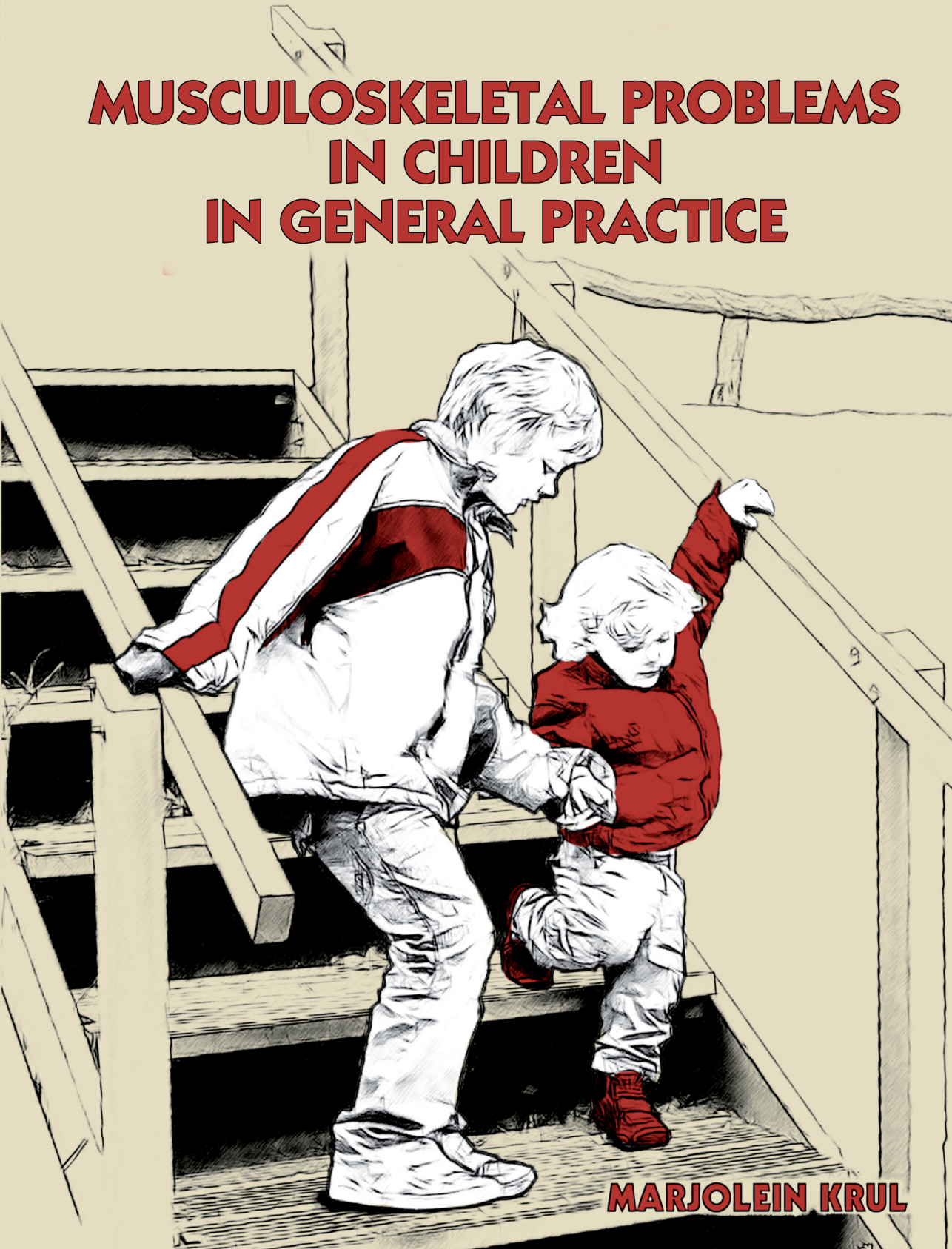
MUSCULOSKELETAL PROBLEMS IN CHILDREN IN GENERAL PRACTICE



MARJOLEIN KRUL

Musculoskeletal Problems in Children in General Practice

Klachten van het bewegingsapparaat bij kinderen in de huisartsenpraktijk

Marjolein Krul

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Contents

CHAPTER 1

General introduction

General introduction

Musculoskeletal diseases are extremely common and have important consequences for the individual and for society. The World Health Organization (WHO) declared musculoskeletal diseases to be a problem in both the developed and developing world. WHO has, together with the United Nations and European governments declared 2000-10 the "bone and joint decade", with the aim of improving the health related quality of life of people with musculoskeletal conditions by means of research and by raising awareness of this growing problem.1
A British study showed that a quarter of the listed population of a general practice consults at least once a year for a musculoskeletal problem.2 The British healthcare system is comparable to the system in the Netherlands. A Dutch study, the second Dutch national survey of general practice (DNSGP-2) performed by NIVEL in 2001, on which some of the articles of this thesis are based, showed that in adults a musculoskeletal problem is the most common reason to consult the general practitioner and that in children it is the third most common reason to consult the general practitioner.3

Epidemiology of musculoskeletal problems in children

Epidemiological background data is important for clinicians as well as researchers. The incidence and prevalence of problems and diseases in a population and in subgroups of a population, give the clinician a global indication of the chance that an individual suffers from a certain condition. This information will help the clinician in deciding about next steps in the diagnostic process and/or treatment and in providing the patient with information. By using Bayes' theorem4,5 we can calculate the posterior chance of a disease after performing a certain diagnostic test by using the incidence as the prior chance. Furthermore researchers can use epidemiological data to target their studies at the most frequent conditions or most relevant subgroups of patients. Knowledge about incidence and prevalence rates is necessary for power calculations.
It is obvious that musculoskeletal problems in children will show different epidemiologic patterns compared to those in adults, since children are still growing and developing, neurologically and psychologically as well as with respect to their musculoskeletal system. Whereas for example in adults back problems are the most common musculoskeletal problems in general practice, followed by problems of the knee, chest and neck, in children under 14 years of age foot problems are predominant.2 In younger age groups most consultations for musculoskeletal problems relate to a single location such as foot or knee problems, while in the older age groups more generalised conditions are diagnosed such as arthritis and limited function or disability.2 In contrast to problems due to degeneration and repetitive use of the musculoskeletal system in adulthood, in childhood problems due to the development of the system and development in general are more common. Some musculoskeletal problems are unique

to childhood due to the developing bones and ligaments, like e.g. pulled elbow and Perthes' disease. What is a deformity in adults can be completely normal in children e.g bowed legs, intoeing and knock knees.
Although musculoskeletal problems in children are the most common reason to contact a GP after airway and skin problems,3 there are not many studies investigating their epidemiology, clinical course and management. Studies which do provide incidence and prevalence figures are usually performed in an outpatient clinic, hospital ward or emergency room. It is usually not justifiable to apply epidemiological data derived from these settings to the general population or a primary care setting. In Dutch primary care we deal with a non-selected population in contrast to the population seen by medical specialists. A priori chances for the presence of a disease are completely different in the setting of the medical specialist as well as their clinical course and susceptibility to treatment. For example, a much higher proportion of the children presenting to the neurosurgeon with back pain will be diagnosed with a spinal tumour, than among patients presenting with the same problem to the general practitioner. According to Bayes' theorem cut-off values for diagnostic tests need to be adjusted when prior chances change, to provide the same posterior chances. This means that diagnostic tools evaluated in secondary care settings usually do not have the same diagnostic value in primary care. Because of these reasons we chose to dedicate a part of this thesis to epidemiological research, to provide necessary and important reference data about musculoskeletal problems in children for primary care clinicians as well as researchers.

Systematic reviews: diagnosis and treatment of musculoskeletal problems in children

While performing our research of the literature for our epidemiological studies, we came across gaps in our knowledge with respect to diagnosis and treatment of musculoskeletal problems in children. We therefore performed a number of systematic reviews with the aim to fill in these knowledge gaps. A systematic review is a review of the literature focused on a single question that aims at identifying, selecting, appraising and synthesizing all high-quality research evidence relevant to that question. Systematic reviews of high-quality randomized controlled trials and diagnostic studies are crucial to evidence-based medicine. Systematic reviews use explicit methods to perform a thorough literature search and critical appraisal of individual studies to identify the most valid and applicable evidence. Selection or screening of articles for inclusion is usually performed by reviewing the titles and abstracts of the articles identified, and excluding those that do not meet eligibility criteria. Reviewers often, but not always, use statistical techniques (meta-analysis) to combine these valid studies, and they usually grade the levels of evidence provided by the included studies depending on the methodology used. A systematic review uses an objective and transparent approach for research synthesis, with the aim of minimizing bias. The leader in producing systematic reviews is the Cochrane

Collaboration; an international, independent, not-for-profit organization with contributors from more than 100 countries. Cochrane Reviews are published online in the Cochrane Library. The aim of a review is to provide new or easily accessible and comprehensive overviews of information that will help the clinician in the diagnostic process and to provide the evidence for the best therapeutic options. Performing these reviews also helped us to identify other gaps in knowledge, where more research is needed.

Aim of this thesis

The aim of this thesis is to provide actual epidemiological and clinical knowledge about children's musculoskeletal problems in general practice. We did this by calculating epidemiological figures which were not available before. Additionally we performed a number of systematic reviews in order to formulate recommendations for clinical practice and research, based on the results of previous studies.

Outline of this thesis

Chapter 2 gives a comprehensive overview of the pulled elbow (subluxation of the radius in a young child); part 2a will give an overview of the literature on anatomy and diagnosis of the condition, part 2b presents the results of our study on the epidemiology in Dutch general practice and finally part 2c presents the results of our Cochrane review on the treatment of the pulled elbow. Chapter 3 presents the results of our comparison of the epidemiology of foot problems of children in general practice in 1987 and 2001. The topic of chapter 4 is acute non-traumatic hip problems in children; part 4a presents our study on its epidemiology in Dutch general practice and part 4b is a systematic review of studies evaluating diagnostic methods for acute non-traumatic hip problems in children. Chapter 5 addresses the difference in prevalence of musculoskeletal problems in overweight and obese children versus normal weight children. Chapter 6 gives an overview of the occurrence and management of sports injuries of children in general practice. Finally, chapter 7 reflects on the main findings of the previous chapters and discusses the implications for future research and clinical practice in the light of the distinctiveness of the developing child and its developing musculoskeletal system.

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CHAPTER 2

The pulled elbow

CHAPTER 2A

Pathology and diagnosis of the pulled elbow

This chapter is partially based on:
Nursemaid's elbow: Its diagnostic clues and preferred means of reduction.
Krul M, van der Wouden JC, Koes BW, Schellevis FG, van Suijlekom-Smit LW.
J Fam Pract. 2010 Jan;59(1):E5-7.

Abstract

Introduction Pulled elbow is a frequently encountered and treated lesion in primary care, but receives little attention during medical training.

Methods A literature search was performed in Medline using PubMed and EmBase (both databases through July 2007), on the topic of pulled elbow in children, to provide an overview of the studies on the pathology and diagnosis of this condition.

Results conclusion The pulled elbow is a subluxation of the proximal end of the radius, through the annular ligament. It is diagnosed by its typical history and presentation. Radiography is usually restricted to less clear cases to exclude more severe injuries.

Introduction

Pulled elbow is a condition that has many synonyms (Textbox 1) most referring to the etiology or pathology. Although the first description is attributed to Fournier in 1671[1-3], others date it back to Hippocrates[4,5].

Pulled elbow is a frequently seen lesion in children and thus one would expect it to be frequently encountered and treated in primary care. However, despite this expected frequent occurrence, the pulled elbow receives little attention in medical training and literature, and many physicians do not recognize the condition[6-8].

Therefore, it is interesting to investigate the following:

- What is the underlying pathology?
- How is it diagnosed? Which tests are available and what is their value?

To this end, we performed a systematic review of the literature to provide a current overview of previous research.

Texbox 1 Synonyms for 'pulled elbow' used in the literature

Radial head subluxation	Sunday afternoon arm
Partial dislocation of the radial head peculiar to children	Slipped elbow of young children
Dislocation of the head of the radius by elongation	Gromeyer's injury
Partial epiphyseal separation of the radial head	Painful elongation of young children
Painful paralysis in young children	Curbstone fracture
Goyrands's injury	Anterior isolated subluxation of the radial head
Malaigne's luxation	Internal derangement of the elbow
Housemaid's elbow	Rotation syndrome
Nursemaid's elbow	Painful pronation
Babysitter's elbow	Supermarket elbow
Tamper tantrum elbow	Pronatio dolorosa infantum Chassaignac
Elbow sprain	

Methods

A literature search was performed in Medline using PubMed and EmBase (both databases through July 2007), on the topic of pulled elbow in children. The databases were searched using all synonyms for pulled elbow (table 1) as search terms. In addition the references of included publications were checked for additional related articles. The articles thus retrieved were judged by two independent reviewers (MK and JCvdW).
All articles found with our search strategy, written in Dutch, English, German or French were included. The articles had to focus on proximal radial subluxation; articles on distal radial subluxation and luxation of the radius were excluded.

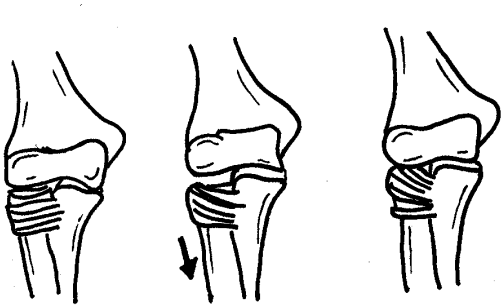
Results

Our literature search produced 368 potentially relevant papers. After scrutinizing titles and abstracts (if available), 60 papers fulfilled our inclusion criteria. Screening the reference lists of selected papers and reviews resulted in an additional 25 papers. 10 had as major topic pathology, 10 diagnosis, 9 treatment, 19 epidemiology and 37 were review articles.

Pathology

In view of its synonyms (table 1), the pathology of the pulled elbow is somewhat mysterious. In early texts the discussion was, whether it is an injury of the wrist or elbow. Some authors e.g. Goyrand believed it was a displacement of the inter-articular fibrocartilage of the wrist in front of the carpal extremity of the ulna. Hamilton[9] suggested that it could be an injury of the musculo-spiral nerve, which according to him, would be especially exposed to strain. Others, like Hutchinson[10], believed it was a slipping of the radius out of the grasp of the orbicular (annular) ligament with or without rupture of the sub-orbicular membrane, with a downward displacement of the radius. To prove this hypothesis, he performed a study on cadavers in 1886, which confirmed his believes. Further research on the mechanism of pulled elbow in cadavers was done by v. Santvoord[11], Stone[12], Mc Rae[13] and Matles[14]. They all came to the same conclusion. Matles[14] also revealed the presence of a meniscoid synovial fold in the posterolateral compartment of the elbow. He noted that the anterior portion of the anterior capsule of the radial head and orbicular ligament displaced proximally over the articular surface of the radial head, and the meniscoid fold displaced anteriorly into the radiocapitellar joint. This was later confirmed by Salter[15]. In many old textbooks and some articles[7], it is written that the subluxation of the radial head in children is due to the fact, that in the child, the perimeter of the cartilaginous head of the radius is not larger, or perhaps even smaller than the shaft. This is stated since 1930 in reference to the anatomic textbook of Piersol[16]. Ryan[17], Salter[15], Mehta[18]

and Walcher[19] studied the head/neck ratio in arms of children's and adult's cadavers and found that the head is usually larger than the neck in both age groups.
Besides the head/neck circumference Salter also studied the mechanism of the lesion. He couldn't create any subluxation due to traction and supination, but traction on a pronated wrist always produced a transverse tear, in the filmy distal attachment of the annular ligament to the periosteum of the neck of the radius. Once this transverse tear had occurred, the radial head continued to move distally and became uncovered anteriorly as it slipped partially through the tear. When traction was discontinued however, the detached portion of the annular ligament became interposed between the radial head and the capitellum[16].
Thus it seems most likely that the pulled elbow is usually caused by a pull of the pronated arm[7] in young children who possess relatively lax tissue, pulling the radius through the annular ligament[11-14], which sometimes partially tears and together with the meniscoid synovial fold becomes entrapped between the radial head and the capitellum[14]. The most common circumstance is as follows: the parent or other taller person is holding the child by the hand while walking and suddenly pulls the child away from a dangerous situation or merely drags the child up a curb or a step[15].



Diagnosis

No article specifically evaluating the value of physical examination or history taking was found; the only articles on diagnosis were those discussing radiography.
Pulled elbow is a diagnosis made on the basis of history and physical examination, and is easily recognized[20]. The typical presentation is a child that suddenly cries out because of pain and refuses to use the arm after a pull, holding it slightly flexed and pronated[21]. The pain might only be felt at the wrist and/or shoulder[2,4,21]. Occasionally, a snap or click can be heard when the accident happens[7]. The elbow can usually be flexed and extended, but supination of the forearm meets resistance and causes pain in the elbow, there is no swelling or bruising[22]. It seems that many physicians do not recognize the condition[7-9]. Children are often referred with the clinical observation "refuses to use arm, please X-ray from shoulder to wrist"[23]. Radiography exposes the child to a dose of ionizing radiation and is considered to be of little help. Although

some studies show small significant differences between the pulled elbow and the normal elbow[24-28], radiography is generally reported as normal[3,6,8,28]. Some assume this is because, while positioning the patient, in an attempt to obtain a true antero-posterior projection of the elbow, the radiology technician may manipulate the arm such that a reposition is performed[16,21,31]. Therefore radiography should be restricted to cases with an unclear history, or a history of trauma, to exclude less benign injuries. The role of sonography is not yet clear, but might be a fast and harmless technique in the diagnosis of uncertain cases[22,31,32].

Discussion/conclusion

The earliest articles on pulled elbow were mostly case reports and case series; at that time (around 1885) the first anatomical attempts were made to discover the pathology. The final conclusion is that the pulled elbow is a subluxation of the proximal end of the radius, through the annular ligament. Although the possibility of a diagnosis by X-ray was first discussed in 1916, studies on diagnosis by radiography did not appear until the 1980s. We found no articles evaluating the value of physical examination and history taking. Nonetheless it is diagnosed by its typical history and presentation. Radiography is usually restricted to less clear cases to exclude more severe injuries.

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CHAPTER 2B

The epidemiology of the pulled elbow in Dutch general practice

This chapter is based on:
Hoe vaak ziet de huisarts een zondagmiddagarmpje?
Krul M, van der Wouden JC, Schellevis FG, van Suijlekom-Smit LW, Koes BW.
Modern medicine 2010; 4:149-151

Abstract

Purpose Pulled elbow is a frequently encountered and treated lesion in primary care. Despite this, its incidence is currently not known in Dutch general practice.

Methods We analyzed data from the second Dutch national survey of general practice (30,408 children aged 0-5 years), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. We calculated incidence rates and 95% confidence intervals, stratified for age, sexe and urbanization level.

Results/conclusion The incidence rate in Dutch general practice in children aged 0-5 years is 2.7/1000 person-years. Pulled elbow is slightly more common in girls, the median age at occurrence is 2 years. A Dutch full-time GP with an average practice sees about one pulled elbow every two years

Introduction

Pulled elbow usually results from forcible traction to the child's pronated hand or wrist, with the elbow extended[1]. It is a painful condition of acute onset, resulting in sudden loss of function of the affected limb in an otherwise healthy child[2]. Pulled elbow is a frequently seen lesion in children (according to most articles written on the topic[3,4] and thus one would expect it to be frequently encountered and treated in primary care. However, despite this expected frequent occurrence, the pulled elbow receives little attention in medical training and literature, and many physicians do not recognize the condition[4-6]. No epidemiological data has been published on the pulled elbow in Dutch general practice; therefore we analyzed a large Dutch database (2001), to provide this data.

Methods

We analyzed data from the second Dutch national survey of general practice (NS2), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. The survey included a representative sample of the Dutch population; for further details see the article by Westert et al.[7] . For the present study, data on children aged 0-5 years were analyzed; pulled elbow is reported to be rare after the age of 5 years and the only occurrence rate known from the literature is among children aged 0-5 years [8] .
In the Netherlands, general practices have a fixed list size, and all non-institutionalized inhabitants are listed in a general practice. The general practitioner (GP) is the first health care professional to consult, and acts as gatekeeper to secondary care. Data on all physician-patient contacts over 12 months were derived from the electronic medical records (EMR) of all listed patients of 195 GP's (104 practices); they registered all health problems presented within a consultation, and coded the diagnosis using the International Classification of Primary Care (ICPC). Baseline characteristics (such as age and gender) were derived from patient records. Nine practices were excluded from analysis, because of insufficient data quality.

There is no ICPC code for pulled elbow; therefore, to retrieve the diagnosis of (probable) pulled elbow, we selected all possibly related ICPC codes of all children aged 0-5 years (ICPC-codes L08, L09, L10, L11, L20, L28, L79, L80, L81, L98, L99). When these codes were present in the child's electronic files we searched the free text of the EMR on 4 Dutch keywords, to find (probable) cases of pulled elbow. The records thus retrieved were checked by two independent reviewers (MK and JCvdW) to judge whether it was a certain, probable or no pulled elbow. 'Certain' diagnoses were those cases in which the diagnosis was explicitly stated, or successful repositioning was mentioned. 'Probable' cases were those with a typical history of pulled elbow: e.g. a fall or pull at the arm, after which the child no longer used that arm, and no other diagnosis was made.

Statistical analysis

The incidence rate was calculated by dividing the total number of newly diagnosed cases (numerator) by the study population at risk (denominator). Persons that moved into or out of the participating practices during the registration period were assumed to contribute for half a year to the follow-up time. Data were stratified for age category, gender and urbanization level. Incidence rates were expressed per 1000 person-years, 95% confidence intervals (CI) were calculated assuming a Poisson distribution using STATA version 8.2. The statistical package SPSS 11.0 was used for all other analyses.

Results

Our study population consisted of 30,408 children aged 0-5 years, yielding 26,212 person years. These children presented 55 definite and 16 probable pulled elbows. In this age group, the incidence rate of (probable and definite) pulled elbow presented to the GP was 2.7 per 1000 person years.

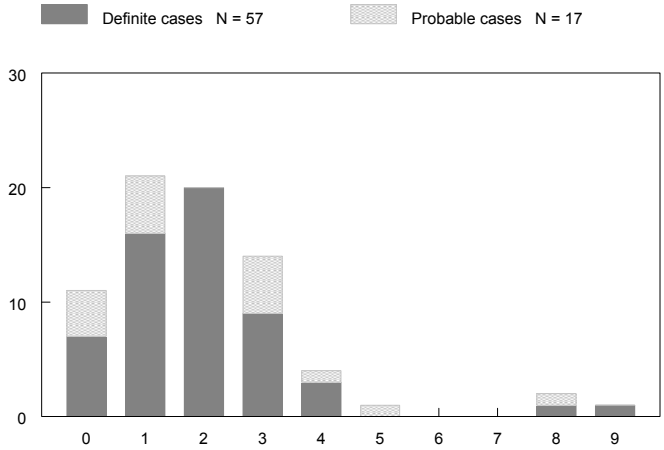
The stratified analysis (Table 1) shows that the occurrence rapidly decreases after the age of 3 years and, is slightly more common in girls than in boys. We found the highest incidence in rural areas (<30,000 inhabitants) and the lowest incidence in the three large cities. Given that

Table 1 Incidence rates of pulled elbow in Dutch general practice, by age, gender, urbanization level, and certainty of diagnosis.

	Incidence rate definite/1000 person years	95% confidence intervals	Incidence rate total/1000 person years	95% confidence intervals
Age in years				
0	2.1	0.8 – 4.3	3.3	1.6 – 5.8
1	3.5	2.0 – 5.8	4.6	2.9 – 7.2
2	4.2	2.6 – 6.5	4.2	2.6 – 6.5
3	2.0	0.9 – 3.8	3.1	1.7 – 5.3
4	0.6	0.1 – 1.9	0.9	0.2 – 2.2
5	0	NA	0.2	0.1 – 1.2
0-5	2.1	1.6 – 2.7	2.4	2.1 – 2.7
Gender				
Female	2.3	1.5 – 3.3	2.9	2.0 – 3.9
Male	1.9	1.2 – 2.8	2.6	1.8 – 3.6
Urbanization				
< 30,000	0.8	0.5 – 1.1	3.9	2.8 – 5.2
30,000-50,000	1.2	0.4 – 2.7	1.9	0.9 – 3.5
> 50,000	1.6	0.8 – 2.7	2.0	1.1 – 3.2
Large cities*	1.5	0.3 – 4.5	1.5	0.3 – 4.5

*) Amsterdam, Rotterdam, The Hague

in 2001 children aged 0-5 years constituted 7.5 % of the total Dutch population [42], and that an average GP practice represents about 2,350 patients, we calculated that a Dutch GP will see about one pulled elbow every 2 years.
Thus in the three large cities a GP will see one case of pulled elbow about every 3 years, and in rural areas about two cases every 3 years.
In addition to the occurrence among children aged 0-5 years, we found one probable case of pulled elbow in an 8-year-old, and one definite case in an 8-year-old and another in a 9-year-old child.



Age distribution of children diagnosed with pulled elbow in Dutch general practice

Discussion

Our study confirms the somewhat higher incidence in girls than in boys [3,4,9,10], as previously reported. The median age of 2 years is also comparable with earlier studies[2,3,-5,9].
The only population-based occurrence rate with which we could compare our incidence rate, is that reported by Jongschaap et al. in Aberdeen[8]. They registered all pulled elbows at the emergency room during one year and sent questionnaires to the 130 GP's covering the same. They calculated an incidence of 1.2%, i.e. almost 4.5 times higher than our incidence rate. In an area with a GP system comparable to the Dutch system, Jongschaap et al. also showed that many patients with a pulled elbow go directly to an emergency room; the condition is rather frightening for most caretakers, who may be convinced that radiography is necessary. In the Dutch database, parents who went directly to an emergency service may have been under-represented in our data.
Our stratified analysis (Table 1) shows, that the incidence rate in rural areas (<30,000 inhabitants) is more than two-fold higher than that in the three large cities, where hospitals are closer

by. This adds credibility to the assumption that many parents with a child with a pulled elbow go directly to an emergency room. Another explanation for the low incidence could be that the condition is not recognized; pulled elbow does not receive much attention during medical training.

Strengths and limitations

This large and representative survey enabled us to accurately assess the occurrence of pulled elbow presenting in primary care. The accuracy of the diagnosis, and the recording of cases presented at out of hour services, might be considered a limitation; in our analysis we assumed that the diagnosis and registration by the GPs was correct and accurate. All participating GPs were trained in correct ICPC coding[11].

Conclusions

The incidence rate in Dutch general practice in children aged 0-5 years is 2.7/1000 person-years. Pulled elbow is slightly more common in girls, the median age of occurrence is 2 years. A Dutch full-time GP with an average practice sees about one pulled elbow every two years; many patients will probably bypass the GP, even though it is easily treated, and unnecessary investigations can be prevented by diagnosing and treating this injury in primary care.

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CHAPTER 2C

Treatment of the pulled elbow; a Cochrane review

This chapter is based on:
Manipulative interventions for reducing pulled elbow in young children.
Krul M, van der Wouden JC, van Suijlekom-Smit LW, Koes BW.
Cochrane Database Syst Rev. 2009 Oct 7;(4):CD007759.

Abstract

Introduction Pulled elbow (nursemaid's elbow) is a common injury in young children. It results from a sudden pull on the arm, usually by an adult or taller person, which pulls the radius through the annular ligament, resulting in subluxation (partial dislocation) of the radial head. The child experiences sudden acute pain and loss of function in the affected arm. Pulled elbow is usually treated by manual reduction of the subluxed radial head. Various manoeuvres can be applied. Most textbooks recommend supination of the forearm, as opposed to pronation and other approaches. It is unclear which manoeuvre is most successful. The objective of this review is to compare the effectiveness and painfulness of the different methods used to manipulate pulled elbow in young children.

Methods We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CINAHL, LILACS, PEDro, clinical trial registers and reference lists of articles. Date of last search: January 2009. Any randomised or quasi-randomised controlled clinical trials evaluating manipulative interventions for pulled elbow were included. Our primary outcome was failure at the first attempt, necessitating further treatment. Two review authors independently evaluated trials for inclusion and, for the included trials, independently assessed the risk of bias and extracted data.

Results Three trials with 313 participants, all younger than seven years old, were included. All three trials compared pronation versus supination. The methodological quality of all three trials was low because of incomplete reporting and high risk of bias resulting from lack of assessor blinding. Pronation resulted in statistically significantly less failure than supination (risk ratio 0.53, 95% confidence interval 0.32 to 0.87). Pain perception was reported by two trials but data were unavailable for pooling. Both studies concluded that the pronation technique was less painful than the supination technique.

Conclusions There is limited evidence from three small low-quality trials that the pronation method might be more effective and less painful than the supination method for manipulating pulled elbow in young children. However, only a small difference in effectiveness was found. We recommend that a high quality randomised trial be performed to strengthen the evidence.

Introduction

Pulled elbow (radial head subluxation or nursemaid's elbow) is a painful condition of acute onset, resulting in sudden loss of function in the affected limb of an otherwise healthy child[1]. It is usually caused when an adult (or taller person) holds the child by the hand while walking and suddenly pulls the child away from, for example, a dangerous situation, or merely drags the child up a curb or a step[2]; or when a child pulls away from an adult impulsively. This sudden pull on the arm in young children (who have relatively lax tissue) pulls the radius through the annular ligament which may partially tear and become entrapped between the radial head and the capitellum[3,4]. This results in subluxation (partial dislocation) of the radial head.

This injury is easily diagnosed on the basis of history and physical examination. The typical presentation is a child that suddenly cries out with pain and refuses to use the arm after a pulling incident, when a snap or click might have been heard[5]. The arm is held slightly flexed and twisted inward[6] , with no swelling or bruising[7] . Pain is usually felt at the elbow but pain may only be felt at the wrist and/or shoulder[6,8] . The elbow can usually be flexed and extended, but twisting of the forearm meets resistance and causes pain in the elbow[9].

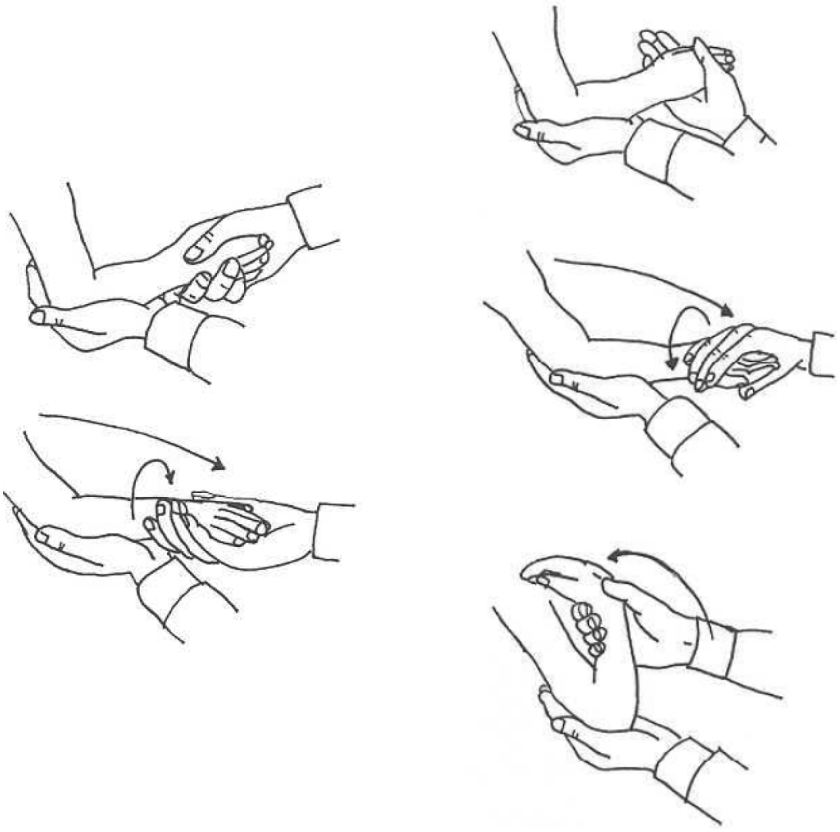
Pulled elbow is a common injury in young children[10,11]. Population-based incidence rates are scarce but an incidence of 1.2% per year in children aged 0 to 5 years old, in the Aberdeen city area of Scotland has been described and extrapolated to an annual incidence of 50,000 cases per year in England, Wales and Scotland[12]. This injury is most common in the left arm and in girls, and a median age of presentation of about two years has been reported[1,10] .

Pulled elbow is usually treated by manual intervention of the subluxed radial head. Various manoeuvres can be applied. (figure 1) Sometimes, these may be in conjunction with application of manual pressure over the radial head. The typical manoeuvre involves supination[13,14,15,16] , where the forearm is twisted or rotated outwards (palm of child's hand facing upwards), sometimes followed by flexion of the elbow[17] . While this has become standard practice, it is not always successful. Other methods, particularly the use of pronation, where the forearm is twisted or rotated inwards (palm of child's hand facing downwards), have also been used. Both methods are generally safe, although bruising can occur and they can be painful.

The purpose of all manipulative interventions is to reposition both the radial head and the annular ligament, thereby restoring the function of the arm and relieving the pain.

Pulled elbow is a common and very painful condition in young children. Although most text-books recommend supination and flexion of the forearm (as opposed to pronation and other approaches), evidence for this advice is usually not presented. It is therefore important to identify and summarise the evidence in order to find the most effective and painless intervention.

The objective of this review is to compare the effectiveness and painfulness of the different methods used to manipulate pulled elbow in young children. The primary comparison, as stated a priori, is the pronation method versus the supination method.



Pronation

Supination/Flexion

Figure 1 Manipulation techniques

Methods

Search strategy

We included any randomised or quasi-randomised (method of allocating participants to a treatment which is not strictly random e.g. by date of birth, hospital record number, alternation) controlled clinical trials evaluating manipulative interventions for pulled elbow in young children. Young children were defined as: all young children aged from birth up to adolescence, of either sex, diagnosed with an acute pulled elbow, either primary or recurrent. Trials specifically focusing on older children or adults with this condition were excluded. Trials of children undergoing interventions for complete dislocation of the proximal radial head were also excluded. We included studies evaluating various manoeuvres, such as pronation or supination

of the forearm, used for the manual reduction of subluxation of the proximal radial head in the pulled elbow. We included interventions that took place in any setting (e.g. hospital, general practice etc).

The primary outcome was failure at the first attempt, where success is defined as immediate restoration of a pain-free, fully functioning arm. Failure was defined by the need for subsequent treatment, usually another attempt at reduction, and lack of spontaneous use of the arm by the child. When available, we also included results on the following outcomes: pain and distress during the intervention, bruising and other adverse effects, ultimate failure in terms of need for more intensive intervention, such as general anaesthesia and recurrence (We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (June 2009), the Cochrane Central Register of Controlled Trials (The Cochrane Library 2009, Issue 1), MEDLINE (1950 to January 2009), EMBASE (1974 to January 2009), CINAHL (1981 to January 2009), LILACS (Latin American and Caribbean Literature on the Health Sciences: 1982 to January 2009), and PEDro (Physiotherapy Evidence Database: 1929 to January 2009). There were no restrictions based on language or publication status. In MEDLINE the subject-specific search was combined with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials: sensitivity- and precision-maximizing version[18] . Search strategies are also shown for the Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, LILACS and PEDro. Search strategies included all synonyms for pulled elbow. We searched the following registers of ongoing trials on 17th March 2009 using the term "elbow": the metaRegister of Current Controlled Trials and The World Health Organisation International Clinical Trials Registry platform. We screened reference lists of relevant articles. We contacted all authors who have published a trial on the treatment of the pulled elbow in the last 10 years, asking for additional studies.

Data collection and analysis

Two review authors (MK and JCvdW) independently screened the results of the searches to identify studies that appeared to meet the inclusion criteria of the review based on title and abstract. These studies were obtained in full text and the above two authors independently applied the review inclusion criteria. Disagreements were resolved by discussion. Using a data extraction form, two review authors (MK and JCvdW) independently extracted data from the included trials. MK and JCvdW entered data into RevMan. Disagreements were resolved by discussion. Extraction of results from graphs in trial reports was considered when data were not provided in the text or tables. We attempted to contact authors of trials not reported in full journal publications for additional information and/or data. Two review authors (MK and JCvdW) independently assessed methodological quality of the included trials using the Cochrane Collaboration's tool for assessing risk of bias[19]. Disagreements were resolved by discussion. Titles of journals, names of authors or supporting institutions were not masked at any stage. The risk of bias tool incorporates assessment of randomisation (sequence generation

and allocation concealment), blinding (of participants, treatment providers and outcome assessors), completeness of outcome data, selection of outcomes reported, and other sources of bias. We considered parent-rated and clinician-rated outcomes separately in our assessment of blinding and completeness of outcome data. Our other sources of bias were selection bias, where we assessed the risk of bias from imbalances in key baseline characteristics (age, time from injury, primary or recurrent injury); and performance bias, where we checked for comparability in the experience of care providers and subsequent provision of treatment interventions such as slings and advice. Quantitative data reported in individual trial reports for the outcomes listed in the inclusion criteria are presented in the text and in the analyses, using risk ratios (RR) with 95% confidence intervals (CI) for dichotomous outcomes. We planned to calculate mean differences for outcomes, such as pain, that are measured with a visual analogue scale. Where different instruments or measures were used, we planned to use the standard mean difference. Sometimes children may present with two pulled elbows, which are randomised to one procedure. There is no easy way to include this cluster effect in our analysis. When reported data allowed, we planned to perform sensitivity analyses, with and without these children. Cases of recurrent pulled elbows will be treated the same way as children who present with a pulled elbow for the first time. Where appropriate, we planned to perform intention-to-treat analyses to include all people randomised to the intervention groups. We planned to investigate the effects of drop outs and exclusions by conducting worse and best case scenario analyses. We were alert to the potential mislabelling or non-identification of standard errors and standard deviations. Unless missing standard deviations could be derived from confidence interval data, we did not assume values in order to present these in the analyses. We considered whether patient characteristics and the setting of the studies (e.g. emergency departments, general practice) were homogeneous enough from a clinical point of view to allow statistical pooling of the study results. Statistical heterogeneity was assessed by visual inspection of forest plots and calculation of the I^2 statistic and chi^2 test for heterogeneity. If more than 10 studies were available, we planned to construct a funnel plot, to assess reporting bias.

We statistically pooled the results using a fixed-effect model and 95% confidence intervals when studies were clinically (e.g. regarding the setting, or age of the children) homogeneous. Where there was significant heterogeneity, we planned to use a random-effects model. We planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above), clinical setting, and whether it was a primary or recurrent subluxation. Where possible, we planned sensitivity analyses examining various aspects of trial and review methodology, including items of study quality (specifically, allocation concealment). We planned to use the test of interaction to establish whether the subgroups were statistically significantly different from one another[20].

Results

Results of the search

The numbers of records identified via our searches of individual databases were as follows: Cochrane Central Register of Controlled Trials (19 records), PubMed (21 records), EMBASE (57 records), CINAHL (15 records), LILACS (no records) and PEDro (no records). After removing duplicates and screening of titles and abstracts, together with references provided from the Specialised Register of the Cochrane Bone, Joint and Muscle Trauma Group, we identified five potentially eligible studies. Of these, four were published in full and one was a conference abstract. Upon study selection, three studies (Green 2006; Macias 1998; McDonald 1999)[21-23] were included, one was excluded (Taha 2000)[24] and one, only reported as a conference abstract, awaits classification[25] (Vidosavljevic 2006). All three included studies were randomised controlled trials. Details of the individual trials are given in Appendix 1. All three trials were performed in paediatric emergency departments or ambulatory care centres in the USA. Enrolled were 75 children aged between six months and seven years in Green 2006[21]; 85 children younger than six years in Macias 1998[22], five of whom were enrolled on two separate occasions thus giving a sample size of 90; and 148 children younger than six years in McDonald 1999[23]. Of the 290 participants for whom baseline data were available, 58% were girls. The included trials compared pronation with supination. The interventions were forced pronation versus supination-flexion in Green 2006[21]; hyperpronation versus supination-flexion in Macias 1998[22]; and pronation-flexion versus supination-flexion in McDonald 1999[23]. All three trials reported on success and failure. A second attempt after a failed first attempt was made at 10 minutes in Green 2006[21], at 15 minutes in Macias 1998[22] and at 30 minutes in McDonald 1999[23]. Green 2006[21] and McDonald 1999[23] also measured pain: in Green 2006[21], various visual analogue scales were used by physicians, nurses and parents; while McDonald 1999[23] used a four point ordinal scale. One trial (Taha 2000)[24] was excluded because it did not compare different methods of reducing pulled elbow.

Risk of bias

Figure 2 summarises our assessment of the risk of bias for the included trials. Comments on the specific items we assessed are given below. While not reporting the method of sequence generation, Macias 1998[22] reported that allocation was concealed to the attending physician. Allocation concealment was not mentioned in the other two trials, and the associated risk of selection bias in these two trials was judged as 'unclear'. Blinding of the participants (not possible), the treatment providers (not possible) or the outcome assessors was not done in any of the studies. The lack of blinding is an important but to some extent unavoidable source of bias in all three trials. In the trial report of Green 2006[21], there were discrepancies in the numbers

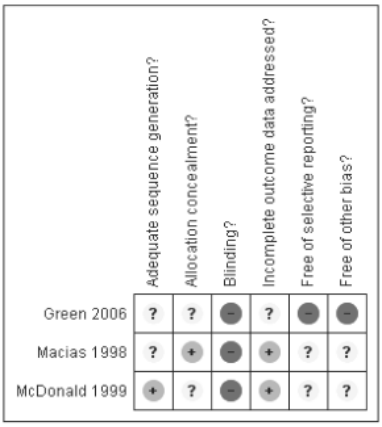


Figure 2 Risk of bias

of participants presented in the table of patient characteristics and that in the flow chart: information was missing for two participants in the former. For some participants of McDonald 1999[23], data on pain scores were missing and unaccounted for. In Green 2006[21], pain was only recorded for successful attempts and not for the nine participants with unsuccessful attempts (9 out of 72 participants). It was unclear whether there was selective reporting in the other two trials. There was a considerable difference between the study groups regarding the time of injury in Green 2006[21]. In the other two trials no other potential sources of bias were identified. There was no information on the experience of the attending physicians. Some reductions in McDonald 1999[23], however, were performed by trainee doctors (residents or senior medical students) under supervision.

Effects of the interventions

Three studies[21-23] provided evidence that pronation was more effective than supination. As these studies were all performed in similar settings and included similar study populations we decided to pool data on failure rates of these studies. We found a statistically significant difference in favour of the pronation methods (risk ratio 0.53; 95% CI 0.32 to 0.87 ($I^2 = 7\%$)). The omission of Green 2006[21], which was potentially confounded by the difference in mean time from injury between the two groups, did not importantly affect this finding (RR 0.53, 95% CI 0.31 to 0.91). The control event rate varied: this was 16.2% in Green 2006[21], 22.7% in Macias 1998[22], and 30.8% in McDonald 1999[23]. However, assuming a mean control event rate of 24.8% (one in four first attempts using the supination method fail) and an absolute difference of 11.5%, the number needed to treat (NNT) is close to 9 (95% CI 5 to 34). This means that nine children would need to be treated with the pronation method rather than the supination method to avoid one failure at the first attempt.

Of our secondary outcome measures, pain was measured in two trials (Green 2006[20]; McDonald 1999[23]) but using very different measures. Data for this outcome were unavailable for presentation in the analyses or for pooling. Moreover, in Green 2006[21], pain was only assessed for successful attempts. Green 2006[21] found that, in the successful attempts, the difference in the visual analogue scores favoured pronation. The difference was 0.7 cm as perceived by physicians (reported P = 0.11); 1.0 cm by nurses (reported P = 0.03) and 1.7 cm by parents (reported P = 0.04). The lattermost finding was both statistically and clinically significant. McDonald 1999[23] reported, based on a four point ordinal score, that the treating physicians perceived the pronation method to be significantly less painful than supination (reported P = 0.013), but parental pain scoring during reduction were similar for both procedures (reported P = 0.169). In conclusion, both studies found that pronation might be less painful, but lack of assessor blinding and incomplete data may have affected this finding.

The other outcome measures we searched for (i.e. bruising and other adverse effects and ultimate failure (in terms of need for more intensive intervention, such as general anaesthesia)) were not reported in any of the studies. Recurrence within one month was reported in Macias 1998[22], but not by treatment group. Our planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above), clinical setting, and whether the subluxation was primary or recurrent were not possible due to lack of data.

Discussion

Summary of main results

In this review, the three included trials compared the effectiveness of pronation versus supination for the reduction of subluxation of the radial head in 313 young children (all younger than seven years old). Pooled data from 292 cases for our primary outcome of failure at first attempt showed that pronation resulted in statistically significantly less failure than supination (RR 0.53, 95% CI 0.32 to 0.87). Two trials reported that pronation might be less painful but data were not available to confirm this.

Comparison with existing literature

We found two other reviews. Lewis 2003[26], which included the studies by McDonald 1999[23] and Macias 1998[22], concluded that pronation with or without elbow flexion should be "the first line method of reduction for pulled elbows". They[26] pointed out that lack of blinding was a key weakness of these two trials. A recent Dutch review[27], which included the studies by Green 2006[21]; Macias 1998[22] and McDonald 1999[23] but also Taha 2000[24] (which we excluded), also concluded that the pronation method was more effective than the supination method. Most

textbooks still only suggest the supination method[13-16]. This is not supported by the findings of this systematic review which provides some evidence that pronation might be more effective and less painful than supination.

Strengths and weaknesses

The objective of this review was to compare the effectiveness of, and pain associated with, different methods for manipulating the pulled elbow in young children. All three included studies addressed our stated primary comparison of pronation versus supination methods. We believe this review provides a relevant answer to the question of effectiveness of these basic procedures, but the evidence is still incomplete and susceptible to bias. In particular, there was insufficient or no evidence on pain, adverse effects or recurrence. Trial settings, care providers and the study populations were comparable in the three trials and the findings of these trials would apply more generally. However, our planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above) and clinical setting were not possible. The quality of evidence was low in all three studies, with high risk of bias resulting from lack of assessor blinding and, in one trial, an imbalance in mean time from injury at baseline. Additionally, there was incomplete assessment of pain in both trials recording this item. Although our search was extensive, we cannot exclude the possibility that we have missed relevant evidence. We tried to contact the authors of the original studies but only one replied and this too did not result in clarification of methods or results. Our search of grey literature, the pursuit of trials listed in clinical trial registers and the fact that we applied no restrictions based on language or publication status aimed to avoid publication bias, location bias, citation bias, language bias and outcome reporting bias. Given there were only three studies available, we were unable to explore whether publication bias could have occurred. Multiple publication bias did not occur.

Conclusion

Three randomised controlled trials comparing the pronation method with the supination method provide limited evidence that pronation might be more effective and less painful than supination. However, only a small difference in effectiveness was found. Many textbooks recommend supination as the preferred method, which notably is not supported by the findings of this systematic review. It would be useful to replicate the head-to-head comparison of pronation versus supination in a larger randomised controlled trial that conforms to high methodological and reporting standards. As well as rigorous and blinded assessment of failure, recorded outcomes should include our secondary outcome measures: pain and distress during the intervention (both preferably blinded), adverse effects, ultimate failure and recurrence. This further research would provide the conclusive evidence for the most effective method.

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Appendix

Characteristics of studies

Green 2006

Methods	RCT
Participants	Emergency department, Miami Children's Hospital, Miami, Florida, USA March 2003 to January 2004 Inclusion criteria: aged between 6 months and 7 years with clinical findings suggestive of radial head subluxation Exclusion criteria: evidence of bony tenderness or swelling 75 children enrolled of whom 3 were excluded due to non-adherence to protocol (1 data form was lost; 2 study packets were completed by residents and not by the attending physician) For pain measurement 9 additional children were excluded due to unsuccessful first attempt of reduction 29 boys and 41 girls (Table 1 of article had 2 missing; see Notes) Age 6 months to 7 years
Interventions	Forced pronation versus supination-flexion
Outcomes	Success rate during first attempt and second attempt (with the alternative method), which was done 10 minutes later. Pain before, during and 1 minute after successful repositioning using VAS. The scale used was not stated, but nurses and physicians were educated on: 0 to 3 years: nonverbal/behavioural scale 3 to adolescence: faces pain rate scale 8 years and older: laminated numeric scale
Notes	Number of participants in flow chart and text do not match with table of baseline characteristics in the paper. The former were assumed to be correct.

Risk of bias table

Item	Judgement	Description
Adequate sequence generation?	Unclear	'randomly assigned using a consecutive case allocation' (p. 235)
Allocation concealment?	Unclear	Not reported
Blinding?	No	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not blinded
Incomplete outcome data addressed?	Unclear	Table 1 is not clear (data discrepancies in the article)
Free of selective reporting?	No	Pain perception reported for successful reduction only
Free of other bias?	No	Considerable baseline imbalance with respect to time of injury (mean time of injury: 6.58 versus 13.47 hours)

Macias 1998

Methods	RCT
Participants	Two urban paediatric emergency departments and two suburban paediatric ambulatory care centres in the USA. June 1996 to May 1997 Inclusion criteria: previously healthy, younger than 6 years with clinical findings suggestive of radial head subluxation Exclusion criteria: point tenderness, local areas of ecchymosis (bruising) or oedema (swelling), deformity and persistent pain 90 episodes (in 85 participants) were included in randomisation, five were excluded because of a fracture, and one patient failed protocol. 51 girls and 34 boys Age range: 2 to 68 months, mean 27.7 months
Interventions	Hyperpronation versus supination-flexion
Outcomes	Success rate (success was return to baseline function of the arm after 15 minutes) at first attempt, second attempt with same procedure or third attempt with the other procedure.
Notes	5 participants enrolled twice (in 4 participants the episodes were more than 2 months apart and 1 patient presented after several days of normal usage of the arm)

Risk of bias table

Item	Judgement	Description
Adequate sequence generation?	Unclear	Not reported
Allocation concealment?	Yes	'Technique assignment was unknown to the attending physician at the time of enrolment'
Blinding?	No	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not blinded
Incomplete outcome data addressed?	Yes	All 90 participants are reported
Free of selective reporting?	Unclear	No details
Free of other bias?	Unclear	No baseline imbalance

McDonald 1999

Methods	RCT
Participants	Emergency department of a tertiary care children's hospital in the USA. July 1996 to December 1997 Inclusion criteria: younger than 7 years presenting with a complaint of an upper extremity injury and who were refusing to use their arm Exclusion criteria: history of neurologic impairment, congential bony malformation, oedema or obvious bony deformity 148 participants enrolled of whom 13 were excluded: 6 had a fracture; 2 spontaneously reduced; in 2 cases the study protocol was not followed; and in 3 cases data were missing 58 boys and 77 girls aged: 3 months to 6 years
Interventions	Rapid pronation and flexion versus rapid supination and flexion
Outcomes	Success rate (success was defined as using the arm to reach for a toy or piece of candy within 30 minutes after manipulation) after first attempt. If failed, second attempt used same procedure and third attempt used the other procedure. Pain during manipulation measured by the physician and the parent on an ordinal scale (0 = no pain, 1 = little pain, 2 = quite a lot of pain, 3 = very bad pain) Parents' scoring sheets were illustrated with descriptive drawings of facial expressions.
Notes	

Risk of bias table

Item	Judgement	Description
Adequate sequence generation?	Yes	Blocked randomisation list generated by computer. Trial was balanced after every 10 patients.
Allocation concealment?	Unclear	Not reported
Blinding?	No	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not
Incomplete outcome data addressed?	Yes	Yes for primary outcome. Unclear for pain assessments: three participants missing in pronation group.
Free of selective reporting?	Unclear	Unsure
Free of other bias?	Unclear	No important baseline imbalance

Taha 2000

Reason for exclusion	Not investigating methods to reduce the pulled elbow, but about subsequent management.

Vidosavljevic 2006

Methods	An eligible comparison but unclear if actually "randomized" as claimed
Participants	Emergency department of University Children's Hospital of Belgrade, Serbia July 2004 to October 2004 54 children less than 4 years old with pulled elbow
Interventions	Hyperpronation versus supination-flexion
Outcomes	Success evaluated by time to return to function, duration of child crying and palpable confirmation of successful reduction. Failure was another attempt using the other method because of non-return of full function after 30 minutes.
Notes	This trial was only reported as a conference abstract. The trial authors referred to "preliminary results". A request for further information has been sent.

CHAPTER 3

The epidemiology of foot problems in children in Dutch general practice; a comparison between 1987 and 2001

Foot problems in children presented to the family physician: a comparison between 1987 and 2001.
Krul M, van der Wouden JC, Schellevis FG, van Suijlekom-Smit LW, Koes BW.
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Abstract

Introduction In recent decades, studies on the management of common foot problems in children have suggested that in many cases there is no indication for treatment. It is not known whether these studies have changed daily practice. Our aim was to establish and compare incidence and referral rates for foot problems in children in 1987 and 2001.

Methods A comparison was made of two large consecutive surveys in Dutch general practice performed in 1987 (86,577 children aged 0-17 years) and 2001 (87,952 children aged 0-17 years), which were carried out by the Netherlands Institute for Health Services Research (NIVEL). Both surveys included a representative sample of the Dutch population. Incidence and referral rates were calculated and, data were stratified for age group and gender.

Results Compared to 1987, in 2001 the overall incidence rate of foot problems presented to the family physician decreased substantially from 80.0 (95%CI 77.0-84.7) to 17.4 (95%CI 16.5-18.3) per 1000 person-years ($p<0.0001$). The incidence rate of flat feet decreased from 4.9 (95%CI 4.0-5.9) per 1000 person-years in 1987 to 3.4 (95%CI 3.0-3.8) per 1000 person-years in 2001 ($p=0.001$). The distribution of referrals to other primary health-care professionals and medical specialists has almost reversed in favor of primary health-care professionals.

Conclusions Total incidence rate of muskuloskeletal foot problems seen by the family physician has decreased substantially, between 1987 and 2001.

Introduction

Children's feet are not simply smaller versions of adult feet. Because their feet are still growing and developing, children have different foot problems than adults. Rapid growth occurs from 4 weeks gestation when the limb bud forms, until 18 months of age when the foot is approximately half its adult size. A child's foot has a much greater range of motion than the adult foot, and joint laxity is common[1]. The longitudinal arch height of the foot increases with age; it is usually absent in the infant, low in the child, and higher in the adolescent and adult foot[2]. In the feet of healthy children, some normal variations/deviations can nevertheless cause great concern to their parents. However, some foot abnormalities do need treatment or are indicators of underlying neuromuscular disorders and syndromic conditions[3,4]. Therefore, it is expected that many parents will visit their family physician (FP) with a question about (supposed) foot deformities and other foot problems. Indeed, in 1995 Vijlbrief et al.[5] showed that the top 15 of most common diagnoses in musculoskeletal disorders in children in Dutch family practice not only contained non-specific diagnoses that might contain foot problems (e.g. tendinitis/synovitis), but also two specific foot-related diagnoses (sprain/strain of foot/toe and flat feet). Although there are publications on foot problems in children[3,4,6], data on their incidence are scarce. The majority of reports discuss only one specific condition, most often flat feet and its treatment [7-14]. In the past 20 years many studies explored the management of common foot problems[11-14]. Most authors suggest that treatment with orthopedic soles or footwear should be restricted to those children with either serious malformations or foot pain, and that this type of treatment does not aim to develop a better longitudinal foot arch or prevent musculoskeletal pain in the future[14,15]. Some even state that the "corrective shoe" is harmful to the child[11,14] and that many unnecessary referrals are made[10].
We were interested to explore whether increased knowledge on the management of musculoskeletal foot problems in children has influenced incidence and referral rates of these problems among children in family practice. Therefore, in the present study we compare the results of two large consecutive surveys in Dutch family practice performed in 1987 and 2001, respectively, with the aim to answer the following questions:

- How often did the FP see children aged 0-17 years with musculoskeletal foot problems and to what extent did this change between 1987 and 2001?
- For which musculoskeletal foot problems did the FP refer children and did the referral rate change between 1987 and 2001?

Methods

We analyzed data from the first and second Dutch national survey of family practice, which were carried out by the Netherlands Institute for Health Services Research (NIVEL) in 1987 and 2001, respectively. Both surveys included a representative sample of the Dutch population

and the Dutch FP population: for further details see Westert et al[17]. In the Netherlands, family practices have a fixed list size, and all non-institutionalized inhabitants are listed in a general practice. FPs have a gate-keeping role, meaning that a medical specialist can only be consulted after referral by a FP. Thus, generally speaking, the first contact with health care is via the FP.

First Dutch national survey 1987

A non-proportionally stratified sample of 161 FPs (103 practices) was selected randomly to participate in the survey. The FPs were divided into four groups and each group registered data (e.g. diagnosis, prescription and referrals) about all contacts between patient and practice on registration forms during one of four consecutive 3-month periods during 1987. The four registration periods covered one calendar year to correct for seasonal variability of morbidity. Specially trained workers using the International Classification of Primary Care (ICPC) coded free-text diagnoses made by the FP. Data on patient demographics were obtained by a questionnaire. Because of the stratified sample, the population was weighted to the Dutch population of 1987.

Second Dutch national survey 2001

In 2001, data on all FP - patient contacts during one calendar year were derived from the electronic medical records of all listed patients of 195 FPs (104 practices). The FPs recorded all health problems presented within a consultation, and coded the diagnosis themselves using the ICPC. In 2001 we excluded data from 9 practices from the analysis because of technical problems with registration.
In 2001, because it was possible to search in the free text for the reasons for the consultation, an analysis was made (by the first author) of the contact with all children aged 0-17 years of age diagnosed with musculoskeletal foot problems and with one of the following ICPC codes: L17 (foot/toe symptom/complaint), L28 (limited function/disability), L29 (symptom/complaint musculoskeletal other), L98 (acquired deformity of limb), or L99 (musculoskeletal disease other). This enabled us to compile more subgroups of foot problems for 2001 than for 1987. All referrals made for all foot problems (to both primary and secondary care) in both surveys were analyzed.

Statistical analysis

The incidence rate was calculated by dividing the total number of new episodes (numerator) by the mid-time population (denominator). Data were stratified for age group and gender. Incidence rates were expressed per 1000 person-years. 95% confidence intervals (CI) were calculated assuming a Poisson distribution using STATA version 8.2. The statistical package SPSS 11.0 was used for all other analyses.

Results

Study populations in 1987 and 2001

The study population in 1987 consisted of 86,577 children aged 0-17 years (mean age 10.4 years) yielding 21,644 person-years; these children had 1749 contacts with the FP concerning foot problems. In 2001, the study population consisted of 87,952 children aged 0-17 years (mean age 8.3 years) yielding 81,716 person-years; these children had 1419 contacts with the FP concerning foot problems.

Incidence

Table 1 shows the distribution of foot problems in Dutch general practice in 1987 and 2001 stratified by gender. Compared to 1987, in 2001 the overall incidence rate of foot problems presented to the FP had substantially decreased from 80.0 (95%CI 77.0-84.7) to 17.4 (95%CI 16.5-18.3) per 1000 person-years ($p<0.01$). The incidence rate of flat feet decreased from 4.9 (95%CI 4.0-5.9) per 1000 person-years in 1987 to 3.4 (95%CI 3.0-3.8) per 1000 person years in

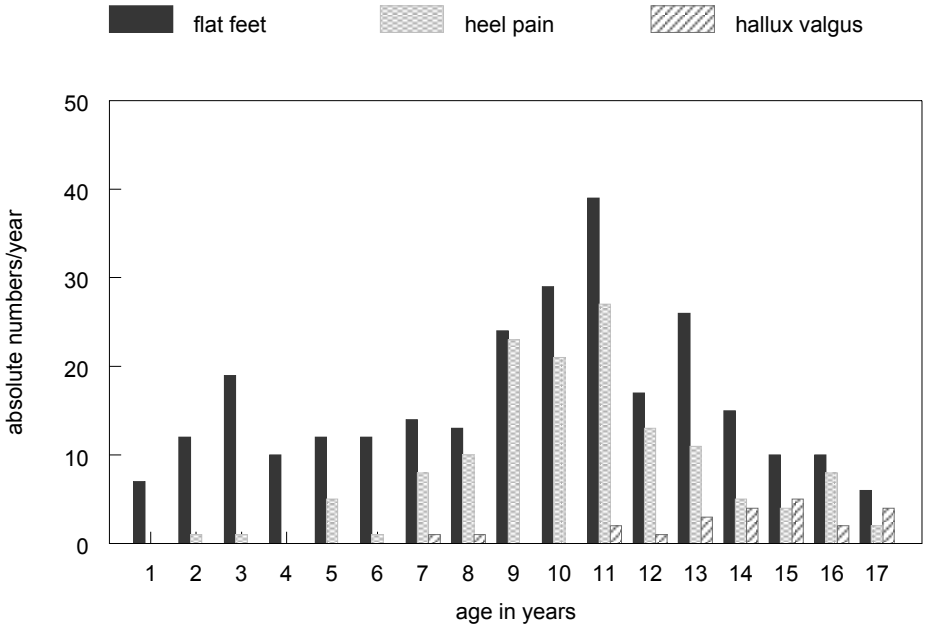

Figure 1 shows the age distribution for the three major foot problems in 2001: flat feet (median age 10.0 years), heel pain (median age 10.5 years) and hallux valgus (median age 14.0 years).

Flat feet	median age 10.0, mean age 9.3
Heel pain	median age 10.5, mean age 10.6
Hallux valgus	median age 14.0, mean age 13.9

Table 1 Incidence rates and confidence intervals of foot problems per 1000 person years in children aged 0-17 years in Dutch general practice in 1987 and 2001, stratified by gender and diagnosis.

Foot problem	1987 incidence rate (95%CI) overall	1987 incidence rate (95%CI) male	1987 incidence rate (95%CI) female	2001 incidence rate (95% CI) overall	2001 incidence rate (95% CI) male	2001 incidence rate (95% CI) female
Flat feet	4.9 (4.4-6.0)	4.5 (3.3-5.9)	5.4 (4.1-7.0)	3.4 (3.0-3.8)	3.7 (3.2-4.4)	3.0 (2.5-3.6)
Hallux valgus	0.6 (0.3-1.0)	0.4 (0.1-0.9)	1.1 (0.6-2.0)	0.3 (0.2-0.4)	0.1 (0.0-0.2)	0.5 (0.3-0.8)
Other foot problems	75.3 (71.7-79.1)	70.1 (65.3-75.2)	80.8 (75.5-86.5)	14.1 (13.3-14.9)	14.3 (13.2-15.5)	13.1 (12.0-14.3)
Total	80.8 (77.0-84.7)	74.9 (69.9-80.2)	8 87.0 (81.5-92.0)	17.4 (16.5-18.3)	18.1 (16.9-19.5)	16.5 (15.3-17.9)

Table 2 Number of cases, incidence rates and confidence intervals per 1000 person years, of foot problems in children aged 0-17 years in Dutch general practice by gender and subgroup, in 2001.

	Total group			Boys			Girls		
Subgroup	**No. Cases**	**Incidence rate**	**95%CI**	**No. Cases**	**Incidence rate**	**95%CI**	**No. Cases**	**Incidence rate**	**95%CI**
Flat feet	275	3.4	3.0-3.8	157	3.7	3.2-4.4	118	3.0	2.5-3.6
Heel pain	140	1.7	1.4-2.0	87	2.1	1.7-2.6	53	1.3	0.9-1.7
Hallux valgus	23	0.3	0.2-0.4	4	0.1	0.0-0.2	19	0.5	0.3-0.8
Toe walker	10	0.1	0.1-0.2	8	0.2	0.1-0.4	2	0.1	0.0-0.2
Clubfoot	6	0.1	0.0-0.2	5	0.1	0.0-0.3	1	0.0	0.0-0.1
Poly-/ Syndactily	7	0.1	0.0-0.1	4	0.1	0.0-0.2	3	0.1	0.0-0.2
Curly toes	22	0.3	0.2	11	0.4	0.1-0.5	11	0.3	0.1-0.5
Intoeing	36	0.4	0.3-0.6	16	0.3	0.2-0.6	20	0.5	0.3-0.7
Outtoeing	8	0.1	0.0-0.2	3	0.1	0.0-0.2	5	0.1	0.0-0.3
Foot deformity not specified	50	0.6	0.5-0.8	26	0.6	0.4-0.9	24	0.6	0.4-0.9
Trauma	318	3.9	3.5-4.3	178	4.2	3.6-4.9	140	3.5	3.0-4.1
Pain	106	1.3	1.1-1.6	42	1.0	0.7-1.4	64	1.6	1.2-2.1
Other complaints	418	5.1	4.6-5.6	220	5.2	4.6-6.0	198	5.0	4.3-5.7
Total	1419	17.4	16.5-18.3	761	18.1	16.9-19.5	658	16.5	15.3-17.9

2001 (p<0.01). The incidence rate of hallux valgus decreased slightly from 0.6 (95%CI 0.3-1.0) per 1000 person-years in 1987 to 0.3 (95%CI 0.2-0.4) per 1000 person-years in 2001 (p=0.05). For all foot problems the incidence in 1987 was higher in girls (significant for hallux valgus p=0.03, other foot problems p<0.01, and total foot problems p<0.01), whereas in 2001 this higher incidence of foot problems in girls was only observed in the hallux valgus subgroup.
In 2001, it was possible to distinguish more subgroups than in 1987. Table 2 gives gender-specific and subgroup-specific incidence rates for 2001; whereas hallux valgus has a higher incidence rate in girls, heel pain is more common in boys (p=0.01).

Referrals

In 1987, 8.9% of the children with a foot problem was referred, in 2001 this percentage increased to 18.0% (p<0.01). Of the 152 children in 1987, 35.5% (n=54) was referred to another primary healthcare provider and 64.5% (n=98) to a medical specialist. In 2001 these percentages were 59.6% (n=152) and 40.4% (n=103), respectively. Table 3 presents data on the distribution of the specialties. Due to a procedural change during the studies (see Methods section) it was not possible to maintain exactly the same division.
In 1987, 38.3% (n=40) of the children who visited the FP with flat feet were referred compared with 22.5% (n=62) in 2001 (p<0.01).

Table 3 Distribution among the specialties of referrals of foot problems in children aged 0-17 years in Dutch general practice.

	1987 **no. referrals in three months** **(% among all referrals)**	**2001** **no. referrals in one year** **(% among all referrals)**
Primary care		
Physiotherapy	23 (15.1%)	70 (27.5%)
Podiatry	NA	66 (25.9%)
Other primary care specialties	31 (20.4%)	16 (6.3%)
Medical specialists		
Surgery	40 (26.3%)	20 (7.8%)
Orthopedics	53 (34.9%)	51 (20.0%)
Pediatrics	4 (2.6%)	27 (10.6%)
Neurology	1 (0.7%)	5 (1.9%)

Discussion

Incidence

Between 1987 and 2001 the incidence rate of foot problems in children presented to the FP decreased drastically: from 80.0 to 17.4 per 1000 person-years, respectively. This decrease could partly be due to studies (during the last 20 years) reporting that most foot problems in children do not need treatment[11-14]. In the Netherlands, preventive youth health care is government controlled and free for all children. Children aged 0-4 years can attend a baby clinic to receive regular health check-ups and vaccinations. School-aged children receive regular health check-ups from special school physicians; these physicians together with FPs play an important role in educating people on healthcare issues.

In the present study the marked decrease in the incidence of foot problems is probably due to the fact that having flat feet and other foot problems is not seen as such a medical problem as it was a generation ago, and we hypothesize that one of the reasons for that is that we as family doctors do a very good job educating our patients, based on our increased knowledge of the literature.

A decrease in the incidence of flat feet was also observed, but this was substantially smaller than the decrease in total foot problems. This result may appear to conflict with the fact that most studies on foot problems focused on flat feet. It is, however, plausible that increased awareness that most foot problems do not need treatment made parents less inclined to visit a FP for other foot problems as well. In addition, in 1987 the group of 'other foot problems' may have also contained children with flat feet. Unfortunately, in the 1987 survey it was not possible for us to search the free text for the reasons for consultation (see Methods section) and exclude this latter possibility.

In our gender-specific comparison of incidence rates between 1987 and 2001, it appears that in 1987 all foot problems are more common in girls. This higher incidence in girls did not emerge in 2001; however, we have no explanation for this change.

Our gender-specific analysis shows that heel pain is more common in boys and hallux valgus is more common in girls. Foot pain and heel pain are a common problem in children[18], but we were unable to find reports on (gender-specific) occurrence rates or a population-based incidence rate of hallux valgus among children aged 0-17 years. Some have reported a low occurrence in children whereas others found valgus deformity in 4.7-22.4% of school girls[19]. A higher incidence of hallux valgus in females than in males has also been reported[31-33].

It was not possible to compare the age distribution of the three problems most often presented to the FP in our study (flat feet, hallux valgus and heel pain) with that of other studies. In a study on children, Craigmile found hallux valgus to be most common in children aged 12 to 15 years[19]. Although there are many publications on flat feet, the age distribution of the children presenting with this problem was lacking until now.

Referrals

In 1987, 8.9% of the patients with a foot problem was referred compared with 18% in 2001; this increase is not consistent with the earlier decrease in total referral rates between these years for children in Dutch primary care[22]. The large decrease in the incidence of total foot problems presented to the FP may be due to the knowledge that treatment is usually not necessary. Consequently, most of the children who visit the FP will have a foot problem that does need treatment, resulting in an increase in the percentage of referrals. Also the fall in incidence is much larger than the increase of referrals, therefore the actual number of referrals is less in 2001 than in 1987. Noteworthy is that the distribution of referrals between primary and secondary care has reversed; in 1987 approximately 65% was referred to secondary care compared with 40% in 2001. This is probably related to the fact that, in 1983, podiatry became a certified primary care profession in the Netherlands. After this date FPs probably referred more patients to a podiatrist rather than to a medical specialist. This relatively new primary care profession may also partially explain the increase in total referrals for foot problems, i.e. FPs may have a lower threshold to refer to a primary care professional than to a medical specialist. In 1987 38.3% of the children with flat feet who visited the FP were referred compared with 22.5% in 2001. Thus, the total referral rate of foot problems increased, whereas for flat feet this rate decreased enormously. This adds credibility to the assumption that increased knowledge through, studies on flat feet, reporting that (invasive) treatment is not necessary in the majority of cases, has changed FPs' management of this problem.

Implications for clinical practice and research

This study has provided important epidemiological background data on foot problems in children, which is useful for research and clinical practice. We also think that this study shows that the increased knowledge in doctors through the literature can influence what we explain to our patients, and this can in some years increase the knowledge of our patients.

Strengths and limitations of the study

These two large, representative and comprehensive surveys enabled us to accurately evaluate epidemiological data on foot problems in children presenting in primary care. However, some differences in the design of the two national surveys might hamper comparability of data. For example, ICPC coding of the diagnosis was not performed in the same way in both surveys: in 1987 this coding was done by clerks after the consultation, whereas in 2001 FPs coded the diagnosis themselves during the consultation. The participating FPs were trained in correct coding. We assume that the coding by clerks in 1987 more often led to a specific diagnostic ICPC code than in 2001 when FPs did the coding themselves leading to more symptom codes. In addition,

in 2001 it was possible to search in the free text for the reasons for the consultation; the first author analyzed all possibly related ICPC codes (see Methods) thereby minimizing differences in the final coding. Therefore, it is possible to make a valid comparison of the incidence rates between 1987 and 2001.

Conclusions

This study shows that the incidence rate of foot problems presenting in general practice dropped drastically between 1987 and 2001. The total referral rate for children with foot problems has increased between these years, in contrast to the decreasing overall referral rate of children in the same period. The distribution of referrals to other primary healthcare professionals and medical specialists has almost reversed in favor of primary healthcare professionals, probably partly due to recognition of the podiatric profession in the Netherlands in 1983. While the total referral rate of foot problems increased, the referral rate of the subgroup with flat feet decreased. The decrease in the total incidence rate and referral rate of flat feet is probably a consequence of the current knowledge that for most foot problems no treatment is necessary. In addition, this study shows that heel pain has a higher incidence rate among boys and that hallux valgus has a higher incidence among girls.

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CHAPTER 4

Acute non-traumatic hip pathology in children

CHAPTER 4A

The epidemiology of acute non-traumatic hip pathology in children in Dutch general practice

Acute non-traumatic hip pathology in children: incidence and presentation in family practice.
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Abstract

Introduction The differential diagnosis of children with acute non-traumatic hip pathology varies from quite harmless conditions such as transient synovitis of the hip to more severe problems like Perthes' disease, slipped capital femoral epiphysis (SCFE), and life-threatening conditions such as septic arthritis of the hip. Our aim is to provide population-based data on symptom presentation and incidence rates of non-traumatic acute hip pathology in family practice.

Methods We analyzed data from a large national survey of family practice (104 practices), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. We included all children aged 0-14 years. Incidence rates were calculated by dividing the total number of cases (numerator) by the average study population at risk (denominator).

Results Our study population consisted of 73,954 children aged 0-14 years, yielding 68,202 person-years. These children presented with 101 episodes of acute non-traumatic hip pathology. The presenting feature in 81.5% of the children was pain, in 8.6% limping and 9.9% presented with both symptoms. Only 27% of the participating FPs reported whether the child had a fever. The incidence rate for all acute non-traumatic hip pathology was 148.1 per 100,000 person-years, and for transient synovitis this was 76.2 per 100,000 person-years.

Conclusion In family practice, most children with acute non-traumatic hip pathology present with pain as the initial symptom. FPs need to be more aware that fever is the main distinguishing factor between a harmless condition and a life-threatening condition. Transient synovitis is the diagnosis with the highest incidence rate.

Introduction

Children with acute non-traumatic hip pathology present in different ways e.g., with a limp or abnormal gait, with pain, refusal to bear weight, or decreased movement of the involved leg. These complaints represent a diagnostic problem for the family practitioner (FP), not only because of the wide range of these complaints but also because the differential diagnosis varies from quite harmless conditions such as transient synovitis of the hip to more severe problems like Perthes' disease, slipped capital femoral epiphysis (SCFE), and life-threatening conditions such as septic arthritis of the hip. A few studies have aimed to establish which (preferably minimally invasive) parameters are most relevant in clinical decision-making for acute non-traumatic hip pathology, in order to make the correct diagnosis in a clinical setting.[1-3] It is unclear whether the existing literature is useful for FPs, because most available studies were performed in hospitals and concentrate on specific diagnoses. However, children do not present to the FP with a diagnosis but with a symptom (e.g. pain or limping), and the FP must make the right assessment and apply appropriate management. It is of value to know which complaints children with acute non-traumatic hip pathology present to the FP and how often the different diagnoses are made in family practice. This helps to determinate the prior chance for the different diagnoses when a child contacts you with hip related symptoms.
In order to provide population-based epidemiological background data and facilitate appropriate assessment in the child with acute non-traumatic hip pathology in family practice, we used data from a national survey performed in Dutch family practice (2001), and aimed to answer the following questions:

- What is the distribution of symptoms presented to the Dutch FP in children with acute non-traumatic hip pathology?
- What is the incidence and distribution of the separate diagnoses in acute non-traumatic hip pathology among children in Dutch family practice?

Textbox 1

Transient synovitis of the hip	An acute self-limiting (3-10 days) benign inflammation of the synovial lining of the hip.
Perthes' disease	Necrosis or degeneration of the ossification centre of the femoral head epiphysis and subsequent spontaneous regeneration and recalcification.
Slipped capital femoral epiphysis	A posterior slipping of the femoral head in relation to its metaphysis, resulting in a shearing failure of the growth plate.
Septic arthritis of the hip	Infection of the hip, which can result in damage to the articular cartilage, osteonecrosis of the proximal part of the femur, femoral osteomyelitis and sepsis.

Methods

We analyzed data from the second Dutch national survey of family practice (NS2), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. In the Netherlands, family practices have a fixed list size, and all non-institutionalized inhabitants are listed in a family practice. The family practitioner (FP) is the first healthcare professional to be consulted, and acts as gatekeeper to secondary care.

The survey represented the 1.5 million contacts between 385,461 patients (i.e all listed patients) and their general practice during a 12-month period. We were able to use the medical record data on these contacts, and in addition, around 77% of patients had taken part in a census in order to provide up-to-date demographic data; for further details see Westert et. al.[4] For the current paper a sub-sample of 73,954 children aged 0-14 years was analyzed.

The FPs registered all health problems presented within a consultation, and coded the diagnosis using the International Classification of Primary Care (ICPC). Contact diagnoses related to the same health problem were clustered into disease episodes. Nine practices were excluded from the analyses because of insufficient data quality.

The FPs in NS2 did not use ICPC sub-coding; therefore, to retrieve all consultations for possible acute non-traumatic hip pathology, the first and second author (MK and JCvdW) selected all possibly related ICPC codes of the children aged 0-14 years (ICPC codes L02, L13, L14, L15, L20, L28, L29, L70, L88, L98, L99 (details see appendix1). Then we screened the free text of the consultations with these diagnostic codes for seven Dutch keywords (English equivalents are: transient, synovitis, Perthes, epiphysis, pain, limp, hip). The cases thus retrieved were compared by MK and JCvdW and discussed in order to reach consensus. The retrieved records were checked for more specific details and diagnoses. Included for analysis were all cases in which one of our four diagnoses of primary interest was made (see textbox 1) and cases in which in the history part of the journal was spoken of a child with an acute limp due to the hip or acute pain in the hip. Excluded were those cases in which the FP mentioned a trauma or cases with diagnoses like congenital malformations or malignancies (diagnoses that not fall in the spectrum of acute non-traumatic hip pathology).

Statistical analysis

The incidence rate was calculated by dividing the total number of newly diagnosed cases (numerator) by the average study population at risk, the so-called mid-time population (denominator). The mid-time population was calculated as the mean of all listed patients (aged 0-14 years) of all FPs at the beginning and at the end of the registration period. We chose to use incidence rates for the following reasons; the conditions under investigation are rare, medical records are dynamic; people are in the database for different periods of time, and other articles also report incidence rates, therefore this makes our work comparable with other studies.

Incidence rates were expressed per 100,000 person-years (this means that for example if the incidence rate would be 25 than in every 100,000 children that are in the family practice for a complete year, the FP will see 25 cases. 95% confidence intervals (CI) were calculated assuming a Poisson distribution using STATA version 8.2. The statistical package SPSS 15.0 was used for all other analyses. Data were stratified for gender.

Results

Study population

Our study population consisted of 73,954 children aged 0-14 years, yielding 68,202 person-years. These children had 147 contacts with the FP concerning acute non-traumatic hip pathology (hereafter referred to as 'hip pathology'), which contributed to 101 episodes; 65 children visited their FP on one single occasion, 29 children returned once, and 7 children paid three or more visits concerning the same episode of hip pathology.

Symptoms

The distribution of symptoms among the different diagnoses is shown in Table 1. In 81.5% of the children pain was the presenting feature, limping was the initial symptom in 8.6% of the children, and 9.9% of the children presented with both symptoms. If pain was the presenting

Table 1 Distribution of presenting symptoms among the different diagnoses of acute non-traumatic hip pathology in children aged 0-14 years in Dutch family practice.

Diagnosis	Transient synovitis N=38*	Perthes' disease N=6	SCFE N=3**	Total hip pathology N=81***
Symptom				
Pain	72.2%	100%	100%	81.5%
Limp	16.7%	0%	0%	8.6%
Pain + Limp	11.1%	0%	0%	9.9%
Location of Pain**				
Hip	56.7%	66.7%	66.7%	69.0%
Groin	5.3%	16.7%	33.3%	9.9%
Knee	10.5%	0%	0%	5.6%
Leg	18.4%	16.7%	0%	15.5%

* For 14 patients diagnosed with transient synovitis it was not possible to retrieve the initial symptom

** For 1 patient diagnosed with SCFE it was not possible to retrieve the initial symptom

*** In 20 of the total patients with acute non-traumatic hip pathology it was not possible to retrieve the initial symptom

**** In the patients which presented with pain as the initial symptom

feature, 69.0% of the children localized it in the hip, 9.9% in the groin, 5.6% in the knee, and 15.5% in the leg.
In 27.0% of the episodes of hip pathology the FP recorded whether the child had a fever. In the episodes where transient synovitis was the final diagnosis the presence or absence of fever was recorded in 34.6% of the episodes. In the present study 11.5% of the cases with transient synovitis presented with a fever; in Perthes' disease and SCFE this was recorded in 1 out of 6 cases and in 1 out of 4 cases, respectively.

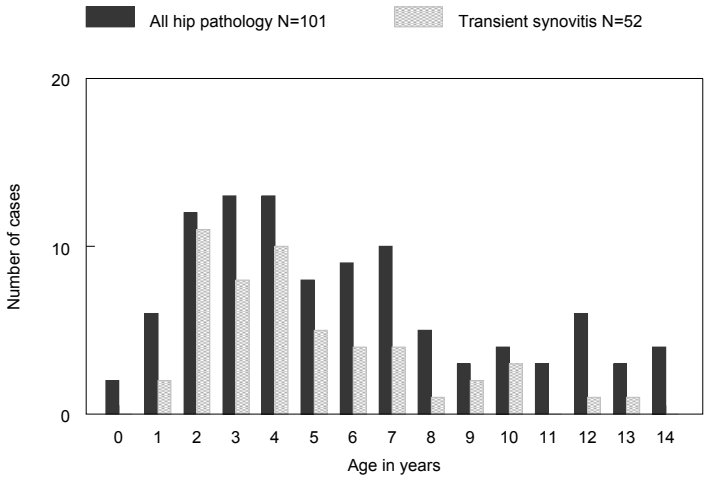
Diagnosis

Table 2 shows the distribution of incidence rates of the different diagnoses stratified by gender. The incidence rate of acute hip pathology was 148.1 (95% CI 120.6-179.9) per 100,000 person-years. Transient synovitis had the highest incidence rate 76.2 (95% CI 56.9-100.0) per 100,000 person-years.

Table 2 Incidence rates/ 100,000 person-years in children aged 0-14 years of acute hip pathology in Dutch family practice, by diagnosis and gender.

	Incidence rate total	95% CI interval	Incidence rate males	95% CI interval	Incidence rate females	95% CI interval
Transient synovitis (n = 52)	76.2	56.9 – 100.0	91.1	62.3 – 128.6	60.5	36.9 – 93.4
Perthes' disease (n = 6)	8.8	3.2 – 19.1	5.7	0.7 – 20.6	12.1	3.3 – 31.0
SCFE (n = 4)	5.9	1.6 – 15.0	2.9	0.1 – 15.9	9.1	1.9 – 26.5
Symptom diagnosis (n = 39)	57.2	40.7 – 78.2	62.6	39.3 – 94.8	51.5	30.0 – 82.4
Total (n = 101)	148.1	120.6 – 179.9	162.3	122.9 – 210.2	133.2	96.8 – 178.8

Figure 1 shows the age distribution for total hip pathology and for transient synovitis (the diagnosis with the highest incidence). The mean age for total hip pathology was 5.9 years: for girls 6.1 years and for boys 5.7 years. The mean age for transient synovitis was 4.7 years, for girls 4.1 years and for boys 5.1 years. We found 6 cases of Perthes' disease with a median age of 10 years, and 4 cases of SCFE with a median age of 9.5 years.



Transient synovitis Mean age = 4.7 years (median = 4)
All hip pathology Mean age = 5.9 years (median = 5)

Figure 1 Age distribution of all acute non-traumatic hip pathology and transient synovitis of the hip seen by Dutch FPs in children aged 0-14 years.

Discussion

Summary of main findings and comparison with existing literature

The 101 children in our study presenting with hip pathology had 147 contacts with the FP; 52 cases were diagnosed with transient synovitis, 6 with Perthes' disease, and 4 with SCFE. In the remaining 39 cases only a symptom diagnosis was available. No case of septic arthritis was diagnosed among the children in our study.

While fever is one of the most important (non-invasive) distinguishing factors between transient synovitis and septic arthritis (texbox 2)[2,6], in our study its presence was recorded in only 27% of the episodes of hip pathology. It was not possible to assess retrospectively why the occurrence of fever was not recorded more often. In our study 11.5% of the cases with transient synovitis presented with fever. Eich et. al.[1] found a comparable percentage of 14.0%; in addition, of their 87 patients with acute non-traumatic hip pathology 8 had septic arthritis, and of these latter patients a substantially higher number (7, i.e. 87.5%) presented with a fever. Kocher et. al.[6] reported fever in 8.1% of their patients with transient synovitis and in 81.7% of their patients with septic arthritis.

Textbox 2

Differentiation between transient synovitis and septic arthritis. Predictors of septic arthritis identified by Kocher et al. [2,6]
- fever
- inability to bear weight
- ESR> 44mm/hour
- WBC>12x10^9/L

Most children presented with pain as the primary symptom. In their study, Fischer and Beattie[5] found that 79.4% of the children with an acute non-traumatic limp in the emergency department presented primarily with pain; this is comparable to the 81.5% that we found. While 100% of the patients diagnosed with Perthes' disease and with SCFE primarily presented with pain, only 77.2% of the patients diagnosed with transient synovitis did. Referred pain in the knee might be associated with transient synovitis: 10.5% of the patients in our study with transient synovitis localised this pain in the knee, while none of the patients with Perthes' disease and SCFE did so (Fisher's exact test p=0.574)). Fischer and Beattie[5] reported comparable results: 8.3% of their irritable hip/transient synovitis patients localised the pain in the knee, compared with none of the patients with Perthes' disease or SCFE.

Unfortunately no occurrence rates are available on total acute non-traumatic hip pathology seen in family practice with which to compare our incidence rate. In the present study transient synovitis is the diagnosis with the highest incidence rate, i.e. 76.2 (95% CI 56.9-100.0) per 100,000 person-years. In a previous study in Dutch family practice in 1987 with a similar design, an incidence rate of 110 per 100,000 person-years was reported in children aged 0-14 years.[7] Other occurrence rates range from 51.9 per 100,000 children under 16 years of age in Finland[8] to 130 per 100,000 in Germany in children aged 0-16 years[9] to 200 per 100,000 in Sweden in children aged 0-14 years.[10] Considerable variability has been reported in the incidence of Perthes' disease in different populations. In our study we calculated the incidence rate of Perthes' disease to be 8.8 per 100,000 person-years; this is comparable to the incidence found in Norway in children aged 0-14 years of 9.0 per 100,000 person-years.[11] Others have reported a low incidence in Asian countries, e.g. the annual incidence in Japan was calculated to be 0.9 per 100,000 person-years.[12] Highest incidence rates were reported in inner city Liverpool: 21.1 per 100,000 person-years.[13]
In our study the incidence rate of SCFE was 5.9 (95%CI 1.6-15.0) per 100,000 person-years. Lehmann et. al.[14] found an annual incidence of 10.8 per 100,000 in the USA in children aged 9-16 years. Kelsey et al.[15] found occurrence rates ranging from 2.13 per 100,000 in New Mexico to 10.1 per 100,000 in Connecticut, USA.

Strengths and limitations of this study

This large and representative survey enabled us to assess the occurrence of hip pathology in primary care. Due to the rarity of the disorders a large sample size is needed and therefore a FP database was a suitable instrument to work with regarding our research questions. Dutch family practice is a potentially valid source because all non-institutionalized inhabitants are registered with a FP, and the FP fulfils the role as "gatekeeper". The lack of accuracy of the diagnosis, and the under-representation of cases presented at out-of-hour services, might be considered a potential limitation in these FP databases.[16,17] In our analysis we assumed that the diagnosis and registration by the FPs was correct and accurate. All participating FPs were trained in the correct coding of the ICPC and were explicitly asked to register the out-of-hour episodes.[4] Despite the large size of this survey, we found few children with Perthes' disease and SCFE, and none with septic arthritis; therefore, it was not possible to accurately assess age and gender distributions for the first two conditions or calculate an incidence rate for the latter.

Conclusion

The present study enabled us to assess incidence rates and occurrence of symptoms of acute non-traumatic hip pathology in children in family practice. This provides important epidemiological background data. There seems to be an association between referred pain to the knee and transient synovitis; this might be a useful diagnostic tool and further research is needed to confirm this. This study shows that while fever is one of the most important non-invasive distinguishing factors between transient synovitis and septic arthritis[2,6] , its presence was recorded in only about 25% of hip pathology. FPs need to be more aware that fever is the main distinguishing factor between a harmless condition and a life-threatening condition.

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CHAPTER 4B

Diagnosis of acute non-traumatic hip pathology in children: a systematic review

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Submitted

Abstract

Introduction The differential diagnosis of children with acute non-traumatic hip pathology ranges from relatively harmless conditions to life-threatening conditions. This literature review explores the diagnostic value of tests used to diagnose four important conditions in the differential diagnosis of non-traumatic acute hip pathology in children, i.e septic arthritis, transient synovitis, Legg-Calve-Perthes'disease and slipped capital femoral epiphysis. The secondary aim is to extract some easily applicable parameters to help determine whether watchful waiting is justified or further testing is necessary.

Methods Medline and Embase were searched from inception until February 2009. Medical subject headings, terms and accompanying entry terms were used for the symptoms, diagnosis, age group and outcome. After scrutinising 1495 titles and abstracts, 81 articles were obtained in full text. 23 articles were selected and quality was assessed according to the QUADAS tool. If possible we constructed 2x2 contingency tables using primary data.

Results Eleven studies were found evaluating diagnostic parameters of septic arthritis, eight evaluated laboratory and anamnestic parameters, five studies created clinical prediction rules. One study validated ultrasound to diagnose transient synovitis. For Legg-Calve-Perthes'disease two studies investigating ultrasound, two studies evaluating MRI and seven studies evaluating the bone scan were included. No studies were found evaluating diagnostic tools for slipped capital femoral epiphysis.

Conclusion In differentiating between septic arthritis and transient synovitis the most helpful tool, albeit limited, is the clinical prediction rule of Kocher; CRP adds more diagnostic certainty to this rule. Ultrasound is commonly used in diagnosing transient synovitis and Legg-Calve-Perthes'disease, this non-invasive diagnostic tool needs further investigation to establish its diagnostic value. The bone scan and MRI have high sensitivity and specificity in diagnosing Legg-Calve-Perthes'disease, but the latter method seems preferable.

Introduction

The differential diagnosis of children with acute non-traumatic hip pathology ranges from relatively harmless conditions such as transient synovitis (TS) of the hip to more severe problems like Legg-Calve-Perthes' disease (LCPD), slipped capital femoral epiphysis (SCFE), and potential life-threatening conditions such as septic arthritis (SA) of the hip. Therefore, to provide adequate treatment and/or advice it is important to make the correct diagnosis in these patients.
Children diagnosed with varying hip conditions may all present with pain in the hip, groin, upper leg or knee, and usually with a limp.[1] The age range in which these conditions occur may differ slightly but generally overlap[2], as do the outcomes of laboratory tests[3,4] and information from physical examination and history taking[4]. The (diagnostic) value of tests used to diagnose these conditions (ranging from harmless to relatively invasive) have been well documented. A few studies attempted to identify which (preferably minimally invasive) parameters are most relevant to establish the correct diagnosis. However, no systematic review of the diagnostic value of the diagnostic tests available for acute non-traumatic hip pathology exists.
Therefore, this literature review explores the diagnostic value of tests used to diagnose four important conditions in the differential diagnosis of non-traumatic acute hip pathology in children, i.e. SA, TS, LCPD and SCFE. The secondary aim is to extract some easily applicable parameters to help determine whether watchful waiting is justified or further testing is necessary.

Case

A four-year-old boy presented to the general practitioner after suffering pain for two days in the upper left leg and knee, and with a limp. No trauma has occurred. In the days before the pain started the boy had a fever. He is still not feeling optimal; however, he is lively and plays but is still limping. His mother is worried because her son usually runs around and is very active. On clinical examination he is unable to bear weight on the affected leg; when lying down, he holds his left hip in a slightly flexed position, and internal rotation and abduction of the hip are painful and slightly limited. Examination of the knee reveals no abnormality. What other questions and/or tests might help the physician to differentiate between the various possible conditions and make the correct diagnosis?

Methods

Inclusion criteria

Studies that investigated diagnostic tests for SA, TS, LCPD or SCFE in children (<18 years) presenting with pain in the hip or a limp were assessed for eligibility. The studies had to include more than 20 participants. Primary data (e.g. in a 2x2 contingency table) or appropriate summary statistics (e.g. sensitivity, specificity, positive or negative likelihood ratios) had to be available. Articles in English, Dutch, German, French, Spanish and the Scandinavian languages were included.

Literature search

Medline and Embase were searched from inception until February 2009. First, a specific search of the literature was made with the assistance of a clinical librarian, targeting all tests used to diagnose SA, TS, LCPD, and SCFE in children presenting with acute non-traumatic hip complaints. For the present study, we compared the results from our primary search strategy with the results of a previous search made for our earlier study on the incidence of acute non-traumatic hip problems[1]; it appeared that, although many articles were found with this search strategy, we had had missed some important articles. Therefore, we adjusted our PubMed strategy to make it more sensitive. Medical subject headings (MeSH), terms and accompanying entry terms were used for the symptoms pain in the hip or a limp, diagnosis (TA, SA, LCPD, SCFE), age group (children) and outcome (sensitivity and specificity, or primary data). Table 1 presents details of the search strategy for this review.

Study selection

First, two reviewers (MK and SB) scrutinised the titles and/or abstracts of all citations. All articles selected by either reviewer were obtained in full text. These same reviewers then independently assessed the full texts for eligibility for this review. Any disagreements were resolved by discussion.

Assessment of methodological quality

Four reviewers, divided into two couples (SB and JB, PB and BK), independently assessed the quality of half of the selected studies, according to the QUADAS tool[5]. QUADAS is a 14-item evidence-based quality assessment tool, designed to assess the quality of primary test accuracy studies included in diagnostic reviews. Because some criteria of the QUADAS need specifying regarding the topic under investigation, we further defined a representative patient spectrum

Table 1 Details of search strategy

	Medline Specific search (Jan 1966-Feb 2009)	Medline Sensitive search (Jan 1966-Feb 2009)	Èmbase (Jan 1980-Feb 2009)
Symptoms	((pain AND hip) OR (limp AND hip))	hip	(hip/exp OR hip)
Diagnosis	perthes OR legg-perthes disease[MeSH] OR scfe OR "slipped capital femoral epiphysis" OR "slipped epiphysis" OR slipped epiphysis[mesh] OR epiphysioly* OR "transient synovitis" OR "septic arthritis" OR "infectious arthritis" OR infectious arthritis[MeSH]	(perthes OR legg-perthes disease[MeSH] OR scfe OR "slipped capital femoral epiphysis" OR "slipped epiphysis" OR slipped epiphysis[mesh] OR epiphysioly* OR "transient synovitis" OR "septic arthritis" OR "infectious arthritis" OR infectious arthritis[MeSH])	(perthes OR 'perthes disease'/exp OR 'perthes disease' OR scfe OR 'slipped capital femoral epiphysis' OR 'slipped epiphysis' OR 'slipped epiphysis' OR epiphysiolysis/exp OR epiphysioly* OR 'transient synovitis' OR 'septic arthritis' OR 'infectious arthritis' OR 'infectious arthritis'/exp)
Age group	(child OR children OR childhood OR infan* OR infant OR adolescence OR adolescent OR pediatr* OR paediatr*)	Limits: Humans, All Infant: birth-23 months, All Child: 0-18 years	(('child'/exp OR 'child') OR ('children'/exp OR 'children') OR ('childhood'/exp OR 'childhood') OR infan* OR ('infant'/exp OR 'infant') OR ('adolescence'/exp OR 'adolescence') OR ('adolescent'/exp OR 'adolescent') OR pediatr* OR paediatr* OR ('newborn'/exp OR 'newborn'))
Outcome	(diagnosis OR diagnostic OR diagnoses) AND (sensitivity OR specificity OR screening OR "false positive" OR "false negative" OR accuracy OR "predictive value" OR "reference value" OR "reference standard" OR roc OR likelihood)	(diagnosis OR diagnostic OR diagnoses) AND (sensitivity OR specificity OR screening OR "false positive" OR "false negative" OR accuracy OR "predictive value" OR "reference value" OR "reference standard" OR roc OR likelihood)	AND (('diagnosis'/exp OR 'diagnosis') OR diagnostic OR diagnoses) AND (sensitivity OR specificity OR ('screening'/exp OR 'screening') OR 'false positive' OR 'false negative' OR ('accuracy'/exp OR 'accuracy') OR 'predictive value' OR ('reference value'/exp OR 'reference value') OR 'reference standard' OR roc OR likelihood)
Combination	Symptoms and Diagnosis and Age group and Outcome	Symptoms and Diagnosis and Age group and Outcome	Symptoms and Diagnosis and Age group and Outcome

as a cohort that included children with non-traumatic acute hip pain or limp. Selection criteria were considered as clearly described when the authors mentioned age, symptoms and duration of symptoms. Correct reference standards were considered to be: arthrocentesis and analysis of joint fluid for SA, anterior-posterior pelvis radiography (repeated if necessary), bone scan or MRI for LCPD, anterior-posterior pelvis radiography with the hips in Lauenstein (frog-lateral) position (repeated if necessary), bone scan or MRI for SCFE, disappearing complaints over time or diagnosis per exclusionem for TS. We considered one week to be the maximum time interval between the reference and index test. We are aware that the QUADAS is not designed to give a

quality score[6] but to give a quick indication of the quality of a study; we calculated a score per study. One point was assigned to each internal validation criterion that was met. The following 7 items were considered the most important for internal validity: item 3) reference standard correct, item 4) time between index test and reference test appropriate, item 5) whole sample reference test, item 6) same reference test regardless of index test result, item 7) reference test independent of index test, item 10) interpretation index test blinded from reference test, and item 11) interpretation reference test blinded from index test. Studies with a score of 4 or more were considered to be of high quality.

Data extraction

Three independent reviewers performed data extraction. MK performed data extraction on all studies, and JB and LS both on half of the studies. Any discrepancies were resolved by discussion. Data extraction included outcome data, characteristics of the study population, whether the study was prospective or retrospective, and which tests and conditions were studied. If possible we constructed 2x2 contingency tables using primary data, if not we extracted the summary statistics on diagnostic values presented in the article.

Analysis

The included articles were divided into three groups based on their target disease. Whenever possible we calculated sensitivity (sens), specificity (spec) and diagnostic odds ratios (dOR) from the 2x2 contingency tables (a dOR is the ratio of a positive test result in diseased children, over a positive test result in non-diseased children). If the 2x2 table contained zeros, 0.5 was added to each number to calculate dORs. Forest plots were constructed showing the sensitivity and specificity of all parameters of which 2x2 contingency tables were available.

Results

Search strategy and study selection

Figure 1 shows the flow of the studies. Of the 1495 potential citations, 1414 articles were excluded based on review of their titles, abstracts or both, and 81 were articles were selected for full text review. Subsequently, 58 studies were excluded: in 38 the patient group was not suitable, 6 were not diagnostic studies, 2 included less than 20 patients, and 12 studies did not report the outcome measures of interest. Finally, 23 studies were included in the present review.

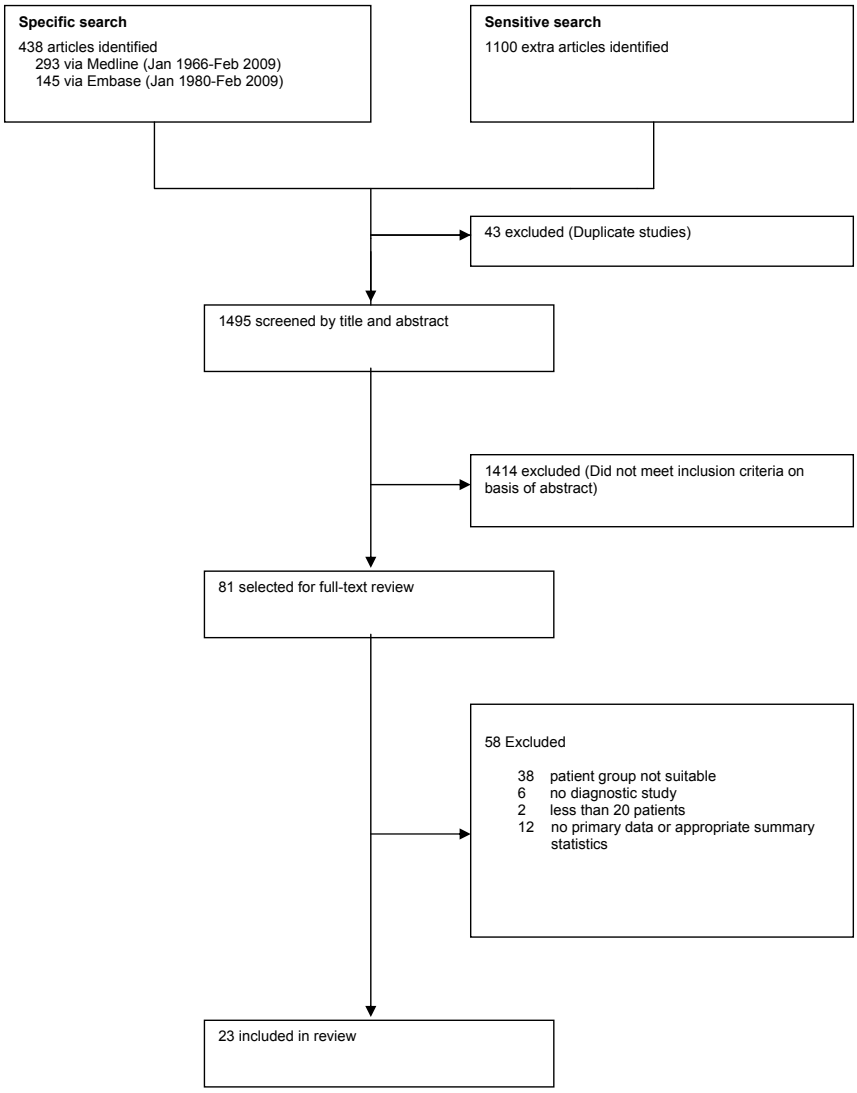

Figure 1 Flowdiagram of articles included in the review

Study characteristics

All included studies were diagnostic cohort studies. Two studies were in German, one in French, and the remainder were written in English. Of the 23 studies, 11 focused on SA, 1 on TS, 11 on LCPD, and none on SCFE. All studies recruited their patients in a hospital setting. Table 2 shows the characteristics of the studies. Of the 11 studies focusing on SA 9 were retrospective, the study on TS was also retrospective, and 3 of the 11 studies focusing on LCPD were retrospective. The mean sample size for SA was 144 (range 48-439) and for LCPD it was 58 (range 21-138).

Table 2 Study characteristics

Index diagnosis / Source	**Prospective/ Retrospective**	**No.**	**Age**	**Patient characteristics**	**Test**	**Quadas**
Septic arthritis (SA)						
Zamzam 2006	Retrospective	73 TS 81 SA	4.3yr (1.1yr-10.9yr)	Charts of patients admitted with suspected SA. Excluded: patients who showed x-ray changes on presentation or proved to have extra-hip problems that mimic hip SA or TS clinically and patients with general diseases that predispose to SA or affect the course of SA.	Ultrasound 7.5-10 mhz Effusion: Thickness of joint capsule > 5mm	1
Yang 2006	Retrospective	49 TS 18 SA	TS 6.1yr (1yr-13yr) SA 4.9yr (1m-15yr)	Medical records and MRI images of children presenting with acute hip pain.	MRI 1,5 Tesla Two radiologists consensus on joint effusion, synovial thickening, synovial enhancement, signal intensity alteration in soft tissue and bone marrow, bone erosion, bone enhancement erosion and presence of joint effusion in contralateral hip	1
Caird 2006	Prospective	14 TS 34 SA	5.5yr (7m-16yr)	Children who underwent ultrasound guided hip aspiration because of a concern that they had SA. Excluded children with immunosuppressive disease and Lyme arthritis.	Temp > 38.5 C ESR > 40 mm/hr WBC count >12x10^9 /L CRP > 20 mg/L Refusal to bear weight Combinations*	4
Luhman 2004	Retrospective	118 TS 47 SA	TS 63.4m (11.4m-109.1m) SA 63.7m (31.9m-95.5m)	All children who had undergone a hip arthrocentesis for the diagnostic workup for an acutely irritable hip.	Validation of previously published guideline Temp > 38.5 C ESR > 40 mm/hr* WBC count >12x10^{919} /L* Refusal to bear weight Prior visits* Combinations*	5

Table 2 Continued

Index diagnosis / Source	Prospective/ Retrospective	No.	Age	Patient characteristics	Test	Quadas
Kocher 2004	Prospective	103 TS 51TS	Not given	Children presenting with an acutely irritable hip and a differential diagnosis of SA and TS.	Validation of previously published guideline Temp > 38.5 C* ESR > 40 mm/hr* WBC count >12x10^{919} /L* Refusal to bear weight * Combinations*	3
Jung 2003	Retrospective	97 TS 27 SA	TS 6.7yr (17m-19yr) SA 5.7yr (1m-15yr)	Medical records and plain radiographs of children with acute hip pain.	T > 37.0 C ESR > 20 and > 40 mm/hr CRP > 10 mg/l WBC > 11x10^{9}/L Combinations* Difference of joint space distance (>2mm) on X-ray*	2
Gordon 2002	Retrospective	29 TS 22 SA	Not given	Ultrasound studies of the hip in children for the evaluation of hip pain. Excluded: children with developmental hip dysplasia and other anatomic questions.	Effusion on ultrasound (Characteristics on mhz and definition of effusion are not given)	3
Kocher 1999	Retrospective	TS 86 SA 82	TS 5.3yr (3.0yr-7.6yr) SA 6.0yr (1.8yr-10.2yr)	Records of children evaluated for an acutely irritable hip and a differential diagnosis of SA or TS.	Temp > 38.5 C ESR > 40 mm/hr* WBC count >12x10^{9} /L* CRP > 20 mg/L * Refusal to bear weight Effusion on X-ray (definition not given) Combinations*	4

Table 2 Continued

Index diagnosis / Source	Prospective/ Retrospective	No.	Age	Patient characteristics	Test	Quadas
Eich 1999	Retrospective	TS 64 SA 8 P 4	5.5yr (1m-12.4yr)	Consultations for acute hip pain.	Temp > 38.0 C WBC > age dependent CRP > 10 en > 20 mg/L Joint effusion on ultrasound (5 or 7.5 mhz; effusion: an echo-poor or echo-free biconvex space between the femoral neck and joint capsule)* Radiographic findings*	3
Taylor 1994	Retrospective	TS 418 SA 21	Not given	Admission records of children admitted with a hip disorder or pain in the region of hip/knee with differential diagnosis of SA or TS. Excluded patients with other evident orthopaedic disorders diagnosed on radiographs.	Temp > 38.0 C ESR > 20 mm/hr Severe hip pain Tenderness Combinations	0
Del Beccaro 1992	Retrospective	94 TS 38 SA	TS 4.3yr (5m-17y) SA 3.5yr (2.5w-12y)	Charts of patients with the diagnosis SA or TS of the hip or presenting with a limp, hip or leg pain or refusal to walk or bear weight. Review terminated when a ratio of 1:2.5 of SA:TS was reached.	Temp > 37.5 and > 38.0 C ESR > 20 and > 30 mm/hr WBC count >15.000/ mm^3 * Abnormal radiograph Bands > 350/mm^3 (ESR > 20 and/or T > 37.5 C)	4
Transient Synovitis (TS)						
Marchall 1987	Retrospective	TS 21 Other 25	5.9yr (10m-17yr)	Referred children with clinical symtoms of pathologic hip conditions.	Ultrasound 5 mhz Effusion: capsule to bone distance	3
Perthes (P)						
Robben 2000	Prospective	TS 31 P 9 Other 5	5,9yr (9mnd-15yr)	All children referred for radiology with a painful hip or limping.	Color doppler sonography 7-10 mhz, resistive index	5

Table 2 Continued

Index diagnosis / Source	Prospective/ Retrospective	No.	Age	Patient characteristics	Test	Quadas
Robben 1998	Prospective	TS 58 P 21 SCFE 5 Other 6	6.4yr (1.1yr-14.3yr)	Children with clinical symptoms of hip disease and control patients. Excluded: patients with bilateral symptoms.	Ultrasound 7mhz Thickness of* - Anterior recess of joint capsule - Articular cartilage of the femoral head - Quadriceps muscle Combinations	6
Curic 1993	Prospective	P 15 Other 20	Not given	Children presenting with pain, limp and limited movement.	Bone Scan 99Tc Loss of uptake in femoral head.	3
Von Rix 1992	Prospective	Unclear	(3-13yr)	Children clinically or radiologically suspect for M.Perthes.	MRT 1.5 Tesla*	5
Goertzen 1991	Prospective	P 24 Other 4	6.4yr (4yr-9yr)	Children suspected of M. Perthes.	MRT 1.0 Tesla Bone scan: ggm-Tc methylendiphosphonat Radiograph	4
Wingstrand 1985	Prospective	TS 20 P1	(1yr-11yr)	Children presenting with clinical symptoms of TS, with normal radigraphs.	Bone Scan 99m Tc MPD Imaging 3-4 hours after injection	6
Cavailloles 1985**	Retrospective	TS 74 P 51 Other 13	6.0yr (2.9yr-9.1yr)	Bonescans preformed in children presenting with hip pain or limping.	Scan 99mTc MDP* Imaging 3 hours after injection	7
Calver 1981	Prospective	TS 45 P 5	6.05 yr (3yr-12yr)	Children with symptoms of pain in the hip, thigh or knee, the presence of a limited range of movement, and associated muscle spasm, with or without a limp. Excluded: children with abnormalities on radiological examination or clinical evidence of SA or osteomyelitis).	Scan 99m Tc methylen diphosphate Imaging 2 hours after injection	7

Table 2 Continued

Index diagnosis / Source	**Prospective/ Retrospective**	**No.**	**Age**	**Patient characteristics**	**Test**	**Quadas**
Sutherland 1980	Retrospective	TS 79 P 48 Other 4	P 6.3 yr (3yr-13yr)	Children referred to the departmetn of nucleair medicine for the exclusion of Perthes disease. Excluded: children with a suspected pyogenic infection.	Scan 99m TC methylene diphosphate Imaging 1,5 hours after injection	3
Heyman 1980	Retrospective	TS 13 P 8 Other 17	Boys 6.3yr (5yr-17yr) Girls 9.9 yr (2yr-13yr)	Medical records of children referred for bone scan consultation where Perthes or TS was suspected	99Tc-MPD Imaging 3-4 hours after injection	2

* Not possible to construct 2x2 table

** and 1982, partly same data probably

Of the SA studies, 5 investigated the value of anamnestic and physical examination features, 8 evaluated laboratory tests, 2 tested the value of ultrasound, 4 examined radiographs, and 1 study evaluated MRI characteristics. The TS study evaluated the value of ultrasound. Of the LCPD studies, 6 focused on bone scan, 2 on MRI and 2 on ultrasound.

Methodological quality

Figure 2 summarizes the results of the quality assessment (see Appendix for Quadas details on specific studies). Study quality was generally poor; only 3 items were met by more than 60% of the studies. Studies scored low on 2 items: description of the selection criteria, and interpretation of index test results without knowledge of the results of the reference standard. The selection criteria were clearly defined in less than 40% of the studies. Review bias is possible in almost 60% of the studies. About 40% of the studies clearly reported on the patient spectrum. Over 80% of the studies used the correct reference test, and most used tests in clinical practice thereby minimizing misclassification and clinical bias.

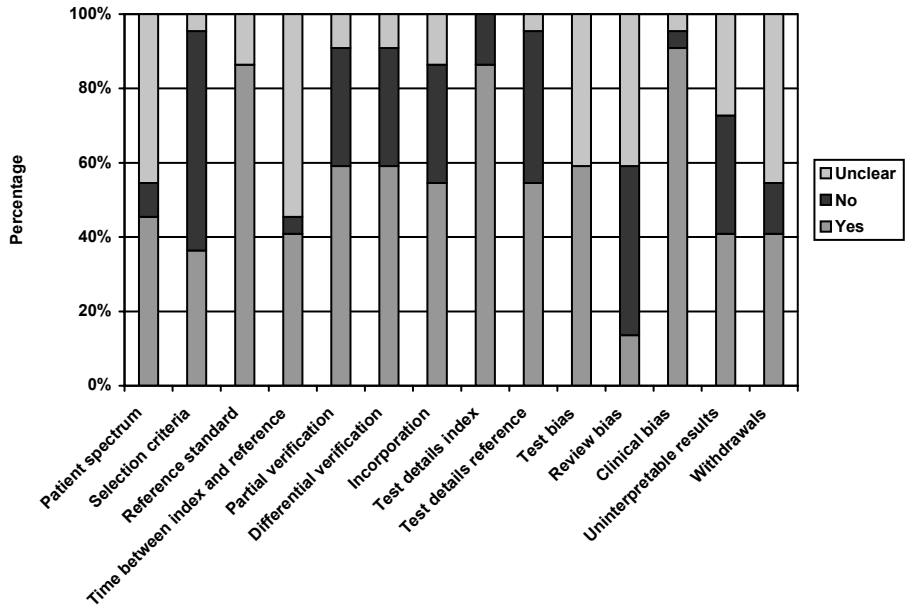

Figure 2 Results of quality assessment

Outcome

Table 3 provides 2x2 tables and dORs of all included studies. Figure 3 shows forest plots with the sensitivity and specificity of all parameters for which 2x2 contingency tables were available. It was not possible to numerically pool any of the studies because of clinical heterogeneity. The

studies selected patients in different ways, used different cut-off values for the tests, and/or examined different characteristics of imaging methods, like ultrasound or MRI.

Septic arthritis

Of the 11 SA studies, 8 evaluated laboratory and anamnestic parameters. Figure 3 shows that almost no parameter has both a high sensitivity and high specificity, except for CRP[7-9] with sensitivity ranging from 0.85-1.00 and specificity ranging from 0.72-0.93 (two cut-off values), studied in one high-quality study[7] and two low-quality study[8,9]. Some studies combined the information from laboratory and anamnestic parameters to produce clinical prediction rules (Table 3). The prediction rule of Kocher et al. in 1999[10] (high quality) (sens 0.31/spec 1.00) consisting of combinations of the predictors fever (Temp. >38.5°C,), ESR >40 mm/h, WBC > 12x10^9/L and not being able to bear weight on the hip, was later validated (retrospectively) by Luhmann et al.[11] (high quality), and prospectively by Caird et al.[7] (high quality) and Kocher et al.[12] (low quality). Using different outcome measures, Caird et al.[7] and Kocher et al.[12] conclude that the prediction rule is valid (Kocher et al. 2004[12]; 4 predictors: sens 0.16/spec 0.99). Caird et al.[7] add CRP to the rule (5 predictors: predicted probability=97.5). Luhmann et al.[11] disregard the rule of Kocher et al.[10] (PPV 0.59) and propose one constituting combinations of the predictors fever (Temp. > 38.5°C), WBC >12x10^9/L and prior visits (PPV 0.71).

Yang et al.[13] in a low-quality study evaluated two parameters on MRI to diagnose SA (sens 0.98 and 0.56/spec 0.71 and 1.00). Three low-quality studies[8,15415] evaluated effusion seen on ultrasound in the diagnosis of SA. However, because they used different definitions to define effusion it is not possible to compare these studies.

Transient Synovitis

Marchall et al.[16] retrospectively validated the value of ultrasound to diagnose TS (sens 0.95/ spec 0.80) in a low-quality study.

Legg-Calvé-Perthes' disease

Two high-quality studies investigated the diagnostic accuracy of ultrasound in LCPD[17,18], both studies were performed by the same research group. The first study[17] investigated the value of measuring the thickness of certain anatomical structures in the hip (sens 0.71/spec 0.99); second study[18] explored the value of the resistive index (sens 0.80/spec 0.71). Two high-quality studies evaluated MRI[19,20] showing high dORs; one of these studies[20] also evaluated radiographs (sens 0.58/spec 1.00). Most studies studied the diagnostic value of the bone scan in LCPD[21-27]with sensitivity ranging from 0.68 to 1.00 and specificity from 0.00 to 1.00, and with large confidence intervals. The studies were mostly of high quality but did not include many patients.

Table 3 Study outcomes

Index diagnosis / Source	**Test**	**TP**	**TN**	**FP**	**FN**	**Sensitivity (95%CI)**	**Specificity (95%CI)**	**Diagnostic Odds Ratio (95%CI)**	***Other outcome measure***
Septic arthritis (SA)									
Zamzam 2006	Ultrasound	51	61	7	8	0.86 (0.75 – 0.93)	0.90 (0.80-0.95)	55.55 (18.86-163.65)	
Yang 2006	MRI 1,5 Tesla								
	-Soft tissue signal intensity alteration and contrast enhancement.	16	35	14	2	0.89 (0.67-0.97)	0.71 (0.58-0.82)	20.00 (4.06-98.60)	
	-Bone marrow signal intensity alteration and contrast enhancement.	10	49	0	8	0.56 (0.33-0.75)	1.00 (0.93-1.00)	122.29 (6.54-2287.70)	
Caird 2006	Temp > 38.5 C	15	14	0	19	0.44 (0.29-0.61)	1.00 (0.78-1.00)	22.11 (1.22-402.13)	*Combinations of predictors;*
	ESR > 40 mm/hr	19	12	2	15	0.56 (0.39-0.71)	0.86 (0.60-0.96)	7.60 (1.47-39.29)	*Fever, non weight-bearing, ESR,*
	WBC count >12x10^9 /L	17	10	4	17	0.50 (0.34-0.66)	0.71 (0.45-0.88)	2.50 (0.65-9.55)	*WBC, CRP*
	CRP > 20 mg/L	29	10	4	5	0.85 (0.70-0.94)	0.72 (0.45-0.88)	14.50 (3.24-64.88)	*1 predictor PPV = 36.7*
	Refusal to bear weight	31	4	10	3	0.91 (0.77-0.97)	0.29 (0.12-0.55)	4.13 (0.79-21.70)	*2 predictors PPV = 62.4*
	Combinations*								*3 predictors PPV = 82.6*
									4 predictors PPV = 93.1
									5 predictors PPV = 97.5
Luhman 2004	Temp > 38.5 C	34	77	41	13	0.72 (0.58-0.83)	0.65 (0.56-0.73)	4.91 (2.34-10.33)	*Kocher PPV = 0.59*
	ESR > 40 mm/hr*								
	WBC count >12x10^9 /L*								*Combination: Fever, WBC>12,*
	Refusal to bear weight	38	37	81	9	0.81 (0.67-0.90)	0.31 (0.24-0.40)	1.93 (0.85-4.40)	*previous healthcare visit*
	Prior visits	30	65	53	17	0.64 (0.50-0.76)	0.56 (0.46-0.64)	2.16 (1.08-4.35)	*PPV = 0.71*
	Combinations*								

Table 3 Continued

Index diagnosis / Source	**Test**	**TP**	**TN**	**FP**	**FN**	**Sensitivity (95%CI)**	**Specificity (95%CI)**	**Diagnostic Odds Ratio (95%CI)**	***Other outcome measure***
Kocher 2004	Temp > 38.5 C* ESR > 40 mm/hr* WBC count >12x10^9 /L* Refusal to bear weight* Combinations*								*Combinations of predictors; Fever, non weight-bearing, ESR, WBC* *1 predictor sens 1.00, spec 0.26* *2 predictors sens 0.90, spec 0.68* *3 predictors sens 0.59, spec 0.89* *4 predictors sens 0.16, spec 0.99*
Jung 2003	T > 37.0 C ESR > 20 mm/hr ESR > 40 mm/hr CRP > 10 mg/l WBC > 11x10^9/L Combinations* Difference of joint space distance (>2mm) X-ray*	21 25 20 24 20	94 57 91 90 91	3 40 6 7 6	6 2 7 2 7	0.78 (0.59-0.89) 0.93 (0.76-0.98) 0.74 (0.55-0.87) 0.92 (0.76-0.98) 0.74 (0.55-0.87)	0.97 (0.91-0.99) 0.59 0.49-0.68) 0.94 (0.87-0.97) 0.93 (0.86-0.96) 0.94 (0.87-0.97)	109.67 (25.36-474.31) 17.81 (3.99-79.51) 43.33 (13.14-142.87) 154.29 (30.09-791.17) 43.33 (13.14-142.87)	*Combinations of predictors; Fever, ESR>20, WBC, CRP, difference in joint space>2mm* AUC = 0.99
Gordon2002	Effusion on ultrasound	18	26	32	2	0.90 (0.70-0.97)	0.45 (0.33-0.58)	7.31 (1.55-34.45)	

Index diagnosis / Source	**Test**	**TP**	**TN**	**FP**	**FN**	**Sensitivity (95%CI)**	**Specificity (95%CI)**	**Diagnostic Odds Ratio (95%CI)**	***Other outcome measure***
Kocher 1999	Temp > 38.5 C ESR > 40 mm/hr* WBC count >12x10^9 /L* CRP > 20 mg/L * Refusal to bear weight Effusion on X-ray Combinations*	67 78 63	79 56 53	7 30 33	15 4 19	0.82 (0.72-0.89) 0.95 (0.88-0.98) 0.77 (0.67-0.85)	0.92 (0.84-0.96) 0.65 (0.55-0.74) 0.62 (0.51-0.71)	50.41 (19.41-130.92) 36.40 (12.14-109.17) 5.33 (2.72-10.43)	*Combinations of predictors; Fever, non weight-bearing, ESR, WBC* *1 predictor sens 1.00, spec 0.22* *2 predictors sens 0.99, spec 0.77* *3 predictors sens 0.84, spec 0.95* *4 predictors sens 0.31, spec 1.00*

Table 3 Continued

Index diagnosis / Source	Test	TP	TN	FP	FN	Sensitivity (95%CI)	Specificity (95%CI)	Diagnostic Odds Ratio (95%CI)	*Other outcome measure*
Eich 1999	Temp > 38.0 C	7	72	9	1	0.88 (0.53-0.98)	0.89 (0.80-0.94)	56.00 (6.16-508.90)	
	WBC > age dependent	6	45	36	2	0.75 (0.41-0.93)	0.56 (0.45-0.66)	3.75 (0.71-19.71)	
	CRP > 10 mg/L	8	66	15	0	1.00 (0.68-1.00)	0.81 (0.72-0.88)	72.94 (3.99-1332.51)	
	CRP > 20 mg/L	8	72	9	0	1.00 (0.68-1.00)	0.89 (0.80-0.94)	129.74 (6.92-2432.68)	
	Joint effusion on ultrasound*								
	Radiographic findings*								
Taylor 1994	Temp > 38.0 C	17	385	33	4	0.81(0.60-0.92)	0.92 (0.89-0.94)	49.58 (15.77-155.93)	
	ESR > 20 mm/hr	19	327	39	2	0.90 (0.71-0.97)	0.89 (0.86-0.92)	79.65 (17.87-354.98)	
	Severe hip pain	13	370	48	8	0.62 (0.41-0.79)	0.89 (0.85-0.91)	12.53 (4.94-31.77)	
	Tenderness	18	346	72	3	0.86 (0.65-0.95)	0.83 (0.79-0.86)	28.83 (8.28-100.47)	
	Combinations*								
Del Beccaro 1992	Temp > 37.5	25	62	27	13	0.66 (0.50-0.79)	0.70 (0.59-0.78)	4.42 (1.97-9.91)	
	Temp > 38.0 C	17	76	13	21	0.45 (0.30-0.60)	0.85 (0.77-0.91)	4.73 (1.99-11.28)	
	ESR > 20 mm/hr	30	66	26	8	0.79 (0.64-0.89)	0.72 (0.62-0.80)	9.52 (3.86-23.47)	
	ESR > 30 mm/hr	27	80	12	11	0.71 (0.55-0.83)	0.78 (0.79-0.92)	16.36 (6.48-41.36)	
	WBCcount>15.000/ mm^3 *								
	Abnormal radiograph	32	51	38	6	0.84 (0.70-0.93)	0.57 (0.47-0.67)	7.16 (2.72-18.84)	
	Bands > 350/mm^3	19	63	21	17	0.53 (0.37-0.68)	0.75 (0.65-0.83)	3.35 (1.48-7.61)	
	(ESR > 20 a/o T > 37.5 C)	37	47	42	1	0.97 (0.87-1.00)	0.53 (0.43-0.63)	41.41 (5.44-315.07)	
Transient Synovitis (TS)									
Marchall 1987	Ultrasound	20	20	5	1	0.95 (0.77-0.99)	0.80 (0.61-0.91)	80.00 (8.56-747.49)	

Index diagnosis / Source	Test	TP	TN	FP	FN	Sensitivity (95%CI)	Specificity (95%CI)	Diagnostic Odds Ratio (95%CI)	*Other outcome measure*
Perthes (P)									
Robben 2000	Color doppler sonography resistive index >70	24	5	2	6	0.80 (0.63-0.91)	0.71 (0.36-0.92)	10.00 (1.54-64.75)	

Table 3 Continued

Index diagnosis / Source	**Test**	**TP**	**TN**	**FP**	**FN**	**Sensitivity (95%CI)**	**Specificity (95%CI)**	**Diagnostic Odds Ratio (95%CI)**	***Other outcome measure***
Robben 1998	Ultrasound : combination of thickness of - Anterior recess of joint capsule - Articular cartilage of the femoral head - Quadriceps muscle	15	122	1	6	0.71 (0.50-0.86)	0.99 (0.96-1.00)	305.00 (34.35-2708.58)	
Curic 1993	Bone Scan 99Tc .	15	0	20	0	1.00 (0.79-1.00)	0.00 (0.00-0.16)	0.76 (0.01-40.26)	
Von Rix 1992	MRT 1.5 Tesla*	10	21	5	2	0.83 (0.55-0.95)	0.81 (0.62-0.92)	21.00 (3.46-127.61)	
Goertzen 1991	MRT 1.0 Tesla Bone scan Radiograph	24 15 14	4 4 4	0 2 0	0 7 10	1.00 (0.86-1.00) 0.68(0.47-0.84) 0.58 (0.39-0.76)	1.00 (0.51-1.00) 0.67(0.30-0.90) 1.00 (0.51-1.00)	441.00 (7.71-25230.31) 4.29 (0.63-29.23) 12.43 (0.60-256.66)	
Wingstrand 1985	Scan 99m Tc	1	22	3	0	1.00 (0.21-1.00)	0.88 (0.70-0.96)	19.29 (0.65-573.82)	
Cavailloles 1985 **	Scan 99mTc					0.86	0.93		
Calver 1981	Scan 99m Tc	5	45	0	0	1.00 (0.57-1.00)	1.00 (0.92-1.00)	1001.00 (18.00-55675.45)	
Sutherland 1980	Scan 99m TC	45	79	4	1	0.98 (0.89-1.00)	0.95 (0.88-0.98)	888.75 (96.37-8196.66)	
Heyman 1980	99Tc-MPD	6	27	3	2	0.75 (0.41-0.93)	0.9 (0.74-0.96)	27.00 (3.67-198.69)	

* Not possible to construct 2x2 table

** and 1982 partly same data probably

Discussion

The present review has systematically analysed studies evaluating diagnostic tests used for children presenting with hip pain. The aim to determine the diagnostic value of tests used to diagnose SA, TS, LCPD and SCFE in children presenting with pain in the hip and/or a limp due to non-traumatic hip pathology was partly met. Unfortunately, no diagnostic studies on SCFE were found for this review. The secondary aim to extract some easily applicable parameters to help determine whether watchful waiting is justified or further testing is necessary, was not fulfilled. Very few studies have explored the value of easily applicable parameters. Only a few studies were conducted prospectively, which is important to avoid selection bias. In all studies, the patient groups were preselected and therefore not directly comparable with children presenting for the first time with pain in the hip or a limp. It remains uncertain, therefore, whether the laboratory values and clinical features tested in these preselected groups have the same diagnostic value in children presenting for the first time.

The differential diagnosis of non-traumatic acute hip pathology in children includes many more conditions than the four we chose to investigate here. To make the review more comprehensive we selected these conditions because of their incidence or seriousness.

Distinguishing SA from TS of the hip joint can be difficult but is of utmost importance. Early diagnosis and aggressive treatment of an infected hip can substantially reduce the risk of complications, such as septicemia and even death, avascular necrosis of the femoral head with severe destruction of the hip joint, growth arrest with leg length discrepancy, and possible osteoarthritis as a sequela, osteomyelitis or persistent hip pain[28] The diagnosis will not be missed in a child presenting with high fever, a toxic appearance and a very painful hip joint when moving. However, when children present in the early stages of the disease it is much less clear; for these latter cases it would help to know the value of anamnestic features, physical examination or simple laboratory tests and other minimally invasive tests, as opposed to the invasive and unpleasant gold standard - hip aspiration. Unfortunately, because no single clinical feature or laboratory test seems pathognomic for SA, researchers have considered combining parameters into clinical prediction rules.

To predict which child is at higher risk of SA and therefore needs to undergo hip aspiration Kocher et al.[10] proposed the first prediction rule in 1999. The rule included the presence of fever (Temp. >38.5°C), ESR >40 mm/h, WBC >12x109/L, and not being able to bear weight on the hip; this later validated by Caird et al.[I], Luhman et al.[11] and Kocher et al.[12]. Caird et al.[7] added CRP to the rule, increasing its accuracy; unfortunately this was not possible in the other validation studies. CRP seems a promising parameter in this diagnosis.[7-9] Jung et al.[9] propose another prediction rule consisting of fever (Temp. > 37.0°C), ESR >20 mm/h, WBC > 11x109/L, and difference in joint space >2 mm; unfortunately their rule is not yet validated. Meanwhile, the most useful clinical tool remains the clinical decision rule by Kocher et al.[10], while CRP measurement might have additional benefit as proposed by Caird et al. [7]. However, sensitivity remains very

low, which is a particular problem in primary care. The rule by Caird et al. has a PPV of 62% meaning that, with this rule, we still miss more than a third of the children presenting with SA. This can be fatal, and is therefore unacceptable.

Regrettably only a few studies have tested the diagnostic accuracy of ultrasound in the differentiation between the different hip conditions. This is unfortunate because it is a non-invasive test and is often used in clinical practice. However, its discriminatory power is not well established. Most studies evaluating ultrasound evaluated the presence of effusion, which is not specific for any of the conditions in the differential diagnosis of hip pain in children. Perhaps it might be in combination with other investigated parameters, such as CRP or fever. Also, most studies used different definitions to define effusion. Robben et al.[17,18] prospectively studied a few promising parameters on ultrasound to diagnose LCPD; these tests had relatively high dORs and the studies were of high methodological quality. These results are not yet validated in other patient groups, but hopefully will be explored in the future.

Two high-quality prospective studies[19,20] investigated the value of MRI in diagnosing LCPD, showing high dORs. Although almost all studies use radiographs in their investigations (some as index test for LCPD, some as verification method for LCPD, and some to exclude participants with LCPD features on radiography in SA/TS studies) no study could be found that shows the diagnostic value of radiographs at different stages in the disease.
While it is known that radiographic changes indicating LCPD are not always present in the beginning of this disease (and it is recommended to repeat this investigation after some time), no studies have investigated after what length of time the first symptoms of these changes occur. Most diagnostic studies in LCPD were focused on bone scanning[19,21-27]; a procedure in which the child is exposed to radiation. The diagnostic accuracy of bone scanning seems relatively high, but the methodological quality of the studies differs. Most of these studies were retrospective and included small numbers of patients. Therefore, it may be preferable to use the less invasive tests, especially as the discussion as to whether and when to operate on these children is still ongoing.

Conclusion

In differentiating between SA and TS the most helpful tool, albeit limited, is still the clinical prediction rule of Kocher et al.[10]; CRP adds more diagnostic certainty to this rule.[7-9] Although ultrasound is commonly used, this non-invasive diagnostic tool needs further investigation to establish its diagnostic value. No studies have evaluated radiographs as a diagnostic tool at the different stages of LCPD. The bone scan and MRI have high sensitivity and specificity, but the latter method seems preferable.

Case

Since our young patient is still unwell, it is recommended to measure his temperature and ESR, WBC and CRP again to differentiate between TS and SA. The boy is slightly too young for SCFE. The ESR, WBC and CRP proved to be normal, making the PPV for SA low enough to justify TS as the first working hypothesis, and to start a watchful waiting policy. Also, to differentiate between TS and LCPD, the time period can initially be used. However, the present review did not provide an answer regarding how much time is involved. If the symptoms do not diminish after one week, either radiographic tests can be made (although not very sensitive), or an MRI scan (more expensive/less accessible, but with higher sensitivity) can be made to exclude LCPD. In the future, after additional high-quality studies, we might be able to make a diagnosis using ultrasound. Unfortunately, at present there is no valid parameter on ultrasound that allows to differentiate between the different conditions.

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Appendix Quadas

	Representative spectrum of patients	Selection criteria	Reference standard correct	Time interval between index and reference test	Whole sample reference test	Same reference test regardless of index test result?	Reference test independent of index test	Descrpiption of index test	Description of reference test	Interpretation index test blinded from reference test?	Interpretation reference test blinded from index test?	Clinical information	Uninterpretable/ intermediate test results reported?	withrawals
Septic arthritis (SA)														
Zamzam 2006	N	N	U	N	N	N	N	Y	N	Y	U	Y	N	N
Yang 2006	Y	N	Y	U	N	N	U	Y	N	U	N	N	N	U
Caird 2006	N	N	Y	U	Y	Y	Y	Y	Y	U	N	Y	Y	Y
Luhman 2004	U	N	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y
Kocher 2004	Y	U	Y	U	U	Y	Y	Y	Y	U	N	Y	N	Y
Jung 2003	U	Y	Y	U	N	N	Y	Y	Y	U	U	Y	U	U
Gordon 2002	Y	N	Y	U	Y	N	N	N	N	Y	N	Y	N	N
Kocher 1999	U	Y	Y	U	N	Y	Y	N	Y	Y	U	Y	N	Y
Eich 1999	Y	Y	Y	U	N	N	Y	Y	Y	Y	N	Y	U	U
Taylor 1994	Y	Y	U	U	N	N	N	N	N	U	N	Y	N	N
Del Beccaro 1992	U	Y	Y	Y	N	U	Y	Y	Y	Y	N	Y	U	U

Appendix Continued

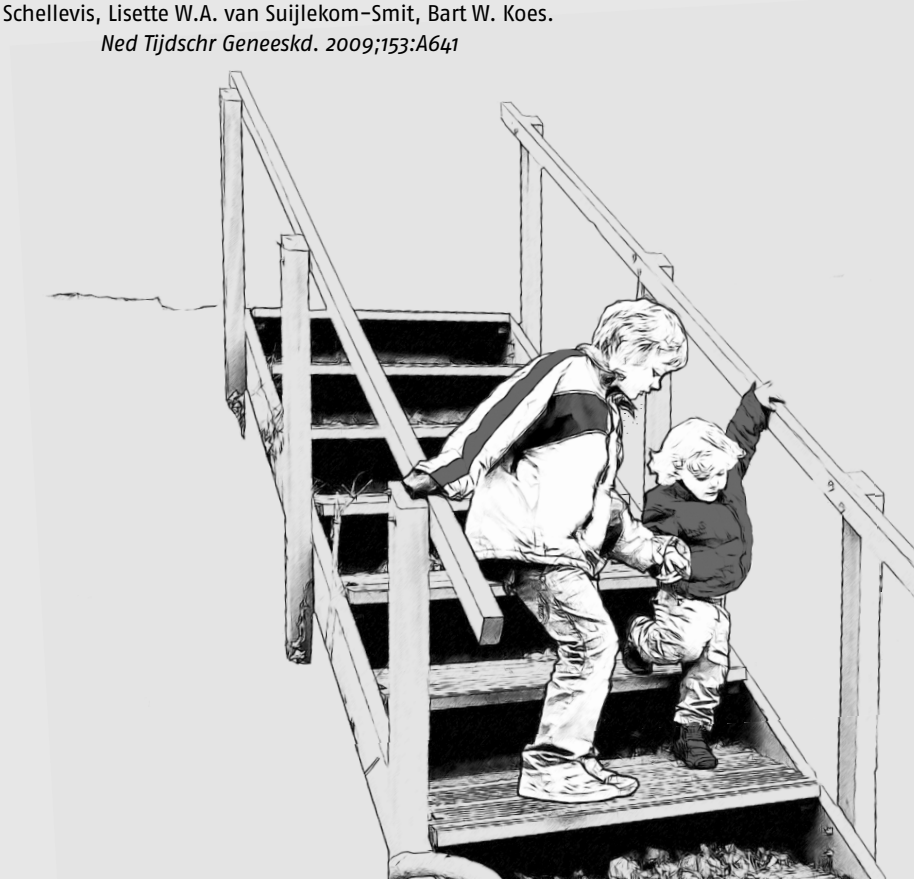
	Representative spectrum of patients	Selection criteria	Reference standard correct	Time interval between index and reference test	Whole sample reference test	Same reference test regardless of index test result?	Reference test independent of index test	Descrpiption of index test	Description of reference test	Interpretation index test blinded from reference test?	Interpretation reference test blinded from index test?	Clinical information	Uninterpretable/ intermediate test results reported?	withrawals
Transient Synovitis (TS)														
Marchall 1987	U	N	Y	U	Y	N	N	Y	N	Y	N	Y	U	U
Perthes (P)														
Robben 2000	Y	Y	Y	Y	U	Y	Y	Y	U	Y	U	Y	U	U
Robben 1998	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Curic 1993	U	N	Y	U	Y	Y	N	Y	N	U	U	U	Y	Y
Von Rix 1992	U	N	Y	Y	Y	Y	Y	Y	Y	U	U	Y	Y	U
Goertzen 1991	U	N	Y	Y	Y	Y	N	Y	Y	U	U	Y	Y	Y
Wingstrand 1985	U	N	Y	Y	Y	Y	Y	Y	N	Y	U	Y	N	Y
Cavailloles 1985	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U
Calver 1981	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sutherland 1980	Y	N	Y	U	Y	U	N	Y	N	Y	N	Y	U	U
Heyman 1980	U	N	U	U	Y	Y	U	Y	N	U	U	Y	Y	U

CHAPTER 5

Musculoskeletal problems in overweight and obese children

Musculoskeletal problems in overweight and obese children.
Krul M, van der Wouden JC, Schellevis FG, van Suijlekom-Smit LW, Koes BW.
Ann Fam Med. 2009 Jul-Aug;7(4):352-6.

Klachten van het bewegingsapparaat bij kinderen met overgewicht
Marjolein Krul, Johannes C. van der Wouden, François G. Schellevis, Lisette W.A. van Suijlekom-Smit, Bart W. Koes.
Ned Tijdschr Geneeskd. 2009;153:A641



Abstract

Introduction Since the obesity epidemic in children is spreading at alarming rates. Musculoskeletal problems can influence physical activity. We compared the frequency of musculoskeletal problems in overweight and obese children to that in children with normal weight.

Methods We performed a cross-sectional database and face-to-face interview study that included 2459 children aged 2-17 years from Dutch Family Practice. We collected self reported height and weight (BMI), self reported musculoskeletal problems in the 2 weeks prior to the interview, Family Physician consultations for musculoskeletal problems in one year and age (two age groups were analyzed; 2-11 years and 12-17 years, because of the proxy interview in the youngest age group). We calculated Odds Ratios (OR) and 95% Confidence Intervals (CI) for musculoskeletal problems in overweight and obese children, compared to normal weight children.

Results Overweight and obese children in both age groups (2-11 years and 12-17 years) reported significantly more musculoskeletal problems; OR (95%CI) 1.86 (1.18-2.93) and 1.69 (1.08-2.65), than normal weight children. The total group of children with overweight and obesity reported more lower extremity problems, than the normal weight children; OR 1.62 (95%CI 1.09-2.41), they reported more ankle and foot problems than children with normal weight; OR 1.92 (95%CI 1.15-3.20). Overweight and obese children aged 12-17 years consulted the FP more often with lower extremity problems than the normal weight children; OR 1.92 (95%CI 1.05-3.51).

Conclusion This study shows that overweight and obese children more frequently experience musculoskeletal problems, than normal weight children.

Introduction

Childhood obesity is a serious health problem. The obesity epidemic is spreading in alarming rates in children [1]. Currently about 16% of the children in Europe are overweight, and 8% are obese [2]. Obesity associated problems and diseases decrease the quality of life and life span. Many studies have shown that overweight children are more likely to become overweight adults than their normal weight peers [3-7]. Furthermore children may also be more vulnerable to specific obesity related health problems (such as hypertension, hepatic steatosis, hyperandrogenism and pseudoacromegaly) [8] because their bodies are growing and developing.
Although adult obesity has been associated with a higher prevalence of musculoskeletal disorders, primarily affecting the lower limb [9-13], comparative data in children is scarce. Some musculoskeletal disorders that are unique to childhood such as slipped capital femoral epiphysis [14] and tibia vara (Blount's disease) [15] have retrospectively been associated with excess weight. Few studies have quantified the prevalence of musculoskeletal problems in overweight and obese children [16-19]. Although these few studies imply that childhood obesity may predispose children to musculoskeletal problems, convincing empirical verification is currently lacking.
In our present research we use the results of a large survey in Dutch family practice performed in 2001 and aim to answer the following questions:

- Do overweight and obese children report more (lower extremity) musculoskeletal problems in daily life than their normal-weight peers?
- Do overweight and obese children seek help for (lower extremity) musculoskeletal problems more often than their normal-weight peers?

Methods

We analyzed data from the second Dutch national survey of family practice (NS2), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. The survey included a representative sample of the Dutch population; for further details see the article by Westert et al.[20]. This national survey consisted of morbidity registration by family physicians and face-to-face health interviews conducted in Dutch language with a randomly selected sample of the listed patient population. Interview and morbidity data were linked and used for the present study.

Interview

An all age computer generated sample of 150 registered patients per participating full-time FP was invited to participate in an elaborate, face-to-face, multiple choice health interview, until the target number of 80 patients per FP had been reached. For non-responders, attempts to

contact, (when possible) reason not to participate, sexe, age and zip code were documented. Trained interviewers performed the interviews and the interviews were evenly distributed among 4 consecutive 3-month periods to adjust for seasonal fluctuations. Items used for this study included age, self reported height and weight and self reported musculoskeletal symptoms during the previous two weeks. If children were younger than 12 years, a proxy interview was carried out with a parent. The information provided by the parents will in the article be reported as if it were information provided by the children themselves, to increase readability.

Morbidity registration

Morbidity data on the interviewed children was derived from the electronic medical records (EMR). The FPs registered all health problems presented within a consultation, and coded the diagnosis using the International Classification of Primary Care (ICPC). This survey was episode orientated, meaning that different consultations concerning the same health problem were clustered into one disease episode. Baseline characteristics (such as age and gender) were derived from patient records.

Overweight and obesity

The body mass index (BMI) was used as a measure of overweight and obesity in the children [21], and was based on self-reported weight and height. A standard developed for age specific overweight and obesity BMI cut-off points in Dutch children was used to determine the prevalence of overweight and obesity in the study population [22]. These cut-off points are almost identical to the recommended worldwide standard definition of overweight and obesity [23].

Study population

Interview data and corresponding FP's morbidity registration data of the 2-17 year old children were analyzed. Only Dutch natives were included to reduce selection bias related to language and enhance compatibility with BMI cut-off values that had been developed for native Dutch children. Children under the age of 2 years were excluded because obesity is not defined for this group. Among 2719 eligible, 2459 (90%) with height and weight data were analyzed. In order to compensate for differences between registration periods per practice, a weighting factor was applied. Children of normal weight and children with overweight and obesity contributed equal amounts of follow-up time.

Analysis

Using age- and sex specific BMI cut-off value curves for Dutch native children [22] the children were divided into three groups; normal weight, overweight and obese children. Because numbers were too small in the overweight and obese group to accurately assess dose-effect relationships, we chose analyze overweight and obese children as one group. We have calculated ORs and 95% CIs comparing the overweight and obese children to the normal weight children. ORs with a 95% CI not including one were considered significant. T-tests and chi-square analyses, as appropriate, were used to examine differences between these two groups. Significance was set at $p < .05$. We distinguished two age groups, namely children younger and older than 12 years of age, because of the proxy interview with children younger than 12 years. We calculated Mantel-Haenszel ORs to assess possible clustering of patients within physician practices. Analyses were conducted using SPSS 15.0.

Ethical approval

The study was carried out according to Dutch legislation on privacy. The Dutch Data Protection Authority approved the privacy regulation of the study. According to Dutch legislation, obtaining informed consent is not obligatory for observational studies.

Results

Participant characteristics

In total 2459 children were included in the analysis, 319 (13.0%) were overweight or obese (219 (8.9%) and 100 (4.1%) children respectively). There was no significant difference between the children with normal weight and overweight & obese children, in mean age or in the distribution of males and females, within the age subgroups. Clustering within physician practices did not affect our outcome since Mantel-Haenszel ORs were comparable to crude ORs.

Self-reported musculoskeletal problems

Self-reported musculoskeletal problems are shown in Table 1. Overweight and obese children in both age groups (2-11 years and 12-17 years) reported significantly more musculoskeletal problems in daily life, than normal weight children; respectively OR 1.86 (95%CI 1.18-2.93) and OR 1.69 (95%CI 1.08-2.65). Children with overweight or obesity aged 2-11 years, reported neck and back pain more often than the children in that age category without overweight; OR 2.60 (95%CI 1.30-5.19). The total group of children with overweight and obesity reported more

Table 1 Self-reported musculoskeletal problems in children with and without overweight or obesity. *

	Children without overweight % (n) *Total group n=2140* *Subgroup 2-11 years n=1374* *Subgroup 12-17 years n=766*	**Overweight and obese children % (n)** *Total group n=319* **Subgroup 2-11 years n=234** *Subgroup 12-17 years n=85*	**OR (95%CI)** *(bold: p<0.05)*
Musculoskeletal problems			
All ages	17.7% (379)	21.9% (70)	1.31 (0.98-1.74)
2-11 years	6.6% (90)	11.5% (27)	**1.86 (1.18-2.93)**
12-17 years	37.7% (289)	50.6% (43)	**1.69 (1.08-2.65)**
Neck and back problems			
All ages	9.6% (206)	10.7% (33)	1.12 (0.76-1.66)
2-11 years	2.0% (28)	5.1% (12)	**2.60 (1.30-5.19)**
12-17 years	23.2% (178)	25.9% (22)	1.15 (0.69-1.93)
Upper extremity problems			
All ages	1.2% (26)	1.3% (4)	1.03 (0.36-2.98)
2-11 years	0.4% (5)	0	NA
12-17 years	2.7% (21)	4.7% 4	1.75 (0.59-5.23)
Lower extremity problems			
All ages	6.9% (147)	10.7% (33)	**1.62 (1.09-2.41)**
2-11 years	4.1% (57)	6.8% (16)	1.70 (0.96-3.01)
12-17 years	12.4% (90)	20.0% (17)	1.77 (0.99-3.14)
Hip/knee problems			
All ages	3.5% (75)	4.1% (13)	1.17 (0.64-2.13).
2-11 years	1.8% (25)	1.7% (4)	0.94 (0.32-2.72)
12-17 years	6.5% (50)	10.5% (9)	1.70 (0.80-3.58)
Ankle/foot problems			
Total	3.4% (72)	6.3% (20)	**1.92 (1.15-3.2)**
2-11 years	2.4% (32)	5.1% (12)	**2.27 (1.15-4.47)**
12-17 years	5.5% (40)	10.0% (8)	1.89 (0.85-4.17)

* Positive response to survey question: In the last two weeks did you experience any xxx problems?
** Reference group (OR 1.0) for each row is normal weight children.

lower extremity problems, than the total group of children with normal weight; OR 1.62 (95%CI 1.09-2.41). We were able to split these lower extremity problems in a subgroup of hip and knee problems and a subgroup of ankle and foot problems. Ankle and foot problems are significantly more common in the total group and the youngest age group of overweight and obese children compared to these groups of normal weight children OR 1.92 (95%CI 1.15-3.20) and OR 2.27 (95%CI 1.15-4.47). Rates of self reported upper extremity problems did not differ between overweight and obese children versus normal weight children for either age subgroup.

Musculoskeletal problems presented in family practice

Episodes of health problems derived from the EMR are shown in Table 2. Among children aged 12-17 years, overweight and obese children consulted the FP more frequently with lower extremity problems: OR 1.92 (95% CI 1.05-3.51). Regarding upper extremity problems and neck and back problems there was no difference in consultation rate between children without overweight and the overweight and obese children.

Table 2 Muskuloskeletal problems presented to the family physician in children with and without overweight and obesity. *

	Children without overweight % (n) *Total group N=2140* *Subgroup 2-11 years N=1374* *Subgroup 12-17 years N=766*	**Overweight/obese children % (n)** *Total group N=319* *Subgroup 2-11 years N=234* *Subgroup 12-17 years N=85*	**OR (95%CI)** *(bold: p <0.05)*
All musculoskeletal problems			
All ages	14.1% (301)	16.0% (51)	1.16 (0.84-1.61)
2-11	9.5% (130)	10.3% (24)	1.09 (0.69-1.73)
12-17	22.3% (171)	31.8% (27)	1.62 (1.00-2.64)
Neck and back problems			
All ages	2.1% (45)	3.1% (10)	1.51 (0.75-3.02)
2-11	1.1% (15)	1.3% (3)	1.18 (0.34-4.10)
12-17	3.9% (30)	8.2% (7)	2.20 (0.94-5.18)
Upper extremity problems			
All ages	1.8% (38)	2.2% (7)	1.24 (0.55-2.80)
2-11	1.3% (18)	1.3% (3)	0.98 (0.29-3.35)
12-17	2.6% (20)	4.7% (4)	1.84 (0.62-5.52)
Lower extremity problems			
All ages	6.1% (130)	7.8% (25)	1.32 (0.84-2.10)
2-11	3.9% (53)	4.3% (10)	1.11 (0.56-2.22)
12-17	10.1% (77)	17.6% (15)	**1.92 (1.05-3.51)**

* Illness episodes recorded over prior 12 months recorded in family physician electronic medical record
** Reference group (OR 1.0) for each row is normal weight children.

Discussion

In this large study of children aged 2-17 years seen in Dutch general practice, we found overweight and obese children to report musculoskeletal problems and lower extremity problems more frequently in daily life than their normal weight peers. Overweight and obese children

aged 12-17 years were also more frequently seen by their FP for lower extremity problems than their peers with normal weight.

Ankle and foot problems are significantly more common in overweight and obese children compared to normal weight children in our study. A number of studies have focused on the foot structure of overweight and obese children [24-27] showing that these children have increased foot length and width and decreased navicular height [24], lower medial arch height [25,26] and higher plantar pressure [27] compared to normal weight children. It therefore seems reasonable to assume that these structural problems in the feet of the overweight and obese children are correlated with the reported ankle and foot problems. This has been postulated before [27,28], but unfortunately none of the foregoing studies was designed in such a way that they could verify this assumption and although our study adds credibility, further investigation is necessary to confirm whether or not there is a causal relationship.

Although the absolute difference may not be large, de Sa Pinto et al.[19] have also reported more back pain among their obese children aged 7-14 years. In accordance with the same report, we found no differences in the occurrence of upper extremity problems between overweight and obese and normal weight children.

Overweight and obese children experience more often musculoskeletal problems. The association between a low fitness level and excess body weight has been described [29,30]. Normal weight children with musculoskeletal problems are possibly less active and can therefore become overweight, musculoskeletal problems can prevent overweight and obese patients from successfully using exercise to reduce bodyweight. We hypothesize that this may lead to a vicious circle where being overweight, musculoskeletal problems and a low fitness level reinforce each other. It is therefore important to be aware of the higher occurrence of musculoskeletal problems in these children, to provide adequate management of their problems and give healthy life style advice pro-actively.

Limitations

We used self reported weight and height to determine the BMI, which may have introduced misclassification. However, we believe that the possible misclassification is limited, because we used face-to-face interviews, which promote validity of answers [31]. Furthermore, people will tend to underestimate weight and overestimate height, resulting in an underestimation of the number of overweight and obese children. Therefore it is not likely that the possible misclassification will have affected the positive relation found in this study. This is supported by the study of Strauss, comparing self-reported with actual weight and height. The study showed

small differences in weight, while it did not have an impact in the assessment of obesity related morbidity [32].

Although there was a 35% non-response for the interview, we argue that selection bias was limited. Our participants were sampled independent of general practice consultation and the children in our sample, compared with data from Statistics Netherlands, were representative (on sexe, age and region) for the Dutch childhood population. In approximately 10% data on height and/or weight was missing, we believe this is random, because the health interview was very elaborate and covered many more topics than obesity and/or musculoskeletal problems.

Conclusion

This study shows that overweight and obese children more frequently report musculoskeletal problems in daily life than children with a normal weight. Next to more self reported musculoskeletal problems in the overweight and obese children, we also see that overweight and obese children older than 12 years more frequently seek medical help for their lower extremity problems than their normal weight peers.

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CHAPTER 6

The epidemiology of sports injuries in children in Dutch general practice

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Submitted

Abstract

Introduction Physical activity is important to children's development. Inevitably, accidents and injuries occur during physical activity. Children are at greater risk of injury than adults and are susceptible to unique injuries. We therefore wanted to provide an overview of the occurrence and management of sports injuries in children by the family practitioner.

Methods Data (2005-2007) from a national morbidity register were used. For children aged 5-17 years, FPs (from 22 of 45 representative practices) who registered all sports injuries, filled in a questionnaire about the nature, management and circumstances of the injury.

Results A total of 724 sports injuries were recorded. Most injuries occurred during soccer (41%), and among boys aged 15 years. Of all sports injuries, 56% occurred during organized sports activities, 23% occurred at school, 63% was a lower extremity injury, 20% was an injury of the knee, and 21% was an injury of the ankle. Sprains and strains were the most common injuries (53%), followed by wounds (23%). Sprains and strains were mostly treated with bandage or tape, and the children advised to rest or adapt their sports activities. Most injuries were managed in primary care. Only 21% was referred to a hospital, usually to the radiology department (15% of all sports injuries).

Conclusions In this study population, most injuries were managed with the advice to rest and to adapt sports activities. Prevention strategies could focus on possibilities to decrease injuries during organized sports and physical exercise at school.

Introduction

Physical activity is important to children's development as it enhances their physical, psychomotoric and intellectual attainments,[1-3] promotes a healthier lifestyle, and may prevent obesity. Inevitably, accidents and injuries occur during physical activity. Children are at greater risk of injury than adults because their coordination is not yet fully developed, i.e. they have a longer reaction time and their risk assessment is less mature.[1,4-6] Children are not only at greater risk, but are also susceptible to unique injuries as their bodies are still growing and developing.[7] For example, their immature skeleton is less able to cope with repetitive biomechanical stress, which can cause overuse injuries at the sites of rapid musculoskeletal development.[7]
Sports injuries (acute ones, or due to repetitive biomechanical stress) can result in an immediate health burden, and/or lead to long-term musculoskeletal consequences that may reduce levels of physical activity later in life. Sports injury is a frequent reason to seek help; however, since most are not severe enough to require a medical specialist, the majority are managed in primary care.[8] Due to lack of reports on the presentation or treatment of sports injuries in children in primary care, it is unknown which type of sports injuries children present to the family practitioner (FP) and how they are dealt with. This type of information is needed to establish the magnitude/frequency of the problem, and is useful when developing training/educational programs for FPs, and defining targets for prevention programs.
Therefore, this study provides an overview of the occurrence and management of sports injuries in children in family practice, using longitudinal data from Dutch family practice.

Methods

Data from the Continuous Morbidity Registration (CMR) in the Netherlands were used. The CMR consists of 45 FP practices (190,392 listed patients) throughout the country, which together are representative for the Dutch population by gender, age, geographical distribution and population density. Since 1970, FPs record data about diseases, events and treatments, which are not part of the routine registration in the electronic medical records.[9] The list of diseases, events and treatments about which data are recorded is revised annually. In the Netherlands, all inhabitants are listed in a family practice and the FP acts as a gatekeeper for specialized medical care. For the present study, data of children aged 5-17 years were used. During the 3-year study period (2005-2007) the participating FPs registered data on all sports injuries presented during daily practice as well as during out-of-hour services. For each registered sports injury the participating FPs filled in a short questionnaire, registering when the injury occurred, during which type of sports, whether it was during organized or non-organized sport, which body part was injured, what kind of injury occurred and how, whether it was an acute or overuse injury,

if the patient had been seen for this injury before, if the patient was referred, if and how the FP treated the injury and, if so, what advice was given by the FP during the present consultation. After a quality check, in which we compared the number of sports injuries registered with the filled-in questionnaires, data of 22 FPs proved to be of sufficient quality for at least 1 of the 3 study years. The patients listed in these 22 practices are still representative for the Dutch population when compared with national data (provided by Statistics Netherlands) regarding age, gender, regional distribution and population density. However, there was a slight over-representation of FPs in urbanized regions.

Data were analyzed using Excel and the statistical package SPSS 15.0. The injuries were categorized to enable valid comparison with other studies and sources. Descriptive statistics were applied and, when appropriate, Chi-square tests were applied.

Results

Patient characteristics

The 22 FPs recorded data on 724 sports injuries in children aged 5-17 years. Figure 1 shows the age distribution of the injured children. The number of injuries increased up to age 15 years, and then decreased. In the total group, 58% of the injuries occurred in boys. Dividing the children into three age groups shows that in children older than 10 years, boys had more injuries than girls (Figure 2). In the age group 5-9 years the male/female ratio was 1: 1.1 (ns), and in the groups aged 10-14 and 15-17 years it was 1.5:1 ($p<0.05$).

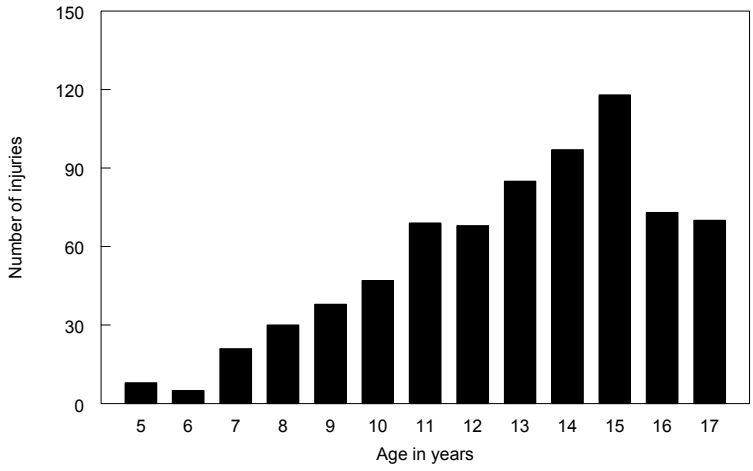

Figure 1 Number of sports injuries in children aged 5 to 17 years

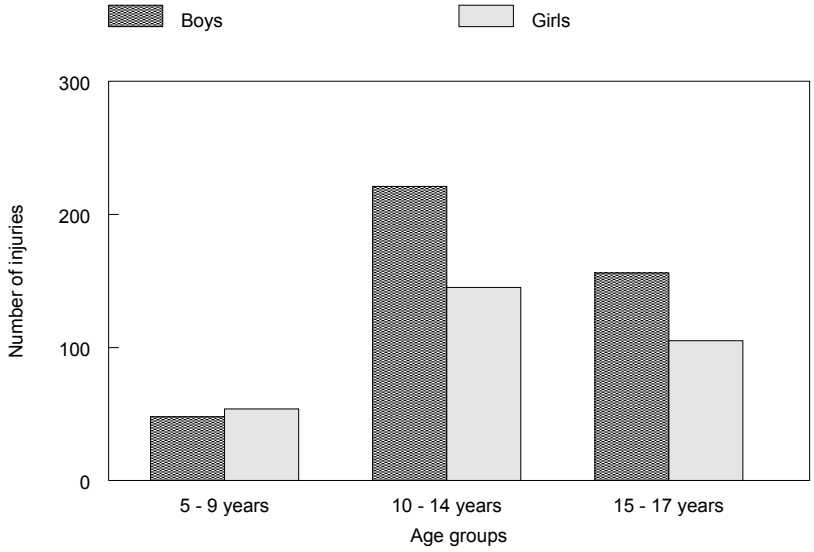

Figure 2 Number of sports injuries per age group and gender

Sports involved and injury onset

Table 1 shows the distribution of injuries in those sports in which 2% or more of all sports injuries occurred, due to acute or overuse injuries (data on 25 injuries are missing due to unknown type of sport or injury). Most injuries (41%) occurred during soccer, followed by gymnastics (13%).

Table 1 Percentage of sports injuries in children aged 5-17 years by type of sport and type of injury.

Type of sport	All injuries		Acute injuries		Overuse injuries	
	N	*%**	*N*	*%***	*N*	*%***
Soccer	290	41	243	84	47	16
Gymnastics	90	13	85	94	5	6
Hockey	33	5	28	85	5	15
Volleyball	30	4	25	83	5	17
Horseback riding	24	3	23	96	1	4
Handball	21	3	12	57	9	43
Basketball	20	3	17	85	3	15
Ice skating	17	2	15	88	2	12
Skeelering	15	2	15	100	-	-
Judo/jiu-jitsu	15	2	13	87	2	13
Skiing	12	2	11	92	1	8
Snowboarding	11	2	9	82	2	18
Other sports	121	17	81	67	40	33
Total	*699*	*100*	*577*	*83*	*122*	*17*

* % of total number of injuries among children in this study

** % of all injuries per category of sport

Table 1 shows that in all specific sports (except for handball) most injuries were acute (range 82-100%), compared to 67% in the category 'other sports'. Of all injuries, about 56% occurred during organized sports (clubs/organisations), and 23% occurred at school (data not shown).

Location and type of injury

Table 2 shows the location and type of sports injuries (data on 17 injuries are missing due to unknown location or type of injury). Of all sports injuries, the majority (63%) was a lower extremity injury: 20% was an injury of the knee and 21% of the ankle. The injuries of the ankle were mainly sprains and strains, while in the knee they were mainly wounds and cartilage problems. Sprains and strains were the most common sports injuries (53%), followed by wounds (23%). Most of the sprains and strains were located in the lower extremities, while most fractures and dislocations were of the upper extremities.

Table 2 Sports injuries in children aged 5-17 years by location and type of injury.

	Wound		**Overuse complaints**		**Sprains & strains**		**Fracture/ dislocation**		**Cartilage injury/ irritation**		**Brain concussion**		**Other**		**Total**	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Head	18	2.5	-	-	10	1.4	1	0.1	1	0.1	6	0.8	4	0.6	40	5.7
Trunk	16	2.3	-	-	20	2.8	-	-	-	-	-	-	6	0.8	42	5.9
Upper extremities	41	5.8	7	1.0	88	12.4	38	5.4	-	-	-	-	9	1.3	183	25.9
Lower extremities	87	12.3	22	3.1	262	37.1	14	2.0	16	2.3	-	-	41	5.8	442	62.5
knee	*31*	*4.4*	*8*	*1.1*	*65*	*9.1*	*5*	*0.7*	*15*	*2.1*	-	-	*19*	*2.7*	*143*	*20.2*
ankle	*9*	*1.3*	*1*	*0.1*	*128*	*18.1*	*2*	*0.3*	*1*	*0.1*	-	-	*6*	*0.8*	*147*	*20.8*
Total	162	22.9	29	4.0	380	53.0	53	7.5	17	2.4	6	0.8	60	8.5	707	100

Management

Table 3 shows the initial treatment of the different types of sports injuries by the FP. Most wounds (80%) were managed by the FPs themselves (no referral was made); 60% of these wounds required no treatment and only advice was given. The highest referral rate (39%) to the physiotherapist was among the children with overuse complaints; of these latter children, 48% also received advice to adapt their sport activities, 23% to take rest, and only 7% were prescribed medication. The most common injuries (sprains and strains) were mostly treated with bandage or tape (27%) and the children were advised to rest (27%), or to adapt their sports activities (25%). Most injuries were managed in primary care; 20% of the children were referred to a hospital, usually to the radiology department (15% of all sports injuries).

Table 3 Management of sports injuries in children aged 5-17 years per consultation by type of injury.

	Wound		Overuse symptoms		Sprains & strains		Fracture/ dislocation		Cartilage injury/ irritation		Brain concussion		Other		Totaal	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Treatment																
No treatment	98	60	22	71	184	48	16	28	12	71	3	43	36	56	371	51
Bandage/tape	19	11	1	3	103	27	7	12	-	-	-	-	4	6	134	19
Medication	8	5	2	7	20	5	1	2	-	-	-	-	6	9	37	5
Other/unknown	39	24	6	19	76	20	33	58	5	29	4	57	19	29	182	25
Total	**164**	**100**	**31**	**100**	**383**	**100**	**57**	**100**	**17**	**100**	**7**	**100**	**65**	**100**	**724**	**100**
Advice																
Rest	31	19	7	23	104	27	15	26	4	23	4	57	13	20	178	25
ICE (ice,compression,elevation)	12	7	1	3	32	8	4	7	-	-	-	-	3	5	52	7
Adapted sporting	38	23	15	48	94	25	1	2	9	53	1	14	14	21	172	24
Watchful waiting	55	34	2	7	57	15	4	7	2	12	2	29	13	20	135	19
Other/unknown	28	17	6	19	96	25	33	58	2	12			22	34	187	25
Total	**164**	**100**	**31**	**100**	**383**	**100**	**57**	**100**	**17**	**100**	**7**	**100**	**65**	**100**	**724**	**100**
Referral																
No referral	131	80	17	55	231	60	7	12	11	64	7	100	33	51	437	61
Check up by own GP	3	2	1	3	10	3	-	-	-		-	-	-	-	14	2
Physiotherapist	3	2	12	39	31	8	3	5	2	12	-	-	9	14	60	8
Hospital	12	7	-	-	80	21	39	69	2	12	-	-	14	21	147	20
Radiology department	*9*	*5*	-	-	*66*	*17*	*25*	*44*	*1*	*6*	-	-	*8*	*12*	*109*	*15*
Emergency department	*3*	*2*	-	-	*8*	*2*	*11*	*19*	-	-	-	-	*4*	*6*	*26*	*4*
Outpatient ward	-	-	-	-	*6*	*2*	*3*	*5*	*1*	*6*	-	-	*2*	*3*	*12*	*2*
Other/unknown	15	9	1	3	31	8	8	14	2	12	-	-	9	14	66	9
Total	**164**	**100**	**31**	**100**	**383**	**100**	**57**	**100**	**17**	**100**	**7**	**100**	**65**	**100**	**724**	**100**

Discussion

This study provides an overview of sports injuries in children presenting in family practice. Few studies have provided data on sports injuries in primary care[10-13] and none provided data on sports injuries among children in primary care. Most studies derived their data from hospitals or Emergency Department (ED) discharge summaries. The present study shows that most sports injuries among children are taken care of by the FPs themselves and are not severe enough to warrant referral to an ED or medical specialist. A public survey among the Dutch population revealed that more than half of all sports injuries among children aged 5-17 years that received medical treatment were treated by the FP, and only 11% of these children visited an ED.[14]

Patient characteristics

In the present population, the peak occurrence at age 15 years is similar to age distributions in other reports.[10,15] However, another study reported that from age 13 to 15 years there is a rapid decline in total daily activity due to a rapid decline in participation in non-organized sports activities, and a small decline in participation in organised sports activities.[16] This decline in daily activity is particularly seen among girls which is in accordance with our finding that most sports injuries after the age of 10 occur among boys, this correlation is also seen in other studies.[17] Possible other explanations for this difference between the sexes are that boys are less cautious and are engaged in more vigorous activities than girls.[15,18] Table 1 shows that most injuries occur during soccer (41%) a sport mostly played by boys in the Netherlands. It is also postulated that this increased risk of injury is also associated with the adolescent growth spurt, due to factors such as muscle tendon tightness, and decreased physeal strength.[17]

Type of sports and injury onset

The majority of sports injuries (56%) occur during organized sports activities, possibly due to excessively high demands on the developing bodies of children. This indicates that organized sports activities for children should be targeted in prevention programs.[19] In addition, 23% of all sports injuries in the present study occurred at school during physical education class, which is similar to the 25% found in Swedish schools.[20] This makes schools a secondary target for prevention programs.

Few studies have provided a breakdown of occurrence by nature of onset; most have presented only acute injuries, although overuse injuries due to sports are becoming more common in children.[21] Overuse injuries seem a better target for prevention than acute injuries because they are often easier to prevent (when discussed and explained) than acute injuries. Some studies claim that half of all sports injuries are overuse injuries.[22] In our population, 17% of all sports

injuries were overuse injuries. Whereas in most sports the majority of injuries are acute, in some specific sports overuse injuries constitute almost half of the injuries, e.g. in our study, handball. In addition, the occurrence of sports injuries often reflects the favourite sports; in the Netherlands among boys this is soccer and among girls gymnastics.[23]

Site and extent of injury

Injuries of the lower extremities (specifically of the knee and ankle) are the most common types seen in sports.[21] Although many reports based on hospital data often find the highest rates in the upper extremities,[15,24] studies using self-reports and large reviews have reported findings in line with ours.[10,18,20] An explanation for this could be that most dislocations and fractures are located in the upper extremities and medical specialists will mainly see the more severe injuries.

Management

Our study shows that most sports injuries among children presented to the FP are dealt with by the FPs themselves and that, when a child is referred, it is mostly to a hospital for an X-ray, casting or other more extensive treatment. The most common injuries (sprains and strains) are mostly treated with bandage or taping combined with the advice to take rest or to adjust sports activities. Most children stay in primary care, and only 20% is referred to a hospital.
Two other studies on injuries related to sports activities seen in family practice, covered all ages.[11,12] Comparison with our findings is hampered by the fact that the questionnaires used differed considerably. However, both studies concluded that most sports injuries are relatively mild, only require conservative forms of treatment, and are treated by the FPs themselves.[11,12]

Non-sport participation

The risk of an injury during physical activity should be seen in relation to the risk of being physically inactive. We have shown in a previous report that overweight and obese children experience more musculoskeletal problems than normal weight children[25] which might cause them to be less physically active and vice versa. Being physically inactive is linked to many diseases and disorders and is probably a greater threat to children than being active and the risk of (mainly mild) sporting injuries.[26]

Strengths and weaknesses

This register-based study allowed to accurately establish which sports injuries children present in primary care and how FPs manage the different types of injury. Only two other studies

have reported on sports injuries seen by the FP.[11,12] Our questionnaires allowed to distinguish between injuries due to organized and non-organized sports, which is often impossible when studies are performed in a hospital setting. A limitation of our study was that only 22 FPs (out of a possible 45 practices) passed the validity rules for inclusion in the analyses. However, since the data of the included practices still proved to be representative for the Dutch population (regarding age, gender, regional distribution, population density, and number of sports injuries), we believe that selection bias was limited.

Conclusion

This study shows that most sport injuries presented to the FP occur among boys and at a peak age of 15 years. More than 50% of the sports injuries occurred during organized sports, and about 25% occurred during physical exercise at school. The FP mainly encounters lower extremity problems related to the knees or ankles. The most frequently presented sports injuries in children are sprains and strains, which are familyly treated with bandage or tape. Most injuries can be managed with the advice to rest and to adapt sports activities. Prevention could focus on possibilities to decrease injuries during organized sports and physical exercise at school.

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CHAPTER 7

General discussion

General discussion

Why study musculoskeletal problems in children in general practice? With the current emphasis on evidence based medicine, it has become clear that much of our work as general practitioners is not based on scientific evidence at all, but much more on clinical experience and habits. We do things because we, or the doctors who have trained us, always have done it like that. Usually there is nothing wrong to base our actions and thoughts on experience but we have to be careful with habits. As a rule it is good to test repeatedly whether what we do is correct and if our assumptions are still right.
During my work for this thesis for instance, I came across a remarkable situation (chapter 2c). Although all textbooks wrote that a pulled elbow should be treated by a supination/flexion movement, the only trials performed to test what maneuver was best, showed that the pronation method was actually better. This shows the importance of randomized clinical trials and systematic reviews. The pulled elbow is of course a minor problem, but we also prescribe medication that has never been tested in the target population, and perform surgery, while we actually do not know what would happen if we would not perform this surgery.
While common musculoskeletal problems in elderly are rather popular study topics, musculoskeletal problems in children are far less studied, although these are common reasons to consult the general practitioner. Especially in general practice we lack research, since most studies are performed in secondary care The population of patients in a secondary care setting is almost never comparable to the population we see every day in general practice. A priori chances for the presence of a disease are completely different as well as their clinical course and susceptibility to treatment. Therefore it is important to perform research in primary care, beside the fact that it is just interesting to gain more insight: to satisfy our curiosity.

In the previous chapters I presented the results of the studies we performed. We provided new epidemiological data for clinical practice and research on the pulled elbow, foot problems, acute non-traumatic hip pathology, sports injuries and musculoskeletal problems in daily life among children in general practice. We compared epidemiological data of certain conditions and problems from different years and among different groups, like boys and girls and overweight and normal weight children. We performed two systematic reviews, on the treatment of the pulled elbow and the diagnosis of acute non-traumatic hip pathology in children. These systematic reviews provided us with answers as well as new research questions.

In many ways children are different from adults, because they are growing and developing. Not only their musculoskeletal system itself, but they also develop their cognitive skills, pain perception and emotional behavior while growing up. Therefore, it is a completely different experience to perform a consultation with a four or even ten year old child with knee pain, usually accompanied by a parent, than with a 65 year old person with the same problem. Not

only the differential diagnosis differs greatly but also the way of history taking and examination is completely different.

In this general discussion I take a helicopter view on the topic of this thesis: musculoskeletal problems in children in general practice. I will place our work into the broader perspective of daily practice: a general practitioner sitting in his or her office with the patient in front of him or her asking for help. I will explain what a general practitioner (GP) has to take into account when this patient is a child presenting with musculoskeletal problems, and what the studies included in this thesis contribute to this situation. I will also discuss which questions still remain unanswered and can be topics for further research.

This chapter is divided in the following paragraphs: the consultation, the developing musculoskeletal system, the need for healthy behavior for the developing musculoskeletal system, methods of the included studies and their strengths and weaknesses and it will end with a final note with the most important insights and findings of this thesis.

The consultation

Management of musculoskeletal problems in children requires knowledge of the differential diagnosis and the prognosis of these conditions but only occasionally involves active treatment. Most musculoskeletal problems in children are not amenable to treatment: some resolve spontaneously, others are simply expressions of normal variability. For treatment to be appropriate, three criteria should be met. First, the treatment should be necessary to prevent death or disability. Second, the treatment should be effective and finally, the benefits of the treatment should exceed the risks both somatically and psychologically.[1] Therefore careful history taking and examination, taking into account the child's development is essential. There is evidence that doctors' skills in musculoskeletal assessment are inadequate, and self-confidence of doctors in pediatric musculoskeletal assessment is lowest compared to other bodily systems, probably as a result of deficiencies in the education process.[2,3] We therefore need better training in musculoskeletal problems, for practicing GPs and GP trainees since these problems are such a common reason to consult the GP.

Communication

A fundamental difference between pediatric and adult medical consultations is the presence of intermediaries: one or two parents and commonly distractive sibling/s, resulting in a minimally three way interaction. Compared to the usual two-way doctor-patient interaction in adults, these multiple players inherently alter the consultation dynamics, creating additional

challenges. For the young child the consultation is primarily between the clinician and the parent, but wherever possible the child must be encouraged to contribute key information that may be unknown to the parents.[2] Developmental cognitive studies have shown that children play a far more active role in the interaction with adults than has been assumed.[4] The child's role in the medical consultation should be important. In medical consultations the patient usually has two needs: the cognitive need to be informed and the emotional need to be taken seriously, to feel known and understood. In the triad consultation two persons' needs need to be taken into account, the needs of the parent and the need of the child. It is clear that these needs change considerably over time. Small children may not even like to participate at all, but teenagers progressively want to tell their own stories and take their own decisions. Studies show that the conversational contribution of the doctor in this triad conversation is about 60%, of the parent 26-39% and of the child 2-14%, which increases with age.[4] In the consultations usually the greater part of the information provided by the doctor is directed at the parent.[5] It has been shown that the parent is usually responsible for excluding the child from medical conversation by interfering.[4] The child's participation seems to occur at the expense of the parental contribution of the consultation.[4] This should be kept in mind since there are two persons' needs involved in the consultation. The parents are usually the ones who are concerned; the child will sometimes not even know why it is necessary to go to see the doctor. The parental control by asking a lot of questions at the end of the consultation and expressing their concern about their child's well-being, may also explain the shift in GP's supportive behavior towards the child.[5] The child has to be taken seriously and should be considered as an intelligent, capable and cooperative participant with its own cognitive and emotional needs. Whether a child can be considered a full participant in medical communication has to be judged based on the child's age, the type of problem, and the parent-child relationship.[4]

Physical examination

In a consultation for musculoskeletal problems a physical examination is necessary, to gain more insight into the problem or to make the patient or parent feel taken seriously. Sometimes children can be scared, due to past experiences or just by the developmental stage they are in. In several periods of development children do not like to be separated from their mother. The GP should adjust him/herself to the child; lower to its level and let it stay on the parent's lap as long as possible. The young child often needs to be distracted, e.g. by feeding or by giving toys or playing music, depending on their developmental stage.[6]

Also pain-behavior changes over the years, most adult consultations for musculoskeletal problems will take place because the patient experiences pain in the musculoskeletal system, in children postural problems and not using certain limbs will commonly be the reason for consultation. It needs no explanation that the motivational-affective component of pain in children is completely different from adults. Pain is an individual experience that depends on verbal

and non-verbal communication in order to express its nature. It carries both a sensory and a motivational-affective component; this last component depends on the level of self awareness, consciousness and the development of 'self'.[7]
In the newborn, the density of the nociceptive nerve endings in the skin is at least as high as in the adult. Afferent nerves and ascending tracts are anatomically present, but may not be fully myelinated. The unmyelinated C fibers and visceral afferent fibers of the sympathetic nervous system carry nociceptive stimuli effectively although at a reduced velocity. It may be that this system with large receptive fields and prolonged responses increases the chance of nociceptive transmission at the expense of precision to the site and timing of the stimulus.[7] Therefore small children may be less adequate in exactly locating the anatomical problem, when they point out where they feel the pain. It is important for the GP to keep this in mind when performing physical examination. This referred pain is illustrated by the most common presentation of a child with a pulled elbow (chapter 2a), a 2 year old not using the affected arm holding it slightly flexed and pronated, because the child is not able to tell exactly where the pain is located. Many times the child will locate the pain in the wrist, this is nicely reflected by the variety of names this condition has been given over the years (chapter 2a, table 1), some of these names dating back from before the actual pathology was discovered. It would be interesting to know how often the pain is located in the wrist, somewhere else in the arm or in the elbow, to help the GP make the correct diagnosis and to prevent unnecessary diagnostic procedures. The database we used for our study unfortunately did not contain this information.

The presence of referred pain in the knee might be a diagnostic clue in differentiating between transient synovitis, Perthes' disease and Slipped Capital Femoral Epiphysis (SCFE). In chapter 4a we showed that referred pain in the knee might be associated with transient synovitis: 10.5% of the patients in our study with transient synovitis localised the pain in the knee, while none of the patients with Perthes' disease and SCFE did so. One other study [8] reported comparable results. Both our and this other study was not designed to prove this possible relation. It would therefore be very interesting to perform a study that explores the relation of referred pain to the knee in hip problems in children, as referred pain could provide a very useful clue in diagnosing hip problems. We could hypothesize that this referred pain is caused by the inflammation of the synovia and is therefore less apparent in Perthes' disease and SCFE. In that case, however, referred pain in the knee could also be present in e.g. juvenile rheumatoid arthritis and septic arthritis, although children presenting with septic arthritis are usually so young that they cannot tell where the pain is located. On the other hand we also do not know whether referred pain in the knee is never seen in Perthes' disease and SCFE.

Additional diagnostic examination

Due to the referred pain in the pulled elbow many unnecessary referrals are made; for instance for an x-ray from shoulder to wrist. This leads to unnecessary exposure to ionizing radiation. Radiation carries a risk of malignancy and children are particularly susceptible. Every effort must be made to avoid unnecessary radiation exposure. It is therefore remarkably surprising that the only diagnostic studies that have been performed for this condition are studies to evaluate radiology instead of evaluating the value of certain aspects of history taking and physical examination.

In chapter 4b we reported on a systematic review for all diagnostic studies on acute non-traumatic hip pathology. Fortunately, for these conditions researchers did try to establish the least invasive parameters to differentiate between septic arthritis and transient synovitis. Efforts were made to develop clinical prediction rules based on parameters with the highest sensitivity and specificity. Unfortunately, most studies were performed in secondary care settings. Therefore we cannot be sure whether they have the same validity when applied in a primary care setting. It would be interesting to validate the most promising prediction rule in a primary care setting. This prediction rule is the prediction rule by Kocher [9,10], it includes the presence of fever (T>38.5C), ESR>40 mm/hr, WBC > 12x109/L and not being able to bear weight on the hip. This prediction rule was later validated amongst others by Caird et al.[11] The authors also added CRP to the rule, which makes it more accurate. For Perthes' disease, one of the possible other diagnoses in a child with an acute non-traumatic hip problem, most studies were performed on the value of bone scanning which has a large ionizing burden. The commonly used golden standard radiography in Lauenstein position has not been studied well in this condition. No studies were found to determine when X-ray indicators of the disease become visible after its first clinical manifestation. This is an important question for further studies because now we do not know when our golden standard becomes "gold". This knowledge would also help us in daily practice, because we would know how many days we should wait before referring a patient for X-ray examination. Some initial investigations have been performed to determine the value of ultrasound and MRI in the diagnosis of Perthes' disease. The results seem promising, but validation studies are necessary. Ultrasound is already commonly used in many centers to diagnose a variety of hip problems in children, although the exact added value of this diagnostic tool has not been determined. The studies that have been performed use different parameters to diagnose the conditions; therefore it was not possible to statistically pool the results of the included studies in a quantitative analysis. Larger studies on the diagnostic value of ultrasound in primary care settings would therefore be very useful, since it is a relatively harmless procedure.

The developing musculoskeletal system

Development over time

A human being develops from a few pluripotential cells by differentiation and growth. During this impressive process all systems develop and grow. The limbs are formed out of four limb buds, starting at around four weeks gestation. In a proximodistal sequence (humerus and femur appear before digits) the cells in the limb buds begin to differentiate. During the first month of fetal life the matrix of the future skeleton is formed. Fetal bone in comparison to mature bone, has a very compact cortex, little remodeling occurs during antenatal life. During the first two years after birth all primary bone is remodeled. The muscles are formed from the eleventh week onwards. Innervation of the muscles, around 20-24th week, enhances muscle development and differentiation. The differentiation of the limb joints occurs over a relatively short period, between four and a half and seven weeks.

At birth extension of the knee and hip, as well as plantar flexion is limited, but at the age of two the elbow, knee and hip can even be extended beyond the zero position.[12] This laxity in the joints of young children also explains some of the injuries specific for this age group; chapter 2b showed that the incidence rate of the pulled elbow (subluxation of the radius) is highest at a median age of 2 years.

The legs in particular change considerably in torsion, shape and function during growth, the child grows from a baby that is lying and doesn't use his legs that much, to a crawling and sitting young child, and finally to a walking individual. Until the age of one year children's legs are bowed. Around the age of one and a half year the legs are straight. Knock knees are normal between the age of two and seven years; after seven the valgus position disappears and a normal tibio-femoral angle develops.[13] When a child presents with leg or foot problems it is therefore very important to distinguish between pathology and a physiological situation that is simply different from the adult situation. In chapter 3 we described which foot problems children present to the general practitioner. We also found that foot problems are presented to the general practitioner much less often in 2001 than in 1987. We hypothesize that the literature published in the period between those years, has found its way to the public and, as a consequence parents are nowadays less concerned about the appearance of their child's legs and feet than they were twenty years ago. In the Netherlands Visser wrote a very well read book for GPs on musculoskeletal problems in children.[13] Chapter 3 also shows that the referral rate increased for foot problems between 1987 and 2001, although the absolute number of referrals to secondary care decreased substantially between those years. We believe that this adds credibility to our hypothesis that - thanks to good health education on foot problems by the GP and youth healthcare - parents are more aware which foot problems require medical attention and which not, and therefore visit the doctor more often with pathological symptoms. Therefore a higher percentage of children that come to the practice with a foot problem will

be referred to secondary care. It would be interesting to study if the child population treated 20 years ago, with orthotics and other treatment modalities, have grown up with less, more or other foot- and statural musculoskeletal problems than the children treated nowadays when these children have become adults. This may tell us if the change in medical behavior probably caused by the changed view due to published literature on the topic has done good to society.

Gender differences

With increasing age the difference between boys and girls becomes more apparent, not only in the way they look and behave, but also in their medical problems, including their musculoskeletal problems. In chapter 3 we showed that heel pain is more common in boys and hallux valgus is more common in girls. We were unable to find other reports on (gender-specific) occurrence rates of heel pain and hallux valgus among children aged 0-17 years. A higher incidence rate of hallux valgus in females than in males has been reported.[14-16] Hallux valgus has been rather well studied, but it would be interesting to see if our finding of more prevalent heel pain in boys can be confirmed in other populations. It would be interesting to see if heel pain is also more common in male adults, or if it is usually Sever's disease (heel pain in young athletes, due to overuse and repetitive micro trauma of growth plates of the calcaneus in the heel). It would also be interesting to study what is causing the heel pain and find out why boys are more susceptible to heel pain than girls. For instance, to establish whether there is a relation to soccer, a game more played by boys in the Netherlands, we could compare a Dutch population to an American population, since soccer is a popular sport among girls there. Of course many more variables can be candidates for a causal relationship.

Etiological and geographical variation

Some conditions are specific to the developing musculoskeletal system, due to its growth plates and developing muscles and ligaments, like the before mentioned Sever's disease. Other examples are the non-acute traumatic hip conditions in children (chapter 4). Perthes' disease for instance is caused by necrosis or degeneration of the ossification centre of the femoral head epiphysis that is followed by spontaneous regeneration at the cartilage site which needs less oxygen to grow. SCFE is a posterior slipping of the femoral head in relation to its metaphysis, resulting in a shearing failure of the growth plate.
In chapter 4a we saw that the occurrence of musculoskeletal problems not only varies with age and gender, but can also have a large geographical variation. Although this variation might also be partially explained through detection bias, the incidence rates vary from 0.9 in Japan to 21.1 in inner city Liverpool per 100.000 person years for Perthes' disease and from 2.13 in New Mexico to 10.1 per 100.000 person years in Connecticut for SCFE.

The need for healthy behaviour for the developing musculoskeletal system

In western societies most individuals have replaced previously common physical activities of daily life with the technical assistance provided by a mechanized and computerized world. Because the musculoskeletal system is adapting to biomechanical challenges and environmental conditions, the body composition of the average child and adolescent has changed dramatically.[17] This seriously influences health in the wrong direction and all systems in the body suffer. It causes obesity and muscle atrophy due to a lack of activity and qualitative malnutrition. Exercise and nutrition are key environmental factors known to affect muscle and bone development. Exercise acts directly through muscle action and indirectly through systemic effects such as endocrine regulation. During growth, exercise is thought to influence bone modelling and thus geometry.[17] Most of the effects of obesity have been attributed to the heavy weight that the bones and joints have to carry, however some newer studies show that obesity affects the musculoskeletal system as a whole through endocrine regulation and the lack of exercise.

The first musculoskeletal disorders associated with obesity that are unique to childhood are SCFE[18] and tibia vara (Blount's disease)[19]. These are attributed to the abnormal weight on the growth plate and the different gait (fat thigh gait) in obese children.[20] In chapter 5 we showed that overweight and obese children more frequently experience musculoskeletal problems in normal daily life, compared to normal weight children. Other authors have also made this observation.[21-23] They also established that lower extremity problems were among most common musculoskeletal problems these children experienced. This is in accordance with our study, in which we show that ankle and foot problems are significantly more common in overweight and obese children, compared to normal weight children. A number of studies have focused on the foot structure of overweight and obese children[24-27] showing that these children have increased foot length and width, decreased navicular height[24], lower medial arch height[25,26] and higher plantar pressure[27] compared to normal weight children. It therefore seems reasonable to assume that these structural problems in the feet of the overweight and obese children are correlated with the reported lower extremity problems and pains. This would be an interesting topic for further investigation since no study has been published to test this assumption.

The association between a low fitness level and excess body weight is commonly known.[28,29] We hypothesized that a vicious circle could develop in which being overweight, musculoskeletal pains and a low fitness level reinforce each other. Normal weight children with musculoskeletal pains are possibly less active and can therefore become overweight. Musculoskeletal pains due to being overweight can prevent overweight- and obese patients from successfully doing exercise to reduce bodyweight. It would be interesting to study this circle in closer detail. Where does the circle start? Does it start with sedentary parents, who set the unhealthy example and give their children unhealthy food? Are these children raised with the idea that passive

hobbies or sitting down is more fun and more normal than playing actively and sporting? Does it start with parents that have weak genetic musculoskeletal make-up, so are these children born with more chances of having musculoskeletal problems anyway? Other interesting study topics would be to finding out how to stimulate these children to play more actively and to let them participate in sport, e.g. by intervention studies. How can we make them loose weight, how can we persuade them towards a more healthy lifestyle? What is the best place to start, at home or at school or maybe at the doctors' surgery? And what is achievable, if the parents are not engaged in healthy behaviour? It might be good to start lifestyle changes at home, but it may be not feasible. Many new study topics can be thought of to gain more insight in this frightening problem, people do not seem to realize that eating such low quality food and being so passive is not only killing them slowly but also next generations.

Of course there are also some disadvantages in being active, during active behaviour there is of course always the possibility to get injured, and thereby creating a musculoskeletal problem, that can send the child 'back into the circle' for a longer or shorter period. In chapter 6 we focused on sports injuries seen in general practice. We see that 56% of the sports injuries occur during organized sports activities, while 23% happened at school during physical education class. Some studies claim that half of the sports injuries are overuse injuries.[30] Overuse injuries take on average more time to recover than acute injuries, and prevent children from being active longer. In our study only 17% of all sports injuries were considered to be overuse injuries, but in handball this percentage was 43%. So this might not be the best sport to advise children to participate in. However, overall sports injuries were mild and could be taken care of by the GP without referral to secondary care, usually only conservative forms of treatment were necessary.

Methods of the included studies and their strengths and weaknesses

General practitioner databases

For the studies reported on in chapter 2b, 3, 4a, 5 and 6 we have used large GP databases. In chapter 2b, 4a and 5 we have used data from the second Dutch national survey of general practice (DNSGP-2), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. In chapter 3 we used data from the first national survey (DNSGP-1) carried out in 1987, as well as from the second national survey. Chapter 6 is based on data from the Continuous Morbidity Registration of Sentinel Practices (CMR).

In the DNSGP-1 a non-proportionally stratified sample of 161 GPs (103 practices) was selected randomly to participate in the survey. The GPs were divided into four groups and each group recorded data about all contacts between patient and practice on registration forms during one of four consecutive 3-month periods during 1987. The four registration periods covered one calendar year to correct for seasonal variability of morbidity. Specially trained workers

using the International Classification of Primary Care (ICPC) coded free-text diagnoses made by the GP. Data on patient demographics were obtained by a questionnaire. Because of the stratified sample, the population was weighted to the Dutch population of 1987. In DNSGP-2, data on all GP - patient contacts during one year were derived from the electronic medical records of all listed patients of 195 GPs (104 practices). The GPs recorded all health problems presented within a consultation, and coded the diagnosis themselves using the ICPC.[31]

The CMR consists of 45 GP practices (190,392 listed patients) throughout the country, which together are representative for the Dutch population by gender, age, geographical distribution and population density. The GPs of these practices record data about diseases, events and treatments, which are not part of the routine registration in the electronic medical records.[32]

These large and representative surveys and databases enabled us to assess the occurrence of the studied conditions in primary care. Due to the rarity of the disorders a large sample size is needed and therefore a GP database was a suitable instrument to work with regarding our research questions. The lack of accuracy of the diagnosis, and the under-representation of cases presented at out-of-hour services, might be considered a potential limitation in the GP databases used in the studies.[33,34] In our analysis we assumed that the diagnosis and registration by the GPs was correct and accurate. All GPs participating in DNSGP-2 were trained in the correct coding of the ICPC and were explicitly asked to register the out-of-hour episodes.[31]

We are fortunate to live in a well digitalized country, at the North American Primary Care Research Group (NAPCRG) annual conference in 2009, figures were presented on the percentage of GPs working with electronical medical records; in the United States as well as in Canada this percentage is around 29 %, in the Netherlands this percentage is 99%. Dutch GPs register their consultations in a specific order: they first register the subjective part of the consultation; the reason for encounter told by the patient or care taker, this is followed by the objective part, results of the physical examination and additional examinations, the third line in the record is for the diagnosis and the record ends with the plan of action. The large percentage of usage of electronic medical records and the analogous way of registering consultations provide us with a treasure of information; it would be a shame not to use it. Looking to the future, provided that privacy can be warranted, imagine the enormous possibilities to study the EPD (electronic patient file) that is planned to be implemented in the Netherlands; one medical record per patient, including all medical care, primary care records as well as secondary care and hospitalisation records. Almost no observational and case control studies would have to be set up anymore; most information would be there and easily accessible. It was a pleasure working with these large databases, especially with those of the two national surveys. The diagnosis and plan of action lines in the patient files were coded in large databases, and NIVEL also made it possible to search the free text of the history of the patient in the second national survey. Regrettably, no information was available on the results of the physical examination and additional examinations. For some of the studies in this thesis and probably for many more research questions, this would be very useful.

Another learning point I gained by using these databases is the fact that it is best to get the information directly from the institution that has collected the data. For our last study (chapter 6) we received information through two institutions (one that had got the information from the other original research institute) this made some analyses impossible, because of linkage problems. This is a pity since information was available but somewhere got lost in translation. We still gathered useful information, but we could have gotten much more out of it if the data had been present in its primary form.

Reviews

Chapters 2a, 2c and 4b included reviews of the literature. Chapter 2a is a narrative review on all published literature on pathology and diagnosis of the pulled elbow found by a systematic search on PubMed and Embase. Chapter 2c summarizes a Cochrane review of treatment of the pulled elbow for which we searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, the Cochrane Central Register of Controlled Trials, MEDLINE/Pub Med, EMBASE, CINAHL, LILACS, and PEDro. Chapter 4b contains a systematic review of all articles found in PubMed and Embase on the diagnosis of acute non-traumatic hip pathology. Although our searches were extensive, we cannot exclude the possibility that we have missed relevant evidence. Performing a review is enjoyable work; it is like getting paid to studying, and you get a chance to really make a contribution to science, by making the information of a variety of studies more easily accessible for your colleagues. The frustrating part of performing reviews is that you can come to the conclusion that most studies are of low quality and not comparable due to completely different patient groups or methods. Sometimes the golden standard, which researchers should compare their new intervention with, is not even studied. Therefore, the value of performing a diagnostic or therapeutic procedure might be more depending on the moment in time that it is performed than on the supremacy of the procedure itself. What is encouraging to see, is that many researchers had come to this conclusion long before I did and have taken action to improve this situation by proposing quality guidelines like CONSORT, QUADAS etc. Therefore it was a pleasure for me to work with the Cochrane Collaboration, they provide as many high quality systematic reviews as possible, and provide you with help and expert reviewers during the process of performing and writing your review. The disadvantage is that it robs you of almost all artistic liberty as a writer and the work is strongly protocollised. However, this also takes the reservation away from the readers, that this work might be not valid. This is reassuring for a clinician, not having to analyse these reviews that much anymore, which saves a lot of time.

Final note

With this thesis, I have given an overview of the child and its developing musculoskeletal system. This thesis and the included studies have provided answers to some of the questions that existed, and by revision of previous studies, also to questions we did not even know about at the start. To some questions we still do not know the answer and new questions emerged. Much research still can and must be performed, to satisfy our curiosity and ultimately to take better care of our children.

The most important new insights and findings were:

- The pulled elbow is best treated by performing a pronation maneuver, not a supination/ flexion maneuver.
- The literature disseminated on the (un)necessity of treatment of certain foot problems in children has sorted an effect: fewer people consult the GP for conditions not considered as problems requiring medical attention.
- No minimally invasive parameters have been tested in a primary care setting, to differentiate between acute non-traumatic hip problems in children. Research is necessary, especially evaluating ultrasound techniques and diagnostic clues from history taking and physical examination.
- Referred pain in the knee in acute non-traumatic hip problems in children might be associated with transient synovitis in a part of the patients.
- Overweight and obese children more frequently experience musculoskeletal problems in normal daily life, compared to normal weight children. This might create or be part of a vicious circle of being overweight and low physical activity.
- Sports injuries in children are usually mild and can be taken care of by the GP without referral.

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Summary

Chapter 1 is the introduction to this thesis. It is obvious that the complaints in children will show a different epidemiologic pattern from that in adults, since children are still growing and developing, neurological and psychological as well as their musculoskeletal system itself. The aim of this thesis is to provide more information and knowledge about children's musculoskeletal problems in general practice. We did this by calculating epidemiological background data that was not available before, primarily to be used as the basis for future studies. Additionally we performed two systematical reviews in order to formulate recommendations for clinical practice and research, based on the results of past studies.

In **chapter 2** we focus on the pulled elbow in three subchapters. **Chapter2a** is a review of all published literature on pathology and diagnosis of the pulled elbow. Since it is an injury of young children (two to four year olds) who can not always tell and feel precisely what is wrong with them, this injury has been given many names until its etiology and pathology was known. The condition results from a sudden pull on the arm, usually by an adult or taller person, which pulls the radius through the annular ligament, resulting in subluxation (partial dislocation) of the radial head. The child experiences sudden acute pain and loss of function in the affected arm. The condition is diagnosed by its typical history and presentation. Radiography is usually restricted to less clear cases to exclude more severe injuries. The pulled elbow is a frequently encountered and treated lesion in primary care. Despite this, its incidence was not known in Dutch general practice. Therefore in **chapter 2b** we analyzed data from the second Dutch national survey of general practice (NS2) (30,408 children aged 0-5 years), which was carried out by the Netherlands Institute for Health Services Research (NIVEL) in 2001. We calculated that the incidence rate in Dutch general practice in children aged 0-5 years is 2.7/1000 person-years. Pulled elbow is slightly more common in girls, the median age at occurrence is 2 years. A Dutch full-time GP with an average practice sees about one pulled elbow every two years. The pulled elbow is usually treated by manual reduction of the subluxed radial head. Various manoeuvres can be applied. Most textbooks recommend supination of the forearm, as opposed to pronation and other approaches. It was unclear which manoeuvre is most successful. In **chapter 2c** we compared the effectiveness and painfulness of the different methods used to manipulate the pulled elbow in a Cochrane review. This provided evidence from three small (total 313 patients) low-quality trials that the pronation method might be more effective and less painful than the supination method for manipulating the pulled elbow. However, only a small difference in effectiveness was found.

In **chapter 3** our aim was to establish and compare incidence and referral rates for foot problems in children in 1987 and 2001. We compared two large consecutive surveys in Dutch general practice performed in 1987 (the first Dutch national survey of general practice (NS1);86,577 children aged 0-17 years) and 2001 (second Dutch national survey of general practice (NS2); 87,952 children aged 0-17 years), which were carried out by the Netherlands Institute for Health

Services Research (NIVEL). Compared to 1987, in 2001 the overall incidence rate of foot problems presented to the general practioner decreased substantially from 80.0 (95%CI 77.0-84.7) to 17.4 (95%CI 16.5-18.3) per 1000 person-years (p<0.0001). The incidence rate of flat feet decreased from 4.9 (95%CI 4.0-5.9) per 1000 person-years in 1987 to 3.4 (95%CI 3.0-3.8) per 1000 person-years in 2001 (p=0.001). The distribution of referrals to other primary health-care professionals and medical specialists has almost reversed in favor of primary health-care professionals.

The topic of **chapter 4** is acute non-traumatic hip pathology in children. The differential diagnosis of children with acute non-traumatic hip pathology varies from quite harmless conditions such as transient synovitis of the hip to more severe problems like Perthes' disease, slipped capital femoral epiphysis (SCFE), and life-threatening conditions such as septic arthritis of the hip. In **chapter 4a** our aim was to provide population-based data on symptom presentation and incidence rates of non-traumatic acute hip pathology in general practice. We therefore analyzed data from NS2. We included all children aged 0-14 years. Our study population consisted of 73,954 children aged 0-14 years, yielding 68,202 person-years. These children presented with 101 episodes of acute non-traumatic hip pathology. The incidence rate for all acute non-traumatic hip pathology was 148.1 per 100,000 person-years, and for transient synovitis this was 76.2 per 100,000 person-years. The presenting feature in 81.5% of the children was pain, in 8.6% limping and 9.9% presented with both symptoms. Only 27% of the participating GPs reported whether the child had a fever, while this is one of the main distinguishing factors between a harmless condition and a life-threatening condition. In **chapter 4b** we present our literature review on the diagnostic value of tests used to diagnose four important conditions in the differential diagnosis of non-traumatic acute hip pathology (Septic arthritis, transient synovitis, Perthes'disease and Slipped capital femoral epiphysis (SCFE)). We searched Medline and Embase from inception until February 2009. In the end 23 studies were included in the review, quality was assessed according to the QUADAS tool. Five of these studies combined the information from laboratory and anamnestic parameters to produce clinical prediction rules to differ between septic arthritis and transient synovitis. One study validated ultrasound to diagnose transient synovitis. Two studies investigated the diagnostic value of ultrasound, two studies the use of MRI and seven studies studied the diagnostic value of the bone scan in Perthes'disease. In differentiating between septic arthritis and transient synovitis the most helpful tool, albeit limited, is the clinical prediction rule of Kocher (combining the presence of fever (Temp. >38.5°C), ESR >40 mm/h, WBC >12x109/L, and not being able to bear weight on the hip) CRP adds more diagnostic certainty to this rule. For Perthes disease the best diagnostic tool seems MRI. Ultrasound is commonly used to differentiate between the different conditions; this non-invasive diagnostic tool needs further investigation to establish its diagnostic value in non-traumatic acute hip pathology in children.

Since the obesity epidemic in children is spreading at alarming rates and musculoskeletal problems can influence physical activity. In **chapter 5** we compared the frequency of musculoskeletal problems in overweight and obese children to that in children with normal weight. We performed a cross-sectional database and face-to-face interview study that included 2459 children aged 2-17 years from Dutch General Practice (NS2). We collected self reported height and weight (BMI), self reported musculoskeletal problems in the 2 weeks prior to the interview and general practioner consultations for musculoskeletal problems in one year. Two age groups were analyzed; 2-11 years and 12-17 years, because of the proxy interview in the youngest age group. The study showed that overweight and obese children more frequently experience musculoskeletal problems, than normal weight children. We were able to calculate that overweight and obese children in both age groups (2-11 years and 12-17 years) reported significantly more musculoskeletal problems; OR (95%CI) 1.86 (1.18-2.93) and 1.69 (1.08-2.65), than normal weight children. The total group of children with overweight and obesity reported more lower extremity problems, than the normal weight children; OR 1.62 (95%CI 1.09-2.41), they reported more ankle and foot problems than children with normal weight; OR 1.92 (95%CI 1.15-3.20). Overweight and obese children aged 12-17 years also consulted the GP more often with lower extremity problems than the normal weight children; OR 1.92 (95%CI 1.05-3.51).

Physical activity is important to children's development. Inevitably, accidents and injuries occur during physical activity. Children are at greater risk of injury than adults and are susceptible to unique injuries. We therefore wanted to provide an overview of the occurrence and management of sports injuries in children by the general practitioner in **chapter 6**.We analysed data (2005-2007) from a national morbidity register. For children aged 5-17 years, GPs (from 22 of 45 representative practices) who registered all sports injuries, filled in a questionnaire about the nature, management and circumstances of the injury. A total of 724 sports injuries were recorded. Most injuries occurred during soccer (41%). Peak age was 15 years. Sports injuries are more common among boys than among girls. Of all sports injuries, 56% occurred during organized sports activities, 23% occurred at school. 63% was a lower extremity injury, 20% was an injury of the knee, and 21% was an injury of the ankle. Sprains and strains were the most common injuries (53%), followed by wounds (23%). Sprains and strains were mostly treated with bandage or tape, and the children advised to rest or adapt their sports activities. Most injuries were managed in primary care. Only 21% was referred to a hospital, usually to the radiology department (15% of all sports injuries).

In **chapter 7** a comprehensive overview is given of what the GP experiences and has to take into account during a consultation with a child presenting with musculoskeletal problems. In this chapter the consultation with a child, the developing musculoskeletal system and the need for healthy behavior for the developing musculoskeletal system, is addressed. Parts of the included studies will be explained in the light of these subchapters and suggestions for further research are given.

Samenvatting

Samenvatting

Allereerst een uitleg van het begrip bewegingsapparaat aangezien dit vaak terug zal komen in deze samenvatting die door iedereen begrepen zou moeten kunnen worden. Het bewegingsapparaat is dat deel van je lichaam waarmee je jezelf voortbeweegt; het bestaat uit je botten, spieren en gewrichten en de weefsels die dit bij elkaar houden. Deze onderdelen worden dan weer aangestuurd door je zenuwen die vanuit de hersenen hun signalen doorkrijgen.

Hoofdstuk 1 is de inleiding van dit proefschrift. Het is duidelijk dat klachten van het bewegingsapparaat bij kinderen niet hetzelfde zijn als bij volwassenen. Kinderen groeien en ontwikkelen zich nog, niet alleen hun bewegingsapparaat zelf, dus hun botten en spieren, wat je ook aan de buitenkant duidelijk kunt zien, maar ook hun zenuwen en hersenen ontwikkelen zich sterk. Het doel van dit proefschrift is om meer inzicht te krijgen in klachten van het bewegingsapparaat bij kinderen in de huisartsenpraktijk. We hebben nieuwe getallen berekend over hoe vaak verschillende aandoeningen voorkomen, om als basis te kunnen dienen voor toekomstig onderzoek en te gebruiken tijdens het consult van de huisarts. We hebben ook twee grote overzichten van al eerder verschenen onderzoek gemaakt, dit hebben wij gedaan om de resultaten uit deze eerdere onderzoeken te kunnen bundelen en daardoor toegankelijk te maken voor zowel andere dokters als onderzoekers.

Hoofdstuk 2 behandelt het zondagsarmpje (een ontwrichting van de elleboog bij kleine kinderen) en is onderverdeeld in drie deelhoofdstukken. In **hoofdstuk 2a** presenteren we een samenvatting van al het onderzoek dat ooit verricht is om te ontdekken wat er nu precies mis gaat in het armpje en hoe de dokter kan vaststellen dat het echt een zondagsarmpje is. Aangezien het een aandoening is die voorkomt bij heel jonge kinderen (tussen de twee en vier jaar), die nog niet goed kunnen voelen en aangeven wat er precies mis met ze is, heeft deze aandoening door de jaren heel wat bijzondere namen gekregen, tot men had uitgevonden wat nu precies de oorzaak was van de pijn die de kinderen voelen. De aandoening wordt veroorzaakt door een plotse ruk aan de arm, meestal door een langer persoon, waardoor één van de botjes in de onderarm ontwricht raakt. Het kind ervaart een plotse pijn in de arm en gebruikt deze niet meer. Meestal weet de dokter vrij snel dat het om een zondagsarmpje gaat omdat het verhaal en de manier waarop het kind met het armpje omgaat, zo typisch is. Verder onderzoek is eigenlijk alleen nodig als er niet zo'n duidelijk verhaal is, of als het kind veel ernstiger gewond lijkt. Er wordt vaak geschreven dat het zondagsarmpje veel gezien zou worden door de huisarts, maar er waren daar eigenlijk nog geen cijfers over bekend voor de (Nederlandse) huisartsenpraktijk. Daarom hebben wij in **hoofdstuk 2b** de gegevens van een heel groot onderzoek (de tweede nationale studie naar ziekten en verrichtingen in de huisartsenpraktijk (NS2), met ruim 30.000 kinderen van0-5 jaar, gebruikt om deze cijfers uit te kunnen rekenen. Daaruit blijkt dat het zondagsarmpje iets vaker bij meisjes dan bij jongens gezien wordt en dat de kinderen

meestal rond de twee jaar oud zijn. Een Nederlandse fulltime huisarts met een praktijk met een gemiddelde hoeveelheid patiënten ziet ongeveer één zondagsarmpje per twee jaar. De huisarts kan het zondagsarmpje vrij gemakkelijk behandelen: door de arm fors te draaien schiet het ontwrichte onderarmpje weer terug in zijn kom. De meeste leerboeken raden aan het onderarmpje ten opzichte van de bovenarm naar buiten te draaien. Het was onduidelijk of dit wel de beste methode was. In **hoofdstuk 2c** kunt u onze samenvatting lezen van al het onderzoek dat hiernaar gedaan is. Deze samenvatting laat zien dat drie kleine onderzoeken, met in totaal 313 patiënten, waarvan de opzet van matige kwaliteit was, laten zien dat het iets beter en minder pijnlijk is om de arm naar binnen te draaien dan de meest gebruikte methode, naar buiten te draaien.

In **hoofdstuk 3** vergelijken we hoeveel kinderen er met voetklachten naar de huisarts komen en hoeveel kinderen de huisarts voor deze klacht verwees in Nederland in de jaren 1987 en 2001. Ook hebben we bekeken voor welke voetklachten de kinderen nu eigenlijk komen. Daarvoor gebruikten we twee grote onderzoeken, de 1^{e} en de 2^{e} nationale studie van het NIVEL (NS 1 en NS2). NS1 bevat de gegevens van 86.577 kinderen tussen de 0 en 17 jaar en NS2 van 87.952 kinderen in die zelfde leeftijdsgroep. Vergeleken met 1987 is de totale hoeveelheid voetklachten gepresenteerd aan de Nederlandse huisarts in 2001 drastisch gedaald. De hoeveelheid kinderen die vanwege platvoeten kwam daalde ook behoorlijk. Huisartsen verwezen kinderen met voetklachten in 2001 veel vaker naar andere medewerkers van de gezondheidszorg buiten het ziekenhuis bijvoorbeeld naar fysiotherapeuten en podologen, en minder naar specialisten in het ziekenhuis, in vergelijking met 1987.

In **hoofdstuk 4** behandelen we de acute, niet door een ongeluk veroorzaakte heupklachten bij kinderen. Het is voor de huisarts lastig om vast te stellen wat de oorzaak is van deze heupklachten. Dat is vervelend want de oorzaak kan heel onschuldig zijn (zoals een onschuldige heup irritatie) maar ook heel ernstig (zoals de ziekte van Perthes waarbij de heupkop af kan sterven en epifysiolyse, waarbij de heupkop van het lange bot afschuift doordat op die plek het bot bij kinderen minder stevig is. Het kan zelfs een dodelijke aandoening zijn, zoals een ontstoken heupkop, die voor een bloedvergiftiging kan zorgen. In **hoofdstuk 4a** berekenen we cijfers over hoeveel kinderen er met welk probleem komen, bij welke oorzaak van de heupklachten welk probleem hoort en over hoe vaak de huisarts elke aandoening ziet. Daarvoor hebben wij weer gebruik gemaakt van het grote onderzoek (NS2). Ditmaal hebben wij de gegevens gebruikt van alle kinderen van 0-14 jaar. Dit betrof 73.954 kinderen. In deze groep zagen wij dat de huisartsen 101 keer benaderd waren door (de ouders van) kinderen met dit soort heupklachten. Bij 81,5% van de kinderen was pijn de reden om naar de huisarts te gaan, voor 8,6% was dit mank lopen en 9,9% kwam voor beide symptomen. Het is heel belangrijk om te weten of er sprake is van koorts, als je het onderscheid wil maken tussen een onschuldige (heup irritatie) en een levensbedreigende aandoening(heupkop ontsteking). Slechts 27% van de aan

het onderzoek deelnemende huisartsen schreef op of er ook sprake was van koorts,. Hoofdstuk 4b bevat het overzicht van de onderzoeken die gekeken hebben naar hoeveel nut het heeft bij bepaalde heupklachten nog aanvullend onderzoek te doen. We hebben 23 onderzoeken kunnen vinden, die 23 onderzoeken hebben we nauwkeurig bekeken om te kijken of de kwaliteit van de onderzoeken goed was. Vijf van de onderzoeken hebben een aantal symptomen en laboratoriumwaarden bij elkaar gevoegd om te kijken of deze combinatie de dokter kan helpen om duidelijk te maken om welke aandoening het gaat of welk volgend onderzoek hij moet aanvragen. Andere onderzoeken keken of de echo, de MRI scan of de botscan (een scan waarbij een radioactieve stof wordt ingespoten) hielp in het maken deze beslissing. Het bleek dat het voor de dokter nuttig is om te weten of het kind koorts heeft boven de 38,5°C; of het kind nog op de pijnlijke kant kan staan en of bepaalde ontstekingswaarden in het bloed verhoogd zijn. Dit helpt hem om het onderscheid te maken tussen een onschuldige heupirritatie en een levensbedreigende heupkop ontsteking. Voor het vaststellen van de ziekte van Perthes lijkt de MRI scan het best. Helaas is er maar weinig goed en vergelijkbaar onderzoek gedaan naar het nut van de echo, terwijl dit toch juist een pijnvrij en onschuldig onderzoek is (in tegenstelling tot de botscan met radioactieve stoffen).

Aangezien er steeds meer kinderen veel te dik worden en kinderen met pijn aan hun bewegingsapparaat minder zullen bewegen, hebben wij in **hoofdstuk 5** gekeken of kinderen die te dik zijn ook meer klachten van hun bewegingsapparaat hebben dan kinderen met een gezond gewicht. Weer gebruikten wij hiervoor de 2^{e} nationale studie uit 2001, ditmaal maakten wij ook gebruik van de gezondheidsvragenlijsten die in het kader daarvan zijn afgenomen. We konden de gegevens 2459 kinderen van 2-17 jaar gebruiken. We verzamelden de zelf gerapporteerde lengte en gewicht en berekende daaruit de BMI (een maat die aangeeft of de verhouding tussen gewicht en lengte gezond is), daarnaast keken we hoeveel klachten van het bewegingsapparaat de kinderen in de twee weken voor het afnemen van de vragenlijst hadden gehad en naar het aantal huisartscontacten voor klachten van het bewegingsapparaat. We vormden twee leeftijdsgroepen, van 2-11 jaar en van 12-17 jaar. Onze berekeningen lieten zien dat kinderen met overgewicht vaker klachten van het bewegingsapparaat hebben dan kinderen met een gezond gewicht. In beide leeftijdsgroepen rapporteerden de kinderen op de vragenlijst meer klachten van het bewegingsapparaat dan kinderen met een gezond gewicht. De totale groep kinderen met overgewicht rapporteerde meer klachten van de benen op de vragenlijst dan de kinderen met een gezond gewicht. Dit was vooral terug te vinden bij de leeftijdsgroep van 12-17 jaar.

Lichamelijke activiteit is belangrijk voor de ontwikkeling van kinderen. Logischerwijs lopen kinderen daar af en toe schade bij op. Kinderen hebben een grotere kans op een ongeluk(je) dan volwassenen. Daarbij komt dat er enkele letsels zeer specifiek zijn voor de kinderleeftijd. Daarom geven we in **hoofdstuk 6** een overzicht te geven van het voorkomen van sportletsels

bij kinderen in de huisartsenpraktijk, en hoe de huisarts daar vervolgens mee om gaat. Voor dit onderzoek gebruikten we gegevens uit een groot landelijk onderzoek (de CMR) van de jaren 2005-2007. Huisartsen registreerden hierin de sportletsels die zij in de praktijk tegenkwamen en noteerden de aard, de behandeling en de omstandigheden van het ongeluk. Onder de kinderen tussen de 5-17 jaar werden 724 sportletsels geregistreerd. De meeste van deze letsels (41%) ontstonden tijdens voetbal. De piekleeftijd was 15 jaar. Het ging vaker om jongens dan om meisjes. Van alle sportletsels ontstond 56% tijdens georganiseerde sportactiviteiten en 23% op school. In 63% betrof het een letsel aan de benen, 20% was een letsel aan de knie en 21% een letsel aan de enkel. Verrekkingen kwamen het meest voor (53%), gevolgd door wonden (23%). Verrekkingen werden meestal behandeld met een bandage of tape en de kinderen werd het advies gegeven rust te nemen en hun sportactiviteiten aan te passen. Het merendeel van de sportletsels werden behandeld door de huisarts, slechts 21% werd verwezen naar het ziekenhuis, als dit toch gebeurde was dit meestal naar de röntgenafdeling (15% van alle sportletsels).

In **hoofdstuk 7** geef ik tot slot een beknopte samenvatting van wat een huisarts in acht zou moeten nemen tijdens het consult met een kind dat komt voor een klacht aan het bewegingsapparaat. Het hoofdstuk is onderverdeeld in drie deelhoofdstukken; het consult met een kind, het zich ontwikkelende bewegingsapparaat en de noodzaak van een gezonde leefstijl voor het ontwikkelende bewegingsapparaat. In het licht van deze deelhoofdstukken bespreek ik de in dit proefschrift opgenomen onderzoeken en doe aanbevelingen voor verder onderzoek.

Publications related to this thesis

Chapter 2a

Nursemaid's elbow: Its diagnostic clues and preferred means of reduction.
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Chapter 2b

Hoe vaak ziet de huisarts een zondagmiddagarmpje?
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Chapter 2c

Manipulative interventions for reducing pulled elbow in young children.
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Chapter 3

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Chapter 4

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Chapter 4a

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Nederlands Tijdschrift voor Geneeskunde 2009;153:A641

Dankwoord

Dankwoord

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Curriculum Vitae en portfolio

Curriculum vitae

Marjolein Krul werd op 08 december 1978 geboren in Dordrecht. Na het behalen van haar VWO diploma aan De Lage Waard te Papendrecht begon zij in 1998 aan haar studie geneeskunde aan de Erasmus universiteit te Rotterdam. Tijdens haar studie was zij actief binnen de Medische Faculteitsvereniging Rotterdam (MFVR) als voorzitter van de culturele integratie commissie (CIC) en de International Federation of Medical Students Association (IFMSA) in de Standing Committee on Refugees and Peace (SCORP). Na de doctoraalfase van deze studie vertrok zij voor 3 maanden naar Peru en Equador om Spaans te leren en vrijwilligerswerk te doen. Daarna volgden twee zware maar ook leuke en leerzame jaren co-schappen, die werden afgesloten met een cum laude artsexamen. Hierna volgde een reis naar Ethiopië, hier heeft zij allerhande voorlichting gegeven. Na de reis werd het tijd voor een jaar ervaring opdoen in het huidige Maasstad ziekenhuis, als arts-assistent interne geneeskunde. In 2006 startte zij met de huisartsopleiding, die zij in het eerste jaar omzette in een AIOTHO traject, de combinatie van de opleiding tot huisarts en een promotietraject. Dit promotietraject vond plaats binnen de afdeling Huisartsgeneeskunde van het Erasmus MC, er werd samengewerkt met het NIVEL en de afdeling Kindergeneeskunde van het Erasmus MC. Tijdens deze periode was zij actief binnen de ROVAH (Regionale Organisatie voor Aspirant Huisartsen) o.a. als voorzitter en later binnen de LOVAH (Landelijke Organisatie voor Aspirant Huisartsen) als algemeen bestuurslid, waar zij zich met name bezig hield met de belangenbehartiging van de AIOTHO's. Tijdens haar bestuurstijd in de LOVAH was zij ook lid Verenigingsraad van het NHG (Nederlands Huisartsen Genootschap). In 2009 behaalde zij haar Master of Science diploma in Clinical Epidemiology aan het (NIHES). Na het afronden van de opleiding tot huisarts werkte zij als scheepsarts/matroos en als waarnemend huisarts. Tegenwoordig is ze Europe Council member van de Vasco da Gama movement (Europese vereniging voor jonge huisartsen) en werkt ze in twee huisartsenpraktijken in Geertruidenberg.

PHD Portfolio

Name PhD student:	Marjolein Krul
ErasmusMC department:	General Practice
PhD period:	2007-2011
Promotor:	Prof. dr. B.W. Koes
Copromotor:	Dr. J.C. van der Wouden

PhD training

MsC training in Clinical Epidemiology, NIHES, Rotterdam, 2007-2008

Biomedical English Writing and Communication, 2009

Systematic review course, Dutch Cochrane Centre, Amsterdam, 2008

Professional Education

Vocational training for general practitioner, Erasmus MC, Department of General Practice, 2006-2010

Conferences/Presentations

National

NHG Wetenschapsdag = Dutch College of General Practitioners: Science day

2009, poster presentation

Congres landelijk onderzoeksnetwerk Jeugd en Gezondheid = Conference National Research Network Youth and Health

2009, oral presentation

2010, oral presentation

LOVAH (Dutch GP trainee network) conference, 2009, oral presentation for international GP trainees

International

WONCA (world organisation for family doctors) conference

Istanbul, Turkey	2008, oral presentation and poster presentation
Basel, Switzerland	2009, oral presentation
Malaga, Spain	2010, oral presentation

NAPCRG (North American Primary Care Research Group) conference

San Juan, Puerto Rico	2008, oral presentation
Montreal, Canada	2009, oral presentation

EGPRN (European General Practitioners Research Network) conference

Bertinoro, Italy	2009, oral presentation

It is obvious that the complaints in children will show a different epidemiologic pattern from that in adults, since children are still growing and developing, neurological and psychological as well as their musculoskeletal system itself. The aim of this thesis is to provide more information and knowledge about children's musculoskeletal problems in general practice. We did this by calculating epidemiological background data that was not available before, primarily to be used as the basis for future studies. Additionally we performed two systematical reviews in order to formulate recommendations for clinical practice and research, based on the results of past studies.

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