DO BIOMECHANISTS REPRESENT THE GENERAL POPULATION? AN INVESTIGATION OF SELECTION BIAS AND HAND FUNCTION

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Introduction: Biomechanical studies are highly susceptible to selection bias due to small study cohorts (n<30) [1]. In studies focusing on young adults, for example, it is common practice to include laboratory members and colleagues to ease subject recruitment burden. However, this recruiting practice can increase participant bias as a biomechanist's experience may influence their behavior due to *a priori* expectations [2]. An example of this would be a study focusing on running techniques that collected data primarily from biomechanists. In this case, biomechanists may subconsciously exaggerate their form in a manner that is not reflective of the population to favor a desired study outcome [3]. Unfortunately, data on recruitment methods and subject occupation are often not reported, so it is unknown how much of the literature has primarily been conducted on biomechanists and whether this practice leads to skewed results.

In this study, we evaluate if subject cohorts made primarily of biomechanists create skewed results by comparing the hand function of biomechanists to an age-matched population. Due to an understanding of common experimental techniques, we expect biomechanists will demonstrate increased hand function compared to naïve subjects. We specifically examined how the anthropometrics and hand strength of attendees at the 2022 North American Congress on Biomechanics (NACOB) compared to that collected from 15 different locations within our local community.

Table 1. Sample Size of Age Clusters from Mean Shift Clustering

Age Cluster	NACOB Population (Male/Female)	General Population (Male/Female)	Total (Male/Female)
18-39	167 (84/83)	262 (92/170)	429 (176/253)
40-62	3 (1/2)	35 (12/23)	38 (13/25)
63-73	0 (0/0)	48 (21/27)	48 (21/27)
74-95	22 (14/8)	31 (13/18)	53 (27/26)

Methods: To test for performance bias in the biomechanics community, we evaluated hand function from subjects (n=596) at 16 unique locations, including the 2022 North American Congress on Biomechanics (NACOB). Subjects participated in a 15-minute, IRB-approved survey, that consisted of demographics, the Michigan Hand Questionnaire [4], maximum grip and lateral pinch strength via dynamometry, and three five-second, maximum lateral pinch trials using a six-degree-of-freedom force sensor that records time-series data.

Given that hand strength is influenced by age, analyses were age stratified using mean shift clustering. The need for age stratification was confirmed with regression analysis ($p<0.001$). Importantly, use of the mean shift clustering algorithm reduced bias. As unlike k-means clustering, this algorithm does not require pre-defining the number of clusters to be identified [5]. As the majority (n=167) of NACOB participants fell within the 18- to 39-year-old cluster, initial analyses were limited to all subjects (n=429) within that age cluster (Table 1).

To determine if recruiting only biomechanists biases results, sex stratified comparisons were performed using a Mann-Whitney U comparison test. The need for sex stratification was confirmed with regression analysis ($p<0.001$). For each sex, we used a Mann-Whitney U comparison test to compare the distributions of nine metrics: height, weight, grip strength, lateral pinch strength, hand length, hand width, as well as the maximum, average, and standard deviation of the resultant 3D pinch force between NACOB attendees and the age-matched population.

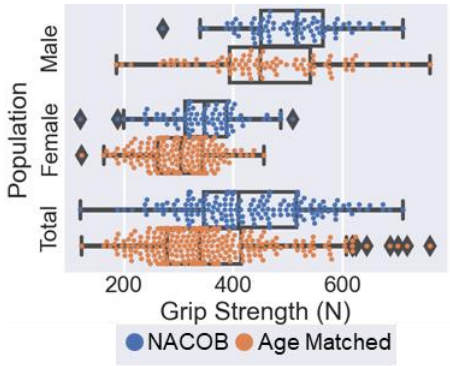

Figure 1: Comparison of grip strength when accounting for recruitment location and sex as biological variables. Male and female participant were found to significantly higher grip strength compared to age-matched non-biomechanists.

Results & Discussion: The NACOB cohort, which consisted of biomechanists, had skewed results for seven of the nine metrics. Specifically, population values for self-reported height, grip strength (Fig. 1), lateral pinch strength, hand length, and average resultant pinch force were significantly higher ($p<0.05$) for both male and female NACOB subjects as compared to age-matched individuals from our local community. Male participants at NACOB had grip and pinch strengths 11.1% and 5.9% above age-matched participants, respectively. Likewise, female NACOB participants had grip and pinch strengths that were 13.8 % and 8.0 % higher than the age-matched population. These findings agree with prior work that has shown subject's expertise can lead to altered performance [2], and that subjects who are biomechanists are often more athletic than the general population [3]. Thus, the increase in strength-based metrics may be a result of subject bias. However, whether this bias is due to biomechanists having more experience with directions, such as "squeeze as hard as you can", versus actual differences in physical strength is unknown.

Significance: These results indicate that findings from subject cohorts consisting primarily of biomechanists may represent skewed results compared to subject cohorts of naïve participants. This highlights the need to collect information on recruitment location and occupation as possible biological variables that should be controlled for in biomechanics research to increase generalizability.

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References: [1] Knudson (2011), *Percept. Mot. Skills* 112(3) [2] Stowell & Addison (2017), *APA* [3] Shorten et al. (2017) *ISBS Proceedings Archive*. 35(1) [4] Chung et al. (1998), *J Hand Surg Am.* 23(4) [5] Virupakshappa et al. (2019) *IEEE IUS*