Loden Sports Performance Lab Internal Validation Analysis

The Loden Sports Performance Lab Application was developed to be an easy-to-use and reliable method of measuring a number of different jump performance metrics using only a compatible iOS device. This document was put together to share internal analysis in regards to the reliability of the Loden Sports Performance Lab App. For this analysis, Loden Sports used a combination of methods including the Intraclass Correlation Coefficient (ICC) to test reliability against existing, trusted tools as well as the Pearson Correlation Coefficient (PCC) to explore test-retest reliability.

I.   ICC Analysis

The intraclass correlation coefficient (ICC) is a descriptive statistic that describes the extent to which outcomes within each cluster are likely to be similar. It is generally understood that ICC values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability.

Metric	Data Points (n)	ICC	Pearson "r"	Variance	Std. Dev.	Std. Error	Measure Against	Units
Two-Legged Jump Height (individual jump)	50	0.989	0.993	0.37	0.61	0.09	Yardstick	inches
Single Leg Jump Height (individual jump)	53	0.963	0.962	0.62	0.79	0.11	Yardstick	inches
Jump Height (average on multiple jump test)	103	0.990	0.991	0.55	0.74	0.07	Yardstick	inches
Reaction Time to Visual Stimuli	33	0.990	0.992	0.00	0.02	0.00	Video Frames	seconds
Ground Contact Time (individual jump)	126	0.981	0.981	0.00	0.06	0.01	MicroGate OptoJump	seconds
Ground Contact Time (average on multiple jump test)	33	0.985	0.985	0.00	0.05	0.01	MicroGate OptoJump	seconds
Jump Used Area	48	0.903	0.909	2.51	1.59	0.23	MicroGate OptoJump	inches (radius)
Ground Force (Concentric Mean)	14	0.811	0.959	891.52	29.86	7.98	VALD Forcedecks	pounds

For this analysis, all but one metric that was tested for reliability against an existing, trusted tool returned an ICC above .9 – indicating excellent reliability. The Concentric Mean Ground Force metric returned a .811 ICC – indicating good reliability. Loden Sports expects that the ICC for the Concentric Mean Ground Force metric will improve when a larger data sample is considered.

II.   Test-Retest Analysis

Loden Sports used the Pearson Correlation Coefficient (PCC) to explore the test-retest reliability of the Loden Sports Performance Lab Application. In statistics, the PCC (r) is the most common way of measuring a linear correlation. It is a number between –1 and 1 that measures the strength of the relationship between two variables. It is generally agreed that PCC values equal to ± 1 are categorized as perfect correlations; PCC values between ± 0.50 and ± 1 are a strong correlation; PCC values between ± 0.30 and ± 0.49 are a moderate correlation; PCC values below ± .29 are a weak correlation; and when the PCC value is at or near zero, then there is no correlation.

The analysis explored the test-retest reliability of the app for the following metrics (see next page): jump height, flight time, contraction time, peak velocity, peak acceleration, average acceleration, peak net ground force, concentric mean ground force, ground contact time, and jump used area. The data set for this analysis consists of 88 high school-aged, male athletes who completed at least two jump tests between November 15, 2022 and March 28, 2023. Some completed as many as five jump tests on unique dates during the time period pushing the total sample to over 230 instances for each metric analyzed.

As expected, the one metric with the lowest PCC was jump used area. This metric is far-and-away the most variable considering the wide-variance in dynamic stability of the average high school-aged athlete. All nine of the other analyzed metrics registered a PCC between .5 and 1. Overall, Loden Sports was thrilled with the strength of the test-retest analysis considering performance factors such as fatigue, time-of-day, physiological maturation, improvement and regression during the time period were not controlled for.

Pearson CC:	0.63			Pearson CC:	0.62		
Jump Height #1		**Jump Height #2**		**Flight Time #1**		**Flight Time #2**	
Mean	18.84	Mean	18.62	Mean	0.62	Mean	0.62
Standard Error	0.206	Standard Error	0.203	Standard Error	0.003	Standard Error	0.003
Median	18.6	Median	18.5	Median	0.6	Median	0.6
Mode	18.6	Mode	13.5	Mode	0.6	Mode	0.6
Standard Deviation	3.155	Standard Deviation	3.105	Standard Deviation	0.052	Standard Deviation	0.052
Sample Variance	9.957	Sample Variance	9.641	Sample Variance	0.003	Sample Variance	0.003
Kurtosis	0.017	Kurtosis	-0.03	Kurtosis	-0.171	Kurtosis	-0.042
Skewness	0.427	Skewness	0.084	Skewness	0.206	Skewness	-0.16
Range	17.653	Range	15.655	Range	0.288	Range	0.264
Minimum	11.633	Minimum	11.151	Minimum	0.491	Minimum	0.481
Maximum	29.286	Maximum	26.806	Maximum	0.779	Maximum	0.745
Sum	4426.909	Sum	4374.621	Sum	146.33	Sum	145.44
Count	235	Count	235	Count	235	Count	235

Pearson CC:	0.63			Pearson CC:	0.62		
Contraction Time #1		**Contraction Time #2**		**Peak Velocity #1**		**Peak Velocity #2**	
Mean	0.28	Mean	0.27	Mean	10.02	Mean	9.96
Standard Error	0.013	Standard Error	0.011	Standard Error	0.055	Standard Error	0.055
Median	0.2	Median	0.2	Median	10.0	Median	10.0
Mode	0.2	Mode	0.3	Mode	9.9	Mode	9.7
Standard Deviation	0.205	Standard Deviation	0.169	Standard Deviation	0.836	Standard Deviation	0.84
Sample Variance	0.042	Sample Variance	0.029	Sample Variance	0.699	Sample Variance	0.706
Kurtosis	5.678	Kurtosis	3.69	Kurtosis	-0.167	Kurtosis	-0.036
Skewness	1.923	Skewness	1.034	Skewness	0.206	Skewness	-0.161
Range	1.419	Range	1.524	Range	4.633	Range	4.256
Minimum	0.011	Minimum	-0.33	Minimum	7.898	Minimum	7.732
Maximum	1.43	Maximum	1.194	Maximum	12.531	Maximum	11.988
Sum	66.331	Sum	63.094	Sum	2353.591	Sum	2339.47
Count	235	Count	235	Count	235	Count	235

Pearson CC:	0.59			Pearson CC:	0.78		
Peak Acceleration #1		**Peak Acceleration #2**		**Avg. Acceleration #1**		**Avg. Acceleration #2**	
Mean	90.49	Mean	89.33	Mean	47.31	Mean	45.98
Standard Error	2.287	Standard Error	2.098	Standard Error	2.068	Standard Error	1.868
Median	85.7	Median	84.7	Median	44.1	Median	44.6
Mode	-	Mode	98.9	Mode	-	Mode	-
Standard Deviation	34.988	Standard Deviation	32.087	Standard Deviation	31.701	Standard Deviation	28.635
Sample Variance	1224.164	Sample Variance	1029.559	Sample Variance	1004.966	Sample Variance	819.988
Kurtosis	0.448	Kurtosis	0.921	Kurtosis	0.128	Kurtosis	-0.134
Skewness	0.45	Skewness	0.2	Skewness	0.803	Skewness	0.618
Range	195.228	Range	186.259	Range	136.955	Range	127.307
Minimum	2.802	Minimum	1.502	Minimum	1.682	Minimum	0.984
Maximum	198.03	Maximum	187.761	Maximum	138.637	Maximum	128.291
Sum	21174.665	Sum	20904.103	Sum	11116.664	Sum	10804.481
Count	234	Count	234	Count	235	Count	235

Pearson CC:	0.62			Pearson CC:	0.66		
Peak Net Ground Force #1		**Peak Net Ground Force #2**		**Concentric Mean Ground Force #1**		**Concentric Mean Ground Force #2**	
Mean	408.92	Mean	405.99	Mean	280.27	Mean	277.94
Standard Error	12.168	Standard Error	13.44	Standard Error	10.016	Standard Error	8.659
Median	387.8	Median	380.3	Median	237.5	Median	251.6
Mode	-	Mode	-	Mode	-	Mode	-
Standard Deviation	186.132	Standard Deviation	205.597	Standard Deviation	153.537	Standard Deviation	132.747
Sample Variance	34645.097	Sample Variance	42270.183	Sample Variance	23573.5	Sample Variance	17621.888
Kurtosis	-0.108	Kurtosis	13.798	Kurtosis	0.985	Kurtosis	1.232
Skewness	0.497	Skewness	2.219	Skewness	1.074	Skewness	1.038
Range	1028.073	Range	1969.091	Range	780.768	Range	697.652
Minimum	6.091	Minimum	9.702	Minimum	10.564	Minimum	6.283
Maximum	1034.164	Maximum	1978.793	Maximum	791.332	Maximum	703.935
Sum	95686.253	Sum	95000.417	Sum	65864.334	Sum	65315.265
Count	234	Count	234	Count	235	Count	235

Pearson CC:	0.53			Pearson CC:	0.19		
Ground Contact Time #1		**Ground Contact Time #2**		**Jump Area #1**		**Jump Area #2**	
Mean	0.49	Mean	0.52	Mean	35.85	Mean	29.12
Standard Error	0.012	Standard Error	0.012	Standard Error	3.733	Standard Error	3.967
Median	0.5	Median	0.5	Median	28.1	Median	16.3
Mode	0.5	Mode	0.3	Mode	-	Mode	-
Standard Deviation	0.153	Standard Deviation	0.151	Standard Deviation	32.757	Standard Deviation	34.813
Sample Variance	0.024	Sample Variance	0.023	Sample Variance	1073.034	Sample Variance	1211.93
Kurtosis	-0.461	Kurtosis	-0.13	Kurtosis	4.277	Kurtosis	6.921
Skewness	0.087	Skewness	0.226	Skewness	1.85	Skewness	2.348
Range	0.826	Range	0.861	Range	175.781	Range	196.686
Minimum	0.155	Minimum	0.156	Minimum	0.313	Minimum	0.308
Maximum	0.981	Maximum	1.017	Maximum	176.094	Maximum	196.994
Sum	77.957	Sum	81.578	Sum	2760.779	Sum	2241.86
Count	158	Count	158	Count	77	Count	77