# Development and validation of a 95th percentile male pedestrian finite element model

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## INTRODUCTION

The pedestrian is one of the most vulnerable road users and comprise about 22 % of the road crash related fatalities in the world [1]. Among the road traffic deaths, the pedestrian fatalities are comprised 22% (World), 26% (Europe), and 22% (US) reported in 2015. Therefore, protection of pedestrians in car-to-pedestrian collisions (CPC) has recently generated increased attention with vehicle regulations (in Europe, Asia, and US) which involve three subsystem tests for pedestrian protection (leg, thigh, and head impact tests). The primary goal of this study was to develop and validate a finite element model corresponding to a 95th percentile male (M95) anthropometry. This pedestrian FE model could be useful to evaluate injury biomechanics in lateral vehicle accident.

## METHODS

A M95 model was developed based on anthropometry of a subject (186.7 cm and 102.1 kg) which is close to the anthropometry of a 95th percentile male [2]. The mesh of FE model was obtained by morphing a linear scaled version of the 50th percentile male (M50) model to target geometry using a radial basis interpolation approach. The defined material properties of the model were based on the GHBMC M50 occupant model [3]. To validate the FE model at a component level, valgus bending and lateral blunt impact loadings were applied on the lower extremity and the upper body, respectively. Then, the whole body model was validated in a CPC scenario. The FE model responses were than compared to corresponding PMHS test data [4]–[7].

## RESULTS AND DISCUSSION

Overall, the model showed promising results and a good capability to predict the injury risk of pedestrian during lateral vehicle impact. Due to the lack of PMHS data for 95th percentile male anthropometry, the impact responses of the pedestrian model were compared to scaled test corridors corresponding to 50th percentile male. Therefore, the force time histories predicted by the FE model were usually close to the upper boundaries of test corridors (Fig 1. a). Similarly, the trajectory of M95 head center of gravity (CG), obtained from the CPC simulation, was close to the trajectories recorded on tall PMHS (Fig 1. b).

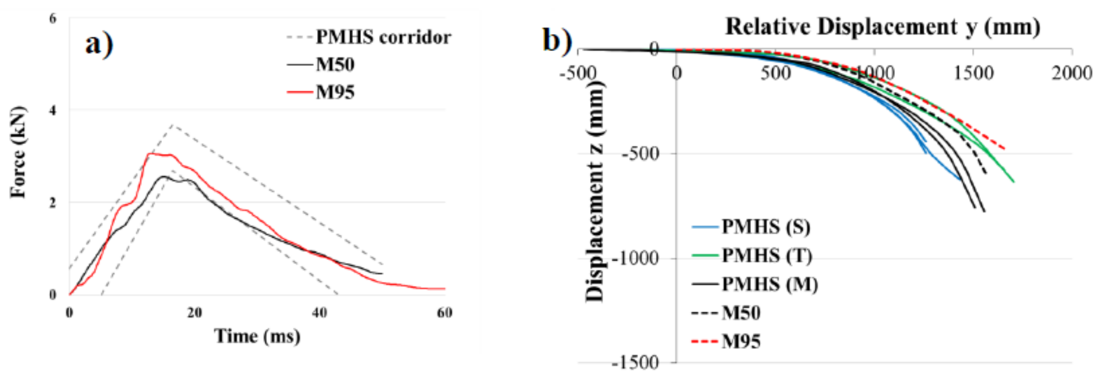


**Figure 1**. Comparison of FE model response against PMHS ($50^{th}$ percentile male) test data.
a) shoulder impact response at 4.5 m/s impactor initial velocity, b) head CG kinematic-marker trajectory relative to the vehicle

## CONCLUSIONS

A 95th percentile male pedestrian finite element model was developed and validated in this study. The model showed relatively accurate results against PMHS test data recorded in components and CPC tests. It is believed that the model could be used to investigate various pedestrian accidents and/or to improve safety regulations and vehicle front-end design for pedestrian protection.

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