

# LOWER EXTREMITY SUPPORT DURING TODDLER GAIT

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## INTRODUCTION

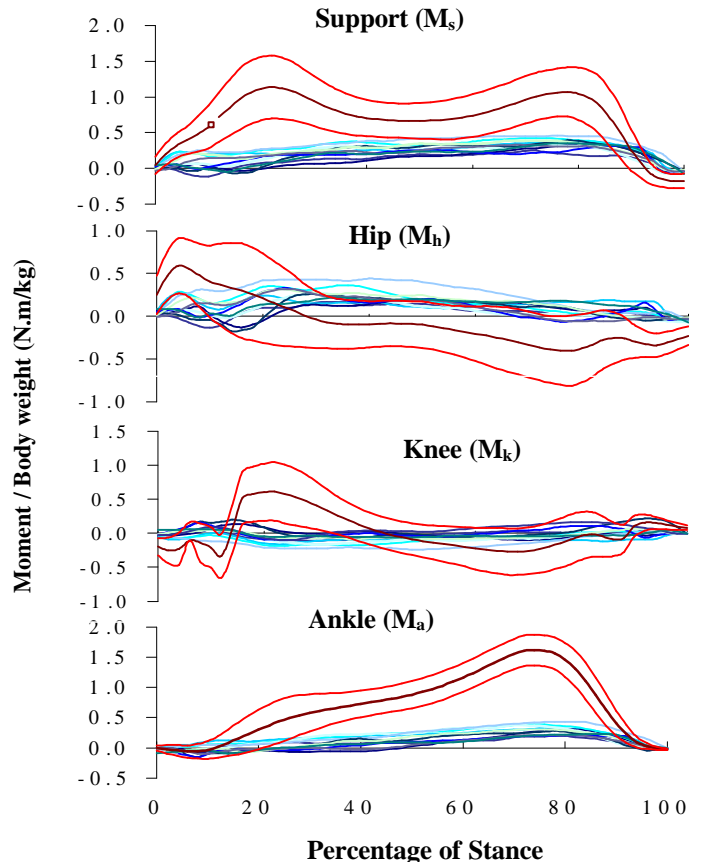
A net support moment of the lower limb,  $M_s$ , is defined as the sum of the moments at the hip, knee and ankle during the stance phase of walking. For adults, the net support moment during stance prevents collapse and brings about push-off (Winter 1980, 1991). It has been proposed (Breniere & Bril, 1988) that children within their first few months of independent walking actually “walk while falling”, whereas adults “fall while walking.” For children this implies that the vertical acceleration of the centre of gravity remains negative through single support and becomes positive only during double support. The purpose of this study was to characterize the  $M_s$  patterns of toddlers in their first year of independent walking and to determine if the proposed “walk while falling” is reflected by a negative  $M_s$ .

## METHODS

Four toddlers aged 12, 16, 21 & 22 months with 2, 3, 7 & 12 months of independent walking, respectively, participated in this study. Surface markers were placed on the ASIS, sacrum, greater trochanter, lateral condyle, tibial tuberosity, lateral malleolus, heel and fifth metatarsal head. Toddlers walked independently at their own speeds across two AMTI force plates. A minimum of nine trials were analyzed for each toddler. Kinematic data were collected using three VHS cameras and processed using the Ariel Performance Analysis System. Force and kinematic data were analyzed and combined using Biomech software (Robertson, 2002) to calculate net joint and support moments. All moments were normalized to body weight.

## RESULTS AND DISCUSSION

Support and lower limb moment curves during the stance phase for all trials from one toddler along with corresponding data (mean +/- st. dev.) from adults are plotted in Figure 1. This toddler's  $M_s$ s are much smaller and lack the double hump profile of adults. In 6 of 11 trials, the  $M_s$  were negative during the first 20% of stance of toddler gait corresponding to the period of weight transfer. In adults, the  $M_s$  at contact was always positive. The negative support moment lends credence to the suggestion that toddlers do not anticipate foot contact and are less stable on the lower limb at contact. The toddlers were able to provide an extensor  $M_s$  for the rest of stance bringing about push-off. Toddler ankle and hip joint moments followed similar patterns as those recorded for adult gait. Knee joint moments were negligible suggesting that toddlers may lock their knee or use it as a pivot point over which they rotate into their next step.



**Figure 1:** Support and joint moments of force for a 2-month walker and averaged adult data (the latter from Winter, 1991).

## SUMMARY

Early walking is characterized by a negative support moment of the lower limb during the first 20% of stance as the toddler attempts to position the body to create the support necessary to prevent a fall. Toddlers are less stable throughout stance and are therefore more susceptible to falls due to their reduced support moments.

## REFERENCES

- Breniere, Y., Bril B. (1988). *Sciences de la Vie*, **11**, 617-622.
- Robertson, D.G.E. (2002). <http://www.health.uottawa.ca/biomech/csb/software/biomech.htm>.
- Winter, D.A. (1980). *J. Biomechanics*, **13**, 923-927.
- Winter, D.A. (1991). *The biomechanics and motor control of human gait*. University of Waterloo Press.

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