Supplementary Material

Effects of a proprioceptive focal stimulation (Equistasi®) on reducing the biomechanical risk factors associated with ACL injury in female footballers

Fabiola Spolaor[1*] , Annamaria Guiotto[1†] , Alfredo Ciniglio[1†] , Federica Cibin[2] , Zimi Sawacha[1,3]

[1] Department of Information Engineering, University of Padova, Italy

[2] BBSoF Srl, Padova, Italy

[3] Department of Medicine, University of Padova, Italy

[†] These authors share second authorship

*** Correspondence:**
Corresponding Author

fabiola.spolaor@unipd.it

1 Supplementary Data A

For each variable, Friedman test (Matlab R 2021) was used for the repeated measure non parametric test between T1, T2 and T4 ($p<0.05$). Wilcoxon Signed Rank Test (Matlab R 2021) was used for paired comparison among T0 and T1 ($p<0.05$) and across the different time frames as follows: T1-T2, T2-T4 and T1-T4 ($p<0.017$ after Bonferroni correction). For what concerns joint angles, joint moments, and ground reaction forces the Wilcoxon Signed Rank was applied to compare the variable values at each instant of the cutting maneuver.

All p values available are reported as follows:

Table 1: P values for comparisons on variables Ellipse, Sway Area, Rms, Path, Path X and Path Z, Velocity, Velocity X and Velocity Z extracted from Romberg Test in the two conditions (Eyes open EO and Eyes Close EC). X= medial lateral direction; Z= anterior posterior direction

Friedman test	**ellipse**	**sway_area**	**RMS**	**path**	**pathX**	**pathZ**	**velM**	**velMX**	**velMZ**
EO	0.074	0.165	0.074	0.247	0.074	0.449	0.165	0.091	0.449
EC	0.449	0.549	0.549	0.449	**0.041**	0.449	0.549	0.074	0.549
Wilcoxon signrank test	**ellipse**	**sway_area**	**RMS**	**path**	**pathX**	**pathZ**	**velM**	**velMX**	**velMZ**
EO vs EC									
T0	0.0625	0.0625	0.0625	0.625	0.0625	0.8125	0.625	0.125	0.8125
T1	0.125	0.625	0.125	0.3125	1	0.1875	0.3125	1	0.1875
T2	0.4375	0.8125	0.3125	0.3125	1	0.1875	0.3125	0.8125	0.125
T4	1	1	0.625	0.8125	0.8125	0.8125	1	0.625	0.8125
EO									
T0 vs T1	0.193	0.084	0.064	0.131	**0.049**	0.322	0.275	0.084	0.375
T1 vs T2	0.0625	0.125	0.0625	0.125	0.0625	0.3125	0.125	0.0625	0.3125
T1 vs T4	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125

T2 vs T4	0.8125	0.625	0.3125	0.8125	0.125	0.3125	0.4375	0.3125	0.1875
EC									
T0 vs T1	0.232	0.193	0.084	0.160	0.131	0.322	0.232	0.193	0.375
T1 vs T2	0.625	0.4375	0.625	0.4375	0.125	0.625	0.4375	0.125	0.625
T1 vs T4	0.125	0.125	0.4375	0.3125	0.0625	0.625	0.4375	0.0625	0.625
T2 vs T4	0.625	0.8125	1	0.8125	0.1875	1	0.8125	0.625	0.8125

Table 2: P values for comparisons on all the variables extracted from the spectral frequencies analysis of the Romberg Test in the two conditions (Eyes open EO and Eyes Close EC) for all the time frames analyzed (T0,T1,T2, and T4). x= medial lateral direction; z= anterior posterior direction

Friedman test	**0_1 0_25_x**	**0_25 0_35_x**	**0_35 0_5_x**	**0_5 0_75_x**	**0_75 1_x**	**0_1 0_25_z**	**0_25 0_35_z**	**0_35 0_5_z**	**0_5 0_75_z**	**0_75 1_z**
EO	0.074	0.165	0.165	0.549	0.074	**0.041**	0.165	0.449	0.449	**0.041**
EC	**0.041**	0.165	0.247	0.449	0.074	0.074	0.165	**0.007**	0.247	0.247
Wilcoxon signrank test	**0_1 0_25_x**	**0_25 0_35_x**	**0_35 0_5_x**	**0_5 0_75_x**	**0_75 1_x**	**0_1 0_25_z**	**0_25 0_35_z**	**0_35 0_5_z**	**0_5 0_75_z**	**0_75 1_z**
EO vs EC										
T0	0.0625	0.0625	0.4375	0.0625	1	0.4375	0.125	0.8125	0.625	1
T1	0.3125	0.8125	0.4375	1	0.3125	0.125	0.3125	1	0.3125	0.625
T2	1	1	0.625	1	0.625	1	0.4375	0.4375	0.4375	0.0625
T4	1	1	0.8125	0.4375	0.625	0.8125	0.1875	0.0625	0.8125	0.625
EO										
T0 vs T1	0.322	1.000	0.232	1.000	**0.002**	0.557	0.770	0.492	0.770	0.846
T1 vs T2	0.3125	0.1875	0.4375	1	0.4375	0.0625	0.1875	0.4375	0.625	0.0625
T1 vs T4	0.0625	0.125	0.0625	0.125	0.0625	0.125	0.125	0.625	0.1875	0.1875
T2 vs T4	0.625	0.1875	0.3125	0.3125	0.3125	0.4375	0.625	0.8125	0.625	0.125
EC										

T0 vs T1	0.193	0.232	0.084	0.922	0.131	**0.049**	0.625	0.131	1.000	0.432
T1 vs T2	0.4375	0.625	0.625	0.625	0.0625	0.0625	0.4375	0.0625	0.625	0.625
T1 vs T4	0.0625	0.0625	0.125	0.1875	0.125	0.625	0.125	0.0625	0.625	0.625
T2 vs T4	0.1875	0.4375	0.1875	0.625	0.625	0.8125	0.625	0.0625	0.8125	0.4375

Table 3: P values for comparisons on position of the peak of each angle analyzed within the task for each joint (H=Hip, K= Knee, A= Ankle).

	PosMax Hip FEAngle	**PosMax Knee FEAngle**	**PosMax Ankle FEAngle**	**PosMin Hip FEAngle**	**PosMin Knee FEAngle**	**PosMin Ankle FEAngle**
T0 vs T1 - Wilcoxon signrank	0.872	0.808	0.310	0.288	0.913	0.935
T1-T2-T4 - Friedman	0.126	0.268	0.052	0.411	0.023	0.160
T1 vs T2 - Wilcoxon signrank	0.314	0.315	0.353	0.930	0.628	0.815
T1 vs T4 - Wilcoxon signrank	0.698	0.939	0.083	0.173	0.056	0.061
T2 vs T4 - Wilcoxon signrank	0.135	0.130	0.010	0.210	0.008	0.023

Table 4: P values for comparisons on position of the peak of each moment analyzed within the task for each joint (H=Hip, K= Knee, A= Ankle).

	PosMax Hip FETorque	PosMax Hip AATorque	PosMax Knee FETorque	PosMax Knee VVTorque	PosMax Ankle FETorque	PosMax Ankle IETorque
T0 vs T1 - Wilcoxon signrank	0.754	0.230	0.782	0.781	0.253	0.155
T1-T2-T4 - Friedman	0.216	0.513	0.241	0.789	0.460	0.278
T1 vs T2 - Wilcoxon signrank	0.779	0.507	0.457	1.000	0.407	0.149
T1 vs T4 - Wilcoxon signrank	0.071	0.211	0.603	1.000	0.273	0.092
T2 vs T4 - Wilcoxon signrank	0.281	0.594	0.106	0.844	0.891	0.905
	PosMinHip FETorque	**PosMinHip AATorque**	**PosMinKnee FETorque**	**PosMinKnee VVTorque**	**PosMinAnkle FETorque**	**PosMinAnkle IETorque**
T0 vs T1 - Wilcoxon signrank	0.542	0.808	0.573	0.661	0.765	0.647
T1-T2-T4 - Friedman	0.097	0.964	0.355	0.359	0.006	0.308
T1 vs T2 - Wilcoxon signrank	0.154	0.456	0.476	0.249	0.097	0.420
T1 vs T4 - Wilcoxon signrank	0.397	0.819	0.155	0.523	0.638	0.931
T2 vs T4 - Wilcoxon signrank	0.048	0.795	0.263	0.658	0.002	0.214

Table 5: P values for comparisons on vertical component of the ground reaction forces

	PosMax VerticalForce
T0 vs T1 - Wilcoxon signrank	0.423
T1-T2-T4 - Friedman	0.268
T1 vs T2 - Wilcoxon signrank	0.483
T1 vs T4 - Wilcoxon signrank	0.130
T2 vs T4 - Wilcoxon signrank	0.079

2 Supplementary data B

To account for the effect of the device, the effect size (Cohen's d) was calculated (Matlab R2023a) based on the ratio of the difference between group means at couples of different T and the pooled standard deviation (Cohen J. 1988. Statistical power analysis for the behavioral sciences. 2nd ed. New York (NY): Lawrence Erlbaum Associates). Ref 44 in the main text.

Table 1. The effect size (Cohen's d) for the position of the peak of each angle and each torque analyzed within the task for each joint .

	T0 vs T1	T1 vs T2	T1 vs T4	T2 vs T4
Peak flexion angle position - Hip	-0.2087	-0.3482	-0.0209	0.2959
Peak flexion angle position - Knee	-0.1585	-0.1784	0.1540	0.3894

Peak flexion angle position - Ankle	-0.3013	-0.2115	0.3698	0.5712
Peak extension angle position - Hip	-0.1984	0.3312	0.0622	-0.2389
Peak extension angle position - Knee	-0.0921	0.2273	-0.5270	-0.7718
Peak extension angle position - Ankle	0.1746	-0.0078	-0.4054	-0.4012
Peak flexion torque position - Hip	-0.0339	-0.0615	-0.4261	-0.3794
Peak adduction torque position - Hip	-0.3667	0.3566	0.3653	0.0071
Peak flexion torque position - Knee	-0.1358	-0.1360	0.1621	0.2881
Peak valgus torque position - Knee	-0.0988	0.2012	0.0873	-0.1127
Peak flexion torque position - Ankle	0.4185	-0.1470	-0.2640	-0.1150
Peak inversion torque position - Ankle	-0.2439	0.3280	0.2984	-0.0244
Peak extension torque position - Hip	-0.1357	0.3154	-0.2311	-0.5356
Peak abduction torque position - Hip	-0.1207	0.2309	0.2194	-0.0152
Peak extension torque position - Knee	0.1325	-0.1806	-0.2162	-0.0391
Peak varus torque position - Knee	-0.0598	0.3512	0.2295	-0.1003
Peak extension torque position - Ankle	-0.1392	0.3616	-0.1678	-0.5462
Peak eversion torque position - Ankle	0.1273	0.2638	0.0679	-0.2328

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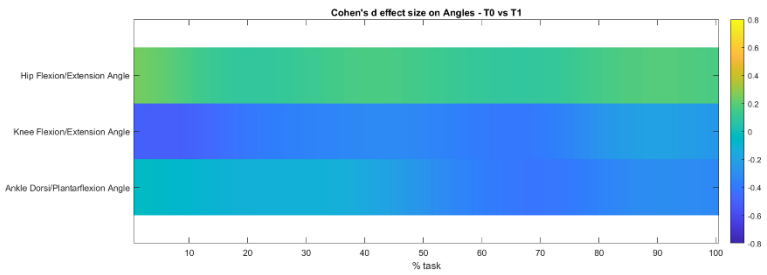
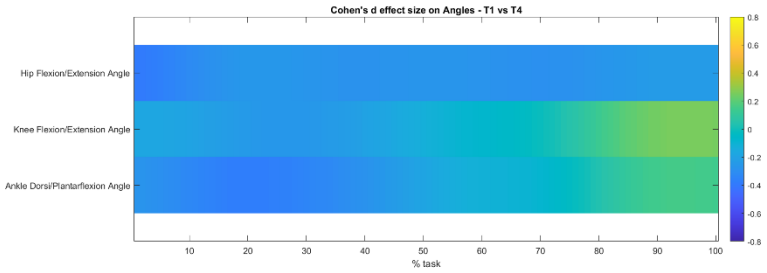
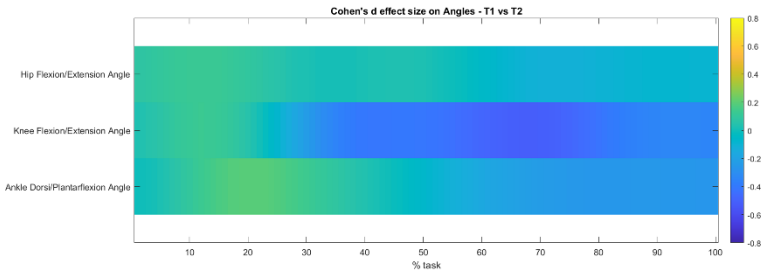
Table 7. The effect size (Cohen's d) for the Ellipse, Sway Area, Rms, Path, Path X and Path Z, Velocity, Velocity X and Velocity Z extracted from Romberg Test and for all the variables extracted from the spectral frequencies analysis of the Romberg Test in the two conditions (Eyes open EO and Eyes Close EC). X= medial lateral direction; Z= anterior posterior direction

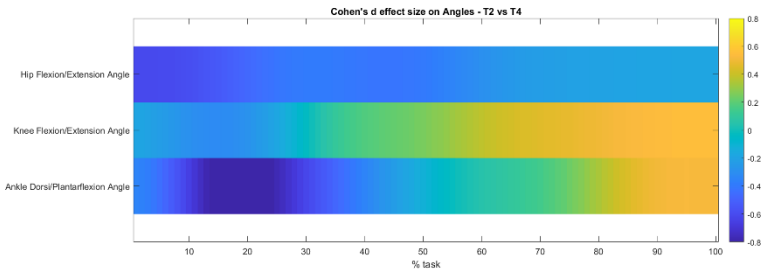
	EO T0 Vs EC T0	EO T1 Vs EC T1	EO T2 Vs EC T2	EO T4 Vs EC T4	EO T0 Vs EO T1	EC T0 Vs EC T1	EO T1 Vs EO T2	EO T1 Vs EO T4	EC T1 Vs EC T2	EC T1 Vs EC T4	EO T2 Vs EO T4	EC T2 Vs EC T4
Ellisse	0.894	0.670	-0.179	-0.077	-0.617	-1.179	1.085	1.336	0.401	0.667	0.112	0.212
Sway Area	0.692	0.277	-0.183	-0.191	-0.591	-1.221	0.986	1.248	0.713	0.785	0.128	0.119
RMS	0.908	0.871	-0.175	0.205	-0.549	-0.957	1.181	0.977	0.390	0.462	-0.308	0.097
Path	0.262	0.244	-0.251	-0.112	-0.615	-0.831	1.020	1.159	0.531	0.580	0.000	0.104
Path X	0.478	-0.014	-0.009	-0.181	-0.723	-1.354	0.963	1.802	1.110	1.506	0.810	0.527
Path Z	0.182	0.342	-0.315	-0.104	-0.569	-0.568	1.038	0.944	0.354	0.335	-0.263	0.026
Vel	0.208	0.192	-0.282	-0.150	-0.615	-0.831	1.020	1.041	0.531	0.479	-0.164	0.014
Vel X	0.422	-0.075	-0.057	-0.219	-0.723	-1.354	0.963	1.632	1.110	1.345	0.621	0.367
Vel Z	0.132	0.295	-0.340	-0.139	-0.569	-0.568	1.038	0.837	0.354	0.243	-0.422	-0.053
0.1:0.25 X	0.890	-0.441	-0.303	-0.058	-0.402	-0.701	0.763	1.160	0.571	0.702	0.475	0.699
0.25:0.35 X	1.024	-0.141	-0.181	-0.043	0.104	-1.131	0.703	1.646	0.453	1.080	0.569	0.626
0.35:0.5 X	0.336	-0.568	-0.357	-0.278	-0.428	-0.973	0.329	1.542	0.355	0.910	0.793	0.630
0.5:0.75 X	0.377	-0.157	0.035	-0.333	0.007	-0.577	0.216	0.979	0.342	0.653	0.791	0.466
0.75:1 X	0.187	-0.324	-0.199	-0.482	-0.325	-1.266	0.591	0.777	1.351	0.837	0.981	-0.146
0.1:0.25 Z	0.334	1.257	0.324	0.004	-1.040	-0.210	1.024	1.125	0.940	-0.029	-0.046	-0.326
0.25:0.35 Z	0.736	0.954	0.141	0.685	-0.752	-0.600	0.758	0.851	0.251	1.033	-0.041	0.334
0.35:0.5 Z	0.188	0.367	0.264	0.196	-0.593	-0.405	0.288	0.398	0.467	0.328	0.035	-0.108
0.5:07.5 Z	-0.056	0.523	-0.074	-0.190	-0.487	0.079	0.439	0.677	-0.090	0.079	0.210	0.121
0.75:1 Z	-0.224	0.130	-0.616	-0.458	-0.896	-0.503	1.127	0.706	0.004	-0.296	-0.749	-0.291

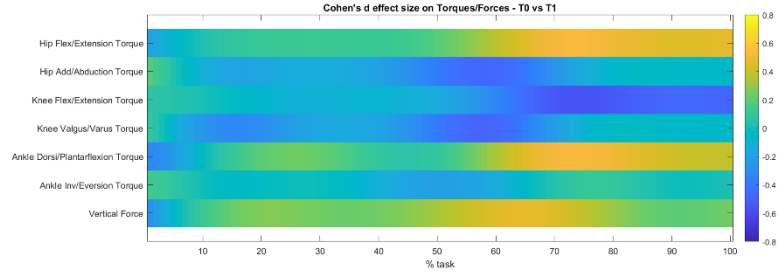
Figure 8. The effect size (Cohen's d) for angles and torques for time series (bands)

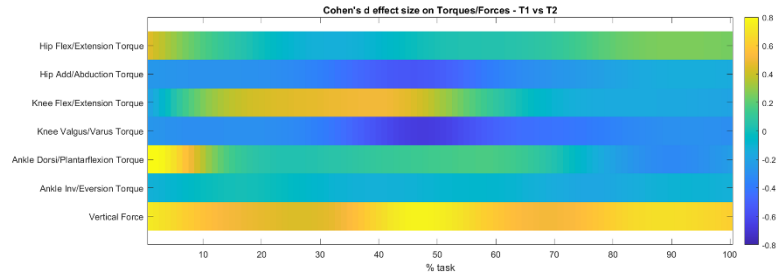

Cohen's d effect size on Angles - T0 vs T1
Hip Flexion/Extension Angle
Knee Flexion/Extension Angle
Ankle Dorsi/Plantarflexion Angle
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8

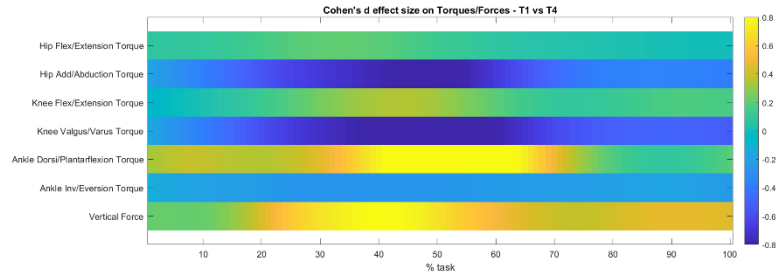

Cohen's d effect size on Angles - T1 vs T4
Hip Flexion/Extension Angle
Knee Flexion/Extension Angle
Ankle Dorsi/Plantarflexion Angle
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8

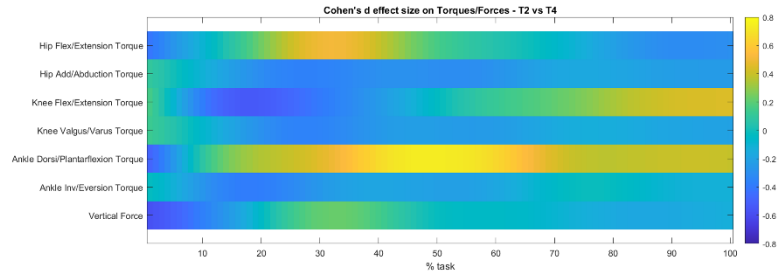

Cohen's d effect size on Angles - T1 vs T2
Hip Flexion/Extension Angle
Knee Flexion/Extension Angle
Ankle Dorsi/Plantarflexion Angle
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8


Cohen's d effect size on Angles - T2 vs T4
Hip Flexion/Extension Angle
Knee Flexion/Extension Angle
Ankle Dorsi/Plantarflexion Angle
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8


Cohen's d effect size on Torques/Forces - T0 vs T1
Hip Flex/Extension Torque
Hip Add/Abduction Torque
Knee Flex/Extension Torque
Knee Valgus/Varus Torque
Ankle Dorsi/Plantarflexion Torque
Ankle Inv/Eversion Torque
Vertical Force
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8


Cohen's d effect size on Torques/Forces - T1 vs T2
Hip Flex/Extension Torque
Hip Add/Abduction Torque
Knee Flex/Extension Torque
Knee Valgus/Varus Torque
Ankle Dorsi/Plantarflexion Torque
Ankle Inv/Eversion Torque
Vertical Force
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8


Cohen's d effect size on Torques/Forces - T1 vs T4
Hip Flex/Extension Torque
Hip Add/Abduction Torque
Knee Flex/Extension Torque
Knee Valgus/Varus Torque
Ankle Dorsi/Plantarflexion Torque
Ankle Inv/Eversion Torque
Vertical Force
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8


Cohen's d effect size on Torques/Forces - T2 vs T4
Hip Flex/Extension Torque
Hip Add/Abduction Torque
Knee Flex/Extension Torque
Knee Valgus/Varus Torque
Ankle Dorsi/Plantarflexion Torque
Ankle Inv/Eversion Torque
Vertical Force
10 20 30 40 50 60 70 80 90 100
% task
0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8