



Figure 1. Gait phases in normal level walking with typical horizontal (F_y) and vertical (F_z) force ground reaction components and their ratios, F_y/F_z , for one step (right foot). Note that peak 1 is caused by the forward force of impact of the heel on to the force plate. Peak 2 is the result of a backward force exerted on the heel after contact during the early landing phase. Peaks 3 and 4, often recorded as one broad spike, are caused by the main forward force, which retards the motion of the foot. Finally, peaks 5 and 6 are recorded during the push-off phase, with the toes in contact with the force plate, pushing in the backward direction (from Perkins 1978). Critical from the slipping point of view are the heel contact (peaks 3 and 4) and the toe-off (peaks 5 and 6) phases (Grönqvist *et al.* 1989).



Figure 2. Soles of the high traction shoe (left) and the low traction shoe (right). The shoes (size 10) are regular running shoes (Pro-wing Joggers, 0456-2011-09-04). One pair of the shoes was altered to decrease its coefficient of friction by inserting 88 metallic one-half inch diameter disc thumbtacks into the outsole.

Table 1. Group means and standard deviations for parameters (multiplied by 100) derived from the lead-foot ground reaction forces (GRF).

Parameters	Low traction				High traction			
	0%	10%	20%	40%	0%	10%	20%	40%
P2								
Mean	16.224 ^{10,20,40%}	18.813*	20.246*	19.757*	26.751 ^{10,20,40%}	38.256 ^{20,40%}	42.359	43.480
SD	2.192	2.844	2.658	3.069	3.780	4.783	5.309	4.762
P3								
Mean	17.311 ^{20,40%}	19.316*	20.664*	21.857*	22.128 ^{10,20,40%}	25.895 ^{20,40%}	30.049 ^{40%}	35.650
SD	1.653	2.245	2.115	2.201	2.862	5.183	6.947	8.119
P4								
Mean	18.305*	18.106*	17.988*	18.006*	32.908 ^{10,20,40%}	36.667 ^{20,40%}	39.966	39.081
SD	3.264	3.252	3.506	3.515	3.415	3.885	2.892	4.126
TS								
Mean	66.426 ^{40%}	67.883 ^{40%}	67.507 ^{40%}	71.051*	69.207 ^{20,40%}	70.599 ^{40%}	72.236 ^{40%}	76.669
SD	3.394	3.356	4.697	4.018	3.187	2.844	2.912	3.576
TB								
Mean	36.736 ^{40%}	36.682 ^{40%}	34.451 ^{40%}	29.616	36.752	37.195 ^{40%}	35.503	33.088
SD	2.273	2.426	4.852	6.168	2.508	3.268	3.603	5.458
TP								
Mean	29.69 ^{40%}	31.201 ^{40%}	33.056 ^{40%}	41.435	32.454 ^{20,40%}	33.404 ^{40%}	36.733 ^{40%}	43.580
SD	2.513	4.144	4.642	4.965	1.911	3.909	4.896	4.283

Note: The four distinct points (P) were extracted from the force ratio trace. P1 = first maximum negative peak; P2 = second maximum positive peak; P3 = second maximum negative peak (P3 is representative of peaks 3 and 4 on Figure 1); P4 = second maximum positive peak (P4 is representative of peaks 5 and 6 on Figure 1). However, peak P1 was discarded from the analysis due to inconsistencies in its occurrence. Three time values were identified from the horizontal GRF. TB = time of the braking period; TP = time of the propulsive period; TS = time of the stance phase. The value for P3 is multiplied by -1, while the values for TS, TB and TP are in seconds multiplied by 100.

*Significantly different between shoes within the same obstacle height ($p < 0.01$).

^{10,20,40%} significantly different between obstacle heights within the same shoe ($p < 0.01$).

Table 2. Results of a 2 × 4 ANOVA with repeated measures on both factors: shoe traction and obstacles.

Parameters	F _s	<i>p</i> <	F _o	<i>p</i> <	F _{s × o}	<i>p</i> <
P2	141.376	0.01	59.864	0.01	30.121	0.01
P3	33.431	0.01	29.705	0.01	12.123	0.01
P4	345.174	0.01	13.191	0.01	16.572	0.01
TS	81.545	0.01	16.305	0.01	7.804	0.01
TB	4.928	-	6.880	0.01	1.881	-
TP	17.774	0.01	28.877	0.01	0.718	-

Note: In tests that resulted in significant F ratios (*p* < 0.05), a post hoc Tukey multiple comparison test was performed to identify the significant differences. F_s = between shoes; F_o = between obstacles; F_{s × o} = interaction.