Musculoskeletal Complaints Among 11-Year-Old Children and Associated Factors

The PIAMA Birth Cohort Study


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Musculoskeletal complaints (MSC) are common among children, often persist into adolescence, and increase the risk of MSC in adulthood. Knowledge regarding determinants of MSC among children is limited. The aim of this study was to determine the prevalence of MSC at age 11 years and to examine associations with sociodemographic factors, growth and development factors, mental health, tiredness, and lifestyle. Data from a Netherlands birth cohort study, the Prevention and Incidence of Asthma and Mite Allergy (PIAMA) Study (n = 2,638), were used (1996–2009). MSC were defined as complaints about the back, an upper extremity, a lower extremity, or any of these sites. Logistic regression analyses using a forward stepwise procedure were performed on multiply imputed data. The 1-year period prevalences of back, upper extremity, and lower extremity complaints that lasted at least 1 month were 2.8%, 4.8%, and 10.9%, respectively. Only poorer mental health was consistently associated with all 3 types of complaints. Poorer mental health, daytime tiredness, early pubertal development, being physically active at age 11 years, and weight-for-height z score were associated with having any MSC. This study showed that MSC, especially lower extremity complaints, are common among 11-year old-children and that only poorer mental health status is associated with MSC at all anatomic sites.

Musculoskeletal complaints (MSC) are common in children, with prevalences up to 32% being reported for children aged 10–12 years (1). This may have a large health impact, since pain can result in restrictions in daily living activities, including school attendance, participation in hobbies, maintenance of social contacts, and sleep problems (2). Additionally, it has been suggested that approximately 40% of children with MSC still have complaints 4 years later (3) and that MSC in childhood substantially increases the risk of MSC in adulthood (4–6), which is a major public health problem with a high economic burden (7, 8). A better understanding of the determinants of MSC in childhood may help in developing preventative strategies for children.

Low socioeconomic status, being overweight, physical activity, a sedentary lifestyle, and mental health problems have been suggested as risk factors for MSC among children or adolescents. However, until now the number of studies has been limited and the results have been inconsistent (9, 10). For instance, some studies showed that physical activity is associated with increased MSC among children or adolescents (11, 12), while other studies found a protective association (13) or no association (14, 15). In addition, most evidence pertains to adolescents aged 12–16 years. Studies in children below age 11 years have not investigated the role of possible risk factors such as socioeconomic status, ethnicity, pubertal status, and changes in weight, height.

Abbreviations: CI, confidence interval; MHI-5, Five-Item Mental Health Inventory; MSC, musculoskeletal complaints; OR, odds ratio; PIAMA, Prevention and Incidence of Asthma and Mite Allergy.
and physical activity over time. Furthermore, most previous research in youth has focused on back pain and, to a lesser extent, on neck pain, shoulder pain, and specific MSC. However, MSC regarding all body parts are common (1, 9, 14), even among children (1). Therefore, additional research is needed, including research on MSC at different anatomic sites and a variety of possible risk factors for MSC, for a better understanding of the occurrence of MSC in children.

Our objective in this study was to determine the prevalence of MSC at age 11 years in a birth cohort study (the Prevention and Incidence of Asthma and Mite Allergy (PIAMA) Study) and to examine which factors are associated with MSC at age 11. We studied back complaints, upper extremity complaints, and lower extremity complaints and their associations with several sociodemographic factors, growth and development factors, psychosocial factors, and lifestyle.

MATERIALS AND METHODS

Study design and study population

Data from the population-based PIAMA Study, which was originally designed to investigate asthma, were used. Details of the study design have been published previously (16). The baseline cohort consisted of 4,146 pregnant women selected at prenatal health clinics in the Netherlands in 1996 and 1997 who agreed to participate and gave written informed consent. A total of 183 participants were lost to follow-up before any data on their children had been obtained, so the study started with 3,963 newborn children. Questionnaires were sent to the participating parents during the last trimester of pregnancy, at the child’s age of 3 months, at the child’s age of 1 year, and annually until age 8 years. At the age of 11 years, questionnaires were sent to both the parents and the child. Our study population consisted of the 2,638 children who completed the questionnaire at age 11 years. Although a few (3.9%) of the children were aged 10 or 12 years when they completed the questionnaire, we refer to them here as 11-year-olds.

Musculoskeletal complaints

Complaints of musculoskeletal pain in the back, upper extremities, and lower extremities were measured as part of a 15-item list of diseases and complaints, which started with: “Could you mark for the following diseases or conditions whether you have had it in the past 12 months (= last year) and whether you visited your doctor in the past 12 months for that reason?” The questionnaire further specified, “If ‘long-lasting’ is stated, we mean conditions which bothered you in total for more than 1 month,” using the following 3 items: “long-lasting back complaints,” “long-lasting complaints of the neck, shoulder, elbow, wrist, or hand,” and “long-lasting complaints of the hip, knee, ankle, or foot.” Children were able to answer “no,” “yes, but I did not visit the doctor,” or “yes, I visited the doctor for this complaint.” “Any MSC” was defined as complaints in one or more of the 3 categories of complaints.

Determinants of MSC

Many variables were measured in the PIAMA Study, but we could only use a limited number of variables because of statistical power issues. We chose variables from different domains: sociodemographic characteristics, growth and development factors, psychosocial factors, and lifestyle.

Maternal educational level when the child was 1 year old was used as a proxy for socioeconomic status. Highest attained educational level was divided into 3 categories: primary school, lower vocational education, or lower secondary education (low); intermediate vocational education or intermediate/higher secondary education (intermediate); and higher vocational education or university degree (high).

Children were classified as non-Western migrants if 1 or both parents had been born in a non-Western country. Children were classified as native Dutch if both parents had been born in the Netherlands. The remaining children were classified as Western migrants.

The child’s body weight (in kilograms), height (in centimeters), and date of last measurement were reported at ages 8 and 11 years. Since the height and weight of a child change with age, measures of body mass index, height, or weight alone are inappropriate for comparisons of groups of children (17). For that reason, we calculated sex-specific standard deviation scores (z scores) for height-for-age and weight-for-height using Growth Analyser software (http://www.growthanalyser.org), based on the reference growth curves of the Dutch Fourth Nationwide Growth Study (18). Weight change in kilograms per year and height change in centimeters per year were defined as the change in weight and height per year between ages 8 and 11 years.

Pubertal status was measured with the Pubertal Development Scale (19), including growth spurt, pubic hair, and skin change for boys and girls. Data on facial hair growth and voice change were recorded only for boys and on breast development and menarche only for girls. The response options were scored on a 4-point ordinal scale which ranged from 1 (no development) to 4 (development already completed). The menarche item was scored 1 if no menstrual periods had occurred and 4 if menstrual periods had already begun. The scores were summed and divided by 5 in order to preserve the original 1–4 metric.

Mental health status and daytime tiredness were included as indicators of psychosocial factors. The Five-Item Mental Health Inventory (MHI-5) is a brief screening questionnaire for mood and anxiety disorders that has been validated in adults (20). This questionnaire has been used previously to assess mental health status among adolescents (14, 21, 22). The MHI-5 consists of the following 5 questions: “How much of the time during the past month 1) have you been a very nervous person?; 2) have you felt calm and peaceful?; 3) have you felt downhearted and blue?; 4) have you been a happy person?; and 5) have you felt so down in the dumps that nothing could cheer you up?” We used a 5-point Likert scale ranging from 1 (all the time) to 5 (never) (23). All scores were summed and transformed into a scale ranging from 0 to 10, with higher scores indicating better mental health.

Two questions were used to assess daytime tiredness. Children were asked how many times a week they felt tired during
the day and fell asleep at school. Children were classified as daytime tired when they answered 1 or both questions positively (≥2 times per week).

The children’s level of physical activity was assessed at ages 5, 7, and 8 years through questionnaires completed by the parents. Children were categorized as “active” when they engaged in at least 1 hour of activity of moderate-to-vigorous intensity on a normal weekday or when they walked/bicycled to school for at least 1 hour on a normal weekday. At age 11 years, the children filled out the questionnaire themselves.

The first question referred to active movement, and examples were given (sports, gym classes at school, cycling, walking, rope jumping, playing tag, walking a dog, delivering newspapers, etc.). The question was formulated as: “How many days a week are you active (altogether) for at least 1 full hour a day?” If a child responded “5 or more days,” he/she was classified as being active. A second question was asked: “How many minutes are you normally walking or cycling from home to school and back?” Children were classified as being physically active when they responded “more than 60 minutes.” We constructed 2 variables for physical activity—physical activity at age 11 years and a variable comparing the children who were “active” at all ages (5–11 years) with those who were inactive at one or more ages.

Watching television and using a computer during leisure time were combined to study sedentary lifestyle at age 11 years. Since recommendations for the duration of screen time among children are set at a maximum of 2 hours per day (24), we dichotomized the mean daily duration of television-watching and/or after-school computer use at 2 hours/day (≤2 hours/day vs. >2 hours/day).

**Statistical analyses**

The statistical analyses included variables that were measured either once or several times during PIAMA follow-up. Firstly, univariable logistic regression analyses were conducted for all variables, and a P value lower than 0.05 was considered statistically significant. Results from all univariable analyses were adjusted for age (in months) and sex. Secondly, the contributions of all factors were explored by means of multivariable analyses using a stepwise forward selection procedure. Age (months) and sex were included in every step of the multivariable analyses, and an entry probability for each variable was set at 0.05. SAS software, version 9.2 (SAS Institute, Inc., Cary, North Carolina), was used. Odds ratios and 95% confidence intervals are reported.

Data on most cross-sectional variables contained only a few missing values (<5.2%), but combining prospectively measured data and multivariable models may lead to exclusion of a substantial proportion of observations. Furthermore, the missing data are unlikely to be “missing completely at random,” and a complete-case analysis may lead to biased results. Therefore, missing data were multiply imputed using the “multivariate imputation by chained equations” method in the statistical program R, version 2.5.0 (http://rss.acs.unt.edu/Rdoc/library/mice/html/mice.html). This technique is considered the best available method for dealing with missing data (25, 26). The imputation matrix consisted of all original outcome variables and independent variables included in this study. Geographic region, other health problems, general health, and television/computer use at ages 5, 7, and 8 years were also included in the imputation matrix. Twenty imputed data sets were created and analyzed by standard logistic regression analysis. Results from these analyses were combined using PROC MIANALYZE in SAS. In addition, we conducted sensitivity analysis to compare the univariable odds ratio lower extremity complaints by 10.9% (10.4% of boys and 11.2% of girls; P > 0.05), and any MSC by 15.8% (14.1% of boys and 17.1% of girls; P < 0.05). One percent of the children visited a physician because of their back complaints, 2.2% because of upper extremity complaints, 5.7% because of lower extremity complaints, and 7.9% because of any MSC. Baseline characteristics in the original data set and the multiply imputed data set were very similar (Table 1).

Mental health status was the only variable that was significantly (P < 0.05) associated with all types of MSC in the multivariable analyses; poorer mental health was associated with more MSC (Table 2). Taking all MSC together, a poorer mental health score (odds ratio (OR) = 0.83, 95% confidence interval (CI): 0.75, 0.92), advanced pubertal status (OR = 1.36, 95% CI: 1.09, 1.70), the presence of daytime tiredness (OR = 1.60, 95% CI: 1.18, 2.15), being physically active at age 11 years (OR = 1.28, 95% CI: 1.02, 1.60), and higher weight (weight-for-height z score (OR = 1.12, 95% CI: 1.01, 1.25) were significantly associated with more MSC.

For lower extremity complaints, associations were also found with weight gain, the presence of daytime tiredness, and being physically active at age 11 years. In addition, greater numbers of upper extremity complaints were reported by children of non-Western origin. Back complaints were associated only with poorer mental health. In the univariable analyses, the presence of daytime tiredness and advanced pubertal status were also associated with more MSC in 2 of the 3 musculoskeletal locations. Pubertal stage was significantly associated with back complaints in boys (OR = 2.86, 95% CI: 1.14, 7.15) but not in girls (OR = 1.09, 95% CI: 0.65, 1.84), and this sex difference was borderline significant (P = 0.08 for interaction). Parental educational status, height, height gain, television/computer use, and physical activity from ages 5 to 11 years were not significantly associated with any of the outcomes in multivariable analyses.

The directions of the associations—statistically significant or not—did not differ for the different MSC, except for physical activity. Being physically active at age 11 years and always being active from age 5 years to age 11 years were associated with a decreased (though nonsignificant) risk of back complaints and an increased (P < 0.01) risk of lower extremity complaints.
The sensitivity analysis showed similar directions of results and only small differences in odds ratios between the complete-case analyses and the imputed-data analyses.

DISCUSSION

The present study shows that at age 11 years, the prevalence of any MSC is 16%. Of a number of factors assessed, only poorer mental health was consistently associated with MSC at the different anatomic sites.

To our knowledge, this is the first time that such a large variety of factors in relation to MSC among young children has been explored both cross-sectionally and longitudinally (i.e., physical activity, weight, and height). Since PIAMA was not originally designed to study MSC, there are some limitations as well. Firstly, we had no information on MSC before the age of 11 years, which prevented us from studying patterns of MSC early in the life course. However, accurate measurement of MSC earlier in children’s lives is not possible, because younger children are unable to fill out questionnaires (10) and parents may not be a reliable source of information on their children’s pain (27). Secondly, the results of our study relate to complaints that had lasted for at least 1 month in the past 12 months. An emphasis on long-lasting complaints can ensure that only the more severe cases are identified (28), but no information regarding intensity and frequency of the complaints was available. We were not able to conduct stratified analyses for children who visited a physician for their complaints, because of statistical power issues.

Thirdly, some associated factors were measured only at age 11 years, allowing for cross-sectional analyses only. Thus, it is difficult to distinguish between causes and consequences of MSC. Furthermore, obtaining accurate and reliable self-reported measures of physical activity among children is difficult, because their physical activity is characterized by frequent short bursts of activity (29) and children have poor recall of activity intensity and duration (30). In addition, children’s physical activity levels at ages 5, 7, and 8 years were reported by the parents, which may not be an accurate measure of physical activity at those ages (31).

A fourth limitation is that we had a relatively high number of children with higher socioeconomic status, but socioeconomic status does not appear to affect MSC (32). At 11 years of follow-up, response rates were still acceptably high, with 67% of children responding. According to stratified analyses (results not presented), differences in socioeconomic status...
Table 2. Associations of Various Factors With Musculoskeletal Complaints in 11-Year-Old Children (n = 2,638), Prevention and Incidence of Asthma and Mite Allergy (PIAMA) Study, 1996–2009\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>Back Complaints</th>
<th>Upper Extremity Complaints</th>
<th>Lower Extremity Complaints</th>
<th>Any Musculoskeletal Complaints</th>
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<tbody>
<tr>
<td></td>
<td>Univariable</td>
<td>Multivariable</td>
<td>Univariable</td>
<td>Multivariable</td>
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<tr>
<td></td>
<td>Analysis</td>
<td>Analysis(^b)</td>
<td>Analysis</td>
<td>Analysis</td>
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<td></td>
<td>OR 95% CI</td>
<td>OR 95% CI</td>
<td>OR 95% CI</td>
<td>OR 95% CI</td>
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<tr>
<td>Sociodemographic factors</td>
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<tr>
<td>Maternal educational level</td>
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<tr>
<td>Low</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Intermediate</td>
<td>0.62</td>
<td>0.34, 1.16</td>
<td>0.80</td>
<td>0.48, 1.32</td>
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<td>High</td>
<td>0.58</td>
<td>0.32, 1.07</td>
<td>0.93</td>
<td>0.56, 1.53</td>
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<tr>
<td>Ethnicity</td>
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<tr>
<td>Native Dutch</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Western migrant</td>
<td>1.10</td>
<td>0.34, 3.58</td>
<td>1.01</td>
<td>0.37, 2.79</td>
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<tr>
<td>Non-Western migrant</td>
<td>1.72</td>
<td>0.68, 4.37</td>
<td>2.43(^*)</td>
<td>1.26, 4.67</td>
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<tr>
<td>Growth and development</td>
<td></td>
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<tr>
<td>Pubertal status (1–4)</td>
<td>1.23</td>
<td>0.77, 1.96</td>
<td>1.46(^*)</td>
<td>1.03, 2.05</td>
</tr>
<tr>
<td>Height-for-age and -sex z score</td>
<td>1.08</td>
<td>0.85, 1.38</td>
<td>1.16</td>
<td>0.96, 1.42</td>
</tr>
<tr>
<td>Height gain, cm/year</td>
<td>0.97</td>
<td>0.77, 1.22</td>
<td>1.02</td>
<td>0.86, 1.22</td>
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<tr>
<td>Weight-for-height z score</td>
<td>1.11</td>
<td>0.88, 1.40</td>
<td>1.06</td>
<td>0.89, 1.27</td>
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<td>Weight gain, kg/year</td>
<td>1.05</td>
<td>0.86, 1.29</td>
<td>1.04</td>
<td>0.88, 1.22</td>
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<td>Psychosocial factors</td>
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<tr>
<td>Mental health status (MHI-5 score (0–10))</td>
<td>0.74(^*)</td>
<td>0.60, 0.90</td>
<td>0.74(^*)</td>
<td>0.60, 0.90</td>
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<tr>
<td>Daytime tiredness</td>
<td></td>
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<tr>
<td>No</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>Yes</td>
<td>2.11(^*)</td>
<td>1.19, 3.77</td>
<td>1.15</td>
<td>0.66, 1.99</td>
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<tr>
<td>Lifestyle</td>
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<td>Television/computer use</td>
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<tr>
<td>≤2 hours/day</td>
<td>1</td>
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<td>&gt;2 hours/day</td>
<td>1.08</td>
<td>0.66, 1.75</td>
<td>0.87</td>
<td>0.59, 1.27</td>
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<td>Physical activity at age 11 years</td>
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<td>&lt;5 days/week</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>≥5 days/week</td>
<td>0.64</td>
<td>0.40, 1.02</td>
<td>0.78</td>
<td>0.54, 1.12</td>
</tr>
<tr>
<td>Physical activity from ages 5 to 11 years</td>
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<td></td>
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<tr>
<td>Not always active</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Always active</td>
<td>0.46</td>
<td>0.19, 1.13</td>
<td>1.00</td>
<td>0.61, 1.63</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; MHI-5, Five-Item Mental Health Inventory; OR, odds ratio.
\(^a\) P < 0.05.
\(^b\) Results were based on multiply imputed data. Age and sex were included in all models.
\(^c\) Additional variables to be included in the multivariable analyses were selected by forward stepwise selection. Only variables that were significantly (P < 0.05) associated with the outcome variable were included in the models.
between dropouts and responders would not be expected to have changed the results.

In addition to the multivariable logistic regression analyses based on forward stepwise selection, we also analyzed the data by adjusting all associations for the 7 most relevant confounders—that is, variables that changed the beta coefficient of at least one of the univariable associations by 10% or more. These variables were MHI-5 score, daytime tiredness, pubertal status, height or height gain, weight or weight gain, sex, and physical activity at age 11 years (results not presented). These 2 different methods of selecting variables to be included in the regression models did not lead to different results.

The prevalence of MSC in our study was relatively low in comparison with other studies. Mikkelsson et al. (1), who included children of almost the same age as those participating in our study, found a prevalence of 32% for MSC among Finnish children. The difference in prevalence can be explained by selection of the more severe MSC cases (complaints lasting for more than 1 month) in our study as compared with Mikkelsson et al.’s case definition (at least once a week). In line with our results, Leboeuf-Yde and Kyvik (33) found a low 1-year prevalence of 1% for back pain that lasted for at least 1 month in 12-year-old children.

The literature on determinants of MSC among children is limited. Some cross-sectional studies among adolescents have also shown associations between poorer mental health and back (12, 34, 35) and upper extremity (14, 34, 35) complaints. However, it is unclear whether mental health problems are a cause or a consequence of MSC, and the same holds for tiredness and MSC. One explanation might be that children with daytime tiredness are exhausted and fatigued, leading to an increased risk of sports injuries of the lower extremities (36).

In the only longitudinal study to have investigated these associations prospectively, El-Metwally et al. (11) showed that when children felt sad or down or experienced daytime tiredness at baseline, more MSC were found after 1 year of follow-up, but the association with feeling down disappeared after adjustment for confounders. In adults, mental health and a large variety of related psychosocial issues are strongly associated with MSC (9), and therefore psychosocial factors are an important component of both prevention and treatment programs. Our data showed that when MSC were present in more than one body area, the relation with mental health is even stronger (OR = 0.64, 95% CI: 0.52, 0.79). It may be impossible to fully disentangle mental health, tiredness, and MSC, but at the least, this shows that treatment and prevention of MSC at a young age should take mental health and tiredness into account.

Earlier studies found that physical activity is associated with traumatic lower extremity complaints and any MSC but not with nontraumatic complaints among children (11, 36). Our results showed that physical activity was associated with lower extremity complaints. It is likely that sports injuries partly explain this association, but we had no information about the causes of the complaints or the types of sports children were involved in. Physical activity was associated with a reduced risk of back complaints among 9-year-old children in one study (13), but not in our study. In line with our study, numerous studies among adolescents have indicated that there is no association between television/computer use and MSC (12, 34, 35, 37, 38).

Anthropometric measures were not associated with MSC among adolescents in most earlier studies (12, 14, 37, 38). However, our results are in line with those of Bell et al. (17), who showed an association between MSC and body mass index z score in 177 children aged 6–13 years. Our study also suggests that children with a relatively high weight gain are more likely to have lower extremity complaints, which was not studied before. Since it is well established in adults that overweight and obesity increase the amount of force on weight-bearing joints and result in damage like osteoarthritis in the knee joints (39), our data may point to a similar mechanism among children. Weight gain has several detrimental effects in childhood, with long-lasting consequences. The prevention of overweight might be an important component of the prevention of musculoskeletal pain, but first the association between weight gain and MSC should be confirmed in other prospective studies.

Pubertal status has rarely been examined in relation to MSC. A study in participants aged 11–21 years showed that those with early pubertal development were more likely to experience MSC (40). In our study, pubertal stage was independently associated with lower and upper extremity complaints, and in the multivariate analyses it seemed relevant for any MSC. More research is needed.

Previous studies among adolescents found that the prevalence of neck/shoulder and back complaints was higher in girls than in boys (15, 34, 35, 37, 38). A higher prevalence in girls may be due to differences in sex-linked biologic factors (hormones or physiology) and different pain sensitivity, or it might be more socially acceptable for girls to complain about pain than boys.

One study of adolescents aged 12–16 years found no associations between ethnic background or maternal educational level and back, arm, and neck complaints (35). Thus, socioeconomic status seems irrelevant regarding MSC at young ages. Our study showed significantly more upper extremity complaints among children of non-Western origin, but no increased risk for other anatomic sites. The question of whether migrant children are at higher risk of developing MSC should be investigated in future studies.

MSC in adulthood represent a large health and economic problem (7, 8). Since MSC have a recurrent and persistent nature and might originate in childhood, MSC research among children needs further attention (3–5). The importance of some factors in childhood, especially the importance of mental health problems in relation to MSC, is emphasized by the results of this study. Additional large-scale longitudinal studies are needed to shed further light on the early-life determinants of MSC. Continuation of PIAMA data collection—with the children now becoming adolescents aged 14 years—will allow further analysis of determinants of developing MSC.

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