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ORIGINAL ARTICLE

Musculoskeletal anatomy core syllabus for Australian chiropractic programs: A pilot study

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ABSTRACT

Objective: The aim of this study is to conduct a pilot survey to determine core anatomy content for chiropractic curriculum based on the perception of chiropractors and anatomy educators involved in teaching in an Australian chiropractic program.

Methods: A survey of anatomical structures previously used in a medical survey, with similar criteria for synthesizing responses, was used and classified according to whether the respondents rated an item as *essential*, *important*, *acceptable*, or *not required* in a chiropractic program. The item was scored as core if ≥60% of respondents rated it *essential*, recommended if 30%–59% rated it *essential*, not recommended if 20%–29% rated it *essential*, or not core if <20% rated it *essential*.

Results: The respondents rated 81.6% of all musculoskeletal concepts as core and 18.4% as recommended, 88.8% of the vertebral column items as core, and 11.2% of the items as recommended, 69.4% upper limb and pectoral girdle items as core, 23.7% of items as recommended, 5.5% as not recommended and 1.3% as not core items for inclusion, 85.3% of all lower limb and pelvic girdle items as core, 14.4% as recommended and 0.3% not recommended.

Conclusion: Chiropractors and anatomists involved in teaching in an Australian chiropractic program rated most musculoskeletal items as *essential* for inclusion in a chiropractic teaching program to ensure adequate preparation for safe practice and to promote alignment with the standards of anatomy education delivered into the clinical professions.

Key Indexing Terms: Chiropractic; Anatomy; Curriculum; Education

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INTRODUCTION

An integral component of chiropractic education is the study of gross anatomy including musculoskeletal (MSK) anatomy, which provides students with the foundational knowledge necessary for safe clinical practice. Anatomical knowledge guides clinical decision making in musculoskeletal conditions commonly managed by chiropractors[1–4] and plays an important role in the differential diagnosis of conditions presenting in the primary care setting.[5] There is therefore a requirement to teach sufficient anatomy to ensure chiropractic graduates are prepared for clinical practice by providing them with the knowledge and understanding of anatomy as a prerequisite for subsequent content delivery, and application to clinical practice in alignment with medical and other allied health graduates.[6–8] There is currently a lack of guidance, however, from pedagogical literature and professional accrediting bodies as to what anatomical knowledge is required for competence in chiropractic practice.

There is a need for evidence to assist curriculum development in chiropractic education programs on what constitutes the minimum anatomical knowledge required for entry-level chiropractic practice. This evidence is required to inform the future development of uniformly accepted standards for anatomical sciences taught in Australian chiropractic programs useful for benchmarking, by accreditation bodies. Similar concerns have previously been raised for medical programs. The decline in the core anatomy knowledge required in medical courses[9] could be reflected in the declining anatomy hours in these programs.[10] This, along with concern for potential inadequate knowledge in medical practitioners has motivated the International Federation of Associations of Anatomists (IFAA) and the Trans-European Pedagogic Anatomical Research Group of the European Federation for Experimental Morphology, to develop a hybrid Delphi

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process to enable the establishment of internationally agreed core syllabuses for anatomy education in health profession programs. These core syllabuses consist of an essential list of core knowledge items common to the health professional program.[11] To date, IFAA core anatomy syllabuses have been published for neuroanatomy,[12] head and neck anatomy,[13] embryology and teratology,[14] and musculoskeletal anatomy of the vertebral column and limbs.[15]

Similarly, recommendations for core anatomy content also have been developed for undergraduate medicine,[16] pharmacy,[17] undergraduate nursing,[18] and dentistry programs.[19] There is, however, no equivalent resource available for chiropractic education programs and it is unclear if the existing information on core anatomy content within medical and other health professional programs translates directly to education in a chiropractic context. The development of an anatomy core syllabus for chiropractic programs must address the needs of all stakeholders, including the public, students, academic staff, clinicians, and professional administrators, to ensure that it is fit for purpose. Societal expectation is that university curriculum should fulfill disciplinary competencies and be sufficiently dynamic to reflect the changes in healthcare and ensure safe practice.[20] Without accepted guidelines, it is unclear how to determine if anatomy content necessary for competent chiropractic practice is provided during training and across programs.

Australian chiropractic students, when previously surveyed, confirmed the importance and relevance of anatomy to clinical practice.[21] Within this context, however, a lack of a standardized anatomy syllabus potentially places these students at risk of content and cognitive overload[22,23] and potentially contributes to a variability in student knowledge, skills, and attitudes between institutions.[4] The lack of formal guidance creates the potential for content to be influenced by institutional policy and/or individual academics' bias and personal experiences.[10,24]

Although chiropractors are required to be proficient with sufficient anatomy knowledge to differentiate between muscular and nonmuscular causes of presenting complaints, the focus of chiropractic treatment relies on musculoskeletal anatomy knowledge for the provision of appropriate manual treatments to the spine and extremity joints, and for soft tissue manipulation.[25] In most circumstances, chiropractic academics, who are practicing clinicians and teaching academics, have authentic knowledge of the dynamic changes in the healthcare field and are cognizant of the anatomy content required to practice as chiropractors. These attributes make their opinions crucial in the development of relevant anatomy curriculum for undergraduate chiropractic programs.[26] Knowledge of the application of anatomy in clinical practice also assists in contextualizing the anatomical teaching, which assists immediate learning and enhances long-term retention.[27]

Furthermore, a regulated framework of standardized anatomy content in undergraduate chiropractic academic programs will enable benchmarking between different healthcare professions and facilitate the opportunity to further strengthen respect, and lead to improved interdisciplinary collaboration for the common goal of a better patient-focused healthcare system.[15]

The primary aim of this pilot study was to investigate the perceptions of current chiropractic and anatomy academics teaching in an Australian chiropractic program, on which items in musculoskeletal anatomy were considered *essential* or *important* for the education of chiropractors in Australia. The secondary aim was to compare the results obtained to those published by Webb et al[15] to provide a preliminary comparison between proposed medical and chiropractic syllabuses for musculoskeletal anatomy. It was hypothesized that the musculoskeletal content recommended for inclusion in an Australian chiropractic anatomy course would be similar to the internationally recognized content recommended for the medical profession.

METHODS

Sample Recruitment

The 50 potential participants invited to take part in this study were identified using a purposive (nonprobability) sampling method. These participants were chosen because of their discipline knowledge of the integration of basic and clinical sciences as a prerequisite for subsequent anatomy content delivery in the chiropractic curriculum, and an understanding of the importance of professional and academic and discipline requirements.[11,28,29] This ensured a knowledge base that supports the appropriate balance and depth of anatomical content required by chiropractic students for clinical practice.

The criteria for selection were anatomists and chiropractic academics with discipline content knowledge, employed in teaching anatomy in an Australian chiropractic program, with a minimum of 5 years' teaching experience. The targeted population included 43 chiropractic academics involved in teaching chiropractic, 4 chiropractic academics engaged in teaching anatomy, and 2 anatomists all involved in teaching in the same chiropractic program. The chiropractic academics were also practicing clinicians. Ethical approval was obtained from the Human Research Ethics Committee of University of New South Wales, Sydney (HC17058).

Survey Instrument

A single round of the IFAA's hybrid Delphi process method published by Moxham et al was used to propose a musculoskeletal anatomy syllabus for possible inclusion in chiropractic educational programs.[11] The same list of 1932 anatomical structures used by Webb et al[15] in a comprehensive survey to confirm musculoskeletal items considered *essential* or recommended in a medical program was used in this study to ascertain opinion on items for inclusion in a chiropractic program. Use of the same items also enabled comparison between the 2 survey responses. The survey comprised content relating to 3 anatomy regions: vertebral column (498 items), pectoral girdle and upper limb (615 items), and pelvic girdle and lower limb (672 items), in addition to musculoskeletal conceptual contents (147 items) pertaining to bones,

Table 1 - Synthesis of Classification of Responses to Items Rated as *Essential*

% Response to an Item as *Essential*	Item Classification
≥60	Core
30–59	Recommended
20–29	Not core
<20	Not recommended

joints, muscles, fascial structures, anatomical spaces, arteries, veins, lymphatics, axillary nodes, nerves, pathology, musculoskeletal concepts, and the spinal cord. Participants were asked to score each item on the same ordinal scale used by Webb et al[15] and in alignment with the IFAA process[11] including (1) *essential*, (2) *important*, (3) *acceptable*, or (4) *not required* fundamental knowledge, for clinical chiropractic practice. At the end of the survey the respondents were provided the opportunity to comment on the questionnaire and propose any new questions. The survey was administered online (Qualtrics XM 2005, Provo, UT) and was designed to be completed by the participant within 40 minutes.

All potential participants were emailed an invitation seeking their participation in the survey along with an accompanying participant information sheet describing the process and informing them that participation was voluntary and anonymous.

Data Analysis

Statistical analysis was performed using Minitab 64-bit version 19.2020.1 (State College, PA, USA). The results were collated and analyzed in concordance with previous studies used to establish an international core syllabus by Webb et al[15] and consistent with those used in the other IFAA Delphi studies.[11] Items were scored as core if $\geq 60\%$ of the respondents rated an item as being *essential*. When 30% to 59% of respondents rated an item as being *essential*, the topic was scored as recommended. Items were scored as not core or not recommended when respondents rated *essential* designations between 20% and 29%, and less than 20%, respectively (Table 1).

To inform discussion relating to curricular change, only topics scored as core (*essential*) for medical curricula were compared with responses in the current study.[15] To determine differences in respondents' preferences for rating categories as *essential*, *important*, and *acceptable* for each item, a chi-squared test was used. If the p value was not significant ($p \geq .05$), then the distribution of responses would indicate a preference for either end of the scale for that item. If the p value was significant ($p < .05$), the percentage incidence was used to determine the status for the item. The category *not required* was ignored as very few respondents selected this category—selected 3 times at most.

To determine differences in core syllabus between chiropractic and medicine responses, a 2-sample Fisher exact test[30] was used to test the significance of the statistical comparisons and compare the responses of the 2 survey groups to items scored as either core or recommended in the tables published by Webb et al.[15]

RESULTS

Responses were received from 31 of the 50 possible respondents (62%) who accepted the invitation to participate. Of these, 24 (77%) were registered chiropractic academics, 5 (17%) were registered chiropractors involved in teaching anatomy, and 2 (6%) were anatomists involved in teaching in the chiropractic program. The chiropractors were also practicing clinicians and involved in supervising in the university's teaching clinics. The responses received were representative of the proportion of invited participants.

Twenty-four (80%) respondents commenced the survey; however, 5 were excluded due to insufficient questions (< 2) completed. A total of 19 (63%) completed surveys were analyzed. All survey responses were anonymous with no option to be identified provided to the respondents. The survey was open for 10 weeks and a reminder email was sent in the week prior to the closing date.

The respondents in this survey rated 81.6% of all musculoskeletal concepts as *essential* and 18.4% as *important*. Only 2 items were rated as *not applicable* or *not required*: venipuncture of the cubital fossa and knowledge of the second part of the axillary artery. The proportion of responses rating items as *essential*, *important*, *acceptable*, or *not required* for inclusion in chiropractic anatomy syllabus by region are described in Table 2.

The proportion of responses rating items as *essential*, *important*, *acceptable*, or *not required* for inclusion in chiropractic anatomy syllabus by region are described in Table 3. These items have been scored as core or recommended or not core or not recommended. The respondents rated most items as *essential*. The questions in the survey were arranged in 4 categories comprising 3 anatomy regions: (1) upper limb and pectoral girdle (615 items), (2) lower limb and pelvic girdle (672 items), (3) vertebral column (498 items), and (4) musculoskeletal concepts (147 items), including bones, joints, muscles, fascial structures, anatomical spaces, arteries, veins, lymphatics, and axillary nodes.

The responses were collated by body region then scored as core, recommended, not core, or not recommended. To explore differences in the core items between chiropractic and medicine survey responses (Table 4), key anatomical concepts scored as core or recommended are presented from the current (chiropractic) survey, then compared to medicine. A 2-sample test of proportions using the Fishers exact test[30] was used to test the significance of the statistical comparisons and compare the responses of the 2 survey groups to items recorded as either core or recommended as flagged in the tables presented by Webb et al.[15] Both groups agree that the item is core in their respective areas if the p value is not significant ($p > .05$).

Where the p value was not significant, the chiropractic group had a higher percentage of respondents identifying the item as *essential* or core (green). Table 4 lists some of the highest scoring concepts rated by the chiropractic survey respondents. For example, the concept samples that scored highest in the chiropractic cohort (innervation, vertebral body, surface anatomy, movements, joints) were scored as core in 42%–100% for those items. The corresponding scores for the same items from the medicine cohort were

Table 2 - Proportion of Responses Rating Items by Region for Inclusion in Chiropractic Anatomy Syllabus. Items Scored as *Essential*, *Important*, *Not Acceptable*, or *Not Required*

Concept	Essential, %	Important, %	Acceptable, %	Not Required, %
Spinal cord concepts	100	0	0	0
Lower limb and pelvic girdle muscles	98.4	1.6	0	0
Musculoskeletal concepts	98.3	1.7	0	0
Upper limb and pectoral girdle nerves	97.7	2.3	0	0
Vertebral column joints and ligaments	97.4	2.6	0	0
Vertebral column muscles	96.9	3.1	0	0
Upper limb and pectoral girdle muscles	94.7	5.3	0	0
Upper limb and pectoral girdle pathology	91.6	6.0	2.4	0
Lower limb and pelvic girdle joints	91.3	8.7	0	0
Lower limb and pelvic girdle bones	90.7	9.3	0	0
Lower limb and pelvic girdle anatomical spaces	88.9	11.1	0	0
Spinal cord pathology/clinical application	87.5	12.5	0	0
Lower limb and pelvic girdle nerves	85.3	14.7	0	0
Upper limb and pectoral girdle bones	76.5	17.6	2.9	2.9
Upper limb and pectoral girdle joints	74.5	24.5	0.5	0.5
Vertebral column bones	70.5	29.5	0	0
Lower limb and pelvic girdle pathology	70.5	29.5	0	0
Lower limb and pelvic girdle fascial structures	57.9	42.1	0	0
Upper limb and pectoral girdle veins	50.0	50.0	0	0
Lower limb and pelvic girdle arteries	42.1	57.9	0	0
Upper limb and pectoral girdle anatomical spaces	40.0	46.7	13.3	0
Lower limb and pelvic girdle veins	20.0	80.0	0	0
Spinal cord vasculature	20.0	80.0	0	0
Lower limb and pelvic girdle lymphatics	16.7	83.3	0	0
Upper limb and pectoral girdle arteries	13.7	58.8	27.5	0
Upper limb and pectoral girdle lymphatics	12.5	87.5	0	0
Upper limb and pectoral girdle fascial structures	3.6	39.3	42.9	14.3

scored as recommended (6%–76%), with the between-group comparison statistically significant ($.0001 < p < .049$).

An additional list of 30 musculoskeletal x-ray items were rated as *essential* (core) by the chiropractic discipline, with a range of 58%–89% and 9 items rated 53%–59% as *important* (recommended); this was not published in the medicine study (Table A42 in the Supplemental Appendix). Only 1 response was received in the survey providing respondents with an opportunity to make open comments or suggestions. This comment suggested the inclusion of the "growth plates in children" concept. All responses for all questions are provided in the Supplemental Appendix associated with this manuscript (available online at www.journalchiroed.com).

DISCUSSION

The study highlights the similarities and differences in responses between the chiropractic and medicine disciplines on core or recommended musculoskeletal knowledge expected of newly qualified graduates. The chiropractors identified 1562 musculoskeletal concepts as core inclusion items, 326 as recommended items, and 44 as neither core nor recommended for inclusion in chiropractic musculoskeletal anatomy curriculum.

The number of respondents in the chiropractic survey (19) and the medical survey (20)[15] were comparable. The medical survey reported 17 respondents completed all 4 sections, 2 completed only the musculoskeletal section, and 1 respondent completed the musculoskeletal concepts and vertebral columns sections. The chiropractic respondents answered nearly all the questions, with only the occasional item not answered.

The final number of concepts assessed in the chiropractic survey was slightly different from those in the medicine survey. The items not selected as core or recommended by the chiropractic and medicine discipline group that did not differ by proportion consisted of fascial structures, minor

Table 3 - Summary of Proportion of Items Scored as Core or Recommended Per Body Region

Concept	Core, %	Recommended, %	Not Core, %	Not Recommended, %
Musculoskeletal concepts	81.6	18.4	0	0
Lower limb and pelvic girdle items	85.3	14.4	0	0.3
Upper limb and pectoral girdle items	69.4	23.7	5.5	1.3
Vertebral column items	88.8	11.2	0	0

Full lists are presented in Tables A1 to A30 in the Supplemental Appendix.

Table 4 - Summary of Comparison of the Concept Rating for Items Regarded as Either Core or Recommended

Concept Samples Scoring Highest Rating by Chiropractic Group	Chiropractic			Medicine			*p* Value Range
	Core, %	Recommended, %	Not Core or Not Recommended, %	Core, %	Recommended, %	Not Core or Not Recommended, %	
Innervation, vertebral body, surface anatomy, movements, joints	42–100				6–76		<.0005–.049
Dermatomes, muscles, nerve supply, joints,	53–95				35–76		>.05
Cervical vertebrae, cauda equina, spinal dura (mater), vertebral canal	53–100			0–78			<.0005–.046
Atlas, axis, sacrum, spinal arachnoid, spinal pia mater,	79–95			61–89			>.05
Atlantoaxial instability or subluxation, central stenosis, vertebral arch fractures, intertransverse ligament, joint classification	47–95					0-50	<.0005–.001
Compartment syndrome, radiocarpal joint, palpation of arterial pulses, low back pain	21–90					29-82	>.05
Distal end of radius, fascial septa, anastomoses around joints, venous sinuses, spinal arteries, plantar nerves		32–74			30–59		>.05
Annular ligament of the radius, arteries, lymph nodes		47–58		61–76			>.05
Ligaments, innervation, blood supply		32–68				0–24	<.0005–.049
Coracoacromial arch, vertebral veins, arteries,		32–58				6–56	>.05
Venipuncture (cubital fossa)			26	82			.001
Second part of axillary artery			26		53		>.05

Items scored in the ranges specified (stratified by significant difference between groups).

ligaments, and artery concepts. The concepts rated as *essential* by the medical discipline representatives, which were rated as *important* by the chiropractic group, comprised concepts including the annular ligament of the radius, internal thoracic artery, cephalic vein, and basilic vein, along with axillary nodes and lumbar puncture or spinal tap, the last 2 fall outside of the scope of chiropractic practice.

Given the focus of chiropractic treatment relies on fundamental musculoskeletal anatomy knowledge for the provision of appropriate manual treatments to the spine, extremity joints, and soft tissue manipulation,[23] the high percentage of musculoskeletal items rated as *essential* knowledge by chiropractic respondents is not surprising. Respondents in this survey rated most items as *essential* and only 2 items were rated as not applicable or *not required*: venipuncture of the cubital fossa and knowledge of the second part of the axillary artery. This response reflects current professional practice guidelines, which permit chiropractors to perform skin penetration procedures for dry needling purposes only. The highest proportion concepts considered to be *essential* comprised spinal cord concepts, lower limb and pelvic girdle muscles, and musculoskeletal concepts, in keeping with the focus of the chiropractic profession on the treatment and prevention of disorders of the musculoskeletal system.[31]

There is currently no evidence available for use by chiropractic curriculum developers to inform appropriate anatomy syllabus and it is unknown if the existing information on core anatomy content within medical programs and other health professions translates directly to education in a chiropractic context. There have not previously been any attempts to define a core syllabus in anatomy in chiropractic programs. This pilot study has provided a detailed list of topics rated *essential* or *important* by the respondents for inclusion in a chiropractic curriculum, which will assist to inform the development of a future Delphi study to establish a mechanism of communication between experts to establish agreement on anatomy content in Australian and hopefully international chiropractic programs.

No major complications were noted in this pilot study, though a possible reason for only 1 comment provided in the open section may be indicative of survey fatigue.

Future Research

This research has been undertaken as a pilot study to test protocols, data collection, and analysis for future application in a larger international Delphi study, which will

inform the selection of musculoskeletal anatomy content appropriate for unit learning objectives specific to chiropractic needs, thereby reducing the unnecessary learning of nonessential content.[22,23] No previous research studies investigating core content development have conducted a pilot study and therefore the findings of this research study will provide an authentic framework for future investigations in Australia and internationally on anatomy content appropriate for chiropractic education programs.

Limitations

A key limitation of the study was the response rate of anatomy educators, though the chiropractors in the study were all involved in teaching in a chiropractic program and thereby interact with the anatomy curriculum via applied anatomy, in teaching diagnosis and management units. Another limitation was the involvement of a single institution in the survey, although this institution graduates the largest number of chiropractic graduates in Australia. A point of difference in the 2 cohorts compared in this study was that the chiropractors were all located in Australia and from 1 institution, whereas those representing the medical discipline were from various institutions located domestically and internationally.

CONCLUSION

This study has provided identification of anatomical musculoskeletal concepts considered to be core for possible inclusion in a basic anatomy curriculum for chiropractic training, relevant to the Australian context. It has also compared and determined the points of difference of core items between chiropractic and medical opinion. Anatomical concepts that the chiropractic respondents scored as core or recommended were not scored at the same level of importance by the medical discipline, which highlights the need for education to be relevant to practice. The comparison of core anatomy syllabus between different medical and health professions may be valuable in planning and developing future interprofessional collaboration.

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