces. While animal studies examining the equivalent of the premotor cortex (PMC) have demonstrated its importance to sequence-specific learning, there is a lack of understanding regarding the role of PMC in sequence-specific learning in humans. The purpose of the current study is to evaluate the role of PMC in sequence-specific motor skill learning. We hypothesized that interfering with PMC activity during sequence-specific training will disrupt sequence-specific motor skill learning. Additionally, we hypothesized that training-related effects will increase corticospinal excitability (CSE) and will correlate with increased motor skill performance. By better understanding PMC's contribution to sequence-specific motor skill learning, the development of targeted rehabilitative interventions that are biologically-informed will be facilitated.

Subjects: Thirty neurotypical right-handed individuals 24.9±2.9 years (26 female).

Methods: Participants performed a modified version of the serial reaction time task (SRTT), a well-studied assessment of sequence-specific learning, and completed a pre-test, post-test, retention test, and five blocks of training. After the pre-test, participants were randomly assigned to PMC (n=10), primary motor cortex (M1; n=10), or control (n=10) groups. Single-pulse transcranial magnetic stimulation (TMS) at sub-active motor threshold was delivered over either PMC or M1 cortical areas during key presses with index finger during training sessions, while control group participants received sham stimulation. Assessments of skill performance and CSE were then performed. At 24 hours after training, participants returned to perform a retention test. Motor performance (MP) was reported as the mean response time for a block of random button presses and change in motor performance (∆MP) at acquisition and retention was calculated by the change in MP from pre-test to post-test (∆MPacq) and from post-test to retention (∆MPret). Skill score (SS) was calculated as the difference in mean response time between random and repeated key presses within blocks. Skill acquisition was measured as the change in SS between pre- and post-tests (∆SSacq). M1 CSE was measured prior to training by measuring motor evoked potential (MEP) amplitudes of the first dorsal interosseus (FDI) muscle in response to varying levels of TMS output (20-80% maximum stimulator output), and an active input-output recruitment curve was plotted. Skill retention was quantified by the change in SS between post-test and retention test (∆SSret). Percent change in CSE was measured by calculating the area under the recruitment curve pre-training/post training * 100.

Results: There were no significant differences of ΔMP across groups at either acquisition (p=0.22) or retention (p=0.95). All groups significantly improved in MP from pre-test to post-test and pre-test to retention (*p<0.005). There were no significant differences in ΔSS across groups for acquisition (p=0.80) and retention (p=0.34). However, only 3/10 PMC group participants demonstrated offline skill stabilization or enhancement compared to 6/10 in the M1 group and 9/10 in the controls. There was a significant positive correlation between ΔSS and % ΔAURC in the PMC group at retention (r=0.95, *p<0.005), while there were no significant correlations for M1 or control groups in changes of motor performance or skill score.

Conclusions: Results suggest PMC was not functionally necessary for sequence-specific learning as ΔSS at acquisition and at retention was not significantly different from M1 or Control groups. However, only 30% of the PMC group showed offline skill enhancement at retention, therefore there may be potential effect of PMC interference on sequence-specific learning that was limited by a small sample size. Within PMC participants, a smaller change in CSE was significantly associated with smaller improvements in sequence-specific skill. No correlation was found for M1 or Control participants between changes in CSE and changes in motor performance and skill score. Further investigation is needed to determine if and to what extent PMC significantly contributes to sequence-specific motor skill learning.

Clinical Relevance: A more comprehensive understanding of the functional roles of motor cortical regions has the potential to inform rehabilitative interventions. Additionally, evaluating at retention rather than at acquisition may better assess motor learning as it includes between-session offline learning; which is clinically relevant when working with patients long-term.

Poster 20

Muscular Contributions at Each Joint During a Single Leg Countermovement Jump

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Purpose/Background: The purpose of this study is to evaluate the muscular contributions of the hip, knee, and ankle joints in relation to rate of force development (RFD) and ground reaction force (GRF) during a single leg countermovement jump (SL CMJ) in volleyball athletes due to the high demand required of single leg plyometric demands in volleyball. [1] DARI motion capture was chosen due to shorter data collection time and the validity of derived GRF compared to a force plate or marker-systems. [2] In female collegiate volleyball, lower extremity injuries account for the majority of all injuries, with most being at the ankle and knee. [3,4,5] During rehabilitation from lower body injuries, it is important to know where the most force is generated and where emphasis needs to be placed when progressing athletes during return to play protocols.

Methods: Twelve female collegiate volleyball athletes were recruited to participate in this study. All participants performed a standardized warm-up consisting of dynamic stretching exercises followed by a series of standardized movements beginning with range of motion and ending with plyometric exercises. Data was first exported from DARI which was then further analyzed manually to compare joint angles and relative torque contributions to the RFD and GRF in SL CMJs.

Results: The torque produced by the knee at takeoff is the highest contributing factor in RFD and GRF during a SL CMJ, followed by the torque produced by the ankle and the hip respectively. The average torque percentage at the hip, knee, and ankle joints for the female collegiate volleyball athletes was 10.09 ± 3.4812%, 14.03 ± 6.136%, and 2.20 ± 0.9316% respectively. Knee torque showed a strong, positive correlation with RFD and GRF (R^2 = 0.81 and 0.74, $p < 0.001$). Ankle torque showed a moderate, positive correlation with RFD and GRF (R^2 = 0.53 for both, $p < 0.001$) Hip torque showed no correlation with RFD and GRF (R^2 = 0.0068 and 0.0036, p = 0.701 and 0.781). Total joint angle during the braking phase showed a strong, negative correlation with GRF and RFD (R^2 = 0.6562 and 0.6545, $p < 0.001$). Hip flexion showed a moderate, negative correlation with GRF and RFD (R^2 = 0.461 and 0.4624, $p < 0.001$). Knee and ankle flexion both showed a weak, negative correlation with GRF and RFD (knee: R^2 = 0.1643 and 0.2256, p = 0.049 and 0.019; ankle: R^2 = 0.1336 and 0.0583, p = 0.079 and 0.256).

Conclusion: Greater single leg countermovement jump RFD and GRF during takeoff are strongly associated with knee torque contributions and moderately associated with the ankle. No association was found between hip torque and RFD or GRF. Additionally, increased joint angles were found to have a negative correlation to both RFD and GRF.

Clinical Relevance: Understanding that the knee contributes the most to RFD and GRF production during SL CMJ is helpful to know in practice for emphasis during return to sport protocols for lower body injuries. Additional research will need to be conducted to determine how previous injuries affect contralateral discrepancies and how injuries affect respective joint torque contributions.