



## Development of normative data for cylindrical grasp pressure

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### ABSTRACT

Normative data of grasp strength (GS) are commonly used in working and clinical environments. Squeezing two parallel bars of a handgrip instrument is a common method to measure GS. These instruments require the use of hook grasp position which differentiates from the other types of power grasp in terms of inclusion of the thumb. Therefore, strength performance measured with these types of dynamometers cannot be generalizable to the other types of power grasp. Although several studies have been conducted to form normative data of hook and spherical grasp strengths, a satisfactory cylindrical grasp strength norm has not been reported yet. The measurement of grasp pressure (GP) is another way of establishing the grasping capabilities of the hand and the preferred method for fragile and weak hands. The purposes of the study were to develop normative data of cylindrical GP in a healthy population and to analyze the changes in the means according to physical demands of the subjects' jobs. 770 healthy subjects (382 females, 388 males) were found to be eligible to participate in the study. A custom-made adapted sphygmomanometer having a cylindrical air-filled bag was used to measure GP. Occupational categories of the subjects were determined based on the classification in the Dictionary of Occupational Titles. The subjects were accommodated to 12 age groups per gender of five-year intervals. The mean GP of the male subjects were higher than those of female subjects in each age group. There were significant differences between the dominant and non-dominant hands in both sexes. Subjects older than 70 years achieved the lowest values. The changes of the means over age were in compliance with the curvilinear function. Only age factor was found to be resulted in significant differences in GP means at both hands of the subjects. The minimum GP means were in the "sedentary" category at both sexes (F: 225, M: 315 mmHg in the dominant hands). Male subjects in the "very heavy" category produced the highest test means (M: 371 mmHg). Further analysis on 52 male subjects demonstrated that hand length, hand circumference and palm length had the highest correlations with GP scores in sequence.

*Relevance to industry:* Development of hand strength norms for a particular type of grasping is necessary for ergonomic evaluations and design purposes. By using this data, it is possible to estimate the relative load levels on a worker. Hand strength measurements are also important in determining the workers at risk and diagnosing some musculoskeletal problems.

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### 1. Introduction

In the field of ergonomics, hand force measurements are conducted to quantify the force exertion levels required for a specific job

(Koppelaar and Wells, 2005; Bao et al., 2009) and to establish maximum voluntary grasping effort of the hand. Determination of the maximum grasp strength (GS) can provide insight into the functional capabilities of the hand. The results of these measurements are used for diagnosis, determining the effectiveness of a given treatment, deciding on the suitability of a worker for a specific job, assessing a patient's ability to return to his/her work and providing guidelines for hand-tool design (Barrows, 1995; Stern, 1996; Ekşioğlu, 2004; Kong and Love, 2005; Tyler et al., 2005; Bao and Silverstein, 2005; Blair et al., 1987; Dewangan et al., 2010). It has also been demonstrated that GS is correlated with the overall upper-limb strength (Bohannon, 1998). The power grasp (PG) is predominantly used to measure GS. PG is a subcategory of prehensile

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