



ORAL PRESENTATION

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# Three-dimensional ankle kinematics in children's school shoes during running

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## Background

Children are more active during the school day than at other times [1] and because school shoes are required as part of a uniform in many countries research on school shoes is required. This study aimed to determine the effect of school shoes on the ankle joint complex motion of children while running.

## Materials and methods

Twenty children (mean age 9 years (SD2.3)) performed five running trials at a self-selected velocity barefoot and wearing school shoes (Daytona, Clarks) in a random order. A 14 camera 200Hz motion analysis system (EvaRT5.0, MAC) was used to calculate marker trajectories. Markers were attached to the right leg and a cluster wand was attached to the calcaneus through a window in the shoe. A standing reference trial was used to embed segment axes and then calculate ankle joint complex motion. Force plate data were collected at 1000Hz (Kistler™). Data were normalised to the stance phase and sub-phases partitioned from the anterior/posterior force data as: loading (initial-contact – maximum-negative force); mid-stance (maximum-negative force – zero) and propulsion (positive force – toe-off).

## Results

Shoes delayed the maximum-posterior force (22.8% to 29.3%;  $p < 0.0001$ ) and the zero crossing of the anterior-posterior force (41.1% to 43.6%;  $p = 0.021$ ). During loading shoes increased ankle range of motion (ROM) in the sagittal ( $9.9^\circ$  to  $13.8^\circ$ ;  $p = 0.007$ ) and transverse planes ( $5.7^\circ$  to  $7.7^\circ$ ;  $p = 0.007$ ). During midstance shoes

decreased ankle frontal plane ROM ( $3.7^\circ$  to  $2.8^\circ$ ;  $p = 0.037$ ). During propulsion shoes increased ankle ROM in the sagittal plane ( $30.3^\circ$  to  $33.3^\circ$ ;  $p = 0.018$ ) and decreased frontal plane ROM ( $14.4^\circ$  to  $12.0^\circ$ ;  $p = 0.042$ ). Overall stance phase sagittal plane ROM increased in shoes ( $31.2^\circ$  to  $34.2^\circ$ ;  $p = 0.034$ ).

## Conclusions

This study shows that school shoes increase sagittal ankle motion during loading and propulsion, but decrease frontal plane motion during mid-stance and propulsion. These findings will assist in harmonising school shoe design with foot function.

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