

## **Supplementary materials**

### **1) Appendix 1. Results concerning MTP angular velocity**

#### **Markerset influence on MTP angular velocity**

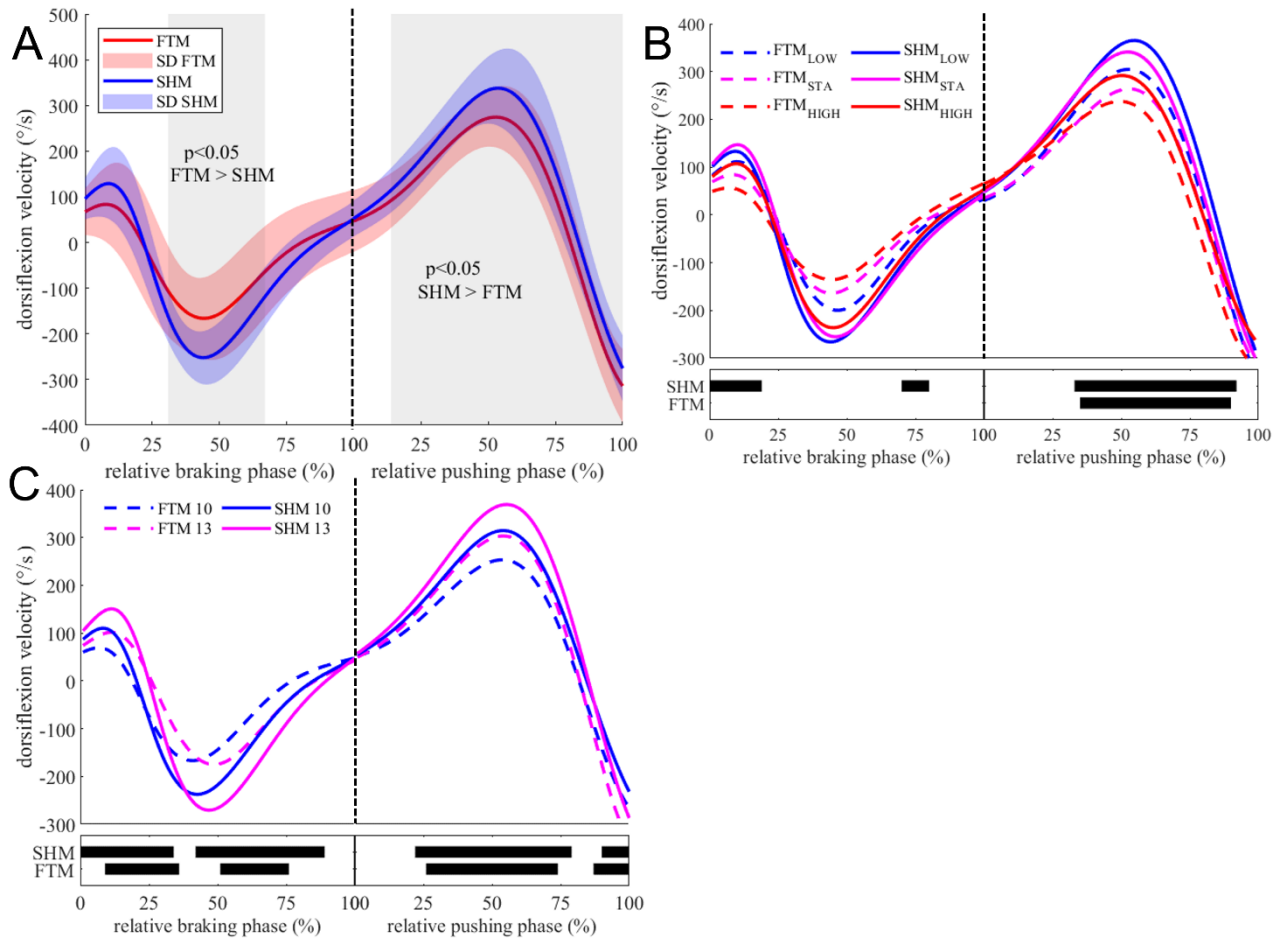
There was a main effect of the markersets on the MTP angular velocity on the middle of braking phase [31 to 69%], with a higher peak plantarflexion velocity for SHM compared to FTM ( $+50 \pm 73$  °/s,  $p=0.009$ ,  $\eta_p^2=0.42$ ). There was also a main effect of the markersets over most of the pushing phase [14 to 100%], with higher dorsiflexion velocity for SHM than for FTM (Appendix A. Figure 1, panel A). There were markerset  $\times$  speed and markerset $\times$ speed $\times$ LBS interactions on dorsiflexion velocity at [83 to 91%] and [87 to 91%] of pushing phase, respectively.

#### **Markerset influence on the effect of LBS on MTP angular velocity**

There was a main effect of LBS on angular velocity in the braking phase, only with shoe markers ([0 to 18,8%] and [70 to 80%] of braking phase), with higher LBS leading to reduced velocity. During the pushing phase, there was a main effect of LBS for both markersets (FTM: [35 to 90%], SHM: [33 to 92%]) in which higher LBS was associated with reduced velocity (Appendix A. Figure 1, panel B).

#### **Markerset influence on the effect of running speed on MTP angular velocity**

There was a main speed effect on MTP angular velocity on [7 to 36%] and [50 to 77%] of the braking phase, and [26 to 74%] and [87 to 100%] of the pushing phase with FTM, whereas it was significant between [0 to 34%] and [42 to 89%] of the braking phase, and [20 to 80%] and [90 to 100%] of pushing phase with shoes markers (Appendix A. Figure 1, panel C).



**Appendix 1. Figure 1. MTP joint dorsiflexion velocity during stance phase measured using both shoe markerset (SHM) and skin markerset (FTM) (panel A), depending on LBS and markerset (panel B), or depending on speed and markersets (panel C). The shaded area on panel A represents phases of significant markerset effect. MTP joint kinematics and kinetics. Black horizontal bars denote periods of significant effect of LBS (panel B) or speed (panel C) on MTP dorsiflexion velocity with SHM and FTM (SPM ANOVA). Dotted black vertical line separates braking and pushing phases (10: 10km/h; 13: 13 km/h).**

## 2) Appendix 2. Results concerning MTP joint work

### Markerset influence on MTP joint work

There was a significant main effect of markerset on  $W^-$  ( $F=50.3$ ,  $p<0.001$ ,  $\eta_p^2=0.795$ ), where  $W^-$  of SHM was  $22 \pm 16$  % higher than FTM. There was also a main effect of markerset on  $W^+$  ( $F=33.3$ ,  $p<0.001$ ,  $\eta_p^2=0.719$ ), where  $W^+$  of SHM was  $16 \pm 21$  % lower than FTM. Significant markerset $\times$ LBS

and markerset $\times$ speed interactions were detected on  $W^+$  (respectively  $F=3.5$ ,  $p<0.047$ ,  $\eta_p^2=0.209$  and  $F=19.4$ ,  $p<0.001$ ,  $\eta_p^2=0.598$ ).

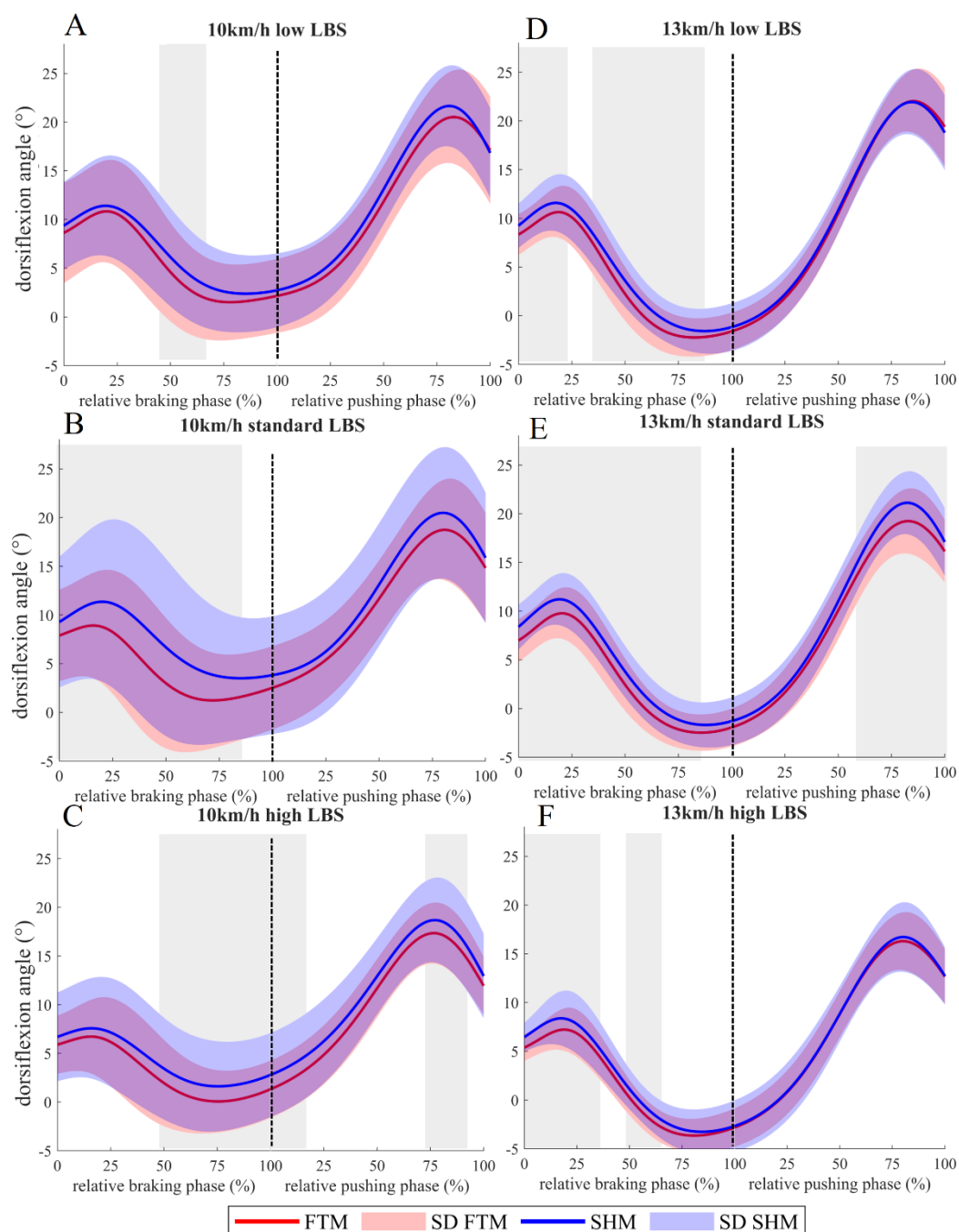
### **Markerset influence on the effect of LBS on MTP joint work**

The LBS effect on  $W^-$  was only significant with FTM ( $F=6.84$ ,  $p=0.004$ ,  $\eta_p^2=0.345$  vs  $F=1.65$ ,  $p=0.212$ ,  $\eta_p^2=0.112$ ), where higher LBSs were associated with lower  $W^-$ . The LBS effect on  $W^+$  was detected with both markersets, giving similar effect-sizes (FTM:  $F=35.5$ ,  $p<0.001$ ,  $\eta_p^2=0.732$ , VS SHM:  $F=25.04$ ,  $p<0.001$ ,  $\eta_p^2=0.658$ ) where a higher LBS was associated with higher MTP joint  $W^+$ .

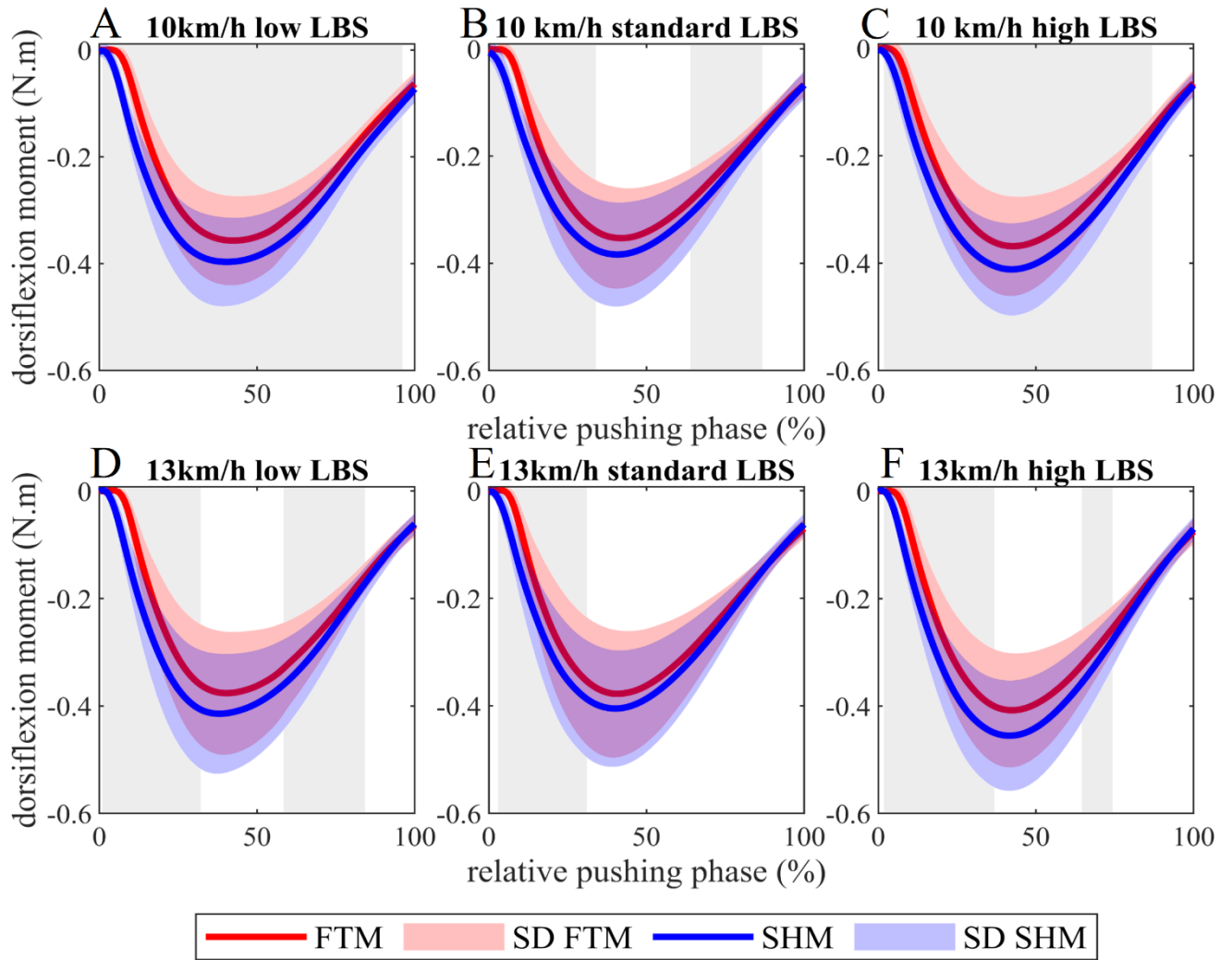
### **Markerset influence on the effect of running speed on MTP joint work**

The speed effect on  $W^-$  was significant with both FTM ( $F=27.7$ ,  $p<0.001$ ,  $\eta_p^2=0.680$ ) and SHM ( $F=12.7$ ,  $p=0.003$ ,  $\eta_p^2=0.495$ ) where a higher speed was associated with a higher  $W^-$ . The speed effect on  $W^+$  was only detected with FTM (FTM:  $F=6.01$ ,  $p=0.029$ ,  $\eta_p^2=0.312$ , vs SHM:  $F=1.15$ ,  $p=0.304$ ,  $\eta_p^2=0.081$ ) where a higher speed was associated with a higher  $W^+$ .

### 3) Appendix 3. Pairwise comparison for each speed and LBS condition.



**Appendix 3. Figure 2. MTP joint angle during stance phase with shoe markerset (SHM) or skin markerset (FTM), at 10km/h with low LBS (panel A), with standard LBS (panel B), and with high LBS (panel C), and at 13km/h with low LBS (panel D), with standard LBS (panel E), and with high LBS (panel F). Shaded areas represent periods of significant differences between markersets ( $p < 0.05/6$ , paired t-tests with Bonferroni correction). Dotted black vertical line separates braking and pushing phase.**



**Appendix 3. Figure 3. MTP joint dorsiflexion moment during pushing phase with shoe markerset (SHM) or skin markerset (FTM), at 10km/h with low LBS (panel A), with standard LBS (panel B), and with high LBS (panel C), and at 13km/h with low LBS (panel D), with standard LBS (panel E), and with high LBS (panel F). Shaded areas represent periods of significant differences between markersets ( $p < 0.05/6$ , paired t-tests with Bonferroni correction).**

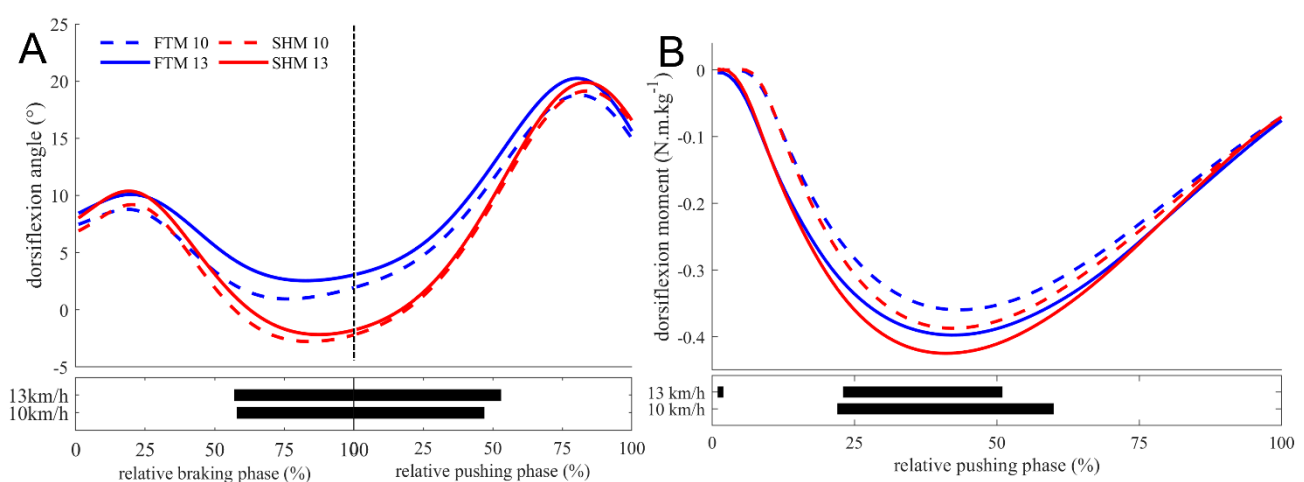
#### 1) Appendix 4. Results comparison between using three vs. two-factor RMANOVA.

Our 3-factor RMANOVA which was conducted to answer to our first question “Does shoe markerset represent the movement of the MTP joint as accurately as the skin markerset?” seem underpowered to detect a potential triple interaction. Conducting a sample size calculation for a 3-factor RMANOVA demands assumptions we cannot provide for this study (variance-covariance matrix) without adding a lot of random effect on our calculation. In the absence of these information, one possibility is to divide alpha by the number of post-hoc comparisons. Here we have  $2 \times 3 \times 2$  RMANOVA, meaning 12 sub-groups and 66 pairwise comparisons. We obtained an  $\alpha = 0.05/66 = 0.00076$ . We can conduct a sample size analysis with this alpha. Focusing on the peak

plantarflexion moment for example, we could expect an estimated large statistical effect of markerset as if there is one effect, it should be relatively systematic (the shoe movement will underestimate the foot movement for nearly everyone). Even if the difference between the SHM and FTM would be small, the standard deviation of the difference should be small too. For the peak plantarflexion moment, a Cohen  $d$  around 0.8 can be suggested. The sample size calculation with Cohen  $d=0.8$ , power=0.8,  $\alpha=0.00076$ , we obtain a sample size of 34 participants.

Our 3RMANOVAs was therefore underpowered, meaning that our results considering the triple interaction are to be taken with caution. However, the purpose of the first part of the study was not to detect a potential triple interaction, but to see if the marker placement influences kinetics and kinematics, independently of running speed and shoe LBS. To verify if our statistical analysis does not lead us to false conclusions and misinterpretations, we conducted a new analysis based on 2-factors RMANOVA (markerset  $\times$  LBS) at each speed. This analysis is enough to respond to our question “Does shoe markerset represent the movement of the MTP joint as accurately as the skin markerset?”. Here are the results at 10 and 13km/h. We haven’t seen any difference in our results between the 2 and the 3-factor RMANOVA which can modify our first analysis.

For both speeds taken together (3-factor RMANOVA), there was a main effect of markerset on MTP joint angle during the second half of the braking phase [57 to 100%] and the first half of the pushing phase [0 to 48%] (*Figure 2A* in the manuscript). When separating the analysis at 10 and 13km/h, there was significant effect of markerset on MTP joint angle during the second half of the braking phase (10km/h: [57 to 100%]; 13km/h: [58 to 100%]) and the first half of the pushing phase (10km/h: [0 to 44%]; 13km/h: [0 to 47%]) (Appendix D. Figure 1).



**Appendix 4. Figure 4. MTP joint angle during stance phase (panel A) and MTP joint moment during pushing phase (panel B) with shoe markerset (SHM) or skin markerset (FTM) at 10 and 13 km/h, for all LBS conditions averaged. Black horizontal bars denote periods of**

**significant effects of markerset at each speed. Dotted black vertical line separates braking and pushing phases.**

Using the three-factor RMANOVA, there was a main effect of markerset on MTP joint plantarflexion moment which was higher with SHM compared to FTM between 22 and 55% of the moment production phase. There were significant markerset  $\times$  LBS and markerset  $\times$  speed interactions at the end of the phase (respectively [88 to 100%],  $F=30.5$ ,  $p=0.009$ , and [67 to 100%],  $F=115$ ,  $p<0.001$ ). When separating the analysis at 10 and 13km/h with two-factor RMANOVA, there was significant effect of markerset on MTP joint plantarflexion moment which was higher with SHM compared to FTM between 26 and 50% of the moment production phase at 10km/h, and between 0 and 2% and between 24 and 51% of the moment production phase at 13km/h. There were significant markerset  $\times$  LBS interactions at the end of the phase (10km/h: [88 to 100%],  $F=17.5$ ,  $p=0.002$ ; 13km/h: [90 to 100%],  $F=35.9$ ,  $p<0.011$ ). The table 1 presented the other results for the 0D part.

**Appendix 4. Table 1. Mean difference and statistical results between the two markersets for each 0D variables using three-factor (“both”) vs. two factors RMANOVAs (10 and 13 km/h).**

Variable	Running speed (km/h)	Mean difference between the FTM and SHM	F (markerset effect)	P (markerset effect)	$\eta_p^2$ (markerset effect)
Peak plantarflexion angle (°)	both	+ 3.5 $\pm$ 4.2	19.3	<0.001	0.60
	10	+ 3.2 $\pm$ 3.3	21.7	<0.001	0.626
	13	+ 3.9 $\pm$ 4.9	16.2	0.001	0.625
Peak plantarflexion moment (N.m)	both	+ 0.029 $\pm$ 0.041	19.1	<0.001	0.60
	10	+ 0.029 $\pm$ 0.039	17.9	<0.001	0.58
	13	+ 0.029 $\pm$ 0.043	18.9	<0.001	0.58
Peak plantarflexion angle variability (°)	both	+ 0.48 $\pm$ 1.14	11.7	0.005	0.47
	10	+ 0.37 $\pm$ 0.96	8.4	0.012	0.39
	13	+ 0.55 $\pm$ 1.30	3.2	0.099	0.19
Peak dorsiflexion angle variability (°)	both	+ 0.09 $\pm$ 1.26	0.8	0.392	0.06
	10	- 0.01 $\pm$ 1.04	1.4	0.66	0.09
	13	+ 0.18 $\pm$ 1.45	0.1	0.77	0.01
MTP pushing duration (ms)	both	-6 $\pm$ 4	86.4	<0.001	0.87
	10	-6 $\pm$ 5	86.1	<0.001	0.87
	13	-6 $\pm$ 4	79.1	<0.001	0.86

SHM: Shoe markerset; FTM: skin markerset; LOW: low LBS; STA: standard LBS; HIGH: high LBS; MTP: Metatarsophalangeal joint; P: p-value;  $\eta_p^2$ : Partial eta-squared; n.s: non-significant; \* indicates a significant main effect of the Anova, \*:  $p<0.05$ , \*\*:  $p<0.01$ , \*\*\*  $p<0.001$ .

Our results seem similar between the two analyses (three vs. two-factor RMANOVAs). Therefore, our interpretation and discussion does not depend on the use of a three vs. two-factor RMANOVAs. Including the "proper" statistics would unnecessarily complicate reading the article, therefore the three-factor RMANOVA has been presented in the manuscript.