

Table S1. Ambulation-Specific normalized RMSE across Prediction Models

		Normalized RMSE									
		Sitting	Sit-to- Stand	Standing	Stand-to- Sit	Walking	Stair Ascent	Stair Descent	Ramp Ascent	Ramp Descent	Turning
Ultrasound-based Model	Knee Position	13.7 ± 8.2%	10.6 ± 4.2%	4.7 ± 5.3%	11.0 ± 2.2%	7.3 ± 1.3%	5.0 ± 2.8%	12.3 ± 2.9%	7.3 ± 2.1%	9.4 ± 1.9%	6.1 ± 2.7%
	Knee Velocity	1.1 ± 0.6%	4.4 ± 2.1%	1.0 ± 0.5%	4.8 ± 1.3%	6.4 ± 0.8%	3.2 ± 1.5%	7.2 ± 1.8%	7.2 ± 1.9%	8.0 ± 0.9%	3.2 ± 1.1%
	Ankle Position	5.2 ± 2.7%	5.4 ± 2.0%	4.8 ± 2.3%	9.0 ± 4.1%	6.4 ± 1.0%	8.8 ± 2.9%	9.3 ± 2.5%	9.2 ± 2.3%	7.6 ± 1.4%	6.0 ± 1.2%
	Ankle Velocity	0.9 ± 0.4%	3.0 ± 2.1%	1.5 ± 1.1%	5.1 ± 2.3%	5.9 ± 2.1%	6.5 ± 3.1%	5.0 ± 2.1%	7.2 ± 2.4%	7.7 ± 2.9%	2.9 ± 1.0%
IMU-based Model	Knee Position	5.5 ± 2.3%	5.7 ± 1.1%	1.8 ± 0.8%	5.6 ± 2.3%	9.8 ± 4.2%	4.9 ± 2.7%	20.6 ± 5.7%	10.5 ± 4.4%	13.1 ± 7.5%	4.6 ± 1.3%
	Knee Velocity	0.6 ± 0.3%	4.2 ± 1.6%	0.9 ± 0.4%	5.7 ± 1.4%	8.4 ± 1.5%	3.2 ± 0.9%	10.1 ± 2.4%	8.9 ± 2.0%	10.7 ± 2.4%	3.3 ± 1.3%
	Ankle Position	3.2 ± 2.0%	5.7 ± 1.8%	3.5 ± 2.0%	8.0 ± 4.1%	6.2 ± 1.3%	10.3 ± 1.9%	8.9 ± 1.3%	8.3 ± 1.9%	9.7 ± 4.2%	5.7 ± 2.9%
	Ankle Velocity	0.7 ± 0.4%	3.0 ± 2.2%	1.5 ± 1.1%	5.0 ± 2.0%	6.0 ± 2.0%	7.4 ± 3.3%	5.3 ± 2.4%	7.8 ± 2.7%	8.4 ± 4.1%	3.3 ± 1.1%
Combined Model	Knee Position	5.5 ± 1.5%	5.2 ± 1.2%	1.5 ± 0.9%	4.9 ± 0.6%	5.9 ± 1.3%	3.0 ± 1.4%	8.5 ± 2.5%	6.1 ± 1.4%	7.1 ± 1.4%	3.0 ± 0.7%
	Knee Velocity	1.2 ± 0.7%	3.3 ± 0.9%	0.7 ± 0.5%	4.0 ± 1.4%	5.7 ± 0.7%	2.0 ± 0.8%	5.9 ± 1.3%	6.5 ± 1.2%	6.8 ± 0.6%	2.4 ± 0.5%
	Ankle Position	4.6 ± 2.4%	4.8 ± 2.5%	3.4 ± 2.1%	8.0 ± 3.8%	4.9 ± 0.5%	6.6 ± 1.7%	7.5 ± 1.4%	6.4 ± 1.4%	6.1 ± 1.1%	3.9 ± 1.6%
	Ankle Velocity	0.7 ± 0.4%	2.8 ± 1.6%	0.8 ± 0.4%	4.6 ± 2.6%	4.9 ± 1.7%	5.9 ± 2.5%	4.7 ± 2.0%	6.1 ± 2.1%	6.3 ± 2.3%	2.7 ± 1.0%

Table S2. Ambulation-Specific RMSE across Prediction Models

		RMSE									
		Sitting	Sit-to- Stand	Standing	Stand-to- Sit	Walking	Stair Ascent	Stair Descent	Ramp Ascent	Ramp Descent	Turning
Ultrasound-based Model	Knee Position	12.7 ± 7.7 deg	9.9 ± 3.9 deg	4.2 ± 4.8 deg	10.2 ± 1.9 deg	6.8 ± 1.3 deg	4.6 ± 2.5 deg	11.4 ± 2.4 deg	6.8 ± 1.9 deg	8.9 ± 2.6 deg	5.7 ± 2.5 deg
	Knee Velocity	10.4 ± 6.4 deg/s	39.8 ± 14.5 deg/s	9.7 ± 5.4 deg/s	45.9 ± 14.4 deg/s	59.9 ± 11.5 deg/s	29.9 ± 12.9 deg/s	67.6 ± 18.6 deg/s	67.8 ± 22.5 deg/s	74.6 ± 10.8 deg/s	29.2 ± 9.5 deg/s
	Ankle Position	1.7 ± 0.7 deg	1.8 ± 0.4 deg	1.6 ± 0.6 deg	3 ± 1.1 deg	2.2 ± 0.5 deg	3 ± 1.2 deg	3.2 ± 1.3 deg	3.2 ± 1 deg	2.6 ± 0.6 deg	2 ± 0.3 deg
	Ankle Velocity	4.5 ± 2.5 deg/s	12.8 ± 5.3 deg/s	8.1 ± 6.6 deg/s	27.7 ± 18.4 deg/s	27.1 ± 6.5 deg/s	28.3 ± 9.8 deg/s	22.3 ± 4.8 deg/s	33.5 ± 9.2 deg/s	35.4 ± 9.9 deg/s	13.6 ± 3.6 deg/s
IMU-based Model	Knee Position	5.3 ± 2.8 deg	5.3 ± 0.8 deg	1.7 ± 0.8 deg	5.3 ± 2.3 deg	9.2 ± 4.1 deg	4.6 ± 2.4 deg	18.9 ± 4.7 deg	9.9 ± 4.3 deg	12.7 ± 8.6 deg	4.4 ± 1.5 deg
	Knee Velocity	5.6 ± 2.9 deg/s	38.9 ± 11.1 deg/s	8.1 ± 4.3 deg/s	53.4 ± 16.4 deg/s	78.6 ± 17.2 deg/s	30.4 ± 9.6 deg/s	94.4 ± 22.1 deg/s	83.6 ± 22.3 deg/s	99.9 ± 19.5 deg/s	30.4 ± 10.7 deg/s
	Ankle Position	1.1 ± 0.6 deg	1.9 ± 0.3 deg	1.2 ± 0.6 deg	2.6 ± 1.3 deg	2.1 ± 0.3 deg	3.6 ± 1.2 deg	3 ± 0.8 deg	2.8 ± 0.8 deg	3.2 ± 1.1 deg	1.8 ± 0.6 deg
	Ankle Velocity	3.4 ± 2.1 deg/s	12.2 ± 4.5 deg/s	6.8 ± 4.4 deg/s	26.6 ± 16.2 deg/s	28 ± 8.2 deg/s	33.6 ± 14.3 deg/s	23.3 ± 4.6 deg/s	36.8 ± 12 deg/s	37.1 ± 10.3 deg/s	15.3 ± 3.5 deg/s
Combined Model	Knee Position	5.2 ± 1.8 deg	4.9 ± 1.6 deg	1.4 ± 0.8 deg	4.6 ± 0.9 deg	5.5 ± 1.3 deg	2.8 ± 1.3 deg	7.8 ± 2.1 deg	5.6 ± 1.3 deg	6.7 ± 1.7 deg	2.8 ± 0.8 deg
	Knee Velocity	11 ± 7.3 deg/s	30.7 ± 6.6 deg/s	7.2 ± 5.8 deg/s	38.5 ± 17 deg/s	53.3 ± 8.7 deg/s	18.9 ± 8 deg/s	55.7 ± 14.1 deg/s	61.4 ± 16.6 deg/s	64.3 ± 11.1 deg/s	22.5 ± 2.3 deg/s
	Ankle Position	1.5 ± 0.7 deg	1.5 ± 0.6 deg	1.1 ± 0.5 deg	2.7 ± 1.4 deg	1.7 ± 0.3 deg	2.3 ± 0.8 deg	2.6 ± 0.7 deg	2.2 ± 0.6 deg	2.1 ± 0.6 deg	1.3 ± 0.3 deg
	Ankle Velocity	3.7 ± 2.3 deg/s	12.3 ± 3 deg/s	3.9 ± 1.8 deg/s	25.9 ± 20.7 deg/s	22.9 ± 6.1 deg/s	26.2 ± 8.6 deg/s	21.2 ± 4.5 deg/s	28.6 ± 7.5 deg/s	29.2 ± 9.2 deg/s	12.5 ± 3 deg/s

Table S3. Two-way ANOVA of RMSE values across predictive models and ambulation modes

	Source	Sum of Squares	df	Mean Square	F	Significance
Knee Position	Predictive Model	480.0	2	240.0	23.6	0.000
	Ambulation Mode	1602.5	9	178.1	17.5	0.000
	Interaction Effect	790.3	18	43.9	4.3	0.000
	Error	1831.3	180	10.2		
	Total	4704.2	209			
Knee Velocity	Predictive Model	8980.1	2	4490.0	25.5	0.000
	Ambulation Mode	133355.3	9	14817.3	84.1	0.000
	Interaction Effect	7593.8	18	421.9	2.4	0.002
	Error	31716.8	180	176.2		
	Total	181646.0	209			
Ankle Position	Predictive Model	10.94	2	5.47	8.8	0.000
	Ambulation Mode	83.36	9	9.26	14.9	0.000
	Interaction Effect	10.54	18	0.59	0.9	0.532
	Error	112.27	180	0.62		
	Total	217.11	209			
Ankle Velocity	Predictive Model	502.33	2	251.16	3.2	0.043
	Ambulation Mode	22537.59	9	2504.18	31.8	0.000
	Interaction Effect	409.72	18	22.76	0.3	0.998
	Error	14155.66	180	78.64		
	Total	37605.31	209			

Table S4. p-Values between RMSE values from different predictive models (t-tests with Tukey-Kramer corrections)

		Sitting	Sit-to- Stand	Standing	Stand-to- Sit	Walking	Stair Ascent	Stair Descent	Ramp Ascent	Ramp Descent	Turning
Ultrasound-based Model vs IMU-based Model	Knee Position	0.03	0.01	0.24	0.00	0.22	1.00	0.00	0.14	0.40	0.35
	Knee Velocity	0.30	0.99	0.84	0.66	0.04	0.99	0.04	0.35	0.01	0.96
	Ankle Position	0.26	0.95	0.38	0.84	0.80	0.57	0.92	0.76	0.35	0.63
	Ankle Velocity	0.64	0.96	0.87	0.99	0.97	0.66	0.92	0.80	0.95	0.64
Ultrasound-based Model vs Combined Model	Knee Position	0.02	0.00	0.17	0.00	0.65	0.28	0.12	0.73	0.71	0.02
	Knee Velocity	0.98	0.31	0.66	0.67	0.61	0.14	0.47	0.83	0.39	0.31
	Ankle Position	0.93	0.57	0.26	0.91	0.06	0.43	0.42	0.11	0.45	0.01
	Ankle Velocity	0.81	0.98	0.25	0.98	0.52	0.93	0.89	0.63	0.47	0.81
IMU-based Model vs Combined Model	Knee Position	1.00	0.95	0.97	0.76	0.04	0.28	0.00	0.03	0.11	0.24
	Knee Velocity	0.22	0.38	0.95	0.21	0.00	0.12	0.00	0.14	0.00	0.21
	Ankle Position	0.43	0.40	0.96	0.99	0.18	0.08	0.66	0.35	0.04	0.06
	Ankle Velocity	0.96	1.00	0.49	1.00	0.38	0.44	0.68	0.29	0.31	0.30

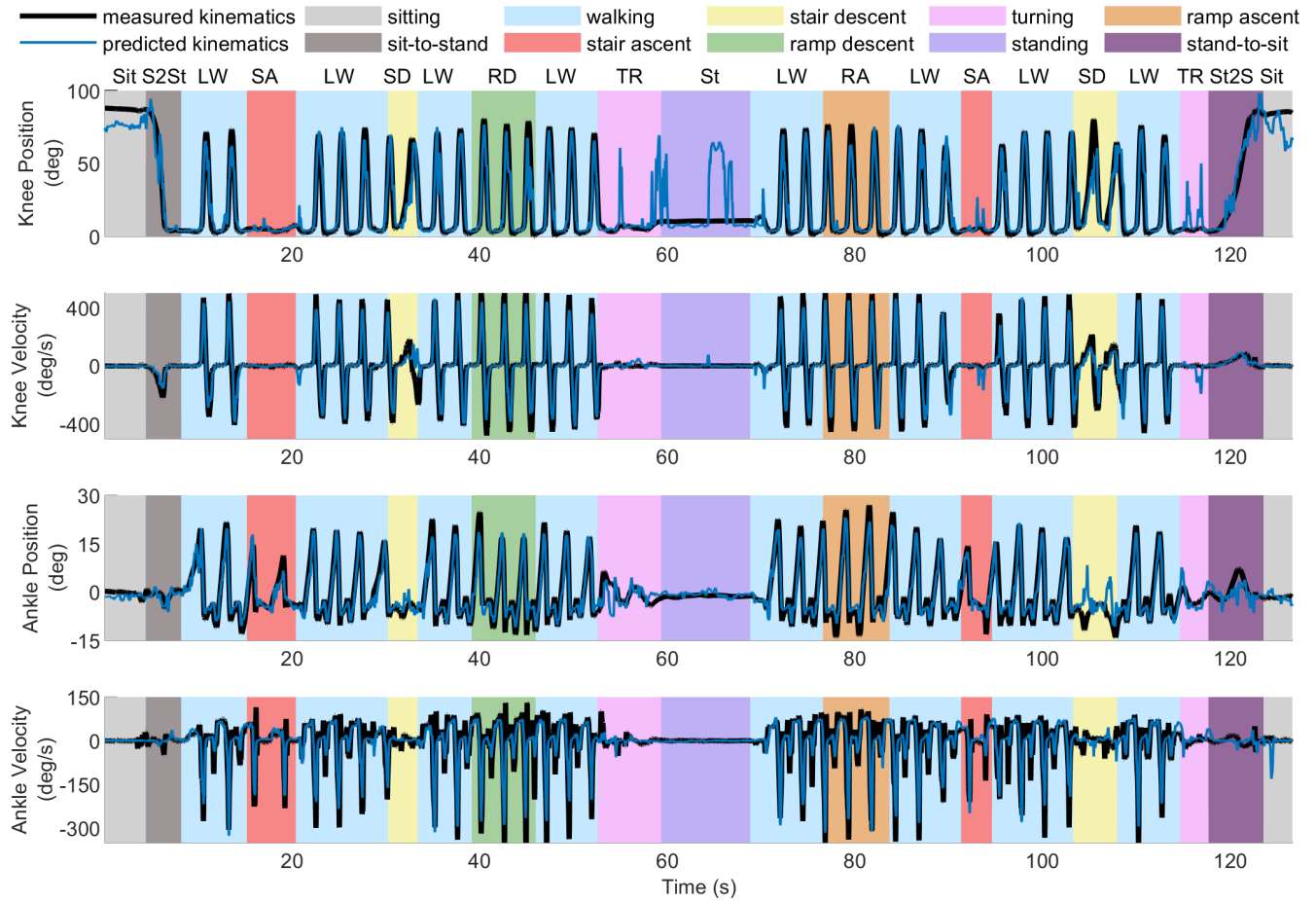


Fig. S1. Representative test trial demonstrating measured kinematics (black) and predicted kinematics (blue) for knee position, knee velocity, ankle position, and ankle velocity. Different ambulation modes denoted by shaded regions and letter labels at the top of figure.

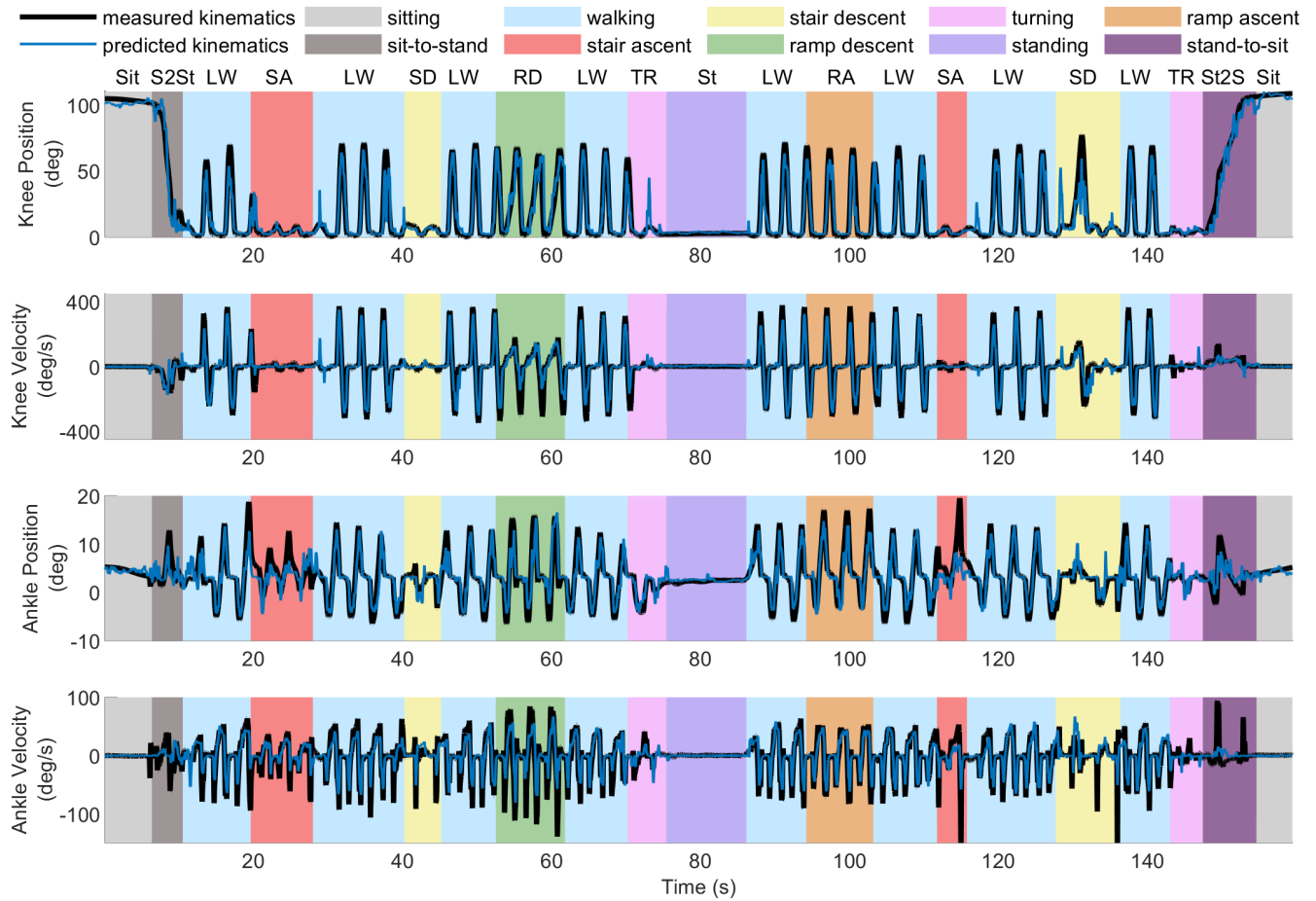


Fig. S2. Representative test trial demonstrating measured kinematics (black) and predicted kinematics (blue) for knee position, knee velocity, ankle position, and ankle velocity. Different ambulation modes denoted by shaded regions and letter labels at the top of figure.