A step forward the democratization of screening tools for ankle sprain risk

Beatrice De Lazzari[1,2], Federico Caramia[1,2], Emanuele Cannizzo[1], Enrico de Bartolo[1], Valentina Camomilla[1,2]
[1]Department of Movement, Human and Health Sciences, University of Rome "Foro Italico", Rome, Italy
[2]Interuniversity Centre of Bioengineering of the Human Neuromusculoskeletal System, University of Rome "Foro Italico", Italy
Email: valentina.camomilla@uniroma4.it

Summary

Ankle sprains are common injuries affecting both sports and daily-life activities. A traditional screening tool, relying on expensive instruments, was transformed into a low-cost solution, using machine learning and smartphone data making injury risk assessment accessible to more athletes in the field. A NuSVC binary classifier, fed with anthropometric data and smartphone features of 126 participants, achieved 70% test phase accuracy to predict ankle risk of injury.

Introduction

Injury risk is a major factor that influences both individual players and team performance [1]. When the injury affects the lower limbs, the limitations affect both sports and daily life. Methods and tools are developed that may assess injury risk in sport contexts. Among these, a proof-of-concept able to analyze the single leg drop jump landing (SLDJ) test using a combination of a smartphone accelerometer and a machine learning classifier was developed for ankle sprain injury risk [2]. This approach could aid in identifying individuals at risk while also guiding preventive strategies for vulnerable athletes. In this work, we want to verify if the democratic approach proposed in [2] is still valid with wider population.

Methods

A group of 126 physically active participants (Table 1) was tested while performing the SLDJ procedure proposed by Fransz [3], jumping on a force plate (FP, Bertec, Bertec Corporation, Columbus, OH, USA; fs = 1000 samples/s; size = 40 × 40 cm), while hand—holding a smartphone (SP, Samsung Galaxy S9+, Samsung Group, Seoul, Republic of Korea; fs = 500 samples/s; full-scale range: accelerometer = ± 8 g; gyroscope = ± 500 deg/s), as proposed in [2]. Each participant performed the SLDJ once per leg.

Table 1: Anthropometric data of males (M) and females (F) participants (mean ± standard deviation).

	Number	Age (y)	Mass (kg)	Height (m)
M	78	22 ± 5	72 ± 13	1.79 ± 0.08
F	48	25 ± 4	60 ± 8	1.64 ± 0.07

After data acquisition, the two risk factors (RMS ML, HOR GRF late) defined in [3] were calculated from both FP and SP signals through MATLAB R2022a (The MathWorks Inc., Natick, MA, USA). Risk factors computed with FP and reference values [3] were used for classification. Participants were considered at risk (class 1) if the combination of their FP risk factors resulted in a risk-level higher than one relative to a participant with average scores, or belonging to class 0, if otherwise.

Age, height, mass and SP risk factors (calculated from the accelerometer, as in [2]) are used as input variables of a binary NuSVC classifier developed in Jupyterlite Notebook (v. 0.5.0) to predict the classification obtained using FP risk factors. After dividing train/test sets (80-20% of the participants) and a z-score normalization step, hyperparameter tuning was performed using GridSearchCV to find the best binary classifier, considering GroupKFold approach for validation to ensure data leakage.

Results and Discussion

A final dataset of 246 trials (49 classified as 0, 197 as 1) was used to develop the classifier (Table 2).

Table 2: Hyperparameter options and ranges for NuSVC with the corresponding best model hyperparameters values and accuracy.

Hyperparameters	Options/ranges	Model
Kernel	'linear', 'poly', 'rbf', 'sigmoid', 'precomputed'	'poly'
Degree	[1,2,3,4,5]	5
Gamma	['scale','auto']	'scale'
Nu	[0.1:0.1:1]	0.3
Accuracy (train-test)	-	74-70%

The accuracy of the model is promising because obtained from a bigger population relative to [2]. Since current reference values and the risk assessment model in [3] only included a male young population, longitudinal studies including females and older male population are required to revise current classification and further develop this classifier.

Conclusions

Smartphone-based solutions could help in democratizing the screening process of ankle sprains injury risk.

References

[1] Hägglund M et al. (2013). *Br. J. Sports Med.*, **47**:738–742.
[2] De Lazzari B et al. (2023). In *Proc XXIII SIAMOC 2023*, pp. 52 [Online].
[3] Fransz DP et al (2018). *Am. J. Sports Med.*, **46**, 3454–3462.