

# RELIABILITY OF IN-SOLE PLANTAR PRESSURE USING SIMPLE AND DETAILED MASKS OF THE FOREFOOT, MIDFOOT, AND HINDFOOT

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## BACKGROUND

Plantar pressure measurements obtained with in-shoe pressure sensor insoles can be analyzed by dividing the foot into anatomical regions using masks. A simple mask could divide the foot into four regions: toes, forefoot, midfoot, and hindfoot. A detailed mask could further divide these regions to capture data from specific anatomical regions/structures. For example, dividing the forefoot into individual metatarsals may help clinicians and researchers identify individuals who are at increased risk of stress-related injuries to these structures (e.g. stress fracture). Regardless of which mask is applied, these measures must be reliable. The purpose of this study was to obtain the reliability of in-sole plantar pressure measurements using simple and detailed masks and to determine which is more reliable.

## METHODS

Ten healthy males (n=8) and females (n=2) participated in this study (age:  $27.7 \pm 4.1$  years, mass:  $77.6 \pm 10.7$  kg, height:  $174.3 \pm 7.0$  cm). Subjects performed a gait task on two different days using the PEDAR-X<sup>®</sup> system (Novel GmbH, Munich, Germany) to measure in-sole plantar pressures (100Hz) using their own athletic footwear (without socks). After familiarization of the task, subjects performed three trials of 20 consecutive straight-line walking steps using usual gait across a level, laboratory floor.

Maximum force (MF), force-time integral (FTI), peak pressure (PP), pressure-time integral (PTI), and maximum mean pressure (MMP) were calculated for simple and detailed masks. Both masks divided the foot into three primary regions: the forefoot, midfoot, and hindfoot. The simple mask divided the forefoot into metatarsal 1, 2, and 3-5; and did not divide the midfoot and hindfoot. The detailed mask divided the forefoot into individual metatarsals and the midfoot and hindfoot into medial/lateral regions. Intraclass correlation coefficients (ICC) were calculated using a two-way random effects model (ICC [2,k]). ICCs were averaged for each variable to obtain a single ICC value for the simple and detailed masks. Left and right foot measurements were combined for the analyses. A t-test was used to identify significant differences between the simple and detailed masks ( $\alpha=0.05$ ).

## RESULTS

No significant differences were found between the simple and detailed masks. Maximum force and force-time-integral resulted in excellent reliability (ICC>0.90) for all masks and regions. Peak pressure, pressure-time-integral, and maximum mean pressure resulted in good reliability (ICC>0.70) for all masks and regions.

Table 1: ICCs (mean  $\pm$  SD) for simple and detailed masks of the forefoot, midfoot, and hindfoot

	Forefoot		
	Simple	Detailed	p-value
MF	0.962 $\pm$ 0.016	0.966 $\pm$ 0.014	0.653
FTI	0.932 $\pm$ 0.027	0.942 $\pm$ 0.024	0.456
PP	0.849 $\pm$ 0.164	0.891 $\pm$ 0.136	0.586
PTI	0.845 $\pm$ 0.078	0.891 $\pm$ 0.083	0.292
MMP	0.929 $\pm$ 0.038	0.943 $\pm$ 0.035	0.454
Midfoot			
	Simple	Detailed	p-value
MF	0.975 $\pm$ 0.003	0.974 $\pm$ 0.010	0.916
FTI	0.955 $\pm$ 0.013	0.955 $\pm$ 0.019	0.972
PP	0.938 $\pm$ 0.044	0.944 $\pm$ 0.023	0.818
PTI	0.852 $\pm$ 0.108	0.887 $\pm$ 0.035	0.549
MMP	0.852 $\pm$ 0.055	0.751 $\pm$ 0.237	0.604
Hindfoot			
	Simple	Detailed	p-value
MF	0.915 $\pm$ 0.018	0.911 $\pm$ 0.041	0.913
FTI	0.959 $\pm$ 0.023	0.952 $\pm$ 0.020	0.720
PP	0.870 $\pm$ 0.021	0.861 $\pm$ 0.047	0.799
PTI	0.908 $\pm$ 0.030	0.911 $\pm$ 0.024	0.912
MMP	0.890 $\pm$ 0.021	0.877 $\pm$ 0.047	0.731

## DISCUSSION

In-sole plantar pressure measurements obtained demonstrated good reliability for all masks and regions indicating that the PEDAR-X<sup>®</sup> system is capable of collecting reliable data, regardless of which mask is utilized. These findings are similar to those of previous studies (Boyd *et al*, 1997; Putti *et al*, 2007). The lowest ICC was for MMP using the detailed mask for the midfoot, which may be a function of the small contact area of the medial midfoot. Since the contact area is relatively small, it is possible that even small variation in the rollover pattern during gait may significantly affect measurements in this region. It is therefore recommended to not subdivide this region in order to maximize the reliability of the measurements obtained, both in the clinical and research settings.

## REFERENCES

- Boyd *et al*, Gait & Posture 5: 165, 1997
- Putti *et al*, Gait & Posture 25: 401-405, 2007