

# Investigating the Effect of Sluggish Cognitive Tempo Symptoms Independent of Attention Deficit and Hyperactivity Symptoms on Extremity Injuries in Children and Adolescents

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## ABSTRACT

**Objective:** Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder. ADHD symptoms in childhood cause a number of comorbidities in adulthood, there is scarce information on whether ADHD in childhood increases the risk of sustaining injuries or accidents. Although previous studies have investigated ADHD-related accidents or extremity injuries, no study has yet examined whether the risk of injury increases in the presence of ADHD combined with Sluggish Cognitive Tempo (SCT) or—although still controversial as a diagnosis—in the presence of SCT alone. The aim of present study was intended to fill this gap in knowledge and to elucidate the effect of SCT on the risk of sustaining injuries in individuals with ADHD.

**Methods:** The study included the following groups: Group 1 consisting of patients aged 6–17 years who presented to orthopedics outpatient clinics for extremity injuries and had suspected ADHD, and their parents; Group 2 consisting of children and adolescents aged 6–17 years who had no extremity injury but had ADHD, and their parents, and Group 3 consisting of children and adolescents aged 6–17 years without any extremity injury or psychiatric disorders, and their parents. After the sociodemographic questionnaire was filled, the DSM IV based Screening and Assessment Scale for Attention Deficit and Disruptive Behavior Disorders and Barkley Child Attention Scale (BCAS) were administered by a clinician specialized in pediatric and adolescent mental health.

**Results:** The study included a total of 94 children and adolescents, of whom 37 had both fractures and ADHD (fracture + ADHD), 37 had ADHD alone and no history of fracture (ADHD), and 20 had neither a history of fracture nor psychiatric diagnosis (control). The groups differed significantly in terms of SCT, inattention and hyperactivity scores ( $p < 0.0001$ ). Based on the results of the regression analysis, it was concluded that the decrease in SCT scores was associated with the fracture + ADHD group; male sex was associated with the ADHD group; and the increase in inattention and hyperactivity scores played a role in the differentiation of the fracture + ADHD group from the control group.

**Conclusion:** The present study was intended to fill this gap in knowledge and to elucidate the effect of SCT on the risk of sustaining injuries in individuals with ADHD. Comparison of the



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groups in terms of attention deficit, hyperactivity, and SCT scores showed a statistically significant difference among the groups for all three parameters. Regression analysis showed that high SCT scores had a reverse causality with fractures. When evaluated within the context of our study, this seems to act as a mechanism that

compensates impulsivity. Although the mechanism is unclear, the strong causality suggests that it may have a protective effect against sustaining injuries.

**Keywords:** Child, Sluggish cognitive tempo, Extremity injuries

## INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that affects an average of 5% of children worldwide [1]. Although ADHD has initially been thought to be a childhood disorder, studies have shown that individuals with this condition experience more social problems, are more prone to mental illnesses, have higher rates of substance use disorders, and are at higher risk for premature death in adult life [2]. A large cohort study has shown that individuals with ADHD are two times at greater risk of death compared to those without the condition [3]. Although these studies have shown that ADHD symptoms in childhood cause a number of comorbidities in adulthood, there is scarce information on whether ADHD in childhood increases the risk of sustaining injuries or accidents.

A study from the United States of America reported that 44% of all fatal accidents in children and adolescents are caused by inattention, that the most common type of injury is traumatic

brain injuries and these accidents result in the death of more than 12,000 children and adolescents annually [4]. Given its dangerous consequences, ADHD should be identified and treated in these children and adolescents to prevent accidents.

The predominantly inattentive presentation of ADHD involves certain specific symptoms similar to those of another disorder called Sluggish Cognitive Tempo (SCT). SCT is defined as a disorder characterized by symptoms such as daydreaming, lethargy, introversion, and low energy [5]. These similarities raise questions on whether SCT should be differentiated from ADHD as a different diagnostic category [6]. Although many studies initially examined SCT in the context of ADHD and still investigate it in that context, recent studies have started to look into the relationship of SCT with clinical conditions such as autism spectrum disorder, sleep disorder and traumatic brain injury [7]. These studies point to a growing recognition of SCT as a separate disorder or construct of transdiagnostic significance for psychiatric disorders [8]. Despite the increasing number of studies in recent years, SCT has not been fully elucidated in terms of its neurocognitive and neurobiological aspects. Although many studies have been conducted on cognitive function and attention deficits, the exact mechanism is unknown [9-10]. Although previous studies have investigated ADHD-related accidents or extremity injuries, no study has yet examined whether the risk of injury increases in the presence of ADHD combined with SCT or—although still controversial as a diagnosis—in the presence of SCT alone. Previous studies have investigated the symptoms of SCT that occur after brain injury, but to our knowledge, no study has yet examined the association between SCT and trauma [11]. The present study was intended to fill this gap in knowledge and to elucidate the effect of SCT on the risk of sustaining injuries in individuals with ADHD.

### Main Points:

- Sluggish Cognitive Tempo is defined as a disorder characterized by symptoms such as daydreaming, lethargy, introversion, and low energy.
- Previous studies have investigated ADHD-related accidents or extremity injuries, no study has yet examined whether the risk of injury increases in the presence of ADHD combined with SCT or in the presence of SCT alone.
- The present study was intended to fill this gap in knowledge and to elucidate the effect of SCT on the risk of sustaining injuries in individuals with ADHD.
- Regression analysis showed that high SCT scores had a reverse causality with fractures. When evaluated within the context of our study, this seems to act as a mechanism that compensates impulsivity.

## MATERIALS AND METHODS

The study received ethics committee approval and was conducted over a period of two months with patients who presented to a Pediatric and Adolescent Mental Health and Diseases Clinic and Orthopedics outpatient clinics and who met

the inclusion criteria. The study included the following groups: Group 1 consisting of patients aged 6–17 years who presented to orthopedics outpatient clinics for extremity injuries and had suspected ADHD, and their parents; Group 2 consisting of children and adolescents aged 6–17 years who had no extremity injury but had ADHD, and their parents, and Group 3 consisting of children and adolescents aged 6–17 years without any extremity injury or psychiatric disorders, and their parents. The diagnosis of ADHD was made using DSM-5 criteria as a result of the clinical evaluation of a specialist clinician. Volunteers, hospital visitors, hospital employees and their children were evaluated for the group without any extremity injuries or psychiatric disorders. The adolescents included in the study and their parents were verbally informed about the study and then were separately asked to fill out a written informed consent form. After the sociodemographic questionnaire was filled, the DSM IV-based Screening and Assessment Scale for Attention Deficit and Disruptive Behavior Disorders and Barkley Child Attention Scale (BCAS) were administered by a clinician specialized in pediatric and adolescent mental health.

### **Data Collection Tools**

#### **Sociodemographic Questionnaire**

The form inquired about the sociodemographic characteristics of patients and was completed by the clinician through direct interviews. It was used to record parameters likely to affect cognitive development such as the age of the patients, maternal age at birth, age at onset of walking and paternal age at birth.

#### **DSM IV-Based Screening and Assessment Scale for Attention Deficit and Disruptive Behavior Disorders**

It is a 30-item scale that screens for all symptoms of ADHD and disruptive behavior disorders, with one item for each symptom, including symptom severity. The scale is completed by the clinician or the patient's caregiver. The scale was developed by Atilla Turgay and the validity and reliability of the instrument was analyzed by Ercan et al. [12].

#### **BCAS**

The questionnaire was developed by Russel Barkley et al. [13] and the validity and reliability of the Turkish version was analyzed by Firat et al. [13]. It is a Likert-type scale scored from 0 to 3, and a score above 23 from the Turkish version is considered as indicative of a high risk for SCT. The present study used a cutoff value of 23.

### **Statistical Analysis**

Study data were analyzed using SPSS 22 statistical software. The data were checked for normality of distribution using skewness and kurtosis values, normality tests, and histograms. To determine whether variables exhibited statistically significant differences between groups, they were analyzed using one-way analysis of variance if normally distributed and using Kruskal–Wallis test if non-normally distributed. Multiclass multinomial logistic regression analysis was used to examine the variables that predicted the differentiation of the group with fractures and ADHD from the other groups. Variables “age” and “sex” were included in logistic regression analysis as covariates alongside the variables identified in the research hypothesis. In all analyses, statistical significance was set at  $p < 0.05$ .

### **RESULTS**

The study included a total of 94 children and adolescents, of whom 37 had both fractures and ADHD (fracture + ADHD), 37 had ADHD alone and no history of fracture (ADHD), and 20 had neither a history of fracture nor psychiatric diagnosis (control). There was no significant difference among the three groups in terms of age and sex distribution ( $p > 0.05$ ). Analysis of the sociodemographic and developmental data showed that the children included in the study differed in terms of the age at which they started talking ( $p = 0.037$ ); children in the fracture + ADHD group had started talking at a significantly later age compared to the other groups. As expected, the groups differed significantly in terms of SCT, inattention and hyperactivity scores ( $p < 0.0001$ ). Post hoc analyses showed that SCT scores were higher in the ADHD group than in the other groups, whereas there was no significant difference between the fracture + ADHD group and the control group. Again, post hoc analyses showed that the inattention score was higher in the ADHD group compared to the other groups, and the score of the fracture + ADHD group was higher only compared to that of the control group. As for hyperactivity scores, there was no difference between the two case groups, but the scores of these two groups were higher than that of the control group.

The study used multinomial logistic regression analysis to identify the independent variables that predicted the differentiation of the fracture + ADHD group from the ADHD group and the control group. The model used the groups as dependent variables; age, SCT, inattention, and hyperactivity as covariates; sex as a factor and finally fracture + ADHD as the reference category ( $R^2 = 0.60$  [Nagelkerke],  $\chi^2 = 153.68$ ).

Analysis results showed that the ADHD\*Fracture + ADHD groups were predicted by the SCT score (B: 0.171; SE: 0.072; OR: 1.187, [1.031–1.367]) and male gender (B: 1.698; SE: 0.773; OR: 5.462, [1.200–24.857]); control\*Fracture + ADHD groups were predicted by inattention (B: –0.238; SE: 0.109; OR: 0.788, [0.636–0.976]) and hyperactivity scores (B: –0.180; SE: 0.066;

OR: 0.836, [0.734–0.952]). Based on the results of the regression analysis, it was concluded that the decrease in SCT scores was associated with the fracture + ADHD group; male sex was associated with the ADHD group; and the increase in inattention and hyperactivity scores played a role in the differentiation of the fracture + ADHD group from the control group.

**Table 1.** Comparison of sociodemographic and clinical variables between groups

	Extremity injuries +ADHD (a) n=37	ADHD (b) n=37	Control (c) n=20	Statistical analysis	
	Mean±SS	Mean±SS	Mean±SS	P	Post hoc
Age	11.16±2.78	10.29±1.84	10.97±2.08	0.248 <sup>a</sup>	
Maternal age at birth	26.18±5.84	25.67±5.49	27.55±3.81	0.153 <sup>a</sup>	
Paternal age at birth	32.10±6.01	29.45±6.66	31.35±4.60	0.073 <sup>a</sup>	
Birth weight (g)	3277±430	3482±648	3161±494	0.077 <sup>b</sup>	
Walking time (month)	12.37±2.55	11.97±2.70	11.50±1.79	0.235 <sup>a</sup>	
Talking time (month)	13.725±37	12.18±3.49	11.50±3.99	<b>0.037<sup>a</sup></b>	a>b=c
Slow cognitive tempo score	15.64±4.81	19.54±5.59	14.45±3.28	<b>&lt;0.0001<sup>a</sup></b>	b>a=c
Attention deficit score	9.27±6.56	14.89±5.75	3.65±2.85	<b>&lt;0.0001<sup>b</sup></b>	b>a>c
Hyperactivity score	13.13±7.86	16.13±7.29	4.50±4.51	<b>&lt;0.0001<sup>b</sup></b>	a=b>c
	n (%)	n (%)	n (%)	P	Post hoc
Gender (male)	26 (70.3)	32 (86.5)	16 (80.0)	0.231 <sup>c</sup>	
Birth type (normal)	28 (75.7)	15 (40.5)	14 (70.0)	<b>0.005<sup>c</sup></b>	a=c>b

<sup>a</sup>Kruskal Wallis Test <sup>b</sup>One-way ANOVA <sup>c</sup>Chi-Square Test

**Table 2.** Results of multi-category multinomial logistic regression analysis

	B	Standard Error	Odds Ratio	Confidence Interval
<b>ADHD * Extremity injuries +ADHD</b>				
Constant	-3.271	2.032	-	-
Age	-0.275	0.141	0.759	(0.577-1.000)
Slow cognitive tempo score	<b>0.171*</b>	0.072	1.187	(1.031-1.367)
Attention deficit score	0.095	0.054	1.099	(0.989-1.222)
Hyperactivity score	0.050	0.042	1.051	(0.968-1.141)
Gender (male)	<b>1.698*</b>	0.773	5.462	(1.200-24.857)
<b>Control * Extremity injuries +ADHD</b>				
Constant	0.251	2.190	-	-
Age	-0.029	0.154	0.971	(0.718-1.314)
Slow cognitive tempo score	0.104	0.112	1.110	(0.891-1.383)
Attention deficit score	<b>-0.238*</b>	0.109	0.788	(0.636-0.976)
Hyperactivity score	<b>-0.180*</b>	0.066	0.836	(0.734-0.952)
Gender (male)	0.985	0.899	2.677	(0.460-15.592)

Referance category: Kirik+DEHB \*p<0,05 \*\*p<0.01 \*\*\*p<0.001

R<sup>2</sup>=.53(Cox-Snell), .60(Nagelkerke). Model x<sup>2</sup>=153.68

## DISCUSSION

The present study investigated the effect of ADHD domains and SCT on fractures and the relationship between these parameters in a total of 94 children and adolescents aged 6–17 years divided into three groups. The groups had no statistically significant differences in terms of sociodemographic characteristics. A study from Turkey found that boys diagnosed with ADHD were more likely than their female counterparts to be admitted to the emergency department with extremity injuries [14]. Also, another thesis study reported that among children with ADHD admitted to the emergency room with head injuries, the proportion of boys was statistically significantly higher than that of girls, but found no statistical difference in their ages [15]. Sex seems to be correlated with the likelihood of sustaining injuries and the lack of a significant difference in the present study prevents this limitation.

Our study found a statistically significant difference between the groups in terms of the frequency of normal delivery. Of note, the frequency of cesarean section was significantly higher in the ADHD group compared to the control group. A recent meta-analysis identified cesarean delivery as a risk factor for autism spectrum disorders and ADHD compared to vaginal delivery [16]. This report is supported by our study in that it found differences in the mode of delivery between the ADHD group and the control group.

Comparison of the three groups in terms of attention deficit, hyperactivity, and SCT scores showed a statistically significant difference among the groups for all three parameters. A study conducted on children aged 3–17 years who presented to the emergency department with injuries used the Conners' Parent Scale for ADHD and analyzed the results. That study used nontrauma participants as the control group and compared the two groups. The results of the comparison showed a statistically significant difference in all Conners' subscales [17]. Our study is in line with previous studies; it found that both hyperactivity and attention deficit domains are correlated with sustaining injuries. Hyperactivity may coexist with impulsivity in ADHD. Impulsivity and psychomotor hyperactivity may be correlated with a higher likelihood of sustaining injuries and accidents in children with ADHD. Another salient difference in children with ADHD is related to executive functions [18]. Of note, individuals with ADHD differ from individuals without the condition in terms of several executive functions including task switching, verbal and spatial memory, inhibition control,

planning, and execution. This may explain the differences, particularly when compared to the control group. Poor planning and inhibition control may be playing a role in the occurrence of injuries or increase the risk of injury.

ADHD may also involve differences in some morphological structures in the brain. The literature on neuroimaging includes strong meta-analyses showing that ADHD is associated with differences in neural regions in the prefrontal cortex as well as in the posterior cortex and subcortical structures that clearly demonstrate differentiation in functioning, consistent with changes in the maturation of frontal control [19]. Also, functional data show alterations in the functioning of dopaminergic systems which exhibit increased activity in ADHD and reveal changes in a number of motor centers and decision-making centers, especially fronto–striatal–thalamic pathways [20]. All these changes lead to disorganization or poor performance in decision-making, action control, and motor control in individuals with ADHD. These factors may be contributing to the likelihood of sustaining injuries.

Our study compared the three groups in terms of SCT scores and found a significant difference among the groups; post hoc analysis showed that this difference was caused by the nontrauma ADHD group. Interestingly, regression analysis showed that high SCT scores had a reverse causality with fractures. SCT is essentially characterized by daydreaming, lethargy, and low energy. Although its relationship with impulsivity has not been clearly demonstrated, this pattern of hypoactive symptoms may have led to avoidance or inhibition of behaviors that might cause fracture and injuries. Studies have shown that young people with high SCT scores are more prone to internalization problems and have low motivation and are more apathetic [21]. This apathetic state and low motivation to act may have unexpectedly protected young people from sustaining injuries.

Although SCT phenomenologically resembles daytime sleepiness, studies suggest that this hypoactive state is actually a problem of executive functioning. Mutlu et al.[22] compared individuals with ADHD who scored high and those who scored low on the SCT and found no statistically significant difference between the two groups in parameters such as sleep duration, falling asleep and daytime sleepiness [22]. When evaluated within the context of our study, this seems to act as a mechanism that compensates impulsivity. Although the mechanism is unclear, the strong causality suggests that it may have a



protective effect against sustaining injuries.

There are some limitations to the present study. First, this is a cross-sectional case-control study and thus does not fully explain causality. Also, the small sample size is another limitation. SCT diagnosis usually requires the assessment of multiple assessors, such as parents, teachers, and clinicians. Although clinician assessment was sufficiently reliable in the studies, the lack of a second assessor is a limitation. The age range was broad in our study. In children and adolescents, symptomatology of ADHD and SCT may present differently. Even in the absence of any statistically significant difference between age groups, this may be a limitation for homogeneous evaluation. The study only measured ADHD and SCT scores and did not measure different domains of attention and hyperactivity (executive functions, impulsivity, etc.). Differences in these parameters may have influenced the likelihood of sustaining injuries. Also, the study did not analyze medications used for ADHD treatment. The medications may have a series of cognitive and physical effects, which in turn may modify the likelihood of injuries.

## CONCLUSION

Our study is the first in the literature to investigate the effect of SCT on the likelihood of sustaining fractures and injuries. regression analysis showed that high SCT scores had a reverse causality with fractures. Although the mechanism is unclear, individuals with ADHD who exhibit SCT activity may be less likely to sustain fractures and injuries. SCT that coexists with ADHD may be protective against impulsivity. Further studies with larger samples are needed to clarify the mechanism and determine the causes in this relationship.

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**Informed Consent:** An informed consent form was filled out by all participants and their parents participating in the study.

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