



Effects of Air Velocity on the Thermal Insulation of Padded Winter Jackets

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Introduction

- Recently, lighter and warmer insulation materials for winter clothing have been developed. The thermal insulation of padded jackets per weight was 1.6 times higher than that of woolen jackets(Kim et al., 2018).
- Padded winter jackets made from various light insulating materials have been popular in Korea because of their lightness. Further, full-length padded jacket made from light materials have become popular among young Koreans(Kim et al., 2019).
- However, there is little information concerning the effects of air velocity on the thermal insulation of padded winter jackets of various lengths and filling materials.

Purpose

This study quantified the thermal insulation of commercially-available padded winter jackets under various air velocity condition in order to provide guideline for customers to select padded winter jackets in Korea

Methods

1. Padded jackets

- A total of 36 commercial padded winter jackets were selected.
 - filling materials : duck down(9 jackets), goose down(13 jackets), synthetic(polyester 100%, 12 jackets), & combination of goose down and polyester(2 jackets)
 - length of padded jackets : 66 – 113 cm
 - weight of padded jackets: 279-1,570 g



Fig. 1 Types of padded winter jackets for this experiments

2. Experimental procedures and measurements

- Thermal manikin: Newton, Thermometrics, USA
- Test Method: based on ISO 9920 (2007)
- Tsk of thermal manikin: 34°C
- Ta: 20±0.2°C, Ha: 50±0.5%RH
- Three Va(air velocity): below 0.1, 1.5, and 3.5 m·s⁻¹

4. Data analysis

- All experiments were repeated three times.
- I_{clu} : the average of 3 repeated measured value
- Repeated ANOVA for the thermal insulation of padded jackets by filling types and three different air velocities ($P < 0.05$)

Results

1. Effects of air velocity on the thermal insulation (I_{clu})

1-1. Thermal insulation(I_{clu}) under air velocity

- The stronger the air velocity, the greater the decrease in I_{clu}
: 0.64 ± 0.05 clo (>0.1 m·s⁻¹), 0.34 ± 0.03 clo (1.5 m·s⁻¹) & 0.31 ± 0.03 clo (3.5 m·s⁻¹)
- Polyester showed highest I_{clu} at ISO 9920(2007) and lowest I_{clu} at 3.5 m·s⁻¹
- Decreasing rates at 1.5 m·s⁻¹ vs. > 0.1 m·s⁻¹
: total (48%), polyester(52%), goose(47%) & duck (43%)
- Decreasing rates at 3.5 m·s⁻¹ vs. > 0.1 m·s⁻¹
: total (53%), polyester(65%), goose(47%) & duck (44%)

Table 1 Thermal insulation of padded jackets by air velocities and filling types

Filling types	Air velocity (m·s ⁻¹ , Mean ± S.E.)			P-value
	Below 0.1	1.5	3.5	
Duck down (N=9)	0.67 ± 0.10 ^b	0.39 ± 0.07 ^a	0.38 ± 0.06 ^a	0.001
Goose down (N=13)	0.59 ± 0.05 ^b	0.32 ± 0.04 ^a	0.32 ± 0.04 ^a	0.001
Polyester (N=12)	0.74 ± 0.12 ^c	0.35 ± 0.06 ^b	0.27 ± 0.05 ^a	0.001
Goose down & Polyester (N=2)	0.32 ± 0.07	0.16 ± 0.03	0.13 ± 0.03	-
Total (N=36)	0.64 ± 0.05 ^b	0.34 ± 0.03 ^a	0.32 ± 0.03 ^a	0.001

2. Filling materials

- No significant differences at 1.5 m·s⁻¹
: duck (0.39 clo), polyester(0.35 clo), goose(0.32 clo)
- Significant differences at below 0.1 m·s⁻¹ ($P > 0.001$) & at 3.5 m·s⁻¹ ($P = 0.05$)

3. Correlation with garment length and garment weight (Fig. 2)

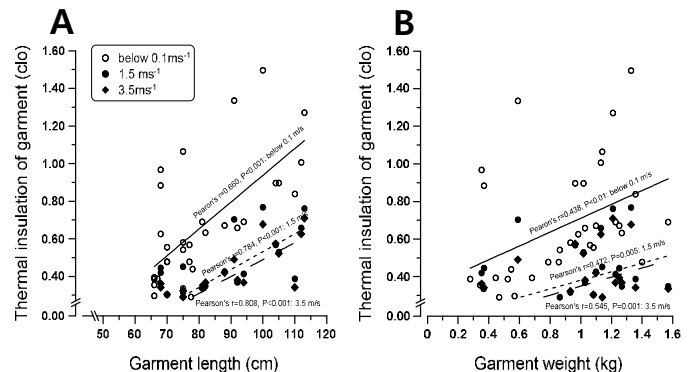


Fig. 2 Correlation analysis between the thermal insulation and the garment length (A) and the thermal insulation and the garment weight (B)

Conclusions

The stronger air velocity, the greater the decrease in thermal insulation of clothing. Thermal insulation of padded winter jackets was influenced by the filling materials when air velocity was high. Especially, the newly developed polyester filling materials for padded jackets showed more sensitivity the strength of air velocity so that caution is needed under air velocity condition.

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