

# BIOMECHANICAL DISCOMFORT FACTORS IN EGRESS OF OLDER DRIVERS

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## INTRODUCTION

In order to identify and quantify various biomechanical factors that affect discomfort in ingress/egress motions of older people, we performed an experimental study by employing eight healthy elderly volunteers. The ingress and egress motions in SUV mockup was captured by 12 infrared cameras for the kinematic analysis. An assistance device was designed to give some variations in the access motions. A bar-type handle was placed at the lower part of B-pillar to provide an additional support on the left arm of the driver at the early stage of the egress motion. The volunteers were normally free to choose their own ingress/egress strategies but were required to use assistant devices for the requested cases. In this paper, the results of the kinematic analysis using a digital human model with reconstructed egress motions are introduced. The joint angle changes of lower limbs showed statistical correlations with egress motion discomfort ratings.

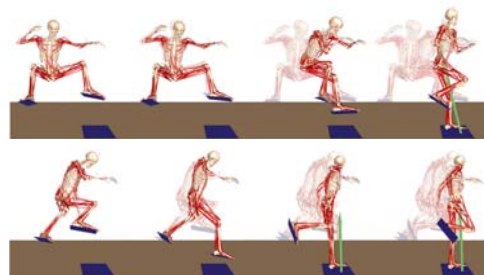
## METHODS

Healthy eight elderly male participants were recruited. The target size and age for this study was over 65 years. During the recruitment process, the subjects who had clinical histories were all excluded. The elementary capacities for balance maintaining and action of each subject were also evaluated through the five kinds of tests to verify their minimum required physical conditions.

Using a SUV mockup composed of sectioned quadrant driver side, each elderly subject was asked to try egress motions under two different scenarios; with and without using assist handle. Each egress tryout was repeated for three times. The egress motion was captured by motion analysis system consisting of twelve infrared cameras. The evaluation of subjective discomfort rating for each egress motion scenario was also simultaneously surveyed in modified Borg's CR-10 form.

The captured egress motions of elderly subjects from motion analysis system were reconstructed by using a muscular skeleton modeling software. Joint angle time histories of knee flexion, hip ad/abduction, hip flexion, and ankle dorsi/plantar flexion were computed from these reconstructed human models for each egress scenario. The portion of whole egress motion starting from outer leg crossing over the side sill till the inner leg passing over the side sill were extracted and normalized to make a time independent span of the motion. The tryout without using assist device shows more hip joint angle changes and wider scattering between trials than the one involving an assist handle. A representative reconstructed egress motion using muscular skeletal human model is also shown in Fig. 1. Based on the previous findings [1] that the discomfort feeling begins to sharply increase when the joint angle exceeds 75% of its maximum ROM from a neutral position, Joint-Stressfulness index is defined as the ratio of region

where the joint angle passes over 75% of the maximum ROM for each leg motion in the OLS-ILS span. These JS indices of each leg motion for different egress scenarios were statistically analyzed to determine if JS index has any significant correlation with discomfort ratings (significance level =0.05).



**Figure 1:** Reconstructed egress motions using muscular skeletal human model (top: with no assistant device, down: with assist handle)

## RESULTS AND DISCUSSION

There was a significant decrease in Joint-Stressfulness indices at lower limb joints by using assist handle compared to the case in which no assist device. The highest reduction rate of 65.4% in Joint-Stressfulness index occurred at the hip abduction. The reductions in knee flexion, hip flexion, and ankle flexion were 55.8%, 51.9%, and 24.6%, respectively. The correlation between subjective discomfort ratings and Joint-Stressfulness indices were also analyzed with linear regressions. The results show that only hip abduction has statistical significance.

## CONCLUSIONS

In this study, we attempted to identify and quantify biomechanical factors that affect motion discomfort of older people. Eight healthy elderly volunteers were recruited for egress tests on a SUV mockup equipped with assist device. Discomfort ratings corresponding to different cases were surveyed and their captured motions were also reconstructed for the kinematic analysis. Using an assist handle placed at a lower B-pillar, a noticeable improvement in discomfort feeling was formed due to the reduced amount of joint motions, especially in hip abduction. This outcome coincides with the D. Kee et al.'s [1] conclusion that the hip joint motion is most susceptible to the feeling of discomfort.

## ACKNOWLEDGEMENTS

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## REFERENCES

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