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Musculoskeletal pain in 6-year-old children: the Generation R Study

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Conflict of Interest
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Abstract

Musculoskeletal (MSK) pain is frequently reported among adolescents and children and a common reason for consultation in primary care. Our aim is to examine its prevalence in 6-year old children in a general population and to assess associations with physical and psychosocial factors. Data from the Generation R Study, a population based cohort, was used. Prevalence and characteristics of MSK pain were assessed with parent-reported questionnaires at 6-years of age (N=6200). Demographics and data on physical activity, sedentary behaviors, previous reported MSK pain and behavioral problems were extracted from questionnaires. The BMI SD score was calculated from objectively measured weight and height. A three-month prevalence of 10.0% was found for MSK pain in children, of which one third was chronic, and 44.6% experienced together with pain at other sites. Univariate analyses showed that boys and children with lower socioeconomic status (SES) reported MSK pain more frequent compared to other pain and no pain. While no associations were found between MSK pain and children's BMI and physical activity level, children with MSK pain were more likely to watch television ≥2 hours/day. Multivariable analysis showed significant associations for MSK pain at 3 years of age (OR 5.10, 95% CI 3.25 to 7.98) and behavioral problems (OR 2.10, 95% CI 1.19 to 3.72) with the presence of MSK pain. So, MSK pain is already common in young children and is often chronic or recurrent. Previous reported MSK pain and behavioral problems are independently associated with MSK pain in the studied population.

Keywords: MSK; complaints; child; pediatric; psychosocial; demographics; weight status; Physical activity; sedentary behavior; child behavior; epidemiology

Introduction

Musculoskeletal (MSK) pain is one of the most common pain types in children. Back pain has a prevalence of 14-24% in children aged 8-18 years, and the prevalence of MSK pain is 4-40% in children aged 9-18 years [23]. In children up to 15 years old, MSK complaints account for 4% of the consultations in primary care [22]. As pain is an important cause for impaired quality of life [16], it is important to gain more insight in pain characteristics and its etiology, in order to be able to treat and prevent pain in childhood and later in life.

Pain is influenced by many factors, both physical and psychosocial. The strongest risk factor for MSK pain is a history of MSK complaints, which is already seen in 14-year-old adolescents [31]. In general, girls tend to experience more pain than boys [23,30], which is also seen for MSK pain [23,31]. However, results seem to be conflicting [5,6,19,23,30,31,42]. Another factor that has often been suggested to be associated with the presence of MSK pain is overweight or higher body mass index (BMI). A systematic review by Paulis et al. (2014) showed that there is a significant association between being overweight and having MSK pain in childhood with a risk ratio of 1.26 (95% CI 1.09-1.45) [29], and this was also seen for higher weight-for-age in relation to back pain in a cohort study of 14-year-olds [31]. Besides weight, length also seems to matter, as taller children seem to be more likely to develop MSK complaints compared to their shorter peers [19].

Similar to research in adult MSK conditions, the association between different psychosocial factors and MSK pain in children has also been studied. A univariate meta-analysis based on seven prospective cohort studies showed that higher levels of negative emotional symptoms were a risk factor for MSK complaints [19]. Moreover, worrying, being bullied, sleeping problems and daytime tiredness were associated with MSK complaints in a cross-sectional analysis in 14-year old children [31], while feeling sad was only associated with MSK pain in girls [6]. Furthermore, in late adolescence externalizing problems were associated to multisite MSK pain at the same time and two years later [18]. These studies showed that psychosocial factors do already seem to be associated with MSK complaints in adolescents.

There has been discussion on the role of physical activity and MSK complaints [13,19,31]. Practicing regular exercise seems to be associated with the onset of low back pain [19], and moderate and vigorous exercise were found to be risk factors for spinal pain in children [13]. And while sports injuries can be a cause of MSK complaints, no associations were found in 14-year-olds between physical activity and MSK pain [31].

As described, several associations and risk factors for MSK complaints in adolescence have been studied, but less is known about factors associated with MSK pain in young children. Our aim is therefore to describe the prevalence and characteristics of MSK pain in young children in a large population based birth cohort study and to identify associations between a variety of physical and psychosocial factors.

Methods

Study population

This study was embedded in the Generation R Study, a population-based prospective cohort study, focusing on growth, development and health from fetal life until young adulthood. Women with an expected delivery date between April 2002 and January 2006 and living in Rotterdam, The Netherlands, were eligible for participation in the study. The study was approved by the Medial Ethical Committee of the Erasmus Medical Center, Rotterdam, and written informed consent was obtained from the parents of all participants. Detailed information on the Generation R study cohort can be found elsewhere [25].

Procedures

For the current study, data of the follow-up phase at the age of six years was used. At this age a total of 8,305 children still participated in the study, 85% of the original cohort. Data was derived from physical examinations at the research center and parent-reported questionnaires, which were filled in by the biological mother in 91.6% of the cases. Information on pain was not available for 2,105 children who were therefore excluded from the current study, resulting in a final study sample of 6,200 children with information on the outcome. The sample size for the univariate analyses differs per analysis depending on the number of missings in the predictor (ranging from 0% for sex and age to 35.1% and 45.6% for mother and father reports of the child's pain at age 3 years). Regression analyses were conducted in a sample of 2569 children who had complete data on all predictors. .

Measurements – Questionnaires

Demographics

Information on child's sex was obtained from midwife and hospital records at birth. Ethnicity of the child was based on the country of birth of both parents (assessed by prenatal questionnaires and if necessary supplemented and corrected according to follow-up questionnaires). Parental educational level was categorized to high (higher education, phase 2), intermediate (higher education, phase 1) and low (no education finished, primary school, or secondary school). The net household income was dichotomized for less or more than €1600,- per month, based on the average income in The Netherlands.

MSK pain

The presence, location and characteristics of pain were assessed with the Pain List in all children [30]. All parents were asked if their child had had any pain in the past three months, which had to be recurring or lasting for longer periods of time and not just a result of falling or bumping. Additionally location, duration, frequency and intensity of the experienced pain, and the number of missed school days were questioned. A list of possible locations (head, stomach, back, arms or legs, neck, throat, ear, chest, other) was provided and parents were asked to check all locations were pain was experienced. MSK pain was in this study defined as pain in the back, neck or limbs. Duration was categorized in shorter than three months or longer than three months (i.e. chronic pain), counted from the day the parents filled in the questionnaire. Four categories were used to assess the frequency of occurrence of the pain (<1x/month, ≥1x/month to <2x/week, ≥1x/week, every day). Pain intensity was measured by the Visual Analogue Scale (VAS), ranging from 0 for no pain to 100 for the worst pain imaginable. All pain characteristics were questioned for the most bothering pain, not necessarily MSK pain. The number of missed school days due to pain in the past three months was assessed by an open ended question. Additionally to MSK pain at six years of age, MSK pain was assessed by the Pain List at the age of 36 months too, which was in this study defined as previous reported MSK pain. At this age there were separate questionnaires filled in by the mothers and the fathers.

Physical activity and sedentary behaviors

Both physical activity and sedentary behavior were analyzed according to a previous study by Wijtzes et al. (2014) [46]. Physical activity was evaluated using outdoor play, sports participation (yes or no) and active transport to/from school. Outdoor play was calculated by dividing the sum of mean hours of outdoor play on weekdays and weekend days by seven, and subsequently categorized in tertiles (<1 hour/day, 1-2 hours/day, and ≥2 hours/day). For active transport, the number of days on which the children walked or cycled to/from school (0-5 days) were summed up for the total number of days per week with active transport and consequently dichotomized into no active transport versus one or more days per week. Sedentary behaviors were measured by television viewing (including video/DVD) and computer use (including video games). The number of days and minutes per day that children viewed television or used the computer were asked for weekdays and weekend days. The mean daily television viewing and computer use was calculated by dividing the sum of mean

hours per day by seven. Daily television viewing was dichotomized into ≥2 hours/day versus <2 hours/day. Daily computer use was dichotomized into ≥1 hour/day versus <1 hour/day.

Child behavior

The Child Behavior Checklist (CBCL) was used to assess child behavior problems among the Generation R participants [2]. The CBCL is a widely used instrument to assess behavioral and emotional problems in children, and has a good reliability, validity and generalizability [2,20]. The CBCL questionnaire consists of 99 items divided in seven subscales: Emotionally Reactive, Anxious/Depressed, Somatic Complaints (without medical cause), Withdrawn behavior (from social contacts), Sleep Problems, Attention Problems and Aggressive Behavior. For the analyses, the total CBCL problem score, and the sum scores on internalizing problems (Emotionally Reactive, Anxious/Depressed, Somatic Complaints, and Withdrawn scales) and externalizing problems (Attention Problems and Aggressive Behavior scales) were calculated [2]. We also analyzed the Somatic Complaints scale separately, because items on Somatic Complaints are included in the internalizing problems sum score and the total CBCL score. Therefore, we additionally calculated these sum scores excluding the somatic items, to be able to assess whether or not the scores were driven by Somatic Complaints. Besides the continuous scores, the number of children with (sub)clinical problems was calculated following the cut-off scores from a Dutch reference group, based on the 84th percentile for the total score, internalizing and externalizing score, and the 93rd percentile for the somatic complaints. These cut-off scores are the standard for defining borderline/clinical problems, which includes enough problems to be of concern (borderline ranges), as well as so many problems that a child clearly deviates from norms for the child's gender and age range (clinical ranges) [2,39].

Measurements – Physical examination

Anthropometry

Child height was measured in standing position using a Harpenden stadiometer (Holtain Limited, Crymych, UK) and weight was measured without heavy clothing and shoes using a mechanical personal scale (SECA). Height and weight were used to calculate the BMI (kg/m^2). SD scores were calculated based on the Dutch reference growth curves [14]. Weight status was categorized according to the cut-offs by Cole [7], and dichotomized to underweight or normal weight versus overweight or obesity.

Statistical analyses

Descriptive statistics were used to describe child characteristics and prevalence of pain. Differences between children with MSK pain, children with pain at other sites ("other pain"), and children without pain ("no pain") were analyzed using the Chi-square test for categorical variables and the ANOVA (normally distributed), Mann-Whitney U (2 groups) and Kruskal-Wallis (>2 groups) tests for continuous variables. Subgroup analyses, using the same tests, were performed within the MSK pain group to compare children with MSK pain only and MSK pain together with other pain, and to compare chronic and non-chronic MSK pain. In addition, associations between demographics, physical and psychosocial factors with the presence of MSK pain were tested with multinominal logistic regression, both univariate and multivariable, expressed in Odds Ratios (OR) with 95% confidence intervals (CI). In case of collinearity, assessed by correlation coefficients, redundant variables were removed from the regression model. All analyses were conducted with non-imputed data, using SPSS software (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). The level of statistical significance was set at $p<0.05$.

Results

Of the 6,200 included children, approximately half were male (50.3%) (Table 1). The median age was 6 (IQR 5.79-6.17) years, the mean BMI SD score was 0.24 (SD 0.92), and 61.2% of the children had a Dutch ethnicity. The maternal educational level was low in 43.1% of the children. The included participants in the present study differed from the excluded participants, as they had a significantly lower age, had more often a Dutch ethnicity, the maternal educational level was higher and they had a lower BMI SD score (Supplementary Table 2, available at http://links.lww.com/PAIN/A940).

In the 6-year questionnaire, 27.2% of the parents reported that their children had experienced pain in the previous 3 months. The three month prevalence of MSK pain was 10.0%, with limb pain as the most reported location (8.9%), followed by neck pain (1.0%) and back pain (0.9%) (Table 2). No differences were seen in the prevalence of MSK pain between boys and girls.

In 35.6% of the children, the pain existed for more than three months and was therefore classified as chronic pain (table 3). Out of the 617 children with MSK pain, 62.6% of the children missed one or more school days in the past three months due to pain. Within the MSK pain group, 44.6% of the children also experienced pain at other sites. Most often in the

stomach (31.3%) or the head (19.8%). No differences were seen in pain characteristics between boys and girls.

Differences between children with MSK pain, pain at other sites, or without pain

Differences in demographics, physical and psychosocial factors between the groups of children with MSK pain, pain at other sites and children without pain are also presented in Table 1. The MSK pain group consisted of more boys compared to the other pain group (53.0% versus 46.0%). Also, in the MSK pain group, there were less parents with a high educational level compared to the other pain group and no pain group (maternal education: 24.2%, 30.3% and 29.9%, respectively). There were more children with a houshold income <€1600/month in the groups of children with MSK pain and children with other pain, compared to the group of children without pain (19.4%, 18.2% and 15.5%, respectively).

No differences were seen for BMI, weight status, and height between the three groups. Neither were any associations found between physical activity and MSK pain, but more children with MSK pain than children without pain watched television ≥2 hours/day (22.7% versus 18.3%). More children with MSK pain at the age of 6 had MSK pain at 3-years of age than children with other pain or without pain (reported by mother: 14.4%, 6.5% and 3.3%, respectively).

The total CBCL score, as well as the internalizing and externalizing problem scores, were significantly higher in the children with MSK pain and pain at other sites compared to children without pain ($p<0.001$). These differences remained after excluding the somatic complaints from the scales. Analyses with the CBCL scores dichotomized into (sub)clinical problems versus no problems indicated that in the pain groups, more children had (sub)clinical behavioral problems ($p<0.001$). No differences were seen in the precense of behavioral problems between the children with MSK pain and pain at other sites.

Regression analyses

Significant associations with the presence of MSK pain compared to no pain were seen only for the presence of MSK pain at the age of 3 years old (univariate: OR 5.14, 95%CI 3.29 to 8.02; multivariable: OR 5.10, 95%CI 3.25 to 7.98) and behavioral problems (univariate: OR 2.15, 95%CI 1.24 to 3.73; multivariable: OR 2.10, 95%CI 1.19 to 3.72) (Table 4).

Subgroup analyses

Less children with overweight were seen in the group of children with MSK pain only compared to the group having MSK and other pain (12.5% versus 18.9%) (Supplementary Table 1, available at http://links.lww.com/PAIN/A940). Furthermore, there were less children with a low or high amount of outdoor play in the only MSK pain group. All behavioral problem scores were significantly higher among children with MSK pain together with other pain, compared to those with only MSK pain.

More boys were seen in the chronic MSK pain group compared to the non-chronic MSK pain group (61.8% versus 49.8%,), and the chronic pain group contains more children with MSK pain at 3-years of age compared to the non-chronic pain group (reported by mothers; 20.0% versus 10.1%) too. No differences were seen between these two groups for the behavioral problem scores.

Discussion

In this study, a three-month prevalence of 10.0% was found for MSK pain in children, of which about one third was chronic, In 44.6% of the cases MSK pain was experienced together with pain at other sites. Univariate analyses showed that boys, children with a lower socioeconomic status (SES) and children with MSK pain at 3 years of age reported MSK pain at the age of 6 years more frequently compared to other pain and no pain. While no associations were found between MSK pain and children's BMI and physical activity level, children with MSK pain were more likely to watch television ≥2 hours/day compared to children without pain. Finally, more behavioral problems were seen both in children with MSK pain and children with other pain compared to children without pain. There were no differences between children with MSK pain and children with other pain regarding the behavioral problems. Multivariable analysis showed significant associations for MSK pain at 3 years of age (OR 5.10, 95%CI 3.25 to 7.98) and behavioral problems (OR 2.10, 95%CI 1.19 to 3.72) with the presence of MSK pain at the age of 6 years.

The total three-month prevalence of 27.2% for pain in this study is lower than the prevalence of 50-60% described in previous studies [6,17,30,45]. For MSK pain in particular, a broad prevalence range has been reported, ranging from 3.9 to 40.0% for children aged 9-18 years old, with a reporting period ranging from point prevalence up to six months [23]. Similar to pain in general, the prevalence of MSK pain of 10.0% in the present study is lower than

reported in most previous studies, which may be explained by the younger age of the children in this study. The pain questions being part of a comprehensive study on the child's health might have resulted in a lower prevalence too. Little focus on child's pain in the survey and less selective response than in specific pain studies perhaps results in a more realistic reflection of reality in the general population. The most reported location of MSK pain was pain in arms or legs, where growing pains may be involved, which are known to be already present at this age [12]. MSK pain was often seen together with pain at other sites, frequently recurring (i.e. ≥1x/month in 78.9% of the children) and already chronic in a third of the children. These characteristics, together with the already relatively high prevalence at this age and known burden of disease [1,8], indicates that MSK pain is already a relevant problem in young children.

SES is known to be a predictor for diverse health outcomes [26,27], which is also seen in the present study, as MSK pain was related to a lower SES in the univariate analyses. It is notable that the known association between SES and MSK pain in adults [15,32] seems already present in young children. However, the association was no longer present when multivariable testing was applied. The univariate relation found between SES and MSK pain in children reported by their parents, might be a reflection of the parent's health perception. Health perception is worse in people with lower SES, which might have led to reporting more pain for their children by parents with lower SES [32,34]. However, this does not mean that a true association between SES and MSK pain is lacking, as the association between lower SES and health problems is well known, and shown to be present for pain too [40].

The association between overweight and MSK complaints, that is clearly present in adults [4,33,35] but debated in previous literature on children [29,31,43], was not found in the present study. An explanation might be that the children in this study are of a young age, and a longer period of exposure is needed to experience the negative consequences of a higher BMI. Furthermore, the BMI SD score was significantly lower in the present study sample compared to the total study population. The number of children with a high BMI might have been too small to be able to analyze its relation with the presence of MSK pain.

In this study, physically inactive children seemed to experience more MSK pain, based on hours television watching. However, this relation was not seen in multivariable analysis, and no clear association was found between the level of physical activity and MSK pain. The latter might be due to the lack of information about the intensity of the physical activity, as it has been found that the intensity of physical activity seems to play an important role for the

presence of spinal pain [13]. Furthermore, sedentary behavior is not simply not being active, which might explain the different results from univariate analyses [38,41]. [13][38,41][13]

A strong association was found between the presence of MSK pain at 3 years of age and MSK pain at 6 years of age. This finding is consistent to the existing literature showing that a previous episode of MSK pain is an important risk factor for a new episode of pain in adolescents [11,31]. The association found in the present study might reflect the nature of MSK pain, a type of pain which seems to be long lasting or recurrent for many children. Additionally, family clustering might play a role in this finding, as children with a family history of MSK pain have a higher risk of experiencing MSK pain themselves [10] and this risk remains over years.

The presence of MSK pain and pain in general was in this study associated with behavioral problems, measured with the CBCL, both in univariate as in multivariable analyses. Psychosocial problems are known to be an important risk factor for the onset and a poorer prognosis of MSK pain in adolescents and adults [18,28,44], and we provide evidence that this relation already seems present in young children too. Furthermore, the association between pain and behavioral problems suggests clustering of physical and psychosocial health problems, which is also seen for other pain locations in the present study and a previous study on chronic multisite pain in adolescents [37]. Poor emotion regulation, which is known to be related to both behavioral problems and pain experience, might play a role [3,9,24,36]. These associations are especially important for health care professionals as they do have to be aware of psychosocial factors that can play a role in pain experience, already in young children.

Strengths and limitations

Strengths of the present study are the large size of the study population with a prospective population based design and the availability of information on several factors studied within the same study sample. The cohort design of the study enabled us to include data from questionnaires at different time points, including the assessment of history of MSK pain. The presence of MSK pain was also assessed at 36 months and not retrospectively, and therefore providing reliable data less prone to recall bias.

Some limitations should be taken into account for the present study. First of all, the main outcome, MSK pain, was studied based on a parent-reported questionnaire. The reliability of this data could be debated. It might be difficult for young children to describe the presence and nature of pain and for the parents to objectively report this. However, for this age group, the parents are the ones to decide whether or not to limit or stimulate their children in their

activities or to seek healthcare, based on their interpretation of their child's pain. Secondly, because the missing values in the multivariable analysis were selective (i.e. not random), imputation was not suitable. Though we expect the differences between the univariate and multivariable analyses are a result of the decrease in power rather than reflecting a selection bias, since univariate ORs in the total study sample (n=6200) were comparable (similar size and direction) but had smaller confidence intervals compared to the univariate ORs in the small study sample (n=2569). Furthermore, no inferences could be made on causality or direction of associations due to the cross-sectional approach of the analyses. And, as multiple factors were tested without correction for multiple testing, the results should be interpreted with caution. Selection bias towards a more healthy and Western population and higher SES might have occurred, as known in the general follow up of the Generation R Study [21] and seen in the non-response analysis of the selected study sample. As a result of this selection, there may be an underestimation of pain, as those of lower SES are more likely to report pain. Finally, the results on pain characteristics might not strictly represent characteristics of MSK pain, as these characteristics were questioned for the most bothering pain, which was unknown in case of multiple pain locations and might therefore not necessarily be MSK pain.

Conclusion

This study shows that MSK pain is already common in young children and is often chronic or recurrent. Furthermore, previous reported MSK pain and behavioral problems are associated with the presence of MSK pain in the studied population. Further research and longitudinal designs are needed to assess the direction of these associations and to give insight in the underlying mechanisms.

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Tables

Table 1 – Differences between children with MSK pain, pain at other sites, and children without pain

		Total n=6200	MSK pain n=617	Other pain n=1068	No pain n=4515	p-value
Demographics						
Sex, boy		3121 (50.3)	327 (53.0)[a]	491 (46.0)[a,b]	2303 (51.0)[b]	**0.005**
Age, years		5.95 (5.79-6.17)	5.95 (5.78-6.19)	5.96 (5.80-6.21)	5.94 (5.78-6.16)	0.387
Ethnicity	Dutch	3790 (61.2)	374 (60.6)	633 (59.4)	2783 (61.7)	0.260
	Other western	584 (9.4)	50 (8.1)	98 (9.2)	436 (9.7)	
	Non-western	1822 (29.4)	193 (31.3)	335 (31.4)	1294 (28.7)	
Maternal educational level	High	1799 (29.4)	147 (24.2)[a,b]	319 (30.3)[a]	1333 (29.9)[b]	**0.041**
	Intermediate	1679 (27.5)	175 (28.8)	276 (26.2)	1228 (27.6)	
	Low	2634 (43.1)	286 (47.0)[a]	457 (43.4)	1891 (42.5)[a]	
Paternal educational level	High	1952 (35.0)	172 (31.0)[a]	356 (38.0)[a]	1424 (34.9)	**0.036**
	Intermediate	1269 (22.8)	136 (24.5)[a]	186 (19.8)[a,b]	947 (23.2)[b]	
	Low	2354 (42.2)	247 (44.5)	396 (42.2)	1711 (41.9)	
Household income, <€1600/month		942 (16.3)	112 (19.4)[a]	180 (18.2)[b]	650 (15.5)[a,b]	**0.012**
Single parenthood, yes		853 (13.9)	91 (14.9)	174 (16.5)[a]	588 (13.2)[a]	**0.015**
Physical factors						
BMI, SD score		0.24 (SD 0.92)	0.21 (SD 0.94)	0.24 (SD 0.95)	0.25 (SD 0.90)	0.618
Overweight, yes		907 (16.2)	87 (15.4)	167 (17.0)	653 (16.1)	0.671
Height, SD score		-0.19 (SD 1.00)	-0.18 (SD 1.04)	-0.21 (SD 1.03)	-0.19 (SD 0.99)	0.840

Sedentary behaviors						
Television viewing, hours/day		1.14 (0.71-1.75)	1.21 (0.75-1.93)[a]	1.14 (0.71-1.79)	1.14 (0.71-1.75)[a]	0.054
Television viewing, ≥ 2 hours/day		1070 (19.0)	128 (22.7)[a]	188 (19.8)	754 (18.3)[a]	**0.036**
Computer game use, hours/day		0.18 (0.04-0.43)	0.21 (0.036-0.43)	0.14 (0.036-0.43)	0.14 (0.036-0.43)	0.534
Computer game use, ≥ 1 hour/day		433 (7.7)	38 (6.9)	80 (8.4)	315 (7.7)	0.559
Physical activity behaviors						
Outdoor play	< 1 hour/day	1750 (34.2)	188 (37.3)	316 (35.4)	1246 (33.5)	0.158
	1-2 hours/day	1837 (35.9)	185 (36.7)	322 (36.1)	1330 (35.7)	
	≥ 2 hours/day	1530 (29.9)	131 (26.0)[a]	254 (28.5)	1145 (30.8)[a]	
Sports participation, yes		2696 (44.2)	269 (44.7)	456 (43.5)	1971 (44.3)	0.864
Active transport, never		1244 (21.9)	107 (19.1)	204 (20.9)	933 (22.5)	0.138
Previous MSK pain						
MSK pain @3 years – mother, yes		195 (4.8)	55 (14.4)[a,b]	43 (6.5)[a,c]	97 (3.3)[b,c]	**<0.001**
MSK pain @3 years – father, yes		136 (4.0)	42 (13.3)[a,b]	23 (4.2)[a]	71 (2.8)[b]	**<0.001**
Psychosocial factors						
Child behavioral problems (CBCL)						

Total problems, score	16.00 (8.00-28.00)	22.00 (12.00-34.00)[a]	21.00 (11.00-36.00)[b]	14.00 (7.00-25.00)[a,b]	**<0.001**
(Sub)clinical total problems, yes	450 (7.4)	65 (10.7)[a]	127 (12.2)[b]	258 (5.8)[a,b]	**<0.001**
Internalizing problems, score	4.00 (2.00-8.00)	6.17 (3.00-11.00)[a]	7.00 (3.09-11.00)[b]	4.00 (1.00-7.00)[a,b]	**<0.001**
(Sub)clinical internalizing problems, yes	715 (11.7)	111 (18.3)[a]	207 (19.9)[b]	397 (8.9)[a,b]	**<0.001**
Externalizing problems, score	6.00 (2.00-11.00)	8.00 (4.00-13.00)[a]	7.00 (3.00-13.00)[b]	5.00 (2.00-10.00)[a,b]	**<0.001**
(Sub)clinical externalizing problems, yes	423 (6.9)	48 (7.9)	103 (9.9)[a]	272 (6.1)[a]	**<0.001**
Somatic complaints, score	1.00 (0.00-2.00)	2.00 (1.00-4.00)[a,b]	2.00 (1.00-4.00)[b,c]	1.00 (0.00-2.00)[a,c]	**<0.001**
(Sub)clinical somatic complaints, yes	468 (7.7)	105 (17.3)[a]	193 (18.6)[b]	170 (3.8)[a,b]	**<0.001**

Values presented as number (%) for categorical factors, or median (interquartile range) or mean (SD) for continuous factors.

[a,b,c] – Indicates the subgroups that significantly differ from each other, based on post-hoc analyses. This table is based on non-imputed data. Missings were 0 for sex, 0 for age, 4 (0.065%) for ethnicity, 88 (1.4%) for maternal educational level, 625 (10.1%) for paternal educational level, 431 (7.0%) for household income, 67 (1.1%) for single parenthood, 1321 (21.3%) for current smoking of the mother, 587 (9.5%) for BMI and height, 594 (9.6%) for overweight, 572 (9.2%) for television viewing, 605 (9.7%) for computer game use, 1083 (17.5%) for outdoor play, 97 (1.6%) for sports participation, 515 (8.3%) for active transport, 2175 (35.1%) for MSK pain @3 years – mother, 2828 (45.6%) for MSK pain @3 years – father, 107 (1.7%) for the Child Behavior Checklist (CBCL) total score, 111 (1.8%) for the CBCL internalizing problems score, 85 (1.4%) for the CBCL externalizing problems score, and 110 (1.8%) for the CBCL somatic complaints score.

Table 2 – Prevalence of musculoskeletal pain, experienced in the past three months

	Total n=6200	Boys n=3121	Girls n=3079	p-value
Any pain	1685 (27.2)	818 (26.2)	867 (28.2)	0.085
MSK pain	617 (10.0)	327 (10.5)	290 (9.4)	0.164
Back pain	46 (0.7)	19 (0.6)	27 (0.9)	0.219
Neck pain	59 (1.0)	32 (1.0)	27 (0.9)	0.547
Limb pain	553 (8.9)	295 (9.5)	258 (8.4)	0.138

Values presented as number (%).

Table 3 – Pain characteristics in the MSK pain group (N=617)

	Total **n=617**	**Boys** **n=327**	**Girls** **n=290**	**p-value**
Frequency of occurrence				
< 1x/month	127 (21.2)	71 (22.4)	56 (19.8)	0.562
≥ 1x/month, < 1x/week	319 (53.2)	160 (50.5)	159 (56.2)	
≥ 1x/week	135 (22.5)	76 (24.0)	59 (20.8)	
Every day	19 (3.2)	10 (3.2)	9 (3.2)	
Pain intensity	40.0 (24.0-60.0)	40.5 (24.0-60.0)	35.0 (24.0-58.0)	0.197
Pain duration, >3 months	213 (35.6)	120 (37.6)	93 (33.2)	0.261
Missed school days				
None	90 (37.5)	46 (35.9)	44 (39.3)	0.863
1-2 days	69 (28.8)	38 (29.7)	31 (27.7)	
3 or more days	81 (33.8)	44 (34.4)	37 (33.0)	
Pain at other sites				
Yes	275 (44.6)	143 (43.7)	132 (45.5)	0.656
Head	122 (19.8)	66 (20.2)	56 (19.3)	0.786
Stomach	193 (31.3)	95 (29.1)	98 (33.8)	0.205
Chest	15 (2.4)	8 (2.4)	7 (2.4)	0.979
Other	104 (16.9)	54 (16.5)	50 (17.2)	0.810

Values presented as number (%) for categorical factors, or median (interquartile range) for continuous factors. IQR = interquartile range. This table is based on non-imputed data. Missings were 17 (2.8%) for frequency of occurrence, 116 (18.8%) for pain intensity, 18 (2.9%) for pain duration, 377 (61.1%) for missed school days, and 0 for pain at other sites.

Table 4 – Univariate and multivariable regression analyses for the presence of MSK pain compared to no pain

		Univariate analyses OR (95%CI)	Multivariable analysis OR (95%CI)
Demographics			
Sex, boy		1.10 (0.84; 1.44)	1.09 (0.82; 1.44)
Age, years		1.13 (0.75; 1.70)	1.15 (0.76; 1.75)
Ethnicity	Dutch	Reference	Reference
	Other western	0.86 (0.52; 1.42)	0.88 (0.53; 1.46)
	Non-western	0.98 (0.69; 1.39)	0.94 (0.64; 1.38)
Maternal educational	High	0.97 (0.70; 1.36)	0.94 (0.65; 1.35)
level	Intermediate	1.21 (0.87; 1.70)	1.20 (0.84; 1.70)
	Low	Reference	Reference
Single parenthood, yes		0.89 (0.55; 1.45)	0.89 (0.54; 1.48)
Physical factors			
BMI, SD score		0.97 (0.82; 1.14)	0.97 (0.82; 1.15)
Height, SD score		1.01 (0.88; 1.16)	1.02 (0.88; 1.17)
Television viewing, ≥ 2 hours/day		1.14 (0.79; 1.66)	1.16 (0.77; 1.75)
Computer game use, ≥ 1 hour/day		1.00 (0.57; 1.78)	0.96 (0.52; 1.75)
Outdoor play	< 1 hour/day	Reference	Reference
	1-2 hours/day	1.07 (0.78; 1.47)	1.05 (0.76; 1.45)
	≥ 2 hours/day	0.84 (0.59; 1.19)	0.81 (0.56; 1.15)
Sports participation, yes		1.12 (0.86; 1.47)	1.18 (0.89; 1.57)
Active transport, never		0.72 (0.50; 1.01)	0.71 (0.50; 1.02)

MSK pain @3 years – mother, yes	**5.14 (3.29; 8.02)**	**5.10 (3.25; 7.98)**
Psychosocial factors		
CBCL - (Sub)clinical total problems, yes	**2.15 (1.24; 3.73)**	**2.10 (1.19; 3.72)**

Odds Ratio's (OR) and 95% confidence intervals (CI) resulting from multinominal logistic regression, including 2569 participants (non-imputed data).