Supplemental digital content

Positive work contribution shifts from distal to proximal joints during a prolonged run

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Table 1 of the supplemental digital content: Heart rate, spatio-temporal parameters, center of mass (CoM) height, kinematic and kinetic parameters of lower extremity joints during stance phase, touch-down (TD), or toe-off (TO) over the course of the 10-km treadmill run with near-maximal effort. Lever arms at the maximal vertical ground-reaction force (GRFmax). All values are given as means ± standard deviation of recreational runners (RR; n = 13) and competitive runners (CR; n = 12). Significant differences from the values at beginning of the run (0 km) are represented by * $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$. To explain the group difference between RR and CR the partial eta squared (η_p^2) values are presented, as well as the running distance main effect and interaction effect between performance level and running distance.

				0 km	0.2 km	0.5 km	1 km	2 km	3 km	4 km	5 km	6 km	7 km	8 km	9 km	10 km	group difference	η_p^2	distance effect	η_p^2	interaction effect	η_p^2
Heart rate and spatio-temporal	heart rate	(BPM)	RR	97 ± 12	**156 ± 16 *****	**159 ± 16 *****	**160 ± 16 *****	**162 ± 14 *****	**163 ± 14 *****	**164 ± 13 *****	**165 ± 13 *****	**166 ± 14 *****	**167 ± 13 *****	**169 ± 14 *****	**170 ± 14 *****	**171 ± 14 *****	***P* = 0.023**	**0.206**	***P* < 0.001**	**0.949**	***P* = 0.001**	**0.300**
			CR	87 ± 18	**162 ± 8 *****	**167 ± 9 *****	**171 ± 8 *****	**176 ± 9 *****	**177 ± 9 *****	**178 ± 9 *****	**179 ± 9 *****	**180 ± 9 *****	**182 ± 9 *****	**183 ± 10 *****	**184 ± 9 *****	**186 ± 10 *****						
	step length	(m)	RR	1.116 ± 0.055	1.120 ± 0.059	1.127 ± 0.064	1.129 ± 0.066	1.136 ± 0.065	1.133 ± 0.064	1.135 ± 0.068	1.132 ± 0.067	1.137 ± 0.064	1.131 ± 0.061	1.133 ± 0.063	1.135 ± 0.068	1.138 ± 0.068	***P* < 0.001**	**0.874**	***P* = 0.005**	**0.169**	*P* = 0.924	0.007
			CR	1.510 ± 0.094	1.515 ± 0.097	1.518 ± 0.099	1.519 ± 0.095	1.525 ± 0.092	1.525 ± 0.096	1.523 ± 0.094	1.526 ± 0.092	1.526 ± 0.098	1.525 ± 0.095	1.526 ± 0.099	1.528 ± 0.097	1.529 ± 0.097						
	step frequency	(Hz)	RR	2.72 ± 0.09	2.71 ± 0.10	2.70 ± 0.11	2.70 ± 0.12	2.69 ± 0.13	2.69 ± 0.12	2.70 ± 0.13	2.70 ± 0.12	2.69 ± 0.13	2.70 ± 0.12	2.69 ± 0.11	2.69 ± 0.11	2.69 ± 0.12	***P* = 0.005**	**0.297**	*P* = 0.053	0.092	*P* = 0.952	0.009
			CR	2.88 ± 0.14	2.87 ± 0.14	2.87 ± 0.15	2.86 ± 0.14	2.85 ± 0.13	2.85 ± 0.14	2.85 ± 0.13	2.86 ± 0.14	2.86 ± 0.14	2.85 ± 0.14	2.85 ± 0.15	2.85 ± 0.15	2.85 ± 0.15						
	contact time	(s)	RR	0.252 ± 0.021	0.253 ± 0.021	0.254 ± 0.022	0.253 ± 0.021	0.256 ± 0.022	0.255 ± 0.023	0.256 ± 0.023	0.256 ± 0.024	0.258 ± 0.024	0.257 ± 0.023	0.258 ± 0.023	0.258 ± 0.023	0.256 ± 0.023	***P* < 0.001**	**0.686**	***P* = 0.003**	**0.192**	*P* = 0.752	0.016
			CR	0.202 ± 0.011	0.203 ± 0.011	0.204 ± 0.011	0.204 ± 0.011	0.205 ± 0.011	0.205 ± 0.011	0.206 ± 0.011	0.205 ± 0.011	0.206 ± 0.011	0.206 ± 0.013	0.207 ± 0.013	0.206 ± 0.012	0.204 ± 0.012						
Center of mass height, ground-reaction force	CoM_{TD}	(mm)	RR	1053 ± 33	1052 ± 34	1051 ± 34	1051 ± 33	**1049 ± 33 ***	1049 ± 32	1049 ± 32	1048 ± 32	**1047 ± 32 ***	1047 ± 32	**1046 ± 32 ****	**1046 ± 33 ****	**1047 ± 33 ***	*P* = 0.541	0.016	***P* < 0.001**	**0.451**	*P* = 0.596	0.025
			CR	1043 ± 41	1042 ± 42	1042 ± 42	1041 ± 42	1040 ± 42	1039 ± 42	1038 ± 43	1038 ± 42	1037 ± 42	1038 ± 43	1038 ± 43	1037 ± 43	1039 ± 43						
	CoM_{min}	(mm)	RR	988 ± 31	986 ± 30	985 ± 30	985 ± 29	982 ± 29	983 ± 27	982 ± 28	982 ± 28	**980 ± 28 ***	**980 ± 28 ***	**979 ± 29 ****	**979 ± 30 ***	**980 ± 29 ****	*P* = 0.750	0.004	***P* < 0.001**	**0.476**	*P* = 0.546	0.032
			CR	982 ± 39	981 ± 39	980 ± 39	980 ± 39	978 ± 39	**978 ± 39 ***	**977 ± 40 ***	**977 ± 39 ***	**976 ± 40 ***	976 ± 40	**976 ± 40 ***	976 ± 40	977 ± 40						
	GRF_{vert}	($N \cdot kg^{-1}$)	RR	23.8 ± 1.9	23.6 ± 1.8	23.5 ± 1.8	23.6 ± 1.8	23.4 ± 1.7	23.4 ± 1.8	23.3 ± 1.7	23.3 ± 1.8	23.2 ± 1.8	23.1 ± 1.9	23.0 ± 2.0	23.0 ± 2.0	23.1 ± 2.0	***P* < 0.001**	**0.515**	***P* = 0.002**	**0.238**	*P* = 0.801	0.010
			CR	27.1 ± 1.4	27.0 ± 1.5	26.9 ± 1.4	26.7 ± 1.3	26.7 ± 1.5	26.6 ± 1.5	26.5 ± 1.6	26.5 ± 1.5	26.4 ± 1.7	26.4 ± 1.7	26.3 ± 1.8	26.4 ± 1.7	26.5 ± 1.6						
Angle	$hip\ flexion_{GRFmax}$	(°)	RR	21.3 ± 5.4	21.9 ± 5.8	22.4 ± 6.0	22.1 ± 6.0	22.0 ± 6.0	21.6 ± 6.1	21.8 ± 6.2	22.0 ± 6.3	22.0 ± 6.6	21.9 ± 6.6	21.7 ± 6.6	21.8 ± 6.3	22.0 ± 6.5	*P* = 0.124	0.100	*P* = 0.068	0.094	*P* = 0.253	0.057
			CR	24.8 ± 4.7	25.3 ± 4.9	25.6 ± 5.0	25.8 ± 5.0	26.0 ± 5.1	25.9 ± 5.3	25.9 ± 5.3	25.6 ± 5.5	25.8 ± 5.7	25.7 ± 5.5	25.5 ± 5.3	25.2 ± 5.5	24.8 ± 5.2						
	$knee\ flexion_{TD}$	(°)	RR	9.5 ± 4.5	10.5 ± 5.1	11.0 ± 4.8	**11.6 ± 5.1 ****	**11.6 ± 5.0 ****	**11.4 ± 5.0 ****	**11.7 ± 5.3 ****	**12.0 ± 5.6 ***	**12.3 ± 5.5 ****	**12.6 ± 5.3 ****	**12.2 ± 5.3 ****	**12.3 ± 5.5 ****	**12.2 ± 5.7 ***	*P* = 0.093	0.118	***P* < 0.001**	**0.555**	*P* = 0.164	0.068
			CR	12.7 ± 3.6	13.0 ± 3.6	13.8 ± 3.8	13.8 ± 3.9	14.7 ± 4.0	**15.0 ± 3.9 ***	15.0 ± 3.9	**15.6 ± 3.9 ***	**15.6 ± 4.1 ***	**15.6 ± 4.1 ****	**15.6 ± 4.0 ****	**16.1 ± 4.2 ****	**16.0 ± 4.0 ****						
	$knee\ flexion_{max}$	(°)	RR	40.5 ± 6.0	41.3 ± 6.1	41.9 ± 6.2	42.0 ± 6.1	**42.9 ± 6.3 ***	42.6 ± 6.3	42.9 ± 6.5	42.7 ± 6.5	**43.0 ± 6.4 ***	**43.0 ± 6.0 ***	**43.3 ± 6.2 ****	**43.1 ± 6.4 ***	**43.0 ± 6.1 ***	*P* = 0.357	0.037	***P* < 0.001**	**0.465**	*P* = 0.237	0.059
			CR	43.1 ± 2.6	43.6 ± 2.6	43.9 ± 2.4	44.0 ± 2.5	44.3 ± 2.4	**44.5 ± 2.5 ***	**44.7 ± 2.5 ***	44.5 ± 2.4	44.7 ± 2.5	44.5 ± 2.5	44.9 ± 2.6 *	44.7 ± 2.4	44.3 ± 2.7						
	$knee\ flexion_{TO}$	(°)	RR	11.9 ± 5.7	12.1 ± 6.2	11.9 ± 6.2	11.8 ± 6.5	12.2 ± 6.4	12.2 ± 6.1	12.5 ± 6.5	12.4 ± 6.4	12.7 ± 6.6	13.0 ± 6.3	13.0 ± 7.0	12.8 ± 6.8	12.5 ± 6.7	*P* = 0.745	0.005	*P* = 0.503	0.034	*P* = 0.087	0.086
			CR	13.6 ± 3.6	13.5 ± 3.8	13.4 ± 3.8	13.0 ± 3.7	12.9 ± 4.1	13.0 ± 4.0	13.1 ± 4.1	13.0 ± 4.3	13.0 ± 4.2	12.8 ± 3.9	13.3 ± 4.2	12.8 ± 4.2	12.7 ± 4.4						
	$ankle\ plantar\ flexion_{TD}$	(°)	RR	-1.2 ± 6.7	-1.5 ± 6.1	-1.1 ± 6.1	-0.6 ± 5.9	-0.9 ± 4.3	-0.5 ± 4.5	-0.6 ± 5.1	-0.8 ± 5.1	-1.6 ± 4.8	-1.6 ± 4.5	-1.2 ± 4.5	-0.7 ± 4.6	-0.1 ± 4.5	***P* = 0.009**	**0.261**	*P* = 0.218	0.064	*P* = 0.299	0.051
			CR	8.0 ± 9.6	7.7 ± 9.5	7.3 ± 9.1	7.1 ± 8.6	6.6 ± 8.3	6.7 ± 8.1	6.6 ± 7.8	6.1 ± 7.7	6.0 ± 7.5	5.3 ± 8.0	5.5 ± 8.0	5.7 ± 7.8	6.7 ± 7.6						
	$ankle\ dorsiflexion_{max}$	(°)	RR	17.8 ± 3.6	18.0 ± 3.5	18.0 ± 3.7	18.0 ± 3.8	18.2 ± 3.7	17.9 ± 3.7	18.0 ± 3.9	17.8 ± 4.1	18.1 ± 3.8	18.0 ± 3.5	18.1 ± 3.5	18.2 ± 3.5	17.9 ± 3.6	*P* = 0.561	0.015	*P* = 0.592	0.026	*P* = 0.685	0.020
			CR	18.7 ± 3.0	18.7 ± 3.0	18.7 ± 2.9	18.6 ± 2.9	18.7 ± 3.0	18.8 ± 3.0	18.8 ± 3.1	18.9 ± 3.1	18.9 ± 3.1	18.8 ± 3.1	18.9 ± 3.1	18.9 ± 3.1	18.8 ± 3.4						
	$ankle\ plantar\ flexion_{TO}$	(°)	RR	21.6 ± 4.4	21.2 ± 4.4	21.2 ± 4.3	21.3 ± 4.7	21.6 ± 4.2	21.5 ± 4.0	21.2 ± 4.3	21.1 ± 4.2	20.6 ± 4.0	20.2 ± 4.0	20.1 ± 4.3	19.8 ± 4.2	**19.4 ± 4.2 ***	*P* = 0.107	0.109	***P* < 0.001**	**0.246**	***P* < 0.001**	**0.251**
			CR	22.9 ± 3.7	23.3 ± 3.9	23.6 ± 4.2	23.6 ± 4.1	23.7 ± 4.4	24.0 ± 4.3	24.0 ± 4.6	23.7 ± 4.3	23.9 ± 4.1	23.7 ± 4.0	23.5 ± 4.0	23.4 ± 4.0	23.6 ± 3.7						
Angular velocity	$hip\ flexion_{max}$	($°\cdot s^{-1}$)	RR	123 ± 63	143 ± 63	143 ± 62	147 ± 56	152 ± 61	146 ± 63	153 ± 69	145 ± 64	142 ± 57	149 ± 61	147 ± 65	142 ± 62	147 ± 65	*P* = 0.768	0.004	*P* = 0.140	0.074	*P* = 0.562	0.030
			CR	130 ± 70	136 ± 70	135 ± 67	146 ± 71	142 ± 74	145 ± 74	138 ± 73	132 ± 71	141 ± 79	139 ± 71	132 ± 70	134 ± 69	131 ± 67						
	$hip\ extension_{max}$	($°\cdot s^{-1}$)	RR	343 ± 41	349 ± 47	351 ± 42	353 ± 49	349 ± 51	350 ± 49	357 ± 48	356 ± 51	361 ± 52	363 ± 55	358 ± 53	361 ± 52	366 ± 61	***P* < 0.001**	**0.416**	*P* = 0.067	0.091	***P* = 0.048**	**0.099**
			CR	432 ± 58	436 ± 57	438 ± 52	442 ± 54	445 ± 57	449 ± 63	443 ± 64	439 ± 55	438 ± 53	440 ± 53	436 ± 60	438 ± 55	438 ± 58						
	$knee\ flexion_{max}$	($°\cdot s^{-1}$)	RR	492 ± 68	492 ± 74	490 ± 71	480 ± 66	492 ± 63	490 ± 71	487 ± 63	484 ± 68	476 ± 64	478 ± 66	483 ± 66	487 ± 65	483 ± 59	***P* = 0.046**	**0.162**	***P* = 0.012**	**0.162**	*P* = 0.091	0.095
			CR	571 ± 90	571 ± 89	558 ± 88	559 ± 87	544 ± 85	544 ± 77	542 ± 69	531 ± 69	539 ± 71	528 ± 63	531 ± 66	523 ± 70	517 ± 70						
	$knee\ extension_{max}$	($°\cdot s^{-1}$)	RR	283 ± 53	289 ± 60	295 ± 57	294 ± 66	290 ± 65	290 ± 63	291 ± 60	293 ± 63	293 ± 66	292 ± 67	293 ± 68	296 ± 71	300 ± 76	***P* < 0.001**	**0.480**	***P* = 0.031**	**0.130**	*P* = 0.310	0.050
			CR	400 ± 83	**413 ± 81 ****	**422 ± 83 ****	**426 ± 81 *****	**432 ± 83 ****	**430 ± 80 ****	**429 ± 77 ****	423 ± 81	424 ± 79	425 ± 76	425 ± 79	427 ± 81	427 ± 80						
	$ankle\ dorsiflexion_{max}$	($°\cdot s^{-1}$)	RR	312 ± 76	309 ± 62	313 ± 70	320 ± 79	308 ± 52	308 ± 52	311 ± 56	306 ± 54	301 ± 49	304 ± 48	308 ± 48	316 ± 47	321 ± 50	***P* < 0.001**	**0.507**	*P* = 0.350	0.043	*P* = 0.413	0.035
			CR	496 ± 132	489 ± 126	475 ± 113	462 ± 108	454 ± 97	457 ± 105	447 ± 106	452 ± 111	456 ± 108	465 ± 107	469 ± 119	466 ± 110	464 ± 115						
	$ankle\ plantar\ flexion_{max}$	($°\cdot s^{-1}$)	RR	594 ± 107	595 ± 109	600 ± 108	607 ± 112	608 ± 104	604 ± 106	603 ± 108	600 ± 109	600 ± 111	596 ± 108	603 ± 116	596 ± 110	595 ± 116	***P* < 0.001**	**0.697**	***P* = 0.002**	**0.170**	***P* = 0.016**	**0.127**
			CR	848 ± 70	856 ± 68	864 ± 73	864 ± 71	**873 ± 75 ****	**872 ± 74 ***	**874 ± 74 ***	**874 ± 75 ***	**877 ± 74 ****	**876 ± 71 *****	**879 ± 75 ***	**879 ± 73 ***	**882 ± 73 ****						
Lever arm (external)	hip_{GRFmax}	(cm)	RR	1.8 ± 1.4	2.3 ± 1.6	2.5 ± 1.5	2.6 ± 1.6	**2.8 ± 1.6 ***	**2.8 ± 1.5 ***	3.0 ± 1.3	**2.8 ± 1.5 ***	**2.8 ± 1.6 ***	**2.9 ± 1.5 ***	2.9 ± 1.5	2.9 ± 1.6	2.9 ± 1.7	*P* = 0.994	0.000	***P* < 0.001**	**0.370**	*P* = 0.251	0.062
			CR	2.4 ± 1.6	2.6 ± 1.8	2.8 ± 1.8	2.9 ± 2.0	3.0 ± 2.1	2.9 ± 2.0	2.9 ± 2.0	2.9 ± 2.0	3.0 ± 2.1	3.0 ± 2.0	2.9 ± 2.0	2.9 ± 2.0	2.9 ± 2.0						
	$knee_{GRFmax}$	(cm)	RR	9.6 ± 1.3	9.8 ± 1.3	9.9 ± 1.3	9.8 ± 1.3	10.0 ± 1.4	9.9 ± 1.5	10.1 ± 1.2	9.9 ± 1.4	10.0 ± 1.6	10.1 ± 1.5	10.1 ± 1.5	10.1 ± 1.4	10.0 ± 1.4	*P* = 0.679	0.009	***P* = 0.026**	**0.155**	*P* = 0.616	0.027
			CR	9.5 ± 1.0	9.6 ± 1.2	9.7 ± 1.3	9.7 ± 1.2	9.7 ± 1.4	9.9 ± 1.4	9.9 ± 1.4	9.9 ± 1.3	9.9 ± 1.4	9.9 ± 1.3	10.0 ± 1.4	10.0 ± 1.4	10.0 ± 1.4						
	$ankle_{GRFmax}$	(cm)	RR	10.5 ± 1.3	10.4 ± 1.3	10.3 ± 1.2	10.2 ± 1.1	10.1 ± 1.1	10.2 ± 0.9	10.1 ± 1.0	10.1 ± 0.9	9.9 ± 0.9	9.8 ± 0.8	9.9 ± 0.8	9.9 ± 1.0	9.9 ± 1.0	***P* = 0.005**	**0.315**	***P* < 0.001**	**0.282**	*P* = 0.871	0.008
			CR	11.8 ± 1.3	11.8 ± 1.2	11.7 ± 1.3	11.7 ± 1.3	11.6 ± 1.2	11.6 ± 1.2	11.5 ± 1.2	11.5 ± 1.2	11.4 ± 1.2	11.3 ± 1.2	11.3 ± 1.1	11.3 ± 1.2	11.4 ± 1.1						
Torque (external)	$hip\ flexion_{max}$	($Nm \cdot kg^{-1}$)	RR	1.62 ± 0.43	1.60 ± 0.45	1.65 ± 0.42	1.65 ± 0.40	1.71 ± 0.41	1.74 ± 0.46	1.79 ± 0.40	1.81 ± 0.42	**1.88 ± 0.41 ***	**1.87 ± 0.43 ***	**1.89 ± 0.42 ****	**1.91 ± 0.43 ****	**1.91 ± 0.41 ****	*P* = 0.526	0.018	***P* < 0.001**	**0.393**	***P* = 0.009**	**0.144**
			CR	1.83 ± 0.40	1.84 ± 0.41	1.82 ± 0.38	1.84 ± 0.42	1.87 ± 0.45	1.87 ± 0.44	1.88 ± 0.49	1.88 ± 0.43	1.92 ± 0.47	1.91 ± 0.48	1.92 ± 0.49	1.93 ± 0.49	1.93 ± 0.52						
	$knee\ flexion_{max}$	($Nm \cdot kg^{-1}$)	RR	2.39 ± 0.29	2.42 ± 0.30	2.45 ± 0.32	2.47 ± 0.32	2.50 ± 0.31	2.50 ± 0.34	2.49 ± 0.32	2.49 ± 0.32	2.51 ± 0.32	2.51 ± 0.32	2.51 ± 0.33	2.49 ± 0.28	2.49 ± 0.31	***P* = 0.032**	**0.184**	***P* < 0.001**	**0.288**	*P* = 0.827	0.018
			CR	2.71 ± 0.34	2.74 ± 0.36	2.75 ± 0.41	2.75 ± 0.40	2.78 ± 0.37	2.80 ± 0.40	2.81 ± 0.38	2.81 ± 0.36	2.82 ± 0.38	2.81 ± 0.36	2.83 ± 0.38	**2.83 ± 0.37 ***	2.82 ± 0.39						
	$ankle\ dorsiflexion_{max}$	($Nm \cdot kg^{-1}$)	RR	2.75 ± 0.38	2.72 ± 0.36	2.70 ± 0.35	2.70 ± 0.32	2.68 ± 0.31	2.68 ± 0.28	2.67 ± 0.30	2.66 ± 0.30	2.62 ± 0.29	2.61 ± 0.28	2.59 ± 0.29	2.60 ± 0.31	2.60 ± 0.31	***P* < 0.001**	**0.538**	***P* < 0.001**	**0.383**	*P* = 0.645	0.018
			CR	3.43 ± 0.34	3.42 ± 0.35	3.39 ± 0.34	3.37 ± 0.34	3.35 ± 0.36	3.33 ± 0.33	3.30 ± 0.34	3.30 ± 0.34	3.28 ± 0.34	3.26 ± 0.35	3.26 ± 0.36	3.26 ± 0.35	3.28 ± 0.32						
Power (positive)	hip_{max}	($W \cdot kg^{-1}$)	RR	4.38 ± 1.78	4.69 ± 2.00	4.75 ± 1.80	4.97 ± 2.12	5.06 ± 2.14	5.02 ± 2.26	5.27 ± 2.02	5.32 ± 2.09	**5.57 ± 2.12 ***	**5.67 ± 2.21 ***	5.69 ± 2.13	**5.72 ± 2.07 ***	5.84 ± 2.31	*P* = 0.305	0.046	***P* < 0.001**	**0.272**	*P* = 0.141	0.074
			CR	5.78 ± 2.06	5.91 ± 2.36	5.91 ± 2.43	6.15 ± 2.88	6.29 ± 3.01	6.38 ± 3.01	6.38 ± 3.20	6.30 ± 2.91	6.45 ± 3.08	6.47 ± 2.84	6.33 ± 2.74	6.55 ± 2.97	6.15 ± 2.92						
	$knee_{max}$	($W \cdot kg^{-1}$)	RR	6.22 ± 1.43	6.33 ± 1.53	6.46 ± 1.55	6.57 ± 1.72	6.57 ± 1.65	6.65 ± 1.70	6.70 ± 1.56	6.80 ± 1.59	6.73 ± 1.45	6.70 ± 1.56	6.70 ± 1.60	6.79 ± 1.78	6.74 ± 2.08	*P* = 0.101	0.112	*P* = 0.150	0.074	*P* = 0.837	0.012
			CR	7.79 ± 2.14	7.81 ± 2.28	7.90 ± 2.31	7.94 ± 2.40	8.05 ± 2.52	8.10 ± 2.55	8.04 ± 2.57	8.04 ± 2.54	7.94 ± 2.51	7.94 ± 2.58	8.06 ± 2.63	8.16 ± 2.43	8.10 ± 2.48						
	$ankle_{max}$	($W \cdot kg^{-1}$)	RR	9.73 ± 1.59	9.33 ± 1.54	9.27 ± 1.43	9.26 ± 1.42	9.04 ± 1.31	8.97 ± 1.24	8.84 ± 1.31	8.81 ± 1.37	**8.61 ± 1.40 ****	**8.51 ± 1.42 ***	**8.49 ± 1.59 ***	**8.43 ± 1.61 ***	**8.50 ± 1.68 ***	***P* < 0.001**	**0.712**	***P* < 0.001**	**0.398**	*P* = 0.766	0.014
			CR	15.52 ± 2.69	15.40 ± 2.66	15.14 ± 2.63	14.97 ± 2.58	14.96 ± 2.65	14.73 ± 2.33	14.58 ± 2.37	14.64 ± 2.25	14.48 ± 2.32	14.42 ± 2.38	14.35 ± 2.44	14.42 ± 2.53	14.55 ± 2.11						
Work	hip_{pos}	($J \cdot kg^{-1}$)	RR	0.23 ± 0.13	0.25 ± 0.13	0.26 ± 0.13	0.26 ± 0.14	0.26 ± 0.14	0.26 ± 0.14	0.27 ± 0.13	0.27 ± 0.14	0.28 ± 0.14	0.28 ± 0.15	0.28 ± 0.14	0.28 ± 0.14	0.28 ± 0.15	*P* = 0.275	0.051	***P* = 0.024**	**0.122**	*P* = 0.278	0.054
			CR	0.32 ± 0.12	0.32 ± 0.12	0.31 ± 0.13	0.33 ± 0.14	0.34 ± 0.14	0.33 ± 0.15	0.33 ± 0.14	0.33 ± 0.15	0.33 ± 0.15	0.34 ± 0.15	0.33 ± 0.15	0.33 ± 0.15	0.32 ± 0.15						
	$knee_{pos}$	($J \cdot kg^{-1}$)	RR	0.35 ± 0.07	0.37 ± 0.07	0.38 ± 0.07	0.38 ± 0.07	**0.40 ± 0.07 ***	0.40 ± 0.07	0.40 ± 0.07	0.40 ± 0.07	0.40 ± 0.07	0.40 ± 0.07	**0.41 ± 0.07 ***	0.40 ± 0.07	**0.40 ± 0.08 ***	*P* = 0.187	0.074	***P* < 0.001**	**0.377**	*P* = 0.810	0.015
			CR	0.40 ± 0.09	0.42 ± 0.10	0.43 ± 0.11	0.43 ± 0.11	0.44 ± 0.12	0.45 ± 0.12	0.45 ± 0.12	0.45 ± 0.12	0.46 ± 0.12	0.45 ± 0.12	0.46 ± 0.12	0.46 ± 0.11	0.45 ± 0.12						
	$ankle_{pos}$	($J \cdot kg^{-1}$)	RR	0.64 ± 0.10	0.62 ± 0.10	0.61 ± 0.10	0.61 ± 0.10	0.60 ± 0.10	0.59 ± 0.09	0.59 ± 0.10	**0.58 ± 0.09 ***	**0.57 ± 0.09 ****	**0.56 ± 0.09 ****	**0.56 ± 0.10 ****	**0.56 ± 0.10 ****	**0.55 ± 0.10 ****	*P* = 0.170	0.224	***P* < 0.001**	**0.495**	*P* = 0.126	0.080
			CR	0.73 ± 0.13	0.72 ± 0.14	0.72 ± 0.14	0.71 ± 0.14	0.72 ± 0.14	0.71 ± 0.13	0.70 ± 0.13	0.70 ± 0.13	0.69 ± 0.13	0.69 ± 0.13	0.69 ± 0.13	0.69 ± 0.14	0.69 ± 0.12						
	hip_{neg}	($J \cdot kg^{-1}$)	RR	0.07 ± 0.03	0.08 ± 0.04	0.08 ± 0.04	0.08 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	*P* = 0.083	0.125	***P* = 0.022**	**0.122**	*P* = 0.168	0.066
			CR	0.11 ± 0.06	0.12 ± 0.06	0.12 ± 0.06	0.13 ± 0.06	0.12 ± 0.07	0.13 ± 0.07	0.13 ± 0.07	0.12 ± 0.06	0.13 ± 0.07	0.12 ± 0.06	0.12 ± 0.06	0.12 ± 0.05	0.12 ± 0.06						
	$knee_{neg}$	($J \cdot kg^{-1}$)	RR	0.49 ± 0.06	0.51 ± 0.09	0.53 ± 0.09	0.53 ± 0.09	0.54 ± 0.09	0.54 ± 0.10	0.54 ± 0.10	0.54 ± 0.10	0.54 ± 0.09	0.55 ± 0.09	0.55 ± 0.09	0.53 ± 0.09	0.54 ± 0.10	*P* = 0.406	0.030	***P* = 0.001**	**0.205**	*P* = 0.628	0.026
			CR	0.53 ± 0.08	0.55 ± 0.08	0.55 ± 0.08	0.55 ± 0.08	0.56 ± 0.08	0.56 ± 0.09	0.57 ± 0.09	0.57 ± 0.09	0.57 ± 0.09	0.57 ± 0.10	0.58 ± 0.11	0.57 ± 0.09	0.56 ± 0.10						
	$ankle_{neg}$	($J \cdot kg^{-1}$)	RR	0.54 ± 0.11	0.55 ± 0.10	0.55 ± 0.09	0.57 ± 0.09	0.56 ± 0.08	0.56 ± 0.06	0.56 ± 0.08	0.56 ± 0.08	0.55 ± 0.07	0.55 ± 0.07	0.55 ± 0.08	0.56 ± 0.10	0.57 ± 0.10	***P* < 0.001**	**0.756**	*P* = 0.247	0.059	*P* = 0.149	0.081
			CR	0.93 ± 0.17	0.92 ± 0.16	0.92 ± 0.16	0.90 ± 0.14	0.89 ± 0.13	0.89 ± 0.12	0.88 ± 0.11	0.87 ± 0.10	0.88 ± 0.10	0.87 ± 0.10	0.88 ± 0.10	0.88 ± 0.11	0.89 ± 0.09						

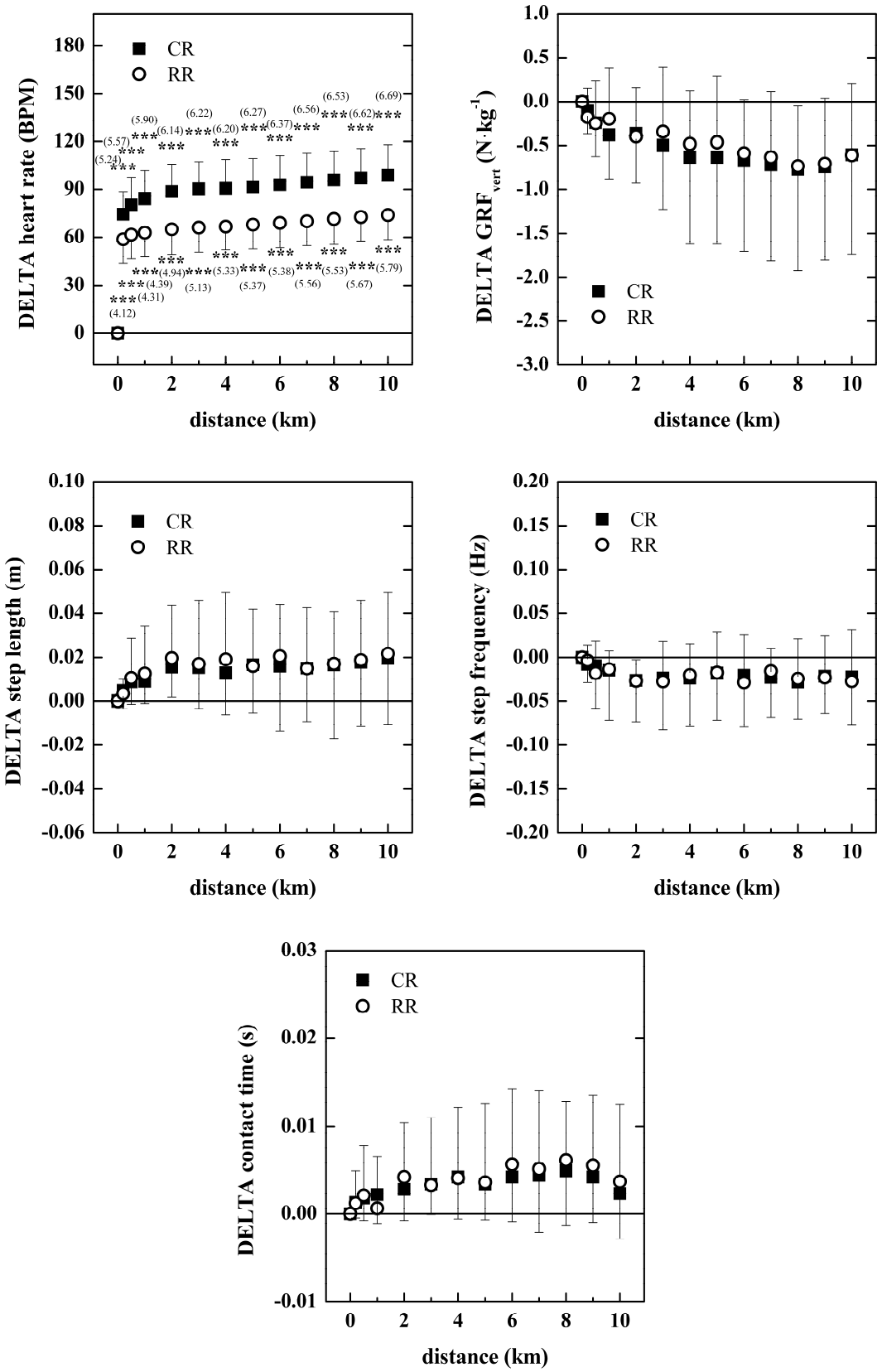

Figure 1 of the supplemental digital content: Changes in the heart rate (left top), vertical ground-reaction force (right top), step length (left center), step frequency (right center), and contact time (central bottom) as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by ***$P < 0.001$. The values in parentheses show the Cohen's *d* effect sizes.

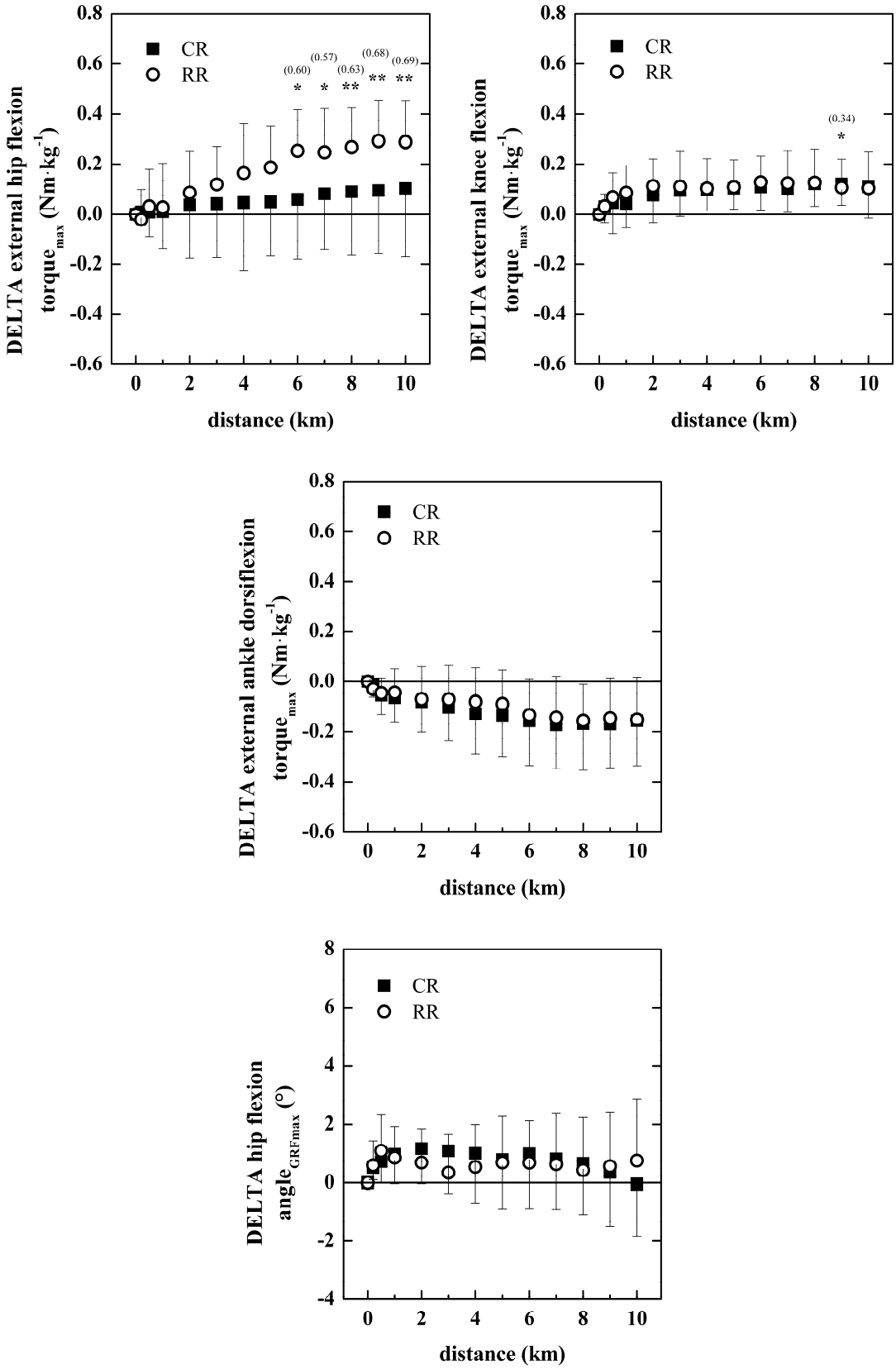

Figure 2 of the supplemental digital content: Changes in the maximal external flexion torque of hip (left top) and knee joint (right top) in the stance phase, and the maximal external dorsiflexion torque of ankle joint (central center) in the stance phase, and hip flexion angle at maximum of the ground-reaction force (central bottom) as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by *$P < 0.05$ and **$P < 0.01$. The values in parentheses show the Cohen's *d* effect sizes.

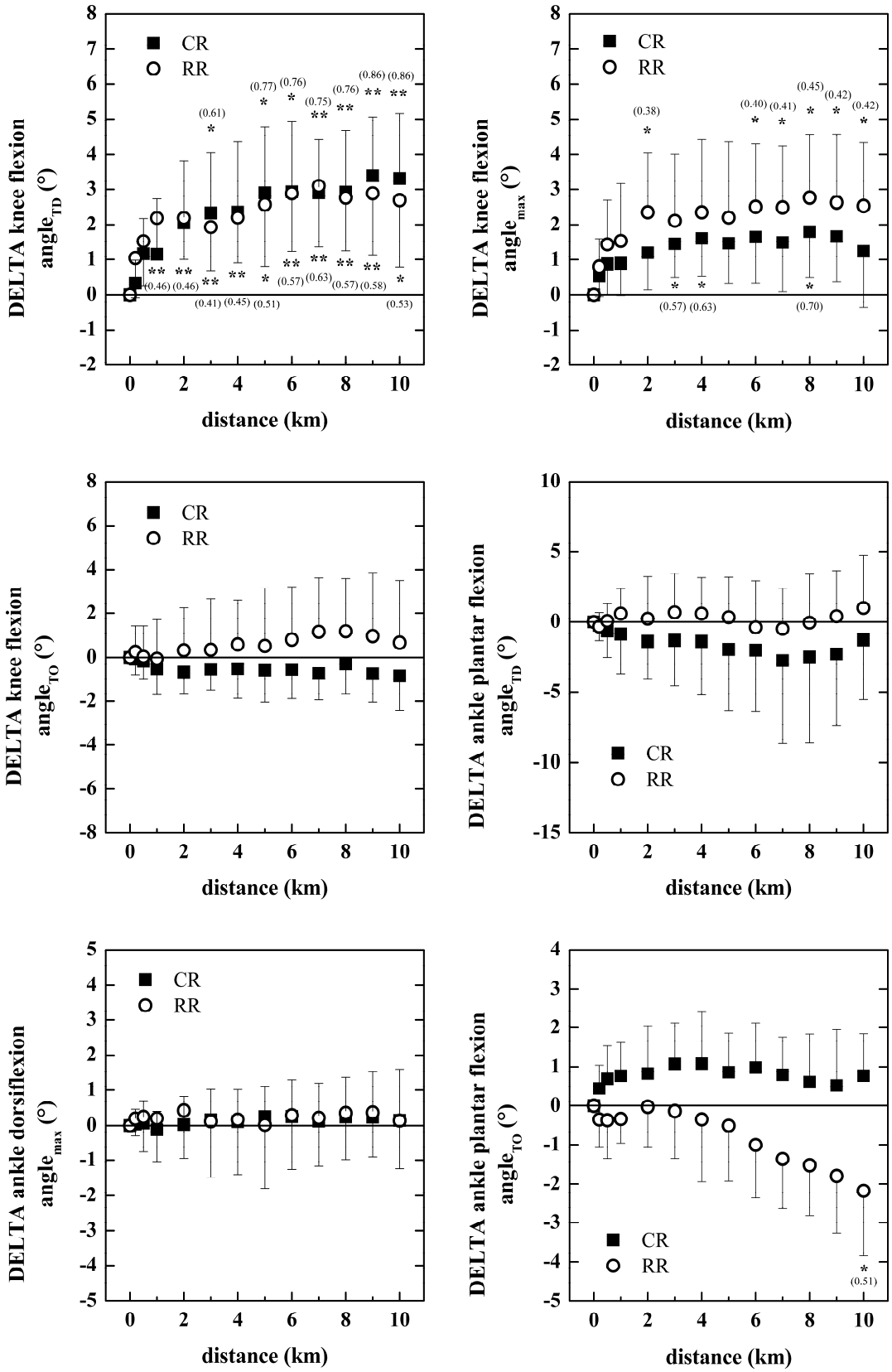

Figure 3 of the supplemental digital content: Changes in the knee flexion angle at touch-down (left top), maximal knee flexion angle in the stance phase (right top), knee flexion angle at toe-off (left center), ankle plantar flexion angle at touch-down (right center), maximal ankle dorsiflexion angle in the stance phase (left bottom), and ankle plantar flexion angle at toe-off (right bottom) as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by $*P < 0.05$ and $**P < 0.01$. The values in parentheses show the Cohen's *d* effect sizes.

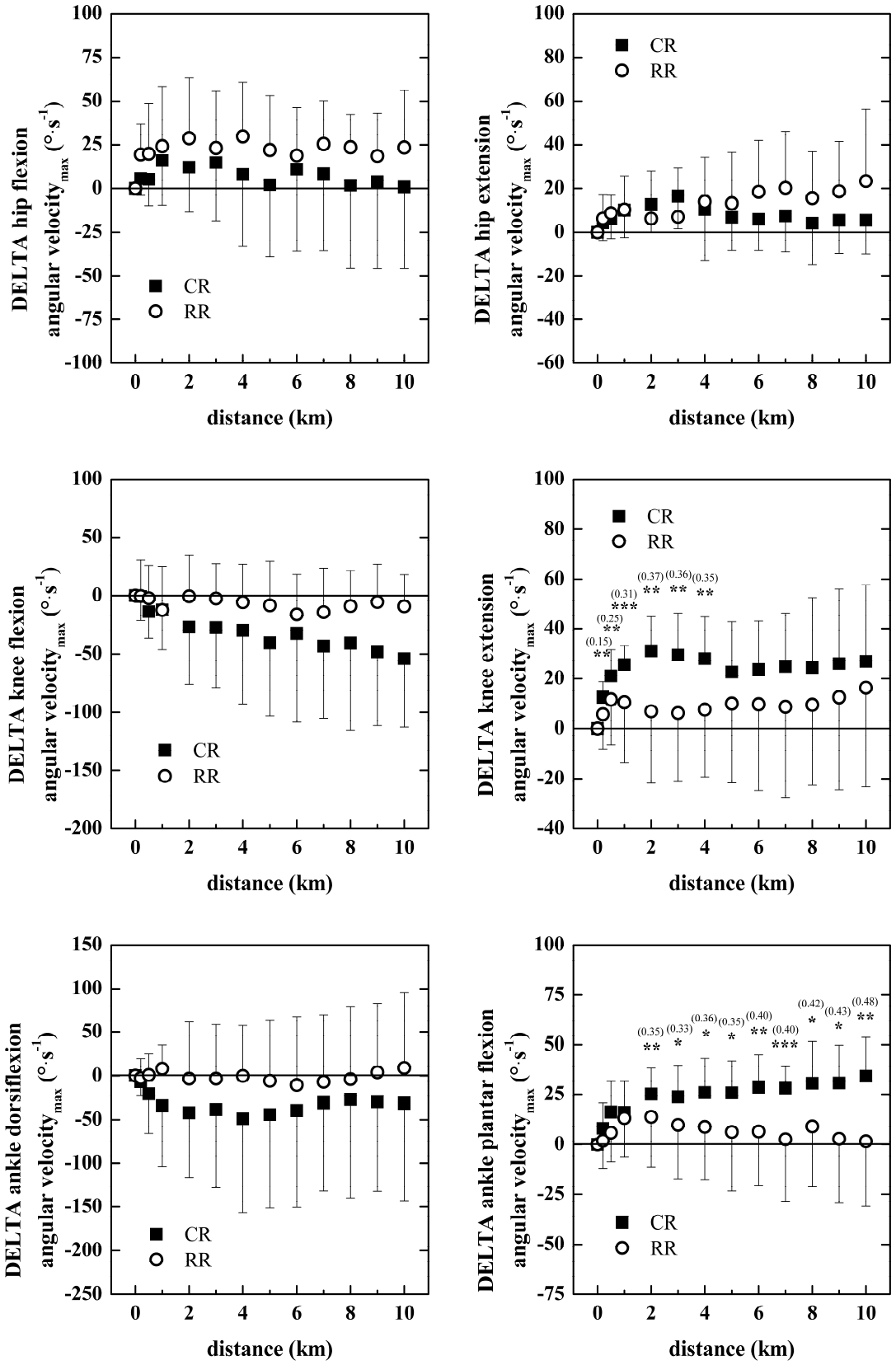

Figure 4 of the supplemental digital content: Changes in the maximal angular velocity of hip (left top) and knee joint flexion (left center) in the stance phase, maximal angular velocity of hip (right top) and knee joint extension (right center) in the stance phase, maximal angular velocity of ankle joint dorsiflexion (left bottom) and plantar flexion (right bottom) in the stance phase as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by $*P < 0.05$, $**P < 0.01$, and $***P < 0.001$. The values in parentheses show the Cohen's *d* effect sizes.

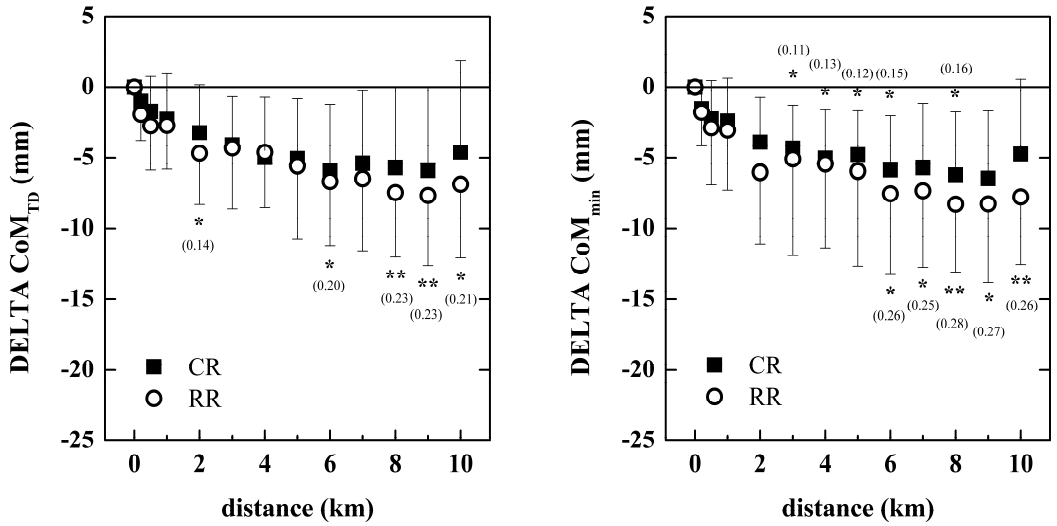

Figure 5 of the supplemental digital content: Changes in the center of mass height (CoM) at touch-down (left) and minimal CoM height in stance phase (right) as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by **P* < 0.05 and ***P* < 0.01. The values in parentheses show the Cohen's *d* effect sizes.

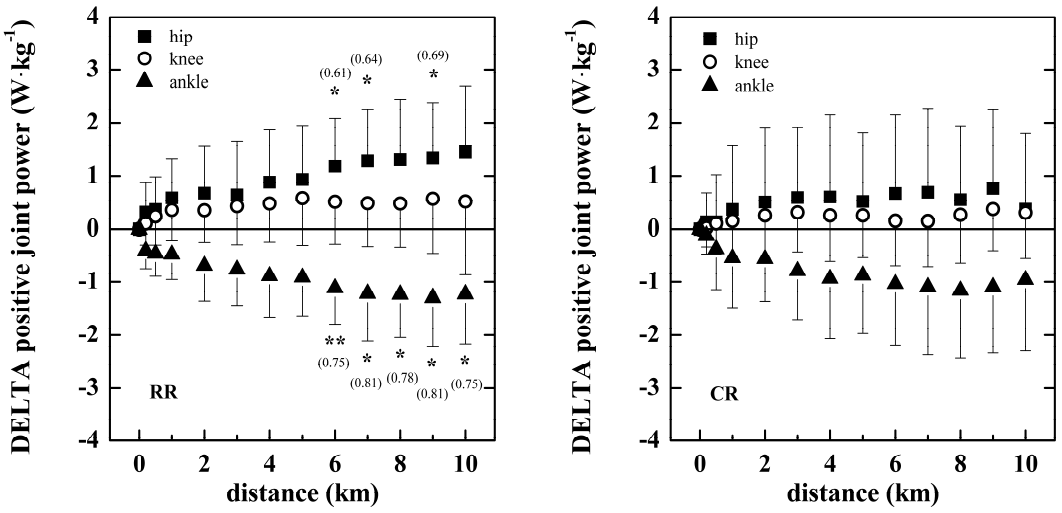

Figure 6 of the supplemental digital content: Changes in hip, knee, and ankle joint power as means (± standard deviation) of recreational runners (RR; n = 13) and competitive runners (CR; n = 12) over the course of the 10-km treadmill run with near-maximal effort. Significant differences from the values at the beginning of the run (0 km) are represented by **P* < 0.05 and ***P* < 0.01. The values in parentheses show the Cohen's *d* effect sizes.