Aim
To collect new information for quantitative modeling of the posture and movement behavior used to grasp, hold and place work objects.

Background
• Computer models that depict human forms and compute biomechanical loads are important design tools. One of the limitations of these models as design tools is that they require users to either observe workers, or users to guess the necessary posture inputs. This work is part of an ongoing study to gather new knowledge and develop models for predicting postures;
• Previous studies show that postures are affected by comfort or effort. It can be shown that perceived effort is related to biomechanical factors, such as external joint load moments;
• Computation of moment requires knowledge of the spatial relationship between the location of load with respect to the joints;
• 3-D motion tracking is ideal for tracking the object and joint locations, and it can be used to compute joint moments for developing models.

Methods
• We used 3D motion tracking (an eight-camera Qualisys motion tracking system) to determine the spatial relationship between the upper limb joints and a work object as 10 healthy female college age subjects reached for, grasped, held and placed cylinders with four weights (3.3, 20.0, 36.7, and 53.3 N);
• Moment arms and quasi-static load moments were estimated for the wrist, elbow and shoulder for the grasp and hold postures and were used to compute relative load moments based on corresponding subject strengths for each posture.

Results
• Subjects demonstrated three basic behaviors for this task (Fig. 1);
• During holding, as weight increases, the frequencies of at shoulder or thigh height posture increase, while the ones for at elbow height postures (semi-pronated grip or underhand grip) decrease;
• When holding at elbow height, subjects extended their shoulder, which reduced the moment arm for the shoulder about 25%, but did not affect the moment arms of the elbow and wrist. When holding at shoulder or thigh height, the wrist, elbow, and shoulder moment arms were reduced 62%, 72%, and 70% respectively.

Conclusion
• These findings support previous work that shows we select postures that minimize the anticipated effort to perform a given task;
• The model (Fig. 2) predicts the probability of holding postures for these subjects and this task;
• The same arm posture in which they first gained control of the object is selected about 20% of the time for low load;
• The thresholds for holding at shoulder or thigh height 90% of the time is ≥ 30% of maximum wrist, elbow or shoulder strength;
• 3-D motion tracking is an important tool for developing posture prediction models.

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References