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Diagnostic Imaging in Chiropractic Practice: A Survey of Opinions and Self-Reported Guideline Adherence of Dutch and Belgian Chiropractors



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ABSTRACT

Objectives: The purpose of this study was (1) to describe diagnostic imaging in Dutch and Belgian chiropractic practice in general, (2) to estimate adherence to the diagnostic imaging guidelines for patients with low back pain (LBP) via vignettes, and (3) to evaluate factors associated with diagnostic imaging and adherence to the guidelines.

Methods: We used a web-based survey to collect sociodemographic data, practice characteristics, amount of imaging, opinions, and indications for requesting imaging from registered Dutch and Belgian chiropractors in 2013.

Additionally, adherence to imaging guidelines for LBP was assessed by 6 vignettes in patients with LBP. Multivariable regression analyses were conducted to explore associations between characteristics of chiropractors and the use of imaging. Generalized mixed models were used to explore guidelines adherence and their relationship with chiropractor's characteristics.

Results: The overall response rate was 60% (n = 203 out of 340). In total, 83% of chiropractors viewed diagnostic imaging in general as an important part of their practice. It is important to note that Dutch and Belgian chiropractors are not allowed to refer directly for imaging. Chiropractors reported that they would like to have imaging in 42% of their patients. Imaging had already been performed in 37% of patients before the first visit and was ordered by another health care provider (ie, general practitioner or medical specialist). The most common indication for ordering imaging was exclusion of contraindications (73%). The most common reason against imaging was the perceived limited value (45%). Many chiropractors (71%) were familiar with imaging guidelines. Adherence to the imaging guidelines for LBP based upon the vignettes was 66%. Dutch chiropractors and chiropractors with less than 10 years in practice demonstrated better adherence to guidelines and imaging use as compared with Belgian and those with more than 10 years of experience.

Conclusions: Most Dutch and Belgian chiropractors reported that imaging in general was important in chiropractic practice. Self-reported indications for ordering diagnostic imaging were in line with the imaging guidelines in the majority of cases. We found some variances between Belgian and Dutch chiropractors and years of experience related to guideline adherence. (*J Manipulative Physiol Ther* 2022;45:57-72)

Key Indexing Terms: *Low Back Pain; Chiropractic; Diagnostic Imaging; Guideline Adherence*

INTRODUCTION

Chiropractors have been using radiographs in their practice from as early as 1910.¹ As new diagnostic imaging modalities were developed (eg, magnetic resonance

imaging [MRI] and computer tomography scans), they have been incorporated as well. Thus, diagnostic imaging is an integral part of chiropractic education and practice.

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The most prevalent diagnostic imaging in chiropractic is imaging of the lumbosacral spine² because patients with low back pain (LBP) are encountered most commonly in chiropractic practices.

Imaging is incorporated in daily chiropractic practice differently in various countries. The proportion of patients radiographed by chiropractors in Europe ranges from 12% to 93%.³⁻⁶ One of the reasons for this variation is a difference in legislation. In countries such as the United States, the United Kingdom, Norway, and Denmark, where chiropractic is legally recognized, chiropractors are allowed to have their own x-ray equipment or are allowed to refer for diagnostic imaging. The chiropractic profession in The Netherlands and Belgium is still a relatively small and unknown profession. In The Netherlands, chiropractic is not regulated by law yet, and in Belgium the chiropractic profession is in the process of legal recognition. At this moment, legislation does not allow Belgian and Dutch chiropractors to have their own x-ray equipment or refer for imaging directly, as this is delegated to medical professionals. However, in The Netherlands the governmental policy of tolerance allows the possession of x-ray equipment under strict supervision of a medical radiologist, but most Dutch chiropractors do not have these facilities.

Chiropractors in Belgium and The Netherlands do use clinical reasoning on a daily basis to decide whether diagnostic imaging is necessary before starting the treatment. If they deem diagnostic imaging necessary, they will request this via the general practitioner (GP) of the patient. The GP agrees with referral and authorizes the imaging. As per Dutch law, it is the GP who determines the amount of imaging. If imaging is already present (ie, already requested by another health care provider), chiropractors get access to the images either through the patients who have the right to access their own medical records or request them on behalf of the patient directly from the hospital.

Because chiropractic in these countries is small by numbers and relatively unknown, and the profession strives for legalization, it is important to provide an insight into chiropractic practice and study the chiropractors' views on diagnostic imaging. Several of the following aspects can be assessed: the amount of imaging present, the amount of imaging retrieved and read by the chiropractors, the clinical reasoning for the use of diagnostic imaging, opinions of chiropractors toward the use of imaging in general, as well as the awareness and adherence to diagnostic imaging guideline for LBP by chiropractors, and lastly, factors associated with diagnostic use and adherence to these guidelines. Two previous, not recently published studies have assessed the amount of imaging deemed necessary and indications for requesting diagnostic imaging.^{3,5} Those studies focused on the amount of plain film radiographs deemed necessary before the start of treatment, but none of the studies described the views of chiropractors on the

amount of advanced imaging necessary. The overall utilization rate of imaging in health care has increased sharply.⁷ This raise is largely because of an increased use of advanced imaging, particularly MRIs,^{8,9} whereas the use of radiographs has remained stable or may even have decreased depending on the health care provider who refers for the imaging. In fact, 1 Canadian study reported that the use of radiographs by chiropractors is decreasing.¹⁰ Therefore, in general, chiropractors' views on imaging and the clinical indications for performing imaging in chiropractic in The Netherlands and Belgium also may have changed over the last 2 decades.

Adherence to Imaging Guidelines for Low Back Pain

Diagnostic imaging is often used by health care providers in the initial evaluation of patients with LBP; however, the use of imaging in this patient population is subject to debate.¹¹⁻¹³ As a consequence of this, international diagnostic imaging guidelines for both medical and chiropractic professions have been developed.¹⁴⁻¹⁸ These all recommend not to use imaging with the exception of certain conditions, for example when there is neurological compromise or suspected pathology (eg, fracture, infection, neoplasm, or serious inflammatory disease).^{8,9} Compliance with these guidelines by health care providers remains suboptimal,¹⁹⁻²¹ as these guidelines have not led to a decreased use of imaging by health care practitioners in general, but this may be different for chiropractors.¹⁰ Moreover, diagnostic imaging in patients with LBP often appears to be inadequately used. For example, results of a systematic review demonstrated that 30% to 60% of diagnostic imaging for LBP in primary care was inappropriate.¹² Overuse can result in an increased radiation exposure, potentially inappropriate treatment of patients and increased health care costs^{7,22} owing to misdiagnosis; however, reticence also could lead to inappropriate or insufficient care.

It is important to estimate (ie, behavior simulation) the level of adherence to diagnostic imaging guidelines for LBP by chiropractors (using vignettes) and the characteristics of chiropractors possibly related to adherence, although Dutch and Belgian chiropractors can only request imaging indirectly via the GP. This provides an insight into the reasons why and when chiropractors would like to have imaging. Studies that have investigated adherence to diagnostic imaging guidelines by chiropractors in North America and Australia have found that adherence ranged from 32% to 90%.^{19,23,24} Other studies^{7,19,25,26} reported characteristics of health care providers such as years in practice and type of practice (solo or group) related to diagnostic imaging use and guideline adherence. However, these studies did not include chiropractors in Europe. Therefore, no data were available on guideline adherence for LBP by chiropractors and characteristics of these chiropractors

influencing adherence in Europe. By understanding factors associated with diagnostic use and adherence to guidelines we get information on how chiropractors use imaging in their practices, which may help to position the chiropractic profession in those countries, and if necessary, we can improve the awareness and implementation of guidelines.

Therefore, the aim of this study was (1) to describe diagnostic imaging in chiropractic practice in general (which includes amount of existing imaging, retrieving existing imaging, requesting imaging before starting the treatment, indications for requesting imaging, and opinions of chiropractors toward the use of diagnostic imaging), (2) to estimate adherence to the diagnostic imaging guidelines for patients with LBP via vignettes, and (3) to evaluate factors associated with diagnostic imaging and adherence to the guidelines.

METHODS

Design and Setting

This study is a web-based cross-sectional survey (SurveyMonkey, SVMK Inc., San Mateo, California). In 2013, all chiropractors in The Netherlands, who were registered with the Foundation for Chiropractors in The Netherlands (“Stichting Chiropractie Nederland”) and all Belgium chiropractors registered with the Union of Belgium Chiropractors (“Belgische Vereniging voor Chiropractie”), were invited to participate.

A link to this web-based survey was sent to all participants. After 3 weeks a reminder email was sent and after 6 weeks a telephone call was made to those chiropractors who had not yet completed the questionnaire.

Ethical Approval

The study protocol was approved by the Review Board of the coordinating institution (EMGO Institute VU University Amsterdam). The protocol also has been approved by the Ethical Committee of the VU University.

Survey

Before data collection, the questionnaire was pretested in a pilot study using 3 Dutch chiropractors. This led to minor textual changes in the questions.

The survey (Supplementary Data) explored various aspects of the management of patients with LBP in chiropractic practice and took a chiropractor approximately 40 minutes to complete. The questionnaire was designed so that participants could only go to the next question if they had completed the previous one. The 3 parts of the survey that are related to diagnostic imaging are presented in this article.

Part 1: Sociodemographics and Practice Information

This section included questions about demographics (eg, age, sex, and nationality) and general characteristics (eg, years in practice, postgraduate training). Chiropractors working in both countries ($n = 9$) were labelled as chiropractor working in The Netherlands. Dutch chiropractors were asked if they had diagnostic facilities in their practice, specifically the following 2 types of diagnostic equipment: (1) the conventional x-ray machine and (2) iDXA scan, designed to measure bone density and give a general overview of the skeleton and the body composition. Belgian chiropractors are not allowed to own these facilities and were therefore not asked this question.

Part 2: Diagnostic Imaging in Chiropractic Practice in General Opinions of Chiropractors Toward the Use of Diagnostic Imaging

This section was used to determine how important diagnostic imaging was for chiropractors and their self-reported abilities in reading various diagnostic images. It included statements with answering options on a 3-point Likert scale: “never, sometimes, always” or “agree, no opinion, disagree.”

The Amount of Already Existing Imaging, of Retrieving Existing Imaging and of Requesting New Imaging, and Indications for Requesting New Diagnostic Imaging.

This section included questions on amount of already existing imaging, retrieving of existing or requesting new imaging before starting the treatment (percentage), and indications for the use of diagnostic imaging relevant to chiropractors in both countries as measured on a 5-point Likert scale. Response options were “never,” “almost never,” “sometimes,” “often,” and “always.” The 5-point Likert scale categories were later combined, yielding 3 categories “never or almost never,” “sometimes,” or “often or always,” in order to create groups of sufficient size in the analyses.

Part 3: Adherence to Diagnostic Imaging Guidelines for LBP

Familiarity of Diagnostic Imaging Guidelines. Data collected included information on the familiarity of clinical guidelines (yes/no) and whether these guidelines were adhered to by chiropractors when ordering diagnostic imaging (yes/no).

Clinical Vignettes. We used 6 patient vignettes (Supplementary Data) reflecting 3 patients with acute LBP and 3 with chronic LBP who chiropractors would typically see in their practices. The vignettes were taken from previous studies and adapted to the Dutch and Belgian situation.^{19,27}

For each clinical vignette, the chiropractors were asked if they would order diagnostic imaging and what type of imaging. These responses (Supplementary Data) were classified as being “strictly in line,” “broadly in line,” or “not in line with guideline recommendations” by the authors. For all vignettes, “no referral for diagnostic imaging” was

strictly in line with the guidelines. In vignette 2, 4, 5 and 6, “ordering radiographs” was broadly in line with the guidelines as patients in these vignettes either did not show the expected improvement after a course of treatments or had “red/yellow flags” in their history. Ordering an MRI scan was not in line. For the analysis of the data, “strictly in line with the guidelines” and “broadly in line with the guidelines” were combined to the category “in line with the guidelines.” In vignettes 1 and 3 no category “broadly in line” was necessary, as the guideline recommendations were clear-cut.

The appropriateness of responses for ordering diagnostic imaging was defined a priori by the authors using the recommendations of the international (chiropractic) diagnostic imaging guidelines.^{14,15} The Dutch multidisciplinary guideline for the management of LBP²⁸ was used to rule out conflicting evidence, or in case a recommendation was not clear. Five chiropractors from the United States, Belgium, and Australia with a background in chiropractic research and not participating in the survey were asked to review our classification of the responses. After minor revisions, they agreed with the classification.

ANALYSIS OF THE DATA

Sociodemographics and Practice Information

We described chiropractic characteristics using means and standard deviations for continuous data and percentages for categorical data.

Diagnostic Imaging in Chiropractic Practice in General

Opinions of Chiropractors Toward the Use of Diagnostic Imaging.

We described opinions of chiropractors toward the use of diagnostic imaging (agree, no opinion, or disagree) using percentages. Explorative univariable multinomial regression was used to explore associations between the dependent variable: the opinions of chiropractors toward the use of imaging and the independent variables: years in practice, type of practice (eg, solo or group), postgraduate education and country of practice. Odds ratios (ORs) and 95% confidence intervals (CIs) are presented.

Amount of Already Existing Imaging, of Retrieving Existing Imaging, and of Requesting New Imaging, and Indications for Requesting New Diagnostic Imaging. We described the amount of imaging using means and standard deviations and indications for the use of diagnostic (always or often, sometimes, and seldom or never) percentages for categorical data. For the Likert scales, percentages were calculated and expressed in frequency distributions. For the evaluation of characteristics associated with frequency of ordering diagnostic imaging, explorative multivariable linear regression analyses were performed with the diagnostic imaging use as dependent variable. Years in practice, type of practice, post-

graduate education, and country of practice were entered simultaneously in the analysis as independent variables (fixed factors). Results are presented as β -coefficients and (CIs).

Adherence to Diagnostic Imaging Guidelines for LBP

The adherence to diagnostic imaging guidelines was based on the recommendations of the international (chiropractic) diagnostic imaging guidelines.^{14,15} The Dutch multidisciplinary guideline for the management of LBP²⁸ was used to rule out conflicting evidence.

Familiarity of Diagnostic Imaging Guidelines

We described familiarity with the guidelines in percentages. Multivariable logistic regression analyses were conducted to explore associations between familiarity with practice guidelines (dependent variable) and the following characteristics: years in practice, type of practice, postgraduate education, and country of practice (independent variables). In this model, all independent variables were entered simultaneously in the regression model. ORs and 95% CIs are presented. ORs in this study described the likelihood of demonstrating a particular behavior (eg, familiarity of diagnostic imaging guidelines) given an individual characteristic (eg, years in practice).

Clinical Vignettes

First, to assess the overall percentage of adherence to the diagnostic imaging guidelines for LBP by chiropractors, a generalized linear mixed model was used. We included a random intercept for each chiropractor in the model. This method was used to allow for the correlation of responses within each individual chiropractor, because each chiropractor answered 6 vignettes and these responses cannot be seen as 6 independent responses. Second, we ran the same model for assessing percentage adherence for the vignettes describing patients with acute LBP and chronic LBP separately. Third, fixed effects for the years in practice, type of practice, postgraduate education, familiarity of practice guidelines, sex, x-ray facilities, and country of practice were estimated in separated mixed models assessing the univariable associations between adherence to guidelines by chiropractors (dependent variable) and these independent variables. We present the ORs and CIs, complemented by prevalences expressed in percentages and their 95% CIs. Prevalences were calculated by $p = \frac{e^{\beta}}{1+e^{\beta}} * 100\%$. In this study these percentages described the estimated percentages of subgroups of chiropractors (eg, longer in practice) adhering to the imaging guidelines.

Finally, all independent variables were simultaneously entered as fixed effects to the mixed model described above to explore associations between the adherence to guidelines

by chiropractors and all independent variables together: years in practice, type of practice, postgraduate education, familiarity of practice guidelines, and country of practice. ORs and 95% CIs are presented.

For ORs, predefined thresholds were small ($OR < 1.6$), medium ($1.6 < OR < 3.5$), and large ($OR > 3.5$), and for standardized mean difference (SMD), small ($SMD < 0.2$), medium ($0.2 < SMD < 0.5$), and large ($SMD > 0.8$).^{29,30} In our case, these SMDs correspond with a unstandardized β -coefficient of 5.5, 13.8, and 22.1. All statistical analyses were performed in Statistical Package for Social Sciences for Windows (SPSS version 21, IBM Corp., Armonk, NY).

RESULTS

Figure 1 provides a flow chart of the recruitment and response. The overall response rate was 60% ($n = 203/340$); (61% ($n = 149/245$) for Dutch chiropractors and 57% ($n = 54/95$) for Belgian chiropractors). The majority (76%) of the respondents completed the questionnaire. Of the partially completed questionnaires more than 90% of data was

present. Characteristics of responding chiropractors are presented in Table 1. Most characteristics of chiropractors were similar in both countries.

Diagnostic Imaging in Practice in General

Opinions of Chiropractors Toward the Use of Diagnostic Imaging in Chiropractic Practice. Opinions of chiropractors toward diagnostic imaging are presented in Table 2. The majority of chiropractors regarded diagnostic imaging as an important part of the clinical decision-making process, and indicated they would like to refer directly for diagnostic imaging. Moreover, almost all chiropractors thought it was important to be able to interpret imaging themselves. Results from the univariable multinomial regression analyses are presented in Table 3. Chiropractors, who were 10 to 20 years in practice were more likely to agree that the use of imaging in practice is important than chiropractors with less experience. Furthermore, Dutch chiropractors and chiropractors in practice longer were more likely to agree with the importance of chiropractors taking radiographs themselves.

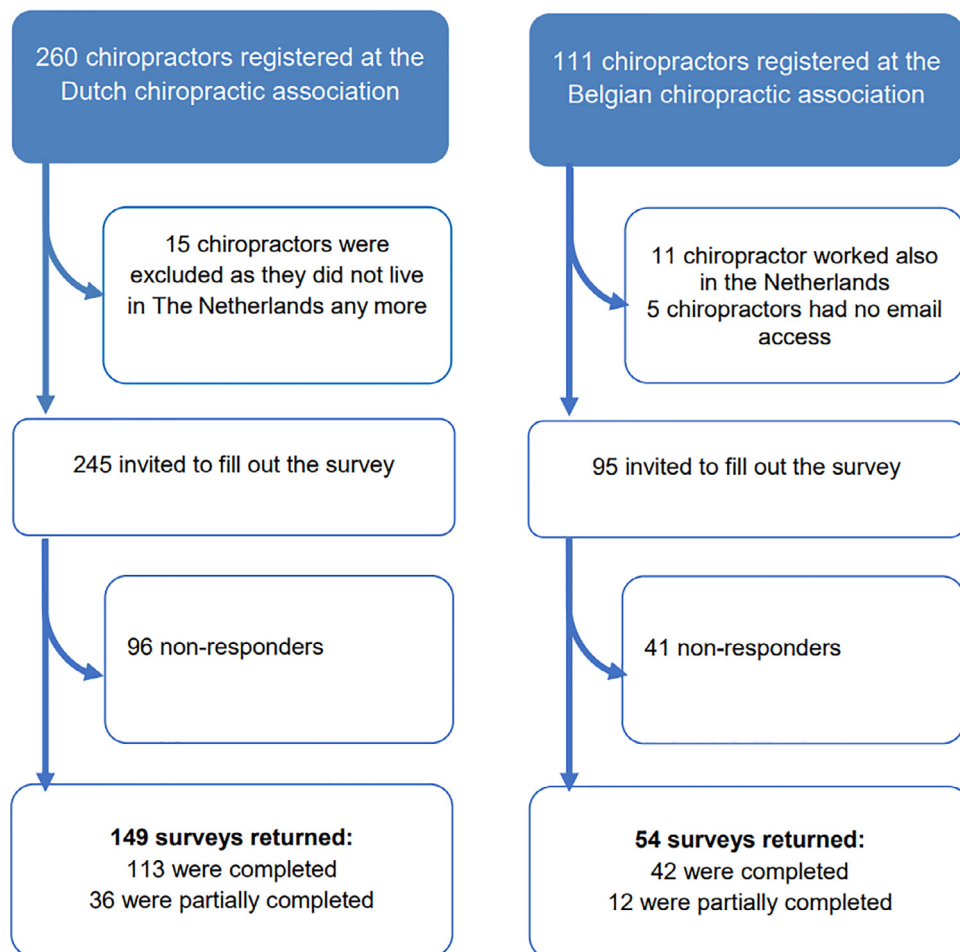


Fig 1. Survey response flow chart.

Table I. Characteristics of Responding Chiropractors in Netherlands and Belgium

	Total (N = 203)	Chiropractors in The Netherlands (n = 149)	Chiropractors in Belgium (n =54)
Sex (%)			
Female	36.9	40.3	27.8
Male	63.1	59.7	72.2
Age: mean (SD)	40.8 (12.2)	40.6 (11.4)	41.4 (14.1)
Nationality (%)			
Dutch	52.7	70.5	-
Belgium	28.1	5.4	87.0
Other	18.9	24.1	13.0
Country where working (%)			
The Netherlands	72.7		
Belgium	26.3		
Years in practice: mean (SD)	14.8 (11.1)	14.2 (10.2)	16.0 (13.2)
Practice type (%)			
Solo practice	41.9	34.2	63.0
Group practice	43.8	49.0	29.6
Multidisciplinary setting	11.8	14.8	3.7
Other	2.5	2.0	3.7
Possession of x-ray facilities (%) (n = 144) ^a			
X-ray machine	6.9	7.0	N/A ^a
iDXA scan	7.6	7.6	
None	85.4	85.4	
Degree before chiropractic career (%)			
Yes	37.4	39.6	31.5
No	62.6	60.4	68.5
Postgraduate training (specialization) (%)			
Yes	37.9	41.6	27.8
No	62.1	58.4	72.2
Specialization (%)			
Neurology	12.8	16.8	1.9
Sport	9.9	10.1	9.3

(continued)

Table 1. (Continued)

	Total (N = 203)	Chiropractors in The Netherlands (n = 149)	Chiropractors in Belgium (n = 54)
Pediatrics	7.9	8.1	7.4
Radiology	3.9	5.4	0
Clinical science	4.4	3.4	7.4
Other (eg, dry needling, veterinary chiropractic)	12.8	31.2	9.3
Graduation from college (%)			
Anglo European College of Chiropractic, England	66.5	69.1	59.3
Other	33.5	30.9	40.7

SD, standard deviation.

^a Only Dutch chiropractors as Belgian chiropractors are not allowed to have x-ray facilities at their practice

Amount of Already Existing Imaging, of Retrieving Existing Imaging, and of Requesting New Imaging, and Indications for Requesting New Diagnostic Imaging. Table 4 presents the amount of existing imaging, requesting, and retrieving of diagnostic imaging in chiropractic practice. Chiropractors reported that just over a third of the patients who visited a chiropractic clinic for the first time had already undergone diagnostic imaging ordered by other health care professionals (eg, GP or medical specialist). Most of these images were radiographs. They also reported that these images were requested from a hospital via the patients. Chiropractors with x-ray facilities indicated they take radiographs in 60% of their patients, and chiropractors without these facilities indicated they refer for radiographs in 30% of their patients.

Chiropractors who had more than 20 years in practice reported that they would like to have diagnostic imaging in a higher percentage of patients compared with chiropractors 0 to 10 years in practice (Table 5). Table 6 demonstrated the indications to use or not use diagnostic imaging in chiropractic practice. In both countries, the most common indications for sending patients for diagnostic imaging were exclusion of contraindications. The most important reason for not referring a patient for diagnostic imaging was the limited value of imaging information.

Adherence to Diagnostic Imaging Guidelines for LBP

Familiarity With Diagnostic Imaging Guidelines. Table 7 shows that 71% of the chiropractors were familiar with practice guidelines for the management of patients with LBP. Most chiropractors who were familiar with the practice guidelines reported to take them into account when referring for diagnostic imaging. Dutch chiropractors and chiropractors who have post-graduate training were more familiar with practice guidelines for management of

patients with LBP. With more years in practice, chiropractors reported less familiarity with practice guidelines.

Clinical Vignettes. Table 8 shows that overall adherence for all 6 vignettes was 65.9% (CI 61.5-70.1), and the acute vignettes were scored slightly better than the chronic vignettes. A higher percentage of chiropractors in The Netherlands acted according to the guidelines compared with Belgian chiropractors, whereas chiropractors with more years in practice less frequently acted according to the guidelines.

DISCUSSION

These results suggest that chiropractors in The Netherlands and Belgium are of the opinion that the use of diagnostic imaging in general is an important part of their clinical practice. They would like to have direct access to diagnostic imaging, refer for new imaging, and request imaging when already available. Importantly, these findings are confirmed in other chiropractic studies.^{3,5,6}

Overall, it was less important for chiropractors to have their own radiograph facilities than to be able to refer for new and request existing imaging. In the past years in The Netherlands, chiropractors were able to possess their own facilities, but times have changed and laws have become stricter. In other words, chiropractors may only possess such facilities under strict supervision. By contrast, Belgian chiropractors have never been allowed to possess their own imaging facilities. This is similar to other European countries and most probably dependent upon the legislation of chiropractic in these countries.^{6,31}

Chiropractors reported they would like to have any diagnostic images in slightly less than half of their patients, and approximately one-third of the new patients present with

Table 2. *Opinions of Chiropractors Toward the Use of Diagnostic Imaging in the Chiropractic Practice*

	Chiropractors (N = 195)		
	Agree % (n)	No opinion % (n)	Disagree % (n)
Is it important that chiropractors use diagnostic imaging in making clinical decisions about their patients?	83.1 (162)	8.7 (17)	8.2 (16)
Is it important that chiropractors take radiographs themselves in their own practice?	20.5 (40)	20.5 (40)	59.0 (115)
Is it important that chiropractors can directly refer for:			
Radiographs	91.2 (177)	6.2 (12)	2.6 (5)
MRI	86.1 (167)	10.3 (20)	3.6 (7)
CT	66.8 (129)	24.4 (47)	8.8 (17)
Other (eg, ultrasound scan)	67.4 (130)	24.4 (47)	8.3 (16)
Is it important for chiropractors to be able to interpret diagnostic imaging themselves			
Radiographs	95.9 (186)	2.6 (5)	1.5 (3)
MRI	89.7 (174)	5.2 (10)	5.2 (10)
CT	76.7 (148)	14.0 (27)	9.3 (18)
Other diagnostic imaging (eg, ultrasound scan)	44.3 (85)	32.5 (62)	23.4 (45)
I read. . . . myself	% Always (n)	% Sometimes (n)	% Never (n)
Radiographs	89.2 (173)	8.8 (17)	2.1 (4)
MRI	75.8 (147)	19.6 (38)	4.6 (9)
CT	58.5 (113)	28.5 (55)	13.0 (25)
Other diagnostic imaging (eg, ultrasound scan)	10.4 (20)	39.1 (75)	50.5 (97)
I feel confident reading	% Always (n)	% Sometimes (n)	% Never (n)
Radiographs	85.1 (165)	13.9 (27)	1.0 (2)
MRI	50.5 (98)	45.4 (88)	4.1 (8)
CT	12.4 (24)	52.8 (102)	34.7 (67)
Other diagnostic imaging (eg, ultra sound scan)	3.6 (7)	32.5 (62)	64.1 (123)

CT, computed tomography; MRI, magnetic resonance imaging.

imaging from other health care professionals (eg, GP or medical specialist). When imaging is not present and the chiropractor feels this is necessary, a request may be sent to the GP who usually agrees with the request. However, we did not examine whether the 42% of cases where chiropractors deem imaging necessary is above and beyond the 37% of cases where imaging already exists. It is plausible that there is overlap suggesting that the requesting rate of radiographs by chiropractors in The Netherlands and Belgium is far less than the reported 42%.

Further, self-reported indications for ordering diagnostic imaging were in line with the imaging guidelines in the

majority of cases. This is comparable with other (recent) studies,^{32,33} and our results suggest that these indications for ordering imaging were better in line with the guidelines compared with older studies in The Netherlands.^{3,23} In the past, radiographs were more often used as a guidance to treatment, while today, imaging is principally used to exclude pathology (eg, fracture). However, these are rarely observed in primary care (1 on 100-2500 radiographs). Importantly, there is a poor relation between the imaging findings, pain, and outcome of a given therapy,^{7,34} therefore chiropractors should be cautious with the use of imaging.

Table 3. Association Between Characteristics and Opinions of Chiropractors Toward the Use of Diagnostic Imaging in the Chiropractic Practice

Univariable Multinomial Regression ^a	Agree OR	95% CI	No Opinion OR	95% CI
Is it important that chiropractors use diagnostic imaging in making clinical decisions about their patients?				
Country Belgium (reference category) Netherlands	1.26	(0.41; 3.83)	1.48	(0.32; 6.90)
Years in practice				
0-10 y (reference category)				
10-20 y	2.47	(0.50; 12.15)	4.00	(0.55; 29.10)
20+ y	0.67	(0.22; 2.06)	1.87	(0.39; 8.89)
Type of practice				
Solo practice (reference category) group practice	0.85	(0.30; 2.41)	3.86	(0.86; 17.32)
Post-graduate education Yes				
No	1.03	(0.36; 2.98)	0.69	(0.16; 2.97)
Is it important that chiropractors take radiographs themselves in their own practice?				
	OR	95% CI	OR	95% CI
Country				
Belgium (reference category) Netherlands	4.80	(1.60; 14.44)	2.13	(0.90; 5.07)
Years in practice				
0-10 y (reference category)				
10-20 y	3.30	(1.36; 8.02)	3.75	(1.57; 8.94)
20+ y	2.01	(0.82; 4.93)	1.67	(0.66; 4.25)
Type of practice				
Solo practice (reference category) Group practice	0.60	(0.28; 1.28)	1.24	(0.59; 2.59)
Post-graduate education				
Yes No	1.04	(0.50; 2.16)	0.67	(0.31; 1.44)

CI, confidence interval; OR, odds ratio.

^a Reference category is disagree.

Referral for or taking imaging by chiropractors in other studies varies from 12% to 93%.^{6,27,35-37} Not taking the difference in legislation into account, this large variation in rates may in part be a reflection of the different methodology used (eg, survey or measurement of actual use). Notably, higher imaging rates were reported in the studies using surveys (range 54%-93%) and studies published less recently. Importantly, many of these studies were published before the development of the “diagnostic imaging.”

In contrast to an overall increase in the use of diagnostic imaging in health care, particularly MRIs,⁷ chiropractors in

this study reported that their imaging use has declined compared with previous studies in The Netherlands and Belgium.^{3,6,31} This decline might be owing to the introduction of diagnostic guidelines in 2010,¹³ which advises limiting the use of diagnostic imaging. This suggests that guidelines have had a positive effect. In order to further reduce the use of routine imaging, trust and a shared responsibility of chiropractors between other health care professionals (eg, GP and neurologists) and imaging centers is necessary.

Further, changes in the national law may have affected these results. Namely, a change in the Dutch law in 2003

Table 4. Amount of Existing Imaging, of Retrieving Existing Imaging, and Requesting Images by Responding Chiropractors in Netherlands and Belgium

	Total
In what percentage of patients would you like to have diagnostic imaging? (mean %, SD) (n = 197)	42.4 (27.6)
New patients at the chiropractic practice who already have diagnostic imaging. (mean %, SD) (n = 202)	37.2 (22.6)
Presence of radiographs (mean %, SD) (n = 198)	50.0 (23.8)
MRIs (mean %, SD) (n = 198)	36.0 (18.2)
CT scans (mean %, SD) (n = 198)	11.0 (14.9)
Other diagnostic imaging (mean %, SD) (n = 198)	3.2 (5.1)
Do chiropractors request the diagnostic imaging when present? (%) (n = 202)	
Always	54.5
Sometimes	44.1
Never	1.5
Do chiropractors request the report of diagnostic imaging?(%) (n= 202)	
Always	30.7
Sometimes	55.4
Never	13.9
In what percentage of patients do you refer for radiographs? (mean %, SD) (n = 177) ^a	30.4 (25.6)
In what percentage of patients do you take radiographs? (mean %, SD) (n = 18) ^b	60.1 (32.9)
In what percentage of patients do you refer for other diagnostic imaging? (mean %, SD) (n = 195)	20.3 (23.9)
Chiropractors with their own diagnostic imaging facilities (mean %, SD) (n = 21) ^b	14.0 (15.5)
Chiropractor with no x-rays facilities (mean %, SD) (n = 177) ^a	21.3 (24.6)

CT, computed tomography; MRI, magnetic resonance imaging; SD, standard deviation.

^a All chiropractors without diagnostic imaging facilities.

^b Only Dutch chiropractors with their own diagnostic imaging facilities, as Belgian chiropractors are not allowed to have x-ray facilities at their practice.

restricted the possession of radiograph equipment for chiropractors. In contrast, the Belgian chiropractic profession recently made significant steps toward legalization that has made it easier to access patient's medical information. The changes in law may lead to a different patient population visiting chiropractors (eg, more complicated patients or

Table 5. Association Between Characteristics and the Use of Diagnostic Imaging

Multivariable linear regression	In what percentage of patients would you like to have diagnostic imaging?	
	Unstandardized Coefficient	95% CI
Country		
Belgium (reference category)	-0.86	(-10.34; 8.62)
Netherlands		
Years in practice		
0-10 y (reference category)		
10-20 y	1.59	(-8.00; 11.18)
20+ y	9.27	(-0.54; 19.07)
Type of practice		
Solo practice (reference category) group practice		
	-0.29	(-8.74; 8.16)
Postgraduate education		
Yes (reference category)	-2.06	(-10.35; 6.22)
No		

elderly patients), which in turn can lead to a change in imaging use.

Furthermore, based on the vignettes, two-thirds of the chiropractors reported adherence to the imaging guidelines for LBP, while chiropractors who have been in practice for fewer years and Dutch chiropractors appear to be more adherent. Imaging guideline adherence for LBP varied across previous studies.^{19,24,27,35} However, all these studies included only vignettes of patients with acute LBP, and we also included vignettes of patients with chronic LBP. Our findings might be more generalizable.

Generally, the studies that demonstrated a lesser guideline adherence (meaning ordering more imaging), were published less recently and performed in countries where chiropractic is legalized.^{19,27} In The Netherlands and Belgium chiropractic is seen as "alternative or complementary," while in Australia and North America, chiropractic is more mainstream. Therefore, improving guideline adherence may help better integration of chiropractic in The Netherlands and Belgium.

Importantly, chiropractors place greater weight on the use of imaging than other health care practitioners such as general practitioners and physiotherapists.^{7,12,38,39} This could be related to the fact that diagnostic imaging is historically more incorporated in chiropractic education. Chiropractors are not only educated to exclude serious pathology, but use it from a biomechanical perspective. This could lead to more use of diagnostic imaging;

Table 6. *Indications to Use or Not to Use Diagnostic Imaging*

Indications to use diagnostic imaging	Seldom or never	Total Sometimes	Often or always
Diagnosis (%) (n = 194)	8.2	28.9	62.9
Prognosis (%) (n = 194)	10.3	36.1	53.6
Exclusion of contraindications (%) (n = 195)	5.1	21.5	73.3
Indication of therapy (%) (n = 194)	41.2	39.2	19.6
Postural analysis (%) (n = 195)	69.7	17.4	12.8
Follow-up (%) (n = 194)	82.0	14.4	3.6
Indications not to use diagnostic imaging			
Limited value of imaging information (n = 194)	20.6	34.5	44.8
No cooperation of the general practitioner (n = 194)	46.2	31.8	22.1
Patient is too young (n = 195)	43.8	37.6	18.6
High radiation load for the patient (n = 194)	52.6	27.8	19.6
No cooperation of the hospital (n = 194)	70.1	15.5	14.4
No cooperation of the patient (n = 194)	84.0	11.3	4.6
High costs for the patient (n = 194)	83.0	13.9	3.1
Indications to retake images			
Obvious change in the patient's situation or health since the existing images were taken (eg, trauma) (n = 194)	9.2	21.5	69.2
Wrong series or incomplete series of imaging (eg, an Anterior Posterior Open Mouth view is not taken) (n = 194)	44.3	41.2	14.4
Images not recent enough in patients with specific conditions (eg, scoliosis) (n = 194)	35.1	48.5	16.5
Image not taken in a standing position (n = 194)	70.1	23.2	6.7
Poor quality of the images (n = 194)	58.8	34.0	7.2
Follow-up after several treatments (n = 195)	94.3	4.6	1.0
Other indications (n = 6)			

however, we did not find that, because in many cases imaging was already available from other health care practitioners. Additionally, the patient population can differ per health care provider (eg, chiropractors see more chronic patients specially in The Netherlands) and patients have often consulted many providers with varying degree of success before visiting a chiropractor.^{40,41}

Strength and Limitations

This study is an update of self-reported views on diagnostic imaging in general by chiropractors in The

Netherlands and Belgium, therefore the results add to our body of knowledge and as such, will help to move forward the chiropractic profession.

No study is immune to limitations and ours is no exception; therefore, there are a number of limitations that should be considered in interpreting these results. First, the data was collected in 2013; however, these data are valuable today since there has been no major change in legislation or guidelines since then and management change in health care is usually a slow process.^{21,42} Only small improvement in adherence can be expected since 2013 because of an influx of new graduates, retirement of older chiropractors, and

Table 7. *Self-reported Familiarity With Diagnostic Imaging Guidelines*

		Yes	No
Are you familiar with practice guidelines in the management of low back pain patients? (%) (n = 193)		71	29
Are you familiar with diagnostic imaging guidelines in the management of low back pain patients? (%) (n = 137)		75	25
Do you take the diagnostic imaging guidelines into account when referring for diagnostic imaging? (%) (n = 97)		80	20
Multivariable logistic regression: Are you familiar with practice guidelines in the management of low back pain patients? (%)			
	Coefficient	OR	95% CI
Country			
Belgium (reference category)			
Netherlands	1.17	3.21	(2.38; 4.33)
Years in practice			
0-10 y (reference category)			
10-20 y	-0.25	0.78	(0.56; 1.09)
20+ y	-0.57	0.57	(0.41; 0.79)
Type of practice			
Solo practice (reference category)			
Group practice	-0.38	0.68	(0.51; 0.91)
Postgraduate education			
Yes (reference category)			
No	0.64	1.90	(1.41; 2.57)

Percentages and results of multiple logistic regression analysis for associations between familiarity with practice guidelines and characteristics of chiropractors.

CI, confidence interval; *OR*, odds ratio.

more focus in postgraduate education on limiting imaging. Moreover, the chiropractic associations have not actively pursued a policy for implementing diagnostic imaging.

Second, although the response rate might seem low (60%), this was comparable to similar studies,^{33,43,44} although we cannot rule out the possibility of selection bias owing to nonresponse. Two-thirds of the Dutch chiropractors and all Belgian chiropractors are registered at national organizations, so it is possible that nonresponders or nonregistered chiropractors may represent a different type of practitioner than those who chose to participate or those not willing to complete the extensive survey. Thus, the actual views on diagnostic imaging might deviate, and caution is urged in interpreting these results.

Third, the time required to complete the survey was great, which could have led to a lower response rate; however, despite this, the response rate was high and little data were missing.

Fourth, there is the potential for recall bias and socially desirable answers leading to bias, as these data were self-

reported. Fifth, the confidence intervals for multinomial regression analyses are very broad, meaning the results of these are less robust.

Finally, the majority of questions and vignettes used in this survey were adapted from previous surveys designed by experienced researchers. They were descriptive in nature, and therefore simple and inexpensive to administer, but they can introduce bias, as they do not allow for the complexity of clinical decision making. To assess this, we tested the questionnaire during the pilot study, which only led to minor revisions. Admittedly, we did not examine the test–retest reliability, and consequently we do not know whether the results of these vignette are consistent over time. More robust testing of these vignettes is needed.

Future Studies

Future research should include data from actual cases, not hypothetical ones. It is exactly these details, which are obtained by the practitioner during the patient consultation,

Table 8. Diagnostic Imaging Guidelines Adherence by Chiropractors in the Vignettes: Results of (Univariate and Multiple) Generalized Mix Model for Diagnostic Imaging Guidelines Adherence in All Vignettes

Univariable Generalized Mixed Model		Diagnostic Imaging Guidelines Adherence in the Vignettes (% [95% CI])	OR (95% CI)
Overall adherence for all 6 vignettes		65.9 (61.5-70.1)	
Overall adherence for the 3 vignettes describing patients with acute low back pain		68.2 (63.4-72.6)	
Overall adherence for the 3 vignettes describing patients with chronic low back pain		62.3 (56.5-67.9)	
Sex	Male (reference category)	63.9 (58.2-69.3)	
	Female	69.4 (62.1-75.8)	0.8 (0.5-1.2)
Postgraduate training	Yes (reference category)	64.6 (57.2-71.4)	
	No	66.8 (61.0-72.1)	0.9 (0.6-1.4)
Country where working	Belgium (reference category)	53.3 (44.5-61.9)	
	Netherlands	70.3 (65.5-74.8)	2.1 (1.4-3.2)
Type of practice	Solo practice (reference category)	62.4 (52.8-71.2)	
	Group practice	68.8 (62.1-74.8)	1.3 (0.9-2.0)
X-ray facilities ^a	Yes (reference category)	45.5 (31.4-60.4)	
	No	73.4 (68.5 -78.0)	0.3 (0.2-0.6)
Years in practice	0-10 (reference category)	71.6 (65.3-77.1)	
	10-20	63.1 (54.5-71.0)	0.7 (0.4-1.1)
	20+	57.6 (48.3-66.3)	0.5 (0.3-0.9)
Familiarity of practice guidelines (reference category = yes)	Yes (reference category)	66.7 (61.4 -71.7)	
	No	64.1 (55.7 -71.8)	0.9 (0.6-1.4)
Multivariable Generalized Mixed Model		Coefficient	OR
Country			95% CI
Belgium (reference category)			
Netherlands		0.82	2.26 (1.42; 3.61)
Years in practice			
0-10 y (reference category)			
10-20 y		-0.41	0.66 (0.42; 1.06)
20+ y		-0.57	0.57 (0.35; 0.91)
Type of practice			
Solo practice (reference category)		-0.24	0.92 (0.61; 1.38)
Group practice			

(continued)

Table 8. (Continued)

Univariable Generalized Mixed Model		Diagnostic Imaging Guidelines Adherence in the Vignettes (% [95% CI])	OR (95% CI)
Postgraduate education			
Yes (reference category)			
No	-0.08	0.80	(0.53; 1.19)
Familiarity of practice guidelines			
Yes (reference category)			
No	-0.14	0.87	(0.56; 1.36)

CI, confidence interval; OR, odds ratio.

^a Only chiropractors in The Netherlands.

that can help guide the practitioner. Further, future studies should focus on (cost-effective) methods to increase implementation of diagnostic imaging guidelines, and thereby reducing inappropriate LBP imaging.

CONCLUSION

Most chiropractors in The Netherlands and Belgium are of the opinion that diagnostic imaging is important in the management of their patients in general. They prefer to have imaging in 42% of their new patients and they reported that some new patients (37%) had images already available. Self-reported indications for ordering diagnostic imaging were in line with the imaging guidelines in the majority of cases. We found some variances between Belgian and Dutch chiropractors and years of experience related to guideline adherence.

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Practical Applications

- The diagnostic imaging in clinical practice remains important for Dutch and Belgian chiropractors.
- Estimated self-reported adherence to national diagnostic imaging guidelines showed that improvement may be necessary, noting that imaging was in 37% of patients already ordered by another health care provider before the patient visited the chiropractor.
- Dutch chiropractors and chiropractors with less than 10 years in practice reported less imaging to be necessary and a better adherence to national guidelines than those with more than 10 years' experience.

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