No difference in the level of physical activity between children who have or have never sustained a fracture

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This study investigates whether children with an acute fracture have a different level of physical activity compared to children who have never sustained a fracture, as measured by the Physical Activity Questionnaire for older children (PAQ-C). The PAQ-C scores of 683 children (295 girls) aged 6–12 years (mean age 9.4 years) who presented to our institution with an acute fracture were compared to the PAQ-C scores of 151 random children (81 girls) aged 6–12 years (mean 9.1 years) in the same area who had never sustained a fracture. Multivariate regression analysis was employed, controlling for age and gender. The mean PAQ-C score of the children who presented to the institution with an acute fracture was 2.85 (95% confidence interval [CI], 2.80–2.91). For the children who had never sustained a fracture, the mean PAQ-C score was 2.78 (95% CI, 2.69–2.87). If there is a true difference in the level of physical activity between children who have or have never sustained a fracture, the PAQ-C questionnaire is not sensitive enough to identify it.

The incidence of pediatric fractures doubled between 1950 and 1980 (Landin, 1983). This has been associated with an increased participation in sport and physical activity (Tiderius et al., 1999), which accounts for nearly 40% of pediatric fractures (Brudvik & Hove, 2003; Hedstrom et al., 2010). Even though childhood fractures are common, most fractures occur in children who will experience two or more fractures during childhood (Goulding, 2007), while half of all children will never experience a fracture (Jones et al., 2002). It therefore seems that some children are at risk of sustaining a fracture.

There is compelling evidence that physical activity in prepuberty increase bone density in children (Karlsson et al., 2008). This suggests that physical activity in childhood should protect against fractures later in life (Janz, 2002). At the same time, vigorous physical activity in children increases the fracture risk during childhood (Clark et al., 2008).

Self-reported questionnaires are important tools in population-based studies on the level of physical activity in children. Physical Activity Questionnaire for older children (PAQ-C) was developed in Canada for the Saskatchewan Pediatric Bone Mineral Accrual Study (Crocker et al., 1997), and has later been used in numerous studies. The purpose of this study was to investigate whether children who has sustained a fracture has a different level of physical activity compared to children who has never had a fracture, as measured by the PAQ-C questionnaire.

Methods

All children between 6 and 12 years of age who presented to Akershus University Hospital with an acute, untreated fracture between March 16, 2010 and March 15, 2011 completed the PAQ-C questionnaire. Virtually all pediatric fractures are treated at this institution (except children involved in high energy trauma), as there are no other competing health institutions, public or private, with a fracture clinic in the area. The questionnaire was completed as soon as possible after diagnosis and pain relief. The children and guardians were instructed to complete the PAQ-C score for the activities the child participated in during the week prior to the fracture. Patients who sustained a fracture during school holidays were instructed to complete the PAQ-C score relevant to the last full week of school prior to the holidays. The fracture diagnosis was recorded according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD). Clinical details were recorded.

In addition, a random selection of 2502 households from the same region was contacted for a telephone interview responding to the PAQ-C questionnaire. The parents of 794 children aged 3–16 years agreed to participate, of which 151 children within the age range of 6–12 years had never sustained a fracture. The telephone interviews were conducted through a professional survey institute (Synovate Norway). To test the validity of the control group, the reported fracture...
incidence of the children in the telephone survey was compared with the actual fracture incidence, and there was no significant difference. The method of selection of the control group is previously described (Randsborg et al., 2013).

The PAQ-C questionnaire is a self-administered, 7-day recall questionnaire that measure general moderate to vigorous physical activity levels during the school year. It consists of nine questions (items) with values from 1 to 5. The items rate the child’s level of physical activity during his/her spare-time, at school, during recess, lunch and physical education classes, after school, in the evenings, and the week-end. The mean of these nine items results in the final PAQ-C activity summary score. A score of 1 indicates low physical activity, whereas a score of 5 indicates high physical activity. The PAQ-C has been demonstrated to be a valid measure of physical activity in children (Crocker et al., 1997). The questionnaire was translated to Norwegian using the guidelines for cross-cultural adaption (Beaton et al., 2000).

The study was approved by the Regional Committee for Medical and Health Research Ethics (registration number 1.2009.1854b). Parental written informed consent was obtained for all participating patients.

Statistical analysis

Statistical analyses were performed using the IBM Statistical Package for Social Science (SPSS), software version 22 (IBM Corp., Armonk, New York, USA).

At first, mean PAQ-C scores were estimated for children who had sustained a fracture and the children who had not sustained a fracture. Independent samples t-test was used to compare mean PAQ-C values between the children who had sustained a fracture and the children who had not sustained a fracture.

For further assessment of associations between PAQ-C and the risk of fractures during childhood, logistic regression analyses were used. Basing our approach on previous literature and clinical assumption, we considered age (continuous variable) and gender as possible confounders and risk factors for sustaining a fracture. The variable for sustaining a fracture was dichotomous, i.e., fracture (yes/no). At first, univariate regression analyses with each of the variables of PAQ-C (continuous variable), age and gender as independent variables and fracture (y/n) as the dependent variable were performed. Then, PAQ-C, age, and gender were included in a multivariate logistic regression analysis as independent variables and fracture (y/n) as the dependent variable.

All P-values less than 0.05 were considered statistically significant. All mean PAQ-C scores and odds ratios (ORs) are presented with 95% confidence intervals (CIs).

Results

The parents of 683 children between 6 and 12 years with an acute fracture and the parents of 151 children who had never sustained a fracture completed the PAQ-C questionnaire. The age and gender distribution of the children with and without fracture(s) are presented in Table 1.

Of the 683 children with a fracture (the cases), 537 patients had sustained a previous fracture (78.6%). The distal radius was the most common type of fracture. The distribution of fractures by anatomic location and mechanism of injury is presented in Table 1. Age and gender distribution of the children with fracture(s) and without fracture(s)

| Age, years, M (SD) | Children with fracture(s) (N = 683) | Children without fracture(s) (N = 151) |
|-------------------|-------------------------------------|----------------------------------------|
| Girls, n (%)      | 295 (43)                            | 81 (54)                                |

Table 2. The mean PAQ-C score of the children who presented to the institution with an acute fracture was 2.85 (95% CI, 2.80–2.91). For the children who had never sustained a fracture, the mean PAQ-C score was 2.78 (95% CI, 2.69–2.87). There were no statistical significant difference in mean PAQ-C scores between the children with an acute fracture and the children who had never sustained a fracture in their lifetime (P = 0.14).

The logistic regression analyses did not show any significant associations between PAQ-C and the risk of fractures (Table 3). However, boys had an increased risk of fractures compared to girls, and increasing age was also associated with a higher risk of fractures.

Discussion

The main finding from the current study was that there was no difference in self-reported level of physical activity in children with an acute fracture compared with children who had never sustained a fracture, despite controlling for age and gender. Like others, we found an increased risk for fracture in boys and with increasing age (Landin, 1997; Goulding, 2007).

Compelling evidence supports the notion that physical activity is osteogenic (Hind & Burrows, 2007). Kannus et al. (1995) suggested that prepubertal training is more effective on BMD than exercise after puberty. In support, numerous randomized trials demonstrate that exercise promotes bone gain in children (Morris et al., 1997; Taaffe et al., 1997; Fuchs et al., 2001; MacKelvie et al., 2002). Moreover, the positive effect on bone density caused by prepubertal exercise persists into adulthood (Bass et al., 1998). Previous studies have suggested that lack of physical activity predisposes children to lower bone mineral density and therefore an increased risk of sustaining a fracture (Clark et al., 2006; Flynn et al., 2007). Children with fractures of the long bones have lower BMD compared to controls without (Goulding et al., 2001; Bradshaw et al., 2008), and are at higher risk for a new fracture. Obese children are more at risk to sustain a fracture (Whiting, 2002; Goulding, 2007). Children with recurrent fractures are less physical active, have higher BMI, and lower bone mass for body size than controls (Manias et al., 2006).
Clark et al. (2008) found that vigorous physical activity is an independent risk factor for fracture in childhood. Furthermore, children with low muscle strength are at an increased risk of fracture (Clark et al., 2011; Määtä et al., 2015). However, this increased risk might only be relevant for children with very high level of activities who partake in high-risk sports, such as snowboard and football (Randsborg et al., 2013). It might seem that on a group level, physical activity is protective of fractures. A recently published 7-year prospective intervention study involving over 3500 children found that physical activity in children was associated with a decreased fracture risk (Fritz et al., 2016). However, we could not identify a difference in physical activity level as reported by the PAQ-C questionnaire in children who had or had never sustained a fracture.

The main limitation of the study is the selection of controls based on parental interviews. As not all families agreed to participate in the survey, the level of physical activity could be different among children in families that elected not to participate. However, the families were selected randomly within the same population halfway through the prospective fracture registration, which we believe increase its reliability. Another limitation is that the controls responded to the PAQ-C questionnaire by telephone, while the cases answered the questionnaire in the clinic. This represents a slight variation in the data collection settings that might affect reliability. The patients who sustained a fracture during school holidays answered the questionnaire relevant to the last full week of school, which introduces a longer recall period and a potential recall bias. Furthermore, height and weight of the controls were not obtainable, and we could therefore not include body weight in our statistical model.

**Perspective**

The measuring and registration of physical activity in children is an important task for health managers, and a questionnaire is attractive because of the

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**Table 3. Logistic regression analyses of risk of fracture**

| Variable | Analysis | All children (n = 834) |
|----------|----------|-----------------------|
|          | OR (95% CI) | P-value               |
| PAQ-C    | Unadjusted | 1.17 (0.91–1.51)      | 0.212 |
|          | Adjusted   | 1.13 (0.87–1.45)      | 0.365 |
| Age, year| Unadjusted | 1.12 (1.01–1.23)      | 0.028 |
|          | Adjusted   | 1.11 (1.01–1.23)      | 0.037 |
| Boys*    | Unadjusted | 1.52 (1.07–2.17)      | 0.020 |
|          | Adjusted   | 1.47 (1.03–2.10)      | 0.036 |

OR, odds ratio; CI, confidence interval. *Girls used as reference category.
simplicity and low cost of administering it. However, the data collected must be analyzed with caution, as it might not be sensitive enough. Other and probably better ways of collecting physical activity data are through repeat interviews, the keeping of an activity diary or by the use of Short Message Service (Johansen & Wedderkopp, 2010), or better still, an objective measurement of activity by the use of accelerometers (Janz et al., 2008; Kolle et al., 2009, 2010; Moller et al., 2009). If there is a true difference in the level of physical activity between children who have or have never sustained a fracture, we conclude that the PAQ-C questionnaire is not sensitive enough to identify it.

Key words: Fracture, physical activity, risk factor, children.

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