

PROJECT TITLE: Non-traumatic pediatric orthopaedic referrals in Manitoba.
(A retrospective review of 680 consecutive consultations, their appropriateness, and implications for future Canadian guidelines).

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SUMMARY:

Musculoskeletal problems account for 20-30% of pediatric medical problems.¹⁻³ Forty to 65% of referrals to pediatric orthopaedic surgeons (POS) involve common conditions that could be diagnosed and managed by primary health care providers.^{1,3,5} The American Academy of Pediatrics Surgical Advisory Panel (AAPSAP) published guidelines for making referrals to pediatric specialists.⁷ There are no equivalent guidelines in Canada and there are no published studies regarding referral patterns to POSs in Canada. We wanted to quantify the frequency and trends of unnecessary referrals made to the Section of Pediatric Orthopaedic Surgery (SPOS) at the Children's Hospital of Winnipeg. A retrospective chart review evaluated non-trauma referrals (n = 680) to the SPOS. The AAPSAP referral guidelines were used to determine the appropriateness of the referrals. The χ^2 test was used to compare categorical variables. Statistical significance was set at $P < 0.05$. We found that 499 (73.4%) of the referrals were unnecessary. The majority of referrals were from general practitioners (47.4%) and pediatricians (30%). The greatest rate of unnecessary referrals came from the eastern-interlake region (87.9 per 100 cases referred) and the southern region (84.4) of Manitoba. Torsional variations (98.4), musculoskeletal pain/overuse injuries (94.3), angular variations (89.9) and idiopathic scoliosis (88.1) accounted for the conditions with the greatest rate of unnecessary referrals. Not only is there a significant number of unnecessary non-trauma pediatric orthopaedic referrals to the SPOS, but there appears to be a predictable pattern of unnecessary referrals. This emphasizes the importance of developing and implementing a set of Canadian pediatric orthopaedic referral guidelines.

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Introduction

Musculoskeletal issues are common among the pediatric population and are becoming an increasingly significant part of primary care medicine.^{1,2} Approximately 20-30% of medical problems in the pediatric population are related to the MSK system.¹⁻³ Musculoskeletal pain alone is responsible for 6-10% of pediatric primary care visits.⁴

Many MSK issues involve common conditions and physiologic developmental norms that could be managed by primary care physicians.^{3,5,6} However, they are frequently being referred to a POS. In the US, it was found that many referrals were based on symptoms rather than a specific diagnosis, and approximately 40% of the referrals involved common conditions that could have been managed by the primary care physician.³ In 2002, the AAPSAP published voluntary referral guidelines to assist general pediatricians in determining when to make a referral to a pediatric specialist.⁷ Referral patterns to pediatric orthopaedic clinics in the US were evaluated using these guidelines.^{1,7} It was determined that nearly 65% of the referrals were inappropriate once diagnosed by a POS.¹ Similar trends have also been found in studies done in the UK.⁵ Nearly 53% of new referrals were for variations of normal anatomy and physiology.⁵

Abbreviations

AAPSAP	American Academy of Pediatrics Surgical Advisory Panel
HCP	Health Care Provider
MSK	Musculoskeletal
POS	Pediatric Orthopaedic Surgeon
SPOS	Section of Pediatric Orthopaedic Surgery
UK	United Kingdom
US	United States of America

The AAPSAP guidelines are inclusive, meaning they identify conditions that should be referred.⁸ However, they fail to consider common pediatric issues such as physiologic developmental variants, MSK pain, kyphosis, and congenital spine abnormalities. They also put age restrictions on referrals for conditions such as congenital malformations of the limbs.⁷ As a result, the AAPSAP guidelines still lead to a considerable number of unnecessary referrals. A UK study created pediatric orthopaedic referral guidelines that were implemented at a hospital.⁸ These guidelines were exclusive, in that they identified conditions that should not be referred.⁸ Once implemented, it was found that 95% of the referrals were considered appropriate, indicating the success of these referral guidelines.⁸ However, these UK guidelines only address the lower limbs.⁸ To our knowledge, there have been no published studies regarding referral patterns to pediatric orthopedic clinics in Canada. Therefore, we set out to quantify the frequency and trends of unnecessary referrals made to the SPOS at the Children's Hospital of Winnipeg.

Materials and Methods

We conducted a retrospective chart review of pediatric, non-trauma referrals made to the three POSs that manage the majority of non-trauma referrals to the SPOS at the Children's Hospital of Winnipeg. The referrals were made during a one-year period, between January 1, 2010 and December 31, 2010. A non-trauma case was defined as a developmental deformity, congenital abnormality, spinal condition, bone/soft tissue neoplasm, or any condition not directly related to acute trauma (i.e. chronic pain or instability). The following data was collected: patient gender, patient age, the type of referring HCP, the provincial health region of the referring HCP, the diagnosis made by the referring HCP, and the definitive diagnosis made by the POS. Age categories were assigned as follows: infants were 0-3 years, juveniles were 4-10 years, and

adolescents were 11-18 years. For the purpose of statistical analysis, provincial health regions were grouped together based on geographic location (Figure 1). Individual patients and practitioners were not identified in this study.

The AAPSAP guidelines for referral to a POS were used to evaluate the appropriateness of the referring HCP diagnosis and the definitive POS diagnosis.⁷ The term “necessary” was assigned to diagnoses that met the AAPSAP guidelines. The term “unnecessary” was assigned to diagnoses that did not meet the AAPSAP guidelines. “Unnecessary” referrals were further categorized as “classifiable”, meaning the diagnoses were mentioned in the guidelines, and “non-classifiable” meaning the diagnoses were not mentioned in the AAPSAP guidelines. The AAPSAP referral guidelines were interpreted as inclusive guidelines. Therefore, “non-classifiable” cases were considered “unnecessary” cases for the purpose of this study. Rate of case referral was calculated as the number of “necessary” or “unnecessary” cases divided by the total number of cases within a demographic or clinical category, and expressed as rate per 100 cases.

Based on the definitive POS diagnosis, the necessary and unnecessary referrals were compared across the gender and age of the patient, the type of referring HCP, the provincial health region of the referring HCP, and the body region and type of condition referred. The referring HCP diagnosis was also compared to the definitive POS diagnosis. The consultation fees relating to the total number of unnecessary referrals were calculated using the standard consult fee in Manitoba. Approval from our institutional ethics review board was obtained prior to beginning this study.

Statistics – A case control study was done using the unnecessary referrals as the “case” and the necessary referrals as the “control”. Data was entered and analyzed using SPSS analytical software. Descriptive data was compared for cases and controls by the use of the χ^2 test for categorical variables and the independent t test for normally distributed continuous variables. Statistical significance was set at $P < 0.05$.

Results

Demographics - Six hundred and eighty (N = 680) new referrals were reviewed (Table 1). There were 373 (54.9%) female patients and 307 (45.1%) male patients. The mean \pm SD age was 8.6 ± 5.6 years; the median age was 10 years (range = 0.01 to 18 years). The mean \pm SD age for females and males was 8.9 ± 5.4 years and 8.2 ± 5.7 years respectively. There were 206 (30.3%) infants, 161 (23.7%) juveniles, and 313 (46%) adolescents. There were 322 (47.4%) referrals from general practitioners. Pediatricians accounted for 204 (30%) referrals. General orthopaedic surgeons and POSs combined made 78 (11.5%) referrals. Sports medicine physicians made 43 (6.3%) referrals. Other medical specialties and non-physician health care providers made 20 (2.9%) referrals and 13 (1.9%) referrals respectively. Health care providers in the Winnipeg region made 486 (71.5%) referrals. Sixty-four (9.4%) referrals were from the southern region, 33 (4.8%) were from the eastern-interlake region, 42 (6.2%) were from the western region, and 17

(2.5%) were from the northern region. There were no referrals from the Churchill Regional Health Authority. Thirty-eight (5.6%) referrals were from outside of Manitoba.

Referral Patterns - Based on the referring HCP diagnosis, 481(70.7%) of the referrals were “unnecessary” by our study’s definition (Figure 2). Of these 481, 174 (36.2%) diagnoses were considered “non-classifiable” because they were not included in the AAPSAP referral guidelines. Based on the definitive POS diagnosis, there were 499 (73.4%) “unnecessary” referrals. Of these 499, 163 (32.7%) diagnoses were “non-classifiable”. There were 219 (32.2%) referrals from referring HCPs that were based on a symptom rather than a specific diagnosis (Table 2). Fifty-nine (8.7%) cases mentioned a parental request for a referral to a POS. Of these 59, 54 (91.5%) were considered “unnecessary” based on the definitive POS diagnosis. Consultation fees for “unnecessary” referrals seen in the year 2010, totaled \$39,920.

Rate of unnecessary referrals differed significantly with respect to patient gender, patient age, HCP type, and HCP region (Table 1). Although general practitioners and pediatricians made the highest number of referrals, their rate of unnecessary referrals was lower than that of non-physician practitioners. This observation however, is based on only 13 non-physician practitioners in this study. As expected, the greatest number of referrals was from the Winnipeg region, however, the greatest rate of unnecessary referrals was from the eastern-interlake region and the southern region of Manitoba. The distribution and rate of unnecessary referrals also differed significantly with respect to body region and diagnosis category (Table 2). There were 149 (21.9%) referrals involving the thoracolumbar spine, 153 (22.5%) referrals involving the leg, and 176 (25.9%) referrals involving the foot. Combined, the thoracolumbar spine, the leg, and the foot accounted for 478 (70.3%) of the total number of referrals, and 378 (75.8%) of the unnecessary referrals. The greatest rate of unnecessary referrals was for conditions that involved the spine and the lower limbs. Angular variations, torsional variations, idiopathic scoliosis, and MSK pain/overuse injuries had a high rate of unnecessary referrals with respect to diagnosis category. Referrals regarding a symptom rather than a specific diagnosis were nearly 30% more likely to be considered an unnecessary referral.

In a significant number of cases, the referring HCP’s diagnosis differed from the POS’s diagnosis (Table 3a). This indicates an inaccurate or wrong diagnosis and was seen most commonly in developmental dysplasia of the hip and congenital talipes equinovarus (Table 3b). There were also a significant number of cases that were unnecessary based on both the referring HCP’s diagnosis and the POS’s diagnosis (Table 3a). This was commonly seen in conditions that involved MSK pain/overuse injuries and variations of developmental norms such as angular and torsional variations (Table 3b).

Discussion

The Children’s Hospital of Winnipeg is the pediatric tertiary care center for Manitoba, Northwestern Ontario, and Nunavut. The SPOS receives all pediatric orthopaedic consultations including trauma and non-trauma cases. We suspected that a significant number of unnecessary

non-trauma referrals were being made to the SPOS at the Children's Hospital of Winnipeg. Currently in Manitoba, there are no pediatric orthopaedic referral guidelines for primary HCPs. To our knowledge, there are no published Canadian studies regarding referral patterns to pediatric orthopaedic clinics. There have been prospective and retrospective studies on pediatric orthopaedic referral patterns in the US and the UK.^{1,3,5,8} However, the present study has a larger sample size when compared with several of the previous studies.^{1,3,5} This study not only identified referrals that were unnecessary according to the AAPSAP guidelines, it also identified referrals that were non-classifiable, meaning the diagnoses were not mentioned in the AAPSAP referral guidelines. Determining the frequency of unnecessary referrals is important because they lead to an increase in health care costs. In consultation fees alone, unnecessary referrals cost the provincial health care system nearly \$40,000 in one year. This study does not take into consideration the costs of travel and accommodation for patients outside the Winnipeg region. Also not included, were the costs of investigative procedures such as lab analysis or imaging procedures. These are all costs incurred by the provincial health care system. Personal costs such as childcare and lost time from school and work were also not considered. These factors would be better analyzed in a prospective study.

As well as increased health care costs, unnecessary referrals result in an increased use of pediatric orthopaedic resources. Studies regarding pediatric orthopaedic workforce demands show a trend towards an increasing number of referrals to POSs concerning issues that used to be cared for by general orthopaedic surgeons.^{6,9} It is predicted, the number of children seen by POSs for both trauma and non-trauma MSK issues will continue to increase.⁶ Although the number of children referred to a POS continues to increase, there has not been a concomitant increase in the number of orthopaedic surgeons specializing in pediatrics.¹⁰ The specialty of pediatric orthopaedics is experiencing a decline due to the aging population of current POSs, as well as fewer residents entering the field.¹⁰ Data from the American Board of Orthopaedic Surgery shows that since 1995, the number of orthopaedic surgeons that specialize in pediatrics has remained steady for the last 11 years.¹⁰ As a result, when the current population of POSs begins to retire, the attrition rate will exceed the replacement rate, creating a shortage of surgeons in the field.¹⁰ Presently, there are approximately 60 orthopaedic surgeons practicing pediatric orthopaedic surgery as a subspecialty in Canada. There are approximately 80 orthopaedic surgeons graduating in Canada each year, however, only 8% choose to sub-specialize in pediatric orthopaedic surgery.¹¹ Similar statistics have also been found in the US.¹² A predicted shortage in pediatric orthopaedic resources, coupled with an increased use of resources secondary to unnecessary referrals demonstrates the importance of determining the cause of unnecessary referrals, and creating possible interventions that decrease POS workforce demands.

Studies have been done regarding the increasing workforce demands on POSs.^{6,9,10} Unnecessary referrals significantly contribute to these increased demands. In order to decrease unnecessary referrals, primary care physicians must receive dedicated MSK education at the medical school and residency level.¹⁰ Often, patients are referred to a POS with a symptom rather than a specific diagnosis.³ In this study, 32.2% of the referrals were for a symptom rather than a specific diagnosis. The rate of unnecessary referrals for symptoms was 86.8 per 100 referred cases,

showing that there was a 30% greater chance of an unnecessary referral when a referral was based on a symptom rather than a specific diagnosis. Pediatric patients are also commonly referred to POSs for variations of normal anatomy.⁵ Over 24% of the referrals in this study involved angular and torsional variations, most of which were considered physiologically normal. There were also 50 referrals that were diagnosed as a normal exam when evaluated by a POS. This indicates a lack of knowledge in the area of pediatric MSK development and assessment. In order to make a specific diagnosis, a physician must understand the natural history of pediatric orthopaedic conditions and be able to carry out the appropriate physical exam and diagnostic tests.³ A lack of basic MSK knowledge results in unnecessary referrals that could have been addressed in a primary care office.^{3,13} Little emphasis is placed on pediatric orthopaedic conditions during medical school and residency.² There is widespread dissatisfaction among undergraduate program directors regarding the MSK education process.¹⁴ Medical schools in Canada devote an average of only 2.26% of their curriculum time to MSK education.¹⁴ It can be assumed, that only a portion of that MSK education time is devoted to pediatric orthopaedic conditions. At the University of Manitoba, approximately 6.27% of pre-clerkship curriculum time is dedicated to MSK education. Approximately 0.42% (~7 hours) of the pre-clerkship curriculum time is dedicated specifically to pediatric MSK education. Similar data was found in studies done in the US and the UK.^{15,16} This indicates that a lack of MSK education is a widespread issue for all primary care physicians regardless of where they received training. Addressing the issue of inadequate MSK education requires fundamental changes to medical school curricula, which could take several years.¹⁰ Recently, several attempts have been made to decrease the number of unnecessary referrals by creating referral guidelines for primary care physicians who are already practicing.^{7,8} Although improving MSK education and creating referral guidelines may help to decrease some unnecessary referrals, there are factors such as patient/parental entitlement and physicians' fear of litigation that will continue to lead to unnecessary referrals. Our study found 59 (8.7%) referrals mentioned parental concern as the reason for referral to a POS. In some of these cases, the HCPs' referral letters indicated they felt the referral was unnecessary. Of the 59 cases that indicated parental request for a referral, 54 (91.5%) of the referrals were unnecessary. These factors would less likely be affected by increased MSK education and implementation of referral guidelines.

Based on the definitive POS diagnosis, our study found that 73.4% of the referrals were unnecessary according to the AAPSAP referral guidelines.⁷ This is similar to previous studies, where it was found that nearly 40 - 65% of referrals to POSs were unnecessary.^{1,3,5} The greatest number of referrals came from general practitioners (47.4%) and pediatricians (30%). This was expected, since 20-30% of pediatric medical problems seen by primary HCPs are related to the MSK system.¹⁻³ Referrals involving the leg and the foot accounted for 48.4% of the total referrals and nearly 51% of the unnecessary referrals. Many of these cases involved angular and torsional variations of normal anatomy. These results are very similar to a UK study, where 53% of the referrals to a pediatric orthopaedic clinic were considered variations of normal anatomy and physiology.⁵ The high number of referrals for developmental variations of normal explains the high number of referrals (30.3%), and the high rate of unnecessary referrals (71.4) seen in the infant age category. Over 88% of the referrals involving the spine were for the thoracolumbar region. The majority of these cases (n = 84) were idiopathic scoliosis with an unnecessary referral rate of 88.1 per 100 referred cases. Idiopathic scoliosis is defined as a curve with a Cobb

angle greater than 10 degrees.² Literature suggests referral to a POS is only necessary if the patient has a Cobb angle greater than 20-25 degrees and is skeletally immature or if the patient has neurological symptoms.^{2,3} In this study, many of the referrals for idiopathic scoliosis involved cases where the Cobb angle was less than 20 degrees and the patient was skeletally mature. This explains the high unnecessary referral rate seen with idiopathic scoliosis. The majority of idiopathic scoliosis occurred in the adolescent age category, resulting in a high number of adolescent referrals (46%) and a high unnecessary referral rate among the adolescent cases (78.0). There were 105 (15.4%) referrals for MSK pain/overuse injuries, which is similar to previous studies that found 6-10% of pediatric primary care visits were due to MSK pain.⁴ The rate of unnecessary referrals for MSK pain/overuse injuries was very high (94.3). The majority of these cases were referred to a POS without any previous form of symptomatic treatment or trial of physiotherapy or athletic therapy. Recent literature suggests referral to a POS for MSK pain/overuse injuries is not necessary unless symptoms persist after prior treatments or there are other symptoms indicating a sinister cause for the pain.³

The AASAP guidelines are inclusive guidelines, meaning that conditions not included in the guidelines are considered unnecessary.⁸ Based on the definitive POS diagnosis, the total number of unnecessary referrals (499) consisted of 336 (67.3%) classifiable referrals and 163 (32.7%) non-classifiable referrals (Figure 2). Non-classifiable referrals included issues regarding physiologic developmental variants, MSK pain, kyphosis, and congenital spine abnormalities. Considering non-classifiable referrals as unnecessary may have contributed to a slightly higher number of unnecessary referrals found in this study when compared to previous studies.^{1,3,5} Many of the referrals that were non-classifiable and therefore considered unnecessary according to the AAPSAP guidelines are considered appropriate referrals in published orthopaedic literature.^{2,3} Our chart review included 20 cases of kyphosis, all of which were considered unnecessary because they were non-classifiable according to the AAPSAP guidelines. However, research indicates that kyphotic curves that are greater than 50 degrees, are ridged, are associated with neurological symptoms, or are associated with Scheuerman's disease should be referred to a POS.² According to these standards, 65% of the kyphosis referrals would have been considered necessary. This inadequacy of the AAPSAP referral guidelines for pediatric orthopaedic surgery is also seen when reviewing the cases involving congenital spine abnormalities. A significant number of these cases were considered unnecessary because they were non-classifiable according to the AAPSAP guidelines. Some of these cases involved conditions such as sacral agenesis, pectus carinatum, pectus excavatum, and congenital scoliosis. Pediatric orthopaedic literature considers these conditions necessary referrals to a POS and suggests additional evaluation of the cardiac, renal, and neurological system to rule out the possibility of concomitant abnormalities.² Another limitation in using the AAPSAP guidelines is the age restrictions on referrals for conditions such as congenital malformations of the limbs. The AAPSAP guidelines specify that only infants between the ages of 0-1 with congenital malformations of the limbs should be referred to a POS.⁷ Therefore, any patient greater than 1 year of age with a congenital malformation of the limb was considered an unnecessary referral. Due to this age restriction in the AAPSAP guidelines, 26 cases of congenital talipes equinovarus and 11 cases of other congenital limb malformations were considered unnecessary referrals in our study. However, literature suggests congenital malformations such as congenital talipes

equinovarus should be referred to a POS regardless of age because various treatments are possible at ages greater than 1 year.²

When using the AAPSAP referral guidelines, our research found several key pediatric orthopaedic conditions were either not addressed or were limited by age restrictions.⁷ This may have lead to an apparent increase in the number of unnecessary referrals. More importantly though, it creates a situation where patients with conditions that truly require referral to a POS may be missed. A UK study developed and implemented pediatric orthopaedic referral guidelines that identified developmental norms and were exclusive in nature, in that they identified conditions that should not be referred.⁸ Once implemented, it was found that 95% of the referrals made to a pediatric orthopaedic clinic were considered appropriate, indicating the success of these referral guidelines.⁸ However, they only addressed conditions involving the lower limbs.⁸ These guidelines were not used to evaluate the referrals in this study because they do not address conditions of the spine and upper limbs, which constituted nearly 37% of the referrals. The success of the UK guidelines indicate that implementing referral guidelines with similar principles could lead to a decrease in unnecessary referrals to pediatric orthopaedic clinics in Canada.

Conclusion

Our retrospective chart review determined that 73.4% of referrals made to the SPOS at the Children's Hospital of Winnipeg were unnecessary according to the current AAPSAP referral guidelines.⁷ The majority of these unnecessary referrals involved variations of developmental norms and referrals based on symptoms rather than a specific diagnosis. This indicates a lack of understanding of pediatric MSK development and MSK examination skills.³ The number of unnecessary referrals in this study was also influenced by inadequacies of the AAPSAP guidelines. It was determined that in order to make referral guidelines more effective, the guidelines should be exclusive in nature and take into consideration the normal developmental variations seen in the pediatric population.⁸ The provincial health care system is constantly challenged by increasing health care costs and the field of pediatric orthopaedic surgery is facing increasing workforce demands.¹⁰⁻¹² It is critical that the number of unnecessary referrals to POSs is decreased in order to decrease health care costs and current POS workforce demands. This study proves there are a significant number of unnecessary non-trauma pediatric orthopaedic referrals in Manitoba, and there appears to be a predictable pattern of unnecessary referrals. This emphasizes the importance of developing and implementing a set of Canadian pediatric orthopaedic referral guidelines.

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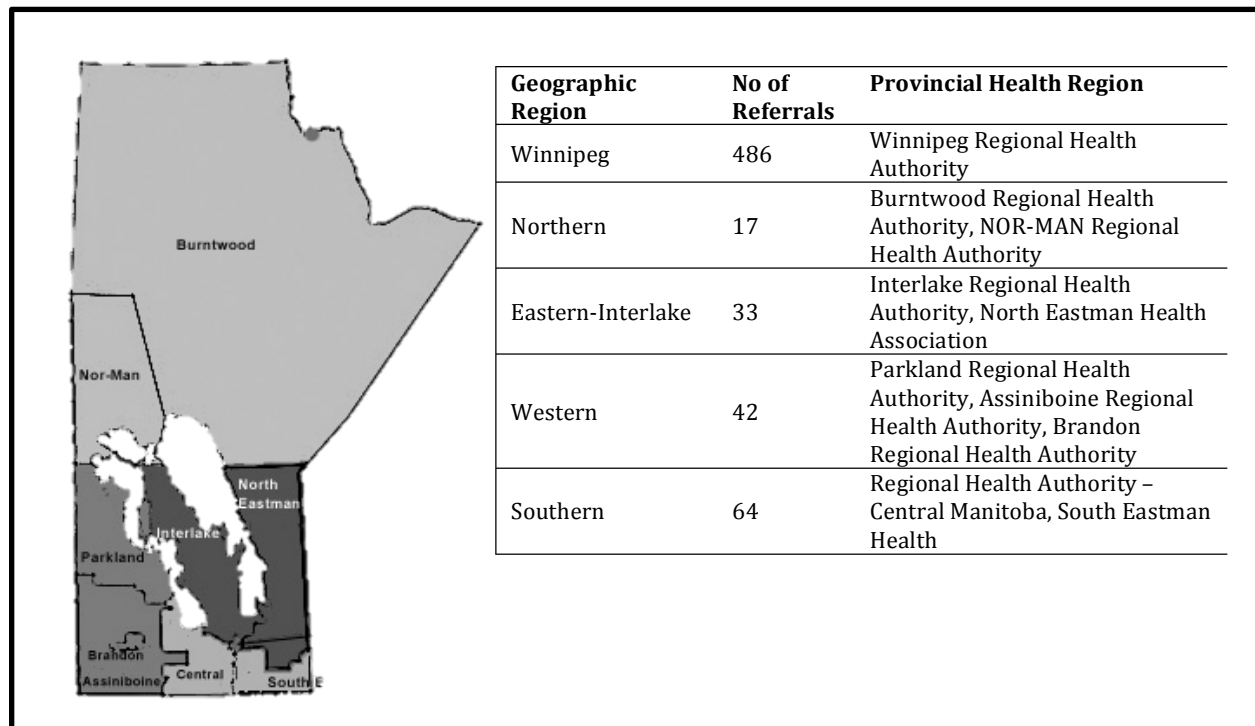


Figure 1: Geographic origin of non-traumatic pediatric orthopaedic referrals in Manitoba in the year 2010.

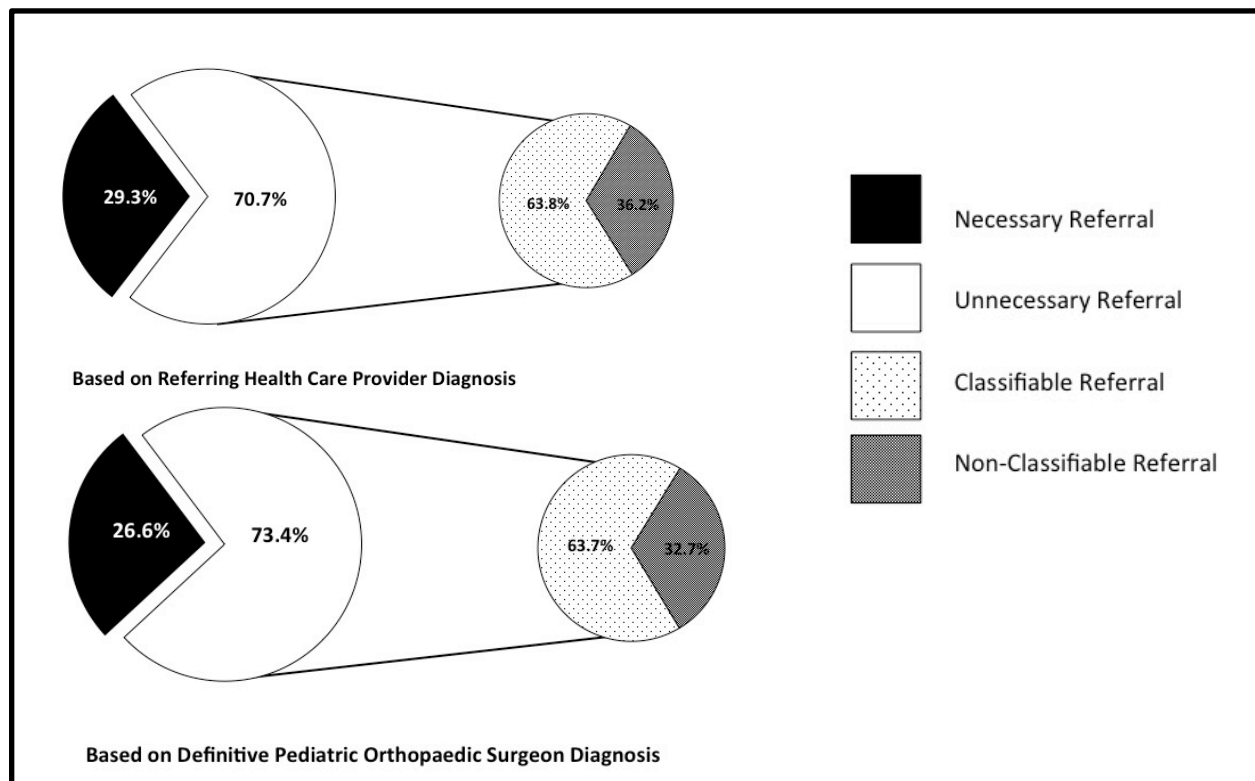


Figure 2: Classification of non-traumatic pediatric orthopaedic referrals in the province of Manitoba in the year 2010. Definition of necessary and unnecessary is based on the AAPSAP guidelines for referral to pediatric surgical specialties. Non-classifiable referrals consisted of diagnoses not mentioned in the AAPSAP guidelines.

Table 1: Unnecessary and necessary referrals compared across patient and referring health care provider demographics.

	Total N = 680		Case Distribution				Rate of Case Referral per 100 Cases		P-Value
			Unnecessary Cases N = 499 (73.4%)		Necessary Cases N = 181 (26.6%)		Unnecessary Cases	Necessary Cases	
	N	%	N	%	N	%			
Patient Demographics									
Gender									
Male	307	45.1	213	42.7	94	51.9	69.4	30.6	0.032
Female	373	54.9	286	57.3	87	48.1	76.7	23.3	
Age									
Infant (0-3 years)	206	30.3	147	29.5	59	32.6	71.4	28.6	0.029
Juvenile (4-10 years)	161	23.7	108	21.6	53	29.3	67.1	32.9	
Adolescent (11-18 years)	313	46.0	244	48.9	69	38.1	78	22	
Health Care Provider Demographics									
Health Care Provider Type									
General Practitioner	322	47.4	262	52.5	60	33.1	81.4	18.6	<0.001
Pediatrician	204	30.0	140	28.1	64	35.4	68.6	31.4	
General/Pediatric Orthopaedic Surgeon	78	11.5	44	8.8	34	18.8	56.4	43.6	
Sports Medicine Physician	43	6.3	32	6.4	11	6.1	74.4	25.6	
Other Specialty	20	2.9	9	1.8	11	6.1	45.0	55.0	
Non-physician	13	1.9	12	2.4	1	0.5	92.3	7.7	
Health Care Provider Region									
Winnipeg Region	486	71.5	349	69.9	137	75.7	71.8	28.2	0.030
Southern Region	64	9.4	54	10.8	10	5.5	84.4	15.6	
Eastern-Interlake Region	33	4.8	29	5.8	4	2.2	87.9	12.1	
Western Region	42	6.2	27	5.4	15	8.3	64.3	35.7	
Northern Region	17	2.5	10	2.0	7	3.9	58.8	41.2	
Out of Province	38	5.6	30	6.0	8	4.4	78.9	21.1	

Table 2: Unnecessary and necessary referrals compared across body region and diagnosis category

	Total		Case Distribution				Rate of Case Referral per 100 Cases		P-Value
			Unnecessary Cases		Necessary Cases		Unnecessary Cases	Necessary Cases	
			N = 499 (73.4%)		N = 181 (26.6%)				
	N	%	N	%	N	%			
Body Region									
Spine	168	24.7	142	28.5	26	14.4	84.5	15.5	< 0.001
Cervical Spine	6	0.9	6	1.2	0	0.0	100	0	
Thoracolumbar	149	21.9	123	24.7	26	14.4	82.6	17.4	
Sacral Spine	4	0.6	4	0.8	0	0.0	100	0	
Ant Precordium	9	1.3	9	1.8	0	0.0	100	0	
Upper Limb	83	12.2	37	7.4	46	25.4	44.6	55.4	
Shoulder	7	1.0	5	1.0	2	1.1	71.4	28.6	
Arm	33	4.9	7	1.4	26	14.4	21.2	78.8	
Elbow	7	1.0	6	1.2	1	0.6	85.7	14.3	
Wrist	13	1.9	11	2.2	2	1.1	84.6	15.4	
Hand	23	3.4	8	1.6	15	8.3	34.8	65.2	
Lower Limb	429	63.1	320	64.1	109	60.2	74.6	25.4	
Hip	48	7.1	20	4.0	28	15.5	41.7	58.3	
Leg	153	22.5	110	22.0	43	23.8	71.9	28.1	
Knee	42	6.2	37	7.4	5	2.8	88.1	11.9	
Ankle	10	1.5	8	1.6	2	1.1	80.0	20.0	
Foot	176	25.9	145	29.1	31	17.1	82.4	17.6	
Diagnosis Category									
Angular Variation	99	14.6	89	17.8	10	5.5	89.9	10.1	< 0.001
MSK Pain/Overuse Injury	105	15.4	99	19.8	6	3.3	94.3	5.7	
Idiopathic Scoliosis	84	12.4	74	14.8	10	5.5	88.1	11.9	
Torsional Variation	63	9.3	62	12.4	1	0.6	98.4	1.6	
Congenital Spine Abnormality	22	3.2	13	2.6	9	5.0	59.1	40.9	
Normal Exam	50	7.4	50	10.0	0	0.0	100	0	
Bone/Soft Tissue Neoplasm	48	7.1	11	2.2	37	20.4	22.9	77.1	
Other Congenital Limb Abnormality	46	6.8	11	2.2	35	19.3	23.9	76.1	
Club Foot	41	6.0	26	5.2	15	8.3	63.4	36.6	
Fracture/Instability	23	3.4	17	3.4	6	3.3	73.9	26.1	
Kyphosis	20	2.9	20	4.0	0	0.0	100	0	
Neuromuscular Abnormality	13	1.9	0	0.0	13	7.2	0	100	
Hip Pathology	13	1.9	0	0.0	13	7.2	0	100	
DDH	11	1.6	0	0.0	11	6.1	0	100	
Limb Length Discrepancy	12	1.8	5	1.0	7	3.9	41.7	58.3	
Other	30	4.4	22	4.4	8	4.4	73.3	26.7	
Diagnosis vs Symptom*									
Diagnosis	461	67.8	309	61.9	152	84.0	67.0	33.0	< 0.001
Symptom	219	32.2	190	38.1	29	16.0	86.8	13.2	

* Unnecessary and necessary referrals were compared to whether the referring health care provider gave a symptom or a specific diagnosis in the referral letter.

Table 3a: Cross tabulation of diagnosis by referring health care provider with diagnosis by pediatric orthopaedic surgeon.*

HCP Diagnosis	POS Diagnosis		Total
	Necessary	Unnecessary	
Necessary	170 (25%)	29 (4.3%)	199 (29.3%)
Unnecessary	11 (1.6%)	470 (69.1%)	481 (70.7%)
Total	181 (26.6%)	499 (73.4%)	680 (100%)

*Distribution significance set at P-value < 0.001

Table 3b: Cross tabulation of diagnosis by referring health care provider with diagnosis by pediatric orthopaedic surgeon – case distribution*

HCP Diagnosis	POS Diagnosis			
	Necessary		Unnecessary	
Necessary	Total	N = 170 (25%)	Total	N = 29 (4.3%)
	Bone/Soft Tissue Neoplasm	N = 35 (20.6%)	Developmental Dysplasia of the Hip	N = 7 (24.1%)
	Other Congenital Limb Abnormality	N = 32 (18.8%)	Congenital Talipes Equinovarus	N = 6 (20.7%)
	Congenital Talipes Equinovarus	N = 14 (8.2%)	Bone/Soft Tissue Neoplasm	N = 4 (13.8%)
	Developmental Dysplasia of the Hip	N = 12 (7.1%)	Other	N = 12 (41.4%)
	Neuromuscular Abnormality	N = 12 (7.1%)		
Unnecessary	Total	N = 11 (1.6%)	Total	N = 470 (69.1%)
	MSK Pain/Overuse Injury	N = 6 (54.5%)	MSK Pain/Overuse Injury	N = 115 (24.5%)
	Other	N = 5 (45.5%)	Angular Variation	N = 107 (22.8%)
			Idiopathic Scoliosis	N = 80 (17.0%)
			Torsional Variation	N = 57 (12.1%)
			Fracture/Instability	N = 18 (3.8%)
			Congenital Talipes Equinovarus	N = 17 (3.6%)
			Congenital Spine Abnormality	N = 13 (2.8%)
			Kyphosis	N = 12 (2.6%)
			Other	N = 51 (10.8%)

* Diagnosis is based on referring health care provider diagnosis.