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Children and adolescents seen at a medical unit – A retrospective review of patient records from the Spine Center of Southern Denmark

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ABSTRACT

Background: Spinal pain in children and adolescents is common and limits their daily In the Region of Southern Denmark, the Spine Center of Southern Denmark provides care for patients with spinal pain who have not improved through primary care. Limited information exists about children and adolescents seen in medical hospital settings.

Method: A retrospective review of clinical encounters with patients under the age of 18 from January 2018 to December 2021. Data were collected on demographic factors, clinical characteristics, functional impairments, and diagnostic codes (International Classification of Disease (ICD-10)).

Results: Patients ranged from age 9 to 17, and 60% were female. Most were in primary school, and physically active. The primary complaint was persistent ongoing lumbar pain without nerve root affection and of non-traumatic origin. Mostly used ICD-10 codes were categorized as *non-specific spinal pain*. However, one-fourth had specific diagnoses, including*disk herniation, spondylolysis and -listhese, specific spinal-related and non-spinal complaints*. Advanced imaging was common, both before referral or at the initial assessment. Approximately 20% were referred to other hospital departments, mostly pediatric departments. Functional impairment varied widely.

Conclusion: Children and adolescents with spinal pain seen at an outpatient spine center predominantly received non-specific pain diagnoses. However, approximately 20% did have a specific cause for their pain. Patients demonstrated high variability in how much their pain affected them; a large proportion had received imaging either before the initial assessment or with a referral from the spine center.

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KEYWORDS
Children; adolescents; hospital; secondary care; spinal pain; youth

Abbreviations

ICC	Intraclass correlation coefficient
ICF	International classification of disease
MRI	Magnetic resonance imaging
STROBE	Strengthening the reporting of observational studies in epidemiology

Background

Pain arising from the back and neck (spinal pain) is a common and costly symptom in the general adult population [1]. In Denmark, spinal pain is one of the highest burdens on an economic and societal level, including the cost of care and loss of work productivity [2], as well as the primary reason for visits to general practitioners and chiropractors [3]. A Danish study estimated the yearly prevalence of back pain in school children to be 30% [4], and similar figures are found across several countries [5,6]. The children and adolescents with back pain often experience restrictions with participation in life events, such as sports and school [6,7], and often experience psychosocial impacts [8]. Furthermore, a correlation between lower back pain in adolescents and developing lower back pain in adulthood was shown with a four-time increase in risk [9].

Guidelines for managing spinal pain in adult patients are thoroughly reviewed and regularly updated [10,11]. No such guidelines exist for children and adolescents with spinal pain, and therefore, treatment is often based on evidence from the adult population or employing more experimental and non-evidence-based approaches [12].

With emerging evidence that spinal pain in children and adolescents is very prevalent [6,13], there is a need for a clinical pathway and recommendations

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for managing spinal pain both in primary care and in secondary care when the initial care is insufficient. In Denmark, detailed clinical pathways for when and how to use secondary care (hospital) settings are available for adults [14] but not for children and adolescents.

In the region of Southern Denmark, adults with spinal pain can be seen at the Spine Center of Southern Denmark (Lillebaelt Hospital) for diagnostic evaluation and suggestions for further management, including surgical evaluations. Until 2018, patients had to be at least 18 years of age for a referral. In 2018, to overcome the lack of a referral pathway, a pilot project was launched in which children and adolescents with spinal pain were given the possibility of referral to the spine center in collaboration with the pediatric department (Lillebaelt Hospital), which oversaw the initial referral for potential malignant or inflammatory causes. The clinical pilot project was led by a specialized hospital chiropractor [15] and included interdisciplinary assessments with medical doctors, physiotherapists, and nurses. The clinical pilot project became an official referral pathway in the Region of Southern Denmark in January 2022.

Considering the scarcity of information about this population, especially in a secondary medical care facility, we need a comprehensive understanding of children and adolescents with spinal pain referred to secondary healthcare settings. Therefore, we will describe the children and adolescents seen at the Spine Center of Southern Denmark during the clinical pilot period using the clinical records on demographic factors and clinical characteristics (including functional impairments and management plans). Second, we will examine if children and adolescents differed in demographic factors, clinical characteristics, and functional impairments between diagnostic codes.

Method

Design

The study is a retrospective review of clinical records. The study's methodology follows the principles of Vassar et al. [16] and Sarkar et al. [17]. The study was reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement for cross-sectional studies [18], modified to fit the study design. Data processing in the present project is regulated in the Danish Act on Research Ethics Review of Health Research Projects section 14, subsection 2, which states that health research based solely on questionnaire surveys and register data is exempt from the obligation to notify the committees. This including waiving the need for signed consent. Instead, the project was registered as quality assurance, and the data extraction was approved by Hospital management and The Region of Southern Denmark (ID:22/993) [19].

Patients and setting

The Spine Center of Southern Denmark is an outpatient medical department specializing in spinal disorders. The center assesses approximately 18.000 unique patients each year, and patients can be evaluated by a multidisciplinary team of medical doctors, chiropractors, or physiotherapists. The assessment includes history taking, objective examination, diagnostic triaging, management planning, and follow-up if necessary. Furthermore, after the clinical evaluation, patients who were evaluated in need of information on pain management were consulted by a physiotherapist or a nurse to provide further recommendations on conservative management approaches.

All clinical encounters with patients under the age of 18 seen at the Spine Center of Southern Denmark from January 2018 to December 2021 (clinical pilot period) were included in the review.

Data sources and variables of interest

Data were extracted and classified by two authors, FGO and SLMB. A third author, CGN, refereed. If a categorization could not be classified upon refereed, it was marked as 'missing'. Before data extraction, consensus-based agreements on relevant variables for extraction were made by FGO, SLMB, and CGN. Next, FGO and SLMB individually classified the identical 10 clinical records, and the Intraclass Correlation Coefficient evaluated agreements using the *average random rater* model (ICC) [20]. If the ICC value were 0.90 or more, the remaining extraction and classification would be split between FGO and SLMB. If the ICC value were below 0.90, the data would be extracted and classified in unison between FGO and SLMB. A complete description of these processes can be found in Appendix 1. All classified variables are described in Table 1.

Variables of interest for each clinical record were extracted and grouped by:

- Demographic factors (e.g. age, sex, school year, employment)
- Pain symptoms (e.g. location, duration, origin)
- Objective findings (e.g. findings on neurological X examination)
- Treatment with health care professionals (i.e. use of oral analgesics (e.g. paracetamol), healthcare services prior to spine center assessment (e.g. physiotherapist, chiropractor))
- Paraclinical investigation (e.g. imaging)
- Management recommendations and treatment plans (e.g. municipal rehabilitation, medicine)

Table 1. Variables of interest, definition, and scoring.

Categories	Variable	Definition	Scoring
Demographic factors	Age	Patient's age	Numerical up to 17
	Sex	Patient's gender	Male or female
	Primary occupation	Work or level of ongoing education	1: Primary school 2: Secondary school 3: Vocational education 4: Work occupation 5: Other 6: None
	Secondary occupation	Parttime occupation done secondarily to primary occupation	1: Leisure work 2: Student 3: Other 4: None
	Physical activity	Level of sports related activities outside school. Elite is defined by being competitive or more than 5 h a week	1: Elite 2: Exerciser 3: None
	Sick leave	Leave from 1 or more subject(s) from school and/or absence from leisure activities	1: Yes 2: Previously 3: No
Pain symptoms	Previous back pain assessment	Categorization of previous back pain assessment	1: Primary health care sector 2: Spine surgery 3: Secondary health care sector 4: No history 5: Complex (to or more from above)
	Pain location	Localization of pain	1: Neck 2: Mid back 3: Lower back 4: Coccyx 5: Multi-site
	Radiating pain	Nerve affection in upper or lower limps	1: Yes 2: No
	Duration	Duration of the back related pain.	1: Acute (0-12 weeks) 2: Persistent chronic (>12 weeks) 3: Persistent fluctuating ((>12 weeks) irregular pain intensity) 4: Recurrent
	Trauma	Either high energy trauma or spine specific trauma	1: Yes 2: No
	Palpation pain	Pain during initial assessment	1: Yes 2: No
	Findings on orthopedic examination	Outcome on selected orthopedical tests	1: Yes 2: No
	Findings on muscular examination	Outcome on selected muscular tests	1: Normal 2: Decreased strength 3: Test stopped due to pain
	Findings on neurologically examination	Outcome on selected neurological tests	1: Normal 2: Abnormal
Treatment	Previous treatment	Treatment with chiropractor, physiotherapist, treatment within sports club by trained professionals or other	1: Yes 2: NO
	Previous medication	Pain relieving medication for back pain	1: Yes 2: No
Paraclinical investigation	Previous imaging	Imaging related to current back pain	1: Yes 2: No
	Diagnostic imaging	Ordered by initial assessor after examination	1: MRI 2: X-ray 3: No
	Blood samples	Ordered by initial assessor after examination	1: Yes 2: No
Management recommendations and treatment plans	Self-management	Self-care-management without assistance from healthcare provider	1: Recommended 2: Not recommended
	Exercises	For the patient to do at home or supervised at the Spine Center	1: Recommended, not defined 2: Recommended, supervised 3: Recommended, instructed 4: Not recommended 5: Referred to municipal rehabilitation
	Municipal rehabilitation	Rehabilitation within public municipals	1: Recommended 2: Not recommended
	Medicine	If recommended, the specific drug would be recorded. Furthermore, discussion of discontinuation and tapering	1: Recommended 2: Not recommended
	Physical therapist	Referred to an inhouse evaluation with a physiotherapist	1: Yes 2: No
Referrals within secondary sector	Further referral	If further medical assessment within secondary sector was needed	1: Pediatric 2: Rheumatologic 3: Orthopedic 4: Neurologic 5: Other
Diagnosis	Diagnosis	ICD10 codes	Value

- Referrals within secondary sector (i.e. surgical evaluations or hospital department)
- Diagnostic codes, using the International Classification of Disease, version 10 (ICD-10) (e.g. DM545)

We also categorized information on patients' functional impairment by the International Classification of Function (ICF) Brief Core Set for Low Back Pain [21,22]. The identification of impairments and disability was assessed by the first two levels of the ICF classification system within the domains: Body Functions (b), Body Structures (s), and Activities and Participation (d) [23]. The category Environmental Factors (e) was excluded due to a lack of consistent reporting in the records.

Variables that could not be sufficiently described based on the clinical records were labeled as 'missing'.

The ICD10 codes were collapsed into five diagnostic subgroups:

1. Non-specific spinal pain: diagnosis related to unspecific pain in the spine (DS134C, DM531, DM539, DM541, DM542, DM545, DM546, DM548, DM549, and DM997).

2. Disk herniation: diagnosis involving a disk herniation with and without radiation (DM511D, DM511E, DM512, DM512D, DM512E, and DM512F).
3. Spondylolysis and -listhesis: diagnosis with either of the two, including bone-marrow edema due to arcolysis (DM430, DM431, DM472A, DM478D, and DM478E).
4. Specific spinal pain: a diagnosis related to structural abnormalities or suspicion of a spinal disease (e.g. scoliosis (DM419), kyphosis (DM402A), DM420, DM432, and DZ039).
5. Non-spinal complaints: diagnosis with pain not related to the spine (DR074, DR262, DR519, DR559B, DM543, DM544, DM626, DM758, DM759, DM769, and DM796)

Statistical analysis

The categorization of the clinical records was described and presented as count and proportions. For each variable, we compared the means or distribution between the five diagnostic groups, using the Kruskal–Wallis rank of sum test [24].

Analyses were conducted using R version 4.2 and RStudio version 1.4 [25] for Zorin OS 16.1 (Linux).

Results

Two-hundred-and-sixty individuals were identified. Fourteen (5.3%) had incomplete data as the treatment course at the spine center was ongoing.

The ICC values between FGO and SLMB for data extraction were 0.96 and 0.97 (95% confidence interval 0.95–0.97, p-value <0.001), respectively, for the two agreement analyses – indicating no need for double data extraction and categorization.

Population

The population ranged from 9 to 17 years of age, with a median of 15, and 60% were females. Seventy-four percent of all patients were in primary school, and most were physically active to some degree during leisure time.

Patients reported primarily persistent ongoing lumbar pain without pain in the extremities and not induced by trauma (Table 2).

Diagnosis

Patients were diagnosed with 34 unique ICD-10 codes. The five mainly used diagnoses, which accounted for more than 75%, were DM549, DM545, DM548, DM542, and DM546, all related to non-specific spinal pain. Consequently, the *non-specific spine pain* category included most participants, whereas the remaining four diagnostic groups ranged between 4 and 8% (Figure 1).

History taking

The most common pain location was the lower back for all groups (100% for the *spondylolysis and -listhese* group), except *specific spinal-related*, where 50% had thoracic pain. Multisite pain was most common for the *non-specific spinal pain* group. Radiating pain was significantly different for the *disk herniation* group, with 71% experiencing radiating pain compared with the other four groups; *non-specific spinal pain* 20%, *spondylolysis and -listhese* 24%, *specific spinal pain* 0%, and *non-spinal complaints* 32%.

Objective findings

Clinicians reported that the patients experienced pain during palpation, whereas the orthopedic and neurological examinations were mainly normal (Figure 2).

Paraclinical investigation

The majority of children and adolescents had yet to receive diagnostic imaging before the assessment. If they had, this was primarily advanced imaging (i.e. magnetic resonance imaging (MRI)) (36%) rather than conventional x-ray (22%). Imaging differed substantially between groups, with more than 80% of children and adolescents with *disk herniations* and *spondylolysis and -listheses* having received imaging prior to the clinical encounter at the spine center, compared to *non-specific spinal pain*, and *non-spinal complaints* where less than half of the children had received imaging.

Of those who did not have advanced imaging prior to the assessment, 52% were referred for imaging following the assessment at the spine center (Figure 3).

Functional impairment

The five most used codes were b280 (95%), s760 (81%), d859 (50%), d415 (45%), and b710 (37%), and constituted more than 60% of all given codes (Figure 4). The distribution was approximately 40% in both Activities and Participation (d) and Body Functions (b) and 23% in Body Structure (s).

There was much variability in how spinal pain affected the children's functioning. Three patients did not describe any impairments or disabilities, whereas four patients were significantly affected with 11 impairment codes.

The most common number of reported impairments or disabilities was 3 or 4 (41% and 54%, respectively).

Table 2. Selected results from clinical records distributed by scoring all variables by diagnosis. 'Missing data' was a variable not described in the clinical records. All findings reported as numbers and proportions, n (%) 1Kruskal-Wallis rank sum test.

Variable	Categories	Non-specific spinal pain *n* = 208	Disk herniation *n* = 17	Spondylolysis- and -listhese *n* = 17	Specific spinal pain *n* = 10	Non-spinal complaints *n* = 21	*p*-value[1]
Age	9–12	20 (9.6%)	5 (29%)	1 (5.9%)	2 (20%)	1 (4.8%)	0.12
	13–14	45 (22%)	3 (18%)	4 (24%)	0	2 (9.5%)	
	15	43 (21%)	3 (18%)	7 (41%)	4 (40%)	10 (48%)	
	16	51 (25%)	4 (24%)	3 (18%)	3 (30%)	3 (14%)	
	17	49 (24%)	2 (12%)	2 (12%)	1 (10%)	5 (24%)	
Sex	Female	125 (60%)	13 (76%)	6 (35%)	3 (30%)	13 (62%)	**0.041**
	Male	83 (40%)	4 (24%)	11 (65%)	7 (70%)	8 (38%)	
Primary occupation	Primary school	154 (74%)	13 (76%)	13 (76%)	9 (90%)	17 (81%)	~1
	Secondary school	31 (15%)	3 (18%)	3 (18%)	1 (10%)	2 (9.5%)	
	Vocational education	14 (6.8%)	1 (5.9%)	0	0	2 (9.5%)	
	Work	2 (1%)	0	1 (5.9%)	0	0	
	Other	2 (1%)	0	0	0	0	
	None	5 (2.4%)	0	0	0	0	
Secondary occupation	Leisure work	37 (90%)	4 (100%)	0	3 (100%)	3 (100%)	0.3
	Student	0	0	0	0	0	
	Other	3 (7.3%)	0	0	0	0	
	None	1 (2.4%)	0	1 (100%)	0	0	
	Missing data	167	13	16	7	18	
Physical activity	Elite	19 (9.7%)	4 (29%)	6 (38%)	0	3 (15%)	0.069
	Exerciser	145 (74%)	9 (64%)	8 (50%)	7 (78%)	14 (70%)	
	None	32 (16%)	1 (7.1%)	2 (12%)	2 (22%)	3 (15%)	
	Missing data	12	3	1	1	1	
Sick leave	Yes	73 (38%)	7 (47%)	11 (69%)	1 (12%)	12 (63%)	**0.034**
	Previously	27 (14%)	3 (20%)	2 (12%)	0	2 (11%)	
	No	93 (48%)	5 (33%)	3 (19%)	7 (88%)	5 (26%)	
	Missing data	15	2	1	2	2	
Previous back pain assessment	Primary health care	12 (5.8%)	2 (12%)	0	3 (30%)	1 (4.8%)	0.10
	Spine surgery	4 (1.9%)	0	0	1 (10%)	1 (4.8%)	
	Secondary health care	32 (16%)	1 (5.9%)	4 (24%)	1 (10%)	5 (24%)	
	No	128 (62%)	8 (47%)	10 (59%)	5 (50%)	11 (52%)	
	Complex	30 (15%)	6 (35%)	3 (18%)	0	3 (14%)	
	Missing data	2	0	0	0	0	
Pain location	Neck	22 (11%)	0	0	1 (17%)	3 (14%)	**0.018**
	Mid back	27 (13%)	0	0	3 (50%)	4 (19%)	
	Lower back	126 (61%)	15 (88%)	17 (100%)	2 (33%)	12 (57%)	
	Coccyx	4 (1.9%)	1 (5.9%)	0	0	1 (4.8%)	
	Multi-site	29 (14%)	1 (5.9%)	0	0	1 (4.8%)	
	Missing data	0	0	0	4	0	
Radiation	Yes	38 (20%)	12 (71%)	4 (24%)	0	6 (32%)	**<0.001**
	Missing data	16	0	0	1	2	
Duration	Acute	31 (15%)	4 (24%)	4 (24%)	0	2 (9.5%)	0.3
	Persistent chronic	72 (35%)	5 (29%)	8 (47%)	5 (56%)	9 (43%)	
	Persistent fluctuating	76 (37%)	8 (47%)	4 (24%)	2 (22%)	5 (24%)	
	Recurrent	24 (12%)	0	1 (5.9%)	2 (22%)	5 (24%)	
	Missing data	5	0	0	1	0	
Trauma	Yes	52 (26%)	1 (6.2%)	4 (24%)	1 (11%)	4 (21%)	0.6
	Missing data	5	1	0	1	2	
Palpation pain	Yes	177 (88%)	9 (82%)	15 (88%)	5 (62%)	16 (84%)	0.3
	Missing data	7	6	0	2	2	
Findings on orthopedic examination	Yes	47 (26%)	9 (53%)	2 (12%)	0	7 (39%)	**0.025**
	Missing data	25	0	0	3	3	
Findings on muscular examination	Normal	172 (97%)	13 (93%)	14 (93%)	8 (100%)	16 (94%)	0.3
	Decreased	2 (1.1%)	1 (7.1%)	1 (6.7%)	0	1 (5.9%)	
	Test stopped due to pain	3 (1.7%)	0	0	0	0	
	Missing data	31	3	2	2	4	
Findings on neurologically examination	Normal	162 (92%)	11 (73%)	14 (93%)	7 (88%)	13 (81%)	0.089
	Abnormal	14 (8%)	4 (27%)	1 (6.7%)	1 (12%)	3 (19%)	
	Missing data	32	2	2	2	5	
Treatment with health care professional	Yes	157 (85%)	11 (73%)	10 (77%)	6 (67%)	18 (90%)	0.3
	Missing data	23	2	4	1	1	
Previous medication	Yes	64 (47%)	7 (64%)	4 (44%)	4 (50%)	8 (57%)	0.8
	Missing data	71	6	8	2	7	
Previous imaging	Yes	97 (47%)	15 (88%)	14 (82.5%)	6 (60%)	10 (47.5%)	**<0.001**
	Missing data	2	0	0	0	0	
Imaging referral	MR/CT	72 (35%)	2 (12%)	6 (35%)	1 (10%)	7 (33%)	0.3
	X-ray	34 (16%)	6 (35%)	4 (24%)	2 (20%)	4 (19%)	
	No	102 (49%)	9 (53%)	7 (41%)	7 (70%)	10 (48%)	

(*Continued*)

Table 2. Continued.

Variable	Categories	Non-specific spinal pain *n* = 208	Disk herniation *n* = 17	Spondylolysis- and -listhese *n* = 17	Specific spinal pain *n* = 10	Non-spinal complaints *n* = 21	*p*-value[1]
Blood samples	Yes	6 (2.9%)	0	0	0	1 (4.8%)	0.9
Self-management	Recommended	160 (77%)	15 (88%)	14 (82%)	5 (50%)	9 (43%)	**0.002**
Exercises	Recommended, not defined	32 (15%)	0	2 (12%)	0	2 (9.5%)	**0.013**
	Recommended, supervised	4 (1.9%)	1 (5.9%)	0	1 (10%)	3 (14%)	
	Recommended, instructed	55 (26%)	6 (35%)	3 (18%)	1 (10%)	1 (4.8%)	
	Not recommended	117 (56%)	10 (59%)	11 (65%)	8 (80%)	15 (71%)	
	Municipal rehabilitation	0	0	1 (5.9%)	0	0	
Municipal rehabilitation	Recommended	18 (8.3%)	6 (35%)	2 (12%)	0	2 (9.5%)	**0.024**
Medicine	Recommended	4 (1.9%)	0	0	0	0	~1
Physical therapist	Yes	119 (57%)	8 (47%)	10 (59%)	1 (10%)	6 (29%)	**0.003**
Further referral	Pediatric	23 (11%)	2 (11.5%)	0	0	5 (24%)	**<0.001**
	Rheumatologic	6 (3%)	0	0	0	2 (9.5%)	
	Orthopedic	4 (2%)	0	2 (11.5%)	4 (40%)	3 (14%)	
	Neurologic	1 (0.5%)	2 (11.5%)	0	0	0	
	Other	0	1 (6%)	0	0	1 (5%)	
	Missing data (no referral)	174 (83.5%)	12 (71%)	15 (88.5%)	6 (60%)	10 (47.5%)	

When the five most common ICF codes were distributed within the five diagnostic subgroups, it illustrates that the groups were almost equally distributed across all five codes, but with the *non-specific spinal pain* group being generally least affected and the *spondylolysis and -listhesis* group most affected (Figure 5).

Recommendation from the spine center (diagnostic assessment and treatment)

The most apparent difference between diagnostic groups relates to the recommended treatment, where both *specific spinal pain* and *non-spinal complaint* differed from the other groups by less recommended self-management (respectively 50% and 43%) and exercises (respectively 20% and 29%), and not as often being referred to an in-house physical therapist (respectively 10% and 29%).

Only one patient was recommended to use oral analgesics, and two received a discontinuation plan.

Children and adolescents with *non-specific spinal pain* were more often referred to pediatrics assessment after their initial spine evaluation (Table 2). Most patients were recommended for management and received information and advice for self-management (Figure 6).

Discussion

Summary of findings

A total of 260 patients under 18 were assessed at the spine center during the clinical pilot project period

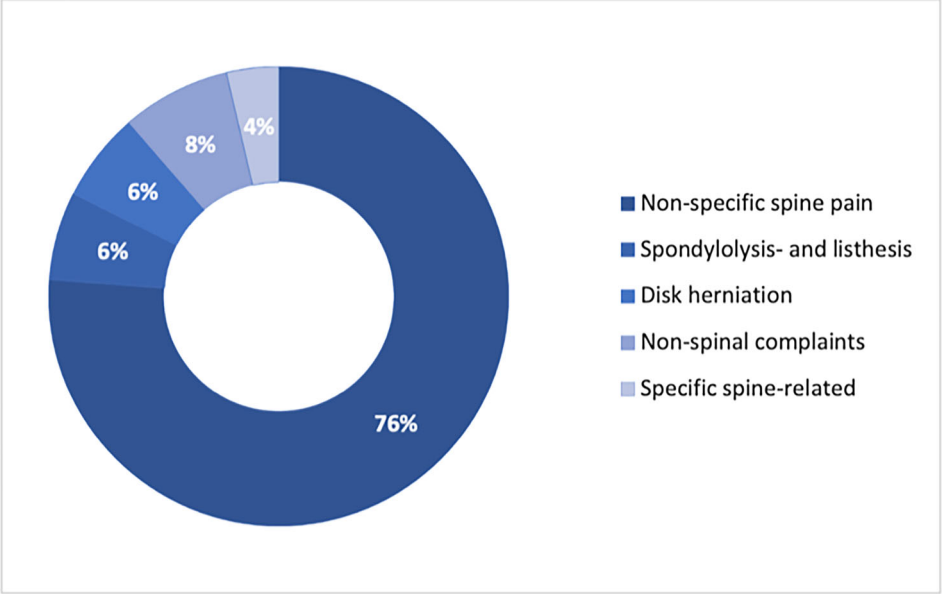

Figure 1. Subgrouping of diagnoses for all distributed diagnoses.

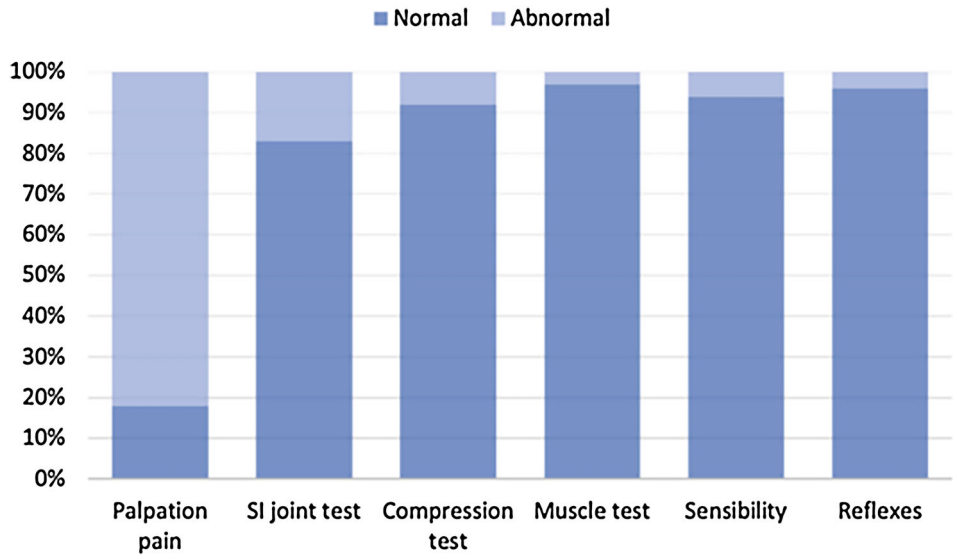

Figure 2. Objective findings from the initial examination as reported in the clinical records.

and consisted primarily of around 15 years old females with persistent non-specific lumbar pain. However, approximately 20% received a specific diagnosis, often *spondylolysis and -listhesis*, or *disk herniations*. Approximately half of the patients who did not have any imaging before the assessment would receive it later. The children and adolescents were functionally affected to a highly variable degree, with about half presenting with impaired work function.

The relatively high age (late teens) is not surprising, as the prevalence of spinal pain appears to increase with age [4,13,26–28]. Fuglkjaer et al. [4] found that in Danish school children, 30% experienced spinal pain within a year, mostly females, and the prevalence increased with age.

The comparison between our sample and that of a general Danish population indicates that fewer are sportingly active. In the general population of children under 15 years old, 65% used to exercise regularly, 30% were labeled 'elitists', and 5% did not exercise or exercised less than one hour a week [29]. The level of exercise differed between the diagnostic codes. The National Board of Health recommends 60 min of daily physical activity for children and adolescents 5–17 years old [30]. The evidence shows that physical inactivity is a risk factor for injury and impacts general health and organ function. Speculatively, this puts our population at a higher risk for cardiovascular and lifestyle diseases compared to the general population [31].

We observed that of the 32 elitists, 6 (19%) were diagnosed with *spondylolysis and -listheses* compared to 8 (4%) from the overall 183 exercisers. Similar findings have previously been established in a different cohort of Japanese sports exercisers with a prevalence of spondylolisthesis up to 30% compared to 6% in the general Japanese population [32].

Seventeen (6%) had symptoms due to *disk herniations* in this highly selected spinal pain population. A recent systematic review [33] found a pooled prevalence of disk herniations of 38% among children presenting with lower back pain. However, this number is likely overestimated based on very small sample sizes with persistent back pain or orthopedic pediatric settings where surgical indications due to spine pathologies are expected. We are unaware of any studies assessing the frequency of disk herniations in a medical unit or in the general population. It corroborates that disk herniations are rare in children and adolescents but can occur in highly specialized settings. Our results are similar to those of the adult population, where disk herniations cause 5-10% of spinal pain [34].

Surprisingly, more than 30% had not received conservative management before their referral to the spine center, even though this is recommended for both acute and chronic low back pain [35] and can relieve pain, potentially making future referrals redundant [12]. However, the lack of treatment may be due to uncertainty with the social context or lack of available information about how to proceed with adolescent back pain. All in all, it does illustrate the need to discuss whether children and adolescents should fulfill the same criteria as adults before referral to hospital settings, especially at specialized spine center units [36]. Consequently, it is imperative for future research to focus on formulating appropriate clinical treatment strategies to address these issues.

The criteria for diagnostic imaging in children is more lenient than in adults, and imaging may arguably be provided despite short duration, no prior trauma, and normal physiological and neurological examinations, which is not recommended for adults [37]. Although the majority were diagnosed with *non-*

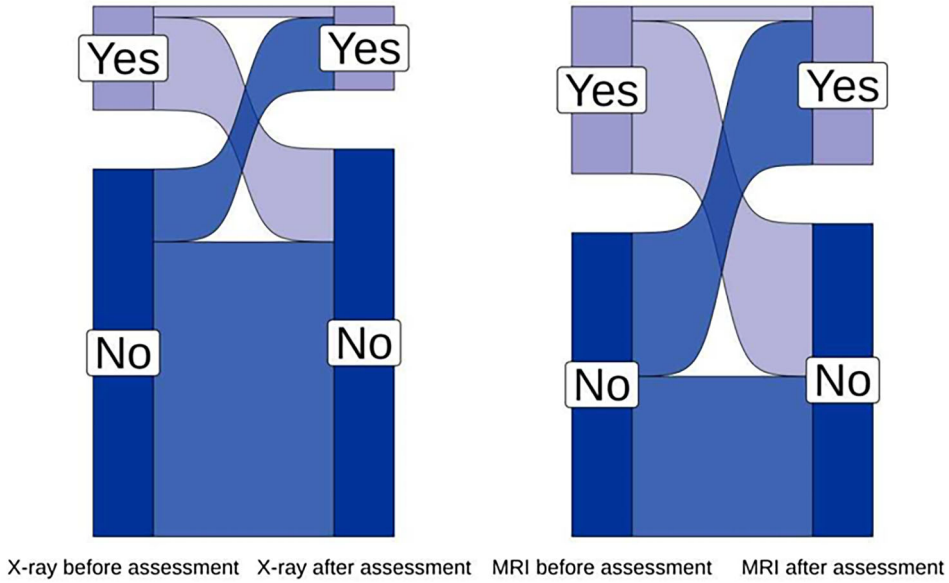

Figure 3. Patients with paraclinical imaging before the Spine Center assessment and those referred to imaging following the assessment.

specific spinal pain, imaging was conducted in more than 50% of this population.

Disk herniation is a clinical diagnosis and can be given based on history taking and symptoms [38]. Discussing the requirements for diagnostical imaging in specialized hospitals appears to be relevant for this population, but we have limited data to provide specific suggestions.

Based on discussions within the clinical team at the spine center: empirically, children and adolescents at risk of long-term school absence, sick leave, or suspected psychosomatic symptoms were more often referred to another hospital department, typically the pediatric department. School absenteeism is strongly associated with poorer mental health, psychiatric disorders, and neurodevelopment disorders [39]. Studies have found that children with back pain more often report missed school days [40] and poorer mental health [41]. Furthermore, national and international studies report associations between lower socioeconomic status and the prevalence of low back pain [42–44].

This supports the need for a more structured and guided management for patients affected by psychosocial factors. However, whether this is or can be provided in often very busy, generalized pediatric departments is not known.

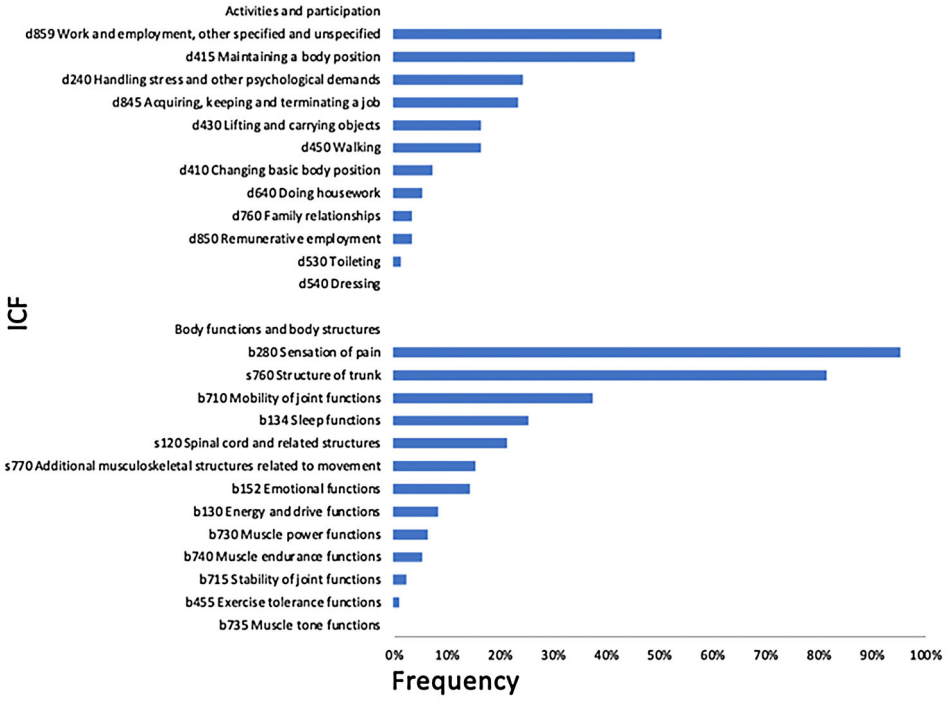

Figure 4. The percentage distribution of ICF codes.

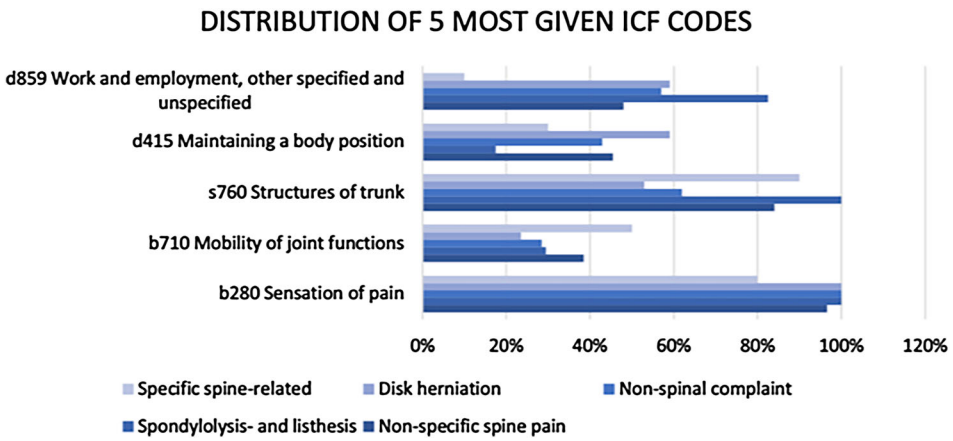

Figure 5. The distribution of the 5 most common ICF codes within each diagnostical subgroup. Each code is divided by the diagnostic group's quantity.

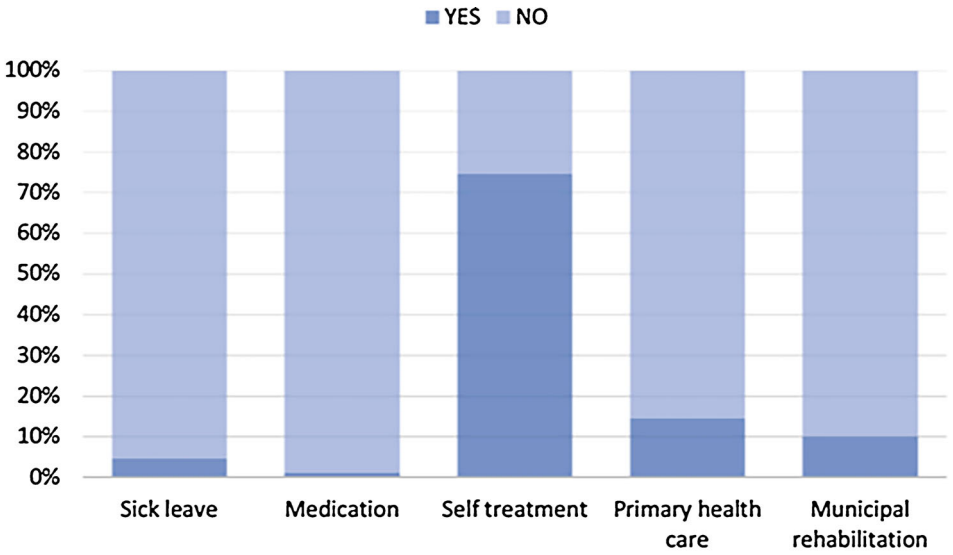

Figure 6. Treatment course from the Spine Center of Southern Denmark. Yes, was defined as treatment given or recommended to the patient.

Limitations

The study design was not without limitations; data were third-party reporting from the clinicians' reports of what patients told them and what clinicians found of significance for reporting. This is the norm for retrospective reviews of patient records, but lack of information and loss of implied information is expected. The record extractions were done by manual browsing as it was technically not possible to extract social security numbers by age within the clinical record system. However, as only select clinicians assessed patients under 18 years of age, we expected to have included the full population. The data extraction method was subjective but rigorously tested and conducted by two trained reviewers, and agreements were supported statistically. Thus, reporting bias was limited.

Another limitation was the interference of parents/guardians. It was not systematically reported if a parent/guardian was present during the assessment and how much he/she interfered. It is well established that children and parents differ when reporting the children's pain [45]. Another limitation was that identification of unique patients was not possible in the database as data were anonymized, and therefore we do not know if a patient appears multiple times. However, we only found two instances of such, both being *non-specific spinal pain* patients.

Conclusion

Non-specific spinal pain is the most frequent diagnosis in children and adolescents referred to the Spine Center of Southern Denmark. There was a wide range in how the pain affected children and adolescents across multiple domains. Approximately 30% had received advanced imaging before referral, and those without imaging were often referred by the spine center, regardless of whether a specific diagnosis was given. Additionally, not all patients had received primary

care treatment before referral. This suggests that many uncertainties exist for the management of this group. This may be a consequence of our limited cross-sectional and prospective knowledge of clinical symptoms and course of care. Arguably, gaining this knowledge is critical to understand how spinal pain will affect these patients in the future. This can be used to conduct prospective research and develop age-specific clinical pathways supporting the secure and streamlined medical assessment of children and adolescents with spinal pain.

Declarations

Ethics approval and consent to participate: This project was registered as a quality project, and the hospital management provided the approval for conduction. All the extracted data was obtained anonymized, and no complete sentences are located within the manuscript or data set [46]. All methods were carried out in accordance with relevant guidelines and regulations.

Data processing in the present project is regulated in the Danish Act on Research Ethics Review of Health Research Projects section 14, subsection 2, which states that health research based solely on questionnaire surveys and register data is exempt from the obligation to notify the committees. This includes waiving the need for signed consent. Instead, the project was registered as quality assurance, and the data extraction was approved by Hospital management and The Region of Southern Denmark (ID:22/993) Consent for publication: not applicable.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Authors' contribution

FGO wrote the initial draft. FGO and SLMB worked on this study as a master thesis. LH was a co-supervisor and contributed to the manuscript. AH helped with ICF and contributed to the manuscript. CGN was the main supervisor throughout the project and conceived the idea, developed the method, conducted the statistical analyses, and was a major contributor to writing the manuscript. All authors read and approved the final manuscript.

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Freja Gomez Overgaard is a specialist in assessing spine pain in children and adolescents. She is developing a clinical database for her research and leading a project to create information materials for young individuals and their parents dealing with long-term non-specific pain. FGO's work aims to improve understanding and support for children and adolescents experiencing spine pain.

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Lise Hestbæk is a dedicated researcher focusing on pediatric health. Her work encompasses spinal pain, motor skills, and childhood headaches. LH investigates prevalence, consequences, and diagnoses of spinal pain in children. She contributes to the development of assessment tools and explores the relationship between motor skills and spinal pain. LH also examines the effects of sedentary behavior and parental programs on infants' motor skills. Her research aims to improve pediatric health and enhance our understanding of these conditions.

Casper Glissmann Nim is a research specialist at the Spine Centre of Southern Denmark, focusing on the "outpatient track for children and adolescents." His expertise includes comparing self-reported retrospective visual pain trajectories with prospective pain tracking. CGN also contributes to the multidisciplinary management of severe persistent low back pain and conducts research on the application site's significance in spinal manipulation for spine pain. His work extends to objective measures in low back pain and educational research involving Danish chiropractic students. CGN's contributions enhance our understanding of spine pain and improve treatment approaches.

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Appendix

Process of developing spreadsheets

Process 1: All clinical records for each initial assessment (first assessment) were transferred to a spreadsheet (Microsoft Excel V. 16 for Windows 10), excluding variables unrelated to their spinal pain. Any assessments directly related to the treatment plan and other departments (e.g. surgical evaluations) were also extracted. Based on five random clinical records, the transfer spreadsheet was made in consensus between FGO, SLMB, and GCN. Subsequently, data from 25 clinical records were extracted independently by FGO and SLMB. Intraclass Correlation Coefficient was calculated using the average random rater model (ICC). If the agreement exceeded an ICC value of 0.90, the remaining records were equally divided between FGO and SLMB. If the ICC values were below 0.90, the data was extracted in unison between FGO and SLMB.

The variables extracted were demographic factors (e.g. age, sex, school year, other employments), pain symptoms (e.g. location, duration, origin), risk factors (i.e. smoking and alcohol use), use of oral analgesics (e.g. paracetamol), healthcare allied services prior to Spine Centre assessment (e.g. physiotherapist, chiropractor), paraclinical investigation (e.g. imaging), and management recommendations and plans.

Variables that could not be sufficiently described based on the clinical records were labeled as 'missing'. CGN handled disagreements, and the scoring was marked as missing if an agreement was not possible. Variables are displayed in Table 1.

FGO, SLMB, and CGN conducted a training session based on the same procedure as *process 1*; 10 records from the transfer spreadsheet were used for data extraction. Subsequently, FGO and SLMB extracted data from 10 individuals independently, and the ICC compared agreements.

Process 3: Information on patients' functional loss was based on the international classification of disease (ICF) Brief Core Set for Low Back Pain. The identification of disability or loss of function was assessed with the first two levels of ICF classification system within the domains: Body Functions (b), Body Structures (s), and Activities and Participation (d). A narrative description was used to transfer the data from the transfer spreadsheet to complete the *ICF spreadsheet*. The category Environmental Factors (e) was excluded due to a lack of consistent reporting in the records. The first 15 ICF assessments were made in consensus between FGO, SLMB, CGN, and AH. As described earlier, FGO and SLMB independently scored the next 15 to assess the ICC.