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Chronic ankle instability and associated factors in the general population: a pilot study

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Abstract

Introduction: Acute ankle sprains have a high recurrence rate associated with the development of chronic ankle instability (CAI). However, such damage can be ameliorated by understanding the contributing factors. Therefore, this study investigated the relationship between the associated independent factors and chronic instability.

Material and methods: This cross-sectional study included 273 volunteers (F/M: 175/98, mean age, 34.4 ± 13.2 years; range, 18–78). Data was collected by a structured two-part questionnaire: (1) sociodemographic features, *viz.* age, gender, height, weight, dominant side, type and duration of physical activity, presence of chronic medical problems, and (2) general health conditions, *viz.* history of operation and trauma, number of painful regions, intensity, duration, of foot and ankle). Subjects are classified as having CAI with a Cumberland Ankle Instability Tool (CAIT) score ≤ 27.

Results: The mean CAIT score was significantly lower in women than men. For both sides, the lowest CAIT scores were demonstrated by subjects with a Body Mass Index (BMI) ≥ 30.0 ($p < 0.05$). The total number of painful areas bilaterally, pain level, and CAIT score of the opposite ankle were determined as predictive factors of CAI (Right: R2 = 0.54, p = 0.049, p = 0.000, p = 0.030, p= 0.000; Left: R2 = 0.48, p = 0.000, p = 0.000, p = 0.000, p = 0.000, respectively).

Conclusions: Obesity, female sex, pain status (intensity and a total number of pain regions), and opposite side CAIT score can be valuable indicators of secondary complications for patients receiving primary care services after injury.

Keywords: body mass index, joint instability, pain, sprains

Introduction

In primary care and in orthopedics and traumatology clinics, one of the most common injuries of the lower extremity is ankle sprain, particularly cases affecting the lateral ankle; this is especially common among athletes [1,2] Lateral ankle sprains are not benign injuries and often result in delayed treatment, prolonged recovery times, and long-term sequelae [3]. After the first episode of a lateral ankle sprain, the subject is at a high risk of sustaining recurrent ankle injuries, which could be approximated to as high as 75% of all initial lateral ankle injuries [4]. In addition, instability and sprain recurrence has been reported in up to 70% of patients [5]. An initial ankle sprain can develop into chronic ankle instability (CAI), due to *inter alia* multiple injuries to the same structure, ultimately leading to insufficiency of the lateral ankle ligament complex. Furthermore, it has been stated that etiological and associated factors of CAI model, including primary tissue damage, impairments in pathomechanics (laxity, arthrokinematic and osteokinematic restrictions, secondary tissue injury, tissue adaptations), sensory-perceptual impairments, motor-behavioural impairments, individualized variables, and environmental component interactions, and factors of therapeutic results [6]. The primary factors contributing to CAI are believed to be impaired balance and proprioception, delayed peroneal reaction time, strength deficits and bone/joint characteristics [7–10].

The common symptoms of CAI are not only pain and a sense of instability, with the ankle giving way in daily activities, but also muscle weakness and functional disability [6,11]. Moreover, degenerative arthritis can be seen as a long-term effect in people with CAI. As such, severe ankle sprains can lead to chronicity and underestimated therapeutic approaches [12,13]. Appropriate rehabilitation programs and precautions to prevent re-injury may assist recovery [14].

A clear understanding of the development of CAI can play an important part in deciding proper interventions and avoiding prolonged symptoms [7]. In primary care, body mass index (BMI), height, weight, previous ankle sprain history, consistent pain, pain intensity and physical activity level are typically recorded on admission [7,15,16]. However, the factors contributing to CAI remain unclear [7]. Further research is therefore needed to identify the factors contributing to CAI with the aim of developing a criterion for determining whether patients referred for physiotherapy and rehabilitation are at risk of re-injury and severe CAI symptoms [7,17,18]. Hence, the aim of this study is to determine the prevalence of CAI and identify its associated factors in the general population.

Materials and methods

Participants

A cross-sectional study was performed. A total of 273 adult volunteers (18-78 years old) were recruited via face-to-face or online (social media) to maximize outreach. The study was conducted from May through December 2017. As per the Helsinki declaration, written informed consent was obtained from all participants before the study. The study was approved by the Bioethics Committee (approval number: 37068608-6100-15-1325, April 27th, 2017). Inclusion criteria were determined as having no history of acute ankle sprain and fracture and not receiving physiotherapy and rehabilitation programs for foot and ankle problems within the last six months. The exclusion criteria comprised any history of foot, ankle, and/or knee surgery, chronic medical problems affecting balance or age below 18 years old

The sample size of the study was calculated with G-Power 3.1.9.2. Based on the average Cumberland Ankle Instability Tool (CAIT) score value of the previous research, it was estimated that it is appropriate to work with 88 samples in total with 0.27 low effect size (±1.5 deviation), one-way alternative hypothesis, 80% power and 5% Type I error margin.

Procedure

All participants received orthopaedic examination from a senior orthopaedic surgeon and then completed a structured questionnaire, either face-to-face or online. The questionnaire consisted of two sections, including sociodemographic and general health conditions (ankle surgery, trauma history, pain location, duration, and severity of foot and/or ankle pain).

Outcome measures

Pain intensity was measured on a Visual Analogue Scale (VAS). The participants marked any points where they felt pain on a diagram of the foot and ankle region.

Ankle instability consisted of the Cumberland Ankle Instability Tool (CAIT). The CAIT is a nine-item questionnaire generating a score from 0 to 30 for each ankle, in which 0 is the worst possible score, meaning severe instability, and 30 is the best possible score, meaning stability. The CAIT is considered a reliable instrument (ICC2,1 = 0.96) to distinguish between functionally-stable and unstable ankles, with a cut-off value of 27 points, according to Hiller et al. [19–21]

Statistical analysis

The collected data were analysed using the Statistical Package for Social Sciences (SPSS) version 22.0. Differences between groups were evaluated using unpaired t-tests and ANOVA. The correlation between CAIT scores and independent potential prognostic factors (pain level, pain duration, total pain area, age, BMI) was also investigated by linear regression. The significance level was set at ≤ 0.05 throughout the analyses.

Results

Our study population consisted of 273 volunteers (Female/Male: 175/98, mean age, 34.4 ± 13.2; range, 18–78). Two hundred thirty-five participants (86.1%) reported right-leg dominance, and 38 (13.9%) were left-leg dominant. The mean height, weight, and BMI of the subjects were 168.7 ± 9.3, 69.9 ±16.0 and 24.0 ± 4.8, respectively. Out of 273 subjects, 113 (41.4) had bilateral functional instability. One hundred and twenty-eight (46.9%) had functional instability on the left and 131 (48%) on the right; in total, 546 lower extremities were examined (Tab. 1.). The mean pain level (VAS) was calculated as 2.4 ± 2.8.

Table 2 presents a comparison of mean CAIT scores according to BMI and sex on each side. Subjects with higher BMIs had lower CAIT scores ($p < 0.05$). Women had significantly lower mean CAIT scores in both the right and left ankles: 24.0 ± 7.3 and 24.1 ± 7.5, respectively ($p < 0.05$).

The CAIT scores were negatively correlated with pain intensity, total duration, and the number of painful areas in both ankles ($p < 0.05$). However, the CAIT score was found to be positively correlated with the CAIT score of the opposite ankle (Tab. 3).

Tab. 1. Distribution of physical characteristics of cases and functional instability status according to the Cumberland Foot and Ankle Instability Scale (CAIT)

Sex (Female/Male)	98/175	
Age [year]	34.4 ± 13.2 (18.0–78.0)	
Height [cm]	168.7 ± 9.3 (150.0–198.0)	
Weight ([g]	69.7 ± 16.0 (40.0–129.0)	
BMI [kg/m^2]	24.0 ± 4.8 (15.00–40.00)	
	Right Side	Left Side
Instability ≠ N (%)	131 (48.1)	128 (46.9)
Stability N (%)	142 (52.0)	145 (53.1)
Total [a]	273 (100)	273 (100)
Dominancy N (%)	235 (86.1)	38 (13.9)
Age Ranges Having Instability (N =259 extremity/546)		
18–24 (years)	46 (35.1)	47 (36.7)
25–34 (years)	34 (26.0)	37 (28.9)
35–44 (years)	24 (18.3)	20 (15.6)
45–64 (years)	24 (18.3)	21 (16.4)
65–78 (years)	3 (2.3)	3 (2.3)
Total	131 (100)	128 (100)

[a] – both lower extremities were taken into consideration (273 · 2 = 546 extremity), BMI – body mass index, CAIT – Cumberland Foot and Ankle Instability Scale, ≠ – CAIT score ≤ 27.

Tab. 2. Comparison of CAIT scores according to BMI and gender on both sides

N = 273	CAIT (right) Mean ± SD	p-value	CAIT (left) Mean ± SD	p-value
BMI [kg/m^2]				
< 18.5 (underweight)	27.7 ± 4.9	F = 7.575 **0.001**	24.2 ± 6.8	F = 3.13 **0.017**
18.5–24.9 (normal weight)	25.9 ± 5.5		25.5 ± 6.2	
25.0–29.9 (overweight)	25.6 ± 7.0		25.7 ± 6.8	
≥ 30.00 (obese)	20.4 ± 8.7		21.9 ± 8.4	
Gender				
Male	26.9 ± 4.6	t = 3.49 **0.001**	26.5 ± 5.5	t = 2.77 **0.006**
Female	24.0 ± 7.3		24.1 ± 7.5	

BMI – body mass index, CAIT – Cumberland Foot and Ankle Instability Scale.

Tab. 3. Correlation between CAIT scores and pain severity, total pain areas and duration of pain on both sides

		r	p-value
CAIT (right)	Pain Level	–0.4	0.001
	Pain Duration (day)	–0.2	0.001
	Pain Duration (week)	–0.2	0.001
	Number of painful regions (right)	–0.4	0.001
	Number of painful regions (left)	–0.3	0.001
CAIT (left)	CAIT (Right)	–0.7	0.001
	Pain Level	–0.3	0.001
	Pain Duration (day)	–0.2	0.005
	Pain Duration (week)	–0.2	0.005
	Number of the painful regions (right)	–0.2	0.003
	Number of the painful regions (left)	–0.4	0.001

CAIT – Cumberland Foot and Ankle Instability Scale.

Tab. 4. Linear regression analysis for predicting risk factors of CAIT (both sides) score

	B	p-value	B (95.0% CI) (Upper-Lower)	
CAIT Score (Right) [a]				
Total Number of Painful areas (Left Side)	0.8	0.049	0.0	1.6
Total Number of Painful areas (Right Side)	–2.2	0.000	–2.3	–1.4
Pain Level (VAS)	–0.3	0.030	–0.6	–0.0
CAIT (Left) Score	0.6	0.000	0.5	0.7
Constant	0.3	0.96	–11.9	12.5
CAIT Score (Left) [b]				
Total Number of Painful areas (Left Side)	–1.8	0.000	–2.5	–1.0
Total Number of Painful areas (Right Side)	1.6	0.000	0.7	2.4
CAIT (Right) Score	0.7	0.000	0.6	0.8
Constant	15.7	0.000	5.9	12.0

[a, b] – dependent variable; CAIT-Cumberland Ankle Instability Tool Score; (CAIT (right): $R^2 = 0.54$, adjusted $R^2 = 0.53$; CAIT (left): $R^2 = 0.48$, adjusted $R^2 = 0.47$), B – the mean partial regression coefficient in the regression equation.

The number of painful areas in both ankles and the CAIT score on the opposite ankle were found to be predictors for instability (Tab. 4). However, multiple linear regression analysis indicated that pain level was only a predictor for right ankle instability (Tab. 4).

Discussion

The aim of this pilot study was to determine predictive factors leading to CAI in community-dwelling populations. Its key findings were that the CAIT scores negatively correlated with pain intensity, the number of painful regions, and duration (weeks and days) for both sides. CAIT scores were found to be the lowest in obese subjects with a BMI of 30.0 or above. In the current study, 41.4 % of participants had bilateral functional instability, 46.9 % demonstrated functional instability on the left, and 48% on the right. Furthermore, multiple linear regression analysis found that total number of painful regions, pain intensity, and opposite ankle CAIT score were possible risk factors for instability in either ankle.

The literature indicates the instability rate for the nonathletic populations to reange from 40% to 50% [1]. In the present study, one hundred twenty-eight (46.9%)

had functional instability on the left, while 131 (48%) functional reported instability on the right. Previous studies have shown that the prevalence of CAI is higher in children and younger adults, i.e. approximately 50% for those aged between 18–34 years, compared to 50% and above for seniors; this may be attributed to higher activity levels in the younger population [16,22]. Similar results regarding the rate of instability were found in the present study.

A prospective study with long-term follow-up by Waterman et al. [2] found a was significantly higher rate of instability in women compared to men, aged between 15–24 years. However, the overall rate did not significantly differ between men and women without their age-matched peers. A two-year cohort study performed in the US Military Academy indicated a higher rate of ankle instability in women than in men [23]. In the present study, the mean CAIT score was found to be significantly lower in women than men, bilaterally, which is consistent with the findings above. It was also indicated that for certain sport types, lateral ankle laxity might serve as a predictor of CAI among women [24]. Therefore, there is a need for further studies to determine why women are more at risk of perceived CAI, and to identify any potential anatomical, hormonal, and neuromuscular contributing factors that might be responsible [25]. Any well-explained potential risk factors can be incorporated in a developmental model of preventive measures.

Other than gender and sport type, Hershkovich et al. [15] propose that increased BMI is associated with CAI for all grades of instability, with both obesity and overweight having a positive relationship with CAI in both men and women [15]. Tyler et al. [26] report that CAI increases significantly in athletes with a high BMI compared to those with normal BMI. It has also been proposed that the biomechanical mechanisms (inversion trauma of the ankle) might be responsible for CAI in people with high BMI [27]. These results are supported by our present findings, indicating a significant association between BMI and CAI: obese subjects demonstrated a significantly higher mean CAIT score than those with normal weight. Indeed, female gender and obesity were associated with higher CAI risk. Hence, we believe that weight management would be an appropriate solution in ankle rehabilitation programs.

This cross-sectional study confirms that an unstable contralateral side, an increased number of painful regions, and higher pain level were found as significant predictors for instability. Indeed, pain severity, swelling and pain duration have been noted previously as potential risk factors for recurrent ankle sprain [7,28]. These parameters can represent valid criteria for referral to physiotherapy and rehabilitation, or orthopaedics and traumatology, during primary care to prevent long-term disability.

The treatment and follow-up strategy for neglected CAI should begin with a thorough explanation of the condition to the patient. They should be introduced to assessment tools such as CAIT, to determine the severity of their symptoms and disability status [29]. These simple tools are recommended for deciding on strategies in clinical practice [30]. Such assessments of disability status and perceived CAI could be valuable for physicians during early intervention and progress with treatment.

Our study has some limitations. The first is the small sample size: although the study was carried out with 273 people, ages 18–78, and the findings could not represent the entire population, a larger study group would provide better results. Future studies should include a larger sample size and a longitudinal design. Furthermore, the wide age range is a source of heterogeneity, and future research should focus on recruiting a more homogenous sample. In addition, it was not possible to evaluate some factors, such as postural changes, proprioception deficits, muscular imbalance, and range of motion, performed in physiotherapy and rehabilitation clinic.

Although the frequency (minutes per day) and duration of regular physical activity undertaken during the last three months (i.e. number of sessions per week, minutes per session) were collected, physical activity level data was not collected using a simple scoring method, such as the International Physical Activity Questionnaire (IPAQ). Finally, although it has been suggested that the CAIT can be a valuable predictor of re-injury when using a cut-off score of 25, the present study used a score of 27 points.

Conclusion

This pilot study emphasizes that high BMI, high pain level, contralateral CAI history, number of painful regions and being female might be related to developing CAI in the community-dwelling population. CAIT may be used to decide on a multifactorial approach, including weight and pain control and prophylactic physiotherapy intervention, at earlier times among patients with CAI. But still, further studies conducted with larger groups are needed to understand the predisposing factors for CAI.

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Conflicts of Interest
The authors have no conflict of interest to declare.

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