CARLoquium 2022

Chiropractic Academy for Research Leadership (CARL)
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The Chiropractic Academy for Research Leadership (CARL) is an innovative program that provides mentorship, training, and leadership opportunities to the next generation of chiropractic researchers through an open application process. The first CARLoquium was launched by in 2021 by the CARL Fellows as a means to meet and disseminate research findings from the chiropractic community during the COVID-19 pandemic with the second CARLoquium held virtually in March 2022. To date, the conference has featured numerous keynote speakers, hundreds of abstracts and continues to provide a cost-effective avenue for our researcher community to gather.

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KEY WORDS: chiropractic, research

Travaux d'un congrès
Le Chiropractic Academy for Research Leadership (CARL) est un programme novateur qui offre un mentorat, une formation et des débouchés de leadership à la prochaine génération de chercheurs en chiropratique grâce à un processus d'application ouverte. Le premier congrès du CARL a été lancé en 2021 par ses membres pour faire part des résultats des recherches effectuées par la communauté de chiropratique au cours de la pandémie de COVID-19, le deuxième congrès s'étant tenu virtuellement en mars 2022. Jusqu'à maintenant, de nombreux conférenciers d'honneur ont été invités et des centaines de résumés ont été présentés au congrès qui continue d'être une façon abordable de rassembler la communauté de chiropratique.

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MOTS CLÉS : chiropratique, recherche

Emergency department care for older adults diagnosed with low back pain

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Background: *In Australian emergency departments (ED), 30% of all back pain presentations are for older adults. Relatively little is known about the care that this population receives during an ED stay, including admission to hospital.*

Aim: *To describe the ED management of older adults diagnosed at discharge with a lumbar spine condition and to determine predictors of healthcare use in this population.*

Methods: *A retrospective analysis of electronic medical record data of adults aged ≥65 years were diagnosed on discharge, with a lumbar spine condition. Demographic, clinical care and costs data were extracted from Sydney Local Health District Targeted Activity and Reporting System; with descriptive analyses and multilevel mixed-effects logistic regression models performed.*

Results: *There were 4,093 presentations to EDs, with most being female (58.3%). Across all lumbar spine discharge diagnoses, 39.9% had some form of lumbar imaging and 34.1% were subsequently admitted to hospital. The most commonly administered pain-relieving medicines were opioid analgesics (67.1%), followed by paracetamol (63.9%) and NSAIDs (33.0%). Predictors of healthcare utilisation and hospital inpatient admission were receiving received a laboratory test and receiving any opioid. For 1,648 lumbar spine diagnoses in 2019-20, the mean (SD) total cost of care per presentation was $5,629 ($11,982).*

Conclusions: *There were more than 4,000 presentations to EDs by an older adult with low back pain of lumbar spine origin. Opioid analgesics were the most commonly administered pain medication, and more than half of all patients received combined opioids and paracetamol. Alternative pathways of care to minimise ED presentations are needed, alongside the development and implementation of new models of care in pre-hospital and post-hospital settings.*

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Preliminary results from the BAck Complaints in the Elderly: Chiropractic – Australia study. A cohort profile

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Objective/Aim: *One in seven adult chiropractic patients are aged >65 years and of these, 60% present with a back problem. The aim of the BAck Complaints in the Elderly:Chiropractic – Australia study is to examine the clinical course of LBP in older adults who seek chiropractic care.*

Methods: *The study design was a 12-month, prospective longitudinal cohort study. Inclusion criteria was a 'new' episode of LBP. Questions about sociodemographic factors, lifestyle characteristics, health, pain, functional status, cognition, adverse events, medications, satisfaction with chiropractic and quality of life were asked at baseline and at follow up (2 and 6 weeks and at 3, 6, 9 and 12 months). Longitudinal SMS pain data was cap-*

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tured daily for two weeks and then weekly for 11.5 months. Descriptive statistics will report the cohort profile.

Results: *226 chiropractic patients were enrolled into the study, with 52.4% female and a mean age of 67.6 (s.d 8.6) years. Only 7.9% reported LBP for the first time, and 65.0% described pain that extended into the lower limb. At baseline, mean VAS for LBP at baseline was 4.2 (s.d. 2.5) and the highest proportion for ODI scores was 48% for moderate disability. The STarT back question-*

naire identified 41.9% of participants as having low risk of chronicity.

Discussion: *At baseline, more than 90% of older adults with LBP had a past history of LBP, disability levels were high and lower limb pain was common. As we finish 12 month longitudinal data collection, the study will allow a better understanding of the demographics, clinical course and predictors of LBP in older adults.*

Exploration of chiropractic students' motivation toward the incorporation of new evidence on chiropractic maintenance care

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Background: *Chiropractic maintenance care (ChiroMC) refers to the long-term care strategies introduced when a majority of clinical benefit has been reached from standard treatments. Previous work has systematically investigated the indications, content, and frequency of ChiroMC and found that low back pain patients can be subgrouped by psychological characteristics. Further, given the wide range of outcomes between these groups, the application of ChiroMC in clinical practice needs to be executed with these groupings in mind. The MAINTAIN tool was developed to assist in classifying patients into their subgroup in clinical settings. This study was designed to explore the optimal way to train chiropractic students on the use of the MAINTAIN tool.*

Objective: *To explore final year students´ attitudes towards incorporating new ChiroMC-focused evidence.*

Methods: *This layered, mixed-method, inductive ap-*

proach explored students´ attitudes towards incorporating new ChiroMC-focused evidence with surveys, monologues, dialogues, and qualitative feedback from chiropractic students at Parker University (Dallas, TX, USA) between January 2021 to November 2021. This study asked all 5th – 10th trimester students (n=563) to complete a quantitative questionnaire that evaluated their attitudes/understanding of patient-centeredness (PPOS) and chronic pain (HC-PAIRS), as well as their current perspectives on incorporating evidence. The qualitative components began with four open-ended, reflective questions sent to all 8th and 9th trimester students (n=215). This was followed with individual semi-structured interviews with students theoretically sampled to further explore responses to the reflective questions. The final phase consisted of one-on-one semi-structured interviews developed from the previous phase with a theoretical sampling of students used again. Descriptive statistics were used to summarize the quantitative questionnaire. For the qualitative phases of the study, responses to the open-ended responses and

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semi-structured interviews were reviewed by multiple team members. Codes and themes were generated for the responses with team members meeting to determine coding agreement and establishing a coding tree.

Results: *The qualitative questionnaire was completed by 74.4% of students (n=419). The majority of students had already received their bachelor's degree (84.5%), were male (57.5%), and had a mean grade point average of 3.15 (SD:0.369). Evidence perspectives were diverse: Biomechanical, n=140(33.4%), General Problem/ Biomechanical, n=18(4.3%); Biomechanical/Organic Visceral, n=6(1.4%); General Problems, n=110(26.3%); Somatic Dysfunction, n=49(11.7%), Vertebral Subluxation, n=96(22.9%). The PPOS (1-6; high score desired) had a mean score of 3.9 (range: 1.72-5.17) and the HC-PAIRS (1-7; low score desired) had a mean score of 4.2* (range: 2.20-6.27). *Concepts identified through the qualitative phases included the need to facilitate basic understanding of MC terminology. There was a large emphasis on the impact of the supervising clinicians' role on discussing evidence, seeing evidence in-action, and how to continue learning after graduation. Interviews identified the need to establish that research is something that builds education and experience, not simply an addition to education, along with the need to increase student's research literacy/confidence.*

Discussion: *As the MAINTAIN tool is furthered explored to assist with treatment plan development, key concepts from this study may assist with optimizing training strategies, including operationally defining terminology, involving instructors who are fundamental to students' training, and increasing research literacy.*

Pressure pain thresholds in a real-world chiropractic setting – topography, changes after treatment, and clinical relevance?

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Background: *Changes in pain sensitivity, as indicated by pressure pain thresholds (PPT), are a commonly suggested mechanism for the pain relief often experienced following spinal manipulative therapy (SMT). While there is agreement that PPT increases systemically, and more so at the SMT site, the research has primarily been conducted in highly experimental setups and often using an asymptomatic population. The clinical relevance of PPT changes following SMT is unclear, as many important factors differ between experimental and clinical setups. Therefore, we investigated PPT before and after chiropractic care in a clinical setting (in which we expected patients to receive SMT) and investigated relationships with various potentially clinically-relevant factors.*

Methods: *We recruited participants from four Danish chiropractic practices between May and August of 2021. A total of 129 participants (72% of the invited) were included. We measured PPT at eight pre-determined test sites (six spinal and two extra-spinal) immediately before the chiropractic consultation (pre-session) and immediately after (post-session). We used linear regression approaches to investigate the PPT changes in relation to the following factors: i) segmental distance to the nearest SMT site, ii) rapid clinical response, and iii) number of SMTs performed.*

Results: *All participants received one or more SMT treatments (range 1 to 12) as we expected. The mean before/after PPT change was 0.14 Kg (95% confidence intervals = -0.01 to 0.29). No significant associations were found in relation to distance between the PPT test site and nearest SMT site, the clinical response of participants to treatment, or the total number of SMTs performed.*

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Discussion: *This real-world trial of private practice chiropractic patients receiving SMT failed to demonstrate a substantial systemic increase in PPT following the clinical encounter. None of our selected a-priori factors were correlated with PPT changes. This is not in line with previous publications and questions the generalizability of using highly experimental setups to determine the neurophysiological mechanism of SMT in a clinical setting.*

What does spinal manipulative therapy specificity mean to you? An international survey of chiropractors

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Introduction: *Chiropractors often use spinal manipulative therapy (SMT) to manage spinal pain. In order to apply SMT, chiropractors may undertake several steps, starting with attempting to locate a clinically relevant site to provide SMT. This is followed by applying a specific force to that site, often in a precise direction (i.e., the thrust vector), and finally inducing a specific local force to the site (e.g., movement in the vertebral motion segment). It is believed that these steps are indicators for the clinical effect of SMT and could be labeled as providing "specific" SMT. However, recent research has called the validity of the specific identification and application of SMT into question. Nevertheless, chiropractors appear to value specificity in SMT but the term may mean different things to different people as it has not been explored previously by research. We aim to understand what SMT specificity means for chiropractors globally and how the chiropractic profession values concepts of SMT specificity.*

Methods (preliminary): *We will develop a survey that examines both the meaning and perceived importance of SMT specificity for chiropractors as a function of their role in healthcare. The survey will be developed as follows: i) We will search the literature for systematic reviews relating to SMT and SMT procedures in PubMed and Epistemonikos. The results will be manually screened according to the inclusion and exclusion criteria. Inclusion criteria are systematic reviews of trials investigating "specificity terms" or "effects" of SMT. We will then extract information regarding SMT procedures, application site, technique, and clinical effects from included studies. These items will provide the initial framework for the items included in the survey. Next, a consensus of relevant items to include will be decided by a team of SMT experts (chiropractors, researchers, and the author team). The survey will be piloted on volunteer chiropractors. We will translate it to relevant languages using Beaton's cross-cultural adaptation technique modified version. This survey will also include items related to chiropractors' perceived role in the health care system and provider characteristics according to the Institute for Alternative Futures grouping. We expect to invite Chiropractors from registered National Associations in including Denmark, Norway, Sweden, Canada, the United States, Australia, and Switzerland. Data will be reported descriptively and will report on how SMT specificity can be defined and what it means to clinicians and regressions models will*

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be used to determine if the perceived role in healthcare is associated with the importance of SMT specificity.

Discussion: This will be the first study to assess chiropractors' perceptions of SMT specificity. The results will illustrate what clinicians consider SMT specificity to represent and its importance. The outcomes from this study could inform future trials relating to providing specific SMT and how this should adequately be designed.

Diversity of the chiropractic profession in Canada: a cross-sectional survey of Canadian Chiropractic Association members

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Background: *Despite rapidly increasing diversity of the Canadian population, there is no available data on the diversity of the chiropractic profession with respect to gender, sexual orientation, race, ethnicity and community of practice. Diversity provides a foundation for culturally competent care delivery at the provider level and is paramount in the pursuit of a culturally congruent model of chiropractic care.*

Objective: *To explore the diversity of the Canadian chiropractic profession.*

Methods: *All registered members of the Canadian Chiropractic Association (N=7721) were invited to participate in a web-based survey between May and June 2021. Survey questions explored diversity with respect to personal demographics (age, sex, gender, sexual orientation, race, ethnicity, language) and practice characteristics (community setting, practice type).*

Results: *We received a total of 3143 survey responses (response rate – 41%). The average age of chiropractors in our sample was 44.7 years (standard deviation (SD) 12.7). Forty-five percent of chiropractors surveyed were female with the same proportion (45.2%) identifying as women. Ninety-one percent of the sample identified as heterosexual. With respect to race, 78% of respondents were Caucasian. Seventy percent of chiropractors in our sample identified themselves as ethnically Canadian and 29% were European. In comparison to the Canadian population, most visible minorities were underrepresented. This was most pronounced for Black and Indigenous chiropractors. With respect to ethnicity, chiropractors who were Canadian, American or from Oceana were overrepresented in our sample compared to others, specifically North American Indigenous, Caribbean, and South, Central and Latin American ethnicities. Sixty-one percent of chiropractors practiced within a major city and most work in interdisciplinary clinics (42% complementary and 33% rehabilitation).*

Discussion: *This study provides an initial description of diversity within the chiropractic profession in Canada. Although women make up nearly half of the profession nationally, very few identify as a gender minority. Overall, there is little racial and ethnic diversity in the profession compared to the Canadian population, with Black and Indigenous peoples underrepresented. This study provides a foundation for future work exploring provider-level attributes that contribute to cultural competence. Future work should focus on patient-level attributes and assess the activities of professional organizations and institutions in support of equitable delivery of chiropractic care.*

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Attitudes, beliefs, and recommendations for chronic low back pain patients: cross-sectional surveys of a chiropractic teaching clinic

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Background: *Attitudes and beliefs of providers have an influence on patient outcomes. Despite the prevalence of chiropractors' confidence and engagement in the care of spine and chronic pain conditions, chiropractors' attitudes and beliefs related to chronic spine pain and its impact on patients are not fully known. The attitudes and beliefs of chronic low back pain (CLBP) patients in chiropractic students and faculty has also not been evaluated.*

Objective: *To assess attitudes and beliefs of students and faculty of a chiropractic teaching institution in 2018 and 2020 regarding CLBP and evaluate their recommendations for work and activity in vignettes of patients with CLBP.*

Methods: *The Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) and clinical vignettes were requested to be completed by chiropractic faculty and all students at Parker University in April 2018 and July-December 2020. The HC-PAIRS is a 15-item measurement tool developed to assess the attitudes and beliefs of health care providers regarding functional expectations for patients with CLBP and 4 factors (Functional Expectations, Social Expectations, Need for Cure, Projected Cognition). It has been shown to be a valid and reliable assessment tool for HCPs using a 1-7 point rating scale. The higher the score, the stronger the belief that CLBP justifies disability and the limiting of activities. Similarly, the 3 clinical vignettes have been found to be valid ways to explore physicians' recommendations regarding work and activity levels for CLBP patients.*

Results: *Response Rate: Student response rates in 2018 and 2020 were 497/781=63.6% and 325/1176=27.6%. Faculty were 23/30=76.7% and 22/53=41.5%, respectively. HC-PAIRS Results: Both students (2018=4.41, 2020=4.42) and faculty (2018=3.66, 2020=3.49) had a slight decrease in scores with students' decrease being statistically significant (mean change=0.19, p<0.05) but not the faculty's score decrease (mean change=0.17, p=0.55). Faculty did have statistically significantly lower scores than students both years (p<0.05). In both years, faculty had lower scores than students in all factors except for Projected Cognition in 2020 (faculty=5.45, student=5.36). Both faculty and student scores decreased for Functional Expectations (faculty=3.51,3.14; student=4.36,4.11) and Need for Cure (faculty=3.38,3.02; student=4.41,4.00). Faculty scores increased for Social Expectation (3.14,3.26) and Projected Cognition (5.00,5.45) and scores did not change for students. Clinical Vignette Results:*

The percentage of faculty that provided adequate activity (62.1%,66.7%) and work (41.0%,45.5%) recommendations increased from 2018 to 2020, but were not statistically significant. The percentage of students that provided adequate activity recommendations decreased (33.9%,30.3%), while adequate work recommendations increased (22.1%,23.8%); both were not statistically significant.

Discussion: *This initial exploration of students and faculty at a chiropractic teaching institution's attitudes and beliefs of CLBP patients found student mean scores (4.22-4.41) to be on the higher end of other published healthcare professional students' scores (3.49-3.66). Faculty mean scores (3.49-3.66) were also on the higher end of HC-PAIRS scores from HCP's scores (2.58-3.80).*

Response rates in 2020 were much lower due to COVID. While spurious decreases occurred, they were not clinical meaningful. Future work should investigate specific strategies to modify attitudes and beliefs regarding CLBP and assess if these changes do enhance patient outcomes.

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Dosing of lumbar spinal manipulative therapy and its association with care escalation: an analysis of insurance claims

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Background: *Dose-response for chiropractic care has been studied clinically in relation to low back pain (LBP), neck pain and headache. However, the relationship between dose of spinal manipulative therapy (SMT) and healthcare utilization from a health services perspective has yet to be investigated.*

Methods: *Our cohort consisted of LBP related episodes from an insurance claims database representing the covered members (≥18 years) of a large fortune-500 company (2012-2018). Episodes of care were identified by 90 day claim free periods, and only the initial episode of care was included. Procedure codes 98940-98942 were used as markers for SMT. Care escalation was defined as the presence of one or more of the following: Imaging (x-ray, MRI, CT scan); Injection procedure; Emergency Department (ED) visit; Opioid medication fill; Surgical procedure. Escalation included the presence of any of these procedures. Age, gender, allowed insurance reimbursement, claim count and risk score were collected for each episode and included as covariates in modified Poisson regression models to estimate relative risk (RR) of care escalation based on SMT dose.*

Results: *A total of 11,114 low back episodes were identified and included in our analysis. Four SMT dosing groups were identified: (1) no SMT (n= 8,137); (2) one SMT visit (n=404); (3) 2-12 SMT visits (n=1,763); (4) 13 (+) SMT visits (n=810). After adjusting for covariates, and using group 1 as the reference: SMT group 2 was associated with the lowest risk of imaging (RR 0.56, 95% CI 0.45-0.69), ED visits (RR 0.06, 95% CI 0.01-0.23), Opioid medication fills (RR 0.39, 95% CI 0.23-0.66) and any escalation (RR 0.46, 95% CI 0.38-0.55); SMT group 3 was associated with the lowest risk of injections (RR 0.32, 95% CI 0.26-0.40) and surgery (RR 0.45, 95% CI 0.33-0.62); SMT group 4 was associated with an increased risk of imaging utilization (RR 1.39, 95% CI 1.27-1.52).*

Conclusions: *With few exceptions, SMT dose ≥1 showed a protective effect against the use of imaging studies, injections, ED visits, surgery, opioid medications, and any escalation when compared to no SMT. These results provide important information to practitioners and policymakers regarding the impact of SMT dose on healthcare utilization.*

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Musculoskeletal comorbidities of chronic low back pain participants presenting to U.S. Veterans Health Administration chiropractic clinics enrolled in a randomized clinical trial

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Background: *Previous work has shown increased prevalence of musculoskeletal comorbidity (MSKC) in chronic low back pain (cLBP) participants. However, the specific types of MSKCs have not yet been described. There has equally been little inquiry into MSKC among participants presenting to chiropractic care.*

Objective: *We aim to describe the prevalence and type of MSKC in cLBP participants presenting to chiropractic clinics in the Veterans Health Administration (VHA) of the United States who are enrolled in an existing randomized clinical trial.*

Methods: *A descriptive analysis of EHR data from participants enrolled in a multi-site pragmatic clinical trial on cLBP (Veterans Response to Dosage in Chiropractic Therapy [VERDICT]) in the VHA between February 1, 2021 and December 31, 2021. International Classification of Diseases 10th Edition (ICD-10) codes were collected for each participant using a 12-month lookback relative to each participant's date of enrollment across four VHA chiropractic clinics. We defined categories of MSKCs using previously established lists of musculoskeletal diagnoses: neck, mid-back, upper extremities, lower extremities, headache, and non-regional musculoskeletal complaints. Non-regional musculoskeletal complaints included ICD-10 codes ranging from myalgia to Chronic Pain Syndrome and Fibromyalgia. Participant placement in MSKC categories was not mutually exclusive.*

Results: *During the time-period, 154 participants were enrolled in the study. Of these 6.5% had 0 MSKCs, 40.9% had 1-2, 40.9% had 3-4, and 11.7% had 5-6. Non-regional MSKCs were identified in 68.2% of participants, lower extremity in 63.0%, upper extremity and mid-back in 35.7%, neck in 34.4%, and headache in 34.7%.*

Conclusion: *Consistent with existing literature, cLBP participants enrolled in the VERDICT clinical trial had MSKCs in large percentages, with only a small minority not having any MSKCs. Therefore, consideration of MSKCs may be important for diagnosis and management of cLBP participants.*

Descriptive comparison of force-time profiles of diversified and terminal point technique measured with a novel hand-held force sensing load cell: a protocol design

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Background: *Low back pain and other musculoskeletal conditions are among the leading causes of disability globally. Chiropractic utilises high velocity, low amplitude spinal manipulative therapy (HVLA SMT) to treat a range of musculoskeletal and health related conditions. HVLA SMT plays a central role in pain management as it has been shown to decrease pain and improve function. Quantifying forces delivered during HVLA SMT (force-time profile) is important when considering the efficacy of therapy and safety of the patient. Chiropractors apply a range of manipulative techniques, but it is unknown how technique choice influences the force-time profile of the HVLA thrust. Previous studies have quantified HVLA SMT, but have used multiple measurement devices, varied sensor placement, and heterogeneous study designs, making technique comparison difficult. The use of a single sensing device across different techniques under controlled conditions will solve this issue.*

Aim: *To descriptively compare two styles of high velocity low amplitude spinal manipulative therapy commonly used by chiropractors, using a novel measurement device.*

Methods: *A hand-held force sensing load cell ("puck") will be used to measure HVLA SMT thrusts delivered by*

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three experts upon a mannequin. Experts (participants) are registered chiropractors/educators who have a minimum five years of clinical experience in Diversified and terminal point technique (TPT). The puck will be positioned on the mid "thoracic" region of a prone mannequin upon a standard treatment table. The puck will be positioned between the participant's hand and the mannequin. Participants will deliver 10 Diversified thrusts to the mannequin. Participants will then deliver 10 TPT thrusts on the mannequin while positioned on a "drop" treatment table. The drop piece within the table is raised (approximately 20mm) to the "cocked" position before each TPT thrust. Measurement outcomes are key parameters of the force-time profile. For each thrust (60 total) the following parameters will be recorded: mean preload force (N), take off force (N), loading rate (N/ms), total peak force (N) and duration (ms). The mean of each set of 10 force-time profiles will be described and compared between each technique.

Expected results: *It is expected the force-time profiles of Diversified and TPT thrusts will differ. Additionally, it is hypothesised force-time profiles will differ between participants. It is anticipated that the Diversified-thrust will generate larger total peak forces, while TPT-thrust will generate a greater loading rate and have two force peaks; the first due to practitioner thrust and the second from the drop table reaction force.*

Conclusion: *The use of a novel hand-held puck will allow the measurement and comparison of force-time profiles between different HVLA SMT styles due to its portability. By using a single measurement device in future studies, we may gain insight into clinical effect based on different force-time profiles.*

Association of chiropractic integration in a Canadian community health centre with prescription of opioids for non-cancer spinal pain: a mixed methods analysis

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Background: *Opioids are commonly prescribed in North*

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America to relieve musculoskeletal pain and improve function. However, opioids provide only modest benefits and are associated with important harms including addiction, overdose and death.

Objective: *We undertook a mixed methods analysis to examine the association between receipt of chiropractic services in a Canadian community health centre (CHC) and opioid prescriptions among adult patients with non-cancer spinal pain.*

Methods: *We used a sequential explanatory mixed methods design. In the quantitative phase, we conducted a retrospective cohort study of all electronic medical records of recipients and non-recipients of chiropractic services at the Langs CHC in Ontario, Canada between January 1, 2014 and December 31, 2020. We used Cox proportional hazards regression analyses to evaluate the*

association between receipt of chiropractic care and time to opioid prescription, adjusted for patient demographics, co-morbidities, visit frequency, and calendar year. In the qualitative phase, we conducted one-on-one interviews with patients and general practitioners (GPs) to explore perceptions of chiropractic integration and its impact on opioid prescribing. Qualitative data were coded and analyzed using content and thematic analysis and integrated with our quantitative findings.

Results: *We extracted data from 945 eligible patient records and completed 23 interviews (14 patients, 9 GPs). Over our 7-year study period, 24% of patients (227 of 945) with non-cancer spinal pain received an opioid prescription. The risk of receiving opioids was 52% lower in chiropractic recipients versus non-recipients (adjusted hazard ratio [aHR] = 0.48; 99% confidence interval [CI], 0.29 to 0.77) and 71% lower in patients who received chiropractic services within 30 days of their index visit (aHR = 0.29; 99% CI, 0.13 to 0.68). Patients whose index*

visit date was in a more recent calendar year were less likely to receive opioids (aHR = 0.86; 99% CI, 0.76 to 0.97). Higher frequency of visits (aHR = 1.02; 99% CI, 1.02 to 1.03), older age (aHR = 1.02; 99% CI, 1.01 to 1.04), smoking (aHR = 1.62; 99% CI, 1.12 to 2.35) and depression (aHR = 1.77; 99% CI, 1.20 to 2.61) were positively associated with receipt of opioids. Follow-up interviews suggested that self-efficacy, access to chiropractic services, opioid stigma, and desire for pain relief were important influencing factors.

Conclusion: *Our analysis found that patients with spine pain who received chiropractic care were less likely to receive opioids than patients who did not receive chiropractic care. Four themes emerged in our qualitative interviews to help provide a richer understanding of this association. A multi-stage, mixed methods randomized controlled trial is needed to verify our findings and establish causality between these variables.*

Characteristics of chronic musculoskeletal pain sufferers treated in a university-affiliated complementary and integrative health care clinic

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Background and objective: *Chronic pain is a substantial driver of high health care costs and disability, especially among certain demographic and socio-economic groups. Indeed, disparities in the experience and treatment of pain based on age, sex and race are significant. A host of factors, including nutrition and inherited genetic polymorphisms may contribute to these disparities. Considering that patients seeking complementary and integrative health (CIH) approaches for chronic pain are dramatically under-studied, we assessed the role of nutritional, genetic and other factors in a sample of chronic*

musculoskeletal (MSK) pain sufferers from a unique patient population seeking complementary and integrative health (CIH) care at an urban university-affiliated clinic.

Methods: *A total of 99 eligible participants were recruited from the University of Bridgeport (UB) Clinics. We assessed participant demographics, medical histories, pain frequency and severity, and administered a validated food frequency questionnaire assessing omega-3 polyunsaturated fatty acid (PUFA) intake. Whole blood fatty acids and fatty acid desaturase (FADS) rs174537 polymorphism status were also measured.*

Results: *Participants with chronic pain were significantly older, and more likely to report White race and use of omega-3 fatty acid supplements. Women reported significantly greater pain severity and exhibited higher levels of linoleic acid (LA) and lower levels of arachidonic*

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acid (AA). Additionally, cervicalgia was approximately twice as prevalent in women, whereas low back pain was approximately twice as prevalent in men. Blood saturated fatty acids (SFA) were significantly lower and mono-unsaturated fatty acids (MUFA) were significantly higher in the chronic pain group. Supplement users reported significantly less pain interference with life enjoyment and had higher levels of total and individual omega-3 PUFA, SFA and trans-fatty acids (TFA), and lower levels of total and individual omega-6 PUFA. FADS rs174537 genotypes were not associated with pain status.

Conclusion: *To our knowledge, we are the first to describe characteristics of chronic MSK pain sufferers in an urban, university-affiliated CIH population. Our findings indicate pain disparities based on age, sex and race, and alterations in blood fatty acids in this unique population. Additionally, while usage of omega-3 fatty acid supplements did not appear to affect pain frequency or overall pain severity, it may have beneficial impact on perception of chronic pain with quality of life, however; concerns of supplement contamination require further study.*

A comprehensive set of systematic reviews of the literature on mechanisms of spinal manipulation, specifically on: i) objectively measured anatomical/biomechanical changes related to spinal manipulation, ii) objectively measured physiological changes related to spinal manipulation, and iii) clinical effects related to spinal manipulation

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Steen Harsted, PhD
Nathan Hutting, PhD
Edward Lee, PhD
Christopher McCarthy, PhD
Casper Glissman Nim, PhD
Luana Nyirö, PhD

Background: *In order to understand the way any therapy works, three elements need to be scientifically studied: 1)* the anatomical/biomechanical/physiological responses in the human body objectively measured after the therapy is applied, 2) clinically relevant effects as demonstrated through validated outcome measures, and 3) the

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link between the two, *i.e. determining whether and how an anatomical/physiological change translates to clinical effects. This generally requires a reductive approach, isolating the "active ingredient" in the therapy by discarding any unnecessary non-active ingredients. This also holds true for manual therapy, specifically joint manipulation, if manipulation is to be given the credit for clinical improvement in patients. Although many mechanisms for the clinical effects have been proposed, none have become well-established, and there is a paucity of strong evidence supporting these. Therefore, it would be useful to understand the current state of the evidence for the effect of spinal manipulation on spine-related anatomical structures and the resultant associations with clinically relevant effects. This, in turn, would help direct future efforts in further developing evidence for manual therapies.*

Methods: *Systematic reviews of the literature without meta-analysis.*

Current status: *Review 1 PROSPERO protocol registered, review teams assembled, search terms defined.*

Results (hypothesised): *Our hypothesis is that there are postural, anatomical and physiological changes in spinal structures as a result of high velocity, low amplitude (HVLA) manipulation, but that an unknown quantity of high-quality research has been conducted that provides definitive links associating clinically significant effects with these changes. We expect to find much fertile ground for future investigations into spinal manipulation.*

Conclusions (hypothesised): *Ultimately, this understanding will help inform patients as to what happens inside their bodies when their spines are manipulated. It may provide clinicians with better information when discussing therapeutic interventions with patients, so that patients can make better informed choices. The results from this study will also help indicate gaps in knowledge, thus highlighting useful areas for further study.*

Proof of concept – automated qualitative scoring of movement patterns using joint center positions collected using motion capture

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Background: *Qualitative scoring of movement patterns is a common element in gross motor test batteries for children and adults. The typical procedure in these tests is to have a subject perform a given movement while an examiner observes and subsequently scores the movement by evaluating subject-posture at or between key events (e.g., in forward jumping: +1 point if "Arms are extended in front of the body and above the head at toe-off"). Markerless motion capture makes it possible to easily capture and accurately quantify human locomotion without disturbing the natural movements of the subject being evaluated. Furthermore, most systems can describe subject posture as 3D joint-center positions on a frame-by-frame basis. This makes it possible to create software algo-*

rithms that automatically identify key events and evaluate postures for most movements evaluated in popular movement screening batteries. The present work proves the concept of automating the qualitative scoring of standing broad jumps. The work shows how the identification of key events and the subsequent postural evaluation of subjects performing standing broad jumps can be automated using joint center positions and simple algorithms.

Discussion*: The proposed method makes it possible to quickly and reliably evaluate large quantities of motion-capture data. However, the technique needs to be fine-tuned and validated before applying it in cohort studies or clinical practice. Furthermore, the accuracy of the automated qualitative scoring algorithm will be limited by the quality of the motion capture data it is applied to.*

Perspectives: *Primary proposed research: The Motor Skills in PreSchools (MiPS) cohort contains motion capture data of +600 children performing standing broad*

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jumps at the ages of 3, 4, 5, and 6 years. If the proposed method proves valid, future research can use it to describe the early locomotor development of jumps in typically developing children. Other potential research: The proposed method of using joint-center positions to break a *movement down to key events and evaluate posture can be applied to a wide range of activities. Therefore, automated scoring of popular screening tests, such as the Functional Movement Screen, are obvious targets for future development of the method.*

Assessment of a downloadable application with avatar guidance for PT-prescribed home exercise after total knee arthroplasty: a 30-day feasibility study

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Objective: *To investigate the feasibility, usability, and comparative functional outcomes using app-based (APP) versus paper handouts (CONTROL) to guide home exercises after total knee arthroplasty (TKA).*

Design: *Prospective feasibility study*

Setting: *Rehabilitation laboratories at two regional medical centers*

Participants: *Individuals with knee osteoarthritis undergoing unilateral TKA (APP group: N = 26; mean age, 67.0 ± 8.2y; CONTROL group: N = 31; mean age, 64.7 ± 7.7y)*

Interventions: *This study compared the user experience of a downloadable app-based to guide postoperative home exercises and instruction compared to the same/similar information delivered by paper handouts. All participants used home exercises for 30 days after TKA.*

Main outcome measures: *The System Usability Scale (SUS) score was used to assess patient experience. SUS scores were dichotomized (≥72 or <72) to determine app usability against a 75% a priori criterion for mean APP group score. Feasibility was evaluated by personal com-* *puting device ownership and study use, technology-based barriers to participation, and completion of app-based testing after 30 days. Exploratory measures compared change from baseline to 30 days for functional and patient-reported outcomes between groups to further examine the feasibility of the app in guiding clinical assessments.*

Results: *The APP group's mean System Usability Scale (SUS) score of 79.2% at 30 days exceeded the 75% threshold for acceptable usability. The app met two of three predetermined priori criteria for feasibility in the TKA population. Personal computing device use in this study failed to meet the feasibility criterion. No differences between the APP and CONTROL groups were observed for functional or patient-reported outcomes.*

Conclusions: *The app-based platform met the a priori criteria for usability for 79% of APP participants. Our findings suggest that app-based home exercise and education after TKA has acceptable feasibility and usability. The app-guided patient assessment capability also demonstrates preliminary feasibility for guiding and administering functional and self-reported outcomes assessments.*

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Fusion versus decompression surgery alone for lumbar degenerative spondylolisthesis: a Bayesian cost-utility analysis protocol

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Background: *Lumbar degenerative spondylolisthesis (LDS)—a condition in which there is slippage of one lumbar vertebra in relation to an adjacent vertebra—represents one of the most common spine-related degenerative pathologies worldwide. Despite recent clinical practice guideline efforts across multiple health systems, the comparative cost-utility of fusion versus decompression surgery alone for LDS remains controversial.*

Aims: *To evaluate the cost utility of decompression plus fusion surgery versus decompression surgery alone in patients with Meyerding grade I or II LDS over a 3-year follow-up for the primary outcome, assuming a provider's perspective for the Bayesian cost-utility analysis (CUA) across three health systems (Swiss, UK, US).*

Methods: *The best available randomized clinical trial evidence to-date will be used to compare decompressive laminectomy with laminectomy combined with posterolateral instrumented fusion. Data from the Lumbar Stenosis Outcome Study (LSOS) will also be extracted to complement missing data values from the trials. A Bayesian pref-erence-based algorithm will be applied, and quality-adjusted life-years will be calculated from the results of the EQ-5D-3L and the Short Form-36 at baseline and 3-year follow-up after the two surgical interventions. In the absence of EQ-5D-3L utility data, other condition-specific outcome measures with a mapping algorithm will be incorporated into the model. A standard discount rate will be applied for costs and benefits. Direct healthcare costs will be obtained from official country-specific cost per unit prices available for Switzerland, UK, and the US. Probabilistic sensitivity analysis will be performed to assess the robustness of the model.*

Relevance: *Given the prevalence of LDS and challenges associated with rapidly ageing populations worldwide, the application of value-based care principles is imperative in orthopedic surgery and healthcare generally. Our Bayesian CUA findings will offer an innovative and standardized mechanism for comparing resource use and health outcomes, and therefore guide surgical decision making in LDS management.*

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Knowledge and beliefs questionnaires for musculoskeletal pain conditions: a systematic review protocol

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Background: *Identifying patients' knowledge and beliefs about pain is relevant to a patient-centred treatment. The best method of measuring knowledge and beliefs about musculoskeletal conditions is unclear. An overview on measurement properties of available questionnaires to assess knowledge and beliefs about musculoskeletal conditions is lacking.*

Objective: *To investigate the measurement properties of available questionnaires that measure knowledge and/ or beliefs about musculoskeletal conditions.*

Methods: *A systematic review will be conducted following the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guideline. Electronic databases MEDLINE, EMBASE, CINAHL, and Web of Science will be searched. The search strategy will include three groups of search terms representing (1) construct, (2) population, and (3) instrument, in addition to a search filter on measurement properties. The search strategy will be devised in consultation with a librarian and no restriction on language, publication period or publication status will be applied. Citation tracking (in Scopus) of eligible studies and contact with experts will be conducted in order to minimise the risk of missing relevant articles. We will include primary studies of any study design that developed and/or tested measurement properties of self-reported questionnaires assessing knowledge and/or beliefs*

about musculoskeletal conditions, targeting people with musculoskeletal conditions or people from the general population. A study will be excluded if the questionnaire was developed and tested exclusively for clinicians or participants with recent trauma history. Search results will be screened by abstract and full text independently by two review authors. Extracted data will include bibliographic details, study characteristics, participants characteristics, questionnaires characteristics, measurement properties results, interpretability, feasibility, and distribution of scores. Authors will be contacted if more information is needed. The methodological quality of included studies will be assessed using the COSMIN Risk of Bias checklist and each item will be scored as "very good", "adequate", reliability (internal consistency, measurement error, and test-retest, inter-rater and intra-rater reliability), validity (content validity including face validity, criterion validity, and construct validity including structural validity, hypotheses testing, and cross-cultural validity), and responsiveness, according to the COSMIN taxonomy definition. The overall assessment of each measurement property of each questionnaire will be classified based on the COSMIN updated criteria. Also, the quality of evidence will be rated using a modified Grading of Recommendations Assessment Development and Evaluation (GRADE) approach. An overall recommendation will be formulated as: (A) Suitable for use: PROMs with evidence for sufficient content validity (any level of evidence) AND at least low-quality evidence for sufficient internal consistency; (B) Potentially suitable for use: PROMs categorised not in A or C; or (C) Not recommended: PROMs with high quality evidence for an insufficient measurement property. Data will be presented descriptively. A pooled result using meta-analysis of the parameters will be conducted if adequate data is available.

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Significance: *The results of this review will contribute to researchers and clinicians making evidence-based decisions on what instrument to use to measure knowledge and/or beliefs about musculoskeletal conditions. Sensitivity analysis of different low-pass filter cut-off frequencies on lumbar spine kinematic data and its impact on the agreement between accelerometers and a motion capture system*

Sensitivity analysis of different low-pass filter cut-off frequencies on lumbar spine kinematic data and its impact on the agreement between accelerometers and a motion capture system

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Introduction: *Spine kinematics are an important measure in the assessment of mechanical back pain. Accelerometers are a cost-effective and practical alternative to motion capture (MC) systems. However, these sensors are subject to high frequency noise, thus raw data must be filtered before analysis and interpretation. A common filter utilized for this purpose is a low-pass (LP) Butterworth filter, however, the specific filtering parameters such as the cut-off frequency (f_c) have been questioned and there is no definitive answer in the literature. The objective of this study was to:*

(1) systematically investigate the effect of different LP Butterworth filter f_c on accelerometer and motion capture data for peak lumbar spine flexion values, and

(2) to determine the optimal f_c to appropriately smooth low velocity movement data without changing the peak ROM measurement.

Methodology: *Twenty asymptomatic female participants (age 30-65 years) were instrumented with accelerometers and MC markers overlying the L2, L4 and S1 spinous processes. Participants then completed a standardized, guided flexion trial with the pelvis constrained. Participants performed a trunk flexion and return-to-neutral bend at constant 6°/s. Synchronized data were sampled at 60Hz. The flexion ROM for the upper segment (L2-L4), lower segment (L4-S1), and whole lumbar segment (L2-S1) were calculated using custom code. Data were iteratively LP filtered with a 4th order bidirectional Butterworth filter with f_c between 1-14Hz. The filtered data were then used to calculated peak ROM for all segments and the range, mean, 95% confidence interval (CI), and root mean square error (RMSE) of peak ROM for each f_c.*

Results: *LP Butterworth filter f_c minimally affected peak ROM for both accelerometers and MC (max diff: 0.66° and 0.23°). Therefore, a lower LP f_c (e.g., 1Hz) can justifiably be applied to accel and MC data without compromising outcomes in comparison to filtering at a higher f_c (e.g., 14Hz). Thus, a lower f_c may be used when smoother data are needed without compromise to peak values. The difference between the systems at each f_c was also minimal (max diff: 0.82°) indicating that accelerometers can be used as an acceptable alternative to MC systems. For context, the differences between systems and LP filter f_c were smaller than the effects of age and sex and the standard error of measurement of lumbar flexion for MC (0.96-7°).*

Discussion: *Both Butterworth LP filter f_c and measurement type had a minimum effect on peak ROM, demonstrating that published data using different cut-off frequencies are still comparable. Secondly, we showed that MC systems and cost-effective accelerometer solutions may be used interchangeably to determine segmental and total lumbar angles with acceptable agreement during low velocity movements. While a LP filter f_c of 1Hz can be applied to spine kinematics data to provide smoother*

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data without negatively affecting outcome measures of interest, this may be due to the relatively slow flexion motion used in this experiment. Future studies should seek

to determine the effect of LP filter f_c on flexion at different speeds.

Social network and lexical analysis of CARLoquium 2021

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Background: *Academic conferences are an important element of the research ecosystem, and so stakeholders will want to understand what to expect of upcoming conferences and what to make of past events. There are no broadly accepted metrics by which to gauge the success of a conference, and it may be that, in general, no formal post-hoc analysis is performed.*

Objectives: *The purpose of this study was to pilot a number of methodologies to characterize the poster presentations and the presenters at CARLoquium 2021.*

Methods: *The conference proceedings from CARLoquium 2021 were downloaded as a pdf and converted to a worksheet using Excel power query. The names, primary affiliations, and countries of the presenters were extracted, as were titles of presentations and the names of co-authors. Numbers of presentations per country and per institution were calculated and graphed in Excel. A corpus of presentation titles was created in Excel and processed in VosViewer 1.6.18 to create a network visualization of nouns and noun phrases which commonly co-occurred in presentation titles. The identification of over-represented terms (also called 'keywords' in linguistics) was confirmed by statistical comparison performed in WordSmith Tools V8, using a reference corpus of general English. A network map of contributors was created in the network application Gephi 0.9.2 by mapping presenters, as 'sources', onto all of their co-authors, as 'targets'. Node sizes were weighted according to the number of presentations on which a participant was listed as a contributor, and nodes were coloured according to whether or not a contributor was a faculty member/fellow of CARL.*

Results: *Data were obtained for 108 poster presentations. Seventy-eight percent (85 of 108) of presentations originated from just 4 countries: Canada (27), Denmark (21), Australia (20) and the USA (17). Thirty-nine percent (42 of 108) of presentations originated from 4 institutions: the University of Southern Denmark (12), Macquarie University (12), Balgrist University Hospital (10) and Canadian Memorial Chiropractic College (8). Lexical analysis of titles showed a predominance of terms associated with clinical practice, especially as it related to musculoskeletal care. References to the basic sciences and education were extremely sparse.*

Faculty and fellows of CARL represented 22% (117 of 537) of contributor listings although they only represented 9% (30 of 339) contributors. Two contributors exhibited very high levels of connectedness within the network as measured by 'degree': 26 and 20, respectively, compared to an average of 2.38 for all participants. Furthermore, one of these contributors exhibited an extraordinarily high level of influence as measured by Eigenvector centrality: 1.0 compared to an average of 0.05 for all participants.

Discussion: *This is the first application of network analysis to an academic conference in chiropractic, and so there are no standards against which to measure the results presented herein. However, the organizers may wish to consider whether the diversity of topics and contributors, and the social dynamics of CARLoquium 2021 reflect their goals for the conference.*

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