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Prevalence and factors associated with chronic ankle instability among children aged 7 to 12 years

Raweewan Lekskulchai* **Supannikar Kadli**

Faculty of Physical Therapy, Mahidol University, Nakhon-Pathom Province, Thailand

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ABSTRACT

Background: Ankle sprain is the most common cause of chronic ankle instability (CAI). After a sprain, CAI and related components may develop and adversely affect movement performances. Prevalence of CAI in specific groups of children has been reported, however, the prevalence in typical children is lacking.

Objectives: This study aimed to determine the prevalence of CAI and related components in school-age children. Additionally, factors associated with the components were also examined.

Materials and methods: Three hundred and eighty-eight children aged between 7 and 12 years with no past or present serious diseases or disabilities were recruited from normal schools. They were interviewed and assessed to identify CAI components and risk factors. Children with at least one of the 3 components of CAI, including perceived instability (PI), mechanical instability (MI) and recurrent sprain (RS) were recorded as having CAI.

Results: The children's mean age was 9.76±1.55 years, and 57% of them were girls. There were 142 children with at least one component of the CAI. Therefore, the prevalence of CAI among the population was 36.60 %. The prevalence of MI, PI and RS were 11.6%, 35.3% and 27.3%, respectively. Significant variables on bivariate analyses (p<0.05) for related components of CAI were overweight, sport participation, living in urban area, moderate degree of initial ankle sprain and poor standing balance in eyes closed condition. After adjusting for the significant variables, overweight (aOR: 1.083, [95%CI: 1.036-1.192], p<0.001) and poor standing balance in eyes closed condition (aOR: 1.142 [95% CI: 1.194-1.311], p<0.001), were associated with RS. Overweight (aOR: 1.229 [95%CI: 1.063-2.264], p<0.001), sport participation (aOR: 1.192 [95%CI: 1.052-3.308], p=0.013), moderate ankle sprain (aOR: 1.143 [95%CI: 1.038-3.541], p=0.004) and poor standing balance in eyes closed condition (aOR: 3.476 [95% CI: 1.872- 6.453], p=0.006) were associated with PI. Moderate ankle sprain (aOR: 1.099 [95%CI: 1.027-4.370], p<0.001), and poor standing balance in eyes closed condition (aOR: 4.251 [95% CI: 1.248- 14.485] p=0.021) were associated with MI.

Conclusion: CAI and related components were existed among typical school-age children. The risk of all CAI components was high in children with poor standing balance. Overweight children were at higher risk of RS and PI. Children with moderate degree of ankle sprain were at higher risk for developing PI and MI. Further studies are recommended to develop preventive managements for this population.

* **Corresponding author.**
Author's Address: *Faculty of Physical Therapy, Mahidol University, Nakhon-Pathom Province, Thailand*
** **E-mail address:** : raweewan.lek@mahidol.ac.th
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Introduction

Ankle is the most commonly injured joint of the body because it has to support and distribute body weight through the foot while performing weight-bearing activities.[1-3] Ankle injury involves tendon and ligaments around the joints. It leads to instability of the ankle and can disturb proprioception and balance abilities.[4] After an ankle injury, chronic ankle instability (CAI) may develop and lead to several long-term residual signs and symptoms.[5] The term CAI was used to classify people with a history of at least an ankle sprain and present residual symptoms such as the sensation of ankle instability for at least 1 year post injury.[5] The CAI can be explained using two instability types, including mechanical and functional instabilities.[6] The criteria to describe CAI are mechanical instability (MI), functional instability (FI) or both. In 2016, the International Ankle Consortium's statement concluded that Hiller et al model can explain the inconsistencies in CAI research regarding to the misconception that CAI is a homogeneous condition.[7] This statement proposed that CAI should be considered as a heterogeneous condition including several homogeneous subgroups. Therefore, it was concluded that CAI consists of at least one of three related components including perceive instability (PI), mechanical instability (MI) and recurrent sprain (RS).[5] Further research indicated that these related components can adversely affect physical activities of the sufferers such as decreased ability to play sport[8], inability to walk long distances[8] and cessation of sporting and occupational activities[9-10].

Many studies focused on exploring effective interventions for adults with CAI with the main aim of helping them to return to their pre-injury levels of physical activities or sports. The effects of CAI will be more serious if it happens in children population. Since children have less developed patterns of motor and postural control but require high level of physical activities in their environmental context.[11] Additionally, previous studies indicated that ankle sprains frequently occur in childhood population.[1-3] A systematic review reported that children with previous ankle sprain show a high rate of recurrent ankle injuries and CAI.[12] The prevalence of CAI in specific children populations including dancers, soccer players, and those with previous ankle trauma, was equal to or higher than that of adult populations.[12] Among the specific populations reviewed, the prevalence of PI, MI and RS was 23-71%, 18-47% and 22%, respectively.[12] A survey research determined the prevalence of CAI as identified by a self-reporting questionnaire in high school athletes (age 15.9±1.2 years) and collegiate athletes (age 19.6±1.2 years), revealed that the prevalence of CAI in high school and collegiate athletes was 31.1 % and 18.7%, respectively.[13] Of all athletes surveyed, 66.8 % of the high school athletes and 65.2% of the collegiate athletes had at least an episode of previous ankle sprain.[13]

The literature reported different prevalence of CAI depending on types of the study population and methods in identifying the condition. Specific groups of children such as athletes are different from children with specific diseases therefore the prevalence of CAI in each specific group of children cannot be compared or even used as the prevalence for typical children. In contrast, if the prevalence in typical children is determined, it can be used as the reference data for other specific groups. Moreover, a systematic review of many research studies on CAI was conducted and confirmed that there is no "gold standard" to identify CAI.[14] Previous studies used self-reporting questionnaires and recent research developed self-assessment tools for clinicians and researchers to help objectively assess patients with CAI.[5, 13] However, these tools were developed for adults and reported as having difficulties to use in children population.[12]

To better understand CAI in children, it is needed to determine the prevalence of CAI among typical children population. In addition, children` s information and outcomes from easy-to-use tests that associate with the CAI components should be identified. Physical therapists, school teachers and parents can use these data to early detection of CAI and to establish preventive managements for children in whom CAI is prevalent. Therefore, the purposes of this study were to determine the prevalence of CAI and its related components and to examine factors associated with the components in typical school-age children

Materials and methods

Participants

Five normal schools were selected with convenient sampling from Bangkok, Nakhon Pathom and Lamphun Provinces. Upon obtaining the permission to collect data from each school, the teachers and students were explained about the study protocol and the criteria of the research participants. Non-athletic children aged 7 to 12 years with no past or present serious illnesses or disabilities and whose parents gave informed consent for them to participate in this study were included and measured of their weight and height. All children with BMI between 5th and 95th percentile were then scheduled to undergo an interview and full assessments from the research team (Figure 1). The study protocol was approved by the university institutional review board for the protection of human subjects.

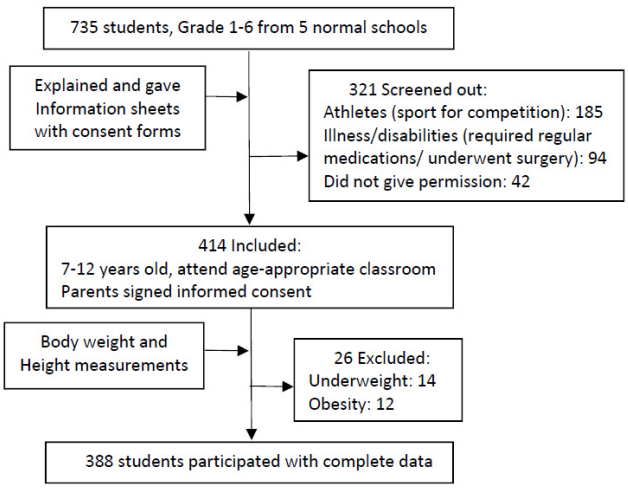

Figure 1. *Flow chart of participant recruitment*

Measurements

Children were interviewed to obtain information including age, gender, limb dominance, sport participation, living area, history of ankle sprain (severity of initial sprain, frequency of ankle sprain) and sensation of ankle instability. Talar tilt test, anterior drawer test, single leg stance eyes open (SLS EO) and eyes closed (SLS EC) conditions were then measured by a physical therapist with over 5 year experiences in pediatric physical therapy. Anterior drawer test and talar tilt test were measured using the standardized protocols.[15] Prior to the data collection, intra-tester reliability were examined and showed an acceptable level of reliability in performing anterior drawer test (ICC (3,1) = 0.75, p<0.05) and talar tilt test (ICC (3,1) = 0.82, p<0.05).

Data regarding to frequency of ankle sprain, sensation of ankle instability, talar tilt test and anterior drawer test were used to identify the presence or absence of the CAI components. The CAI components included perceived instability (PI), mechanical instability (MI) and recurrent sprain (RS).[5] Perceived Instability was self- report of having feeling of giving way or instability of the ankle. For the present study, the feelings that occurred within 1 year post initial ankle sprain were recorded. Mechanical instability was recorded if the talar tilt test or anterior drawer test were positive. Children who reported as having greater than one episode of ankle sprain were recorded as RS. Children with at least one of the 3 components of CAI were recorded as having CAI.

Data for examining the associations with the CAI components included gender, limb dominance, sport participation, living area, severity of the initial ankle sprain, body mass index (BMI), SLS-EO and SLS-EC. Score of "1" was recorded for female, left limb dominance, sport participation, living in urban area, moderate degree of the initial ankle sprain[16], overweight[17], positive SLS EO and positive SLS EC[18].

Body mass index was calculated and plotted against the age- and sex-specific BMI growth charts. The BMI-for-age status categories were used[17]. Normal weight was defined as BMI-for-age between the 5th and 85th percentiles, and the percentile of greater than 85th but below the 95th percentiles was defined as overweight [17].

Initial ankle sprain was graded on the basis of severity including mild, moderate and severe degrees.[16] For mild degree, children would report that the ankle was stable and they could walk with minimal pain immediately after the sprain. For moderate degree, children would report that the ankle was slight instability with moderate pain and they could not bear weight on the sprained ankle immediately after the sprain. For severe degree, walking was impossible because of the severe pain and swelling with marked instability of the ankle.

Single leg stance is commonly used to assess the ability of children to maintain static balance within a narrow base of support.[18] The children were instructed to stand on one leg as long as possible with a maximum of 30 seconds for each trial. They were bare foot and with hands on hips. The test was performed three times with eyes open (SLS EO) and three times with eyes closed (SLS EC). Before testing, they were allowed to practice once. A digital stopwatch was used to measure the standing duration. The measurement was completed when any of the followings occurred; 1) at 30 seconds, 2) any changes in position of the weight-bearing foot, 3) any body part except the weight-bearing foot touched the floor, and 4) open eyes during eyes closed condition. The durations of 3 trials were averaged to obtain the scores for SLS-EO and SLS-EC conditions. The average duration of less than 30 seconds was considered as poor standing balance in the condition.

Statistical analysis

Sample size was calculated using the expected proportion from a pilot study at 30%, and a margin of error of 0.05 with 95% confidence intervals.[19] The optimum sample size of 323 was required. The significance level was set at p<0.05. All statistics were analyzed using the statistical package SPSS version 19. Frequencies were calculated to determine the prevalence of CAI, PI, MI and RS.

A nonparametric chi-square test was used for association between CAI components and gender, BMI, limb dominance, sport participation, living area, severity of initial ankle sprain, SLS EO and SLS EC. In multivariate analysis, variables with p<0.05 in bivariate analyses were simultaneously analyzed by multiple logistic regression. Crude and adjusted odds ratios were computed.

Results

Demographic data

Three hundred and eighty eight children were recruited from five normal schools in Bangkok (32.7%), Nakhon Pathom (41.8%) and Lamphun (25.5%) Provinces. There were 167 (43%) boys and 221 (57%) girls. The average (± standard deviation) of the children's age and body mass index were 9.76 (±1.55) and 17.88 (±5.81), respectively. Of the 388 children, 270 (69.6%) reported previous history of ankle sprain(s). Table 1 shows distribution of previous history of ankle sprain among the population.

Table 1 Distribution of history of ankle sprain among the population (N=388).

Ankle sprain	Severity of initial ankle sprain	Recurrent sprain	n	%
No	-	-	118	30.4
Yes	Mild degree	No	121	31.2
Yes	Mild degree	Yes	69	17.8
Yes	Moderate degree	No	43	11.1
Yes	Moderate degree	Yes	37	9.5

Notes: *Severity of initial ankle sprain; Mild degree: ankle was stable and children could walk with minimal pain immediately after the sprain; Moderate degree: ankle was slight instability with moderate pain and children could not bear weight on the sprained ankle.*

Prevalence of CAI

Of the 388 children recruited, 142 (36.6%) had at least one component of the CAI. Therefore, the prevalence of CAI among the population was 36.6 %. The prevalence of MI, PI and RS were 11.6%, 35.3% and 27.3%, respectively (Table 2).

Table 2 Summary of prevalence of chronic ankle instability and related components (N=388).

Variables	n	%
Chronic Ankle Instability	142	36.6
Mechanical Instability	45	11.6
Perceived Instability	137	35.3
Recurrent Sprain	106	27.3

Factors associated with CAI components

In bivariate analysis, overweight, sport participation, living in urban area, moderate degree of initial ankle sprain and poor standing balance in eyes closed condition showed statistical associations with RS, PI and MI. Non significant variables on bivariate analysis (p>0.05) and being excluded from the multivariate analyses were gender, limb dominance and single leg stance with eyes open (SLS-EO) condition. Tables 3, 4 and 5 present results on the logistic regression analysis of factors associated with RS, PI and MI, respectively. After adjusting for the effects of other factors, it was found that overweight and poor standing balance in eyes closed condition showed significant associations with RS (Table 3), while overweight, sport participation, moderate degree of initial ankle sprain and poor standing balance in eyes closed condition showed significant associations with PI (Table 4) and moderate degree of initial ankle sprain and poor standing balance in eyes closed condition showed significant associations with MI (Table 5).

Table 3 Logistic regression analysis of factors associated with recurrent sprain.

Variables	Crude OR	95% CI		Adjusted OR	95% CI		*p* value
		Lower	Upper		Lower	Upper	
Overweight	1.088	1.042	1.181	1.083	1.036	1.192	<0.001*
Sport participation	1.280	1.172	1.399	0.845	0.752	1.364	0.234
Living in urban area	1.941	0.957	2.100	1.539	1.361	1.741	0.531
Moderate degree of initial ankle sprain	1.269	1.163	1.384	1.139	0.646	1.617	0.052
Poor standing balance: (closed eye condition)	1.414	1.257	1.591	1.142	1.194	1.311	<0.001*

Notes: *OR: ODDs Ratio, CI: Confidence Intervl, *significance at p<0.05.*

Table 4 Logistic regression analysis of factors associated with perceived Instability.

Variables	Crude OR	95% CI		Adjusted OR	95% CI		*p* value
		Lower	Upper		Lower	Upper	
Overweight	2.120	1.064	3.225	1.229	1.063	2.264	<0.001*
Sport participation	1.905	1.017	3.569	1.192	1.052	3.708	0.013*
Living in urban area	1.444	1.252	1.665	1.093	0.992	1.205	0.056
Moderate degree of initial ankle sprain	1.346	1.206	4.582	1.143	1.038	3.541	0.004*
Poor standing balance: (closed eye condition)	5.725	1.636	20.041	3.476	1.872	6.453	0.006*

Notes: *OR: ODDs Ratio, CI: Confidence Interval, *significance at p<0.05*

Table 5 Logistic regression analysis of factors associated with Mechanical Instability

Variables	Crude OR	95% CI		Adjusted OR	95% CI		*p* value
		Lower	Upper		Lower	Upper	
Overweight	0.199	0.100	0.398	0.968	0.254	3.691	0.962
Sport participation	9.230	4.121	20.672	0.446	0.139	1.423	0.173
Living in urban area	15.190	7.411	31.136	0.861	0.239	3.101	0.819
Moderate degree of initial ankle sprain	3.315	1.372	8.013	1.099	1.027	4.370	<0.001*
Poor standing balance: (closed eye condition)	30.908	14.370	66.480	4.251	1.248	14.485	0.021*

Notes: *OR: ODDs Ratio, CI: Confidence Interval, *significance at p<0.05*

Discussion

The present study found that 69.6% of the typical school-age children had previous ankle sprain(s). Severity of the initial sprain varied from mild to moderate degrees as shown in Table 1. The prevalence was higher than that reported in another community that reported in people aged between 18 and 65 years.[9] However, this prevalence was comparable to that reported in high school athletes (66.8 %) and collegiate athletes (65.2%).[13] In addition, it was found that 27.3% of the children with previous ankle sprain reported re-injury of the same ankle (Table 2).

The factors associated with RS were overweight and poor standing balance in eyes closed condition (Table 3). This is consistent with result of a previous study that obese children experienced a higher incidence of recurrent sprain than those of normal weight.[20] Even though obese children were not included in the present study, high BMI seemed to associate with RS. The positive SLS EC referred to poor standing balance in eyes closed condition in this study which indicated impaired ankle proprioceptors.[21] Therefore, previous ankle sprain may lead to a greater opportunity to have another sprain and develop motor performance problems.

The prevalence of CAI was 36.6% in this study population. This prevalence was higher than that determined in high school athletes (31.1%) and collegiate athletes (18.7%).[13] The different prevalence may be due to the differences in children characteristics that the present research studied in younger children who are not athletes. All children in this study engaged in a sport for recreation only. Therefore, knowledge specific to each sport and advice from sport professionals may be useful for the children to prevent injury and deal with CAI.

To explore the CAI components in more details, it was found that PI was the most common component among the three related components of CAI (Table 2). It was found that the prevalence of PI in the population was 35.3%. A previous research in children with severe ankle injuries reported the prevalence of 31%.[22] The risk of PI was high in children with overweight, sport participation, moderate degree of initial ankle sprain and poor standing balance in eyes closed condition (Table 4), whereas previous research indicated the risk factors for PI included previous ankle injury[22] and obesity[20].

Mechanical instability is the only one related components of CAI that requires physical examinations. The prevalence of MI in the present study was 11.6 % (Table 2). This prevalence was lower than that reported for children with severe ankle trauma (18%)[22] because those with severe ankle sprain were not included in the present study. This finding may be due to the fact that children with severe ankle trauma had impaired tendon and ligaments around the joints which could be detected by the anterior drawer test and talar tilt test. Therefore, they were easily detected as having MI than those without severely impaired structures. The present study also found the higher risk for MI in children with moderate degree of ankle sprain and poor standing balance in eyes closed condition. Therefore, early screenings and preventive managements in typical children are recommended. Additionally, exercises or intervention to

improve proprioceptive sensation for standing balance in children with ankle sprain and poor standing balance should be given to minimize the risk of developing MI.

There is a limitation of this study. This study collected data of typical school-age children using convenient sampling. Since the living area of the children was one of the study factors, normal schools from urban, suburban and rural areas were selected. Although we had children from the three different living areas, generalization of the results may be limited to the sampling communities. Since, children in different types of community may have different lifestyles, further studies to explore multidimensional effects of children's lifestyles on prevalence of CAI are highly recommended.

Conclusion

This study determined the prevalence of CAI and related components in typical school-age children by using interview combined with easy-to use tests. The prevalence of CAI was 36.6%. It was found that 69.6% of the population had previous ankle sprain(s), and 27.3% of them re-sprained of the same ankle. The prevalence of PI and MI was 35.3% and 11.6%, respectively. These outcomes confirmed that CAI and related components could occur in general children population.

The factors associated with RS were overweight and poor standing balance in eyes closed condition. The factors associated with PI were overweight, sport participation, moderate degree of initial ankle sprain and poor standing balance in eyes closed condition. While, the factors associated with MI were moderate degree of initial ankle sprain and poor standing balance in eyes closed condition. These findings raised awareness that early screenings and preventive managements in typical school-age children are necessary. Additionally, early intervention strategies should be developed to prevent prolonged suffering of the related components of CAI.

Conflicts of interests

None

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