HOKKAIDO UNIVERSITY

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Kinesiophobia, self-reported ankle function, and sex are associated with perceived ankle instability in college club sports athletes with chronic ankle instability

Abstract

Objective: To investigate the association between sex, self-reported ankle function, pain intensity, kinesiophobia, and perceived ankle instability in athletes with chronic ankle instability (CAI).

Design: Cross-Sectional Study.

Setting: University.

Participants: College club sports athletes with CAI (n = 42).

Main Outcome Measures: Relationships with the Cumberland Ankle Instability Tool (CAIT) score and the Tampa Scale for Kinesiophobia-11 (TSK-11), the Foot and Ankle Ability Measure (FAAM), sex (0: male, 1: female), and ankle pain intensity by the Numeric Rating Scale were explored with multiple regression analysis.

Results: The regression model explained 50.3% of the variance of the CAIT score ($P < 0.001$), and the TSK-11 score ($B = -0.382$, $P = 0.002$), the FAAM sports subscale score ($B = 0.122$, $P = 0.038$), and sex ($B = -2.646$, $P = 0.031$) were significant independent variables for the CAIT score ($P < 0.001$), while pain intensity was not significant ($B = -0.182$, $P = 0.504$). These results indicated that greater TSK-11 score, lower FAAM sports subscale score, and being female were related to lower CAIT score.

Conclusions: Kinesiophobia related to perceived instability along with self-reported function and sex in athletes with CAI. Clinicians should assess the psychological aspects of athletes with CAI.

Key Words: ankle sprain, injury-related fear, fear of movement, patient-reported outcome

INTRODUCTION

Lateral ankle sprain (LAS) is one of the most frequent injuries in various sports (Fong et al., 2007) and interferes with athletes' participation in sports activities (Kofotolis & Kellis, 2007; Waldén et al., 2013). A previous history of LAS increases the risk of recurrent LAS, and the risk ratio is 1.29–6.06 (Wikstrom et al., 2021). LAS is a major cause of ligamentous posttraumatic ankle osteoarthritis (Valderrabano et al., 2006), and its adverse effects on health in the mid-to-long term are of concern. Chronic ankle instability (CAI) is a health condition in which patients have perceived ankle instability and frequent recurrent sprains after initial LAS (Gribble et al., 2013). Forty percent of patients with first-time LAS progressed to CAI (Doherty et al., 2016), and 20% of collegiate athletes had CAI (Koshino et al., 2020). Individuals with CAI have not only functional impairments such as muscle weakness and balance deficits but also decreased health-related quality of life (Hertel & Corbett, 2019). Among the impairments associated with CAI, the feeling that the ankle is unstable or that it is at risk of giving way is a common complaint in patients. This is referred to as "perceived instability." Perceived instability is a key factor in determining the presence or absence of CAI and may be related to recurrent sprains in individuals with CAI. Therefore, CAI is a common health problem in the sports population, and perceived instability is an essential factor in understanding its conditions.

The characteristics of individuals with CAI have been revealed by a number of previous studies on motor-behavioral (e.g., balance deficits, altered movement patterns, and muscle weakness) and pathomechanical impairments (e.g., joint laxity and range of motion restriction). Recent studies have focused on sensory-perceptual impairments, including kinesiophobia (Suttmiller & McCann, 2021). Kinesiophobia refers to a fear of movement,

re-injury, and pain, and kinesiophobia in CAI is particularly focused on the fear of movement and re-injury (Hertel & Corbett, 2019). Individuals with CAI had greater kinesiophobia than either copers or healthy controls (Suttmiller & McCann, 2021), and this is no exception in athletes (Fukano et al., 2020). Increased kinesiophobia after sports injury may have led to decreased levels of physical activity, resulting in decreased self-reported function. Additionally, it may change movement patterns that increase the likelihood of re-injury (Hsu et al., 2017; Marok & Soundy, 2021). Therefore, it may be a factor associated with self-reported instability, function, and re-injury in individuals with CAI. The negative association between kinesiophobia and self-reported ankle function has been reported previously (Suttmiller et al., 2022), but the association with perceived instability, a key factor in CAI, has not been investigated. Investigating the relationship between kinesiophobia and perceived instability may provide a further step forward in the understanding of CAI, which involves a variety of factors. Kinesiophobia may negatively affect both perceived instability and ankle function.

The Tampa Scale for Kinesiophobia (TSK) is a patient-reported outcome (PRO) measure commonly used to assess kinesiophobia. It was originally designed to measure fear of pain in patients with low back pain but is now used to measure kinesiophobia in patients with various musculoskeletal injuries, including individuals with CAI (Goldberg et al., 2018; Suttmiller & McCann, 2021). A previous study suggested that pain intensity affects the TSK-11 score in patients with a diagnosis related to musculoskeletal pain (Goldberg et al., 2018). In individuals with CAI, the presence of pain is associated with perceived instability (Adal et al., 2020). Similarly, lower self-reported ankle function assessed by the Foot and Ankle Ability Measure (FAAM) was associated with greater kinesiophobia

assessed by the TSK and greater perceived instability assessed by the Cumberland Ankle Instability Tool (CAIT) (Vuurberg et al., 2018; Wang et al., 2021; Suttmiller et al., 2022). Therefore, the effects of these potential confounders should be considered simultaneously when investigating the association between perceived instability and kinesiophobia.

In a previous study, multiple regression analysis revealed that perceived instability, pain presence, pain catastrophizing, and kinesiophobia contributed to self-reported ankle-regional and global function in individuals with CAI (Suttmiller et al., 2022). By using multiple regression analysis, we can investigate the relationship between specific factors and the dependent variable after controlling for the relationship with other factors. Furthermore, since multiple factors can be analyzed simultaneously, it is possible to determine the relative contribution of kinesiophobia to perceived instability compared to ankle function, which has been commonly assessed in athletes with CAI. This may provide meaningful insight into the understanding of CAI, a multifactorial model. Therefore, this study aimed to investigate the relationship between self-reported ankle function, pain intensity, kinesiophobia, and perceived instability in athletes with CAI using multiple regression analysis. The hypothesis was that self-reported ankle function, pain intensity, and kinesiophobia would be associated with perceived instability, with lower ankle function, greater pain intensity, and greater kinesiophobia associated with greater perceived instability. This study would clarify the importance of kinesiophobia in athletes with CAI. In addition, the identification of new factors associated with perceived instability may also lead to advances in the assessment and treatment of CAI.

METHODS

Study Design

The present study was a cross-sectional study via a web-based questionnaire. The questionnaire consisted of four parts: our original questionnaire (asking about demographic data, previous history, ankle pain intensity, etc.), the CAIT, the FAAM Sports subscale, and the TSK-11. A collective survey was conducted among athletes in our university clubs to investigate the association between the dependent variable (CAIT score) and the independent variables (TSK-11 score, FAAM Sports subscale score, sex, and pain intensity) using multiple regression analysis. This study was approved by the ethical committee of our university.

Participants

We asked 18 sports clubs in our university to participate in this study, and a total of 329 athletes took part in the study. All participants were fully informed about the purpose and procedure of the study and agreed to participate in this study. Among them, only those who met the criteria for CAI based on the recommendations of the International Ankle Consortium (Gribble et al., 2013) were included in the statistical analysis. Inclusion criteria for CAI were as follows: i) a history of at least one LAS; ii) a history of at least two episodes of "giving way" within six months before enrollment in this study and/or recurrent LAS to the same ankle; iii) the CAIT score ≤ 25 (Kunugi et al., 2017); and iv) at least one year after the first-time LAS. Exclusion criteria for CAI were as follows: i) history of fracture and/or surgical treatment and ii) history of major musculoskeletal injuries within three months of enrollment in this study.

Procedure

The questionnaire survey was conducted using a collective survey method to reduce self-selection bias. We visited the club practices or meetings and explained the purpose and procedures of this study. Next, the URL of the questionnaire created using Google Forms (Google LLC, Mountain View, California, USA) was shared with the participants' smartphones or computers through a club representative, and the participants answered the questionnaire online. The first question asked if they agreed to participate in the study, and those who did not agree were guaranteed the right to stop answering the questionnaire at that point. Participants were asked to complete the questionnaire on-site, and no time limit was set. While completing the questionnaire, the researchers remained in place and replied if the participants had any questions. We then ensured that all participants completed the questionnaire. All participants responded to the original questionnaire first, then the CAIT, the FAAM Sports subscale, and the TSK-11 in that order.

The questionnaire consisted of our original questionnaire (described below) and three PROs. PROs were the ankle-specific PROs recommended by the International Ankle Consortium (Gribble et al., 2013) and the TSK-11 commonly used to assess kinesiophobia in individuals with CAI (Suttmiller & McCann, 2021).

Original questionnaire

Our original questionnaire asked the following questions: age, sex, height, weight, sports discipline, hours per week in sports activity, previous histories for the lower extremity including the ankle, and pain intensity at the ankle. The participants answered the questions in the order given above.

Perceived instability

The CAIT was used to assess perceived instability (Kunugi et al., 2017). It consists of nine questions: one about ankle pain and eight about feelings of ankle instability. The total score ranges from 0 to 30, with a lower score indicating greater perceived instability.

Self-reported ankle function

The Foot and Ankle Ability Measure (FAAM) was used to assess self-reported ankle function (Uematsu et al., 2015). The FAAM consists of the Activity of Daily Living (ADL) subscale with 21 questions and the Sports subscale with eight questions. All questions are scored on a 5-point Likert scale, from 0 (not possible to do) to 4 (no difficulty at all). The total score was divided by the full score, and the percentage was used as the final score. In this study, the Sports subscale was used for analysis because the participants were athletes, and we were interested in their ankle function during sports activities.

Kinesiophobia

The TSK-11 was used to assess kinesiophobia (Kikuchi et al., 2015). The TSK-11 consists of 11 questions and is scored from 1 (strongly disagree) to 4 (strongly agree) for all questions. The total score ranges from 11 to 44, with a higher score indicating a stronger kinesiophobia.

Pain intensity

Ankle pain intensity was assessed with the Numeric Rating Scale (NRS). Participants rated the worst pain they perceived during sports activities on an 11-point scale from 0 (no pain at all) to 10 (the worst pain imaginable).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics 26 (IBM Corporation, Armonk, NY) on all participants determined as with CAI. Median and interquartile or percentages were calculated for demographic variables (age, sex, height, weight, and the number of previous LAS) and the CAIT score, the TSK-11 score, the FAAM Sports subscale score, and pain intensity.

Before the multiple regression analysis, the correlation between the independent variables was checked by calculating Spearman's rank correlation coefficient to reduce the possibility of multicollinearity. When the correlation between any variable was Spearman's rank correlation coefficient ≥ 0.7 (Hair et al., 2018), the variable we considered more important in this study was entered into the regression model, and the other was excluded. Multiple regression analysis was performed to investigate the factors related to perceived instability. The dependent variable was the CAIT score. The independent variables were the TSK-11 score, the FAAM Sports subscale score, sex (0: male and 1: female), and pain intensity. Model 1 was a regression model with the TSK-11 score and the FAAM Sports subscale score as independent variables. Models 2 and 3 were models with sex and pain intensity which may be potential confounders sequentially entered as control variables. The variance inflation factor (VIF) was calculated to check multicollinearity and interpreted that VIF ≥ 3 might result in multicollinearity (Hair et al., 2018). The Durbin-Watson ratio (d)

was calculated to check for the autocorrelation of the residuals for the final multiple regression model. Based on the significance point presented by Durbin and Watson (Durbin & Watson, 1951), when $1.25 \leq d \leq 1.57$, the residuals were interpreted as having no autocorrelation. Statistical significance was set at $\alpha = 0.05$.

RESULTS

Of the 329 participants, a total of 42 participants with CAI were included in the statistical analysis. They participated in badminton, baseball, basketball, futsal, gymnastics, lacrosse, soccer, softball, table tennis, tennis, and track and field. Table 1 shows the participants' demographic data and the results of the PROs.

There was no combination of variables with Spearman's rank correlation coefficient ≥ 0.7 (Table 2); all independent variables were entered into multiple regression analysis.

Table 3 shows the results of multiple regression analysis with the CAIT score as the dependent variable. The final multiple regression model (Model 3) showed that the TSK-11 score, the FAAM Sports subscale score, and sex were significant independent variables. Pain intensity was not a significant independent variable. The final multiple regression model explained 50.3% of the variance of the CAIT score ($P < 0.001$). Unstandardized coefficients (B) indicated that higher TSK-11 score, lower FAAM Sports subscale score, and being female were associated with lower CAIT score. All independent variables for all regression models were VIF < 3, suggesting that no multicollinearity would affect each coefficient's accuracy. The Durbin-Watson ratio (d) of the final multiple regression model was 1.456, suggesting no autocorrelation in the residuals. Standardized partial regression plots (Figure 1) were used to check the linearity between the dependent variable and each

independent variable, and residual plots (Figure 2) were used between the dependent variable and the independent variables collectively. In all cases, any nonlinear relationship was not observed, and the assumption of linearity was confirmed. The linearity of the residual plots also confirmed the assumption of homoscedasticity (Figure 2). In all cases, standardized residuals were within ±2.5 standard deviations, and Cook's distance was <1, thus all cases were determined not to be influential to the final regression model (Hair et al., 2018). Finally, a visual examination of the normal probability plots of the residuals (Figure 3) checked the normality of the residuals.

DISCUSSION

This study aimed to clarify the relationship between kinesiophobia, self-reported ankle function, sex, pain intensity, and perceived instability in athletes with CAI. Higher TSK-11 and lower FAAM Sports subscale scores were significantly associated with lower CAIT score, as we hypothesized. Furthermore, being female was also significantly associated with lower CAIT score.

Kinesiophobia, which means fear of movement and re-injury, is assessed using various PROs in individuals with CAI, and there is strong evidence that individuals with CAI have a higher level of kinesiophobia than healthy participants and copers (Suttmiller & McCann, 2021). The median TSK-11 score for individuals with CAI in this study was 24 points. There is no cutoff value for TSK-11 to be considered high kinesiophobia. In a previous study (Houston et al., 2014), the median TSK-11 of individuals with CAI was 18 (range: 17–21). It seemed that individuals with CAI in the present study had a greater kinesiophobia than in the previous study. Previous studies have reported that kinesiophobia

was associated with joint position sense, postural control, and self-reported ankle function in individuals with CAI (Alshahrani & Reddy, 2022; Suttmiller et al., 2022). However, studies investigating the association with other factors are still lacking. Our results showed that kinesiophobia related to perceived instability, even after controlling for the association with self-reported ankle function, sex, and pain intensity. Additionally, the standardized coefficient (β) of the TSK-11 score was almost equal to that of the FAAM Sports subscale score (TSK-11: β = -0.437, FAAM Sports subscale: β = 0.367). These results suggested that in managing perceived instability in CAI, it is necessary to focus on kinesiophobia as well as ankle function.

The median FAAM Sports subscale of individuals with CAI in this study was 96.9%. In a previous study (Houston et al., 2014), the FAAM Sports subscale of physically active participants with CAI was reported to be 78% (range: 69–86), suggesting that the individuals with CAI in this study had higher ankle joint function than in a previous study. The level of competition and race may have influenced this difference. It is not surprising that the FAAM Sports subscale explained perceived instability, but it was somewhat unexpected that the control variable, sex, was a significant independent variable. Since we created a dummy variable for sex with 0 for males and 1 for females, the unstandardized coefficient (*B*) meant that being female decreased the CAIT score by 2.646 points. Previous studies reported a higher incidence of ankle sprain or prevalence of CAI in females (Doherty et al., 2014; Lin et al., 2022; Roos et al., 2017; Tanen et al., 2014). The ankle joint laxity in the frontal plane was greater in females than in males (Ericksen & Gribble, 2012). These may have some relationship to the contribution of being female to perceived

instability. Because there were only 5 female participants in this study, future studies should further investigate the effect of sex.

Contrary to our hypothesis, pain intensity was not a significant independent variable of perceived instability. In individuals with CAI, the presence of pain was associated with perceived instability and self-reported ankle function (Adal et al., 2020; Suttmiller et al., 2022). Those previous studies assessed pain as a binary variable, presence/absence. In contrast, this study used 11-point NRS to assess pain intensity. In individuals with CAI, the presence of ankle pain is related to increased perceived instability, but its intensity may not be a matter.

Clinicians should recognize that among athletes with CAI currently participating in sports activities, perceived instability was associated with kinesiophobia and self-reported ankle function. Currently, the CAIT and the FAAM are commonly used for individuals with CAI. The present study showed the association between low CAIT scores and high TSK-11 scores, which indicates that those with greater perceived instability may have greater kinesiophobia. In clinical practice, kinesiophobia should be assessed by the TSK-11 for athletes with CAI. Assessment of athletes' perceived fear of movement and/or re-injury using the TSK-11 may help to manage ankle instability perceived by athletes during sports activities.

This study has some limitations that should be considered. First, the cross-sectional study was a major limitation. Since multiple regression analysis cannot explain causal relationships, prospective studies are expected to assess psychological factors in the future. Second, recall bias was possible in the results such as information about the diagnosis of ankle sprains because the present study was conducted as a questionnaire survey. Third,

this study used Google Forms, but the order of the questionnaires could not be randomized due to its specifications (all participants answered the original questionnaire, CAIT, FAAM, and TSK-11 in that order). Therefore, the possibility of order bias should be considered.

In addition, the main delimitation is that participants in this study were club sports athletes belonging to only one university, which may limit the generalizability of the study's results for such as younger or older patients and more elite athletes. The TSK-11, the FAAM Sports subscale, sex, and pain intensity explained only about 50% of the variance of the CAIT in the present study. The independent variables in this study did not include objective assessments such as balance ability, muscle strength, or joint laxity, which have been widely assessed in previous studies, and this was also a delimitation. Variables based on these may explain the remaining 50%.

CONCLUSION

Multiple regression analysis on athletes with CAI revealed that higher TSK-11 score, lower FAAM Sports subscale score, and being female were related to a lower CAIT score, while the pain intensity at the ankle during sports activities was not associated with perceived instability. The standardized coefficient (β) suggested that the TSK-11 score affects the CAIT score as strongly as the FAAM Sports subscale score. The results suggested the need to assess not only ankle function but also kinesiophobia when managing athletes with CAI.

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Table 1. Participants' demographics and patient-reported outcome data

	n (%) / Median (IQR)
Participants	
Male	37 (88.1%)
Female	5 (11.9%)
Age (years)	20.5 (2.0)
Height (cm)	170.0 (11.8)
Weight (kg)	64.0 (13.5)
Hours per week in sports activity	12.0 (6.5)
Number of previous ankle sprains	3.0 (2.5)
CAIT score	22.0 (5.8)
TSK-11 score	24.0 (6.8)
FAAM Sports subscale score (%)	96.9 (9.4)
Pain intensity	2.0 (4.0)

Abbreviations: IQR, interquartile range; CAIT, Cumberland Ankle Instability Tool; TSK-11, Tampa Scale for Kinesiophobia-11; FAAM, Foot and Ankle Ability Measure.

Table 2. The correlation matrix with Spearman's rank correlation coefficients

	CAIT	TSK-11	FAAM Sports subscale	Sex	Pain intensity
CAIT	—				
TSK-11	-0.485*	—			
FAAM Sports subscale	0.541*	-0.349*	—		
Sex	-0.145	-0.091	-0.020	—	
Pain intensity	-0.328*	-0.012	-0.573*	0.254	—

* $P < 0.05$

Sex was a dummy variable for male as 0 and female as 1, respectively.

Abbreviations: CAIT, Cumberland Ankle Instability Tool; TSK-11, Tampa Scale for Kinesiophobia-11; FAAM, Foot and Ankle Ability Measure.

Table 3. The multiple regression model to explain the Cumberland Ankle Instability Tool score

	B	*95% CI for B*		*β*	*t*	*P*	VIF
		Lower	*Upper*				
Model 1 (R^2=0.436, P < 0.001)							
TSK-11	-0.333	-0.559	-0.108	-0.381	-2.994	0.005	1.122
FAAM Sports subscale	0.142	0.056	0.228	0.428	3.358	0.002	1.122
Model 2 (R^2=0.497, P < 0.001)							
TSK-11	-0.358	-0.575	-0.141	-0.409	-2.860	0.007	1.135
FAAM Sports subscale	0.148	0.066	0.230	0.447	2.342	0.025	1.128
Sex	-2.438	-4.732	-0.144	-0.250	-2.152	0.038	1.024
Model 3 (R^2=0.503, P < 0.001)							
TSK-11	-0.382	-0.612	-0.152	-0.437	-3.359	0.002	1.260

FAAM Sports subscale	0.122	0.007	0.237	0.367	2.150	0.038	2.172
Sex	-2.646	-5.042	-0.250	-0.272	-2.238	0.031	1.099
Pain intensity	-0.182	-0.729	0.365	-0.112	-0.675	0.504	2.042

The dependent value is the Cumberland Ankle Instability Tool score. Sex was a dummy variable for male as 0 and female as 1, respectively.

Abbreviations: *B*, unstandardized coefficient; CI, confidence interval; *β*, standardized coefficient; VIF, variance inflation factor; TSK-11, Tampa Scale for Kinesiophobia-11; FAAM, Foot and Ankle Ability Measure.

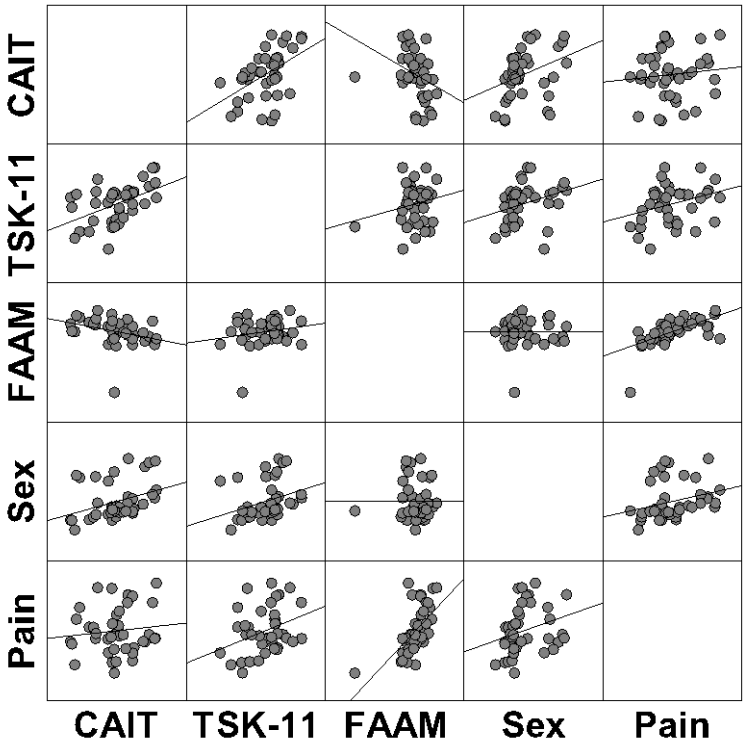

Figure 1. The standardized partial regression plots.

Abbreviations: CAIT, Cumberland Ankle Instability Tool; TSK-11, Tampa Scale for Kinesiophobia-11; FAAM, Foot and Ankle Ability Measure Sports subscale; Pain, Pain intensity

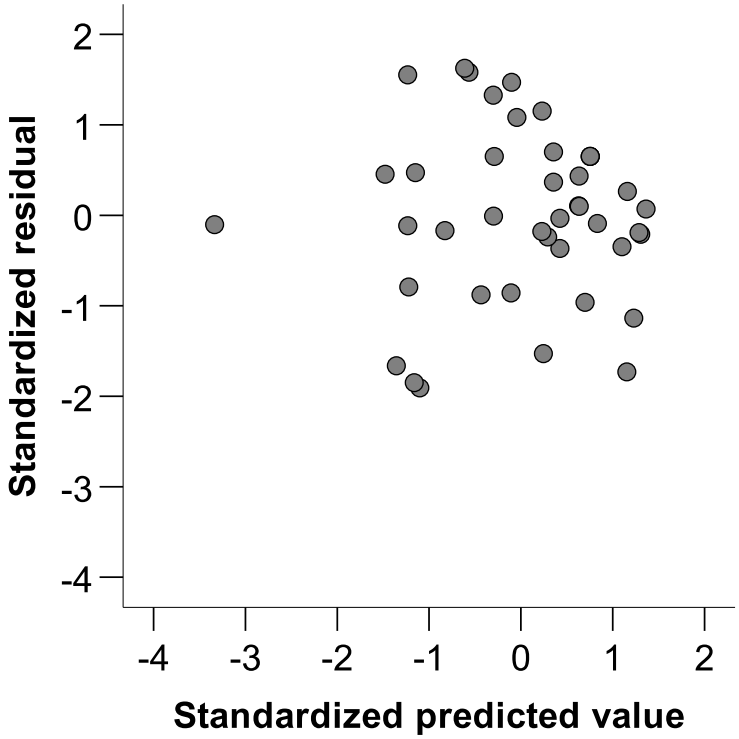

Figure 2. The residual plots.

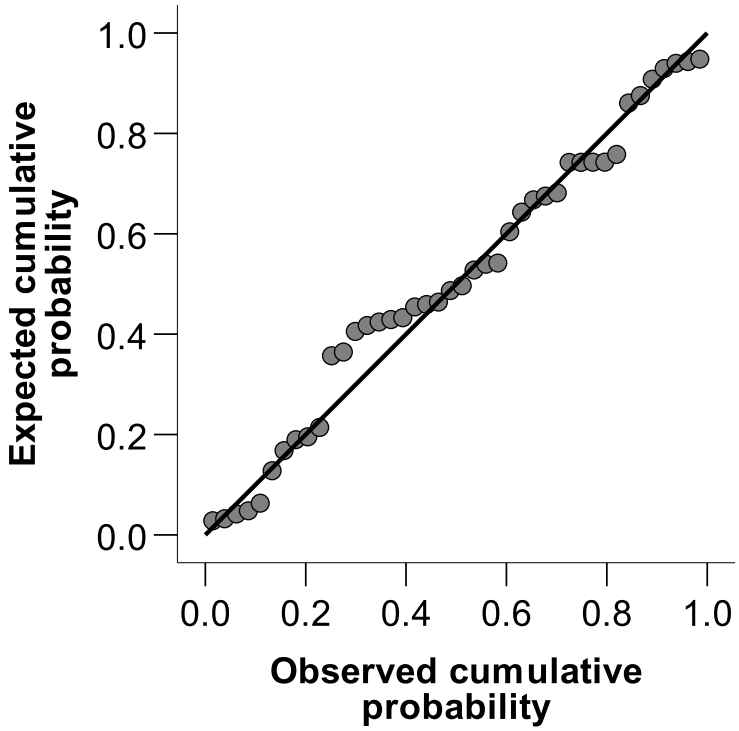

Figure 3. The normal probability plots of the residuals.