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# JCCA

## Journal of the Canadian Chiropractic Association

*(Formerly the Canadian Chiropractic Association Journal)*

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### John J. Triano, DC, PhD



John J. Triano, DC, PhD  
Dean, Graduate Education & Research Programs  
Canadian Memorial Chiropractic College

The Journal of the Canadian Chiropractic Association is delighted to announce that Dr. John J. Triano has joined the JCCA as an Assistant Editor.

Dr. John J. Triano, DC, PhD, is a graduate of Logan College (DC), Webster College (MA), and the University of Michigan (PhD). He is a Fellow of the College of Chiropractic Scientists (Canada) and serves as an editorial advisor to the *Journal of Manipulative and Physiological Therapeutics* (since 1986), to *Spine* (since 1994), *The Spine Journal* (2000–2007) and *The BackLetter*. Dr.

Triano was Research Professor in the University of Texas Southwestern Medical Center Arlington, Joint Biomedical Engineering Program. To date he has written 82 scientific and clinical articles and 25 book chapters. From 1992 to 2005 he was the Co-Director of Conservative Medicine and Founding Director for the Chiropractic Division at the Texas Back Institute, a multidisciplinary spine facility caring for 15,000 new patients per year. Currently, he is Professor and Dean of Graduate Education at the Canadian Memorial Chiropractic College with cross-appointment as Associate Professor, Rehabilitation Sciences, McMaster University.

Dr. Triano is the recipient of a number of awards and honors including the ICA Researcher of the Year (1987), FCER Researcher of the Year (1989), AHCPR Service Award (1993), the US Department of Health and Human Services (1993), ACA Council on Rehabilitation Doctor of the Year Award (1998), DC Person of the Year (2002) and the 2005 Earl Homewood Professorship. He regularly serves as a reviewer on US National Institutes of Health grant study section panels on pain, centres of excellence for research, complementary and alternative medicine. From 2005 to 2007, Dr. Triano served as the only chiropractor on the US National Committee for Quality Assurance that recently released its first Spine Physician Recognition Program in the US, a program that acknowledges quality spine care by chiropractors on par with medical physicians. He is recipient of the first NCCAM-NIH/CIHR research award supporting studies in the mechanisms of spinal manipulation.

Dr. Triano's research approach is focused on the understanding of the nature of the interaction between the joint and related structures of bone, cartilage, ligaments, discs, tendons, muscles and neural components. These relationships are of paramount interest to the sound clinical practice as it allows optimal design of treatment strategies for pain management, rehabilitation, exercise and life style change. The primary research tools used include biomechanics, soft-tissue elastography, computer modeling and clinical trials.

### The Chiropractic dilemma. To be isolated or integrated?

Paul Carey, DC\*



Dr. Paul Carey, DC

In the 44 years since I became a Chiropractor the world has changed a great deal but ... has the chiropractic profession? In the last century chiropractors remained apart and distant from main stream health care. The profession believed it was unique and if it did not stay distant from medicine it would be swallowed up and lose its identity.

The chiropractic profession held different views on health and vitality that made it feel strong and independ-

ent as well as unique. We thought this health care model, based on strongly held *beliefs*, insulated us from any of the criticism about us levelled by other health professions. Instead we chose to believe there was acceptance of our health care model because our patients seemed to love us. The chiropractic profession thought it was the world that needed to change in order to understand our chiropractic paradigm. If they understood us then all people would be able to benefit from our life changing care. It was felt that once everyone was exposed to our “story” they would become believers too. That was “then” but, even today, some among us still cling to this ideology.

We are now in a new century where old ideals and beliefs may not be valid or even valuable. The chiropractic profession’s beliefs, formed long ago in the 1900’s or even up to the new millennium, need to change based on current evidence. Resisting critical self examination of our beliefs, practices and protocols is now irrelevant because others are doing it for us. The risk of ignoring an inward look at ourselves is that our profession may become redundant at first and then forgotten with the passage of time. It is as if some among us believe the earth is still flat! This group of chiropractors seem unable to allow fact and science to displace their unsustainable *belief* system. The time for change is upon us.

In some ways the chiropractic profession has made some significant changes in the last few years. For example, the quality of education offered to our new practitioners is a quantum leap ahead of even 10 or 15 years ago. Our research endeavours are amazing and continue to impress. These improvements have occurred even with many obstacles, especially outside funding, in our way. Never the less much has been accomplished.

Even with these positive changes, segments of the pro-

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\* President, Canadian Chiropractic Protective Association  
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fession refuse to let go of their old *beliefs*. I think this places the chiropractic profession at a cross roads. Down one path is continued isolation and separation from main stream health care. If this path is taken there is a real risk it will lead to our eventual demise. The chiropractic profession would become irrelevant because other professions can and will do what we do but, from within the system.

The other, more hopeful, path leads to the chiropractic profession integrating into mainstream health care as part of a much larger team. In this model the focus is on what is best for the patients we serve. Current evidence suggests that what we do best is care for musculoskeletal problems, in the broadest sense. The profession needs to continue to emphasize university level training, collaboration with other professions and continue to lead cutting edge research in spinal health care. The goal should be to always look after the patient's best interests by providing economic and effective care in a timely manner. Inherent in choosing this path is that some chiropractors would be compelled to give up dated or simplistic concepts.

We have a rich history as a profession. Many fine

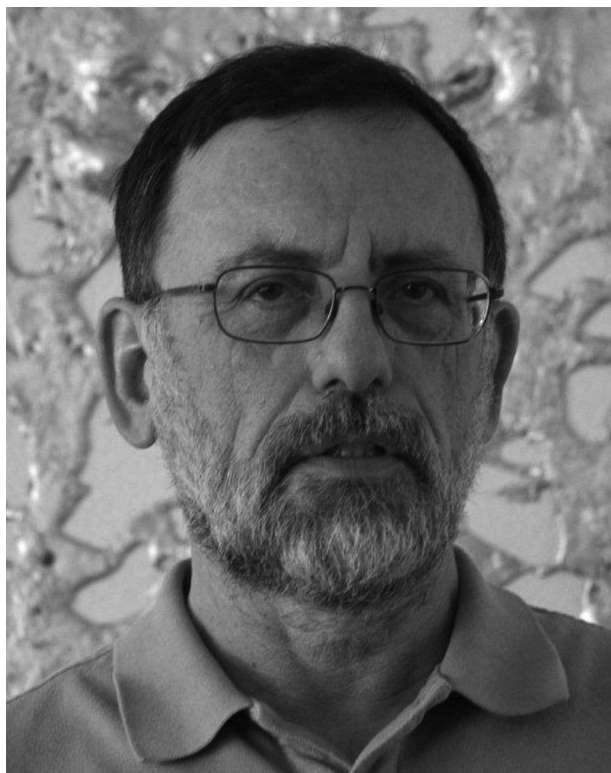
people have contributed to our development and growth to this point. We can also be justifiably proud of our heritage. That being said ... there is much more to do. No profession can afford to stand still in this era of rapid change. Demanding and savvy consumers, as well as professional competition make staying the same a huge risk. I would suggest that one of our great weaknesses has been our willingness to accept the status quo. Looking back I can see the beginning of our profession over 100 years ago but, looking forward, I am unable to see a clearly defined future. We have failed in our efforts to develop an understandable and consistent identity. This is a weakness that hurts us. The public sees us as "back doctors". To me this is neither a bad thing nor in any way limiting. Unfortunately, we have no such clearly established image of ourselves. This confuses the public.

The chiropractic profession has so much to offer to the public. It is time to put our old beliefs to rest and establish a clear image that is in harmony with current evidence so we can get out and do what we do best! The choice is yours. When and how will you make it?



### The long term survival of chiropractic: involvement and research

Larry Merritt, DC\*



Dr. Larry Merritt, DC

Today at Google alert on spinal manipulation for back pain I read a posting: *"What's the evidence for spinal manipulation for long-term back pain?"* The conclusion of the article was that manipulation was only slightly better than bed rest. The author quotes four references to support this conclusion.

This got me thinking about all the other studies that show the benefits of chiropractic care. Some health care

professionals will never change their attitude, no matter how many positive studies there are. This means that as a profession, we must work harder, publish more, and produce better quality studies. We need a larger number of top quality research studies leaving no doubt that what we do does work. We must try harder.

I graduated from Canadian Memorial Chiropractic College in 1972, when research was almost a foreign word. The knowledge that we acquired was handed down from years of clinical practice. There were a few case studies and occasional bits of research being published. If you did research, you were considered "different," and you (the researcher) had to fund your own research. Today we have fulltime researchers at chiropractic colleges and researchers at several major universities in Canada and around the world.

In spite of this improvement in the quality and quantity of research, we have our detractors. There are still a group of critics that will do all that they can to discredit chiropractors and their work, regardless of the facts.

No matter how negative our detractors are, we can take pride in the positive results we see in our offices every day. A recent Ipsos – Reid poll from British Columbia stated that chiropractic utilization in British Columbia rose from approximately 14% in 2001 to 24% in 2008. What makes this so amazing is that this has happened even though the B.C. government had de-listed chiropractors from the Medical Services plan. It seems that paying cash for a service that works is not a financial deterrent when the traditional free (to the patient) medical service is not getting results.

Patient results tell a more positive story. Chiropractors must be helping because patients can get free care through their MD but are paying cash to see the chiroprac-

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\* Vice President, British Columbia Chiropractic Association.  
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tor. Something is sending them to chiropractors, despite the cost. They are seeking chiropractic care in increasing numbers. This would not happen if the results of chiropractic care were negative.

This profession is constantly under attack from other health care professions, who seem to be trying to undermine chiropractic health care. This is a concern, but the biggest danger to the profession comes from within.

We have major problems to overcome. First, we must overcome the problem of professional infighting. We are constantly fighting battles within the profession. This takes a considerable amount of time, energy and money that could be better used to promote the profession, fund much needed research, and increase the utilization closer to 50%. Just imagine the positive results that could be achieved if, we worked together instead of trying to tear each other apart. Although we have differences in our approaches, we are all chiropractors with one goal: to improve the health of our patients. No matter what your chiropractic stripe, good patient care is the goal. Taking pot shots at each other does no good. No matter what you think of your colleague, he is in practice because he is getting patients better. If he was not, he would not survive in practice. No chiropractor or chiropractic technique has all the answers to all the patients' problems and the sooner we, as a profession accept this, the better off our profession will be.

Apathy is another major problem for the chiropractic profession. Apathy can be defined as an absence or suppression of emotion, feeling, concern or passion. According to Wikipedia, apathy is a psychological term for a state of indifference. Many chiropractors appear to have a form of apathy – not necessarily apathy toward their practice or patients, but toward their profession. According to Dr. D.P. Towle, we have too many “office potatoes.” The office potato puts in time at his office for his patients and then goes home. There is no reinvestment into his profession.

Professional apathy can be manifest in many ways:

- Not keeping up on the latest information.
- Not getting involved in professional activities.
- Not voting on association issues.
- Avoiding association activities, (AGM etc.).
- Not communicating with governing bodies or associations or colleagues.

If you sit back and do nothing, then nothing is what you

should expect. “We must do more than set goals and dialogue. We must take action! No longer can we idly stand by and wait for someone else to do it for us.” (The Chiropractic Century by Daryl Willis)

Two papers that try to address some of these problems are “The Relevance of Joining,” by Dr. Arlan Fuhr, *Dynamic Chiropractic* Oct.6 2003 and “Something Worse than Apathy” by Dr. Terry Rondberg. Both of these papers are important to the state of the chiropractic profession. Although they are talking to the profession in the USA, it is the same in Canada. In “The Relevance of Joining” Dr. Fuhr talks about the importance of joining the state (provincial) or national association. All too often we “let the other guy do it.” The activity of your association is often what influences the direction the profession takes, such as relations with WCB, third party payers and the government.

Not only is it important to join the association, but it is equally important to participate in the association. Dr. Rondberg's paper, “Something Worse than Apathy” suggests that you only join an organization if it stands for what you stand for – a noble idea. Unfortunately, this can lead to a multitude of small self-serving organizations. Dr. Rondberg says, “Those doctors, who don't care one way or the other, really shouldn't join anything more political than their local country club. It's far better for them to be “apathetic” – at least they're less likely to do any damage that way!”

This approach does nothing to solve the problems that face this profession. In fact it may be preferred by our detractors. If we form several groups and have no focus, we would have less influence and diluted resources because of infighting. Dr. Rondberg states, “If, like the majority of the profession, you want chiropractic to retain its identity as a drug free health care system geared to correcting vertebral subluxations, join the WCA and ICA.” The significance of this statement is that the majority needs to become involved with our professional association. A minority can only control a situation through default. If the majority are apathetic and do not get involved, a minority can then hijack any association and use it for their special interest.

I believe that we, as individual chiropractors, owe it to our patients to not only help them with their health needs, but to ensure the survival of a strong and vibrant chiropractic profession. This can only be accomplished if

chiropractors get involved. We need to put service above Self. (Willis)

There are many different levels of involvement.

- Becoming involved with your association or college.
- Communicating with your association. Let them know your ideas and thoughts.
- Voting on all issues.
- Publishing case studies. (A first step in developing research.)
- Participating in and publishing research.
- Supporting research by others.

According to Dr. William H. Dallas DC., “Research is more than an academic exercise. It is the key ingredient in establishing chiropractic’s role in an evolving health care system.” Research – the search for knowledge, or as any systematic investigation, with an open mind, to establish novel facts, usually using a scientific method. The primary purpose for applied research (as opposed to basic research) is discovering, interpreting, and the developing methods and systems for the advancement of human knowledge on a wide variety of scientific matters of our world and the universe.

Using this definition, we can see the importance of research to a vibrant and evolving profession. In this day of evidence based care, the need for research is paramount

to a profession’s survival. If we do not do the research, others will and we lose our identity.

Long term acceptance of chiropractic by our patients, policy makers, the scientific community, and other health professions will depend on us doing the research. We are talking about our survival as a profession!

So what does this have to do with you the field practitioner? First, get involved in supporting research. It has been stated that less than 1% of Canadian chiropractors directly support research. This is totally unacceptable for a profession trying to improve its utilization numbers. If, you are happy with 14% utilization and happy with other professions doing what we do and researching what we do then change nothing. If on the other hand, you think we should be proactive and advance the chiropractic profession so that we can continue to provide our patients with the best possible care, then you need to get involved. *Make a choice, make a difference.* “get involved!”

Support the Canadian Chiropractic Research Foundation and support Chiropractic research at Canadian Universities. If you do nothing else for the profession, you can join the CCRF and support others doing research. At this time there are approximately 15 researchers associated with major Universities and a similar number working on their PhD’s. It is your future, invest in it!!! Invest in them!

### Research – preparing for tomorrow!

Dr. David Peeace, DC\*



Dr. David Peeace, DC

There is an old African proverb that says “tomorrow belongs to the people that prepare for it today.” In the ever changing dynamic we call health care, it requires great vision and insight to take the first steps to prepare our profession for its place. The profession that has the research to back up its claims in evidence based health care, will not only succeed, but thrive. We live in a society where every dollar spent on health care is scrutinized; by government based health care delivery, third party payers

and our patients are also becoming savvy conscious consumers. Information is at the fingertip. One simple click tells our patients how well the treatment protocols we are advising and the therapy we are administering are backed up by research, or which protocols have not yet been tested through the scientific method. I know this will probably upset a few. Some will shout foul and complain that much of health care in general has not been put through such methodology; however the difference lies in the credibility of each profession.

Whether we like it or not, there are other professions that seem to be above reproach. We, as a profession do not have that luxury. Rather, we have had to prove and demonstrate what we do is not only effective but backed by concrete evidence. In the past few years, I have had the privilege of attending both the WFC conference in Montreal and the National Convention in Toronto. I have witnessed the tremendous amount of research that has come forward, as well as the increasing number of DC's with PhDs. In fact, at the WFC conference, the session that had the greatest attendance was the showcase of Canadian Researchers, with the room jam packed and many forced to stand to hear the presentations. One of the attendees commented on how far we have come as a profession. He stated, he could remember such a time when a meeting of researchers would rarely be attended by more than 10–20 people, most of whom would have been the researchers themselves. We have come far indeed!

This could not have been accomplished without the vision of the CCRF (Canadian Chiropractic Research Foundation) and its desire to develop University-based Research Chairs. We have come a long way from the first chair at the University of Calgary, (Dr. Greg Kawchuk), to ten research chairs and professorships at universities

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\* Governor, Canadian Chiropractic Association, Province of Saskatchewan.  
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across Canada, the latest coming in Manitoba and Saskatchewan. In the past eleven years this foresight has fostered the opportunity for much more research to occur, and facilitated greater opportunity for more DC's to be trained in a PhD program. Who can predict what breakthrough will arise and the tremendous benefits that will happen? As the amount of research increases and the interweaving of our profession into the mainstream of healthcare occurs, the enhancement of our profession's credibility likewise grows. It is indeed an exciting time to be in practice.

In the past year, I have had the privilege of hearing Dr. Marion McGregor DC PhD present on the role research plays on market share. A very thought-provoking presentation, based on her paper, "*A System Dynamics Approach to Jurisdictional Conflict between a Major and a Minor Healthcare Profession*,"<sup>1</sup> demonstrated the link research plays on enhancing a profession's market share and cultural authority. Simply put, the more research a profession produces the more influence and the greater potential the profession has on increasing its market share and cultural authority. This attests to the urgent need of our profession to mature and take our place in the world of evidence-based health care delivery. Not only does research continue to hold the door open for us to mainstream health care delivery, but it gives us a place at the table to voice our views when public health care policy is discussed. The resulting enhancement of our credibility not only ensures our survival but also situates our profession to be viewed as the experts in the delivery of spinal health care.

We, as a profession are at a crossroads. In the past there have always been the financial resources to cover the cost of supporting our researchers. However, with the increased number of DC PhDs, these finite resources are stretched to the point where difficult choices will be required. Should new funding sources not be found, new research projects will have to be delayed or may not be funded. In the latest edition of the Canadian Chiropractic Research Bulletin, Dr. Vince Adams states "we currently have 15 DC, PhD's in fulltime active research and another 15 DC's being trained in a PhD program."<sup>2</sup> While this is tremendous news and will invariably advance our profession, the question arises; where will these new Chiropractic researchers find the funds to continue their research?

Current and prior funding has come from the philan-

thropy of the profession. The members of our profession need to be congratulated for their dedication to supporting research. In addition, the members of the CCRF, and the FRCQ (Fondation de recherche chiropratique du Québec) need to be recognized for their vision, resolve, and passion for promoting research in our profession. While we do have some very loyal partners who contribute to Chiropractic research we need to build upon this. Bridges need to be built to the private sector and others that value the care they receive from the profession. This must be done strategically and in a sustainable fashion. While fundraisers and increased awareness among our profession is commendable, a long-term strategy to address the pressing needs of funding must be developed.

Eventually, even deep wells go dry if used too many times. We cannot continually expect our members and the provincial and national organizations to shoulder the weight of funding research. A sustainable strategy that involves all stakeholders must be envisioned. One that will meet the needs of new and upcoming research and maintain the funding demands we are presently supporting. When the leadership of the profession meet, the CCA will initiate a discussion on the development of a coordinated strategy of sustainable funding for research. It is vital that all the stakeholders are on board and it is not just a solitary group that champions this, but a pan-Canadian approach, united and supported in its pursuit to advance the research of our profession.

If tomorrow is to indeed be ours, we must be preparing for that reality today. We all must ensure our profession is ready for the challenges that we will continue to face. We all must be active participants in the support of research in our profession. Whether that is through attending research presentations, keeping aware of what the latest advances are, or as simple as becoming a member of the CCRF or FRCQ. We can no longer afford to allow petty differences to derail our profession. We have the opportunity now to prepare for our tomorrow. Simply resting on our laurels and applauding ourselves for what we have done in the past is not enough. We are all part of the solution; if we look beyond our differences and focus on what unites us, delivering the best care to our patients.

Unfortunately, we are playing catch up. We need more DC's involved in active research. We are lacking in the number of DC's with PhD's and in the number of papers that are published in comparison with other healthcare

disciplines. However, this is changing, and we are seeing more and more determined DC's entering graduate studies. We need to support these new leaders of the profession and aid them in finding of resources to conduct their research. We must find a sustainable funding source for our research. By accomplishing this, it will be exciting to see where our profession will be in 5 or 10 years from now.

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## Canadian Chiropractic Research Foundation



## Creating a culture of research

# Incident Reporting and Learning Systems for chiropractors – Developments in Europe

Haymo Thiel, DC, MSc (Orth), FCCS(C), Dip Med Ed, PhD\*



Dr. Haymo Thiel, DC, MSc (Orth), FCCS(C), Dip Med Ed, PhD

Providing health care of any kind, including the provision of chiropractic treatment, can be a complex and, at times, risky activity. Safety in healthcare cannot be guaranteed; it can only be improved.<sup>1</sup> The capturing and recording of information on patient safety incidents, and analysing this information are essential steps to reduce and manage risk and ultimately improve patient safety. With this in mind

the first chiropractic incident reporting systems within Europe started to be developed in England and Switzerland, and both countries have now established national online reporting systems. Furthermore, under the auspices of the European Chiropractors Union, work is currently underway to finalise European guidelines for chiropractic incident reporting and learning systems.

Early efforts linked to the management of clinical risks within the healthcare professions, including chiropractic, were primarily related to the setting up of processes in an attempt to control litigation and to reduce associated costs. Due to the increasing move in the late twentieth century towards documenting and learning from patient safety incidents, individuals within the chiropractic profession in Europe also realised that it was paramount to become part of this developing safety culture.

### The UK Chiropractic Patient Incident Reporting and Learning System

In 2005, the Anglo-European College of Chiropractic (AECC), in conjunction with the British Chiropractic Association (BCA), introduced the 'Chiropractic Reporting and Learning System' (CRLS) to collect patient safety incident data from BCA members.<sup>2</sup> It was taken up by the student clinics at AECC and, in modified form, at the Welsh Institute of Chiropractic and was subsequently rolled out to members of the Scottish Chiropractic Association. Although available to approximately 1600 of the UK's chiropractors, the initial take-up had been low.<sup>3</sup> Lack of awareness of the system and the types of incident that should be reported, as well as fear and confusion regarding anonymity and the medico-legal implications of submitting reports, were identified as key in explaining

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this underutilisation.<sup>2</sup> A second system known as the Patient Incident Reporting and Learning System (PIRLS) was developed at the McTimoney College of Chiropractic during 2007.<sup>4</sup> PIRLS was launched by the McTimoney Chiropractic Association ensuring incident reporting was available to a further 600 UK chiropractors.

In order to unify the process of safety incident reporting in the UK and to facilitate participation among all 2500 UK chiropractors, the College of Chiropractors, the three UK chiropractic educational institutions, and the four UK professional associations combined their experiences in a joint project to develop a new online reporting system known as the Chiropractic Patient Incident Reporting and Learning System (CPiRLS). The CPiRLS project aims to enhance the learning element and improve the ease and accessibility of incident reporting, to help educate chiropractors about the types of incidents they should report and to reassure chiropractors that the administration of incident reporting is independent, secure and anonymous such that they have nothing to fear by sharing their experiences. The project forms part of a wider initiative to further enhance the culture of safety within the UK chiropractic profession.

The CPiRLS website (<http://www.cpirls.org>) informs all visitors of the purpose and nature of incident reporting and learning but, in its initial form, is set up such that only UK registered chiropractors can submit and read reports. This is ensured through secure access with a universal password available only to chiropractors via the membership areas of their association websites. The universal nature of the password and design of the website database mean that individuals submitting reports cannot be identified by anybody, including those administering the system. This was felt to be essential if chiropractors are to feel comfortable and secure in submitting and sharing reports without fear of legal retribution.<sup>5</sup>

The CPiRLS online reporting form is provided in three versions according to whether the incident under report has either happened, nearly happened (near miss) or has been identified as an incident waiting to happen (following identification of an error or discrepancy of process for example). Users start by choosing between these three types of incident and then progress through the form explaining what happened, why it happened and what actions were taken. Drop-down lists and radio buttons assist simple and rapid completion of the form.

Submitted reports are published in outline form on the website. Users who are logged in to the site can read these reports and submit comments. This sharing of information and interaction among peers is designed to maximise the learning aspect of CPiRLS. All submitted material is monitored by CPiRLS team members who can edit inappropriate matter and access/download all data for future thematic analysis.

The CPiRLS initiative is actively addressing the current underutilisation of incident reporting as a learning tool and has led to the publication, by the CPiRLS team, of alerts and detailed guidance to assist chiropractors in managing risk more effectively.

### The Swiss Chiropractic Reporting and Learning System

It is primarily legislation (Swiss Sickness and Accident Insurance and the Swiss Law on Medical Professions) that drives quality management for patient safety in chiropractic practice in Switzerland. The increasing awareness and political commitment to improve safety affects all health care sectors - including the chiropractic profession. The need for health professionals to continually improve quality and enhance patient safety is omnipresent. Unfortunately, the majority of well developed critical incidents reporting systems are implemented in clinical inpatient and hospital settings, almost none of them in private medical or chiropractic practices. These facts and the low reporting rate cited in the UK study conducted by Thiel and Bolton (2006)<sup>2</sup> encouraged the Swiss Chiropractic Association to further investigate chiropractic incident reporting, its promotion and implementation. A first reporting and learning project – Swiss Critical Reporting and Learning System (CRLS) was launched in September 2007 by Wangler and Zaugg.<sup>6</sup>

Regular patient safety training is not yet established in chiropractic. In order to promote a change in attitudes towards greater patient safety, information and education should be part of the training of future chiropractors. With the help of a literature synthesis,<sup>7</sup> Bland et al.'s 10 factors<sup>8</sup> were adapted for a successful promotion of patient safety competence in private practice, i.e. reporting and learning from adverse events in chiropractic care. The annual Swiss National Continuing Education Convention 2007 was considered to be the ideal environment to introduce and promote this first reporting and learning pro-



ject. A survey on chiropractors' readiness and capacity for patient safety attitude change – using the Safety Attitude Questionnaire (SAQ)<sup>9,10</sup> for ambulatory care – was conducted to assess the competencies of Swiss chiropractors in relation to patient safety issues. The project consisted of four instructional approaches: written documentation, lecturing including a short movie, large and small group discussions on patient safety and safety culture, and feedback by experts. Qualitative analysis showed the following results:<sup>6</sup>

- (A) The biggest challenge seemed to be the culture shift from blame to trust, from covering up to disclosure.
- (B) Lecturing is inexpensive and convenient, but did not change behaviour in practice. As with clinical reasoning, reporting cannot occur in a vacuum – but must be built into the daily practice.
- (C) Reporting and learning have first to be judged as an important skill to be developed and practised.
- (D) An interactive forum on a password-protected website to discuss real life adverse events driven by discussion between experts and practitioners could be used to help in developing such a skill.
- (E) A strong statement from leaders of the organisation i.e., “all its members have a responsibility towards reporting and learning” was missing.
- (F) Safety and quality have to be integrated into training on a regular basis as well as into continuing education programmes.

The Swiss CRLS website<sup>11</sup> ([www.crls-chiro.ch](http://www.crls-chiro.ch)) informs on the purpose and scope of incident reporting and learning. As with the UK CPiRLS, only chiropractors can submit and read reports on the password-protected website. Reports and discussions are kept totally anonymous. The password-secured forum is user-friendly and the reporting procedure is clear. Different to the UK CPiRLS the Swiss chiropractor describes the incident with a first reflection without categorisation. That means the user simply analyses what went wrong and what first action has to be taken. Regular, timely and effective feedback by experts regarding proposed action is essential.

A new supporting team was created in 2009 and a workshop – dealing with structured and systematic analysis of real-life adverse events in chiropractic care – was offered to a few chiropractors<sup>12</sup> in order to promote a climate of openness, to move away from finger pointing and routine

assignment of blame, and to facilitate the production of formal reports. The London Protocol<sup>13</sup> was the chosen analysis method. Several follow-up workshops have been held since.

## Conclusion

In order to facilitate our patients' care with a maximum chance of benefit and a minimum risk of harm, continuing professional development following under-graduate education must relate to self-directed, life-long learning by reflection and evidence to provide effective care as knowledge and practice evolve.<sup>14</sup> The essence of reflection is a deliberate process used to develop an understanding, or making sense, of a situation so that future actions can be informed. Critical incident reporting, and learning from it, is an excellent platform for practising reflection in order to learn, improve therapeutic relationships and develop professional practice. However, ethical considerations about confidentiality include who will have access to the reflection and for what purpose. Therefore incident reporting is best performed in a safe environment, anonymously, secure and supported by patient safety experts.

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### It was my understanding that there would be no math

Paul Bruno, BHK, DC, PhD\*



Paul Bruno, BHK, DC, PhD\*

The choice of title for this commentary needs a word or two of explanation. For those of you who do not recognize the reference, it is a quote by Chevy Chase from a 1976 *Saturday Night Live* sketch in which he portrayed

then U.S. President Gerald Ford fielding a question related to budgetary figures during a presidential debate. Since its sentiment is also how some clinicians feel when presented with statistical figures in a research paper, it seemed an appropriate choice considering the topics that will follow. There was a time when the p value was the be all and end all of statistical reporting. Thankfully, there has been a gradual trend towards the use of statistical methods that present research findings in a more clinically-relevant manner. A requirement of this evolution, however, is that clinicians are able to understand and interpret such methods in order to appropriately apply the current evidence base to their patients. Inspired by an excellent series of articles<sup>1-4</sup> written by Professor Jennifer Bolton, a former mentor of mine at the Anglo-European College of Chiropractic, the purpose of this commentary is to discuss several important statistical concepts as a refresher for clinicians. Specifically, we will consider the use and interpretation of risk statistics.

#### Risk Statistics

Although commonly used in statistical reporting, p values are of limited use when attempting to apply research findings to individual patients in a clinical setting. To overcome this, the use of risk statistics (e.g. relative risk, odds ratios) in reporting results has become relatively common. These statistical methods require the use of categorical data (e.g. yes/no, present/absent) and are used to compare the “risk” of an outcome occurring when an exposure is present relative to when it is not present (see Figure 1).

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		Outcome	
		Present	Absent
Exposure	Present	a	b
	Absent	c	d

Figure 1 An example of a  $2 \times 2$  contingency table constructed to evaluate the relative risk or odds ratio of an outcome of interest.

		Improvement	
		Improved	Not Improved
Treatment Group	Treatment	a	b
	Control	c	d

Figure 2 An example of a  $2 \times 2$  contingency table constructed to evaluate the “risk” of a person improving with treatment compared to no treatment.

To put this in clinically-relevant terms, let’s use an example of a study designed to assess the effectiveness of a particular treatment in improving pain levels compared to a sham treatment. In such a study, the treatment group (e.g. treatment/control) would represent the “exposure”, whilst the degree of improvement (e.g. improved/not improved) would represent the “outcome” (see Figure 2). Some of the people who receive the treatment will improve, whilst others will not. The same is true for the people who do not receive the treatment. Risk statistics could then be used to essentially compare the “risk” of a person improving with the treatment relative to the “risk” of him/her improving without the treatment.

It is important to note that the interpretation of an increased or decreased “risk” depends on the nature of the outcome of interest. If the outcome is positive (e.g. improvement with treatment – see Figure 2), then an increased “risk” is desirable. Conversely, if the outcome is negative (e.g. the presence of a disease – see Figure 3), then an increased “risk” is undesirable.

Two statistics are generally used to calculate the magnitude of this “risk”: relative risk (RR) and an odds ratio (OR). Although often used interchangeably, these two measures are not the same:

- RR is the more appropriate statistic to use for

		Presence of Disease	
		Yes	No
Risk Factor	Present	a	b
	Absent	c	d

Figure 3 An example of a  $2 \times 2$  contingency table constructed to evaluate the “risk” of a person developing a disease following exposure to a risk factor compared to no exposure.

prospective studies (e.g. randomized controlled trials, cohort studies) when participant selection is based on the exposure (e.g. treatment vs. no treatment). In such cases, the RR is the proportion of people with the exposure who develop the outcome relative to the proportion of people without the exposure who develop the outcome.

- An OR is the more appropriate statistic to use for retrospective studies (e.g. case-control studies) when participant selection is based on the outcome (e.g. disease vs. no disease). In such cases, the OR is the odds of the outcome in the people with the exposure relative to the odds of the outcome in the people without the exposure.

Using the table presented in Figure 1, these definitions would be represented mathematically by the following equations:

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

$$OR = \frac{a/b}{c/d}$$

To be honest, an understanding of the mathematical nuts and bolts of how to calculate these statistics is probably not as important to clinicians as how to interpret them:

- If the RR or OR *equals one*, there is no increased (or decreased) risk of the outcome with the exposure.
- If the RR or OR is *greater than one*, there is an increased risk of the outcome with the exposure.
- If the RR or OR is *less than one*, there is a decreased risk of the outcome with the exposure.

	Overweight		Obese	
	Males	Females	Males	Females
Hypertension	1.3	1.6	1.8	2.4
Coronary Artery Disease	1.3	1.8	1.7	3.1
Type II Diabetes	2.4	3.9	6.7	12.4

Figure 4 *The relative risk of co-morbidity incidence comparing overweight to normal weight and obese to normal weight.*<sup>5</sup>

To better illustrate the interpretation of these statistics, Figure 4 provides an adaptation of data regarding the relative risk of certain co-morbidities (outcomes) associated with being overweight or obese (exposure).<sup>5</sup> Below are examples of how to interpret these figures.

- Overweight males have a 30% increased risk (RR = 1.3) of developing hypertension compared to normal weight males.
- Obese females are 12.4 times more likely (RR = 12.4) to develop type II diabetes compared to normal weight females.

### Putting it into Perspective

The following examples are adapted from those presented elsewhere<sup>3</sup> and serve to illustrate the advantages of risk statistics over p values from a clinical point of view.

Example 1 (Figure 5)

Treatment Group	Mean VAS (Pre-Treatment)	Mean VAS (Post-Treatment)	Mean Difference
SMT	50	25	25
Control	50	35	15

Between-group difference = 10  
95% CI of the difference = 6.8 to 13.2  
p < 0.001

Figure 5 *Data collected for a hypothetical randomized controlled trial assessing the effect of spinal manipulative therapy (SMT) on pain levels as measured by Visual Analogue Scale (VAS) compared to no treatment in a sample of low back pain patients.*<sup>3</sup>

Although the p value in isolation indicates that a “significant difference” exists in the change in pain levels between the two groups, it gives no indication as to the magnitude or direction of the difference (i.e. how much

“better” or “worse” the treatment was). The 95% confidence interval (CI) does admittedly provide some indication of the expected mean effect of the treatment in the low back pain population as a whole. However, the direct application of these results to an individual patient sitting in your office is somewhat limited (e.g. how likely he/she is to improve, how much improvement he/she can expect with the treatment).

Example 2 (Figure 6)

Treatment Group		Improvement	
		Improved	Not Improved
	SMT	10	10
	Control	4	16

% Improved = 50% (SMT), 20% (control)  
RR = 2.5

Figure 6 *Data collected for a hypothetical randomized controlled trial assessing the effect of spinal manipulative therapy (SMT) on the improvement of pain levels compared to no treatment in a sample of low back pain patients.*<sup>3</sup>

Converting the data presented in Example 1 into categorical data using a predetermined definition of “improvement” or “no improvement” in pain levels allows for the calculation of the RR of improvement with treatment. Doing so yields a RR of 2.5. You could therefore say to a patient that he/she is 2.5 times more likely to improve (as defined in the study) with treatment than if he/she does not receive treatment. This is far more meaningful to both you and the patient than an interpretation of either the p value or 95% CI reported in Example 1.

### Conclusion

The purpose of this commentary is *not* to suggest that p values do not have a place in statistical reporting. To the contrary, the p value is a very useful statistic that provides important information regarding a data set. However, for certain research questions, the use of complementary measures such as risk statistics can be highly advantageous in assisting clinicians to apply research findings more directly to individual patients. Henceforth, it is not only crucial that clinicians are able to understand and interpret such figures, but that researchers also consider the advantages of incorporating the use of these statistical

measures (when appropriate) into their study designs in order to allow clinicians to use their results more efficiently in their clinical practices.

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## Canadian Chiropractic Research Foundation



## Creating a culture of research

### Does chiropractic truly understand research?

Martin Descarreaux, DC, PhD\*



Martin Descarreaux, DC, PhD\*

As I do every two years, I recently attended the World Federation of Chiropractic conference that was held in Rio de Janeiro. Each time I go to these conferences, I pick and choose from the proposed “intellectual buffet” a number of sessions and original research presentations related to my field of expertise or simply my personal interests. Variety is great, but whenever Dr.

Scott Haldeman DC, MD, PhD is presenting, no matter how many times I have seen him in the previous years or months, I always attend the session. There was no exception to this rule in Rio. Dr. Haldeman’s presentation title this year was “Joint manipulation – Physiological Mechanisms and Effects” and as exciting as it may sound, what caught my attention was his initial remark. As an introductory comment, he roughly said that if you attend a chiropractic conference where one of the speakers suggests that he knows exactly how chiropractic or spinal manipulation works, you should promptly walk away. There was no particular reaction in the audience but, in one sentence, Dr. Haldeman had just summarized what science and research is all about: uncertainties.

Three years ago (2008), the *Journal of the Canadian Chiropractic Association* (JCCA) published an insightful commentary written by Dr. Reed B. Phillips, DC, PhD. The paper was entitled “Is chiropractic ready for research?”<sup>1</sup> and discussed the evolution of chiropractic research, its current state, and most importantly, its pivotal role for our future. To summarize his thoughts, Dr. Phillips wrote that “It really doesn’t matter if chiropractic is ‘ready’ for research or not, it is going to happen regardless.” Even if I am in full agreement with such a statement, one has to question why some members of our profession may not be ready for research and its potential impact on the development of the chiropractic profession. It is therefore as a complementary thought to Dr. Phillips’ comment but also to arouse reflection that I have chosen a title that some JCCA readers might consider a “provocative question.”

Regrettably, research and science are too often viewed as processes that can only constrain, hamper or distort

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chiropractic. Some might argue that things have changed, that the new generations of chiropractors are not “afraid of research” anymore and that, in fact, they understand the value of a strong evidence-based approach in the development of our profession. Of course, like all other clinical professions, we have now theoretically embraced the evidence-based model of clinical practice, but I was recently bewildered when colleagues and chiropractic representatives feared the possible negative consequences of good quality research and of its dissemination within and outside the profession. Although I can understand the disappointment when negative results regarding spinal manipulation therapy are published, it should not come as a surprise that alternative therapeutic options may be as effective as chiropractic care are, or that spinal manipulation may not be the most effective intervention for a given condition.

I have had the privilege to observe and be involved in the clinical, academic, scientific and political forums of the chiropractic profession, and I would humbly suggest that in most cases, and as illustrated by the previous examples, “fear of research” is simply “misunderstanding of research and science”. People tend to deify or demonize science when in fact it only is an organized and systematic process to study and understand various phenomena. According to Webster’s New Collegiate Dictionary, science represents the knowledge or a system of knowledge covering general truths, or the operation of general laws especially as obtained and tested through the scientific method and concerned with the physical world and its phenomena.<sup>2</sup> Through science and experimentation, chiropractic researchers, like all other researchers, engage in an “unbiased” process which goal is to test chiropractic and other clinical hypotheses to eventually draw conclusions that confirm or infirm these hypotheses. In science and epistemology, an important and contemporary concept is falsifiability. Also known as refutability, falsifiability is defined by the possibility of any hypothesis to be eventually proven wrong.<sup>3</sup> Therefore, a central component of science is that all claims or assertions investigated by science must be open to being proven false. If a researcher cannot define what would count as an empirical or experimental disproof of a claim, then the claim itself must fall outside

the domain of science. It may sound counterintuitive, but science’s role is not to demonstrate theories and hypotheses; it is rather to actively disprove and at the same time improve them. If a chiropractic theory or clinical principle is not even open to refutability, then it is not in the sphere of science, but rather belongs to the realm of philosophy, or perhaps pseudo-science. In fact, scientific knowledge is created by adding successive layers of data and interpretation derived from thorough experimentation, and what holds “true” at one point in time may be proven partially true or even completely false in a near future.

Therefore, being ready for research as a profession also means that, by nature, good news or bad news related to chiropractic knowledge is always temporary, partial, debatable and of course refutable. Consequently, the value of research resides not only in the “relative truth” it may provide, but perhaps mostly in the credibility and recognition gained by engaging, as a profession, in the act of research. Recognizing the value of the process, strategically exposing both our strengths and weaknesses in a transparent manner and engaging in scientific debates and collaboration with other health professionals will probably yield better results than any given publication of positive results about chiropractic. It is impossible to predict what will be discovered or proven wrong as the result of future research; some of the profession’s premises might hold true while some may be proven inadequate. However, one can predict with limited uncertainty that chiropractic’s future is brighter with research than without it.

In conclusion, I will again refer to the words of Dr. Phillips, who a few years ago was wisely proposing that “whether *the chiropractic profession is ready or not for research really doesn’t matter. The research enterprise is taking off, and we will either get on the train or be left standing at the station. Let’s all get on board.*”<sup>1</sup>

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### La profession chiropratique comprend-elle bien le rôle de la recherche?

Martin Descarreaux, DC, PhD\*



Martin Descarreaux, DC, PhD\*

Comme je le fais tous les deux ans, j'ai récemment participé au congrès biennal de la Fédération mondiale de chiropratique (WFC) qui s'est tenu à Rio de Janeiro. Lors de ces colloques, j'étudie les propositions de conférences générales et scientifiques qui me sont offertes et je choisis celles qui correspondent le mieux à mon expertise en recherche, mais aussi à mes intérêts personnels. Les options

sont toujours très nombreuses, mais je ne rate jamais une occasion d'entendre le Dr. Scott Haldeman DC, MD, PhD et ce, peu importe le nombre de fois où j'ai pu l'entendre dans les dernières années ou même les derniers mois. Rio ne fût pas exception à cette règle et j'ai évidemment assisté à la présentation du Dr. Haldeman qui s'intitulait "Joint manipulation – Physiological Mechanisms and Effects." Bien que la présentation fût des plus intéressantes, c'est avant tout une simple remarque dans son introduction qui a retenu mon attention. En deux mots, le Dr. Haldeman mit en garde les participants en leur proposant de fuir tout conférencier prétendant connaître les mécanismes qui expliquent les résultats cliniques obtenus en chiropratique et plus particulièrement ceux qui sous-tendent la manipulation vertébrale. Cette remarque n'a pas entraîné de réaction particulière dans la salle, mais, en une seule phrase, le Dr. Haldeman venait de résumer l'essentiel de ce qui définit la science et la recherche : l'incertitude.

En 2008, le *Journal of the Canadian Chiropractic Association* (JCCA) publiait un commentaire fort intéressant rédigé par le Reed B. Phillips, DC, PhD. Cet article intitulé « Is chiropractic ready for research? »<sup>1</sup> présentait l'évolution de la recherche en chiropratique, sa situation actuelle, mais surtout le rôle essentiel qu'elle jouera au cours des prochaines années, dans le développement de notre profession. L'essentiel de ses propos est probablement résumé par une phrase clé de son article : « It really doesn't matter if chiropractic is 'ready' for research or not, it is going to happen regardless ». Encore que je sois en parfait accord avec sa vision et sa compréhension du rôle de la recherche, il semble essentiel de se demander si tous les membres de notre profession sont vraiment « prêts » à accueillir les résultats de la recherche en chiro-

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pratique. C'est donc dans le but de compléter les propos du Dr. Phillips et de susciter la réflexion que j'ai choisi un titre que certains considéreront comme audacieux.

Malheureusement, la recherche et la science sont trop souvent perçues comme des processus hermétiques qui ne peuvent mener qu'à une restriction, un affaiblissement ou une distorsion de la chiropratique. Plusieurs prétendront que les choses ont changé, que les jeunes chiropraticiens n'ont pas « peur de la recherche » et qu'en fait ils saisissent parfaitement l'importance d'une approche basée sur les données probantes dans le développement de la chiropratique. Bien évidemment, comme toutes les professions cliniques, nous avons théoriquement accepté ce modèle de pratique, mais j'ai encore récemment constaté avec stupéfaction les craintes et réticences générées par la publication et la diffusion de résultats scientifiques liés à la pratique chiropratique. Je comprends parfaitement la déception associée à la publication de résultats cliniques négatifs concernant la manipulation vertébrale, mais devrions-nous vraiment être surpris que d'autres alternatives cliniques puissent mener à des résultats cliniques intéressants et que la manipulation vertébrale ne soit pas toujours la première stratégie à envisager?

J'ai eu le plaisir et le privilège de participer à la vie scientifique, clinique et politique de ma profession et j'oserais avancer que dans la plupart des cas, la « peur de la recherche » n'est simplement qu'une « incompréhension de la recherche ». On défie trop souvent la science alors que celle-ci ne représente qu'un processus systématique et organisé permettant d'étudier différents phénomènes. Selon le dictionnaire Robert,<sup>2</sup> la science se définit comme suit : Ensemble de connaissances, d'études d'une valeur universelle, caractérisées par un objet (domaine) et une méthode déterminés, et fondées sur des relations objectives vérifiables. Grâce à la science et à l'expérimentation, les chercheurs en chiropratique, comme d'ailleurs tous les autres chercheurs, participent à un processus « objectif » dont le but est d'évaluer certaines hypothèses cliniques pour éventuellement en tirer des conclusions qui permettront de valider ou d'invalidier ces hypothèses. En science tout comme en épistémologie (philosophie des sciences), la réfutabilité est un concept très important. Aussi connue sous le nom de falsifiabilité, la réfutabilité se définit par la possibilité qu'une hypothèse donnée puisse être démontrée comme fausse.<sup>3</sup> Par conséquent, un élément central de la science consiste en la possibilité pour

une proposition, hypothèse ou affirmation donnée qu'elle puisse éventuellement être démontrée, par expérimentation, comme étant fausse. Si un chercheur ne peut définir ce qui constituerait une preuve empirique ou expérimentale invalidant une proposition scientifique, cette dernière n'appartient tout simplement pas au domaine de la science. Bien que cela puisse paraître contre nature, le rôle de la science et par conséquent celui du chercheur ne sont pas de démontrer la véracité d'une théorie, mais bien de les infirmer pour ensuite les raffiner. Si pour une théorie ou une hypothèse chiropratique clinique, la possibilité de la réfuter n'existe pas, il s'agit donc d'une proposition qui ne relève pas du domaine de la science, mais plutôt de la philosophie ou du domaine des pseudosciences. De fait, la connaissance scientifique se construit par l'accumulation de strates successives de données et d'interprétations de données obtenues par expérimentation minutieuse. Ainsi, ce qui est considéré aujourd'hui comme une « vérité » pourrait tout aussi bien s'avérer complètement faux ou, peut-être, partiellement vrai demain.

Par conséquent, être prêt pour la recherche signifie aussi que la profession comprenne que les percées scientifiques, « positives ou négatives » ne sont que temporaires, critiquables et bien évidemment réfutables. Corollairement, la valeur de la recherche scientifique en chiropratique ne réside pas seulement dans l'éclosion de « vérités relatives », mais probablement aussi dans le rehaussement de notre crédibilité professionnelle qui lui découle de l'engagement ferme de la profession dans la démarche scientifique. Reconnaître la valeur de la démarche scientifique, exposer de façon stratégique et transparente nos forces et nos faiblesses tout en s'impliquant dans les débats scientifiques et en collaborant avec les autres acteurs du secteur de la santé mènera probablement à des résultats plus concrets que n'importe quelle publication scientifique. Il est impossible de prédire ce que la recherche saura prouver ou infirmer dans les prochaines années et certaines hypothèses chiropratiques pourraient s'avérer fondées tandis que d'autres ne le seront pas. Cependant, on peut facilement prédire sans grande incertitude, que l'avenir de la chiropratique est plus florissant avec que sans la recherche.

En guise de conclusion, je me permettrais de citer à nouveau le Phillips qui sagement nous laissait à nos propres réflexions avec la phrase suivante : *“whether the chiropractic profession is ready or not for research really*

*doesn't matter. The research enterprise is taking off, and we will either get on the train or be left standing at the station. Let's all get on board."*<sup>1</sup>

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## Canadian Chiropractic Research Foundation



## Creating a culture of research

# Interprofessional education for medical students in clinical settings: a practical guide for an elective half-day

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## Introduction

Use of complementary and alternative medicine (CAM) in Canada is considerable and in 2006 more than half (54%) of a random sample of 2000 Canadian adults (response rate 18.8%) reported use of CAM in the past year.<sup>1</sup> In response to CAM use by Canadians, there is growing interest by faculty at medical schools for providing education on chiropractic.<sup>2</sup> As well, interprofessional education (IPE) is recognized by the World Health Organization (WHO) as a means to address upcoming healthcare workforce shortages.<sup>3</sup> Canadian students support the need for greater interprofessional collaboration<sup>4</sup> and have highlighted a lack of knowledge with respect to CAM providers as a barrier.<sup>5</sup>

Since 2008, chiropractic in Switzerland has been a publicly funded medical profession regulated on the same federal level as medical doctors.<sup>6</sup> The Swiss Bachelor of Medicine program has all medical students (including future chiropractors) immersed in the same program for 3 years.<sup>7,8</sup> In addition, chiropractors must complete

a 4-month, full time, rotation through rheumatology and orthopaedic surgery in a hospital setting as part of the requirements of the Swiss Chiropractic Academy.<sup>9,10</sup> During these rotations they must participate in history taking, physical examination, diagnosis, drug prescription (supervised) and general problem solving. In orthopaedics they scrub into surgery and have the opportunity to assist in surgical procedures, including difficult spine cases. The Swiss system provides an example of medical doctors and chiropractors working and training together, whereas in most of the world this opportunity does not exist which leads to a lack of understanding of what chiropractors do and how best to use their services.

Opportunities will increasingly arise for chiropractors to provide IPE in various clinical settings, such as private practice, hospital-based practice,<sup>11</sup> or as part of a Family Health Team.<sup>12</sup> The Centre for the Advancement of Interprofessional Education has defined IPE as: “when two or more professions learn with, from and about each other to improve collaboration and the quality of care.”<sup>13</sup>

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Systematic reviews on models of IPE aimed at improving collaboration and quality of care favour clinical encounter approaches.<sup>14,15</sup> However, structure is necessary for effective IPE or there is a risk that the learners may become overwhelmed.<sup>16</sup> Also, providing structure to IPE will help to ensure information deemed pertinent to a successful elective is provided.<sup>17</sup>

A survey of all Canadian medical school deans and associate deans (100% response rate) in 1999 noted that 6 of 16 medical schools included chiropractic in their course material and 3 programs offered a structured clinical experience on CAM interventions.<sup>18</sup> In 2010, 42.5% of medical students graduating from the Michael G. DeGroote School of Medicine at McMaster University ranked family medicine as their first choice for post-graduate training.<sup>19</sup> During the family medicine clerkship all learners participate in mandatory half-day observations with CAM providers, such as chiropractors. Students have given feedback that even a half-day observation or shadowing experience is sufficient to generate a positive experience.<sup>20</sup>

Chiropractors often train in isolation from other health-care professions, which limits opportunities for IPE,<sup>21</sup> and many may feel unprepared to participate in training medical students or residents. Boud et al. has suggested three steps for learners to achieve an effective observation experience:<sup>22</sup>

- 1 Preparation before events
- 2 Active observation
- 3 Reflection during the observation and afterwards

We propose a structure for providing IPE to medical learners based on this 3-step framework for an elective half-day clinical observation. Our recommendations are based on our experiences as teachers of medical students (JJR and JWB), a medical resident with dual certification in chiropractic and medicine (KED-A), a student pursuing chiropractic training within a medical school (TPG), medical resident who have completed a clinical observation with a chiropractor (AMC and JER) and researchers with experience interacting with physicians (JWB and SJB).

### Arranging an Observership and Sending a Biography

Most learners prefer to arrange sessions via e-mail and re-

quests from a learner should be replied to in a timely fashion with: your office hours; where to park; who to contact on arrival; dress code; number of hours required for the observation; and directions to the clinic. Once a mutually convenient time is arranged, a confirmation e-mail should be sent to the learner along with a 1-page biography of the chiropractor. The biography should inform the learner about your scope of practice, training, services provided, fee schedule and any areas of specialization.

### Practice and Research Information Package

A brief focused information package should also be provided in advance of the placement that includes patient intake and informed consent forms relevant to your jurisdiction. Information on therapy, whenever possible, should consist of systematic reviews or randomized controlled trials, as these research designs are generally accepted to represent the highest quality research.

Neither the format nor the research content of an ideal chiropractic information package for medical learners has been formally studied; however, one of us (JWB) has recently surveyed 1000 North American orthopedic surgeons (response rate 49%) regarding their attitudes towards chiropractic,<sup>23</sup> and these findings may be helpful in designing an information package. Specifically, most respondents (68%) felt that medical training should include exposure to chiropractic, and key areas of interest were the clinical training of chiropractors, safety of cervical spine manipulation, effectiveness of joint manipulation for musculoskeletal complaints, and diversity within the chiropractic profession. The following provides some guidance for addressing these issues.

A brief statement on training, admission requirements and scope of practice is helpful. In Canada, approximately 80% of chiropractors are graduates of the Canadian Memorial Chiropractic College (CMCC),<sup>24</sup> the only English-language chiropractic college in Canada, and as such the curriculum at CMCC provides a relevant summary of the training of most Canadian practitioners.<sup>25</sup> In other jurisdictions, the local chiropractic institution or WHO guidelines<sup>26</sup> may provide helpful information.

Risk of vertebral artery stroke following cervical spine manipulation is a controversial and evolving topic. Nonetheless, recent high quality studies have failed to confirm either an association between increased utilization of chiropractic and increased risk of stroke,<sup>27</sup> or an

association between chiropractic care and an increased risk of stroke compared to primary care.<sup>28</sup>

The effectiveness of joint manipulation, for predominantly axial musculoskeletal conditions, has been endorsed by a number of practice guidelines<sup>29</sup> and systematic reviews<sup>30–33</sup> that can be summarized as a basis for discussion. A brief description of interventions chiropractors provide in addition to spinal manipulation should also be considered, including patient education and active care.

The chiropractic profession in Canada represents a diverse array of practice styles, techniques, and practitioner philosophies.<sup>34</sup> During the observership ensure that the student is aware that, should they wish to refer patients for chiropractic care, they will need to identify practitioners who are aligned with their treatment expectations.

### Meeting the Medical Student or Resident

When first meeting a learner to begin their observership, their current level of medical training and specialty interest should be considered. Those students destined for primary care specialties such as family medicine or pediatrics may focus their interests more on how to bring other health professionals like chiropractors into a multi-disciplinary team;<sup>35</sup> whereas those destined for specialist work in hospitals may focus more on learning when referral for chiropractic treatment may be appropriate.

There should be time reserved at the beginning of the elective session for an introduction to the practice and treatment modalities offered without patients present. The introduction should be brief and include some protocol description for the observership ahead, including:

- at what time the observership will end
- how many patients will be seen
- what type of appointments are in the schedule (i.e. follow ups, new patients)
- the procedure for obtaining patient consent before each encounter

Learners should be informed of the expectations of both the chiropractor and the medical school administrator who facilitated the elective. An example of an achievable learning objective between a learner and a chiropractor would be teaching a focused musculoskeletal examination of the spine or extremity area. Being an elective, learners should have the opportunity to modify the goals

of the session within the context of their pre-determined (or core) curriculum objectives to achieve a mutually beneficial learning experience for both the chiropractor and learner.

An office tour provides an opportunity for discussions around quality indicators<sup>36</sup> you strive for at your site. The learner, who typically will have no previous training on chiropractic, should gain some sense of where chiropractic fills gaps within the healthcare system so that they can incorporate this knowledge into their future care decisions. If there is a team meeting scheduled for the day, invite the learner to attend as this has been shown to positively influence their ability to understand how the care team works together at the site.<sup>37</sup>

Discuss the types of services typically provided, including costs and treatment frequency related to chiropractic care, both in general terms across the profession and specific to your practice. It is helpful for the learner to understand treatment frequency and costs as their future decisions regarding referral for chiropractic care may be influenced by patient's financial ability to pay for services.<sup>38</sup>

### Active Observation with Patients

Learners should be made aware that their patients may be hesitant to bring up chiropractic care on their own for fear of being thought of as “fringe, ungrateful, unrealistic or gullible”;<sup>39</sup> or because they believe that chiropractic care is irrelevant to medical treatment.<sup>40</sup> It seems reasonable that physicians who are comfortable discussing chiropractic care will be more likely to engage in discussions on this topic with patients. This may allow physicians to better participate in shared decision-making regarding complaints that may be amenable to chiropractic care.

While the learner is observing the chiropractor in the treatment room, a few questions can be posed informally to each patient to help convey how chiropractic care fills gaps within the healthcare system:

- 1 “What made you decide to see a chiropractor?”
- 2 “How is this different than medical care?”
- 3 “How is this different than massage therapy or physiotherapy?”

Review the patient's medical record for each patient so the student understands both the similarities and differ-

ences in record-keeping format between medicine and chiropractic. Point out the value of record sharing in a team of providers for both continuity of care and clinical effectiveness.<sup>41</sup> As well, highlight profession-specific terminology and forms of diagnoses in the patient's record, relevant to chiropractic, that may be either similar or different than medical practice. This can be achieved by asking the learner to point out any terms they do not recognize.

Fragmentation of care is a potential problem for patients that are under both medical and chiropractic care<sup>42</sup> and you may wish to use an example from your own practice to highlight this issue. Lastly, at the end of the session, time should be reserved to discuss any remaining questions about specific patients or treatments.

### Reflection for Learner and Chiropractor

Reflection will occur naturally between each patient by using a review of the clinical records and through learner dialogue with the chiropractor regarding the patient encounter. Practically, a chiropractor may wish to schedule more time for patient visits leaving more time to allow for this discussion. Following the half-day observation, both the learner and chiropractor should make an effort to actively reflect on the value of the experience. This exercise, done in person or via e-mail afterward, is not only helpful for the student, but provides feedback to the chiropractor.

Areas for the reflection with the student may revolve around what surprised them most and how the experience can be improved for future students. Also, a particular focus should be on whether mutually agreed upon learning objectives between the learner and chiropractor were accomplished during the session. Finally, this offers a quality improvement perspective to assist in ensuring that future students have the best possible experience.

### Learner Perspectives

Due in large part to the lack of chiropractic exposure during medical school, our experiences suggest that learners and medical school faculty in Canada commonly equate chiropractors exclusively with spinal manipulation. Few understand that chiropractors assess extremity complaints, treat headaches, order and interpret plain films, formulate diagnoses, provide exercises or consult on lifestyle problems. Since chiropractors often train in isolation of other health providers and maintain primarily independ-

ent practices, there has historically been limited potential for communication between chiropractors and medical practitioners, which has likely contributed, to these basic knowledge gaps.

From a medical student's perspective, an observership with a chiropractor provides a unique opportunity to enhance interprofessional communication. In order for the elective session to be successful for the medical student and chiropractor, good communication needs to be established. Communication starts before the initial visit, when the goals and objectives of the elective session are being discussed, and should continue to be developed and enhanced throughout the observation.

Discussing a controversial issue with the learner, such as the association between vertebrobasilar stroke and cervical spine manipulation, demonstrates how the chiropractor may convey both the risks and benefits of a particular therapy to a patient. Addressing a controversial topic also provides the chiropractor with an opportunity to demonstrate an evidence-based approach to discussing therapies they provide.

After graduating from medical school, medical doctors must complete a residency program ranging from 2–6 years in length depending on whether they are training to become primary care or specialist physicians. Most of what medical residents learn is acquired through direct, hands-on patient care under the guidance of supervising staff, and senior residents and fellows. Participants in a pilot IPE program involving CAM providers reported enhanced understanding after active involvement in history-taking, physical exams and formulating treatment plans.<sup>43</sup> It follows that giving the medical resident opportunities to take patient histories and perform physical exams concurrently with the chiropractor would be an important feature of the half-day experience.

### Effective Teaching Behaviours

Medical students and residents are well acquainted with health conditions that are readily treated with conventional medical therapies. One important question of particular relevance to learners is: does chiropractic have the potential to treat a medical condition for which conventional medical approaches are lacking?<sup>44</sup> Chiropractic preceptors may wish to consider how to emphasize the evidence for conditions they treat as well as how to teach this information in an effective way.

Characteristics thought to be effective teaching behaviours of preceptors to medical learners are ones that:<sup>45</sup>

- actively involve the student
- foster a supportive interpersonal relationship
- emphasize problem solving and the understanding of general principles versus factual items
- balance clinical and teaching responsibilities
- demonstrate clinical and professional competence
- use an organized approach, including goal setting and summation
- provide ongoing feedback, assessments and evaluations

## Conclusion

Those interested in hosting medical learners will discover that there are important educational opportunities to be realized for themselves. While the medical learner gains knowledge on chiropractic, discussion during the observation also assists the chiropractor in understanding the medical reasoning behind care decisions that often is unknown or assumed.

To our knowledge, this is the first published work that attempts to define a standardized clinical IPE observation between a medical learner and chiropractor. Further research in this area should be geared towards surveying medical learners and faculty from medical programs in order to identify the optimal format and content of an information package, prioritize learning objectives, and further define useful characteristics of the 3-step process for a clinical observation.

## Key Points

- Improved communication is the goal of an inter-professional observation
- Include preparation, active observation and reflection components
- Send a biography and information package in advance
- Highlight how chiropractic fills gaps within the healthcare system
- Address diversity within the profession
- Increased collaboration and quality improvement in patient care may occur as a result of these observations

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# Baseline knowledge on vehicle safety and head restraints among Fleet Managers in British Columbia Canada: a pilot study

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**Background:** *Whiplash is the most common injury type arising from motor vehicle collisions, often leading to long-term suffering and disability. Prevention of such injuries is possible through the use of appropriate, correctly positioned, vehicular head restraints.*

**Objective:** *To survey the awareness and knowledge level of vehicle fleet managers in the province of British Columbia, Canada, on the topics of vehicle safety, whiplash injury, and prevention; and to better understand whether these factors influence vehicle purchase/lease decisions.*

**Methods:** *A survey was administered to municipal vehicle fleet managers at a professional meeting (n = 27).*

**Results:** *Although many respondents understood the effectiveness of vehicle head restraints in the prevention of whiplash injury, the majority rarely adjusted their own headrests. Fleet managers lacked knowledge about the seriousness of whiplash injuries, their associated costs for Canada's healthcare system, and appropriate head restraint positions to mitigate such injuries. The majority of respondents indicated that fleet vehicle purchase/lease decisions within their organization did not factor whiplash prevention as an explicit safety priority.*

**Conclusions:** *There is relatively little awareness and*

**Historique :** *le coup de fouet cervical est le type de blessure la plus courante suite à une collision impliquant un véhicule à moteur. Il mène souvent à une invalidité et des souffrances permanentes. La prévention de telles blessures est possible grâce à l'usage d'un appuie-tête pour véhicule correctement positionné.*

**Objectif :** *effectuer un sondage du niveau de connaissances des gestionnaires de parc automobile de la province de la Colombie-Britannique, au Canada, relativement à la sécurité routière, au coup de fouet cervical, et à la prévention ; et mieux comprendre si ces facteurs influence l'achat/la location d'un véhicule.*

**Méthodes :** *le sondage fut mené auprès de gestionnaires de parc automobile municipal lors d'une réunion professionnelle (n = 27).*

**Résultats :** *bien que la plupart des répondants comprennent l'efficacité d'un appuie-tête pour véhicule dans la prévention d'un coup de fouet cervical, la majorité d'entre eux ajustent rarement leur appuie-tête. Les gestionnaires de parc automobile ne possèdent pas les connaissances nécessaires sur la gravité de ce type de blessure, les coûts de celle-ci pour le système de santé canadien, et les positions appropriées de l'appuie-tête pour atténuer de telles blessures. La plupart des répondants ont indiqué que les décisions d'achat/ de location concernant le parc automobile de leur organisation ne tenaient pas compte de la prévention du*

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*enforcement of whiplash prevention strategies among municipal vehicle fleet managers.*  
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KEY WORDS: whiplash, injury, headrest, prevention

## Introduction

Traffic safety researchers have focused mainly on vehicular injury types which are likely to be life-threatening. However, although fatalities due to whiplash injuries are relatively rare,<sup>1</sup> whiplash often results in pain, suffering, and disability, with significant personal and societal financial consequences.<sup>2</sup> Furthermore, rear-end collisions – the leading cause of whiplash injuries – are the most common type of motor vehicle collision, and neck injuries are a frequent result of these crashes.<sup>3</sup>

Studies conducted in Sweden reveal that whiplash injuries account for 70% of all injuries leading to disability,<sup>4</sup> and constitute more than half of the permanently disabling injuries resulting from motor vehicle crashes.<sup>5</sup> Hence, neck injuries such as whiplash can lead to a significant economical costs to society.<sup>6</sup> Within Canada, the societal costs of whiplash injuries are continuing to increase. The annual estimated cost of whiplash injury claims in Canada is \$600,000,000 resulting in a consumer cost annual estimate of \$135 per vehicle.<sup>7</sup>

Relatively simple safety precautions can greatly reduce the probability of whiplash-type injuries arising from vehicular collisions. Of these, appropriately positioned geometrically suitable head restraints play a particularly large role in protecting vehicle occupants from whiplash injury.<sup>8–10</sup> At the 2007 World Congress on Neck Pain, it was reported that 35% of serious neck injuries – defined as injuries accompanied by pain lasting more than 6 weeks – could be prevented or mitigated with appropriate vehicular head restraints.<sup>1</sup> Strikingly, these numbers may represent an underestimate of the potential benefit of head restraints, since they do not take into account whether head restraints were appropriately adjusted. Unfortunately, however, consumers tend to assign lower priority

*coup de fouet cervical en tant que priorité en matière de sécurité.*

Conclusions : les gestionnaires de parc automobile municipal sont très peu sensibilisés à la prévention du coup de fouet cervical et à la mise en œuvre de stratégies à cet égard.

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MOTS CLÉS : coup de fouet cervical, blessure, appuie-tête, prévention

to safety features which can prevent whiplash injuries, such as head restraints, compared to advanced braking systems and front passenger airbags, when making vehicle purchase/lease decisions.<sup>11</sup>

Head restraints are designed to prevent whiplash injuries by minimizing neck movement during a collision.<sup>3</sup> According to the Insurance Institute of Highway Safety (IIHS), to be effective, a head restraint must be positioned behind and close to the back of the head (i.e., between 2–7 cm behind the head), while the vertical position of the head restraint should be level with the top of the head.<sup>12</sup> However observational studies report that only 14% of Canadians implement proper adjustment of vehicular head restraints (23% of all surveyed females and 7% of all surveyed males), and that only 18% of drivers in the province of British Columbia adjust their head restraints appropriately.<sup>13</sup> Surprisingly, this lack of awareness also extends to Canadian health care professionals.<sup>14</sup> Indeed, a recent study of chiropractic interns from the New York Chiropractic College in the United States revealed that only 13.3% of interns knew the recommended vertical distance for vehicular head restraints, and only 20% of surveyed interns knew the recommended horizontal distance.<sup>15</sup> The failure to practice simple safety precautions for such injuries is probably related to a scarcity of transport professionals, as well as a general lack of public awareness of the importance of proper head restraint positioning in the prevention of whiplash-type injuries.

Vehicle fleet managers are responsible for purchasing and managing company vehicle fleets. Fleet management often includes a range of additional functions such as financial management, vehicle maintenance, vehicle tracking and diagnostics, driver supervision and training, management of fuel usage, and health/safety manage-

ment.<sup>16</sup> In order to make informed decisions to optimize vehicle occupant safety, it is imperative that fleet managers be knowledgeable of key vehicle safety features, including the effectiveness of head restraints in whiplash injury prevention, and knowledge of appropriate head restraint positioning.

The objective of the present pilot study, therefore, was to examine the awareness and knowledge level of vehicle fleet managers regarding the benefits of head restraints and appropriate head restraint positioning for the prevention of whiplash injury. Further, whether whiplash injury prevention factored into vehicle acquisition decision-making or driver training was also examined. Here, we report results obtained from a cross-sectional survey conducted during a municipal fleet manager association annual general meeting held in British Columbia, Canada. To our knowledge, this is the first study of its kind conducted within a North American sample population. This study was undertaken as a part of the “AUTO21 whiplash injury prevention” project, initiated in 2009 to increase whiplash prevention awareness among fleet managers, injury prevention stakeholders and general consumers within the province of British Columbia, Canada.

## Methods

### *Study Design and Population*

A voluntary written survey was administered to a cross-sectional convenience sample of 27 municipal fleet managers from municipalities within British Columbia, Canada. Ethics approval was obtained through the University of British Columbia’s Institutional Review Board and informed consent was obtained from each participant before enrolment in the project. To prepare for this study, a small focus group session was held, which included five fleet managers and one occupational health and safety professional, in order to better understand their roles and responsibilities, their knowledge regarding whiplash and whiplash prevention, and the fleet vehicle selection process. Within the focus group session we identified key challenges facing fleet managers, opportunities to foster dissemination of knowledge, and common information resources used by fleet managers, including social media and communication networks. This information was used to develop and refine the finalized survey questionnaire administered at a subsequent meeting of municipal fleet

managers. The final survey questionnaire contained 26 questions on the following topics: fleet vehicle and organization characteristics (7 questions); vehicle safety knowledge (2 questions); head restraint awareness knowledge (8 questions); opinion questions (3 questions); and behavioural questions on safety and head restraint adjustment practices (6 questions). Questions were mostly multiple choice format (e.g., choose correct/most accurate answer from a list of options, rank items in order of importance, or yes/no responses). Some questions utilized visual analogue scale responses, where the respondent indicated their response relative to two extremes by marking an “x” along a horizontal 10 cm line. Further, some questions required short written answers and/or included a comment section. The survey was designed to take approximately 10–15 minutes to complete.

The finalized survey was delivered to attendees at a fleet manager association general meeting. Following a verbal introduction describing the voluntary nature and purpose of the survey, as well as providing an introduction to the team conducting the survey, participants were invited to complete the questionnaire. A participation incentive (two GPS units) was included, with winners selected by raffle after completion of the questionnaires. No personal identifiers were collected and the survey results were anonymous. Subsequent to the survey, a 30 minute educational presentation was conducted focusing on the causes, consequences, and prevention of whiplash injury, as well as the societal costs of whiplash injuries.

### *Data analysis*

Survey data was entered into a spreadsheet. Responses from visual analogue scale questions were directly converted to a scale ranging from 0–10, based on measurement of the position of the respondent’s mark along the 10 cm line, and data is presented as mean  $\pm$  standard deviation (SD).

### *Results*

A total of 27 participants completed the questionnaire. Results from demographic questions revealed that the majority of respondents represented large organizations – 64% were employees of institutions with more than 200 employees, 20% were employees of institutions with 50–200 employees, and 16% were employees of institutions with less than 50 employees. Participants represented

organizations operating a total of 7839 vehicles (mean  $340.8 \pm 430.7$ ), and employing 11541 drivers (mean  $501.8 \pm 666.0$ ).

To examine the perceptions of respondents regarding the seriousness of whiplash injuries (in terms of being a medical/economic burden), participants were asked to place a mark along a visual analogue scale ranging from 0 (not serious) to 10 (extremely serious). The mean response to this question was  $8.0 \pm 1.4$ . On the same scale, when asked whether whiplash injuries were a serious issue among professional drivers, the mean analogue response was  $6.3 \pm 2.3$ . Whiplash injury is, however, considered to be an extremely serious issue both among the general driving population<sup>17</sup> and professional drivers.<sup>18</sup> In Canada, approximately 2,000,000 whiplash-related injury claims are made each year.<sup>17</sup> In a multiple choice-type question querying this issue, only 13.3% of respondents chose the correct answer of 2,000,000 claims, while 40.0% chose 1,000,000 claims, 23.3% chose 500,000 claims, 13.3% chose 200,000 claims, and 10.0% chose 100,000 claims. Taken together, these results indicate that respondents generally underestimated the overall seriousness of whiplash injuries.

To examine the opinions of respondents on the importance of different vehicular safety features in preventing injuries resulting from front- or rear-end collisions, participants were asked to rank the top three safety features from a list of eleven items. For front-end collisions, 62.1% of respondents ranked seatbelts as the most important safety feature, 45.2% ranked airbags as the second most important safety feature, and 26.7% ranked vehicle crushability as the third most important safety feature (figure 1). For rear-end collisions, 55.2% of respondents ranked seatbelts as the most important safety feature. Headrests and airbags received an equal number of responses as the second most important safety feature (22.6% of responses each), and these two features were also tied for the third most important safety feature (30.0% of responses each) (figure 2).

The subsequent set of questions examined respondent knowledge level regarding the causes and prevention strategies of whiplash injuries. All respondents (100%) correctly selected rear end collisions<sup>3, 19, 20</sup> over front-end or side impact collisions as the collision-type most associated with whiplash. The mean response for the question “How preventable are whiplash-type injuries with correct

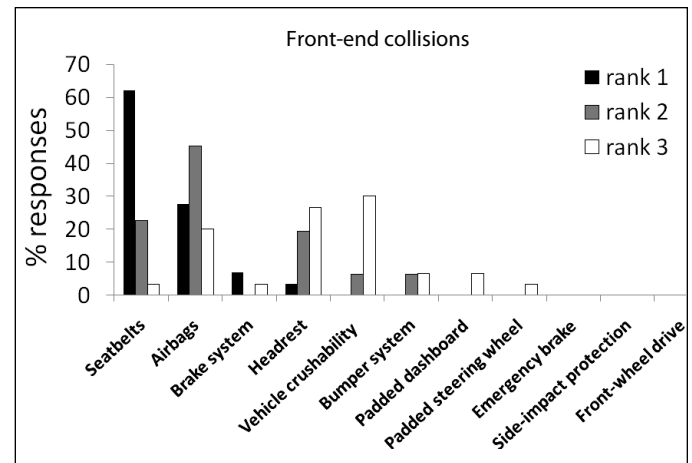


Figure 1 Summary of survey results indicating fleet managers' rankings of vehicular safety features which best mitigate injuries resulting from front-end collisions.

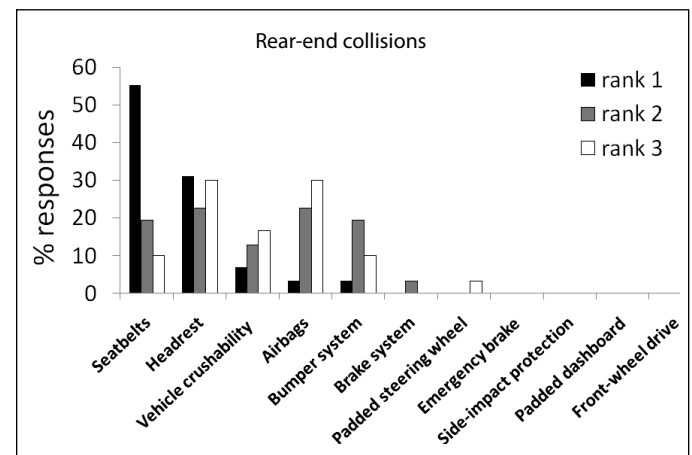


Figure 2 Summary of survey results indicating fleet managers' rankings of vehicular safety features which best mitigate injuries resulting from rear-end collisions.

headrest positioning?,” on a visual analogue scale of 0 (not preventable) to 10 (completely preventable) was  $7.4 \pm 2.0$ , consistent with reports from various sources.<sup>5,12,19</sup> Together, these results indicate that participants were well aware of the primary causes and preventability of whiplash-type injuries due to vehicle collisions. Despite this knowledge, however, the majority of respondents rarely adjust their own headrests, both as a driver and when travelling as a passenger (table 1). Results show that the

Table 1 Respondent head restraint adjustment patterns

Vehicle type	Head restraint adjustment (%)			
	Never	Once	Frequently	Every time
Personal vehicle	23.3	46.7	23.3	6.7
Work vehicle	30.4	30.4	39.2	0.0
Other vehicle as driver	69.0	17.2	6.9	6.9
Other vehicle as passenger	76.6	10.0	6.7	6.7
Rental vehicle as driver	50.0	23.3	16.7	10.0
Rental vehicle as passenger	73.3	6.7	10.0	10.0

majority of fleet managers (70.0%) do not adjust their head restraints frequently in their personal vehicles, and 60.8% of respondents do not routinely adjust their head restraints before driving work vehicles. Similarly, a large proportion of fleet managers only infrequently adjust head restraints in other vehicles or rented vehicles either as driver (86.2% and 73.3%, respectively) or as a passenger (86.7% and 80.0%, respectively). The majority of respondents (90%) also believed that only a small proportion of individuals in the general population ( $\leq 25\%$ ) correctly adjusted their headrests. Surprisingly, 33.3% of participants indicated that they would *not* advise family/friends regarding the correct positioning of head restraints before driving a vehicle.

When asked to select from a list of factors that affect whether or not respondents adjusted their own headrests, the majority reported that they never considered adjusting their headrests (43.4%), while 33.3% reported that adjustments were too inconvenient or time consuming, 16.7% responded that they didn't know how to adjust it, 16.7% responded that their headrests were not adjustable, and 10.0% responded that their headrests were too difficult to adjust. Interestingly, on a scale ranging from 0 (least important) to 10 (most important) respondents placed similar levels of importance on comfort ( $6.1 \pm 2.4$ ) and being able to view their "blind spot" ( $6.7 \pm 2.4$ ) with the importance of protecting themselves from injury ( $7.3 \pm 2.6$ ).

Table 2 shows the summary of a set of questions examining respondents' knowledge of the properties of position of head restraints that best protect from whip-

lash-type injuries. From a list of five possible answers querying properties of head restraints that best protect from whiplash-type injuries, roughly half of the respondents (52.9%) correctly identified that headrests must be of sufficient stiffness such that it will reduce the relative displacement between the head and the body.<sup>21</sup> Seventy percent of respondents were aware that the recommended distance between the back of the head and the headrest is 5 cm (2 inches) or less;<sup>21</sup> almost two-thirds of respondents (65.7%) were aware that the recommended positioning of headrests is immediately behind the head;<sup>21</sup> however, less than a quarter of participants (23.3%) were aware that the top of the headrest is recommended to be aligned with the top of the head.<sup>21</sup>

A striking result of this survey was that acknowledgement of fleet managers of the unawareness of their own employees of whiplash prevention policies in place within their organization, the mean response being  $2.5 \pm 1.5$  on a visual analogue scale ranging from 0 (not at all aware) to 10 (very aware). In addition, only a small fraction of respondents indicated that their organization monitors incidences of rear-end collisions (33.3%), whiplash injuries (20.0%), or maintains records detailing the duration of employee absenteeism/disability due to vehicle collisions (30.0%).

While many respondents indicated that their organizations routinely record the incidence of motor vehicle collisions (81.8%), when specifically referring to rear-end collisions, this number decreased to 47.6%. Importantly, only 28.6% of respondents indicated that their organiza-

Table 2 Summary of participant responses to question querying properties of head restraints that best protect from whiplash-type injuries

<i>What are the most important qualities of good head restraint design to reduce risk of injury during a rear end collision?</i>	
It is shaped to fit the contour of your neck when the occupant hits it	17.6%
The head restraint cushion does not adjust forward past the top end of the seat	26.5%
It is quite soft such that the head can easily rotate over it	0.0%
<b>It is sufficiently stiff such that it will reduce the relative displacement between the head and the body [CORRECT RESPONSE]</b>	52.9%
It is compliant and thus bends substantially rearward when your head contacts it	3.0%
<i>How do you normally position your headrest?</i>	
Immediately behind your neck	14.3%
<b>Immediately behind your head [CORRECT RESPONSE]</b>	65.7%
Below your neck	14.3%
I don't have a preference	5.7%
<i>Where is the top of your headrest situated when you are seated in your vehicle?</i>	
<b>Level with the top of your head [CORRECT RESPONSE]</b>	23.3%
In the middle of your head	63.3%
Below your ears	3.4%
Don't know	10.0%
<i>How far away is your headrest from the back of your head when you are seated in your vehicle?</i>	
Touching the back of your head	16.7%
<b>5 cm (2 in) or less away from your head [CORRECT RESPONSE]</b>	70.0%
More than 5 cm (2 in) but less than 10 cm (4 in)	3.3%
10 cm (4 in) or more	0.0%
Don't know	10.0%

tions recorded the incidence of whiplash and duration of disability (42.9%). Only 42.9% of the organizations represented by surveyed respondents maintain records detailing the duration of employee absenteeism/disability due to vehicular collisions. Furthermore, only one-third (33.3%) of respondents indicated that this surveillance

information was taken into consideration in vehicle purchase/lease decisions. It is not surprising, therefore, that when asked to rank the top criteria respondents' organizations consider when acquiring fleet vehicles, on average, vehicle safety lags behind functional requirements, vehicle cost, and other economical considerations such as

Table 3 Collection and utilization of collision and disability data within respondents' organizations

	yes	no	unaware
Routine recording of incidence/types of motor vehicle collisions	81.8%	9.1%	9.1%
Consider collected collision data when purchasing/leasing fleet	42.9%	52.4%	4.8%
Routine incident/injury surveillance include			
• Rear-end collisions	47.6%	42.9%	9.5%
• Incidence of whiplash	28.6%	57.1%	14.3%
• Duration of disability	42.9%	42.9%	14.3%
Consider surveillance information when purchasing/leasing fleet	33.3%	52.4%	14.3%

fuel economy and maintenance costs. The top ten considerations were: (i) functional requirements (22.2%), (ii) cost (18.5%), (iii) economical considerations (14.8%), (iv) safety (13.6%), (v) reliability (9.9%), and (vi) "green" value (8.6%), (vii) comfort (3.7%), (viii) resale value (2.5%), (ix) make (1.2%), (x) trade-in value (1.2%).

## Discussion

The present study was designed to evaluate the baseline knowledge of municipal fleet managers in British Columbia on the causes and prevention of whiplash injury, the benefits of proper head restraint adjustment, and the overall impact and prevalence of whiplash injuries within society.

Current research provides strong evidence that whiplash prevention is possible when drivers and passengers are in vehicles with head restraints that are rated "good" or "better," and when head restraints are positioned appropriately.<sup>18,19</sup> Fleet managers can play an important role in whiplash prevention through the purchase/lease of vehicles with "good" or "better" rated head restraints and ensuring that employees are trained to frequently adjust their vehicular head restraints appropriately.<sup>22</sup> The results from this study therefore raise important concerns. Surveyed municipal fleet managers within British Columbia appear to generally underestimate the overall seriousness of whiplash injuries, and as a consequence are either unaware or opt to overlook simple yet effective injury prevention strategies. Survey participants acknowledge that

the organizations they represent largely do not place emphasis on these safety features when making vehicle acquisition decisions. These results are in agreement with a recent survey of Swedish and Spanish fleet managers, which revealed that respondents were more likely to consider vehicle price, reliability, running costs, size, and fuel consumption rather than the vehicle safety when acquiring fleet vehicles.<sup>23</sup> Respondents also indicated that their employees were likely not aware of whiplash prevention policies in place within their organization. Additionally, these results suggest that routine safety checks and training sessions carried out by fleet managers likely assign lower priority toward whiplash injury prevention strategies.

Although survey-based questionnaires are relatively cost effective when collecting data from larger populations, they have some potential limitations. The most serious limitation is the validity and reliability of responses obtained. For instance, in surveys, respondents are often unwilling to indicate that they have engaged in behavior considered "unacceptable" by society as a whole. Further, respondents tend to answer questions rapidly – without extensive thought – if the questionnaire is lengthy. To reduce these potential limitations, the present questionnaire was designed to contain only 26 questions, taking approximately 10–15 minutes to complete, and was anonymous. Another possible limitation of survey-based methodology is whether the sample accurately represents the population being sampled. Although 100% of those attending the annual meeting participated in our survey, the sample size



was relatively small and therefore any extrapolations to this specific population must be made with caution. It is worth noting, however, that although this cross-sectional sample consisted of only 27 fleet managers, these individuals represented organizations operating over 7800 vehicles and employing over 11500 drivers. Our questionnaire also did not collect demographic data (sex, age, annual income, etc) and thus we cannot confirm that our sample is fully representative of the British Columbia fleet managers. Finally, we acknowledge that future surveys assessing these issues, especially those to be conducted on a larger scale, would benefit from the consultation of a larger number of safety professionals representing a variety of backgrounds, in order to better assess the relevance and validity of each item within the questionnaire.

The present cross-sectional pilot study reveals that awareness levels regarding whiplash injuries and related factors among municipal fleet manager in British Columbia is alarmingly low, congruent with reduced awareness observed in both the general population and among health care practitioners.<sup>14,24</sup> It will be important, therefore, to implement educational programs targeting fleet managers – individuals well positioned to have far-reaching influence on the safety of many individuals – to increase awareness regarding (i) the seriousness and high prevalence of whiplash injuries due to vehicular collisions, (ii) the importance of purchasing/leasing vehicles with better-rated head restraints, and (iii) the appropriate adjustment of head restraints for different occupants. In addition, vehicle safety information, such as IIHS crash-test results, must be disseminated more widely and effectively, in order to play a more prominent role in new vehicle choices. Based on our results and data from previous work,<sup>13</sup> our research team is proposing a province-wide social marketing campaign to increase the awareness of optimal head restraint position. Finally, health care practitioners such as chiropractic professionals, are also well poised to play a vital role in preventing whiplash injury by educating their patients about preventative strategies to avoid whiplash injuries, including the correct use of head restraints.<sup>15,24</sup>

In conclusion, the results from this survey indicate that municipal fleet managers in British Columbia place relatively low importance on whiplash injury prevention strategies, which directly impact employee safety. This study highlights a need to emphasize the importance of

whiplash injury prevention strategies among fleet managers of British Columbia, and warrants an assessment of awareness levels fleet managers across other jurisdictions across Canada.

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# The effect of spinal manipulation on imbalances in leg strength

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*We hypothesized that spinal manipulation (SM) would reduce strength imbalances between legs. Using an unblinded randomized design, 28 males and 21 females ( $54 \pm 19$ y) with at least a 15% difference in isometric strength between legs for hip flexion, extension, abduction, or knee flexion were randomized to treatment or placebo (mock spinal manipulation). Strength of the stronger and weaker legs for hip flexion, extension, abduction, and/or knee flexion was assessed before and after the intervention. SM reduced the relative strength difference between legs for knee flexion (mean  $\pm$  SD  $57 \pm 53$  to  $5 \pm 14\%$ ) and hip flexion ( $24 \pm 12$  to  $11 \pm 15\%$ ) compared to placebo ( $34 \pm 29$  to  $24 \pm 36\%$ , and  $20 \pm 18$  to  $22 \pm 26\%$ , respectively) ( $p = 0.05$ ). SM also improved strength in the weak leg for hip abduction ( $104 \pm 43$  to  $116 \pm 43$  Nm) compared to placebo ( $84 \pm 24$  to  $85 \pm 31$  Nm) ( $p = 0.03$ ). This study suggests that spinal manipulation may reduce imbalances in strength between legs for knee and hip flexion. (JCCA 2011; 55(3):183-192)*

**KEY WORDS:** hip, hamstring, flexion, extension, abduction

*Notre hypothèse est que la manipulation vertébrale (MV) réduirait le déséquilibre entre les jambes. À l'aide d'un essai aléatoire ouvert, 28 hommes et 21 femmes ( $54 \pm 19$ a) ayant une différence de force isométrique d'au moins 15 % entre les jambes pour la flexion, l'étirement et l'abduction de la hanche, ou la flexion du genou, ont subi de façon aléatoire un traitement réel ou un traitement placebo (manipulation vertébrale simulée). On a alors évalué la force des jambes plus fortes et plus faibles en fonction de la flexion, l'étirement et l'abduction de la hanche, ou la flexion du genou, avant et après l'intervention. La MV a réduit la différence de force entre les jambes quant à la flexion du genou (moyenne  $\pm$  ET  $57 \pm 53$  à  $5 \pm 14$  %) et la flexion de la hanche ( $24 \pm 12$  à  $11 \pm 15$  %) par rapport au traitement placebo ( $34 \pm 29$  à  $24 \pm 36$  %, et  $20 \pm 18$  à  $22 \pm 26$  %, respectivement) ( $p = 0,05$ ). La MV a également amélioré la force de la jambe faible quant à l'abduction de la hanche ( $104 \pm 43$  à  $116 \pm 43$  Nm) par rapport au traitement placebo ( $84 \pm 24$  à  $85 \pm 31$  Nm) ( $p = 0,03$ ). Cette étude suggère que la manipulation vertébrale peut réduire le déséquilibre de la force entre les jambes quant à la flexion du genou et de la hanche. (JCCA 2011; 55(3):183-192)*

**MOTS CLÉS :** hanche, tendon du jarret, flexion, étirement, abduction

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## Introduction

Musculoskeletal injuries may be partly related to strength imbalances between limbs. Strength imbalances between legs may affect performance of activities and result in increased chance of injury occurrence.<sup>1-8</sup> Contra-lateral imbalances in strength of hip flexors, hip extensors, and knee flexors in asymptomatic subjects predict future lower extremity injuries such as hamstring strains or single leg overuse injuries<sup>1,3,4,6,8</sup> while contra-lateral differences between hip extensors strength in asymptomatic subjects predicts future lower back pain.<sup>9</sup> Contra-lateral strength differences have also been observed in injured athletes<sup>2,5</sup> or athletes who have a past history of injury.<sup>7</sup> In contrast, there are a number of studies indicating no relationship between strength imbalance and injury occurrence.<sup>10-12</sup> The objective of this study was to determine whether a single chiropractic spinal manipulation (SM) could improve strength imbalances between legs.

Strength is influenced by both muscle mass and the ability of the nervous system to recruit muscle.<sup>13</sup> Unilateral muscle weakness and strength imbalances between the legs may therefore be caused by neural deficits. It has been suggested that spinal manipulation may overcome neural deficits by a number of mechanisms including reduced nerve impingement, altered discharge from muscle spindles, Golgi tendon organs, mechanoreceptors and nociceptors, altered sensory processing in the spinal cord (allowing increased pain tolerance), and altered skeletal muscle reflexes.<sup>14</sup> These changes may alter afferent feedback to the spinal cord to cause an increase in motor neuron excitability. Spinal manipulation on one side of the body can reduce inhibition of limb musculature on the same side of the body. For example, spinal manipulation of the sacroiliac joint on the ipsilateral side of an injured knee resulted in reduced motor unit inhibition to the knee extensors of the injured limb, as measured by the interpolated twitch technique.<sup>15,16</sup> Manipulation of the lumbar spine also increases motor neuron excitability as measured by transcranial magnetic stimulation.<sup>17</sup> Spinal manipulation has a greater effect on the weaker limb – the removal of motor unit inhibition occurred to a greater extent in an injured than non-injured limb.<sup>15,16</sup> We therefore hypothesized that spinal manipulation of the lumbar spine would increase strength of the weaker limb; and that this would decrease the imbalance in strength in subjects with an imbalance in strength between legs.

## Methods

The study was approved by our university's ethics review board. Subjects were volunteers from the general community who responded to advertisements posted around a university campus, and at chiropractic clinics. Subjects who responded to the advertisement were contacted initially by a research assistant who explained the nature and purpose of the study. If subjects were still interested in participating an initial appointment was made with the research assistant. At the initial appointment the procedures were fully explained, and subjects gave their informed consent to participate in the study. They then filled out a physical activity readiness questionnaire (PAR-Q). An initial measurement of strength deficits between lower limbs was then performed using an isokinetic dynamometer (Biodex System 3, Biodex Medical Systems Inc., Shirley NY) set in isometric mode. Assessment of isometric hip abduction, hip flexion, hip extension, and knee flexion strength has been described in detail previously.<sup>18-20</sup> Three isometric contractions of 5 seconds were performed for each movement with a 30 second rest period between contractions. The highest peak torque obtained was recorded in newton meters (Nm). Knee flexion was tested with the participant in a seated position with the hips at 90° and the knee flexed at 30° (where 0° indicates full extension). Stabilizing straps were applied diagonally across the chest, waist, and just above the knee on the leg not being tested. The dynamometer attachment was adjusted so the pad was placed just proximal to the lateral malleoli of the leg being tested and the knee joint was in line with the axis of rotation of the dynamometer. All hip movements were performed from a standing position, with the hip joint in line with the dynamometer axis of rotation. Participants placed their hands on the machine at waist level for balance and in order to stabilize the standing position. The dynamometer attachment was adjusted so the pad was placed three finger widths above the lateral joint line of the knee for hip abduction, flexion, and extension. Participants were asked to keep their foot just off the ground with knee slightly flexed for abduction and extension. Hip abduction was performed with the leg at an angle of 10° of abduction. For hip extension the contraction was performed from 0° or as close as their hip range would allow. Hip flexion was performed with the leg set at 80° of flexion. All hip joint angles were referenced from thigh to vertical. All measurements were corrected for the

effects of gravity on the leg and the dynamometer's resistance pad. Reproducibility of these strength tests was assessed using the initial test results on day 1 and the first test on the treatment day one week later (i.e. before SM or placebo treatment; i.e. mock SM). Intra-class correlation coefficients for hip abduction, hip flexion, hip extension, and knee flexion strength were 0.91, 0.80, 0.88, and 0.92, respectively.

Subjects were considered eligible for the study if they had at least a 15% difference in strength between their legs for hip extension, hip flexion, hip abduction, or knee flexion at the initial testing session. This criterion has previously predicted lower extremity injuries.<sup>1</sup> Eligible subjects were invited back to our laboratory at least one week later for an additional session where they were stratified by sex, and randomized to receive either a SM or placebo (i.e. mock adjustment). Randomization was done by a computerized random-number generator and group allocation for each subject was concealed in a sealed envelope and held by an individual who was not involved in any other aspect of the study. Subjects then performed the strength test(s), for which they had greater than or equal to 15% differences between legs on the initial testing day, before and after they received SM or placebo (mock SM). The SM or placebo intervention was given immediately after the strength tests. These strength tests took between 5 to 30 minutes depending on the number of strength tests (i.e. subjects were given 1–4 strength tests depending on which tests they had a 15% or greater difference between their limbs a week earlier). After the intervention was completed, strength tests were repeated. If more than one strength test was done, the order of the tests was randomized before the intervention and the same order of testing was followed after the intervention. At least a 3-minute rest was given between strength tests. Sixty-seven subjects were initially evaluated and 50 met the inclusion criteria. One subject from the placebo (mock SM) group withdrew for personal reasons. The flow of participants through the study is summarized in Figure 1.

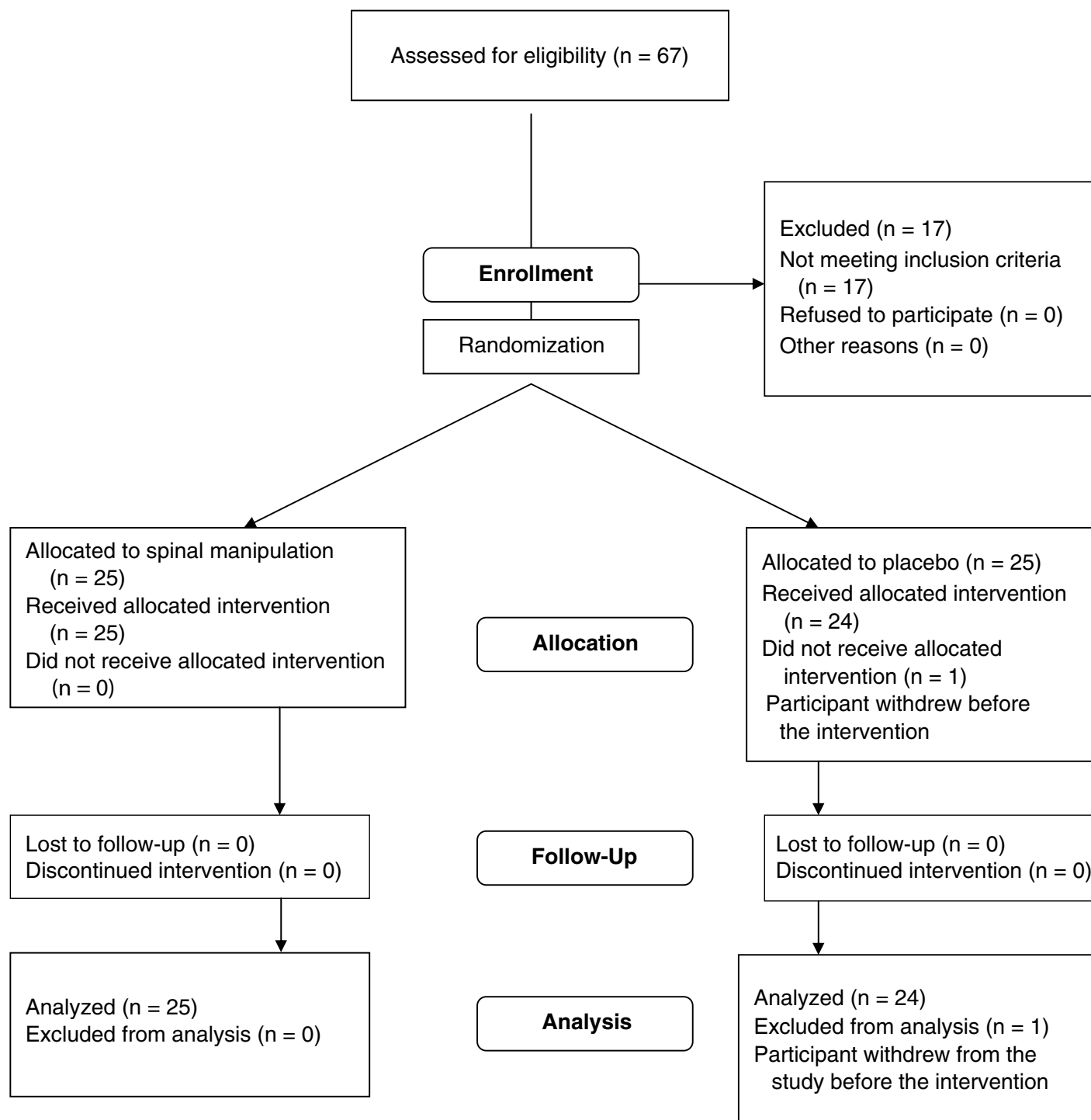
Subjects and investigators performing the strength measurements were blinded to the treatment groups, while the chiropractor performing the treatment was blinded to the strength results throughout the study.

All spinal manipulations or placebo (mock spinal manipulation) treatment were performed by the same chiropractor. The theoretical rationale for the manipulation was

to influence the nerve root that goes to the weak muscle group by delivery of a high velocity, low amplitude thrust to the appropriate area.<sup>21</sup> Treatments were as follows:

- **Left Hip Flexors Weakness Treatment:** Hip flexors are mainly innervated by L2–3 spinal nerves.<sup>22</sup> If the left hip flexors were weak, this suggested the left L2–3 nerve roots have the neurological deficit. The patients lay on their right side, with the superior leg bent. The lumbar spine was placed into right rotation. The chiropractor's left hand held back the patient's left shoulder, and the chiropractor's right hand contacted the left L3 transverse process. A pre-load torque was applied to the spine through the patient's shoulder and pelvis and then a high-velocity low amplitude thrust was given at the end range of motion, directed at the level of the L3 transverse process.
- **Right Hip Flexors Weakness Treatment:** The patient received the same treatment as above except on the opposite side.
- **Left Leg Abduction Weakness Treatment:** Abductors are mainly innervated by the L4 spinal nerve.<sup>22</sup> If the left leg was weak in abduction this suggested a neurological deficit at the left L4 nerve root. The same manipulative procedure described above was done except the segmental contact point was the left L5 transverse process.
- **Right Leg Abduction Weakness Treatment:** The patient received the same treatment as above except on the opposite side.
- **Left Hip Extension Weakness Treatment:** The major hip extensor [gluteus maximus] is mainly innervated by S1 and S2 spinal nerves.<sup>22</sup> If the left hip extensors were weak this suggested a neurological deficit to the S1 nerve root. The same manipulative procedure described above was done except the segmental contact point was the upper left iliac crest.<sup>23</sup> With the iliac crest contact one can slightly rotate the ilium on the sacrum to influence the S1 nerve root.
- **Right Hip Extension Weakness:** The patient received the same treatment as above except on the opposite side.
- **Left Knee Flexion Weakness Treatment:** Knee flexors are mainly innervated by L5 spinal nerves.<sup>22</sup> If the left knee flexors were weak, this suggested that L5 nerve root on the left side had a neurological deficit.

Figure 1 Flow of participants through the study



The patients lay on their left side. The lumbar spine was placed into left rotation. The chiropractor's right hand held the patient's right shoulder back, and the chiropractor's left hand contacted the patient's mid right ilium. A pre-load torque was applied and then a high-velocity low amplitude thrust was given at the end range of motion, rotating the sacrum on the L5 vertebra.

- **Right Knee Flexion Weakness Treatment:** The patient received the same treatment as above except on the opposite side.

All lumbar adjustments were "resisted" adjustments as described by Bergman and Peterson.<sup>24</sup> Participants who had more than one strength deficit on initial testing received multiple spinal manipulations (i.e. one for each deficit). There were cavitations during these manipulations. Mock spinal manipulation was done according to the methods of Roy et al.<sup>25</sup> For the mock treatment, participants were placed in the exact same position as the SM group. The contact of the hands were the same as above and the patient's lumbar spine was taken in rotation to the end range of motion and held for three seconds (to match the physical contact time given to the SM group) but there was no high-velocity low amplitude thrust given. There were no cavitations with the mock adjustments.

As a test of our blinding, subjects were asked whether they thought they received the actual SM treatment, the mock placebo treatment, or did not know which treatment they received. This was done by telephone by a research assistant after the intervention.

### Statistics

Subjects performed only the strength test(s) for which they had greater than 15% differences between legs on the initial testing day, before and after they received SM or placebo (mock SM). Subjects therefore were tested for between one to four movements (i.e. hip abduction, hip flexion, hip extension, and/or knee flexion) on the day of the intervention. The absolute strength difference between legs was calculated as the strong leg minus the weak leg. To calculate the relative (percent) strength differences between limbs (i.e. to determine how much stronger the strong limb was relative to the weak limb) we subtracted the strength of the weaker limb from the strength of the stronger limb, divided this by the strength of the weaker

Table 1 *Baseline characteristics of the treatment groups*

	<b>Spinal Manipulation (15 males, 10 females)</b>	<b>Placebo (mock treatment) (13 males, 11 females)</b>
Age (y)	54.7 (18.7)	52.7 (20.0)
Height (cm)	171 (9)	171 (11)
Weight (kg)	78.4 (14.8)	80.8 (17.7)

All values are means (SD)

limb, and multiplied by 100. This was done for comparison to the literature where percent differences of 15% or greater, as calculated by this manner, was determined to predict future injury.<sup>1</sup> A Shapiro-Wilk's test was done on each data set to determine normality. A Mann-Whitney U test (for data that was not normally distributed) or a one-way ANOVA (for normally distributed data) was used to determine differences between the spinal manipulation group and the placebo (mock spinal manipulation) group for changes in the absolute and relative strength differences between legs for each functional movement. For the strong and weak leg for each movement we also performed either a Mann-Whitney U test or one-way ANOVA (depending on whether the data were normally distributed) to determine if the change scores were different between the spinal manipulation and placebo (mock spinal manipulation) groups. The significance level was set at  $p \leq 0.05$ . All data are presented as mean (SD). All data were analyzed using Statistica 6.0 (Stat Soft, Chicago, IL) by PDC.

### Results

Baseline data are presented in Table 1. There were no adverse events reported that were related to the treatment. Overall, 42 spinal manipulations were performed (11 for knee flexors imbalance, 10 for hip flexors imbalance, 11 for hip extensors imbalance, and 10 for hip abductors imbalance), and 41 mock (placebo) adjustments were performed (15 for knee flexors imbalance, 11 for hip flexors imbalance, 9 for hip extensors imbalance, and 6 for hip abductors imbalance). Sixty-seven percent of subjects correctly identified which group they were in, while 33%

Table 2 Mean (SD) absolute and relative strength differences between weak and strong legs for individual movements for spinal manipulation and placebo (mock spinal manipulation) groups

	Absolute strength difference (Nm) before the intervention	Absolute strength difference (Nm) after the intervention	Relative strength difference (%) before the intervention	Relative strength difference (%) after the intervention
<b>Knee Flexors</b>				
Spinal manipulation (n = 11)	20 (14)	4 (8)	57 (53)	5 (14)*
Placebo (n = 15)	15 (10)	9 (15)	34 (29)	24 (36)
<b>Hip flexors</b>				
Spinal manipulation (n = 10)	28 (15)	16 (22)	24 (12)	11 (15)*
Placebo (n = 11)	23 (16)	26 (33)	20 (18)	22 (26)
<b>Hip extensors</b>				
Spinal manipulation (n = 11)	19 (10)	14 (13)	22 (15)	13 (13)
Placebo (n = 9)	24 (19)	17 (17)	22 (16)	15 (19)
<b>Hip abductors</b>				
Spinal manipulation (n = 10)	21 (10)	7 (10)	25 (18)	10 (13)
Placebo (n = 6)	9 (7)	0 (8)	10 (6)	2 (9)

\* The change in the relative strength difference between limbs was greater in the spinal manipulation group compared to the placebo (mock spinal manipulation) group ( $p = 0.05$ )

either guessed the incorrect group or stated that they did not know which treatment they received.

### Strength Differences

In general, the participants reproduced the strength difference between limbs of 15% or greater between the first and second visits. The number of participants who had strength differences of at least 15% on both visits corresponded to 22/26, 17/21, 14/20, and 9/16 individuals for knee flexion, hip flexion, hip extension, and hip abduction, respectively. Participants who did not have a strength difference of at least 15% on the second visit were still included in the analyses.

There was a significant decrease in the relative strength difference between limbs during knee and hip flexion in the SM compared to the placebo (mock SM) group ( $p = 0.05$ ; Table 2). The change in relative strength difference between limbs for hip extension and abduction, and the change in absolute strength differences between limbs for all movements was not different between groups

(Table 2). When comparing changes in weak and strong limb strength, spinal manipulation increased weak limb strength during hip abduction compared to the placebo (mock spinal manipulation) ( $p = 0.03$ ; Table 3) with no other differences between groups.

### Discussion

The main results of this research indicate that a spinal manipulation is able to reduce the relative strength difference between the lower limbs for knee and hip flexion in people that had a 15% or greater difference in strength between limbs at baseline (Table 2). Spinal manipulation also increased the strength of the weaker limb in hip abduction compared to placebo (mock spinal manipulation) (Table 3). Spinal manipulation reduced the relative strength differences between limbs from a mean (SD) of 57(53)% to 5(14)% for knee flexion and from 24(12)% to 11(15)% for hip flexion (Table 2). This may have clinical significance. For example, a 15% or greater strength imbalance between limbs for knee flexion is associated with greater



Table 3 *Baseline and post-intervention means (SD) for strength of individual movements for spinal manipulation and placebo (mock spinal manipulation) groups*

	Baseline strength (Nm)	Post-intervention strength (Nm)	P-value for difference in change between groups
<b>Weak side knee flexors</b>			
Spinal manipulation (n = 11)	51 (27)	65 (21)	0.38
Placebo (n = 15)	60 (36)	64 (32)	
<b>Strong side knee flexors</b>			
Spinal manipulation (n = 11)	71 (29)	68 (21)	0.89
Placebo (n = 15)	75 (41)	73 (35)	
<b>Weak side hip flexors</b>			
Spinal manipulation (n = 10)	118 (40)	139 (40)	0.11
Placebo (n = 11)	118 (39)	126 (45)	
<b>Strong side hip flexors</b>			
Spinal manipulation (n = 10)	145 (47)	155 (49)	0.70
Placebo (n = 11)	141 (47)	152 (60)	
<b>Weak side hip extensors</b>			
Spinal manipulation (n = 11)	101 (33)	115 (35)	0.17
Placebo (n = 9)	115 (39)	121 (39)	
<b>Strong side hip extensors</b>			
Spinal manipulation (n = 11)	120 (35)	129 (38)	0.11
Placebo (n = 9)	139 (45)	139 (44)	
<b>Weak side hip abductors</b>			
Spinal manipulation (n = 10)	104 (43)	116 (43)	0.03
Placebo (n = 6)	84 (24)	85 (31)	
<b>Strong side hip abductors</b>			
Spinal manipulation (n = 10)	126 (47)	122 (39)	0.49
Placebo (n = 6)	93 (28)	85 (25)	

development of lower limb injuries in female collegiate athletes.<sup>1</sup> Future research should determine whether spinal manipulation can actually reduce the chance of future injury for individuals with lower leg strength imbalances.

The results are in agreement with a number of previous studies that have assessed the effects of spinal manipulation on knee extensor strength,<sup>15,16,26</sup> trunk extensor strength,<sup>27,28</sup> and elbow flexor strength.<sup>29</sup> Our results are unique: While other studies have shown that spine manipulation can increase strength of weakened muscles,

our study shows that a strength deficit between limbs may be reduced with a single lumbar spine manipulation. This could have implications for recreational or competitive athletes, or older people with functional impairments who have a large strength difference between limbs. Previous observations have suggested that those with large strength imbalances between limbs have a significantly increased risk of future injury.<sup>1,3,4,6,8,9</sup>

The mechanism whereby spinal manipulation improves the strength deficit between limbs is unknown

in this study. Our study showed an immediate reduction in relative strength differences between limbs with one spinal manipulation. There are a number of studies suggesting enhanced motor unit excitability or reduced motor unit inhibition with spinal manipulation. A recent case series found that the thickness of the contracted transverse abdominus muscle was enhanced after spinal manipulation suggesting enhanced ability to recruit the musculature for contraction.<sup>30</sup> Motor neuron excitability, as measured by transcranial magnetic stimulation increased after lumbar spine manipulation.<sup>17</sup> Motor neuron inhibition, as measured by the interpolated twitch technique, was reduced in the knee extensors of a limb weakened by injury following manipulation of the sacroiliac joint on the ipsilateral side of the weaken limb.<sup>15,16</sup> A number of mechanisms are proposed for the increase in motor neuron excitability or the removal of motor neuron inhibition with spinal manipulation, including altered excitability of mechanoreceptors in paraspinous tissue, altered discharge from muscle spindles or Golgi tendon organs, increased pain tolerance, increased opiate release, and alteration in sympathetic nervous system activity.<sup>14</sup> These factors could alter afferent feedback to the spinal cord and ultimately enhance motor unit discharge. Another possibility is that spinal manipulation reduces connective tissue-mediated constriction of either the spinal nerve roots or of the blood vessels supplying the nerve roots,<sup>31</sup> thus allowing increased recruitment of alpha motor neurons. Our study cannot determine which mechanism is responsible, but improvements in the weak leg strength of our participants is most likely due to enhanced motor unit excitability (or reduced motor unit inhibition) in these weak muscles.

There are a number of limitations to the current study. Although the reduction for relative (%) strength difference between legs was greater in the SM compared to the placebo (mock SM) group for knee and hip flexion (Table 2), there were no differences between groups for changes in absolute strength differences between legs. Our study was underpowered to detect these changes. For example, for knee flexion, the change for the SM group was about 16 Nm, and the change for the placebo (mock SM) group was 6 Nm (Table 2). The standard deviation for these change scores was about 15 Nm. With our sample size the power for this comparison was 0.36. Put another way, we would require 37 participants per group to achieve statis-

tical significance at an alpha of 0.05 and a power of 0.8. Our study is limited in that power was calculated post-hoc. An additional limitation is that we did not correct our alpha-level for multiple statistical tests. Given that the statistical differences for change scores between groups from Tables 2 and 3 were of borderline significance (i.e. p-values between 0.03 and 0.05), there is a chance of type I statistical error.

It may have been difficult to blind some subjects to the treatment as many were recruited from advertisements in chiropractic clinics and therefore would have been familiar with actual chiropractic manipulation. Two thirds of the participants were able to correctly identify which group they were in and this might introduce bias into our results. Since many of the participants were aware they were receiving SM or placebo (mock SM) our study might more appropriately be described as a comparative study, rather than a placebo study. An innovative technique for blinding involving general anesthesia delivered before SM or placebo has recently been introduced and could be used in future clinical trials.<sup>32</sup>

Another limitation is that we did not perform long-term follow-up on participants to determine if the spinal manipulation was effective in the long-term. Our results indicate that spinal manipulation can reduce differences in leg strength immediately after spinal manipulation, but we do not know whether such an effect dissipates over time. If the effects of spinal manipulation dissipate over time, then the results of the strength tests after the spinal manipulation may have differed for those who had between-leg differences for multiple functional muscle groups compared to those with differences for only one muscle group (i.e. it would have taken up to 30 minutes to do all the strength testing after spinal manipulation for those with multiple strength tests).

We assumed that adjustment of specific lumbar vertebrae would affect specific nerve roots; however the accuracy of lumbar spine manipulations has been called into question. Ross et al.<sup>33</sup> determined that the average error from target for lumbar spine manipulations was at least one vertebra away from the target and only about half of lumbar spine manipulations were deemed accurate. Given this non-specificity of spinal manipulation, the patients that received multiple adjustments (i.e. those who had more than one functional muscle group that showed a 15% strength difference between legs) might have re-

ceived a higher dose of spinal manipulation compared to other participants.

Other limitations include the heterogeneity of our participant population and the lack of reproducibility of the 15% difference between contra-lateral legs for all functional measurements. Our study included participants of a wide range of ages and fitness levels. Our only inclusion criterion was a significant difference in strength between their weaker and stronger legs. Participants had the strength differences compared between legs and then were invited back into the lab a week later for spinal manipulation or mock placebo treatment if they had a 15% or greater strength difference for one or more functional movements. Between 15% and 44% of participants (depending on the strength test) improved strength on the second visit to an extent that they no longer had the hypothesized clinically important threshold of a 15% strength difference between limbs. These participants were still included in the study.

## Conclusion

A single lumbar spinal manipulation may decrease the relative (%) strength difference between limbs for knee and hip flexion in individuals with 15% or greater discrepancy in strength between limbs at baseline. These results could have important implications for recreational and high performance athletes, or older people with functional impairments, as strength deficits between limbs may predict future injury. These conclusions are limited by the fact that 67% of the participants were able to identify whether they received actual spinal manipulation or the placebo (mock spinal manipulation). It is unknown whether the effect of spinal manipulation is transitory in nature because the durability of the effect was not assessed. Further research should evaluate the mechanism whereby the strength deficit between limbs is enhanced following spinal manipulation, and the durability of this effect. The clinical significance of the reduction in strength differences between limbs needs testing in future studies to determine if it actually prevents occurrence of future injury.

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# The effect of spinal manipulation on imbalances in leg strength

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*We hypothesized that spinal manipulation (SM) would reduce strength imbalances between legs. Using an unblinded randomized design, 28 males and 21 females ( $54 \pm 19$ y) with at least a 15% difference in isometric strength between legs for hip flexion, extension, abduction, or knee flexion were randomized to treatment or placebo (mock spinal manipulation). Strength of the stronger and weaker legs for hip flexion, extension, abduction, and/or knee flexion was assessed before and after the intervention. SM reduced the relative strength difference between legs for knee flexion (mean  $\pm$  SD  $57 \pm 53$  to  $5 \pm 14\%$ ) and hip flexion ( $24 \pm 12$  to  $11 \pm 15\%$ ) compared to placebo ( $34 \pm 29$  to  $24 \pm 36\%$ , and  $20 \pm 18$  to  $22 \pm 26\%$ , respectively) ( $p = 0.05$ ). SM also improved strength in the weak leg for hip abduction ( $104 \pm 43$  to  $116 \pm 43$  Nm) compared to placebo ( $84 \pm 24$  to  $85 \pm 31$  Nm) ( $p = 0.03$ ). This study suggests that spinal manipulation may reduce imbalances in strength between legs for knee and hip flexion. (JCCA 2011; 55(3):183-192)*

**KEY WORDS:** hip, hamstring, flexion, extension, abduction

*Notre hypothèse est que la manipulation vertébrale (MV) réduirait le déséquilibre entre les jambes. À l'aide d'un essai aléatoire ouvert, 28 hommes et 21 femmes ( $54 \pm 19$ a) ayant une différence de force isométrique d'au moins 15 % entre les jambes pour la flexion, l'étirement et l'abduction de la hanche, ou la flexion du genou, ont subi de façon aléatoire un traitement réel ou un traitement placebo (manipulation vertébrale simulée). On a alors évalué la force des jambes plus fortes et plus faibles en fonction de la flexion, l'étirement et l'abduction de la hanche, ou la flexion du genou, avant et après l'intervention. La MV a réduit la différence de force entre les jambes quant à la flexion du genou (moyenne  $\pm$  ET  $57 \pm 53$  à  $5 \pm 14$  %) et la flexion de la hanche ( $24 \pm 12$  à  $11 \pm 15$  %) par rapport au traitement placebo ( $34 \pm 29$  à  $24 \pm 36$  %, et  $20 \pm 18$  à  $22 \pm 26$  %, respectivement) ( $p = 0,05$ ). La MV a également amélioré la force de la jambe faible quant à l'abduction de la hanche ( $104 \pm 43$  à  $116 \pm 43$  Nm) par rapport au traitement placebo ( $84 \pm 24$  à  $85 \pm 31$  Nm) ( $p = 0,03$ ). Cette étude suggère que la manipulation vertébrale peut réduire le déséquilibre de la force entre les jambes quant à la flexion du genou et de la hanche. (JCCA 2011; 55(3):183-192)*

**MOTS CLÉS :** hanche, tendon du jarret, flexion, étirement, abduction

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## Introduction

Musculoskeletal injuries may be partly related to strength imbalances between limbs. Strength imbalances between legs may affect performance of activities and result in increased chance of injury occurrence.<sup>1-8</sup> Contra-lateral imbalances in strength of hip flexors, hip extensors, and knee flexors in asymptomatic subjects predict future lower extremity injuries such as hamstring strains or single leg overuse injuries<sup>1,3,4,6,8</sup> while contra-lateral differences between hip extensors strength in asymptomatic subjects predicts future lower back pain.<sup>9</sup> Contra-lateral strength differences have also been observed in injured athletes<sup>2,5</sup> or athletes who have a past history of injury.<sup>7</sup> In contrast, there are a number of studies indicating no relationship between strength imbalance and injury occurrence.<sup>10-12</sup> The objective of this study was to determine whether a single chiropractic spinal manipulation (SM) could improve strength imbalances between legs.

Strength is influenced by both muscle mass and the ability of the nervous system to recruit muscle.<sup>13</sup> Unilateral muscle weakness and strength imbalances between the legs may therefore be caused by neural deficits. It has been suggested that spinal manipulation may overcome neural deficits by a number of mechanisms including reduced nerve impingement, altered discharge from muscle spindles, Golgi tendon organs, mechanoreceptors and nociceptors, altered sensory processing in the spinal cord (allowing increased pain tolerance), and altered skeletal muscle reflexes.<sup>14</sup> These changes may alter afferent feedback to the spinal cord to cause an increase in motor neuron excitability. Spinal manipulation on one side of the body can reduce inhibition of limb musculature on the same side of the body. For example, spinal manipulation of the sacroiliac joint on the ipsilateral side of an injured knee resulted in reduced motor unit inhibition to the knee extensors of the injured limb, as measured by the interpolated twitch technique.<sup>15,16</sup> Manipulation of the lumbar spine also increases motor neuron excitability as measured by transcranial magnetic stimulation.<sup>17</sup> Spinal manipulation has a greater effect on the weaker limb – the removal of motor unit inhibition occurred to a greater extent in an injured than non-injured limb.<sup>15,16</sup> We therefore hypothesized that spinal manipulation of the lumbar spine would increase strength of the weaker limb; and that this would decrease the imbalance in strength in subjects with an imbalance in strength between legs.

## Methods

The study was approved by our university's ethics review board. Subjects were volunteers from the general community who responded to advertisements posted around a university campus, and at chiropractic clinics. Subjects who responded to the advertisement were contacted initially by a research assistant who explained the nature and purpose of the study. If subjects were still interested in participating an initial appointment was made with the research assistant. At the initial appointment the procedures were fully explained, and subjects gave their informed consent to participate in the study. They then filled out a physical activity readiness questionnaire (PAR-Q). An initial measurement of strength deficits between lower limbs was then performed using an isokinetic dynamometer (Biodex System 3, Biodex Medical Systems Inc., Shirley NY) set in isometric mode. Assessment of isometric hip abduction, hip flexion, hip extension, and knee flexion strength has been described in detail previously.<sup>18-20</sup> Three isometric contractions of 5 seconds were performed for each movement with a 30 second rest period between contractions. The highest peak torque obtained was recorded in newton meters (Nm). Knee flexion was tested with the participant in a seated position with the hips at 90° and the knee flexed at 30° (where 0° indicates full extension). Stabilizing straps were applied diagonally across the chest, waist, and just above the knee on the leg not being tested. The dynamometer attachment was adjusted so the pad was placed just proximal to the lateral malleoli of the leg being tested and the knee joint was in line with the axis of rotation of the dynamometer. All hip movements were performed from a standing position, with the hip joint in line with the dynamometer axis of rotation. Participants placed their hands on the machine at waist level for balance and in order to stabilize the standing position. The dynamometer attachment was adjusted so the pad was placed three finger widths above the lateral joint line of the knee for hip abduction, flexion, and extension. Participants were asked to keep their foot just off the ground with knee slightly flexed for abduction and extension. Hip abduction was performed with the leg at an angle of 10° of abduction. For hip extension the contraction was performed from 0° or as close as their hip range would allow. Hip flexion was performed with the leg set at 80° of flexion. All hip joint angles were referenced from thigh to vertical. All measurements were corrected for the

effects of gravity on the leg and the dynamometer's resistance pad. Reproducibility of these strength tests was assessed using the initial test results on day 1 and the first test on the treatment day one week later (i.e. before SM or placebo treatment; i.e. mock SM). Intra-class correlation coefficients for hip abduction, hip flexion, hip extension, and knee flexion strength were 0.91, 0.80, 0.88, and 0.92, respectively.

Subjects were considered eligible for the study if they had at least a 15% difference in strength between their legs for hip extension, hip flexion, hip abduction, or knee flexion at the initial testing session. This criterion has previously predicted lower extremity injuries.<sup>1</sup> Eligible subjects were invited back to our laboratory at least one week later for an additional session where they were stratified by sex, and randomized to receive either a SM or placebo (i.e. mock adjustment). Randomization was done by a computerized random-number generator and group allocation for each subject was concealed in a sealed envelope and held by an individual who was not involved in any other aspect of the study. Subjects then performed the strength test(s), for which they had greater than or equal to 15% differences between legs on the initial testing day, before and after they received SM or placebo (mock SM). The SM or placebo intervention was given immediately after the strength tests. These strength tests took between 5 to 30 minutes depending on the number of strength tests (i.e. subjects were given 1–4 strength tests depending on which tests they had a 15% or greater difference between their limbs a week earlier). After the intervention was completed, strength tests were repeated. If more than one strength test was done, the order of the tests was randomized before the intervention and the same order of testing was followed after the intervention. At least a 3-minute rest was given between strength tests. Sixty-seven subjects were initially evaluated and 50 met the inclusion criteria. One subject from the placebo (mock SM) group withdrew for personal reasons. The flow of participants through the study is summarized in Figure 1.

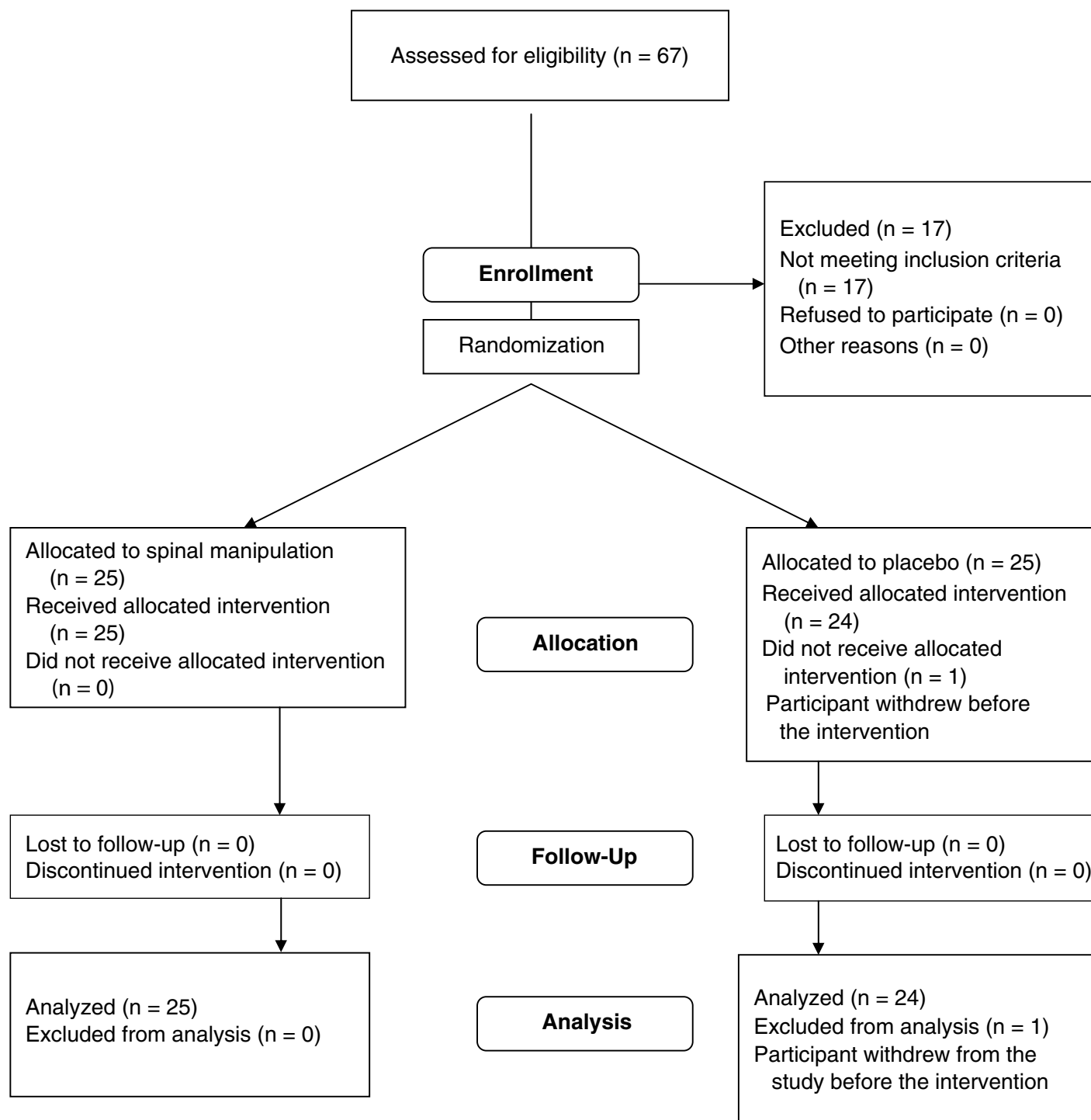
Subjects and investigators performing the strength measurements were blinded to the treatment groups, while the chiropractor performing the treatment was blinded to the strength results throughout the study.

All spinal manipulations or placebo (mock spinal manipulation) treatment were performed by the same chiropractor. The theoretical rationale for the manipulation was

to influence the nerve root that goes to the weak muscle group by delivery of a high velocity, low amplitude thrust to the appropriate area.<sup>21</sup> Treatments were as follows:

- **Left Hip Flexors Weakness Treatment:** Hip flexors are mainly innervated by L2–3 spinal nerves.<sup>22</sup> If the left hip flexors were weak, this suggested the left L2–3 nerve roots have the neurological deficit. The patients lay on their right side, with the superior leg bent. The lumbar spine was placed into right rotation. The chiropractor's left hand held back the patient's left shoulder, and the chiropractor's right hand contacted the left L3 transverse process. A pre-load torque was applied to the spine through the patient's shoulder and pelvis and then a high-velocity low amplitude thrust was given at the end range of motion, directed at the level of the L3 transverse process.
- **Right Hip Flexors Weakness Treatment:** The patient received the same treatment as above except on the opposite side.
- **Left Leg Abduction Weakness Treatment:** Abductors are mainly innervated by the L4 spinal nerve.<sup>22</sup> If the left leg was weak in abduction this suggested a neurological deficit at the left L4 nerve root. The same manipulative procedure described above was done except the segmental contact point was the left L5 transverse process.
- **Right Leg Abduction Weakness Treatment:** The patient received the same treatment as above except on the opposite side.
- **Left Hip Extension Weakness Treatment:** The major hip extensor [gluteus maximus] is mainly innervated by S1 and S2 spinal nerves.<sup>22</sup> If the left hip extensors were weak this suggested a neurological deficit to the S1 nerve root. The same manipulative procedure described above was done except the segmental contact point was the upper left iliac crest.<sup>23</sup> With the iliac crest contact one can slightly rotate the ilium on the sacrum to influence the S1 nerve root.
- **Right Hip Extension Weakness:** The patient received the same treatment as above except on the opposite side.
- **Left Knee Flexion Weakness Treatment:** Knee flexors are mainly innervated by L5 spinal nerves.<sup>22</sup> If the left knee flexors were weak, this suggested that L5 nerve root on the left side had a neurological deficit.

Figure 1 Flow of participants through the study





The patients lay on their left side. The lumbar spine was placed into left rotation. The chiropractor's right hand held the patient's right shoulder back, and the chiropractor's left hand contacted the patient's mid right ilium. A pre-load torque was applied and then a high-velocity low amplitude thrust was given at the end range of motion, rotating the sacrum on the L5 vertebra.

- **Right Knee Flexion Weakness Treatment:** The patient received the same treatment as above except on the opposite side.

All lumbar adjustments were "resisted" adjustments as described by Bergman and Peterson.<sup>24</sup> Participants who had more than one strength deficit on initial testing received multiple spinal manipulations (i.e. one for each deficit). There were cavitations during these manipulations. Mock spinal manipulation was done according to the methods of Roy et al.<sup>25</sup> For the mock treatment, participants were placed in the exact same position as the SM group. The contact of the hands were the same as above and the patient's lumbar spine was taken in rotation to the end range of motion and held for three seconds (to match the physical contact time given to the SM group) but there was no high-velocity low amplitude thrust given. There were no cavitations with the mock adjustments.

As a test of our blinding, subjects were asked whether they thought they received the actual SM treatment, the mock placebo treatment, or did not know which treatment they received. This was done by telephone by a research assistant after the intervention.

### Statistics

Subjects performed only the strength test(s) for which they had greater than 15% differences between legs on the initial testing day, before and after they received SM or placebo (mock SM). Subjects therefore were tested for between one to four movements (i.e. hip abduction, hip flexion, hip extension, and/or knee flexion) on the day of the intervention. The absolute strength difference between legs was calculated as the strong leg minus the weak leg. To calculate the relative (percent) strength differences between limbs (i.e. to determine how much stronger the strong limb was relative to the weak limb) we subtracted the strength of the weaker limb from the strength of the stronger limb, divided this by the strength of the weaker

Table 1 *Baseline characteristics of the treatment groups*

	<b>Spinal Manipulation (15 males, 10 females)</b>	<b>Placebo (mock treatment) (13 males, 11 females)</b>
Age (y)	54.7 (18.7)	52.7 (20.0)
Height (cm)	171 (9)	171 (11)
Weight (kg)	78.4 (14.8)	80.8 (17.7)

All values are means (SD)

limb, and multiplied by 100. This was done for comparison to the literature where percent differences of 15% or greater, as calculated by this manner, was determined to predict future injury.<sup>1</sup> A Shapiro-Wilk's test was done on each data set to determine normality. A Mann-Whitney U test (for data that was not normally distributed) or a one-way ANOVA (for normally distributed data) was used to determine differences between the spinal manipulation group and the placebo (mock spinal manipulation) group for changes in the absolute and relative strength differences between legs for each functional movement. For the strong and weak leg for each movement we also performed either a Mann-Whitney U test or one-way ANOVA (depending on whether the data were normally distributed) to determine if the change scores were different between the spinal manipulation and placebo (mock spinal manipulation) groups. The significance level was set at  $p \leq 0.05$ . All data are presented as mean (SD). All data were analyzed using Statistica 6.0 (Stat Soft, Chicago, IL) by PDC.

### Results

Baseline data are presented in Table 1. There were no adverse events reported that were related to the treatment. Overall, 42 spinal manipulations were performed (11 for knee flexors imbalance, 10 for hip flexors imbalance, 11 for hip extensors imbalance, and 10 for hip abductors imbalance), and 41 mock (placebo) adjustments were performed (15 for knee flexors imbalance, 11 for hip flexors imbalance, 9 for hip extensors imbalance, and 6 for hip abductors imbalance). Sixty-seven percent of subjects correctly identified which group they were in, while 33%

Table 2 Mean (SD) absolute and relative strength differences between weak and strong legs for individual movements for spinal manipulation and placebo (mock spinal manipulation) groups

	Absolute strength difference (Nm) before the intervention	Absolute strength difference (Nm) after the intervention	Relative strength difference (%) before the intervention	Relative strength difference (%) after the intervention
<b>Knee Flexors</b>				
Spinal manipulation (n = 11)	20 (14)	4 (8)	57 (53)	5 (14)*
Placebo (n = 15)	15 (10)	9 (15)	34 (29)	24 (36)
<b>Hip flexors</b>				
Spinal manipulation (n = 10)	28 (15)	16 (22)	24 (12)	11 (15)*
Placebo (n = 11)	23 (16)	26 (33)	20 (18)	22 (26)
<b>Hip extensors</b>				
Spinal manipulation (n = 11)	19 (10)	14 (13)	22 (15)	13 (13)
Placebo (n = 9)	24 (19)	17 (17)	22 (16)	15 (19)
<b>Hip abductors</b>				
Spinal manipulation (n = 10)	21 (10)	7 (10)	25 (18)	10 (13)
Placebo (n = 6)	9 (7)	0 (8)	10 (6)	2 (9)

\* The change in the relative strength difference between limbs was greater in the spinal manipulation group compared to the placebo (mock spinal manipulation) group ( $p = 0.05$ )

either guessed the incorrect group or stated that they did not know which treatment they received.

### Strength Differences

In general, the participants reproduced the strength difference between limbs of 15% or greater between the first and second visits. The number of participants who had strength differences of at least 15% on both visits corresponded to 22/26, 17/21, 14/20, and 9/16 individuals for knee flexion, hip flexion, hip extension, and hip abduction, respectively. Participants who did not have a strength difference of at least 15% on the second visit were still included in the analyses.

There was a significant decrease in the relative strength difference between limbs during knee and hip flexion in the SM compared to the placebo (mock SM) group ( $p = 0.05$ ; Table 2). The change in relative strength difference between limbs for hip extension and abduction, and the change in absolute strength differences between limbs for all movements was not different between groups

(Table 2). When comparing changes in weak and strong limb strength, spinal manipulation increased weak limb strength during hip abduction compared to the placebo (mock spinal manipulation) ( $p = 0.03$ ; Table 3) with no other differences between groups.

### Discussion

The main results of this research indicate that a spinal manipulation is able to reduce the relative strength difference between the lower limbs for knee and hip flexion in people that had a 15% or greater difference in strength between limbs at baseline (Table 2). Spinal manipulation also increased the strength of the weaker limb in hip abduction compared to placebo (mock spinal manipulation) (Table 3). Spinal manipulation reduced the relative strength differences between limbs from a mean (SD) of 57(53)% to 5(14)% for knee flexion and from 24(12)% to 11(15)% for hip flexion (Table 2). This may have clinical significance. For example, a 15% or greater strength imbalance between limbs for knee flexion is associated with greater

Table 3 *Baseline and post-intervention means (SD) for strength of individual movements for spinal manipulation and placebo (mock spinal manipulation) groups*

	Baseline strength (Nm)	Post-intervention strength (Nm)	P-value for difference in change between groups
<b>Weak side knee flexors</b>			
Spinal manipulation (n = 11)	51 (27)	65 (21)	0.38
Placebo (n = 15)	60 (36)	64 (32)	
<b>Strong side knee flexors</b>			
Spinal manipulation (n = 11)	71 (29)	68 (21)	0.89
Placebo (n = 15)	75 (41)	73 (35)	
<b>Weak side hip flexors</b>			
Spinal manipulation (n = 10)	118 (40)	139 (40)	0.11
Placebo (n = 11)	118 (39)	126 (45)	
<b>Strong side hip flexors</b>			
Spinal manipulation (n = 10)	145 (47)	155 (49)	0.70
Placebo (n = 11)	141 (47)	152 (60)	
<b>Weak side hip extensors</b>			
Spinal manipulation (n = 11)	101 (33)	115 (35)	0.17
Placebo (n = 9)	115 (39)	121 (39)	
<b>Strong side hip extensors</b>			
Spinal manipulation (n = 11)	120 (35)	129 (38)	0.11
Placebo (n = 9)	139 (45)	139 (44)	
<b>Weak side hip abductors</b>			
Spinal manipulation (n = 10)	104 (43)	116 (43)	0.03
Placebo (n = 6)	84 (24)	85 (31)	
<b>Strong side hip abductors</b>			
Spinal manipulation (n = 10)	126 (47)	122 (39)	0.49
Placebo (n = 6)	93 (28)	85 (25)	

development of lower limb injuries in female collegiate athletes.<sup>1</sup> Future research should determine whether spinal manipulation can actually reduce the chance of future injury for individuals with lower leg strength imbalances.

The results are in agreement with a number of previous studies that have assessed the effects of spinal manipulation on knee extensor strength,<sup>15,16,26</sup> trunk extensor strength,<sup>27,28</sup> and elbow flexor strength.<sup>29</sup> Our results are unique: While other studies have shown that spine manipulation can increase strength of weakened muscles,

our study shows that a strength deficit between limbs may be reduced with a single lumbar spine manipulation. This could have implications for recreational or competitive athletes, or older people with functional impairments who have a large strength difference between limbs. Previous observations have suggested that those with large strength imbalances between limbs have a significantly increased risk of future injury.<sup>1,3,4,6,8,9</sup>

The mechanism whereby spinal manipulation improves the strength deficit between limbs is unknown

in this study. Our study showed an immediate reduction in relative strength differences between limbs with one spinal manipulation. There are a number of studies suggesting enhanced motor unit excitability or reduced motor unit inhibition with spinal manipulation. A recent case series found that the thickness of the contracted transverse abdominus muscle was enhanced after spinal manipulation suggesting enhanced ability to recruit the musculature for contraction.<sup>30</sup> Motor neuron excitability, as measured by transcranial magnetic stimulation increased after lumbar spine manipulation.<sup>17</sup> Motor neuron inhibition, as measured by the interpolated twitch technique, was reduced in the knee extensors of a limb weakened by injury following manipulation of the sacroiliac joint on the ipsilateral side of the weaken limb.<sup>15,16</sup> A number of mechanisms are proposed for the increase in motor neuron excitability or the removal of motor neuron inhibition with spinal manipulation, including altered excitability of mechanoreceptors in paraspinous tissue, altered discharge from muscle spindles or Golgi tendon organs, increased pain tolerance, increased opiate release, and alteration in sympathetic nervous system activity.<sup>14</sup> These factors could alter afferent feedback to the spinal cord and ultimately enhance motor unit discharge. Another possibility is that spinal manipulation reduces connective tissue-mediated constriction of either the spinal nerve roots or of the blood vessels supplying the nerve roots,<sup>31</sup> thus allowing increased recruitment of alpha motor neurons. Our study cannot determine which mechanism is responsible, but improvements in the weak leg strength of our participants is most likely due to enhanced motor unit excitability (or reduced motor unit inhibition) in these weak muscles.

There are a number of limitations to the current study. Although the reduction for relative (%) strength difference between legs was greater in the SM compared to the placebo (mock SM) group for knee and hip flexion (Table 2), there were no differences between groups for changes in absolute strength differences between legs. Our study was underpowered to detect these changes. For example, for knee flexion, the change for the SM group was about 16 Nm, and the change for the placebo (mock SM) group was 6 Nm (Table 2). The standard deviation for these change scores was about 15 Nm. With our sample size the power for this comparison was 0.36. Put another way, we would require 37 participants per group to achieve statis-

tical significance at an alpha of 0.05 and a power of 0.8. Our study is limited in that power was calculated post-hoc. An additional limitation is that we did not correct our alpha-level for multiple statistical tests. Given that the statistical differences for change scores between groups from Tables 2 and 3 were of borderline significance (i.e. p-values between 0.03 and 0.05), there is a chance of type I statistical error.

It may have been difficult to blind some subjects to the treatment as many were recruited from advertisements in chiropractic clinics and therefore would have been familiar with actual chiropractic manipulation. Two thirds of the participants were able to correctly identify which group they were in and this might introduce bias into our results. Since many of the participants were aware they were receiving SM or placebo (mock SM) our study might more appropriately be described as a comparative study, rather than a placebo study. An innovative technique for blinding involving general anesthesia delivered before SM or placebo has recently been introduced and could be used in future clinical trials.<sup>32</sup>

Another limitation is that we did not perform long-term follow-up on participants to determine if the spinal manipulation was effective in the long-term. Our results indicate that spinal manipulation can reduce differences in leg strength immediately after spinal manipulation, but we do not know whether such an effect dissipates over time. If the effects of spinal manipulation dissipate over time, then the results of the strength tests after the spinal manipulation may have differed for those who had between-leg differences for multiple functional muscle groups compared to those with differences for only one muscle group (i.e. it would have taken up to 30 minutes to do all the strength testing after spinal manipulation for those with multiple strength tests).

We assumed that adjustment of specific lumbar vertebrae would affect specific nerve roots; however the accuracy of lumbar spine manipulations has been called into question. Ross et al.<sup>33</sup> determined that the average error from target for lumbar spine manipulations was at least one vertebra away from the target and only about half of lumbar spine manipulations were deemed accurate. Given this non-specificity of spinal manipulation, the patients that received multiple adjustments (i.e. those who had more than one functional muscle group that showed a 15% strength difference between legs) might have re-

ceived a higher dose of spinal manipulation compared to other participants.

Other limitations include the heterogeneity of our participant population and the lack of reproducibility of the 15% difference between contra-lateral legs for all functional measurements. Our study included participants of a wide range of ages and fitness levels. Our only inclusion criterion was a significant difference in strength between their weaker and stronger legs. Participants had the strength differences compared between legs and then were invited back into the lab a week later for spinal manipulation or mock placebo treatment if they had a 15% or greater strength difference for one or more functional movements. Between 15% and 44% of participants (depending on the strength test) improved strength on the second visit to an extent that they no longer had the hypothesized clinically important threshold of a 15% strength difference between limbs. These participants were still included in the study.

## Conclusion

A single lumbar spinal manipulation may decrease the relative (%) strength difference between limbs for knee and hip flexion in individuals with 15% or greater discrepancy in strength between limbs at baseline. These results could have important implications for recreational and high performance athletes, or older people with functional impairments, as strength deficits between limbs may predict future injury. These conclusions are limited by the fact that 67% of the participants were able to identify whether they received actual spinal manipulation or the placebo (mock spinal manipulation). It is unknown whether the effect of spinal manipulation is transitory in nature because the durability of the effect was not assessed. Further research should evaluate the mechanism whereby the strength deficit between limbs is enhanced following spinal manipulation, and the durability of this effect. The clinical significance of the reduction in strength differences between limbs needs testing in future studies to determine if it actually prevents occurrence of future injury.

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# Perceived effects of the delisting of chiropractic services from the Ontario Health Insurance Plan on practice activities: a survey of chiropractors in Toronto, Ontario

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*The purpose of this study was to survey a random sample of Toronto chiropractors and gather their perceptions of the effects that the delisting of chiropractic services from OHIP had on their practices profiles.*

**Methods:** A survey was mailed to 199 chiropractors who were asked to disclose demographic information, if they were in practice at the time when OHIP coverage was in effect, the perceived effect OHIP delisting had on their patient volumes, income, the profession's credibility and if they would be in favor of having OHIP reinstated.

**Results:** Among the 123 respondents in practice during OHIP coverage ( $n = 92$ ), 48.9% indicated they perceived their practice income and 36.6% perceived their patient volume was negatively affected; 57.5% reported both had subsequently recovered. Almost 50% perceived OHIP delisting negatively affected the profession's credibility and 46.1% of respondents were in favor of it being reinstated for chiropractic services; this percentage was much higher among chiropractors who were not in practice during the time of OHIP coverage.

**Conclusion:** Most chiropractors reported that patient volumes and incomes have returned to pre-delisting levels and few chiropractors who were in practice

*Cette étude avait pour objet d'effectuer un sondage auprès de chiropraticiens de Toronto afin de recueillir leurs perceptions sur les conséquences du retrait des services de chiropraxie de l'ASO sur le profil de leur pratique.*

**Méthodes :** un sondage fut posté à 199 chiropraticiens à qui l'on a demandé de divulguer des renseignements démographiques, s'ils exerçaient leur profession au moment l'ASO couvrait ces soins, les conséquences du retrait de la part de l'ASO sur leur clientèle, leurs revenus, la crédibilité de la profession, et s'ils seraient favorables à ce que les soins soient de nouveau couverts par l'ASO.

**Résultats :** parmi les 123 répondants qui exerçaient leur profession durant la période où les soins étaient couverts par l'ASO ( $n = 92$ ), 48,9 % ont indiqué que leurs revenus avaient diminué, et 36,6 % ont indiqué que leur clientèle avait diminué ; 57,5 % ont affirmé que leurs revenus et leur clientèle avaient subséquemment augmenté au niveau antérieur. Près de 50 % ont perçu le retrait de l'ASO comme ayant une influence négative sur la crédibilité de la profession, et 46,1 % des répondants étaient favorables à ce que les soins soient de nouveau couverts par l'ASO.

**Conclusion :** la plupart des chiropraticiens ont indiqué que leur clientèle et leurs revenus étaient maintenant identiques au niveau antérieur, et quelques chiropraticiens qui exerçaient leur profession au moment

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*during OHIP coverage expressed interest in having it reinstated.*

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KEY WORDS: chiropractic, services, OHIP, delisting

## Introduction

The Canada Health Act (CHA) forms the legislative basis of Canada's national health insurance program.<sup>1,2</sup> For provinces to be eligible for federal transfer payments they must provide, at no direct cost to residents, all health care services deemed medically necessary, provided by physicians or provided within hospitals;<sup>1–4</sup> other services may be insured at the discretion of each province. Thus, the CHA definition of “medical necessity” places non-physician health providers practicing outside of hospital settings at the boundary of what may or may not be considered an insured service<sup>5</sup> leaving provinces with the flexibility to make funding decisions with respect to community-based services.<sup>2,3</sup> With the cost of Canadian health care estimated by the Canadian Institute of Health Information exceeding \$142 billion in 2005,<sup>6,cited in 4</sup> which represented a 7.7% increase from the previous year, the Ontario government used its concerns with respect to health care spending and its legislative flexibility as policy change levers to partially deinsure (more commonly referred to as “delist”) some health care services in 2004, such as physiotherapy, or completely delist some health services, such as chiropractic.

Prior to 2004, starting in the mid-1970s, the Ontario Health Insurance Plan (OHIP)- the provincial insurance branch of the Ministry of Health and Long Term Care (MOHLTC) in Ontario – partially covered chiropractic services. Initially, OHIP paid \$11.75 for an initial visit, \$9.65 for a subsequent visit and \$12 for house call to a total of \$225 per person per year; this amount was decreased to \$150 per year in 2002–03.<sup>7</sup> However, effective December 1st, 2004, the Government of Ontario delisted chiropractic services from OHIP eligibility with limited warning. This was the first time a jurisdiction in Canada completely delisted chiropractic care from its provincial payment plan and this may have been the first jurisdiction in the world to do so.<sup>8</sup> At the time of the impending delisting of chiropractic services from OHIP, two docu-

*l'ASO couvrir ces soins ont démontré de l'intérêt envers le retour de la couverture de l'ASO.*

(JCCA 2011; 55(3):193–203)

MOTS CLÉS : chiropratique, services, ASO, retrait

ments were published- one a self-published study by Professor Pran Manga from the University of Ottawa<sup>8</sup> and the other by Deloitte<sup>9</sup> sponsored by the Ontario Chiropractic Association (OCA) – that forecasted the negative effects this action would have on patients in terms of wait times, accessibility to services, costs to the health care delivery system and the marginalization of chiropractic (see Table 1). The OCA also conducted an online survey in 2007 to ascertain what the impact of delisting had on respondents<sup>7</sup>; however, no data has been collected from the chiropractic profession with respect to the perceived effects delisting had on chiropractic practice activities since that time.

The purpose of this study was to survey a random sample of Toronto chiropractors and gather the following information: their perception of the impact OHIP delisting had initially on their patient volumes and subsequent to it; their perception of the impact OHIP delisting had on their office incomes and subsequent to it; their perception of the effects OHIP delisting had on the profession's credibility and; whether or not they would be interested in OHIP coverage being reinstated for chiropractic services and, if so, who should be eligible and what amount should be covered.

## Methods

### *Ethics Review*

This study was approved by the Research Ethics Board of the Canadian Memorial Chiropractic College (CMCC).

### *Selection*

The study design was a cross sectional survey targeted towards licenced chiropractors practicing in the Greater Toronto Area (which encompasses Toronto and Mississauga), Ontario. This was an appropriate sample for the investigators to access since 20% of all Ontario chiropractors practice in Toronto. To select our population, the par-



Table 1 *Predicted negative consequences of OHIP delisting to chiropractors and their patients*<sup>8,9</sup>

- Decrease access to chiropractors due to escalation in costs per visit
- Decrease in quality of care to patients
- Longer wait times to receive care
- Less cost-effective care provided to patients
- Less appropriate care provided to patients
- Increased costs to the MOHLTC
- Increase in expenditures on prescription drugs
- Increase in emergency room visits
- Directional shift away from governments transformation and integration agenda
- Marginalization of the chiropractic profession

ticipants were recruited from Toronto via the College of Chiropractors of Ontario (CCO) online directory on October 21, 2009 [all practicing chiropractors in Ontario must be registered (or licenced) with CCO]. The 591 practicing chiropractors in Toronto were assigned a number; the numbers were randomized to reduce sampling bias by statistical software listed as R project<sup>10</sup> and the first 199 chiropractors selected were used in the study. Since the sampling frame includes all practicing chiropractors in the GTA (population of interest), a randomly chosen group is considered to be highly representative. Chiropractors not in Toronto or not registered with the CCO were excluded from this study. Since not all selected chiropractors had email, it was decided that surveys would be distributed by ground mail. Also, it was posited that mailing out the survey as opposed to an interview would be more efficient both in terms of time and cost.

The surveys were mailed to 199 chiropractors on October 28, 2009 and were received up until December 18, 2009. Data was collected and analyzed January 26, 2010. The choice of sample sized was taken such that 95% confidence intervals around proportions of interest would be sufficiently narrow. Based on the estimate of a 60% response rate we believed we would get 120 people.<sup>11</sup> This would ensure that any CI around a proportion with sample size around 120 would yield a confidence interval no wider than 18 percentage points. Surveys were coded and a second survey was re-sent on April 19, 2010 to those chiropractors who had not responded initially. The second

set of surveys were accepted until June 1, 2010. Data was collected from this second step and was analyzed June 8, 2010.

### *Confidentiality*

Each of the participant's records were stored on a password protected computer and any paper work was locked in a filing cabinet and then shredded subsequent to data acquisition in order to protect the privacy of the individuals. Respondents were not required to identify themselves any where on the survey.

### *Deception*

No deception was used in this study.

### *Survey instrument*

The survey questions were developed during a series of discussion among the research team. Since, to the best of our knowledge, this is the first survey of its kind, a unique set of questions were developed that the authors' believed would best capture the data they sought to gather (see Appendix). Thus, the survey had a degree of face validity but was not pre-tested. The study participants were asked to disclose their age, sex, length of time in practice, if they were in practice at the time when OHIP coverage was in effect, if they perceived OHIP delisting affected their patient volume and practice income and, if so, whether or not they perceived their patient volume had subsequently recovered during the intervening years. The participants were also asked if they perceived that OHIP delisting negatively impacted the credibility of the profession. Lastly, survey participants were asked if they would be in favor of OHIP coverage being reinstated and, if so, to what extent and for whom.

### *Statistical Analysis*

Percentages were calculated from the data and are presented in Table form along with raw numbers. A two sided test of differences between proportions was used to compare results.<sup>10</sup> An alpha level of 0.05 was used as the standard for statistical significance. Due to the nature of each variable being dichotomous a chi squared test is warranted. This test is also representative of a test of difference in proportions. Data were coded into a spread sheet. R project statistical software was used in the randomization process.<sup>10</sup>

Table 2 *Number of years in practice among respondents (n = 123)*

Years in practice	Percent (n)	95% Confidence Interval
0–5	25.2% (32)	(17.5, 32.9)
6–10	30.1% (37)	(22.0, 38.2)
11–15	13.8% (17)	(7.7, 19.9)
16–20	8.9% (11)	(3.9, 13.9)
21–25	4.1% (5)	(0.6, 7.6)
26–30	6.5% (8)	(2.1, 10.9)
31–35	10.6% (13)	(5.2, 16.0)
>36	0.8% (1)	(0.0, 2.4)

## Results

### *Response rate and number of years in practice*

Of the 199 OHIP surveys mailed out, 123 chiropractors responded to the questionnaire representing a response rate of 61.8%. Six surveys were returned to sender. This number of respondents provided a reasonably large proportion of the entire population of interest (chiropractors in the GTA) and thus was thought to be representative of this population with respect to age, gender and number of years in practice. Of the chiropractors who responded, the number of years in practice ranged from 1 to 52 with the average being 13.5 years (SD = 10.4) (see Table 2).

### *Perception of the Effect of OHIP delisting on Chiropractors' Practice Income*

Chiropractors were asked to respond whether or not they perceived the delisting of OHIP in 2004 initially affected their businesses financially. Forty-five respondents reported that their practice was negatively affected (36.6%) [95% CI: (0.281, 0.451)], 47 reported their practice was not affected (38.2%) [95% CI: (0.296, 0.468)], and 31 (25.2%) [95% CI: (0.175, 0.329)] were not in practice at the time of OHIP coverage; therefore, this question was not applicable to them. (NB: Seven chiropractors stated that their business was not effected, but circled a

Table 3 *Perceived percentages of income lost among those chiropractors in practice during OHIP coverage subsequent to its delisting (n = 52)*

Percentages of income lost (%)	Percent (n)	95% Confidence Interval
0–10	30.8% (16)	(18.3, 43.3)
11–20	32.7% (17)	(19.9, 45.5)
21–30	23.1% (12)	(7.6, 38.6)
31–40	5.8% (3)	(0.0, 12.2)
41–50	3.8% (2)	(1.4, 9.0)
>50	3.8% (2)	(0.0, 9.0)

“0–10%” decline in practice income. This is explained further in the “study’s limitations” section below). Thus, of the 92 chiropractors in practice at the time of OHIP coverage, 48.9% [95% CI: (0.387, 0.591)] reported their practice was negatively affected and 51.2% [95% CI: (0.410, 0.614)] reported it was not.

With respect to those chiropractors who reported that their practice incomes declined due to OHIP delisting ( $n = 52$ ), roughly a third reported they perceived their practice revenues declined by less than 10%, a third reported they perceived their practice income declined between 11% and 20%, and the remaining third perceived their practice revenue dropped more than 20% (see Table 3).

### *Perception of the effect of OHIP delisting on chiropractors' patient volume*

Respondents were asked whether or not the delisting of OHIP resulted in a decrease of their patient population (or volume) immediately after delisting. Forty-five chiropractors (36.6%) [95% CI: (0.225, 0.507)] said their patient population decreased, 52 (42.3%) [95% CI: (0.225, 0.507)] said their patient population did not decrease, and 26 (21.1%) [95% CI: (0.092, 0.330)] were not in practice at the time of OHIP coverage therefore, this question was not applicable.

Of the respondents who reported a decline in patient populations attributed to OHIP delisting ( $n = 45$ ), 12

Table 4 *Perceived decline in patient volume immediately after the delisting of OHIP (n = 45)*

Percentage of patients lost (%)	Percent (n)	95% Confidence Interval
0–10	26.7% (12)	(13.8, 39.6)
11–20	40% (18)	(25.7, 54.3)
21–30	22.2% (10)	(10.1, 34.3)
31–40	8.9% (4)	(0.6, 17.2)
41–50	2.2% (1)	(0.0, 6.5)
>50	0	

(26.7%) [95% CI: (0.138,0.396)] reported a decline of 0–10%, 18 (40.0%) [95% CI: (0.257,0.543)] reported a decline of between 11–20%, 10 (22.2%) [95% CI: (0.101,0.343)] reported a decline between 21–30% and 5 (11.1%) [95% CI: (0.019,0.203)] reported a decline of over 31% of their patient base (see Table 4).

Those chiropractors who said that their patient volume decreased immediately after delisting of OHIP were asked to state whether or not their patient population has since recovered. Only 40 of the 45 chiropractors who reported a decline in patient volume responded to this question. Of these 40 respondents, 12 (30.0%) [95% CI: (0.158,0.442)] reported that their patient population recovered and is higher than before the delisting, 11 (27.5%) [95% CI: (0.137,0.413)] that their patient population has recovered and it is equal to what it was before and 17 (42.5%) [95% CI: (0.349,0.501)] reported that their patient population has not recovered (Table 5).

#### *Perceived effect of OHIP delisting on the profession's credibility*

Chiropractors were asked if they thought that losing OHIP coverage detracted from the credibility of the profession. One hundred and twenty two chiropractors responded to this question. Sixty-four (52.5%) [95% CI: (0.436,0.614)] reported that OHIP delisting detracted from the credibility of the profession, while 58 (47.5%) [95% CI: (0.386,0.564)] said that it did not. However, of the 29 chiropractors who were not in practice under OHIP cover-

Table 5 *Whether or not the patient population/volume has recovered among those chiropractors who perceived their patient population immediately decreased after the delisting of OHIP coverage (n = 40)*

Effects on patient population	Percent (n)	95% Confidence Interval
Patient population recovered and higher than before	30% (12)	(15.8,0.44.2)
Patient population recovered and is equal to before	27% (11)	(13.7,41.3)
Patient population has not recovered	42.5%(17)	(34.9,50.1)

age who responded to this question, 17 (58.6%) [95% CI: (0.407,0.765)] felt that losing OHIP took away from the credibility of the profession. Of the 93 chiropractors who were in practice under OHIP coverage and responded to this question, 47 (50.5%) [95% CI: (0.403,0.607)] believed that losing OHIP detracted from the credibility of the profession as compared to 45 (49.5%) [95% CI: (0.393,0.597)] who did not ( $\chi^2 = 0.58$ ,  $df = 1$ ,  $p = 0.447$ ,  $p = 0.45$ ). There was no statistical significance between these two groups (Figure 2).

#### *Perception of whether or not OHIP should be reinstated for chiropractic services*

Chiropractors were surveyed as to their desire for OHIP coverage to be reinstated. One hundred and fifteen respondents addressed this question. Of these 115 respondents, 53 (46.1%) [95% CI: (0.370,0.552)] were in favor of OHIP coverage reinstatement as compared to 62 (53.9%) [95% CI: (0.448,0.630)] who were not. Of the 28 chiropractors that were not in practice under OHIP coverage, 19 (67.9%) [95% CI: (0.846,0.846)] wanted OHIP reinstated compared to 34 of the 87 (39.1%) [95% CI: (0.288,0.494)] chiropractors who were in practice under OHIP coverage ( $\chi^2 = 7.06$ ,  $df = 1$ ,  $p = 0.001$ ). There was a statistical significance between these two groups (see Figure 2)

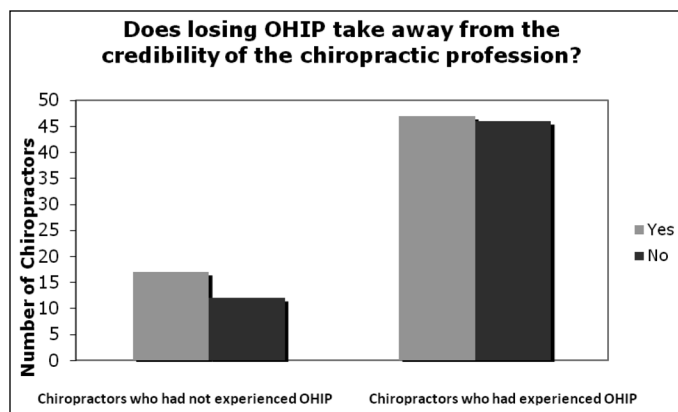


Figure 1 A comparison between chiropractors who had and had not experienced OHIP coverage and if the delisting of OHIP took away from the credibility of the profession.

#### Perception of amount OHIP should pay for chiropractic services if it were to be reinstated and who should be eligible

Of the respondents who wanted OHIP coverage reinstated ( $n = 53$ , roughly half of whom were not in practice under OHIP coverage), 43 (91.5%) [95% CI: (0.840,0.990)] wanted greater than the prior coverage of \$9.65 for the general population, 2 of the 47 (4.3%) [95% CI: (-0.012,0.098)] respondents wanted the same coverage (\$9.95) and 2 of the 47 (4.25%) (4.3%) [95% CI: (-0.012,0.098)] respondents wanted less coverage than prior to the delisting (<\$9.95). However, when asked about OHIP coverage for the elderly and children, only 43 chiropractors responded to the question. Of these respondents, 40 expressed their desire for greater coverage (93.0%) [95% CI: (0.854,1.006)], while 2 wanted the same coverage (4.7%) [95% CI: (-0.016,0.110)] and 1 wanted less coverage (2.3%) [95% CI: (-0.002,0.068)] compared to the previous OHIP coverage.

#### Discussion

In 2004, some physiotherapist (PT) services (so-called “Schedule 5” PT clinics, which are privately owned and community-based) were partially delisted.<sup>3,4,11</sup> In order to be eligible for public funding under OHIP after December 2004, clients (at the time, PTs were not permitted to use the designation of “doctor” and thus tended not to use the

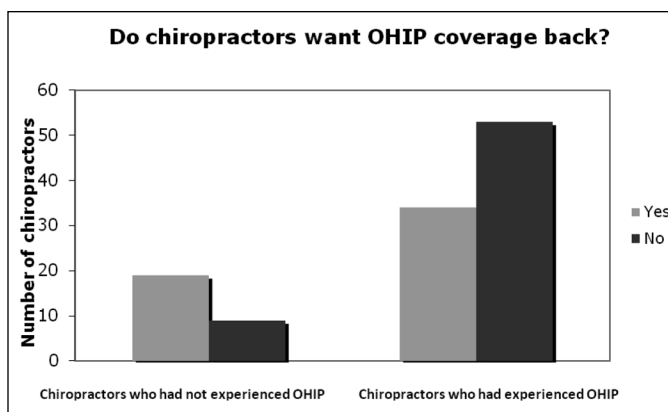


Figure 2 A comparison between chiropractors who had and had not experienced OHIP coverage and if they wanted OHIP coverage reinstated.

term “patient”) in the newly termed “Designated Physiotherapy Clinics” (DPC) must be (a) aged 65 years or older; (b) aged 19 years or younger; (c) resided in a long-term care facility; (d) required PT services at home post-hospitalization or; (e) received social benefits.<sup>4,11</sup> Three studies reported on the perceptions from PTs and their patients with respect to the impact that delisting had on utilization and accessibility of PT services. Gordon *et al*<sup>11</sup> conducted a phone interview of 33 PTs two weeks before and two weeks after the implementation of the new reimbursement requirements. These researchers reported that, immediately following delisting, PTs practicing in Schedule 5 clinics perceived there would be an immediate decrease in demand of services, whereas PT providers from other categories reported no such change. Subsequently, however, all PTs forecasted that there would be a continued decrease in access for ineligible clients but a potential for increased access and reduced wait time among clients who remained eligible for public funding. This posited decrease in access was attributed to the concern that clients would be less likely to pay out-of-pocket for PT services. Further concerns expressed by the interviewees were that clients would be compelled to access other sectors of the publicly funded health care system, principally medical physicians, thus not only driving up health care costs but also increasing medication use as well. Moreover, interviewees in this study expressed their concerns that there would be a diminished quality of care provided to clients

at Schedule 5 clinics due to a low payment structure per client visit, forcing facilities to provide less care in order to maintain their profitability. Lastly, Gordon *et al*<sup>12</sup> noted that, within the European literature, there was a significant reduction in the use of essential medication by patients when they had to co-pay (rather than receive their medications at no cost) and that the effect of delisting of PT services in other provinces, notably British Columbia, resulted in “increased waiting time, a 28% decrease in patients accessing community-based care and reports of patients ending treatment prematurely.”<sup>13:p166</sup>

Landry *et al*<sup>3</sup> reported on any changes among PT clients before and after delisting with respect to access to services and self-reported health (SRH) status. Also using a telephone questionnaire design, these researchers reported that after partial delisting of PT services, 81 of 113 (71.7%) participants who required services continued to receive them; among this group, roughly half (50.6%) remained eligible for OHIP, indicating the remainder of the clients were willing to assume the cost of care themselves (that said, the researchers reported that one-third of clients were able to continue with care because they had private insurance coverage for it). Perhaps more importantly, access after delisting was statistically associated with good health. Specifically, participants who required PT services and received them after delisting were more than 10 times as likely to report good health compared to clients who required but did not receive services.<sup>3</sup>

In a study that sought to monitor the effect of the partial delisting of PT services on both clients and providers 12 months after its implementation, Paul *et al*<sup>4</sup> reported that clients rendered ineligible for OHIP coverage continued to experience barriers to access of services across Ontario, most due to the inability or unwillingness to pay out-of-pocket for services. Also, clients in this study expressed their concern with respect to their health status and reported increased use of other health professionals (principally physicians) and services (i.e. hospitals). These authors also reported that DPC providers had experienced a drop in clinic volumes from between 18% to 50%. Similar to the study by Landry *et al* described above, the researchers of this study reported that both PTs and their clients perceived delisting had had a detrimental effect on their health status. These findings led Paul *et al* to conclude: “On the basis of our study of the perceptions of clients and providers, we believe that health outcomes for

individuals no longer eligible for PT services and those who choose to forgo PT entirely may be negatively impacted by delisting policies such as the one implemented by Ontario.”<sup>4p338</sup> That said, the authors also noted that some PT providers did view delisting of services from publicly-funded government plans as potentially advantageous in terms of financial profitability since clients are paying for services out-of-pocket at a much higher unit price than received by provincial public payors. In other words, these authors, as well as Landry *et al* speculated that the only PTs and clients who were burdened by delisting were DPCs and some home care providers.<sup>4</sup>

Similar studies have been published on the forecasted effects of the delisting of chiropractic services in Ontario. Deloitte, a consulting service, was hired by the Ontario Chiropractic Association (OCA) to conduct a review of the potential consequences of OHIP delisting in 2004.<sup>9</sup> Deloitte, as well as others, have reported that musculoskeletal (MSK) disorders are among the most costly and disabling disorder to the health care system and of the 1.2 million Ontarians who visit chiropractors a year do so for MSK conditions.<sup>9</sup> It was predicted that the delisting of OHIP coverage for chiropractors and other health care providers would result in savings by the provincial government of \$200 million dollars over a two year period.<sup>8,9</sup> However, these expected cost savings may not have accounted for the increased cost caused by the transfer of patients with MSK problems from chiropractors to other health care providers, principally medical doctors or visits to emergency rooms (ERs).<sup>8,9</sup> In support of this concern, Deloitte reported that a recent poll indicated that, among Ontarians who had seen a chiropractor in the previous year, more than half (54%) indicated that delisting would discourage them from continuing to seek out chiropractic care and would, instead, seek out care from family physicians or emergency departments.<sup>9</sup> Since OHIP paid approximately \$10 per chiropractic visit, whereas OHIP paid roughly \$30 per physician visit, the cost of a medical consultation would be at least three times higher than a chiropractic consultation, and this cost does not include other costs such as prescription drugs, laboratory or other diagnostic testing. Moreover, the average visit to an emergency room is estimated to be between \$125 and \$143, or an order of magnitude higher than the fee for a chiropractic service.

In addition to concerns above escalating costs to the

health care delivery system, Deloitte also raised concerns with respect to quality of care (in terms of prolonged wait time), effectiveness and appropriateness of care, availability of providers (there is a chronic shortage of family physicians in Ontario), cost-effectiveness of care (chiropractic care is often shown to be more cost-effective than other forms of therapy for MSK conditions such as low back and neck pain), patient satisfaction (chiropractic patients typically report they are very satisfied with the care they receive) and alignment with government priorities.<sup>9</sup> Manga<sup>8</sup> raised similar concerns and calculated that although the Ontario government would save \$100 million annually by not paying for chiropractic services they would incur at least \$200 million in additional health care expenditures as patients shift from chiropractors to more costly provincially funded health care services. Manga also voiced his concern that the delisting of chiropractic services would marginalize the profession from the health care sector in Ontario.<sup>8</sup>

A few years after the delisting of services, the OCA surveyed its members to ascertain if their patient numbers and the fees charged to these patients changed as a consequence of it.<sup>7</sup> Data was collected during two week periods, one in September 2004 and the other in September 2006. The results revealed that respondent chiropractors increased their fees by \$3 in addition to the \$9.65 which was once covered by OHIP. From 2004–2006, the overall number of patients seen by chiropractors decreased with the number of new chiropractic patients reportedly declining by 22% and the average number of patients visits fell from 8.6 annually to 8.3. Conversely, it was reported that patients visiting chiropractors with extended insurance coverage increased by 40% and patients claiming through the Workplace Safety and Insurance Board (WSIB) increased by 44%.<sup>7</sup>

Our study found that many chiropractors reported a decline in their practice revenue around the time of delisting, which chiropractors in this study attributed to that event. However, there may have been other factors effecting this perceived decline in practice revenue, and it bears emphasizing that we are not drawing a causal relationship between OHIP delisting and practice pattern changes based on the data obtained in this study. Mior and Laporte<sup>14</sup> reported that the number of chiropractors in Ontario is on the rise while the number of chiropractic patients has remained unchanged, resulting in a decline in the net rev-

enue of Ontarian chiropractors between 1993 and 2003. Mior and Laporte posited that these demographic trends, combined with the loss of public funding through OHIP, may contribute further to this declining revenue of field practitioners and create more challenges for them in terms of economic sustainability.<sup>14</sup> In this study, some respondents reported they experienced a detrimental effect to both their patient volume and practice income as a result of the OHIP delisting, at least initially. However, almost two-thirds of chiropractors surveyed indicated that their patient volume and practice revenues are now the same or greater than they were at the time of OHIP delisting.

Although it appears that having chiropractic covered under OHIP would benefit the provincial health care system and practicing chiropractors alike, the results of our study indicate that most chiropractors in Toronto do not want OHIP coverage reinstated, a finding most evident among those chiropractors who were in practice during the time OHIP partially covered chiropractic services. There was statistical significance between those chiropractors who were in practice under OHIP as compared to those chiropractors who were not in terms of their desire to have OHIP coverage reinstated. Specifically, those chiropractors who were in practice during OHIP coverage were much less favorably inclined to have OHIP coverage reinstated. There are several possible explanations for this observation.

For the chiropractor, the mechanization of OHIP payment was an arduous process (Gleberzon – personal communication). A practitioner would typically receive reimbursement 30 or 60 days after the date service was rendered, provided the practitioner had the correct demographic information on their patient (date of birth, sex), that the patient informed their chiropractor of any change to their Health Care Card Version Code and that the patient did not exhaust their chiropractic OHIP coverage in a calendar year with another chiropractor. In addition, for a period of time in the early 2000s, the Ontario government instituted the “Social Contract” which reduced the amount reimbursed for a chiropractic service from \$9.65 to \$8.44. In addition, there was another level of regulatory oversight by the MOHLTC, which operated through the Chiropractic Review Committee via the College of Chiropractors of Ontario. It is noteworthy that, according to the OCA survey, patients who had private insurance coverage for chiropractic care through their place of

employment, did not feel the effects of OHIP delisting.<sup>7</sup> This is because these persons had to exhaust their OHIP coverage prior to accessing their private insurance coverage, since insurance companies considered OHIP another type of insurance and would not co-pay while a patient was eligible under OHIP. OHIP covered patients up to, initially, \$220 a calendar year (beginning July 1), which was reduced to \$150. Thus, it would require roughly 15 visits for a patient to exhaust their OHIP coverage; however, few patients required that many treatments, and thus did not exhaust their OHIP coverage. However, in the absence of OHIP coverage, a patient could immediately be reimbursed for the total amount of a treatment if he or she possessed a private insurance plan. To these patients, OHIP's delisting of chiropractic treatment would be of financial benefit to them.

Over half of the respondents opined that losing OHIP took away from the credibility of the chiropractic profession. Almost 60% of the chiropractors who were *not* in practice during OHIP coverage felt that delisting diminished the credibility of the profession. By comparison, roughly half of the chiropractors who were in practice during OHIP coverage perceived that the credibility of the profession was negatively affected by its delisting. The differences between these two groups were not statistically significant. That said there was a statistically significant difference between those chiropractors who were in practice during OHIP coverage compared to those chiropractors who were not in terms of their desire for OHIP to be reinstated; specifically, the desire to have OHIP reinstated is statistically higher among those chiropractors who were not in practice when it was in effect. Among those chiropractors who do wish to be covered under OHIP again, the vast majority would only do so if they were paid more than the previous amount of \$9.65 and they would be in favor of coverage if it was extended towards seniors, children and low-income persons.

### Study Limitations

There were several limitations to this study. The survey instrument was developed by the research team and, although it had face validity, it was not pre-tested to determine its clarity and reliability among respondents.

In constructing our survey, we assumed that the delisting of OHIP would negatively affect chiropractors both in terms of patient numbers and practice revenues

and constructed our survey to reflect this hypothesis. That is to say, we did not provide an option that would indicate a respondent experienced an increase in patient volume or revenue immediately subsequent to delisting. In the comment section of our survey a few chiropractors explained that their practice was positively affected financially and patient numbers increased immediately following the delisting of OHIP coverage. Also, because of the manner in which responses were grouped in our survey, if a chiropractor had not suffered a loss of patients or revenue s/he would have had to circle the "0–10% loss" option. These design flaws must be addressed in any subsequent version of this study. We instructed respondents who asserted that their patient population had declined immediately after delisting to indicate whether or not patient population (volume) had returned to pre-delisting levels; we chose not to ask the same question with respect to patient income since we assumed that patient income would be related to patient volume and a positive improvement in one would result in a positive improvement in the other. However, this did not take into account the possibility that a practitioner may have altered his or her practice activities to increase revenue by means other than patient visits (by offering more services such as acupuncture, orthotics, rehabilitation or perhaps by refocusing on other practice opportunities such as performing independent chiropractic examinations for third party payors such as insurance companies). This possibility ought to be addressed in subsequent studies

The survey was only mailed to chiropractors in Toronto. They may not be representative of all Ontarian chiropractors since Toronto is a large, urban, ethnically-diverse city, and one of the most expensive cities in which to operate a private practice in Ontario, in terms of rent, utilities and so on. Future studies should survey chiropractors in different cities, both urban and rural.

### Conclusion

To the best of our knowledge, this is the first study to examine the perceived effects of the delisting of chiropractic services in Ontario on practice revenues, patient volumes and the impact that delisting had to the profession's credibility among a group of randomly selected chiropractors. The findings of our study indicate that, although the delisting of chiropractic services had a detrimental effect on patient volumes and practice revenues,

these negative effects were short-lived. However, over half of practicing chiropractors opined that the delisting of OHIP coverage has had a negative impact on the profession's credibility. Despite this finding, many chiropractors expressed no interest in having OHIP reinstated; this trend was highest among those practitioners who were in practice during the time OHIP was in effect.

Chiropractic services in Alberta and Saskatchewan have recently been delisted from their respective provincial health care plans. It would seem prudent that advocacy groups in these provinces undertake studies such as the one reported here in order to better strategize their actions. For example, perhaps provincial coverage of chiropractic services should be directed towards the elderly, children and low-income persons rather than the population at large. It is possible that, although negatively impacting the credibility of the profession in the short term, many chiropractors may not want a return to the same structure of provincial coverage for chiropractic services, and perhaps neither to all of their patients.

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## Appendix A: Research Questionnaire used in this study

1. How many years have you been in practice? \_\_\_\_\_
2. Were you in practice under OHIP coverage?                      Yes                      No  
If No, please proceed to question number 5.
3. A) Did OHIP delisting in 2004 immediately affect your business financially?  

Yes	No	N/A
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B) If yes, please estimate the percentage of income lost:

	0–10%
	11–20%
	21–30%
	31–40%
	41–50%
	>50%
4. A) Do you feel that the delisting of OHIP decreased your patient population immediately after removal?  

Yes	No	N/A
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B) If yes, please estimate the percentage of patients lost:

	0–10%
	11–20%
	21–30%
	31–40%
	41–50%
	>50%

C) Has your patient population recovered?

	Yes, and is higher than before
	Yes, it is about equal
	No
5. Do you feel that losing OHIP takes away from the credibility of our profession in healthcare?  

	Yes                      No
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6. A) Do you want OHIP back?  

	Yes                      No
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B) If yes, under what circumstances?

General population:	<div>&gt;\$9.65</div> <div>\$9.65 (old coverage)</div> <div>&lt;\$9.65</div>
Children/elderly:	<div>&gt;\$9.65</div> <div>\$9.65 (old coverage)</div> <div>&lt;\$9.65</div>
Other:	_____

# Amyotrophic lateral sclerosis presenting as upper limb weakness in a 35 year old female: a case report

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*Chiropractors regularly assess and provide treatment for a variety of neuromuscular complaints. Many of these respond well to conservative care however some represent conditions that must be referred for further evaluation. This article chronicles the management of a patient who presented with upper limb weakness and was subsequently diagnosed with amyotrophic lateral sclerosis (ALS). Chiropractors should be informed of the nature and presentation of this disease to facilitate early diagnosis and treatment.*

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**KEY WORDS:** amyotrophic lateral sclerosis, upper limb weakness, chiropractor

*Les chiropraticiens évaluent régulièrement et offrent des traitements pour diverses douleurs neuromusculaires. La plupart de ces douleurs réagissent bien au traitement conservateur, mais certaines constituent des états pathologiques nécessitant un examen plus approfondi. Cet article explique la gestion d'un patient qui présentait une faiblesse des membres supérieurs, et pour qui l'on a émis un diagnostic de sclérose latérale amyotrophique (SLA). Les chiropraticiens doivent être informés de la nature et de l'aspect de cette maladie afin de faciliter le diagnostic hâtif et le traitement de cette maladie.*

**MOTS CLÉS :** sclérose latérale amyotrophique, faiblesse des membres supérieurs, chiropraticien

## Introduction

ALS is characterized by relentless degeneration of both upper motor neurons (UMN) and lower motor neurons (LMN) leading to progressive muscular paralysis and death usually within five years.<sup>1</sup> Recent studies report yearly incidence rates ranging from 1.5 to 2.5 cases / 100,000 population.<sup>2</sup> The disease principally affects people aged 50–60 years with only 5% of patients having onset before the age of 30 years. It is usually not inherited with genetics involved in a minority of cases.<sup>3</sup>

A 2008 study published in *Neurology* showed that limb weakness is the most common symptom at disease onset followed by dysarthria, dysphagia, cramps, fasciculations and shortness of breath.<sup>4</sup> These LMN signs are often accompanied with the clinical signs of UMN disease: overactive tendon reflexes, clonus and Babinski responses.<sup>5</sup> After the disease begins, it follows a typical progressive

course and it eventually affects almost all voluntary muscles. The cause of death is usually respiratory compromise related to diaphragm and intercostal weakness.<sup>6</sup>

Chiropractors frequently assess and treat patients for limb complaints.<sup>7</sup> While many of these complaints, for example carpal tunnel syndrome<sup>8,9</sup> and spinal radiculopathy<sup>10,11,12</sup> often respond well to treatment some are more serious neuromuscular conditions that require appropriate referral. ALS is one such disease that can mimic some of the limb conditions which are seen in chiropractic practice and may need to be considered as a differential diagnosis.

The purpose of this case report is to describe the presentation of a patient with upper limb weakness that she believed was secondary to her occupational demands as administrative assistant. Her condition had been previously diagnosed by her medical doctor as carpal tunnel syndrome. She was diagnosed with ALS by a neurologist

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one month after her presentation to a chiropractic clinic and died 15 months later.

### Case Presentation

A 35 year old, right-handed female presented to a chiropractic clinic with a complaint of progressive weakness in the right upper limb. She described the weakness as no hand strength and a loss of dexterity in the third, fourth and fifth digits. Upon further questioning it was revealed that she found handwriting difficult, was prone to dropping cups of coffee and that recently it had taken her 10 minutes to put on her pants. This condition began six weeks prior to her appointment at the clinic. She felt her symptoms were related to a time she was working 48 hours a week doing data entry.

She described associated pain and tingling in the right third, fourth and fifth digits, pain in multiple areas in the right upper limb and bilateral cervico-thoracic pain. She reported visible muscular twitching in both hands. These symptoms were aggravated when she worked and relieved when, for extended periods, she did not work. Heat and a hand therapy ball had not provided relief of symptoms. She denied past history of a similar complaint.

She had previously seen her medical doctor for this complaint. The doctor felt her symptoms were due to carpal tunnel syndrome and had scheduled an electromyogram in three months. No previous imaging had been completed. Past medical history revealed asthma for which she required previous hospitalization and ongoing medications. She reported a motor vehicle accident five months earlier but did not sustain injury. Maternal family history revealed stroke and arthritis while paternal history revealed type 1 diabetes and occupational claw-hand. The patient was a widow with no children of her own.

The patient appeared in discomfort and dysarthria was noted throughout the visit. Postural exam revealed an elevated right scapula and hypertrophy in the bilateral cervico-thoracic musculature. Spinal joint fixations were noted in the cervical and thoracic spine. Cervical spine range of motion was full and pain-free in all planes. Tender myofascial trigger points were noted in the right medial intermuscular septum, flexor carpi ulnaris and tunnel of Guyon. Generalized muscular tension was palpated in the right flexors and extensors of the forearm. Fasciculations were observed in the right triceps. A normal Babinski response was elicited. An upper limb motor strength

exam revealed weakness in the flexors and extensors of the right wrist as well as in flexion and abduction of the right digits. Decreased sensation was documented in the palmar surfaces of digits four and five as well as the medial aspect of the hand, forearm and arm which corresponds to C6, C7 and C8 dermatomes. Severe hyper-reflexia was elicited bilaterally in the C5, C6, C7, L4 and S1 deep tendon reflexes. Elevated arm stress test revealed the patient was unable to flex her right fifth digit and after the test, fasciculations were noted in the thenar eminence bilaterally.

The patient was treated for her musculoskeletal findings. Treatment involved a prone adjustment of her mid-thoracic spine and Active Release Techniques® to the affected soft tissues. The patient's cervical spine was not treated with a high-velocity, low-amplitude manipulation. This decision was based on the presence of the neurological signs and symptoms in case of a possible cervical myelopathy, space occupying lesion affecting a nerve root or vertebrobasilar insufficiency.<sup>13</sup> The case was discussed with a colleague at the clinic and it was agreed the patient was to be referred to her medical doctor for a neurological consult. This referral was discussed with the patient at her next chiropractic appointment and no treatment was done. She saw a neurologist one month later.

### Management and Outcome

The neurologist noted in her report that the patient described progressive hand weakness, dysarthria, twitching in the extremities, dysphagia as well as new symptoms including cramping in the left forearm, intermittent blurred vision and difficulty walking. Examination revealed tongue weakness and mild spastic dysarthria. Bilateral atrophy of her hands and fasciculation in the right biceps and triceps were observed. Strength in the deltoids was 4/5 bilaterally and 3/5 in the hands bilaterally, graded on the Medical Research Council Muscle Strength Grading System,<sup>14</sup> however the right arm was slightly weaker than the left throughout. Motor testing in the lower extremities was normal. Reflexes were graded as pathologically brisk in the arms and in the right leg. Three positive UMN signs were noted bilaterally: a Hoffman sign,<sup>15</sup> a crossed knee adductor response<sup>16</sup> and a spastic catch<sup>17</sup> (Table 1). Sensory testing was normal. Gait was described as normal except difficulty with heel walking.

Right ulnar and median motor nerve conduction studies demonstrated moderately diminished amplitudes. Right

Table 1 Description of the UMN signs<sup>15,16,17</sup>

**Hoffman Sign** – A sudden nipping of the nail of the index, middle or ring finger produces flexion of the terminal phalanx of the thumb and of the second or third phalanx of some other finger.

**Crossed Knee Adductor Response** – The patient is sitting or lying supine, the examiner taps the adductor tendons on the medial distal thigh with a reflex hammer. The crossed adductor response describes adduction of the contralateral leg when the adductor tendons are tapped. Under normal circumstances, only the leg which the hammer hits should adduct.

**Spastic Catch** – The limb is passively and quickly moved through its range of motion. As the limb moves, it seems to catch. This catch is followed by a slow relaxation through the remainder of the movement. No catch is demonstrated if the limb is moved slowly.

median mixed palmar, superficial radial and sural sensory studies were normal. Electromyography studies showed active denervation in all muscles studied including the right first dorsal interosseous muscle, pronator teres, deltoid and medial gastrocnemius as well as the tibialis anterior bilaterally.

It was noted that the patient demonstrated clinical and/or electrophysiological evidence of LMN involvement at at least two spinal levels and UMN involvement at three spinal levels. It was further noted this meets the criteria for probable to definite ALS. Riluzole, the established disease modifying medication, which has been shown to modestly slow progression and lengthen survival in ALS<sup>18,19</sup> was prescribed. Lithium was also prescribed. A 2008 paper revealed promising results for lithium slowing disease course in a pilot study and its neuroprotective effects in an animal model study;<sup>20</sup> however, subsequently the drug failed to show evidence of benefit in a larger, randomized, double-blind, placebo-controlled trial.<sup>21</sup>

The neurologist referred the patient for an MRI of her brain and cervical spine. The MRI study conducted two months later, showed hyperintense signal along the corticospinal tract in the brain bilaterally with a cervical spine

examination within normal limits. This verified the diagnosis.

A progression of symptoms was reported when the patient was re-evaluated by the neurologist one month later. Examination showed moderate bifacial and tongue weakness as well as fasciculations in the tongue. Strength remained relatively preserved in the upper extremity bilaterally except marked weakness was noted in the intrinsic hand muscles graded at 0–1/5. It was noted that the patient's family physician had recently prescribed ativan, a medication with anxiolytic and sedative properties<sup>22</sup> as well as citalopram, a selective serotonin reuptake inhibitor.<sup>23</sup> The patient also presented to an ALS clinic that day and was assessed by a multidisciplinary team composed of an occupational therapist, registered dietician, social worker, speech language pathologist and registered nurse.

Three months later the patient was re-assessed. The neurologist's notes from that visit reveal progression in her dysphagia and increased weakness in hands and legs. It was noted the patient's forced vital lung capacity was at 60% of predicted. Consequently she was referred to a gastroenterologist for feeding tube placement. The note of this referral is the last entry available. The patient died nine months later.

## Discussion & Conclusion

ALS involves progressive muscular paralysis reflecting degeneration of the motor neurons in the primary motor cortex, brainstem and spinal cord. Male gender, aging, a positive family history and military service are established risk factors for the development of the disease while smoking, exposure to toxins (e.g. lead), repeated head injury, playing football professionally and a family history of non-ALS neurodegenerative diseases (e.g. Parkinson's disease) are proposed yet unconfirmed. The hypothesis most authors favor is a complex interaction of factors.<sup>24,25</sup>

The precise molecular pathway causing degeneration is unknown. It is likely interplay between several pathogenic cellular mechanisms including cell injury through excitotoxicity of postsynaptic glutamate receptors, oxidative stress, mitochondrial dysfunction, impaired axonal transport, neurofilament and protein aggregation in neural tissues, immune deregulation based inflammatory dysfunction and deficits in neurotrophic factors signaling pathways.<sup>25</sup>

The disease has pathological hallmarks. UMN disease is indicated by the loss of motor cortex cells with variable astrocytic gliosis affecting cortical grey and underlying white matter. Additional characteristics include axonal loss within the descending pyramidal tracts as well as myelin pallor and gliosis in the corticospinal tracts. LMN pathology affects the anterior horn motor cells of the spinal cord and brainstem. At autopsy loss of motor neurons can be as high as 50% and the remaining neurons are atrophied and contain characteristic intraneuronal inclusions.<sup>25</sup>

Investigative medicine plays an important role in the confirmation of diagnosis and the exclusion of mimic disorders. Standard electrophysiological studies include nerve conduction studies and conventional electromyography (EMG). Typically, EMG reveals evidence of denervation and chronic neurogenic changes. In the absence of concomitant entrapment or other neuropathies, nerve conduction studies are normal or near normal.<sup>26</sup> MRI has a dual value. It aids in the exclusion of treatable structural lesions that mimic ALS and it often reveals abnormalities reflective of the disease's degeneration. The most common finding in ALS is hyperintensity of the corticospinal tract.<sup>27,28</sup>

Diagnosis is based on the presence of characteristic clinical findings in conjunction with investigations to exclude "ALS-mimics" (Table 2<sup>25,29</sup>) which are distinct disorders with a similar presentation. Signs suggestive of a combined UMN and LMN disease that is progressive and cannot be explained by any other disease process is required for the diagnosis.<sup>30</sup> The World Federation of Neurology Research Group on Motor Neuron Diseases developed the 1994 El Escorial Diagnostic Criteria to aid in the classification of patients suspected of having ALS. In 2000 the Revised El Escorial Diagnostic Criteria was published (Table 3<sup>25,30</sup>).

There are two types of typical ALS, spinal onset and bulbar onset, named according to the type of symptoms that first manifest. Spinal onset is 1.5 to 4 times as common as bulbar onset depending on classification criteria and has a better prognosis than bulbar onset.<sup>29,31</sup> ALS has variant syndromes involving motor neuron disease with distinctive clinical presentations and prognosis. These include primary lateral sclerosis (PLS) which is a UMN disease in which patients have no LMN signs.<sup>32</sup> Progressive muscular atrophy (PMA), on the other hand, is a pure LMN disease.<sup>33</sup> Additional variants include flail leg and

Table 2 Conditions that may mimic ALS<sup>25,29</sup>

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#### STRUCTURAL DISORDERS

- Syringomyelia or syringobulbia
- Cervical spondylotic myelopathy
- Central nervous system (CNS) tumors
- Arnold-Chiari malformations
- Cervical disc herniations
- Lumbo-sacral radiculopathy

#### IMMUNE AND INFLAMMATORY DISORDERS

- Multifocal motor neuropathy
- Multiple sclerosis
- Myasthenia gravis
- Inclusion body myositis

#### METABOLIC DISORDERS

- Hyperthyroidism
- Hyperparathyroidism

#### OTHER CNS DEGENERATIVE DISORDERS

- Parkinson disease

#### INFECTIOUS DISORDERS

- Creutzfeldt-Jakob disease
- Syphilis

#### HEREDITARY NEUROLOGICAL DISORDERS

- Kennedy's disease

flail arm syndromes. Flail arm syndrome is a LMN disorder of the upper limbs while flail leg syndrome is a LMN disorder of lower limbs.<sup>34</sup> PLS and the flail syndromes have a more benign course than ALS however PMA has a prognosis almost as poor as ALS.<sup>32,33,34</sup> These syndromes are considered variants because they share molecular findings and at autopsy both UMN and LMN involvement is visualized.<sup>5</sup>

ALS has a predictable progressive, rapid and widespread clinical course. A 28-year retrospective study pub-

Table 3 Summary of Revised El Escorial Diagnostic Criteria for diagnosing ALS<sup>25,30</sup>

The clinical diagnosis of ALS, without pathological confirmation, may be categorized into various levels of certainty by clinical assessment alone, depending on the presence of UMN and LMN signs together in the same topographical anatomical region in either the brainstem (bulbar cranial motor neurons) or the cervical, thoracic, or lumbosacral spinal cord (anterior horn motor neurons).

Table adapted and printed with permission from Wijesekera LC, Leigh PN. Amyotrophic lateral sclerosis. *Orphanet J Rare Dis.* 2009; 4:3

Diagnostic Category	Clinical Features
• Definite ALS	• UMN & LMN signs in the bulbar region and in at least 2 spinal regions or UMN & LMN in 3 spinal regions
• Probable ALS	• UMN & LMN signs in 2 regions with at least some UMN signs rostral to the LMN signs
• Probable ALS (laboratory supported)	• UMN & LMN signs in 1 region or UMN signs in 1 region and LMN dysfunction defined by EMG in at least 2 regions
• Possible ALS	• UMN & LMN signs in 1 region (together) • UMN signs in 2 or more regions • LMN signs rostral to the UMN signs without evidence for Probable ALS(laboratory supported)

lished in 2004 showed median survival from symptom onset ranges from 2.4 years for bulbar onset and 3.1 years in spinal onset with a long term survival observed in only 6% of patients.<sup>31</sup> Riluzole, which has been hypothesized

to inhibit the release and effects of glutamate, has been shown to extend survival.<sup>35</sup> A 2007 study showed that riluzole therapy increased survival rates at 12 months by approximately 10% and prolonged life by 6 months independent of other interventions.<sup>36</sup> Additional prognostic factor include age of symptom onset, time from symptom onset to diagnosis, El Escorial diagnostic category at presentation and baseline respiratory function.<sup>25</sup>

In the absence of a cure, the goal of ALS care is to enable the patient to achieve maximal functioning and maintain autonomy for as long as possible. Helping the patient overcome communication and ambulation difficulties as well as managing ventilation and nutrition are key independence issues. Furthermore all efforts should be made to improve quality of life through treatments for the associated physical symptoms including cramps, spasticity, pain, sialorrhea, fatigue and insomnia, constipation, aspiration and laryngospasm. The psychological symptoms that ALS patients face such as fear, hopelessness, depression and anxiety as well as cognitive impairment need to be attended to.<sup>6</sup> A multidisciplinary approach is essential. It has been shown to improve quality of life<sup>37</sup> as well as improve prognosis and lengthen survival<sup>38</sup> in recent studies.

This case highlights important aspects of the disease. As is most common in ALS, the presenting symptom was limb weakness. The patient presented to our clinic with LMN signs in two regions evidenced by dysarthria and the weakness and fasciculation in the upper limb as well as UMN signs in two regions displayed by pathological reflexes in the upper and lower limb. This presentation is compatible with possible-probable ALS.<sup>25,30</sup> This was unknown to the author at the time; however, there were sufficient signs and symptoms to warrant concern and recommend a neurological consult. Following the investigations by the neurologist, a diagnosis of ALS was established. In spite of the medication and multidisciplinary care, the patient’s deterioration was progressive, rapid and relentless.

There were aspects of the case that initially confounded the diagnosis. The onset of symptoms appeared related to increased hours at work and they were relieved by rest. On examination, the patient did demonstrate sensory findings which would not be expected with ALS however it is likely there was a musculoskeletal condition such as a nerve entrapment. Additionally, a normal Babinski re-

sponse was elicited which would suggest that there was not an UMN lesion.

A literature search for previously published studies on this topic was done. The PubMed and Index to Chiropractic Literature databases were searched with the terms ("Amyotrophic Lateral Sclerosis" [Mesh] or "Amyotrophic Lateral Sclerosis" or "Lou Gehrig's disease") and ("Manipulation, Chiropractic"[Mesh] or "Musculoskeletal Manipulations"[Mesh] or "chiropract\*" or "manipulat\*" or "spinal manipulation") revealed no results for articles detailing the involvement of chiropractors with ALS. It is possible that chiropractic is a safe and effective palliative option for the musculoskeletal effects of the disease similar to its benefits for tardive dyskinesia<sup>39</sup> and multiple sclerosis<sup>40</sup> outlined in previous studies; however, research specifically into its benefits for ALS patients is required before a more definitive statement can be made. The need for a controlled trial into the role chiropractic has in relieving the chronic pain of neuromuscular diseases was stated in a 2005 study published in *Archive of Physical Medicine and Rehabilitation*, after it was revealed chiropractic care was the most effective treatment option and the only one that continued to be used by most patients who tried it.<sup>41</sup>

Chiropractors can contribute to the early detection of ALS by being cognizant of its nature and presentation. Early ALS diagnosis has become increasingly important as this facilitates arrangement of the best care and enables early administration of disease modifying medication as a potential means to improve quality of life in patients with this devastating disease.<sup>26,42</sup>

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# The association between neck pain, the Neck Disability Index and cervical ranges of motion: a narrative review

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**Background:** *The Neck Disability Index (NDI) and Cervical Ranges of Motion (CROM) are measurement tools that are used for neck pain patients.*

**Objective:** *To review the literature to determine how the NDI is associated with neck pain and CROM outcomes.*

**Methods:** *Computer based searches of 5 databases were performed and supplemented by internet and hand searching of article references and "related citations."*

**Results:** *The search yielded 23 studies that met the inclusion and exclusion criteria and these were summarized into four categories: NDI, NDI and other questionnaires, whiplash and NDI and cervical range of motion and NDI. The NDI was shown to be a well validated and reliable self-reported questionnaire, especially when compared to other questionnaires, in both neck pain and whiplash (WAD) patients. There are very few studies that discuss the NDI and cervical range of motion.*

**Conclusion:** *This review outlines the strength of the NDI as a self-reported neck disability questionnaire, but also demonstrates a need for further research to explore the association between the NDI, neck pain and cervical ranges of motion.*

(JCCA 2011; 55(3):211-221)

**KEY WORDS:** neck pain, neck disability index, range of motion, whiplash

**Historique :** *l'indice d'invalidité du cou (NDI) et la portée du mouvement cervical (CROM) sont des outils servant à mesurer la douleur au cou des patients.*

**Objectif :** *lire la documentation afin de déterminer le lien entre le NDI et la douleur au cou et les résultats de CROM.*

**Méthodes :** *recherche par ordinateur de 5 banques de données, à laquelle s'ajoute une recherche sur Internet et une recherche à la main de références et de « citations connexes ».*

**Résultats :** *la recherche a permis de consulter 23 études répondant aux critères d'inclusion et d'exclusion, et ces études furent résumées en quatre catégories : NDI, NDI et autres questionnaires, coup de fouet cervical et NDI, et portée du mouvement cervical et NDI. Le NDI s'avéra un questionnaire fiable et bien documenté par rapport aux autres questionnaires, autant chez les patients souffrant de douleur au cou que chez ceux qui souffrent de coup de fouet cervical. Il existe peu d'études traitant du NDI et de la portée du mouvement cervical.*

**Conclusion :** *cette analyse résume les points forts du NDI en tant que questionnaire rempli directement par les patients souffrant de douleur au cou, mais aussi à des fins de recherche visant à déterminer le lien entre le NDI, la douleur au cou et la portée du mouvement cervical.*  
(JCCA 2011; 55(3):211-221)

**MOTS CLÉS :** douleur au cou, indice d'invalidité du cou, portée du mouvement cervical, coup de fouet cervical

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## Introduction

Self-reported disability and other outcome measures are an important part of patient assessment and provide important clinical information to the clinician. Neck pain related disability and function need to be measured in order to assess pre and post treatment patient outcomes, as well as provide valuable information to other stakeholders.

The Neck Disability Index (NDI) is a 10-item questionnaire that measures a patient's self-reported neck pain related disability. It was the first of its kind when it was published in 1991 in JMPT and was based on the Oswestry Low Back Pain Disability Questionnaire. The NDI was reviewed in 2008 by the same author. The NDI is the most widely used, translated and oldest questionnaire for neck pain. It has been shown to have high "test-retest" reliability. The NDI has also been shown to be valid when comparing it to other pain and disability measures. Questions include activities of daily living, such as: personal care, lifting, reading, work, driving, sleeping, recreational activities, pain intensity, concentration and headache. Each question is measured on a scale from 0 (no disability) to 5, and an overall score out of 100 is calculated by adding each item score together and multiplying it by two. A higher NDI score means the greater a patient's perceived disability due to neck pain. The "minimally clinically important change" by patients has been found to be 5 or 10%. The NDI has been translated into over 20 languages, cited by over 350 articles in the scientific literature, used in over 100 treatment studies and has been endorsed by many guidelines.<sup>1,2</sup>

Cervical ranges of motion are frequently used in clinical practice as a functional outcome measure, but is usually performed visually and not with a CROM device. How CROM relates with a neck pain patient's self-reported disability still needs to be investigated. In a recent cross-sectional survey of chiropractors, the majority reported that they do not use psychosocial questionnaires or condition-specific disability indices to document health status. Most rely on history taking and pain drawings, as well as neurological and visual testing for patient visits. The NDI and CROM device were reported to be underused in clinical practice, but are important tools to give practitioners clinical baselines and treatment outcome measures.<sup>3</sup>

The association between neck pain (including WAD), the Neck Disability Index, and cervical ranges of motion was investigated in the literature. The aims of this litera-

ture review are to investigate any association between the three; describe any lack of information; and to suggest areas for further research.

## Methods

MEDLINE (via EBSCO and PubMed), CINAHL, Index to Chiropractic Literature, SPORTDiscus and the Cochrane Database of Systematic Reviews were searched for the earliest possible dates of inclusion through to September 2010. Search terms included MeSH terms: "neck pain," "disability evaluation," "severity of illness index," "health status indicators," "pain measurement" "range of motion - articular" and "whiplash," as well as "neck disability index/NDI." All searches met the inclusion criteria: human, adult (18 years of age or older) and English-language studies. Types of studies included were systematic and narrative reviews, randomized controlled trials, cohort studies and case series. Exclusion criteria included: non-NDI data, non-English language, not adult subjects, unpublished data, as well as those that were not from peer-reviewed publications and did not use methodologies (such as editorials, commentaries, case studies, etc). Additional references were later identified from references of relevant articles, as well as "related citations" (in PubMed's MEDLINE feature) were also assessed for the review. One rebuttal was included, as it applied specifically to a particular study and was written by the NDI's original author.

## Results

A literature search of the five databases resulted in 54 articles, including the following: MEDLINE (n = 26), CINAHL (n = 27), ICL (n = 6), SPORTDiscus (n = 15), and Cochrane (n = 6). The total located citations that met the inclusion and exclusion criteria and were also found by references from the original articles (n = 23) were reviewed.

## Discussion

The association between NDI, CROM, and neck pain (including whiplash) has not been well studied. There were many articles that measured each individual factor, but the association between them has not been reviewed in depth. Since there is a general lack of information on these topics, this review attempts to summarize the small parts found in the few articles that discuss these topics. The review has been structured into four parts, including:

NDI, NDI and other questionnaires, NDI and WAD, and NDI and cervical ranges of motion (CROM). A recommendation for future research would include further studies with respect to the correlation between neck pain, NDI and cervical ranges of motion.

### **I. The Neck Disability Index (NDI) (see table 1 for summary)**

In a cross sectional study of 237 neck pain patients, Hains et al. evaluated the responses in the original NDI and 7 other modified versions of the NDI. They determined that there was a lack of response set bias, concluding that patients were responding to the questionnaire content and not the format of the items. They also reported a high internal consistency. The authors concluded that each item of the NDI contributes equal weight, relates positively to the VAS measured pain, and that overall the NDI possesses stable psychometric characteristics to assess disability and treatment response over time for neck pain patients.<sup>4</sup>

Another more recent study of the psychosocial, physical and workplace features of female office workers found that those with neck pain and disability can be differentiated from those with no disability (using the NDI). Low supervisor support was reported to be associated with a higher NDI score. As well, they observed a linear relationship between the frequency of mouse use and NDI score.<sup>5</sup>

In 2007, Pool et al. reported a prospective, single-cohort study to assess the minimally clinically important change (MCIC) on the NDI and the Numerical Rating Scale for neck pain patients. They summarized that the NDI is frequently used, has good validity and test-retest reliability. They stated that MCIC was investigated as a measure of the change in health status within patients, as opposed to minimally clinically important difference (which they state is different between patients). In the 183 neck pain patients they studied, they found that MCIC can be used to detect clinically important change. They used the method of the optimal cutoff point of the receiver operator characteristic curve (ROC) curve, which helps to improve the interpretability of change scores since it is expressed in scale points and is a diagnostic test to discriminate between important and non-important improvement in disability and index scales. For example, when they used the ROC curve optimal cutoff point, they found the MCIC or change score of 3.5 on the NDI could best distinguish patients who are clinically improved from those who are not.<sup>6</sup>

In 2009, Young et al. studied 91 neck pain subjects in a cohort study that looked at the test-retest reliability, construct validity minimally clinically important difference (MCID) and the minimal detectable change (MDC) for the NDI. They found that the NDI appeared to show moderate test-retest reliability, adequate responsiveness and that a 10-point change out of 50 points (the MDC) should be used as the MCID for patients with and without concurrent upper extremity symptoms.<sup>7</sup>

In 2008, Cleland et al. undertook a single-group repeated measure cohort study of 137 neck pain patients. They studied the test-retest reliability, construct validity and minimal levels of detectable and clinically important change for the NDI and the numeric rating scale (NRS). They found both the NDI and the NRS have fair to moderate test-retest reliability and adequate responsiveness. They also reported that the MCID was twice what was previously reported for the NDI (19 points).<sup>8</sup> Vernon rebutted the findings in this study a few months later in a letter to the editor, stating that 6 studies were published in 2007 reporting good test-retest reliability. Also, that Cleland used a “stable group” after a single treatment, which violates the test-retest assumption that the two testing occasions are similar (leaving subjects to be selected based on clinical status after the fact). It was also stated that the variance in subjects with minimal change in their NDI scores may have been a factor why Cleland obtained a low reliability. NDI values were only obtained with one rating, as opposed to the numeric rating scale for pain (which they did 3 ratings), therefore reducing the reliability of one and increasing the other. Vernon also noted another limitation to the study was that the time interval used to assess the true responsiveness of the NDI was too short, since the investigators obtained information from patients over up to 2 intervals of 2–4 days. Finally, the year prior to Cleland’s article being published, Vernon stated that 11 publications reported responsiveness of the NDI, but that Cleland only mentioned 2 references to report MDIC values. None of these studies had treatment intervals of less than two weeks. Vernon concluded that disability and pain are different constructs and that each will have different responsiveness. The short time-line used in Cleland et al.’s study was stated to be too short and was never advocated by the NDI developer, Vernon himself.<sup>9</sup>

In 2009, MacDermid et al. systematically reviewed the measurement properties of the NDI. They found that most

Table 1 *The Neck Disability Index (NDI)*

Study	Design Strength	Design limit	Measure	Results
Hains, et al 1998	N = 237 Cross-sectional study	Patients recruited from chiropractic college clinic who were already seeking treatment	7 modified versions + original NDI	NDI has stable psychometric properties and is an objective measure
Johnston et al 2009	N = 52 neck pain subjects and 22 controls Laboratory based cross-sectional design	Non-disabled subjects still reported occasional symptoms	NDI, surveys, Thermotest unit, PPT, skin blood flow, active neck ROM, sEMG, heart rate	Low supervisor support and higher mouse use correlate with higher NDI score
Pool et al 2007	N = 183 Prospective single-cohort study	Explanation confusing at times of the MDC and ROC curve cutoff point	NDI, NRS pain scale, global perceived effect with 6-point Likert scale	MDC for the NDI is 10.5 & a change score of 3.5 distinguishes disabled from not
Young et al 2009	N = 91 Cohort study	Short 3 week follow up (after 6 treatments); recall bias with GRC; 60% patients had upper extremity symptoms;	NDI, Global Rating of Change (GRC) scale	NDI demonstrates adequate responsiveness & 10-point change out of 50 (the MDC) should be used as the MCID
Cleland et al 2008	N = 137 Single-group repeated measures design	Other studies report good test-retest reliability; use of stable group after one treatment; NDI values obtained with only one rating (unlike pain scale used three ratings); short time-line used; did not reference other numerous MDIC value studies	NDI, NRS, GRC	NDI and NRS fair to moderate test-retest reliability & adequate responsiveness; MCID twice previously reported
MacDermaid et al 2009	N = 37 primary studies, 3 reviews and 1 in-press paper; Systematic literature review	A large number of authors could lead to reviewing inconsistencies.	NDI	Acceptable reliability, validity and responsiveness; culturally valid; MDC 5-10/50; NDI strongly correlates with other similar indices

studies suggested that the NDI has acceptable reliability (and that longer test intervals and defining stable helped to influence their findings), validity and responsiveness. The MDC is around 5/50 for uncomplicated neck pain and up to 10/50 for cervical radiculopathy. They also found many cultural validation studies for multiple languages. They found inconsistency for the reported clinically important difference from 5/50 to 19/50. They stated that the NDI is strongly correlated to many other similar indices and moderately related to physical and mental aspects of general health.<sup>10</sup>

## **II. NDI and other questionnaires (see table 2 for summary)**

The NDI and the Neck Bournemouth Questionnaire (NBQ) were compared in a prospective longitudinal study of 23 chronic uncomplicated neck pain patients by Gay et al. in 2007. They found that both questionnaires had similar sensitivity to change (better than pain VAS) and similar responsiveness, acceptable internal consistency, and low respondent burden. They reported a lack of strong correlation between pain VAS change and both questionnaires and suggested that this meant that clinical improvements may be more complex than pain severity rating alone. They also found that the NBQ had good convergent validity with the NDI, with a strong correlation between them for pre and post treatment scores.<sup>11</sup>

Hoving et al. assessed the validity of the NDI and the Northwick Park neck pain questionnaire (NPCP) in 71 whiplash patients. They found that the NDI and NPCP questionnaire correlated highly with each other. They also found that only the NDI included work driving and sleep factors, while commonly problematic emotional and social items are absent.<sup>12</sup>

In her narrative review, Resnick observed that the NDI was the first outcome measurement to assess the impact of neck pain on activities of daily living (ADLs). This review revealed a high degree of reliability, internal consistency, construct validity and a moderate correlation between NDI, VAS and MPQ. She also found the NDI did not assess emotional function, but it had more correlation with SF-36 scores than with cervical ROM. Resnick concluded that developing a gold standard subjective outcome measure for neck pain would be difficult, since the wide range of bio psychosocial influences acting on each patient are so individual. She

suggested instead that a standard set of outcome measures would allow for treatment effect comparison across studies.<sup>13</sup>

McCarthy et al. compared the NDI with the short form-36 health survey questionnaire in a prospective cohort study of 150 completed questionnaires. They found that the NDI and SF-36 both had good internal consistency, the NDI had high test-retest reliability and the NDI had good reliability and validity and compares well to the SF36 in the spinal surgery out patient setting (which they stated has been shown in physiotherapy settings or whiplash injured patients in previous studies). They also reported that the minimum clinically important difference for the NDI is around ten points.<sup>14</sup>

Most recently, Ferreira et al. did a systematic review in 2010 that compared neck pain scales and questionnaires to see if they are compatible with the international classification of functioning, disability and health (ICF). They found that the NDI alone has shown excellent reliability, including internal consistency and test-retest reliability, and convergent correlation with the pain visual analog scale. They also stated that the NDI had four items categorized as body functions, six sections as activity and participation and two sections that were linked to two ICF categories (personal care and reading). Overall, they found that the neck Bournemouth questionnaire (NBQ), NDI and neck pain and disability scale (NPDS) all showed a well-balanced item distribution in terms of body function and activity and participation components. They also concluded that these three have the best fit to the bio-psycho-social framework that the World Health Organization promotes with a good distribution of items across the components and ICF categories. All three were reported to have excellent reliability and validity, excellent to adequate consistency, but that their sensitivity to change needs further investigation.<sup>15</sup>

## **III. Whiplash and the NDI (see table 3 for summary)**

When correlating the NDI to whiplash, Vernon reported in his review in 2008 that the NDI has been used in 41 WAD studies. Several of these studies reported that the NDI score was the best predictor of outcome, meaning that a low initial NDI score predicted recovery and a high initial NDI score predicted chronicity. It was shown that the NDI is very useful in patients with WAD injury alone or with multivariable models when it came to prognos-

Table 2 *NDI and other questionnaires*

Study	Design Strength	Design limit	Measure	Results
Gay et al 2007	N = 23 Prospective longitudinal study	Small sample size; short 4 week treatment timeline follow-up; no minimum pain level required for study entry	NDI, NBQ	Both had similar sensitivity to change and responsiveness; acceptable internal consistency; good convergent validity with each other and strong correlation for pre and post treatment scores
Hoving et al 2003	N = 71 WAD patients Cross-sectional study	More women in study; mean scores low on some items and doesn't allow for detection of improvement; only cross-sectional data collected and therefore did not look at change over time	NDI, NPQ	Correlate highly with each other; NDI only includes certain factors measured; emotional and social items are absent in both.
Resnick 2005	N = 11 Narrative review	Did not include all neck pain measures because some unavailable; did not include non-organic signs tools	BNQ, CNFDS, DRI, ABPS, FRI, NDI, NPAD, NPNPQ, PSFS, WDQ, VAS	NDI first outcomes measure for neck pain and ADLs; high reliability, internal consistency, construct validity and moderate correlation between NDI, VAS and MPQ; NDI more correlation with SF-36 than with CROM.
McCarthy et al 2007	N = 150 questionnaires; Prospective single cohort study	Did not do with specific defined neck pain populations; hospital setting; did not investigate responsiveness to change of the NDI or floor or ceiling effects of NDI.	NDI & short form-36 health survey	Both have good internal consistency; NDI high test-retest reliability, good reliability and validity; NDI compares well with SF-36; MDID for NDI around 10 points.
Ferreira et al 2010	74 Systematic review	Not all questionnaires include all ICF categories, therefore all will fall short of fulfilling the requirements; some items could not be classified; not all descriptions fit into ICF framework.	NDI, PDI, NPQ, CNFDS, NPDS, NBQ, FRI; all compared with the ICF	NDI had excellent reliability and convergent correlation with VAS; NBQ, NDI and NPDS all have well-balanced distribution of items for body function, activity and participation components (and are best fit to ICF bio-psycho-social framework)

Table 3 *NDI and whiplash*

Study	Design strength	Design limit	Measure	Results
Vernon 2008	41 NDI and WAD studies Review	Review done by NDI author himself (could have some bias)	NDI	NDI most widely used and strongly validated self-rated disability measure for neck pain; best outcome predictor (especially of longer term physiological dysfunction and physical impairment)
Kaale et al 2005	N = 92 chronic grade 2 WAD patients & 30 controls	Controls were being treated by physical therapist for other conditions (not specified); controls slightly older than WAD patients.	MRI , NDI	Transverse ligament and posterior atlanto-occipital membrane lesions relate to NDI scores.
Pereira et al 2008	N= 30 WAD and 30 controls Case control study	WAD patients older, had more driving experience, had higher composite driving tasks scores and used more assistance with driving than controls; measures were taken in laboratory and not in real driving context;	NDI, GHQ-28, IES-R, TSK, DHQ, CROM (with Fastrak), cervical joint position sense, smoother pursuit neck torsion test	WAD had CROM deficits (more so in flexion, extension and rotation); moderate correlation between driving task scores and pain and disability levels
Stewart et al 2007	N = 132 chronic WAD patients Cohort study	Baseline and 6 weeks follow-up measurement (after 12 session of exercise program); used diary (not supervised exercise).	NDI, pain intensity, bothersomeness, SF-36, PSFS, FRS, Copenhagen Scale, SF-36 physical summary	NDI and other region-specific measures no more responsive than other general disability measures; region-specific measures are easy to administer and score and are relevant to neck pain population
Vernon et al 2009	N = 107 chronic WAD Cross-sectional correlation design	Pain and disability status of sample higher than previous studies; referral bias of obtaining subjects; no-fault insurance system jurisdiction;	NDI, TSK, pain VAS, pain diagram.	Fear avoidance beliefs and pain amplification have some moderate influence on self-reported disability (and NDI scores) in WAD subjects; Pain diagram correlates with NDI scores

sis of outcome. It was determined that it was better than “pain level” and that high levels of NDI 3–36 months post accident were strongly correlated with key physiologic dysfunction and physical impairment measure. Vernon stated that this demonstrated that attention must be paid to pathophysiologic factors as a cause of high self-rated disability and not just psychosocial and accident-related findings in chronic whiplash patients.<sup>2</sup>

Kaale et al. observed MRI findings in 92 whiplash patients and 30 controls and found that lesions in the transverse ligament and the posterior atlanto-occipital membrane were related to NDI score (and less so for the alar ligament). They also found that whiplash patients scored higher on NDI scores than the controls, especially for questions related to neck pain, reading, headache, concentration, driving and overall activity level. They concluded that whiplash patients’ symptoms can be linked to structural abnormalities in upper cervical ligaments and membranes observed in high resolution MRI.<sup>16</sup>

In 2008, Pereira et al. reported in their case-control study that chronically injured whiplash subjects had deficits in range of motion, significantly so in flexion, extension and rotation. They also found a moderate correlation ( $r = 0.5$ ) between driving task scores and reported levels of pain and disability (NDI). However, they did not find a correlation between neck ROM and driving habits scores or degree of difficulty with reversing or reverse parking. They concluded that chronic whiplash patients present with physical performance deficits as well as ongoing psychologic features and that driving difficulties are associated with ongoing psychologic distress.<sup>17</sup>

In 2007, Stewart et al. compared several pain and disability measures in 132 chronic whiplash patients in their cohort study, including the NDI. They included many measurement tools, including: pain intensity, SF-36 bodily pain score, Patient Specific Functional Scale, NDI, Functional Rating Scale, Copenhagen Scale and the SF-36 physical summary. They found that the NDI and other region-specific disability scales were not better than others, which they extrapolated to suggest that any could be used for whiplash patients. They also reported no difference between external responsiveness of these measures and the generic disability measure. They did state that the region-specific measures are easy to administer and score and are relevant to the neck pain population. Overall, they recommended the Patient Specific Func-

tional Scale as the most responsive measure for this patient group.<sup>18</sup>

Most recently in 2009, Vernon et al. published a cross-sectional clinical study on 107 chronic whiplash patients. They found that important psychological factors, including fear avoidance beliefs and pain amplification, have some moderate influence on self-reported disability in this patient population and that this effect plateaus fairly early in post-injury time period. They also reported that duration of symptoms, age and gender did not seem to have a significant association with NDI scores. They discussed that fear avoidance beliefs and pain amplification ratings correlated with NDI scores and added approximately 30% of score variance for an average 13.4 months post whiplash but the NDI is an accurate reflection of self-rated disability. They also reported that the Pain Diagram correlated with NDI scores and pain severity and may provide insights into nonorganic pain behaviours. They concluded that generally, the NDI does provide an accurate picture of chronic whiplash sufferers, with psychological factors only moderately influencing NDI scores (including pain VAS and fear avoidance, as measured by the Tampa Scale for Kinesiophobia).<sup>19</sup>

#### **IV. Cervical Range of motion (CROM) and the NDI (see table 4 for summary)**

In 2005, Kumbhare et al. reported that cervical flexor endurance (CFE) had more between subject variability than NDI or range of motion scores, but that overall CFE, CROM in each plane and NDI had similar effect sizes. They quoted Vernon in 1997, stating that ROM seems consistent with weak correlations between NDI and CROM in chronic neck pain patients. Also, that side flexion only correlated with NDI unilaterally and that there were no correlations between NDI and flexion, extension and rotation. They also stated they found that CFE is relevant to disability and that CROM measures different aspects of neck function.<sup>20</sup>

Ylinen et al. studied 175 female office workers in 2004, using VAS, NDI, passive ROM and maximal isometric neck muscle strength testing. They stated that several studies have shown significantly reduced CROM in flexion and extension in patients with disabling neck pain. They found a considerable variability in their subjects in the amount of neck pain and disability due to chronic neck pain. They also found a great variation in passive



Table 4 *NDI and range of motion*

Study	Design Strength	Design limit	Measure	Results
Kumbhare et al 2005	N = 81 WAD grade II patients & 160 controls	Controls had no more than 3/10 VAS for neck pain (true controls?); pain increased by 50% during CFE testing; CFE measurement variability;	VAS, CROM, NDI, grip strength, CFE using a stopwatch	CROM and NDI have similar effect sizes; CROM consistent with weak correlations to NDI; side flexion correlates with NDI unilaterally; CFE relevant to disability
Ylinen et al 2004	N = 175 female office workers	Female subjects only included; most subjects right-handed;	VAS, NDI, passive CROM (with 3D motion-testing device), Maximal isometric neck muscle strength	Studies showed reduced CROM in flexion and extension in disabled neck pain patients; found considerable variability; weak correlation between pain and CROM;
Piva et al 2006	N = 30 neck pain patients	Only included subjects with NDI of less than 60%; reliability of PIM/palpation as a measure?	NDI, active CROM (gravity goniometer), PIM (palpation)	Active CROM in sagittal and transverse planes were significantly associated with disability scores
Jordan et al 1997	N = 119 chronic neck pain patients & 80 age-matched controls	Patients were seeking neck pain treatment;	VAS, ADL Standardized Nordic Questionnaire, Maximum isometric muscle strength (strain gauge dynamometer), Active ROM (goniometer)	Active CROM had good within-day and day-to-day reproducibility, was significantly reduced in women and not in all males; physical measurements are of clinical value and demonstrate weak correlations to patient reported pain and disability.

CROM. They did find that neck pain was felt by subjects more often and more intensely in right rotation compared to the left, which they concluded may be related to handedness. They expected that more severe pain would lead to greater disability, decreased muscle strength and restricted CROM. They did find several patients who did have restricted CROM, but that there was no significant correlation between pain and ROM. They also stated that that passive ROM has been suggested to be more reliable than active motion. The only significant correlations were

found to be weak between ROM and pain were in extension and left rotation, leading them to conclude that pain is not the reason for reduced ROM in most directions.<sup>21</sup>

Piva et al. measured passive intervertebral and active cervical spine movements in neck pain patients using a gravity goniometer. They included patients with an NDI score of less than 60%, since above this point patients have a high level of disability whereby repeating the examination procedures would exacerbate the patient's symptoms.

They reported that establishing the validity of active ROM and its association to disability helps practitioners interpret clinical meanings of the measurements they take. They found that measures of active ROM in the sagittal (flexion/extension) and transverse (rotation) planes were significantly associated with disability scores. Therefore, they suggested that practitioners should pay attention to total changes in these planes of movement when assessing patients with neck pain. They stated that improvements in active ROM will most likely be clinically relevant to patients overall functional improvement and correlated to their overall prognosis.<sup>22</sup>

Jordan et al. found significant reductions in active ROM during extension in 119 neck pain patients when compared with 80 age-matched controls. Using an electronic goniometer, they found that active ROM had good within-day and day-to-day reproducibility and was significantly reduced in women, but not in all male age groups. They also reported that physical measurements do have clinical value, but demonstrate weak correlations to patients' self-reported pain and disability.<sup>23</sup>

## Conclusion

Overall, the literature agrees that the NDI is a valid, reliable, responsive and internally consistent clinical tool to measure self-reported disability as it relates to patients with neck pain. It objectifies the self-rated experience of the patient. The NDI provides us with a starting point, off of which to springboard further research possibilities. When compared to other questionnaires, the NDI correlates well with other measures and has similar sensitivity to change and responsiveness, good convergent validity and correlates with pre and post treatment scores. The NDI was shown to not assess emotional function and that its sensitivity to change needs further investigation. Specifically in whiplash patients, studies showed that the NDI was a good predictor of long term outcomes and that patient's symptoms can be linked to structural abnormalities on MRI and NDI scores. Correlations were found with pain, disability and driving task scores in WAD patients but duration of symptoms, age and gender did not have a significant association with NDI scores in WAD patients. Pain diagrams were found to correlate with NDI scores. Overall, there has been more research in the WAD population and the NDI seems to be appropriately used.

Cervical range of motion also provides us with another

commonly used and important clinical outcome measure that measures neck function. CROM can relate to clinical prognosis, but in the four studies reviewed it was shown in only one paper to have a weak correlation to the NDI and CROM was found to be reduced in disabled neck patients in another study. There is a real lack of information in this area and a therefore a great need for more studies that look at the association between CROM and NDI.

The articles in this review represent the current state of the literature. The association between neck pain (including whiplash), the NDI and cervical ranges of motion is not well documented and therefore, it is appropriate to recommend further studies in this area.

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# The Tampa Scale of Kinesiophobia and neck pain, disability and range of motion: a narrative review of the literature

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**Background:** *The Tampa Scale of Kinesiophobia (TSK) that was developed in 1990 is a 17 item scale originally developed to measure the fear of movement related to chronic lower back pain.*

**Objective:** *To review the literature regarding TSK and neck pain, perceived disability and range of motion of the cervical spine.*

**Methods:** *Medline, MANTIS, Index to Chiropractic Literature and CINAHL were searched.*

**Results:** *A total of 16 related articles were found and divided into four categories: TSK and Neck Pain; TSK, Neck Pain and Disability; TSK, Neck Pain, Disability and Strength; and TSK, Neck Pain and Surface Electromyography.*

**Conclusion:** *The fear avoidance model can be applied to neck pain sufferers and there is value from a psychometric perspective in using the TSK to assess kinesiophobia. Future research should investigate if, and to what extent, other measureable factors commonly associated with neck pain, such as decreased range of motion, correlate with kinesiophobia.*  
(JCCA 2011; 55(3):222-232)

**KEY WORDS:** kinesiophobia, neck pain, cervical spine

## Introduction

The persistence of pain (or chronic pain) can lead to changes in behaviour for both physical and psychological reasons. The International Association for the Study of Pain has defined chronic pain as "... that which persists be-

**Historique :** *l'Échelle de kinésiophobie de Tampa (TSK) fut élaborée en 1990 à titre d'échelle de 17 éléments dont le but consistait à mesurer la crainte du mouvement lié aux douleurs lombaires chroniques.*

**Objectif :** *lire la documentation concernant la TSK et les douleurs au cou, l'invalidité perçue et la portée du mouvement de la colonne cervicale.*

**Méthodes :** *recherche dans Medline, MANTIS, l'index de la documentation sur la chiropratique, et CINAHL.*

**Résultats :** *16 articles ont été trouvés, puis divisés en quatre catégories : TSK et douleur au cou ; TSK, douleur au cou et invalidité ; TSK, douleur au cou, invalidité et force ; et TSK, douleur au cou et électromyographie de surface.*

**Conclusion :** *le modèle d'évitement de la peur peut être appliqué à ceux qui souffrent de douleurs au cou, et d'un point de vue psychométrique, il peut être utile de recourir à la TSK pour évaluer la kinésiophobie. Des recherches plus approfondies pourraient servir à déterminer si et dans quelle mesure d'autres facteurs quantifiables communément associés à la douleur au cou, tels que la portée de mouvement diminuée, ont un lien avec la kinésiophobie.*  
(JCCA 2011; 55(3):222-232)

**MOTS CLÉS :** kinésiophobie, douleur au cou, colonne cervicale

yond the normal time of healing."<sup>1</sup> One source reported that up to 80% of the population will have musculoskeletal pain and that it is a major cause of disability and limitation of activity.<sup>1</sup> In 1983 a concept known as the fear avoidance model was introduced by Lethem, Slade,

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Troup and Bentley which attempts to “explain how and why some individuals develop a more significant psychological overlay than others do.”<sup>1,2</sup> The model explains that avoidance of pain because of fear and the avoidance of painful activities (cognitive and behavioural avoidance) lead to physical and psychological consequences.<sup>1</sup> This model has been widely used and supported.

Kinesiophobia is a term that was introduced by Miller, Kori and Todd in 1990 at the Ninth Annual Scientific Meeting of the American Pain Society and describes a situation where “a patient has an excessive, irrational, and debilitating fear of physical movement and activity resulting from a feeling of vulnerability to painful injury or reinjury.”<sup>1,3</sup> The Tampa Scale for Kinesiophobia (TSK) is a 17 item questionnaire used to assess the subjective rating of kinesiophobia or fear of movement.<sup>1,4,5</sup> The original questionnaire was developed to “discriminate between non-excessive fear and phobia among patients with chronic musculoskeletal pain.”<sup>3,4</sup> Several studies have found the scale to be a valid and reliable psychometric measure.<sup>1,4,5</sup> Initially used to measure fear of movement related to chronic low back pain, the TSK has been used increasingly for pain related to different body parts including the cervical spine.<sup>6</sup> The TSK is a self-completed questionnaire and the range of scores are from 17 to 68 where the higher scores indicate an increasing degree of kinesiophobia.<sup>6</sup>

Initial research has concluded that the fear avoidance model may be predictive after acute whiplash injury regarding the transition to chronic whiplash symptoms.<sup>7</sup> For the practitioner who regularly treats patients with this type of injury, it would be helpful to identify specific, easy and inexpensive tools to use to identify patients who are at higher risk of developing chronic symptoms and kinesiophobia. The purpose of this narrative review of the literature was to review, and summarize the literature regarding the use of the Tampa Scale of Kinesiophobia and its relationship to neck pain, perceived disability and range of motion of the cervical spine.

## Methods

An initial search was performed on July 13, 2010 of Medline, MANTIS and the Index to Chiropractic Literature (ICL). CINAHL was searched on August 17, 2010 and these databases were searched for a second time to determine if the searches yielded any new arti-

cles. The following MeSH terms were used in the CINAHL, Medline and ICL searches: “Pain Measurement,” “Questionnaires,” “Severity of Illness Index,” “pain and Psychology,” “Avoidance Learning,” “Fear/Psychology,” “Neck Injuries,” “Neck Pain,” and “Cervical Vertebrae.” The following keywords were also used: “Tampa Scale of Kinesiophobia.” The only limiter used was English Language only articles in the searches.

## Results

Numerous studies were identified regarding the TSK and musculoskeletal pain. Far fewer were found regarding TSK in relation specifically to cervical spine pain. A total of 16 studies, including one review of the literature, were found using these inclusion criteria. These studies fell into four distinct categories. The first category was TSK and neck pain which includes a total of 4 studies including the review mentioned above spanning from 2006 through 2008. The second category is TSK, neck pain and disability (using the Neck Disability Index (NDI) or other measure) and includes 10 studies spanning 2004 through 2009. The last two categories are TSK, neck pain, disability and strength and TSK, neck pain and surface EMG, each of which include one study in 2009 and 2006 respectively.

## Discussion

Each of the 16 studies identified are discussed and summarized below (Table 1).

### *TSK and Neck Pain*

The first study in this section and one of the first studies using the TSK on neck pain patients was conducted by Buitenhuis, Jaspers and Fidler and published in 2006.<sup>8</sup> Using the Dutch version of the TSK (TSK-DV) this one year prospective cohort study sent out 889 questionnaires to whiplash sufferers with neck symptoms from motor vehicle accidents from a Dutch insurance company. Sixty-six percent of the studies were returned and 367 were used for analysis. The purpose of the study was to investigate the “predictive value of early kinesiophobia on the duration of neck symptoms after a motor vehicle accident.”<sup>8</sup> It was found that a higher score on the TSK-DV was associated with longer duration of neck symptoms but that information on “early kinesiophobia does not improve prediction of duration of neck symptoms after a motor vehicle accident.”<sup>8</sup> Although this was the conclusion for

Table 1 Study summary

Study reference number(#), Publication date and Authors	Sample size	Type of Study	Objective	Results and conclusion	Limitations
(6) September 2009 Pool et. al.	13	Inception cohort with baseline assessment	To determine the applicability of the TSK to neck pain	– Supports the use of the fear avoidance model for neck pain	– use of the 'think aloud' method to fill in questionnaire may confound results
(7) 2007 Vangronsveld et. al.	N/A	Topical review	Review of a few studies that investigated the applying the fear avoidance model to chronic whiplash syndrome	– Supports the use of the fear avoidance model for neck pain	– narrow focus of topical review regarding the use of the fear avoidance model for neck pain.
(8) March/April 2006 Buitenhuis et. al.	367	Questionnaire	investigate the "predictive value of early kinesiophobia on the duration of neck symptoms after a motor vehicle accident	– Higher TSK scores predicted increased symptom duration. – Early Kinesiophobia does not improve symptom prediction	– used mailed questionnaires therefore no control over situation in which questionnaire was completed. – participants contacted through insurer (MVA) which may influence scoring on questionnaires.
(9) November 2007 Feleus et. al.	679	Prospective cohort	"determine if mean scores of kinesiophobia change over time" in those patients that they considered 'non-recovered'	– Unrecovered subjects do not exhibit changing TSK scores over time	– no previous reports of value of TSK and neck, shoulder and arm pain. – number of variables may confound study results.
(10) March 2004 Nederhand et. al.	82	Prospective longitudinal	Investigate if fear avoidance variables increase prediction of chronic neck pain	– The use of the NDI along with TSK can predict future neck pain outcomes	– recruitment method and facility of research may cause selection bias and/or symptom magnification.
(11) 2005 Sterling et. al.	80		Determine predictive capacity of the TSK measured early at long term follow up.	– Higher NDI scores (with decreased ROM (9)) and increased psychological distress/PTSD can predict the persistence of symptoms/poor outcomes	– recruitment method may cause selection bias and/or symptom magnification. – first study of its kind therefore results have yet to be confirmed.
(12) 2006 Bunketorp et. al.	47	RCT	To determine the effect of individualized supervised physical training vs. home self exercise on patients with subacute whiplash	– Self efficacy is an important factor in persistent neck pain disability	– differences in exercise programs to supervised patients may exist as different practitioners were used which may confound results. – Blinding not possible on patients or treating physiotherapists which may produce bias – increased contact with treating physiotherapists in supervised group would increase level of patient education and may confound results.
(13) March 2006 Buketorp et. al.	49	RCT	To analyze the effects on disability of subacute whiplash patients from the different factors of pain(sensory, cognitive, affective)	– Self efficacy is an important factor in persistent neck pain disability	– differences in exercise programs to supervised patients may exist as different practitioners were used which may confound results. – Blinding not possible on patients or treating physiotherapists which may produce bias – increased contact with treating physiotherapists in supervised group would increase level of patient education and may confound results. – unclear if patients matched appropriately in consideration of this study

Table 1 (Concluded)

Study references number(#), Publication date and Author	Sample size	Type of Study	Objective	Results and conclusion	Limitations
(14) 2006 Sterling et. al.	80	Prospective longitudinal	Analyze the predictive capacity of higher levels of certain variables (older age, pain, disability, cold hyperalgesia, impaired sympathetic vasoconstriction and moderate PTSD symptoms) at long term follow up of whiplash injury.	<ul style="list-style-type: none"> <li>Higher NDI scores (with decreased ROM (9)) and increased psychological distress/PTSD can predict the persistence of symptoms/poor outcomes</li> </ul>	<ul style="list-style-type: none"> <li>recruitment method and facility of research may cause selection bias and/or symptom magnification.</li> <li>unknown if findings can be extrapolated to other populations</li> </ul>
(15) February 2008 Cleland et. al.	78	Cohort	Determine the value of using the FABQ and TSK in neck pain patients	<ul style="list-style-type: none"> <li>Supports the use of the fear avoidance model for neck pain</li> </ul>	<ul style="list-style-type: none"> <li>recruitment method and facility of research may cause selection bias and/or symptom magnification.</li> <li>test-retesting may have been done too close together promoting bias.</li> </ul>
(16) 2006 Gustavsson, C and von Koch, L.	37	RCT	To examine the usefulness of this particular study design (RCT) in evaluating patients with long term neck pain and compare the effects of treatment.	<ul style="list-style-type: none"> <li>Applied relaxation group had better perceived control over pain</li> <li>Self efficacy is an important factor in persistent neck pain disability</li> </ul>	<ul style="list-style-type: none"> <li>preliminary study therefore small sample size</li> </ul>
(17) May 2008 De Loose et. al.	629	Questionnaire (cross sectional)	Estimate the prevalence and identify risk factors of neck pain in military office workers	<ul style="list-style-type: none"> <li>neck pain is prevalent in military office workers and psychosocial factors are more important in the short term</li> </ul>	<ul style="list-style-type: none"> <li>used mailed questionnaires therefore no control over situation in which questionnaire was completed.</li> <li>population may have a reluctance to admit to pain and disability/fear.</li> </ul>
(18) 2009 Nieto et. al.	147	Questionnaire	Identify if fear of movement and pain catastrophizing predict disability and depression in subacute whiplash patients.	<ul style="list-style-type: none"> <li>Supports the use of the fear avoidance model for neck pain</li> </ul>	<ul style="list-style-type: none"> <li>recruitment method and facility of research may cause selection bias and/or symptom magnification.</li> <li>long term follow up needed.</li> </ul>
(19) 2009 Vernon et. al.	107	Cross sectional design	Used chronic whiplash patients to determine if fear avoidance behaviour and pain amplification along with several factors (age, gender, duration and pain severity) correlate with perceived disability.	<ul style="list-style-type: none"> <li>Supports the use of the fear avoidance model for neck pain</li> </ul>	<ul style="list-style-type: none"> <li>focused on chronic neck pain and subjects entered study after referral for third party specialist assessment which may produce selection bias.</li> </ul>
(20) March 2009 Pearson et. al.	14 WAD 28 healthy patients	Cross sectional repeated measures design	To determine if there is a link between neck strength measurements and pain, kinesiophobia and catastrophizing in WAD patients	<ul style="list-style-type: none"> <li>No significant association was found between TSK/NDI and neck strength</li> <li>3 of 6 muscles tested in chronic WAD showed decreased strength compared to healthy subjects.</li> </ul>	<ul style="list-style-type: none"> <li>recruitment method and facility of research may cause selection bias and/or symptom magnification.</li> <li>most WAD sufferers were in driver's side collisions which may produce bias to which muscles affected</li> </ul>
(21) August 2006 Nederhand et. al.	92	Prospective longitudinal design	To determine the influence of pain and fear of movement on activation patterns of the upper trapezius muscle during the transition from acute to chronic neck pain	<ul style="list-style-type: none"> <li>Supports the use of the fear avoidance model for neck pain</li> <li>Supports the use of the pain adaptation model for neck pain</li> </ul>	<ul style="list-style-type: none"> <li>use of sEMG which is currently classified as an experimental assessment technique by the American Academy of Neurologists.</li> <li>recruitment method and facility of research may cause selection bias and/or symptom magnification.</li> </ul>

the study, it was noted that a relationship does exist between the TSK score and the duration of neck symptoms. However, when other variables were accounted for such as sex and age, the significance was lost. These variables have been previously shown to have a relationship to neck pain duration.<sup>8</sup> It was also noted that there was a relationship between TSK score and symptom intensity as well as difficulty with concentration and initiation of sleep. This study utilized mailed questionnaires to victims of motor vehicle accidents and were contacted through a Dutch insurance company. Although the authors maintain that it was made clear on the letter of invitation to the study that involvement would be independent of compensation from the insurer regarding the claim, one cannot be sure that symptom exaggeration was not present in responses. In addition, as the study was mailed, the authors identified that there was no control of the environment under which the questionnaires were completed.

In 2007, Feleus, van Dalen, Bierma-Zeinstra, Bernsen, Verhaar, Koes and Miedema used a prospective cohort design to describe the degree of kinesiophobia in patients with non-traumatic complaints of arm, neck and shoulder in general practice.<sup>9</sup> The study used the 13 item adjusted Dutch version of the TSK (TSK-AV). The aim was to “determine if mean scores of kinesiophobia change over time” in those patients that they considered “non-recovered.”<sup>9</sup> Additionally they sought to evaluate variables including age, gender, educational level, work, sports participation, duration of complaint, severity of complaint, as well as psychosocial characteristics and their association with kinesiophobia at baseline. The category of recurrent complaint was also included and accounted for not only recurrent complaints, but also multiple complaints and complaint location. The study evaluated 36 patients with a new complaint or episode of neck, upper back, shoulder, upper arm, elbow, forearm, wrist or hand pain aged 18 to 64 years. Excluded from the study were those with pain that could be explained. The patients completed an initial questionnaire and then again at 6 and 12 month follow up. It was found that the degree of kinesiophobia was unchanged in patients who did not recover during the 12 month follow up. Limitations include the lack of previous reports of the psychometric value of the TSK with respect to neck, shoulder and arm pain, the lack of measurement of depression in the patients and the use of one question to give an indication of “health locus of control.” Relation-

ships were noted between baseline scores of kinesiophobia and catastrophizing, disability and other musculoskeletal complaints/comorbidities. This said, it was noted that this made it unclear if the origin of kinesiophobia was rooted in the other comorbidities (low back pain) or a previous bad experience. Although the authors reported that these comorbidities did not modify the association, the high number of variables in this study could have confounded results. In addition, the study was not limited to neck pain only patients and included patients with arm and shoulder complaints. This could artificially inflate relationships between kinesiophobia and neck pain as patients frequently have difficulty separating these types of symptoms and their effects.

In 2007 Vangronsveld, Peters, Goossens, Linton and Vlaeyen published a topical review “Applying the fear-avoidance model to the chronic whiplash syndrome.”<sup>7</sup> This review sought to review what the authors considered to be relevant studies that examined whether the fear avoidance model can be applied to chronic whiplash syndrome. All of the studies examined in this review will be examined in detail in this paper. It was concluded that the fear avoidance model “may offer a novel framework to explain the transition from acute whiplash injury to chronic whiplash syndrome.”<sup>7</sup> It was suggested that future research should include multiple outcome measures as patients who suffer an acute whiplash not only are at risk of developing high pain levels and disability but also mood disorders and post traumatic stress disorder. Suggestions for future research include determining if high levels of catastrophizing soon after a whiplash injury lead to more complaints at final follow up, as well as studying other potential predictors (anxiety sensitivity and acute traumatic stress symptoms). This review included only a few studies as it was a topical review. The limitation is primarily that by its nature, a topical review provides a small window into the research.

Pool, Hiralal, Ostelo, van der Veer, Vlaeyen, Bouter and de Vet published a study regarding “The applicability of the Tampa Scale of Kinesiophobia for patients with sub-acute neck pain” in 2009.<sup>6</sup> This study sought to “qualitatively evaluate patients” understanding and interpretation of the wording in test items of the TSK” which was initially developed to measure fear of movement of patients suffering from low back pain. It attempted to elicit or discover problems that patients with sub-acute neck pain may have in filling out the TSK. Thirteen



patients (7 women and 6 men) aged 18 to 70 were evaluated using the Three-Step Test Interview (TSTI) which aims to identify problems with self-administered questionnaires. It was reported that two problems were identified including the use and meaning of specific words such as “dangerous” and “injury” as well as that implicit assumptions within some items make it difficult for some respondents to answer these questions. The authors concluded that in the “development and validation of questionnaires such as the TSK not only qualitative psychometric properties are important, but also qualitative research has an important contribution to enhance applicability.”<sup>6</sup> Questionnaires in this study were filled out using a “think aloud” method which the authors reported proved difficult for some participants. By its nature, this method may cause participants to become uncomfortable if they feel they are being judged by the study investigators which may influence their verbalizations. It was reported that some participants answered quickly while others did so slowly but it was not reported if any specific participant characteristic (age, gender) was related to this.

### *TSK, Neck Pain and Disability*

In 2004 Nederhand, IJzerman, Hermens, Turk and Zilvold attempted to determine the “Predictive value of fear Avoidance in developing chronic neck pain disability.”<sup>10</sup> Using an inception cohort design with a baseline assessment one week post trauma and outcome assessment at 24 weeks post trauma, the purpose of this study was to improve clinical decision making in patients with post traumatic neck pain by investigating fear avoidance in predicting neck pain disability.<sup>10</sup> Ninety-one percent of the 90 participants between the ages of 18 and 70 in the study completed the follow up outcome. It was found that by using a combination of baseline NDI and TSK scores it was possible to predict chronic disability with a probability of 54.2% after using NDI alone and 83.3% when using a combination of NDI and TSK scores. The authors concluded that a “rating of neck pain disability within a week of trauma used separately or in combination with a test for fear of movement can be used to predict future outcomes.”<sup>10</sup> This finding is opposite to the first study discussed above by Buitenhuis in 2006. However, unlike the previously discussed study this study excluded patients with neurologic signs and focused on head and neck pain alone. Limitations of this study include recruitment

method (patients admitted to the emergency department of a hospital) and the fact that the study was conducted at a well known rehabilitation and research facility. These characteristics may well lend to symptom magnification and/or have a tendency towards selection bias of those more prone to catastrophizing or symptom magnification.

In 2004, Sterling, Jull, Vicenzino, Kenardy and Darnell investigated “physical and psychological factors (that) predict outcome following whiplash injury.”<sup>11</sup> This prospective longitudinal designed study investigated 80 patients with a mean age of 36.27+/-12.69 years that reported neck pain as a result of a motor vehicle accident. The purpose of this study was to determine the predictive capacity of the combined comprehensive set of measures that included motor, sensory and psychological measures encompassing the broad biopsychosocial model of musculoskeletal pain. Measures used included motor functioning (range of motion, kinesthetic sense, and activity of superficial neck flexors on EMG), sensory testing, vasoconstrictor responses, psychological distress (including various measures along with the TSK) and the NDI. The outcome measure was persistent pain at six months post injury. It was concluded that “higher NDI scores, greater psychological distress and decreased range of motion predicted subjects with persistent milder symptoms from those who fully recovered.”<sup>11</sup> The authors suggested that both “physical and psychological factors play a role in recovery or non-recovery from whiplash injury.”<sup>11</sup> When a combination of the variables was used, the predictive value was better than when compared to previous models that did not use all of these variables. The authors reported that they could account for 67% of the variation in pain and disability using this model compared to 35% when using a combination of age, gender, psychological factors or age, gender and accident features. As this study was the first of its kind, that being the first to show that physical and psychological factors when added to previously known factors (age and initial symptom intensity) are important in predicting outcomes of whiplash injuries, confirmation of results are needed. Interestingly, higher pain reports were predicted by cervical range of motion loss. This was the only motor function that predicted long term outcomes while EMG activity in flexion of the cervical spine and joint position error were not isolated to only WAD sufferers with higher level of pain symptoms. The limitation for this study is similar to that of the study

published in 2004 by Nederhand et. al. above as patients were recruited following a motor vehicle accident in hospital emergency rooms; however, this effect is lessened as people were also recruited from primary care practice, and advertisement.

Bunketorp, Lindh, Carlsson and Stener-Victorin first used the results of their randomized controlled trial using 40 subjects in a publication in 2005.<sup>12</sup> The purpose of the study was to evaluate if a tailored and supervised physical training program had a greater influence on self efficacy, fear of movement and re-injury than a self administered home exercise program. The study used the Self Efficacy Scale and the TSK as primary measures and the Pain Disability Index as a secondary measure. It was reported that the supervised training was significantly more effective than the home training program” with a more rapid improvement in self efficacy and fear of movement at three months and that the results were partially maintained at nine months.” This was the only study elicited in the literature search that measured the outcomes of treatment with the TSK for neck pain. Improvement in kinesiophobia, perceived disability due to pain, self efficacy and analgesic use was noted to be significant in the group that received a tailored supervised exercise program compared to the home exercise group. Although the investigator performing measurements was blinded to the group the patient was in, due to the nature of the study, the five treating physiotherapists and the patients could not be blinded which may have influenced outcomes. As five different physiotherapists were used to provide treatment, and the group getting tailored treatment each had different programs, it is unclear if each patient in the supervised training group was provided with equally effective programs. In addition, the added contact between the supervised group and physiotherapists would provide increased education levels to these patients as it would be near impossible for the practitioner not to continue to educate the patients. It is therefore a confounding factor as it cannot be definitively said that the exercise program differences account for the significant differences in groups as patient education would also be a likely factor in the differences seen.

In 2006, the same investigators (Bunketorp et. al.) used the data collected in for their 2005 study to “clarify relations between sensory, affective and cognitive dimensions of pain and to analyze what influence these components

have on persistent disability in patients with sub-acute whiplash associated disorder.”<sup>13</sup> It was reported that “self efficacy was the most important predictor of persistent disability.”<sup>13</sup> Additionally the following factors were found to correspond to lower self efficacy: high pain intensity and pain affect, widespread pain and fear of movement. As the same data was used as in the previous study, it begs the question were the investigators planning this component of the research prior to the investigation or did they use existing data because a relationship was noted. If the latter is the case, bias may be present as the groups may not have been matched effectively to investigate this portion of the research. In addition, all of the same limitations listed above would also apply to this study.

The predictive value of variables including initial higher levels of pain and disability, older age, cold hyperalgesia, impaired sympathetic vasoconstriction and moderate post-traumatic stress symptoms were investigated in a study published in 2006 by Sterling, Jull and Kenardy.<sup>14</sup> The investigators noted that while these variables have been shown to be associated with poor outcomes at 6 months post whiplash, investigation of associations at long term follow up was lacking. This study used a prospective longitudinal design to follow and assess 80 acute whiplash patients to 2, 3, and 6 months post injury and again at 2–3 years post injury. The study employed the TSK and NDI as well as cervical range of motion, joint position error, pressure pain and thermal thresholds and measures of the sympathetic nervous system function (sympathetic vasoconstrictor response). It was concluded that “higher initial NDI scores, older age, cold hyperalgesia and post traumatic stress symptoms were significant predictors of poor outcome at long term follow up”<sup>14</sup> When the TSK along with Impact of Events Scale and the General Health Questionnaire 28 were used it was found that there was a “significant group effect for the group with moderate/severe symptoms at 2–3 years when compared to groups with milder symptoms.”<sup>14</sup> As it was noted that the physical and psychological characteristics of those who did not recover at 6 months and long term follow up were present at one month post injury, it was implied that this poses significant implications for early management of this type of patient. The authors suggest that this group of patients may benefit from early multidisciplinary management to include adequate pain control using pharmacotherapy, physical and psychological therapy. Subjects were re-

cruited from emergency departments following a motor vehicle accident (as well as their primary care physicians and advertisements) which may produce a bias towards those with symptom magnification. It was reported by the authors that the findings in a small group of whiplash patients may not extrapolate to expand to other populations.

In 2008 Cleland, Fritz and Childs attempted to examine “the psychometric properties of the Fear Avoidance Beliefs Questionnaire (FABQ) and the TSK in Patients with neck pain.”<sup>15</sup> Using a cohort design, 78 subjects were asked to complete the Fear Avoidance Beliefs Questionnaire Work (FABQW) and Physical Activity (FABQPA) as well as the TSK at baseline and 2 day follow up. It was reported that “the FABQW and FABQPA had subset test-retest reliability and the TSK was moderately reliable for neck pain patients.”<sup>15</sup> Consistency was found for all measures. The authors concluded that this study suggested a “weaker relationship between measures of fear and avoidance and pain/disability in patients with mechanical neck pain than has been reported among patients with lower back pain.”<sup>15</sup> The authors identified limitations of the study including the inclusion of sub-acute neck pain patients which they felt may have influenced the results as well as the fact that the dimensionality of the scales were not assessed. This factor affects the statistical tool they used (Cronbach’s alpha), which they felt may account for lower TSK scores in comparison to the other measures they used. It was also noted that subjects included were consecutive patients presenting to a hospital physiotherapy department with history of a whiplash injury within 6 weeks. This may present a bias towards patients with symptom magnification. The follow up testing was done only 2 days following initial testing which may not prove to be a significant enough amount of time between tests as patients may have a tendency to recall what they scored only two days prior. It would be interesting to have repeated this measure a more significant amount of time later such as one to three months.

Gustavsson and von Koch used measures of neck pain, TSK and NDI to “evaluate the feasibility of study design and method for evaluating effects of interventions on patients with long lasting neck pain and to compare the treatment effects of (i) a pain and stress management group intervention with applied relaxation and (ii) individual physiotherapy treatment as usual.”<sup>16</sup> Using a randomized controlled pilot study, the authors evaluated

37 patients with long lasting neck pain. Patients were assigned to either an applied relaxation group which received 7 group sessions over 7 weeks or the “as usual” group who had an average of 11 physiotherapy sessions over 20 weeks. Using the NDI, Coping Strategies Questionnaire, Hospital Anxiety and Depression Scale, TSK and questions regarding neck pain, analgesic use, sleep, sick leave and health care utilization, it was found that the applied relaxation group had “better perceived control of pain” at 20 week follow up compared to the “as usual” group. The authors concluded that “this design and methods would be suitable for a larger RCT study.”<sup>16</sup> The limitations of this study is that of its preliminary nature and small sample size for each group.

In 2008 De Loose, Burnotte, Cagnie, Stevens, Van Tiggelen and Defense used a cross sectional questionnaire study of 942 office workers of the Belgian Defense to attempt to identify short and long term risk factors in the occurrence of neck pain in military office workers.<sup>17</sup> Using the NDI and TSK to assess the impact of neck pain on the respondent’s life and pain-related fear avoidance it was concluded by the authors that the results “supported the role of physical and psychosocial job characteristics in the etiology of neck pain in military office workers.”<sup>17</sup> It was noted that in those that did respond (147 of 942) neck pain is common. As this was a questionnaire that was sent out, the study could not control the environment in which the questionnaire was filled out which may have influenced results. In addition, as it was sent to military workers, the population may have a reluctance to admit to pain, fear and disability.

Using a stepwise regression analysis, Nieto, Miro and Huguet analyzed the “fear-avoidance model in whiplash injuries” in a publication in the European Journal of Pain in 2009.<sup>18</sup> The purpose of the study was to determine if “fear of movement and pain catastrophizing predict pain related disability and depression in sub-acute whiplash patients.” While controlling for descriptive variable and pain characteristics, 147 sub-acute whiplash patients between the ages of 18 and 65 completed the Pain Catastrophizing Scale (PCS), TSK, NDI and the Beck Depression Inventory (BDI) and current neck pain was recorded on an 11 point numeric scale where 0 is “no pain” and 10 was “pain as bad as could be.” It was found that “catastrophizing and fear of movement were predictors of disability and depression” and that “pain intensity was a predictor of dis-

ability but not depression.”<sup>16</sup> The authors concluded that as the fear avoidance model suggests, fear of movement and catastrophizing are important factors with respect to developing disability and depression in whiplash patients. The study used whiplash sufferers who were involved in a car accident with pain of less than three months duration who were seeking treatment in rehabilitation facilities. As these participants were already seeking treatment, there is the possibility that this population may have a bias toward symptom magnification. This study provides data for a small period of time, namely whiplash of less than three months duration. Further study is required to determine if the relationships identified continue over time.

Vernon, Guerriero, Kavanaugh, Soave and Moreton attempted to “determine if fear avoidance behavior and pain amplification along with age, gender, duration and pain severity correlate with sources of self rated disability in chronic whiplash sufferers.”<sup>19</sup> Published in 2009, this study used a cross sectional clinical study design examined 107 subjects with a mean age of 45.5 years who completed the NDI, TSK, pain visual analogue scale and pain diagram. It was concluded by the authors that “important psychological factors including fear avoidance beliefs and pain amplification have some influence on self rated disability in chronic whiplash sufferers, (though this influence was not) larger than that found in studies of acute/sub-acute patients.”<sup>19</sup> The authors report that it is not yet clear how fear avoidance behaviour and pain amplification influence perceived disability in chronic Whiplash Associated Disorder (WAD) though they have influence on its development. The study focused on chronic patients at least three months post WAD who were referred to the study after presentation for a third party specialist assessment. This may have produced a selection bias.

### *TSK, Neck Pain, Disability and Strength*

The only study found in the literature to be included in this section was published in 2009 by Pearson, Reichert, De Serres, Dumas and Cote.<sup>20</sup> In this controlled laboratory cross-sectional, repeated measures design 14 subjects with chronic whiplash grades I and II were age matched with a healthy group and cervical strength was measured in 6 directions with a Multi-Cervical Unit. Pain was measured using a Visual Analog Scale and the WAD group completed the NDI, TSK and Pain Catastrophizing Scale (PCS). It was found that the WAD group had

“significant deficits in strength” compared to the healthy group especially in extension and lateral flexion but that “no significant association between neck strength and NDI, TSK and PCS was found.”<sup>20</sup> The study did identify strength deficits in WAD sufferers ranging from 52% to 72% in extension, retraction and left lateral flexion. The authors had difficulty explaining the reason behind deficits in left lateral flexion and reported that the majority of the sample had driver’s side collisions. This study should therefore be repeated with subjects who were in various positions of the car with various types of impacts as different muscles may be affected depending on position, seat belt position and direction of impact. The study also recruited chronic WAD sufferers from rehabilitation and return-to-work program which may have caused a selection bias.

### *TSK, Neck Pain and Surface Electromyography*

The last study to be reviewed, and the only one in this section was published by Nederhand, Hermens, Ijzerman, Groothuis and Turk in 2006.<sup>21</sup> The purpose of this study was “to evaluate the role of pain and fear of movement in the muscle activation pattern of the upper trapezius muscle during the transition of acute to chronic post traumatic neck pain.” Using a prospective longitudinal design 92 subjects with acute traumatic neck injury after MVA were followed up for 24 weeks. Using a Visual Analog scale rating of pain, TSK and surface Electromyography (sEMG) during sub-maximal isometric activation of the trapezius muscle. Subjects were evaluated at 1, 2, 8, 12, and 24 weeks. The results indicated that lower levels of muscle activity was independently associated with both the increase in fear of movement and pain intensity. Interestingly, it was reported that patients reporting higher pain intensity had a stronger association between fear of movement and decreased muscle activity which appears to decrease as time passed since the injury. The authors concluded that both the pain adaptation and fear avoidance models were supported by their results. This study used sEMG which is currently classified as an experimental assessment technique by the American Academy of Neurologists. While less invasive than needle EMG, needle EMG remains the gold standard for this type of testing. The sample of patients was recruited from a hospital emergency room after a motor vehicle accident, which, like in many of the other studies may produce a

Table 2 *Summary of study findings or conclusions*

<b>Findings or Conclusions</b>	<b>Study reference</b>
Higher TSK scores predicted increased symptom duration	8
Early Kinesiophobia does not improve symptom prediction	8
Unrecovered subjects do not exhibit changing TSK scores over time	9
Supports the use of the fear avoidance model for neck pain	7, 15, 18, 19, 21
The use of the NDI along with TSK can predict future neck pain outcomes	10
Higher NDI scores (with decreased ROM (9)) and increased psychological distress/PTSD can predict the persistence of symptoms/poor outcomes	11, 14
Self efficacy is an important factor in persistent neck pain disability	12, 14
No significant association was found between TSK/NDI and neck strength	20
Supports the use of the pain adaptation model for neck pain	21

selection bias towards those with tendencies for pain amplification or catastrophizing. The authors report that as a result of this study, reclassification of the Quebec Task Force injury severity classification system is required as they found that WAD II “is not characterized by muscle spasm but rather by muscle recoordination.” Further study and confirmation possibly using needle EMG is required prior to the implementation of this recommendation.

The findings or conclusions from the studies reviewed have been summarized in table 2.

### Conclusion

The TSK was originally developed to measure the fear of movement with respect to low back pain sufferers. As previously stated, the TSK has been used more recently to measure kinesiophobia in different body parts including the neck. There have been only 16 studies conducted regarding neck pain and the TSK in general that were found during the research phase for this review. Despite this, preliminary research has shown that there is value from a psychometric perspective in using the TSK with neck pain patients. It also seems that the fear avoidance model can be applied to neck pain sufferers from the initial research conducted. The TSK has been used with measures of perceived disability including the NDI to measure how

kinesiophobia and neck pain are related to perceived disability. Further research is needed to determine if, and to what extent, other measureable factors commonly associated with neck pain, such as decreased range of motion, correlate with kinesiophobia. Several of the studies currently available used recruitment methods that may have induced a bias. Although WAD is a common cause of neck pain, it is not the only cause of neck pain. The studies reviewed have a heavy bias towards the use of WAD sufferers in their research. It would be advisable that future research use neck pain sufferers from other causes as well. This review has identified some areas of research including neck range of motion, strength, and muscle activation with regard to fear of movement and the TSK that require further study.

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