Influence of Sex and Hand Anthropometrics on Cold-Induced Vasodilation, Dexterity, and Tactile Sensation

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Introduction

Cold-induced vasodilation (CIVD) is a phenomenon characterized by the dilation of peripheral blood vessels in the hands and feet during cold exposure. CIVD is variable where factors such as sex and hand/finger anthropometrics can influence the magnitude of the response. During cold stress, studies have shown lower skin temperature and skin blood flow in the fingers of females compared to males [1], however others have found no sex differences [2]. On average, females have a larger surface-to-mass ratio and longer/thinner fingers than males. A larger surface-to-mass ratio generates less heat because of the smaller body size and a greater surface area in the hands/fingers promotes greater heat loss due to conductive heat transfer. It is not known whether potential sex differences in CIVD are related to anthropometric differences or other physiological sex variances. Therefore, the purpose of the study is to investigate the influence of sex and hand/finger anthropometrics on CIVD, dexterity, and tactile sensation responses.

Methods

Thirty-nine participants (mean ± SD age: 24 ± 3 yr; height: 174 ± 28 cm; weight: 75.3 ± 15.2 kg; 20 males & 19 females) completed a 30-min finger immersion in cold water (0- 2°C) while indoors (22°C). Skin temperature was measured continuously on anterior pads of the 2nd – 4th digits (index, middle, ring, and pinky) to assess CIVD parameters (onset time, T_{min}, T_{max}, and T_{mean}). CIVD parameters for each finger were averaged over all fingers to establish a single indicator. The Purdue Pegboard Test (PPT) was conducted to measure finger dexterity (total # of pegs placed within 30 secs at baseline and immediately post-immersion). Tactile sensation was evaluated by touching Semmes Weinstein monofilaments on each fingertip. The weight of the monofilaments felt was quantified. T-tests were used to compare sex differences. When evaluating anthropometric differences, normality of data was assessed using the Kolmogorov–Smirnov test. Pearson correlations were used for parametric variables, such as dexterity scores. Significance was set at $P < 0.05$.

Results

CIVD, dexterity, and tactile sensation responses are shown in Table 1. Recovery peg gain (difference between pegs placed immediately after immersion and pegs placed after 10 min of spontaneous rewarming) was greater in males compared to females (Males: 4.6 ± 2.4 pegs; Females: 2.1 ± 3.9 pegs, P=0.02). A strong link between dexterity and tactile sensation was found where those with weaker tactile sensation lost more pegs than those with stronger tactile sensation (Weak: 6.1 ± 2.7 pegs; Strong: 8.2 ± 3.7 pegs, P=0.002). Correlation coefficients using the average of all 4 fingers to compare CIVD variables to body dimensions and hand/finger anthropometrics are shown in Table 2.

Table 1. Male and female CIVD parameters, dexterity, and tactile sensation responses. * Indicates significance set at $P \leq 0.05$

	Male	Female	p-value
CIVD Parameters			
*T_{min} (°C)**	5.7 ± 1.8	4.7 ± 1.2	*P* = 0.045
T_{mean} (°C)	8.6 ± 2.1	8.3 ± 2.2	*P* = 0.66
T_{max} (°C)	12.2 ± 2.8	7.2 ± 1.1	*P* = 0.61
Onset time (min)	10.9 ± 4.4	11.5 ± 2.8	*P* = 0.44
Tactile Sensation			
Baseline (grams)	0.09 ± 0.06	0.08 ± 0.04	*P* = 0.29
Post-Immersion (grams)	0.15 ± 0.04	0.14 ± 0.07	*P* = 0.53
Dexterity			
*Baseline (pegs) **	16.6 ± 2	18.3 ± 1.4	*P* = 0.005
*Post-Immersion (pegs) **	9.9 ± 3	12.1 ± 3	*P* = 0.03

Table 2. Correlations using the average of all 4 fingers to compare CIVD variables (left column) to body dimensions and hand/finger anthropometrics (n= 39). BSA = body surface area, SM= surface-to-mass ratio, RFL= relative finger length, RFW= relative finger width. Bold indicates significance set at $P \leq 0.05$

Variable	BSA (unit)	SM (m^2/kg)	RFL (unit)	RFW (unit)	Wt (kg)
T_{min}	0.20	-0.18	0.10	-0.18	0.17
T_{max}	0.30	**-0.39**	0.30	**-0.37**	**0.35**
Onset time	-0.07	0.19	-0.20	-0.01	-0.13
T_{mean}	0.20	**-0.32**	0.30	-0.21	0.25

Conclusions

Findings suggest that there were no CIVD differences between males and females, except for T_{min}. However, those with a larger surface-to-mass ratio, displayed a poorer CIVD response, illustrated by lower T_{max} and T_{mean}. Individuals with a weaker tactile sensation tend to exhibit compromised manual dexterity suggesting the sensory feedback provided by tactile sensation plays a crucial role in maintaining optimal motor function, particularly in cold conditions where sensory input may be attenuated. It appears that surface-to-mass ratio plays a larger role in CIVD responses compared to sex as the sole contributor.

References

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