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ORIGINAL ARTICLE

The role of the psychological attributes of parents and children, and fracture history in upper extremity fractures in school-age and adolescents: A case-control study

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Injuries to the musculoskeletal system are one of the most common events in childhood period and that result in merely one-half of children remaining fracture-free growth during childhood.[1] Although childhood fractures often cause temporary activity restriction, they also may lead to permanent functional limitations.[2] Depending on the severity of the fracture, children's general quality of life together with their education process is adversely affected.[2] In addition, the diagnostic evaluation and the treatment of pediatric orthopedic injuries lead to significant healthcare expenditures.[3]

Various factors have been identified regarding musculoskeletal system trauma and fracture formation during childhood and adolescence.[4]

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ABSTRACT

Objectives: This study aims to investigate the influence of parents and children's psychological attributes and previous fracture history on upper extremity fractures in school-aged and adolescent children.

Patients and methods: Between January 2022 and January 2023, a total of 194 participants consisting of 97 cases with upper extremity fractures (23 males, 74 females; median age: 10 years; range, 6 to 16 years) and 97 age-matched controls suffering from growing pains (47 males, 50 females; median age: 10 years; range, 6 to 16 years) were included in this case-control study. Both cases and controls were of school-age or over. The parents of the children were interviewed face-to-face using psychological scales including the Adult Attention Deficit Hyperactivity Disorder Self-Report Scale (ASRS), the Autism-Spectrum Quotient (AQ), the Short Form of the Conners' Parent Rating Scale-Revised (CPRS-R:S), and the Developmental Coordination Disorder Questionnaire 2007 (DCDQ'07). The results derived from these scales and the demographics of the participants were evaluated in terms of their association with the risk of upper extremity fractures.

Results: A household income below the official minimum monthly wage (MMW) and a previous fracture history showed a higher risk for upper extremity fractures (odds ratio [OR]=2.38, 95% confidence interval [CI]: 1.07-5.26 and OR=24.93, 95% CI: 3.27-189.98, respectively). In the univariate analyses, elevated scores on the hyperactivity subscale of CPRS-R:S (CPRS-R:S-HS) were associated with a higher fracture risk (OR=1.14, 95% CI: 1.05-1.24). Furthermore, both a household income below MMW, a previous fracture history, and higher CPRS-R:S-HS scores were found as independent risk factors for upper extremity fractures in the multivariate regression analysis (OR=2.78, 95% CI: 1.13-6.86, OR=21.79, 95% CI: 2.73-174.03), and OR=1.11, 95% CI: 1.02-1.22, respectively).

Conclusion: Our study results highlight the importance of known risk factors for upper extremity fractures such as lower monthly wage and the presence of previous fractures. The psychological states of parents and children should be evaluated together.

Keywords: Bone fractures, children, psychological factors, risk factors, school-age population, upper extremity.

Epidemiological research points out that children who are hyperactive, aggressive, and oppositional have a higher risk of injury and fracture.[5,6] In addition, parental factors and parent-child relationships influence their children's behavior and activities, as they gain independence in making decisions within the potentially injurious environment during the school-age and adolescent years.[7] Higher level of paternal depression and anxiety has been reported as risk factors for childhood injury.[8]

Knowledge of parental psychological attributes alongside demographic and sociocultural factors may be important to put targeted prevention measures into medical care practice. There is little information about a comprehensive understanding of the psychological factors contributing to upper extremity fractures in school-aged children. Taking into account this gap, in the present study, we aimed to evaluate the influence of both parents' and children's psychological attributes on the risk of upper extremity fractures among school-aged and adolescent children.

PATIENTS AND METHODS

Study design and study population

This single-center, hospital-based, age-matched case-control study was conducted at Konya City Hospital, Department of Orthopedics and Traumatology between January 2022 and January 2023. The cases comprised children receiving treatment at the orthopedics and traumatology clinic for upper extremity fractures, while the controls were selected to match the cases and were sourced from children seeking care at the clinic for concerns associated with growing pains. Following this, parents who decided to participate in the study were invited to the face-to-face interviews.

Inclusion criteria were as follows: *(i)* admission with an upper extremity fracture, excluding fractures caused by traffic accidents, falls from heights, and gunshot injuries, *(ii)* age between six and 16 years, *(iii)* a minimum parental educational level of primary school, and *(iv)* living with biological parents. Inclusion criteria for the controls were as follows: *(i)* admission with growing pains, *(ii)* age between six and 16 years, *(iii)* a minimum parental educational level of primary school, and *(iv)* living with biological parents. Patients with chronic health conditions (diabetes mellitus, cancer, etc.), with neurological and/or psychiatric disorders (neurodegenerative disorders, epilepsy, mental retardation, autism spectrum disorder, schizophrenia, bipolar disorder, etc.), and taking psychopharmacological treatment were excluded from both groups.

Initially, a total of 173 children were admitted to our clinic with upper extremity fractures. Following the exclusion of 48 patients who did not meet inclusion criteria, 125 children were identified as eligible candidates for the case group. A total of 128 children were found to be ineligible for the control group. Finally, 223 controls were identified as eligible for participation. Among the eligible cases, 28 parents declined participation in the study, while there was no refusal among the parents of the controls. The data of 194 participants consisting of 97 cases (23 males, 74 females; median age: 10 years; range, 6 to 16 years) and 97 age-matched controls (47 males, 50 females; median age: 10 years; range, 6 to 16 years) were included in the analysis (Figure 1).

Data and variables

An array of data encompassing children's demographic information, familial socioeconomic attributes, and psychological-behavioral characteristics of both parents and children was procured via the diligent administration of a structured questionnaire. These questionnaires were completed by the parents of the children.

Household income was categorized based on the minimum monthly wage (MMW). These classifications included: the lowest-income tier, representing incomes below the MMW; the subsequent bracket encompassing incomes up to twice the MMW; the following tier covering incomes up to three times the MMW; and the highest-income category comprising incomes exceeding three times the MMW. Concurrently, the Hollingshead Redlich Scale (HRS) was employed to assess the socioeconomic status. The HRS score was calculated through a detailed evaluation of parental occupational classification and educational attainment. Within the framework of this scale, parents were stratified into five hierarchical strata, ranging from Stage I (highest socioeconomic status) to Stage V (lowest socioeconomic status).[9]

Psychological assessment tools

In this study, we employed a collection of four psychological assessment instruments. Among these tools, two were completed by parents, allowing for a comprehensive evaluation of their psychological characteristics. These instruments consisted of the Adult Attention Deficit Hyperactivity Disorder (ADHD) Self-Report Scale (ASRS), and the Autism-Spectrum Quotient (AQ). In addition,

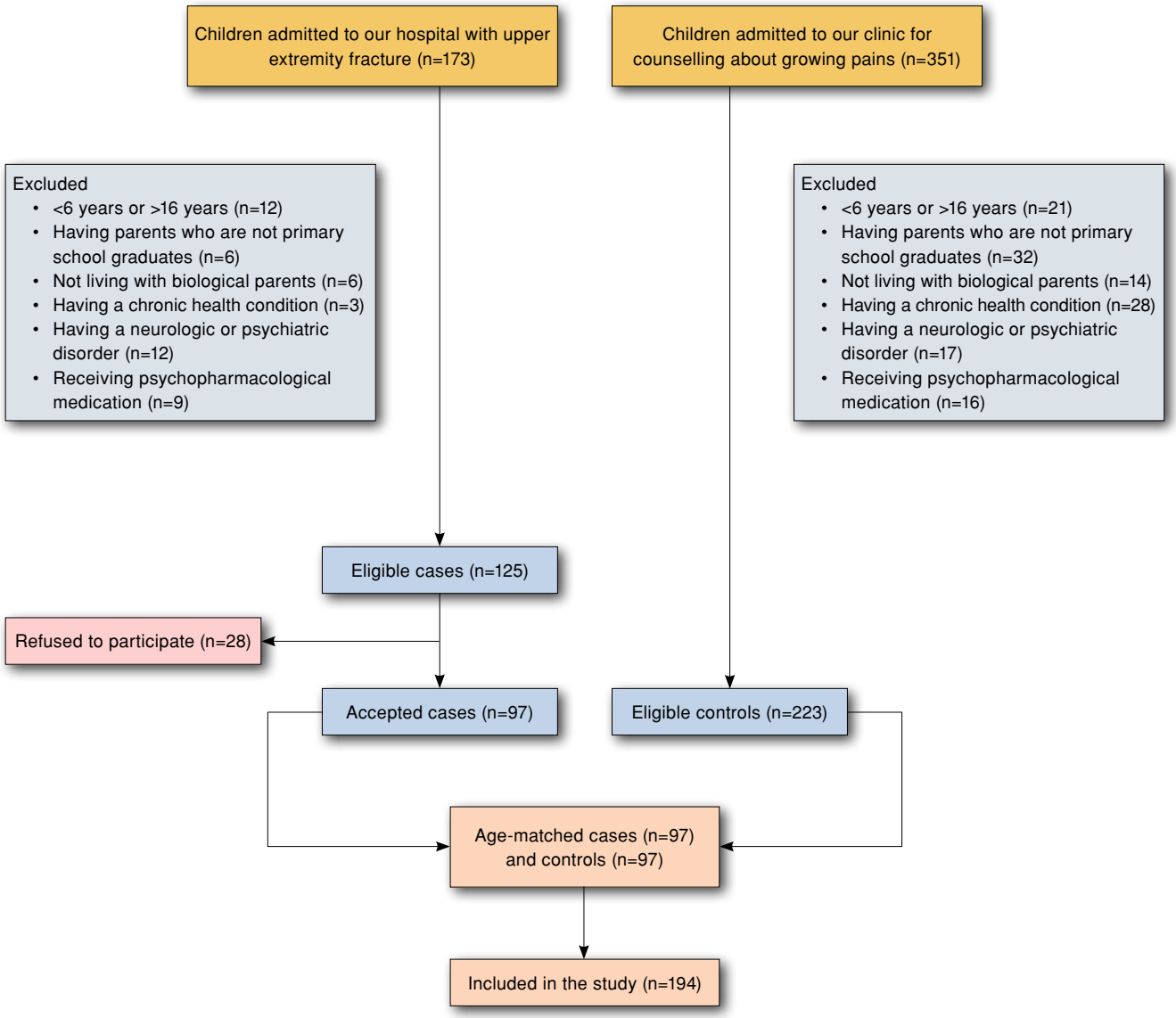


FIGURE 1. Study flowchart.

the Short Form of the Conners' Parent Rating Scale-Revised (CPRS-R:S) and the Developmental Coordination Disorder Questionnaire 2007 (DCDQ'07) were utilized to assess the psychological attributes of the children.

The ASRS was developed in conjunction with the World Health Organization (WHO) to evaluate adult ADHD cases. Comprising questions that probe 18 symptoms, the scale aligns with the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV). The scale has a dual-component: "Inattention (ASRS-I)" and "hyperactivity/impulsivity (ASRS-H)". Increases in both the subscale scores and the overall cumulative score correspondingly indicate a higher intensity of attention deficits, hyperactivity, and the severity of ADHD symptoms.[10]

The AQ scale is characterized by an array of 50 questions, which are further segmented into five subscales. These subscales were: "Social Skill (AQ-SS)", "Attention Switching (AQ-AS)", "Attention to Detail (AQ-AD)", "Communication (AQ-C)", and "Imagination (AQ-I)". A decrease in social skills, imagination, attention shifting, and communication, coupled with an increase in attention to detail, corresponds to recognized traits within the autistic spectrum. Notably, an elevation in scores across all subscales signifies an enhanced presence of autistic traits.[11]

The CPRS-R was specifically developed to evaluate cognitive and behavioral challenges in children and adolescents aged between 3 and 17. The abbreviated version of the scale, known as the CPRS-R:S, is composed of 27 items distributed across four distinct subscales. These subscales are the "Oppositional Scale", "Cognitive Problems Scale", and "Hyperactivity Scale", all of which are derived from the CPRS-R:S. Additionally, an "ADHD Scale" can be derived to distinguish between children with ADHD and those without. An increase in scores across all subscales signifies a greater severity of the identified problems.[12,13]

The DCDQ is a parental assessment instrument designed to identify motor difficulties in children aged between five and 15 years. A revised version, known as DCDQ'07, was developed and validated in the year 2007. Parents employ this tool to gauge their children's motor and coordination abilities concerning their peers. The DCDQ'07 consists of 15 items organized into three factors: control during movement, fine motor skills, and general coordination. Lower scores on the scale indicate more pronounced motor and coordination challenges.[14]

All psychological assessment instruments were administered in a paper format under the supervision of an orthopedist who was blinded to the group allocation. The completion of the scales took place in a dedicated outpatient clinic room, ensuring the required privacy and confidentiality.

Statistical analysis

A priori sample size calculation was conducted using the G*Power version 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The minimum required study population was determined to be 164 patients, evenly divided into 82 cases and 82 controls. This calculation utilized an alpha (α) value of 0.05 and a power of 0.90, employing an allocation ratio of 1.

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were presented in median and interquartile range (IQR) for continuous variables and in number and frequency for categorical variables. The Mann-Whitney U test was used to compare numerical data between the two study groups. The Pearson chi-square test or Fisher exact test was used for comparing categorical variables. Univariate binomial logistic regression analyses were employed to estimate the impacts of variables on upper extremity fracture risk. After

TABLE I
Demographics and socioeconomic characteristics of the participants

	Controls (n=97)				Cases (n=97)				
Characteristics	n	%	Median	IQR	n	%	Median	IQR	*p*
Age (year)			10.0	8.0-13.0			10.0	8.0-13.0	NA
Mother's age (year)			38.0	34.0-42.0			38.0	33.5-43.0	0.543[a]
Father's age (year)			41.0	37.0-45.0			42.0	38.0-46.0	0.541[a]
Mother's educational attainment (year)			5.0	5.0-11.0			5.0	5.0-8.0	0.094[a]
Father's educational attainment (year)			8.0	5.0-11.0			5.0	5.0-11.0	0.051[a]
Household income									**0.022**[b]
Below MMW	4	4.1			4	4.1			
Up to twice MMW	36	37.1			22	22.7			
Up to three-times MMW	36	37.1			57	58.8			
Above three-times MMW	21	21.6			14	14.4			
HRS									0.352[c]
I	2	2.1			2	2.1			
II	20	20.6			12	12.4			
III	17	17.5			12	12.4			
IV	22	22.7			30	30.9			
V	36	37.1			41	42.2			
Fracture history	1	1.0			20	20.6			**<0.001**[c]

IQR: Inter-quartile range; MMW: Minimum monthly wage; HRS: Hollingshead Redlich Scale (I=highest, V=lowest); a Mann-Whitney U test was used; b Fisher exact test; c Pearson chi-square test.

the univariate analyses, a multivariate logistic regression model using the enter method was employed with the statistically significant variables in the univariate model. Odds ratios (ORs) with a 95% confidence interval (CI) were used to evaluate the magnitude of the risk. A p value of <0.05 was considered statistically significant.

RESULTS

In the case group, the distribution of fractures was as follows: four children (4.1%) with clavicle fractures, 10 (10.3%) with humeral fractures, 66 (68.0%) with radial and/or ulnar fractures, nine (9.3%) with carpal fractures, seven (7.2%) with metacarpal fractures, and one (1.0%) with a phalangeal fracture.

Table I presents the demographics and socioeconomic characteristics of the participants. The ages of both children and parents, parents' educational achievements, and HRS classifications were statistically significantly similar between the two study groups. The majority of the cases' household income was within the range of two- to three-times MMW, while the control group's household income displayed a more consistent distribution. This difference in income distribution was statistically significant (p=0.022). Furthermore, prior upper-arm fractures were more prevalent within the case group than among the controls, indicating a statistically significant difference (p<0.001) (Table I).

Table II presents the outcomes of the univariate analysis of the demographics and socioeconomic characteristics of the participants in estimating fracture risk. Families with a household income below the MMW exhibited a higher risk of fractures in comparison to those with an income exceeding three times the MMW (OR=2.38, 95% CI: 1.07-5.26). Additionally, a statistically significant elevation in the fracture risk was observed in children with a history of upper extremity fractures (OR=5.43, 95% CI: 1.74-0.96) (Table II).

In the univariate analyses assessing the connection between psychological instrument scores and the estimation of fracture risk, all scales, except for CPRS-R:S-HS, did not exhibit statistically significant associations with the risk of upper extremity fractures. However, increased scores in CPRS-R:S-HS, indicative of heightened hyperactivity in children, corresponded to an escalation in fracture risk (OR=1.14, 95% CI: 1.05-1.24) (Table III).

Following the univariate analyses, a multivariate regression model using the enter method was conducted. All variables that showed statistical significance in the univariate analyses were included in the multivariate model. As a result, having a household income below the MMW, a history of upper extremity fractures, and higher CPRS-R:S-HS scores were identified as statistically significant independent risk factors for upper extremity fractures

TABLE II

Univariate analysis of the demographics and socioeconomic characteristics of the participants in estimating fracture risk (n=194)

Characteristic	OR	95% CI	*p*
Household income			
Below MMW	2.38	1.07-5.26	**0.033**
Up to twice MMW	0.92	0.39-2.16	0.843
Up to three times MMW	1.50	0.32-7.01	0.606
Above three times MMW		1.00	
HRS			
I	1.00		0.631
II	0.60	0.07-4.83	0.744
III	0.71	0.09-5.73	0.765
IV	1.36	0.18-10.44	0.899
V	1.14	0.15-8.50	
Fracture history			
Absent	R	R	
Present	24.93	3.27-189.98	**0.002**

OR: Odds ratio; CI: Confidence interval; MMW: Minimum monthly wage; HRS: Hollingshead Redlich Scale (I=Highest, V=Lowest).

TABLE III
Univariate analysis of the psychological instrument scores of the participants in estimating fracture risk

Characteristics	OR	95% CI	*p*‡
ASRS-I	1.01	0.97-1.06	0.609
ASRS-H	0.99	0.95-1.03	0.619
AQ-SS	0.97	0.92-1.02	0.203
AQ-AS	0.95	0.90-1.01	0.109
AQ-AD	0.99	0.93-1.05	0.734
AQ-C	0.96	0.92-1.01	0.140
AQ-I	0.97	0.92-1.02	0.258
AQ-Total	0.99	0.97-1.01	0.247
CPRS-R:S-OS	0.95	0.89-1.02	0.162
CPRS-R:S-CPS	0.97	0.90-1.04	0.328
CPRS-R:S-HS	1.14	1.05-1.24	**0.002**
CPRS-R:S-ADHDS	0.97	0.93-1.02	0.250
DCDQ'07	1.01	0.99-0.03	0.410

OR: Odds ratio; CI: Confidence interval; ASRS: Adult ADHD Self-Report Scale (I: Inattention, H: Hyperactivity); AQ: Autism-spectrum quotient; SS: Social skill; AS: Attention switching; AD: Attention to detail; C: Communication; I: Imagination; Total: Total score; CPRS-R:S: Conners' Parent Rating Scale-Revised: Short Version (OS: Oppositional Scale; CPS: Cognitive Problems Scale; HS: Hyperactivity scale; ADHDS: ADHD Scale); DCDQ'07: Developmental Coordination Disorder Questionnaire-2007; ‡ Univariate logistic regression analysis with Enter method was used.

TABLE IV
Multivariate analysis of the demographics and psychological instrument scores of the participants in estimating fracture risk

Characteristics	aOR	95% CI‡	*p*‡
Household income			
Below MMW	2.78	1.13-6.86	**0.026**
Up to twice MMW	1.39	0.53-3.62	0.503
Up to three-times MMW	2.48	0.50-12.42	0.268
Above three-times MMW	1.00		
Fracture history			
Absent	R	R	
Present	21.79	2.73-174.03	**0.004**
CPRS-R:S-HS	1.11	1.02-1.22	**0.021**

aOR: Adjusted odds ratio; CI: Confidence interval; MMW: Minimum monthly wage; CPRS-R:S-HS Conners' Parent Rating Scale-Revised: Short Version-Hyperactivity Scale; ‡ A multivariate logistic regression model was employed using Enter method.

in the multivariate model (OR=2.78, 95% CI: 1.13-6.86, OR=21.79, 95% CI: 2.73-174.03), and OR=1.11, 95% CI: 1.02-1.22, respectively) (Table IV).

DISCUSSION

Upper extremity fractures in school-age children and adolescents are the result of various risk factors. Previous studies have predominantly focused on demographic and sociocultural determinants as primary factors.[2,5] In contrast, our approach involved a comprehensive assessment of the psychological characteristics of both families and their children.[15] By expanding our perspective and utilizing diverse psychological assessment questionnaires, we attempted to gain a more nuanced understanding of the risk factors associated with fractures from multiple angles.[15]

Upper extremity fractures are the most frequently reported type of fractures, with forearm skeletal structures accounting for the majority of cases.[16] In an epidemiological study with over 90,000 children, fractures in the upper extremity were found to be the most frequently observed among those aged two to 18, with fractures of the radius and ulna prevailing over other skeletal segments.[17] Although spinal fractures mostly resulted from high fall injuries, upper extremity fractures were caused by various etiology.[16,18] Therefore, these fractures are affected by many different risk factors such as such as living environment, activity area, family structure, parental behavior, and parental psychological characteristics.[19] Previous studies have emphasized the significance of several factors in preschool-/school-age children and adolescent unintentional injuries resulting in fractures, including parent's age, maternal education level, maternal occupation, family structure, and monthly household wage.[18,20] In the light of current literature, we concluded that the lower household income emerged as a risk factor.

The crucial role of parenting styles and the psychological well-being of both parents and children in the occurrence of children's injuries with fractures has been found.[21] School-age children and adolescents spend a large part of their time outside of their families without vigilant parental care such as in their school or other settings of social activity.[22] The physical and psychological health of parents play a critical role in their children gaining independence in making decisions within potentially injurious environments during the school-age and adolescent years.[7] Adults with psychological symptoms and/or disorders may face difficulties in their child-rearing processes due to the characteristics of these disorders.[21] Indifference to the needs of their children, forgetfulness, attention deficiency, and loss of concentration adversely affect them in terms of their parental tasks and responsibilities, and their children gain self-confidence, anticipate risky situations, and develop coping behaviors. These factors may also influence negatively both parents to take part in their children gaining experience within a potentially injurious environment. A distinct correlation has been determined between the symptoms of ADHD and increased risk of injury and fracture in their children compared to parents without ADHD symptoms.[7,21] In the context of the presented study, the ASRS-I, ASRS-H, all five distinct subscales (AQ-SS, AQ-AS, AQ-AD, AQ-I), and total AQ scores did not emerge as risk factors for upper extremity fractures in school-age children. Nevertheless, further investigation is warranted to comprehensively evaluate this potential psychological well-being of parents and its implications.

Previous studies investigating the risk factors of injuries and or fractures in children of preschool age have predominantly centered on maternal mental well-being and its implications.[23,24] The increased time spent by mothers with preschool-age children, particularly compared to fathers, results in the majority of reported injuries occurring under the supervision of mothers.[25] However, maternal predominance is not considered valid for school-age children, fathers and mothers frequently spend time with their children together and take on different roles at the start of the school period.[26] In the present study, parental psychological well-being was evaluated collectively, without individualized assessments of mothers and fathers. As the child continues to grow and develop, both parents independently teach and get to know the environment, risky situations, and safety behaviors of their children.[16] Fostering children's self-assurance and nurturing their peer relationships pave the way for gaining independence in making decisions within potentially injurious environments during the school-age and adolescent years. Consequently, developed ability to anticipate risky situations and improved safety behaviors help to decrease the incidence of unintentional injuries and fractures.

Children diagnosed with ADHD, characterized by traits of inattention, impulsivity, and hyperactivity, represent a repetitive behavior pattern and render them more susceptible to injuries compared to their healthy counterparts.[27] Lange et al.[28] reported that the rate of accidents requiring medical admission was notably higher within the ADHD group (23%) compared to the non-ADHD cohort (15.3%). Genç et al.[29] exhibited that higher levels of ADHD symptoms were related to increased supracondylar humerus fractures in children between the ages of three and 17 years. In the presented study, all psychological assessment scales, except for CPRS-R:S-HS, did not exhibit statistically significant associations with the risk of upper extremity fractures. However, increased scores in CPRS-R:S-HS were correlated with an elevated fracture risk in the univariate and multivariate regression models. Currently, although an increase in children represent hyperactivity sign and symptoms has been reported, it is recognized that most cases are associated with today's modern lifestyle and are not a real inconvenience. It is thought to be associated with the restriction of children's

movement areas, spending longer periods of time in closed areas and longing for outdoor activities.[4,17,22] Therefore, identifying and diagnosing children with true hyperactive symptoms can prevent them from being exposed to various risks of injury. With this perspective, children with symptoms of severe injury and fracture and symptoms of hyperactivity can be evaluated with a prioritized and more careful perspective.

Several studies have shown that children who experience one fracture have a significant and high risk of new fractures compared to those who have not experienced a fracture previously. Children who have risk factors for injuries related to fracture development face re-injury situations, if the risk factors are not determined and the necessary arrangements are not made.[23,28,29] In accordance with the literature, our result supported that the occurrence of new fractures was significantly increased in children who had already experienced a fracture. As previously mentioned, a comprehensive evaluation of the risk factors associated with fracture-risk behaviors is of utmost importance to prevent children from being harmed in their future lives.

Nonetheless, there are some limitations to this study. Foremost among these is the potential for response bias stemming from the collection of self-report data regarding the psychological attributes of individuals through questionnaires. Such a mode of data collection may inadvertently introduce subjectivity and bias, thereby influencing the outcomes. The patients included in the case group had fractures, excluding those caused by traffic accidents, falls from heights, and gunshot injuries. Additionally, the relatively modest sample size encompassed by the study may curtail the extent to which the findings can be extrapolated and applied across broader populations. Consequently, the generalizability of the study's conclusions could be potentially limited due to this sample size constraint.

In conclusion, our study results highlight the importance of known risk factors such as lower monthly wages and previous fracture history in this patient population. Furthermore, the psychological states of parents and children should be evaluated together as an additional facet contributing to the prevalence of injuries and fractures. Psychological characteristics of families and children together with known risk factors should be assessed through comprehensive studies along with its effectiveness in clinical practice.

Ethics Committee Approval: The study protocol was approved by the Necmettin Erbakan University Non-Pharmaceutical and Medical Device Research Ethics Committee (date: 07.10.2022, no: 2022/3998). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: Written informed consent was obtained from all participating parents who agreed to participate in the study.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Concept, design: M.Z.G., F.Ç; Supervision: F.D., A.S.S., A.Y.; Data collection: M.Z.G., F.D., A.S.S.; Data analysis, literature review, writing: M.Z.G., F.D., A.S.S., F.Ç.; Critical review: A.Y.

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