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Differential diagnosis in children with musculoskeletal pain in Emergency Department

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Abstract
Objective: The study was aimed to analyze the diagnostic approach to a child with a non-traumatic musculoskeletal pain registered in the pediatric Hospital Emergency Department (HED). Since the pandemic COVID-19 affects patient health and the healthcare system, we also evaluated the impact of pandemic on type of musculoskeletal symptoms.
Study design: A retrospective cross-sectional study was conducted by statistical analysis of data of patients with non-traumatic musculoskeletal pain registered in HED between January 2018 and December 2020. Data of patients referred and not referred to hospital ward and admitted to HED before and during COVID-19 pandemic have been compared.
Results: Majority of patients presented acute, non-trauma related, single-site pain, usually localized in the hip, the knee and the spine. 21,49% of patients were referred to a hospital ward, usually rheumatological, neurological or orthopedic. Final diagnoses in almost ¾ patients belong to the group of musculoskeletal system and connective tissue disorders. During the pandemic significantly less patients with musculoskeletal pain reported to our HED. The duration of symptoms before admission was not significantly longer than in previous years, but the problem in children and the impact of the pandemic on the musculoskeletal system in children is complex.
Conclusions: Our study provides detailed information on patterns of pediatric musculoskeletal consultations in HED. A positive history of trauma preceding musculoskeletal pain in a child may only be accidentally related to the final cause. Musculoskeletal pain can be also a symptom of a lot of various systemic conditions, not only diseases of the musculoskeletal system. The still ongoing COVID-19 pandemic may require changes in the organization of the HED. We believe that the presented results can help in organizing and planning care in pediatric HEDs, develop diagnostic algorithms and training for HED staff.

Key words: musculoskeletal pain; childhood, emergency department, COVID-19

Introduction

Musculoskeletal pain is a common symptom in children and represents over 6-8% of all pediatric primary care visits [1-5]. Although the problem in the pediatric primary care was described in several articles, current data on musculoskeletal disorders in the pediatric Hospital Emergency Department (HED) are limited [6], except related to the injury [7].

Musculoskeletal symptoms are characterized by diverse etiology, which makes it a challenge for physicians to identify the cause of the symptoms. However, many cases are self-limiting and may be also considered as a normal part of development [8].

The primary objective of this study was to analyze the characteristics of the symptoms and diagnostic approach to a child with non-traumatic musculoskeletal pain in HED.

Since the pandemic COVID-19 affects patient health and the healthcare system, we also evaluated the impact of pandemic on type of musculoskeletal symptoms. Our observation can help in planning care in HED, diagnostic algorithms and training for HED staff.

Methods

A retrospective cross-sectional study was conducted by analysis of data of the patients with musculoskeletal pain registered in HED of University Children's Hospital in Lublin, Poland, between January 2018 and December 2020. Lublin Province is currently inhabited by 307314 children aged 0-14 (December 2020) [9] and the study was conducted at the only pediatric HED and specialized pediatric hospital in this region.

The inclusion criteria included:

- selected initial diagnoses according to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD 10) with nonspecific arthritis (M13.9), myalgia (M79.1), pain in limb (M79.6), back pain (M54.9 - dorsalgia, unspecified and M54.8 – other dorsalgia),
- age under 18 years
- reporting to the emergency department without prior consultation with the family doctor.

The exclusion criterion was the final diagnosis associated with acute injuries of the musculoskeletal system.

We have gathered available data from the medical charts of the hospital system, such as age, sex, pain localization, pain features, occurrence of trauma, past or present symptoms of infection, laboratory tests (leukocytes, neutrophils, erythrocyte sedimentation rate - ESR, C-reactive protein - CRP and creatine kinase - CK), plain radiograms, ultrasonography, referral to appropriate hospital ward and final diagnosis.

Patients were divided in groups:

1) patients referred and not referred to hospital ward,
2) patients admitted to HED before COVID-19 pandemic (Jan 2018 – Feb 2020) and during COVID-19 pandemic (Mar 2020 – Dec 2020).

All data analyses were performed using StatSoft Poland Sp. z o.o. 2021. Medical Package, version 5.0.76. The Chi-square test and Mann-Whitney U tests were performed on categorical and non-parametric continuous data between the compared group. Statistical significance was accepted at p-values of <0.05.

Results

1. Population characteristics

Among the total number of 104323 patients admitted to pediatric HED in the years 2018-2020, 498 patients (0.48%) with nonspecific arthritis, myalgia, limb or back pain were included according to the criteria of the study. The study involved 290 males (58.23%) and 208 females (41.77%) in age 1-18.

The average age was 8.47±5.10, with a median of 8. 62 patients (12.45%) were under 3 years old, 258 patients (51.81%) - 3-10 years old, and 178 patients (35.74%) - 11-18 years old.

254 patients were diagnosed with nonspecific arthritis (M13.9), 16 patients – myalgia (M79.1), 145 patients – limb in pain (M79.6), 83 patients – back pain (M54.9 or M54.8).

107 (21.49%) patients were referred to the hospital ward and 391 (78.51%) patients were referred for further outpatient care.

In the period: Jan 2018 – Feb 2020 (26 months), before the pandemic COVID-19 - 423 patients (84.94%) were admitted to HED (an average of 16.27 per month) and during COVID-19 pandemic: Mar 2020 – Dec 2020 (10 months) - 75 (15.06%) (an average of 7.50 per month).

2. Clinical examination

In 81.12% of patients (n=402) we have reached information about particular pain localization. The hip, the knee, the whole lower limb and the spine were the pain localization in the majority of patients. The most common pain localizations are presented in Table 1. Less frequently reported localizations, not included in Table 1. were the whole body (n=7), elbow (n=5), wrist (n=5), upper limb (n=5), torso (n=5), whole spine (n=4), hand (n=3), heel (n=3), multiple joints (n=3), skull (n=2), sacroiliac joint (n=1), multiple muscles (n=1), anterior superior iliac spine (n=1), back (n=1) and sternoclavicular joint (n=1).

Table 1. The most common pain localization of the musculoskeletal pain in children in ED.

Pain localization	Number of patients with reported pain localization No (%)
Hip joint	123 (31.06%)
Knee	73 (18.43%)
Lower limb (generalized)	67 (16.92%)
The spine - Lumbar region - Thoracic region - Sacral region - Cervical region - Coccyx	 24 (6.06%) 9 (2.28%) 9 (2.28%) 6 (1.52%) 2 (0.57%)
Ankle	22 (5.56%)
Calf	16 (4.04%)
Foot	15 (3.79%)
Back and scapula	13 (3.28%)
Thigh	11 (2.78%)
Shoulder joint	8 (2.02%)

More than 55% (n=223) of patients presented pain localized in one site of the body. Patients with multi-site pain were more frequently referred to the hospital ward than patients with single-site pain (Chi-squared test; $p<0.0001$) (Table 2.).

Table 2. Clinical data from history and physical examination in groups of patients referred and not referred to hospital ward.

Patients Clinical data		Total group with available data No. (%)	Referred to hospital ward No. (%)	Referred to outpatient care No (%)	Statistical significance, p-value
History of trauma	Yes	60/498 (12.04%)	8/107 (7.47%)	52/391 (13.30%)	p=0.10691*
Infection	upon the admission	65/324 (20.06%)	16/78 (20.51%)	49/246 (19.92%)	p=0.28194**
	in history during last 6 weeks	56/324 (17.28%)	18/78 (23.08%)	38/246 (15.44%)	
	No	203/324 (62.65%)	44/78 (56.41%)	159/246 (64.63%)	
Fever	Yes	55/487 (11.29%)	21/102 (20.59%)	34/385 (8.83%)	p=0.00176*

Statistical significance at $p<0.05$. *Pearsons Chi-squared test; **Chi-squared test

In 91.16% of patients (n=454) the pain did not last more than 7 days before visiting ED. Only 5 patients experienced chronic pain lasting more than 90 days. Statistically significant difference in pain duration occurred between groups of patients referred to hospital ward and patients referred to outpatient care (Table 3.). In the group of patients referred to the hospital ward the pain lasted 3 times longer, on average, before admission to HED than in the group of patients without indication to hospitalization (Mann Whitney U test; p=0.0322). Long lasting pain (more than 7 days) occurred more often in the group of patients referred to the hospital ward (Chi-squared test; p=0.3103).

Table 3. Number of patients with conducted laboratory test and number of abnormal outcomes.

Laboratory test	Total number of patients tested No (%)	Patients with elevated levels* No (%)	Patients with elevated level* referred to hospital ward No (%)	Patients with elevated levels* referred to outpatients care No (%)
ESR	17 (3.41%)	11 (2.21%)	8 (7.48%)	2 (0.51%)
CRP	289 (58.03%)	28 (5.62%)	18 (16.82%)	10 (2.55%)
CK	85 (17.07%)	24 (4.82%)	13 (12.15%)	11 (2.81%)
Leukocytes	285 (57.23%)	104 (20.88%)	32 (29.91%)	72 (18.41%)
Neutrophils	280 (56.22%)	54 (10.84%)	21 (19.63%)	33 (8.44%)

*Elevation level of ESR >10 mm, CRP >3.0 mg/l, CK>300 IU/l, leukocytes>10000/ml, neutrophils >7000/ml.

Clinical data, such as occurrence of infection, fever and history of trauma, were also collected and compared (Table 4.). Majority of patients did not report an infection neither while admitted nor previously. However, 37.35% of patients (n=121) had infection present upon admission or within the last 6 weeks before admission to ED. In patients with known localization of infection, the most common was upper respiratory tract infection (68.57%, 75 out of 105 patients). The incidence of infections did not differ significantly between patients referred to hospital wards and those referred to outpatient care (Chi-squared test; p=0.28194).
At the moment of admission to ED, fever was present in 11.29% of children (n=55). Fever was present more frequently in patients referred to hospital ward than referred to outpatient care with statistically significant difference (Chi-squared test; p=0.00176).

Table 4. Laboratory tests outcome in patients referred and not referred to hospital ward.

Patients Laboratory test		Total group	Referred to hospital ward	Referred to outpatient care	Statistical significance, Mann Whitney U test; p-value
Leukocytes (G/L)	mean±SD median	9.41 ±3.59 9.11	9.78±4.38 9.73	9.29±3.30 8.91	p=0.4627
Neutrophile (G/L)	mean±SD median	5.01±2.87 4.48	5.67±3.28 5.10	4.80±2.71 4.29	p=0.0589
CRP (mg/l)	mean±SD median	1.26±4.31 0.11	3.70±8.06 0.58	0.48±1.19 0.07	p<0.0001
ESR (mm)	mean±SD median	36.06±36.19 30	39.17±39.87 30.50	28.60±27.75 18.00	p=0.8744
CK (IU/l)	mean±SD median	972.75±2449.8 114	1363.56±2745.3 122	699.18±2207.6 111	p=0.7922

Statistical significance at p<0.05.

Traumatic events were reported by 12.04% of patients (n=60). The trauma history occurrence did not differ significantly between patients referred to hospital wards and those referred to outpatient care (Pearsons Chi-squared test; p=0.10691).

3. Laboratory tests

Laboratory tests, such as a full blood count, blood film, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and creatine kinase (CK) were conducted on some of the patients reporting musculoskeletal pain (Table 5.). All of the laboratory outcomes were higher in the group of patients referred to hospital ward than in the group of patients not referred to hospital ward, with statistically significant difference in CRP levels (Mann Whitney U test; p= p<0.0001) (Table 6.)

Table 5. Final diagnoses in patients referred to hospital ward (according to ICD 10).

Group of diseases		**Final diagnoses**	**Patients No**
Infectious and parasitic	A, B	A02.8, A69.2, B01.9, B34	6
Neoplasms and diseases of blood	D	D72.8, D69.8	3
Endocrine, nutritional and metabolic	E	E10.1, E55.9	3
Nervous system	G	G03.8, G44.8, G93.9, G96.8	6
Eye and ear	H	H66.0	1
Respiratory system	J	J01.0, J03.9, J06.9	3
Digestive system	K	K61.0	1
Skin and subcutaneous tissue	L	L50.9	1
Musculoskeletal system and connective tissue	M	M00.0, M00.4, M00.8, M00.9, M02.8, M06.0, M08.3, M08.4, M08.8, M13.0, M13.18, M13.8, M13.9, M22.8, M24.5, M25.0, M25.5, M31.0, M48.8, M51.8, M54.1, M54.4, M54.5, M54.9, M60.0, M60.8, M60.9, M62.9, M66.0, M70.9, M79.1, M79.6, M95.8	77
Genitourinary system	N	N23	1
Congenital	Q	Q67.5	1
Others	R, U	R10.4, R26.8, R29.8, U10.9	4

Table 6. Comparison between patients admitted to ED before COVID-19 pandemic and during COVID-19 pandemic.

Characteristics		Prepandemic period	Pandemic period	Statistical difference, p-value
Total No of patients		423 (84.94%)	75 (15.06%)	-
Total No of patients / month		16.27	7.5	Yes, p < 0.0001**
Age (years) - mean; median		8.46; 8.00	8.53; 7.00	No, p = 0.9771**
Localization of the pain	Single site	171 (52.13%)	52 (70.27%)	Yes, p = 0.0040 *
	Multiple-site	157 (48.87%)	22 (29.73%)	
Pain duration (days)	mean	8.34	6.55	No, p = 0.1931**
	median	2	2	
Number of patients with pain duration:	<=7 days	389 (92%)	65 (87%)	No, p = 0.09267*
	8-90 days	29 (7%)	10 (13%)	
	>90	5 (1%)	0 (0%)	
History of trauma	Yes	45 (11%)	15 (20%)	Yes, p = 0.0277*
Infection	upon the admission	57 (23%)	8 (11%)	Yes, p = 0.02358*
	in history during last 6 weeks	45 (18%)	11 (15%)	
	No	147 (59%)	56 (75%)	
Fever	Yes	46 (11%)	9 (12%)	No, p = 0.76184*
CRP	Mean	1.15	1.81	No, p = 0.7973**
	median	0.11	0.10	
ESR	Mean	28.80	90.50	No, p = 0.0624**
	median	18.00	90.50	
CK	Mean	1079.37	72.39	Yes, p = 0.0110**
	median	119.50	56.17	
leukocytes	Mean	9.22	10.43	Yes, p = 0.0180**
	median	8.89	10.09	
neutrophils	mean	4.93	5.48	No, p = 0.1157**
	median	4.36	5.26	
Pathological changes in X-rays		45 (32.61%)	5 (23.81%)	No, p = 0.9527*
Pathological changes in USG		80 (59.26%)	23 (67.65%)	No, p = 0.29803*
Referral to hospital ward	Yes	93 (22%)	14 (19%)	No, p = 0.51308*
Direction of referral (department)	Rheumatology	47 (51%)	6 (43%)	Yes, p = 0.01542 ***
	Neurology	20 (22%)	1 (7%)	
	Orthopedics	18 (19%)	3 (21%)	
	Other	8 (9%)	4 (29%)	

*chi-squared test, **Mann Whitney U test, ***Pearson chi-squared test

4. Imaging tests

X-ray pictures were performed in 31.93% of patients (n=159); 31% of them (n=50) showed pathological changes. X-ray examination was most often ordered to the patients with M54.8 and M54.9 recognitions - dorsalgia (n=51/83 patients, 61.45%), and the least often - M79.1 – myalgia (n=1/16, 6.25%).

USG was used in 33.94% of patients (n=169); 101 of conducted ultrasound (n=101/169; 59.76%) showed pathological changes. The most common was an exudate, diagnosed in 60 cases (35.50%, n=60/169). USG was most often conducted in M13.9 primary recognition – nonspecific arthritis (43.70%, n=111/254) and least often in M79.1 – myalgia (12.50%, n=2/16).

USG was performed a bit more often than X-ray examination – 33.94% vs. 31.93%. However, it exposed almost twice as many pathological changes – 59.76% vs. 31.14%. The most common premise to do an X-ray was back pain, while USG was most often conducted in case of joint pain. In the group of patients referred to hospital ward pathological changes in X-ray pictures occurred in 44% patients (n=8/18); in the group of patients referred to outpatient care – in 29.78% (n=42/141). In the group of patients referred to hospital ward pathological changes in USG occurred in 64.00% patients (n=16/25); in the group of patients referred to outpatient care – in 59.03% (n=85/144).

5. Referral to hospital ward

In 387 patients (77,71%) there were no indications to hospitalization. 107 (21,49%) patients with musculoskeletal pain were admitted to the particular hospital ward. Parents or legal guardians of 4 (0,8%) children refused hospitalization despite medical indications. Patients with initial recognition of myalgia or nonspecific arthritis were more frequently referred to hospital ward (Table 7.) 53 patients (49,53%) were directed to the rheumatology department, 21 patients (19,63%) – to the neurology department, 21 patients (19,63%) to the orthopaedics department, 4 - infant pathology department, 2 - haematology and oncology department, and 6 – other departments.

6. Final diagnosis

In 104 patients out of 107 patients referred to hospital ward the final diagnoses were described. Three patients ended up with double recognition, which gives a total number of 107 final recognitions (Table 8.). In 77 (71.96%) cases it was a disease from the group of the musculoskeletal system and connective tissue (group M, according to ICD 10), which is consistent with the prior recognition. Subsequently, 6 patients were diagnosed with an infectious or parasitic disease (groups A and B) and 6 with a disease of the nervous system (group G). Each of the following group included 3 patients: neoplasms (group D), endocrine, nutritional and metabolic diseases (group E), diseases of the respiratory system (group J) and symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified (group R). Furthermore, a few children were diagnosed with the diseases from the group H, K, L, N, Q or U. (Table 5.).

The most frequent diagnosis were in sequence: non-specified arthritis, muscle pain and other reactive arthropathies. All of those were diseases of musculoskeletal system, agreeably with the recognition at admission to HED. However, pain symptoms from the musculoskeletal system may also be indicators of illnesses ongoing in different systems and be a premise of admission to a hospital department, which was confirmed in our study.

What is important, in two male patients the musculoskeletal pain was later diagnosed as due to vitamin D deficiency. It is also worth emphasizing that an U10.9 case – multisystem inflammatory syndrome associated with COVID-19 – was observed in December 2020 in a 2-year old boy. Lower limb pain and fever as the first symptoms was accompanied by elevated levels of CRP (6,55mg/l), leukocytes (14120/ml) and neutrophils (8850/ml) and CK within physiological limits (43I U/l).

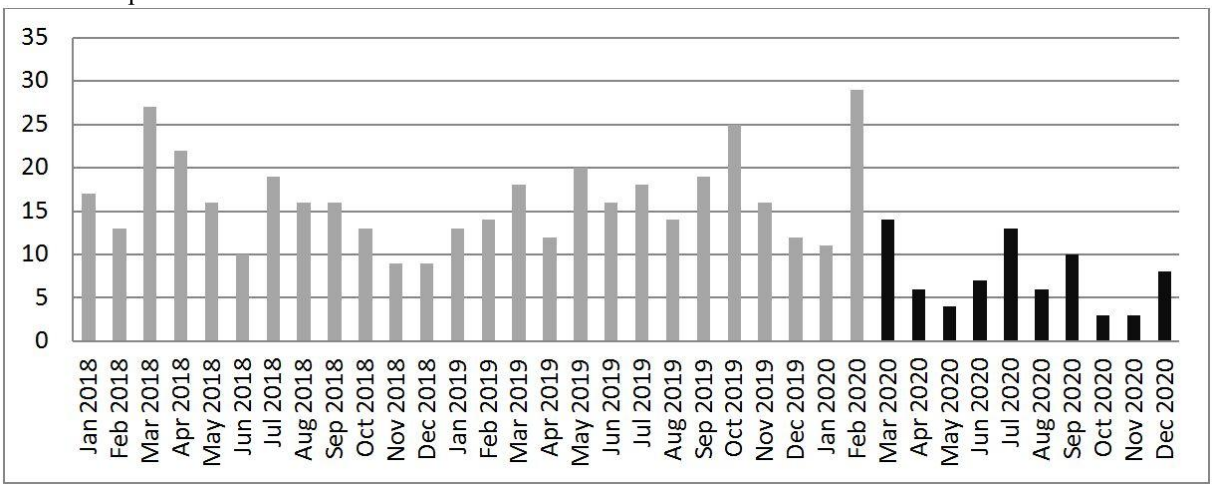
7. No laboratory or imaging tests at the emergency room

In 90 patients with musculoskeletal pain neither laboratory nor imaging tests were conducted while admission to the emergency room. The reason for the lack of testing in HED could be the mildness of the symptoms or the clinical condition requiring hospitalization based on clinical symptoms. The group of 30 patients were admitted to the hospital and had conducted proper tests afterwards, which is 6.02% of the total number of 498 patients admitted to the emergency room and 1/3 of the children with no tests conducted upon admission. They were eventually diagnosed among others with various kinds of arthritis and polyarthritis, such as juvenile idiopathic arthritis (JIA), reactive arthritis, rheumatoid arthritis, spondylopathy, septic arthritis, or other conditions, e.g. vitamin D deficiency, diabetes mellitus. Most often no tests were conducted if dorsalgia was initial recognition (20.48%). On the contrary, only 12.50% of patients with initial recognition of myalgia upon admission had laboratory and/or imaging tests done at the emergency room (Table 9.).

8. Patients with musculoskeletal pain on prepandemic period and during COVID-19 pandemic

During COVID-19 pandemic number of patients admitted to ED due to unspecified arthritis, myalgia, limb or back pain was lower than in prepandemic period (16.27 patients per month vs. 7.50 patients per month) (Figure 1.).

Figure 1. Number of patients admitted to ED between January 2018 and December 2020. Admissions during COVID-19 pandemic in black.



In patients admitted to HED during COVID-19 pandemic compared to patients admitted to before pandemic the pain was more frequently single-site than multi-site (chi-squared test; p = 0.0040). The occurrence of infection upon admission and in 6 weeks before admission was lower, probably due to COVID-19 restriction and testing (chi-squared test; p = 0.02358). Among laboratory investigations, ESR, leukocytes and neutrophils levels were higher in patients in the pandemic period. In contrast, CRP and CK levels were lower. Pathological changes were revealed more frequently in USG and less frequently in X-rays during COVID-19 pandemic. Among these data, statistically significant differences occurred in neutrophils and CK levels (Table 10.).

Patients admitted to HED due to musculoskeletal pain in the pandemic period reported acute pain (<7days) less frequently, and more frequently pain lasting between 8 and 90 days, which suggest delaying a decision about visiting HED due to pandemic. Chronic pain (>90 days) did not occur in this group. Traumatic history was more frequently reported in patients during COVID-19 pandemic (chi-squared test; p = 0.0277).

The difference in percentage of the patients referred to hospital ward in these two groups was not revealed. Statistically more often patients were referred to The Department of Pediatric Pulmonology and Rheumatology and less often to The Department of Pediatric Neurology (Pearson chi-squared; test p = 0.01542).

Among patients referred to hospital ward, the final diagnosis were nonspecific arthritis (n=6), pyogenic arthritis (n=1), juvenile idiopathic arthritis (n=1), rheumatoid arthritis without rheumatoid factor (n=1), infective myositis (n=2), unspecified myositis (n=1), unspecified soft tissue disorder related to use, overuse and pressure, limb in pain (n=1), haemarthrosis (n=1), and others, such as diabetes mellitus (n=1), other specified hemorrhagic conditions (n=1) and acute suppurative otitis media (n=1). One patient's final diagnosis was multisystem inflammatory syndrome associated with COVID-19 (n=1).

Discussion

Our study presents data on children consulted in the HED for non-traumatic musculoskeletal pain in the past 3 years. Among nearly 500 analyzed cases 12.4% of children were under 3 years old, 51.8% - 3-10 years old and 35.7% - 11-18 years old. Our study indicates that musculoskeletal pain, such as muscle pain, pain in unspecified arthritis or limb and back pain, are the reason for approximately 16 visits per month in HED, on average. These symptoms were the cause of HED visits more often in boys than girls, which correlates with the other studies [6, 10, 11]. The number of visits was lower in young children and increased with the age [6]. This may be related to more frequent and intensified sports activity in boys. Some joint diseases such as reactive arthritis or JIA with enthesitis are also more common in boys [12]. The hip, the knee, the whole lower limb and the spine were the pain localization in the majority of our patients. Nowadays, upper musculoskeletal pain is a growing problem in children and it may be related to using electronic devices on the lap[13], uncorrected vision problems [14], improper sitting position [15], or carrying heavy backpacks [16]. Nevertheless, every patient with musculoskeletal pain must be precisely diagnosed in order to detect or exclude severe conditions.

Pain located in one site of the musculoskeletal system may indicate a relationship with the trauma, but not always. In our study single location of the pain was reported more often than multi-site pain. This correlates with

the ratio of single- to multi-site musculoskeletal pain in Danish schoolchildren [17]. In the Spanish epidemiological study on musculoskeletal pain in pediatric HED the most common complaints are the pain at the wrist, ankle and finger, which represent over 50% of reported localization [6]. Moreover, that study indicates that the etiology of musculoskeletal pain in almost 90% of children is trauma, especially contusion, fracture, sprain, post-traumatic arthritis or soft tissue trauma. In our study only 12.04% of children have a positive history of trauma and the pain is the most commonly localized in the lower limb – the hip, knee and the back. This difference occurs due to the fact that our study focuses on unspecified pain from the musculoskeletal system and does not include common diagnoses in children, such as fractures of the bones. Moreover, the history of trauma may be incidental and may coexist with severe conditions, such as malignancy [18]. In our study patients with multi-site pain were more frequently referred to the hospital ward than patients with single-site pain.

Chronicity of the pain may narrow down the differential diagnosis. Acute onset is characteristic of traumatic etiology, septic arthritis and osteomyelitis or hemarthrosis. Onset of pain over several days suggests non-inflammatory pain syndromes, rheumatic diseases, osteochondroses, slipped upper femoral epiphysis or even malignancy [18, 19]. Majority of patients visited our HED early, within less than a week from the beginning of the pain. Only 1% of patients with initial diagnosis of muscle pain, unspecified arthritis or limb and back pain, experienced chronic pain, which lasted more than 90 days. According to Dutch study, the prevalence of chronic musculoskeletal pain in the general population of children is much higher, up to 6,1% for limb pain and 2,9% for back pain [20]. This indicates that children with chronic pain rarely report to HED. Chronic pain in children cannot be neglected, as it may cause physical impairment, depression or anxiety, problems in concentration, peer relation and managing stress [21].

In history taking it is crucial to remember that the musculoskeletal pain may be a symptom of musculoskeletal disorder itself or can be a manifestation of ongoing infection in different systems of the body. These two conditions may be related or may coexist accidentally, in view of the high prevalence of upper respiratory tract infections in childhood, up to 5 episodes per child a year, on average [22]. In our study 20% of children had signs of infection upon admission to the emergency room. In the majority of patients the source of infection was the upper respiratory tract. Moreover 11.3% of patients had fever. Differential diagnosis of musculoskeletal pain accompanied by fever include, not only benign viral infection of respiratory tract, but also severe conditions, such as septic arthritis and malignancy [18, 23]. In 17.3% of our patients the past medical history comprehended infection up to 6 weeks before admission. Genitourinary or gastrointestinal may precede reactive arthritis, upper respiratory tract infection can trigger the arthritis and rash of IgA vasculitis (former Henoch-Schönlein purpura).

Differentiation between inflammatory and non-inflammatory pain can be helpful. Relief with exercise, no relief with rest, nocturnal pain not relieved by simple analgesia, morning stiffness (improving with rising) and persistent joint swelling suggest inflammatory features. These are alarming features of possible severe conditions. The other “red flags” are fever, night sweats, rush, and weight loss [18]. A comprehensive physical examination can disclose additional disturbing symptoms, weakness of muscles or bony tenderness, and features of ongoing inflammation - warmth, joint swelling, restriction of movement, and guarding of the joint. All of them require prompt diagnostics [18, 19]

Laboratory investigations assist in diagnosis of musculoskeletal pain in children, especially in excluding conditions, such as malignancy, infections and inflammatory diseases. The most frequent tests performed in the present study were CRP (58.03% patients) and blood counts (57.23%). But only the CRP levels were significantly higher in patients referred to hospital ward than to outpatient care, which indicates the value of this test. However, a lot of patients do not require laboratory tests at the HED. In some cases, a reasonable suspicion of a serious condition can lead to a referral to a suitable hospital department, without a delay that could be due to prolonged diagnosis at the emergency room [18]. In our study such a situation concerned 30 out of 498 (6.02%) patients, which were eventually treated at the proper hospital department. These 30 hospitalized patients were diagnosed with various kinds of arthritis and polyarthritis, myalgia, spondylopathy, among others. It confirms that proper, skilful and detailed history taking and physical examination can be sufficient to differentiate benign conditions from serious ones that require hospitalization.

Full blood film, ESR, CRP, if are normal, reduce probability of severe conditions, e.g. septic arthritis. However, it is highlighted that serum blood tests should not be used to definitely exclude this condition [24]. It is crucial to remember that these tests aid in directing differential diagnosis, but they should be analyzed along with all clinical data. For example, in JIA oligoarthritis, a serious illness in early childhood, all markers of inflammation are usually normal [12].

Plain radiography should be conducted in initial evaluation of the children with significant localized joint or bone pain [19]. In our study X-ray pictures were performed in 31.9% of patients, most often in patients with dorsalgia and revealed pathological changes in almost one third of conducted radiographs. According to the study on back pain in pediatric HED, radiologic imaging was performed in 37.9% of patients with back pain and it revealed abnormalities in 16.9% of radiographs [25]. X-rays in pediatric back pain can detect tumours of the spine, a variety of infectious and mechanical diseases of the spine. In the X-rays of the limbs, abnormal radiological findings can support the diagnosis of bone tumours, fractures and chronic osteomyelitis [19].

Moreover, radiographic changes may occur in systemic severe conditions. For example, 75.3% of pediatric patients with musculoskeletal pain and leukemia show radiographic abnormalities, such as osteoporosis, pathological fractures, osteolysis [26]. No radiological changes occur in early juvenile rheumatoid arthritis [12]. In our opinion, this is a high frequency of X-rays. X-ray examinations should be limited in children and replaced with non-invasive examinations such as ultrasonography and low field non-contrast magnetic resonance. Nevertheless, it requires additional training of physicians and HED equipment.
Ultrasonography should be the first method of imaging in most cases of joint and soft tissue pain in children. Ultrasound was used in 33.9% of our patients and 59.8% of conducted exams showed pathological changes. The most common finding was an articular effusion, diagnosed in 35.50% of exams. Ultrasound was most often conducted in M13.9 primary recognition – nonspecific arthritis (43.7%).
Ultrasound was performed as often as X-ray examination (33.9% vs. 31.9%,). However, it exposed almost twice as many pathological changes (59.8% vs. 31.1%). USG can identify joint effusion, thickening of the synovium, increased vascular flow in synovium, enthesitis, tendonitis, or tendon injury among others [27].
In the case of a child with musculoskeletal pain the challenge is to distinguish benign condition from serious disease with an indication for hospitalization. In our retrospective study 22.3% of patients admitted to HED required hospitalization. However, parents or legal guardians of 4 patients refused it, despite medical indications. Only a few studies describe how many children with musculoskeletal pain require admission to hospital. One study found that 4% of children admitted to the HED due to any kind of pain required further diagnosis and treatment in the hospital [28]. A single retrospective study showed that 39% patients aged 16-19 and 26% aged 10-15, present to HED for any reason, are admitted to a proper hospital department, but the reasons were not specified [29].
Musculoskeletal pain may be the presenting feature of some systemic disease. Though final diagnosis in our study in almost ¾ cases corresponded with the diagnosis at admission, at least regarding the group of the musculoskeletal diseases (group M according ICD-10), in 25.9% children musculoskeletal pain was a manifestation of disease in other systems.
In the M group (77 cases) 6 patients were diagnosed with septic arthritis, 10 with JIA and 26 – with other arthritis, which gives a total of 54,54%.
The second most common final diagnosis in our study was the diseases from the group G (5.77% patients). However, 23.2% of patients admitted to hospital were directed to the neurology department, which can be parallel with other study, which showed that 28.6% of older adolescents were admitted to HED due to neurological issues [29]. Our study confirmed that musculoskeletal pain is rarely connected with haematological problems, still precise investigation at HED is needed to prevent overlooking any malignancies [18, 29, 30].

To our knowledge, none of the published studies have provided separate data on children with musculoskeletal pain in HED during the COVID-19 pandemic, although for adults or collective were presented [31-33]. During the pandemic fewer patients with musculoskeletal pain reported to our HED. The duration of symptoms before admission was longer than in previous years but the difference was not significant. Our conclusions are confirmed by data from the United Kingdom and Italy, where a significant drop in attendances at HED in both children and adults due to musculoskeletal pain was observed during pandemic [32, 33]. Some reports present neurological and musculoskeletal symptoms in patients with COVID-19, including myalgia (19%) and back pain (10%) [34].
The problem of musculoskeletal pain in children during COVID-19 pandemic is complex. Due to lockdown, children in our region stayed at home for most of 2020, which made them less vulnerable to infections and injuries. Nevertheless, from our practice, many children report back pain, neck pain, and elbow pain associated with long-term work with monitors and computers. Additionally, a new symptom with pain is reported in children in our practice and reports – erythema pernio toes, rarely hands, temporarily related to the pandemic COVID-19, also known now as 'COVID toes'. The pathogenesis is still not well explained but there is a presumed connection between vascular damage and activity limitation rather than SARS-CoV-2 infection [35].

Article Limitations
We selected the most common diagnoses for analysis, but we are aware that we did not include all patients with musculoskeletal symptoms in the HED. Nevertheless, we believe that the presented analysis well reflects the practical aspect of the problem.

Conclusions:
Our study provides detailed information on patterns of pediatric musculoskeletal consultations in HED. Musculoskeletal pain was localized the most commonly in the hip, the knee, the whole limb or the spine, and often was related to infection. Musculoskeletal pain can be a symptom of a lot of various systemic conditions, not only diseases of the musculoskeletal system, whereas a positive history of trauma preceding pain may only be accidentally related to the final cause. Approximately one in a five children with presenting musculoskeletal

pain, requires hospital diagnosis and treatment usually in rheumatological, neurological or orthopedic wards. For this reason, to distinguish benign from serious illness is crucial in the HED. Along with history taking and physical examination, laboratory or imaging tests are helpful in distinguishing patients with severe conditions. Ultrasonography should replace X-rays whenever possible. Initial assessment should be performed at the HED, unless the diagnosis is clear or the performance of these tests may delay the patient's referral to the appropriate hospital ward and treatment.
During the COVID-19 pandemic fewer patients with musculoskeletal pain reported to HED. The duration of symptoms before admission was longer than in pre-pandemic years but the difference was not significant. The still ongoing COVID-19 pandemic may require changes in the organization of the HED.
We believe that the presented results can help in organizing and planning care in pediatric HEDs, develop diagnostic algorithms and training for HED staff.

List of abbreviations:
CK - creatine kinase
CRP - C-reactive protein
ESR - erythrocyte sedimentation rate
HED - Hospital Emergency Department
ICD 10 - International Statistical Classification of Diseases and Health Problems 10. Revision
JIA - juvenile idiopathic arthritis

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