INTRODUCTION
To date very little is known about the loading during the static postures of deep squatting and kneeling. This is even though kneeling and deep squatting are common activities in daily living and are typical postures especially in social-cultural and religious contexts in Asia and the Middle East.

The goal of this study was to develop a biomechanical measurement and modeling approach suitable for the estimation of the tibiofemoral and patellofemoral joint forces arising during kneeling and squatting and to determine measurement and modeling approach suitable for the estimation of the tibiofemoral and patellofemoral joint forces arising during kneeling and squatting.

METHODS
A model of the lower limb in the sagittal plane consisting of the three segments, namely foot, shank, and thigh was configured for calculation of the knee joint forces arising during kneeling and squatting (Fig. 1). The anatomical data of the knee joint and its surrounding muscles and tendons were derived from anatomical models reported in literature [1,2].

Special issues that need to be considered in squatting and kneeling are the multiple points of ground contact during kneeling and the thigh-calf-contact at full knee flexion (Fig. 2). A 12-camera Vicon-system running at 100 Hz was coupled with two Kistler force plates (600 x 400 mm²), a pressure sensitive pad (250 x 120 mm², Paromed) attached at the dorsal surface of the thigh, and a 4-channel EMG system (sampling rate = 1 kHz).

Based on inverse dynamics and application of the reduction method, the compressive joint forces in the tibiofemoral and patellofemoral joints were computed. The surface EMG activity of the quadriceps muscle (%MVC) served as qualitative validation of the muscle force predictions.

Ten healthy males (age: 41.6 ± 11.3 yrs, body weight (BW): 79.5 ± 11.7 kg) agreed to be a part of this study. Each participant performed different tasks of deep squatting and kneeling. Additionally for comparative purposes, the movements of lowering and rising from these static positions were analyzed.

RESULTS
In squatting, kneeling, and deep kneeling, the maximum tibiofemoral compressive joint force achieved a mean range of 0.4 to 0.7 BW (Fig. 5, Table 1). The maximum patellofemoral joint forces ranged from 0.8 to 1.1 BW. The model predictions of the overall low knee joint loadings in the terminal static postures of kneeling and squatting were in agreement with the EMG recordings (Fig. 4).

CONCLUSIONS
The study’s outcome suggests that for the static postures at rest of squatting, kneeling, and deep kneeling, the compressive knee joint forces are substantially lower than has been suggested by earlier studies [3-5]. The results can be explained by the distribution of the body weight on multiple floor support points and the thigh-calf contact force at full knee flexion (Fig. 6).

REFERENCES