PART A: Ergonomics investigation into thermal comfort

1) Data Processing

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Participant	Gender	Thermal	Age	Weight	Height	Overall	Hands	Feet	Preference	Lab_Acceptable	Satisfied	Home_Acceptable	Office_Acceptable	Distraction	Prediction
2	A	0	1	251	63	1.76	1.4	1.3	2.5	-1	1	1	1	0	3	1
3	B	0	1	238	59	1.77	2.4	2.3	2.3	-1	0	0	0	0	2	1
4	C	0	1	256	76	1.85	1.8	2.0	2.0	0	1	1	1	1	1	1
5	D	0	1	252	78	1.76	1.7	1.7	1.7	-1	0	0	0	0	3	1
6	E	1	1	247	57	1.57	1.0	1.0	2.0	0	1	1	0	0	3	1
7	F	1	1	243	70	1.75	1.5	0.0	1.7	0	1	1	1	0	2	1
8	G	1	1	244	54	1.63	0.0	-0.8	0.8	0	1	1	1	1	1	0
9	H	1	1	240	73	1.63	1.0	0.0	3.0	-1	0	1	0	0	2	1
10	I	0	0	235	66	1.75	0.1	0.2	-1.0	0	1	1	0	1	2	0
11	J	0	0	242	83	1.80	-2.3	-1.9	-1.8	1	0	0	0	0	3	1
12	K	0	0	252	78	1.76	1.8	1.7	1.7	0	1	1	1	1	1	1
13	L	0	0	238	59	1.77	1.5	1.4	1.4	0	1	1	1	1	1	0
14	M	1	0	247	57	1.57	-2.0	-2.1	-2.1	1	0	0	0	0	2	1
15	N	1	0	239	78	1.74	-2.2	-2.3	0.4	1	1	1	0	0	3	1
16	O	1	0	244	54	1.63	-2.6	-3.0	-1.9	1	0	0	0	0	4	0
17	P	1	0	243	70	1.75	-0.1	-0.1	0.0	0	1	1	1	1	1	0
18	Q	0	-1	242	83	1.80	-3.0	-3.0	-3.0	1	0	0	0	0	4	1
19	R	0	-1	249	72	1.73	-3.0	-3.0	-3.0	1	0	0	0	0	4	1
20	S	0	-1	251	63	1.76	-2.2	-3.0	-0.3	1	0	0	0	0	4	1
21	T	0	-1	238	59	1.77	-2.9	-3.0	-3.0	1	0	0	0	0	4	1
22	U	1	-1	247	57	1.57	-3.0	-2.9	-2.9	1	0	0	0	0	4	1
23	V	1	-1	239	78	1.74	-2.6	-2.6	-0.7	1	0	0	0	0	3	1
24	W	1	-1	245	60	1.63	-2.6	-3.0	0.9	1	0	0	0	0	4	1
25	X	1	-1	240	73	1.63	-3.0	-3.0	0.0	1	0	0	0	0	3	1

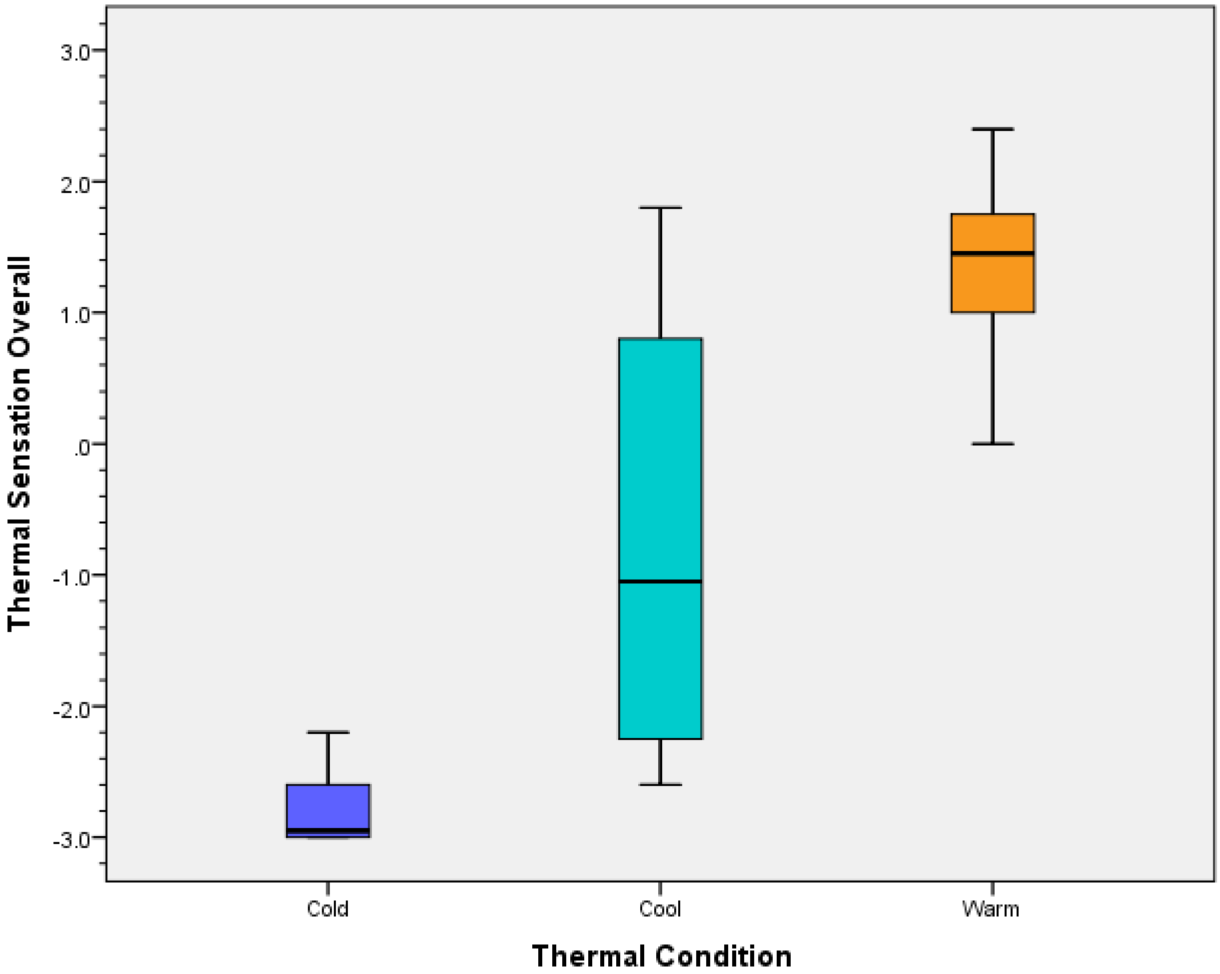
	Participant	Gender	Thermal	Age	Weight	Height	Overall	Hands	Feet	Preference	Lab_Acceptable	Satisfied	Home_Acceptable	Office_Acceptable	Distraction	Prediction
1	A	0	1	251	63	1.76	1.4	1.3	2.5	-1	1	1	1	0	3	1
2	B	0	1	238	59	1.77	2.4	2.3	2.3	-1	0	0	0	0	2	1
3	C	0	1	256	76	1.85	1.8	2.0	2.0	0	1	1	1	1	1	1
4	D	0	1	252	78	1.76	1.7	1.7	1.7	-1	0	0	0	0	3	1
5	E	1	1	247	57	1.57	1.0	1.0	2.0	0	1	1	0	0	3	1
6	F	1	1	243	70	1.75	1.5	.0	1.7	0	1	1	1	0	2	1
7	G	1	1	244	54	1.63	.0	-.8	.8	0	1	1	1	1	1	0
8	H	1	1	240	73	1.63	1.0	.0	3.0	-1	0	1	0	0	2	1
9	I	0	0	235	66	1.75	.1	.2	-1.0	0	1	1	0	1	2	0
10	J	0	0	242	83	1.80	-2.3	-1.9	-1.8	1	0	0	0	0	3	1
11	K	0	0	252	78	1.76	1.8	1.7	1.7	0	1	1	1	1	1	1
12	L	0	0	238	59	1.77	1.5	1.4	1.4	0	1	1	1	1	1	0
13	M	1	0	247	57	1.57	-2.0	-2.1	-2.1	1	0	0	0	0	2	1
14	N	1	0	239	78	1.74	-2.2	-2.3	.4	1	1	1	0	0	3	1
15	O	1	0	244	54	1.63	-2.6	-3.0	-1.9	1	0	0	0	0	4	0
16	P	1	0	243	70	1.75	-.1	-.1	.0	0	1	1	1	1	1	0
17	Q	0	-1	242	83	1.80	-3.0	-3.0	-3.0	1	0	0	0	0	4	1
18	R	0	-1	249	72	1.73	-3.0	-3.0	-3.0	1	0	0	0	0	4	1
19	S	0	-1	251	63	1.76	-2.2	-3.0	-.3	1	0	0	0	0	4	1
20	T	0	-1	238	59	1.77	-2.9	-3.0	-3.0	1	0	0	0	0	4	1
21	U	1	-1	247	57	1.57	-3.0	-2.9	-2.9	1	0	0	0	0	4	1
22	V	1	-1	239	78	1.74	-2.6	-2.6	-.7	1	0	0	0	0	3	1
23	W	1	-1	245	60	1.63	-2.6	-3.0	.9	1	0	0	0	0	4	1
24	X	1	-1	240	73	1.63	-3.0	-3.0	.0	1	0	0	0	0	3	1

	Participant	Gender	Thermal	Age	Weight	Height	Overall	Hands	Feet	Preference	Lab_Acceptable	Satisfied	Home_Acceptable	Office_Acceptable	Distraction	Prediction
1	A	M	Warm	251	63	1.76	1.4	1.3	2.5	Cooler	Yes	Yes	Yes	No	Distracting	Yes
2	B	M	Warm	238	59	1.77	2.4	2.3	2.3	Cooler	No	No	No	No	Slightly Distracting	Yes
3	C	M	Warm	256	76	1.85	1.8	2.0	2.0	No change	Yes	Yes	Yes	Yes	Not Distracting	Yes
4	D	M	Warm	252	78	1.76	1.7	1.7	1.7	Cooler	No	No	No	No	Distracting	Yes
5	E	F	Warm	247	57	1.57	1.0	1.0	2.0	No change	Yes	Yes	No	No	Distracting	Yes
6	F	F	Warm	243	70	1.75	1.5	.0	1.7	No change	Yes	Yes	Yes	No	Slightly Distracting	Yes
7	G	F	Warm	244	54	1.63	.0	-.8	.8	No change	Yes	Yes	Yes	Yes	Not Distracting	No
8	H	F	Warm	240	73	1.63	1.0	.0	3.0	Cooler	No	Yes	No	No	Slightly Distracting	Yes
9	I	M	Cool	235	66	1.75	.1	.2	-1.0	No change	Yes	Yes	No	Yes	Slightly Distracting	No
10	J	M	Cool	242	83	1.80	-2.3	-1.9	-1.8	Warmer	No	No	No	No	Distracting	Yes
11	K	M	Cool	252	78	1.76	1.8	1.7	1.7	No change	Yes	Yes	Yes	Yes	Not Distracting	Yes
12	L	M	Cool	238	59	1.77	1.5	1.4	1.4	No change	Yes	Yes	Yes	Yes	Not Distracting	No
13	M	F	Cool	247	57	1.57	-2.0	-2.1	-2.1	Warmer	No	No	No	No	Slightly Distracting	Yes
14	N	F	Cool	239	78	1.74	-2.2	-2.3	.4	Warmer	Yes	Yes	No	No	Distracting	Yes
15	O	F	Cool	244	54	1.63	-2.6	-3.0	-1.9	Warmer	No	No	No	No	Very Distracting	No
16	P	F	Cool	243	70	1.75	-.1	-.1	.0	No change	Yes	Yes	Yes	Yes	Not Distracting	No
17	Q	M	Cold	242	83	1.80	-3.0	-3.0	-3.0	Warmer	No	No	No	No	Very Distracting	Yes
18	R	M	Cold	249	72	1.73	-3.0	-3.0	-3.0	Warmer	No	No	No	No	Very Distracting	Yes
19	S	M	Cold	251	63	1.76	-2.2	-3.0	-.3	Warmer	No	No	No	No	Very Distracting	Yes
20	T	M	Cold	238	59	1.77	-2.9	-3.0	-3.0	Warmer	No	No	No	No	Very Distracting	Yes
21	U	F	Cold	247	57	1.57	-3.0	-2.9	-2.9	Warmer	No	No	No	No	Very Distracting	Yes
22	V	F	Cold	239	78	1.74	-2.6	-2.6	-.7	Warmer	No	No	No	No	Distracting	Yes
23	W	F	Cold	245	60	1.63	-2.6	-3.0	.9	Warmer	No	No	No	No	Very Distracting	Yes
24	X	F	Cold	240	73	1.63	-3.0	-3.0	.0	Warmer	No	No	No	No	Distracting	Yes

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Participant	String	1	0	Participant ID	None	None	7	Left	Nominal	Input
2	Gender	Numeric	8	0	Participant Gender	{0, M}...	None	4	Right	Nominal	Input
3	Thermal	Numeric	8	0	Thermal Condition	{-1, Cold}...	None	5	Right	Nominal	Input
4	Age	Numeric	8	0	Age (months)	None	None	3	Right	Scale	Input
5	Weight	Numeric	8	0	Weight (Kg)	None	None	5	Right	Scale	Input
6	Height	Numeric	8	2	Height (m)	None	None	4	Right	Scale	Input
7	Overall	Numeric	8	1	Thermal Sensation Overall	None	None	4	Right	Scale	Input
8	Hands	Numeric	8	1	Thermal Sensation Hands	None	None	4	Right	Scale	Input
9	Feet	Numeric	8	1	Thermal Sensation Feet	None	None	3	Right	Scale	Input
10	Preference	Numeric	8	0	Preferred change in temperature	{-1, Cooler}...	None	7	Right	Nominal	Input
11	Lab_Acceptable	Numeric	8	0	Acceptable thermal environment for lab	{0, No}...	None	10	Right	Nominal	Input
12	Satisfied	Numeric	8	0	Satisfied with thermal environment	{0, No}...	None	5	Right	Nominal	Input
13	Home_Acceptable	Numeric	8	0	Acceptable thermal environment for home	{0, No}...	None	12	Right	Nominal	Input
14	Office_Acceptable	Numeric	8	0	Acceptable thermal environment for office	{0, No}...	None	12	Right	Nominal	Input
15	Distraction	Numeric	8	0	Level of distraction from thermal environment	{1, Not Distracting}...	None	12	Right	Ordinal	Input
16	Prediction	Numeric	8	0	Reasonable prediction	{0, No}...	None	8	Right	Nominal	Input

2) Data presentation using graphs

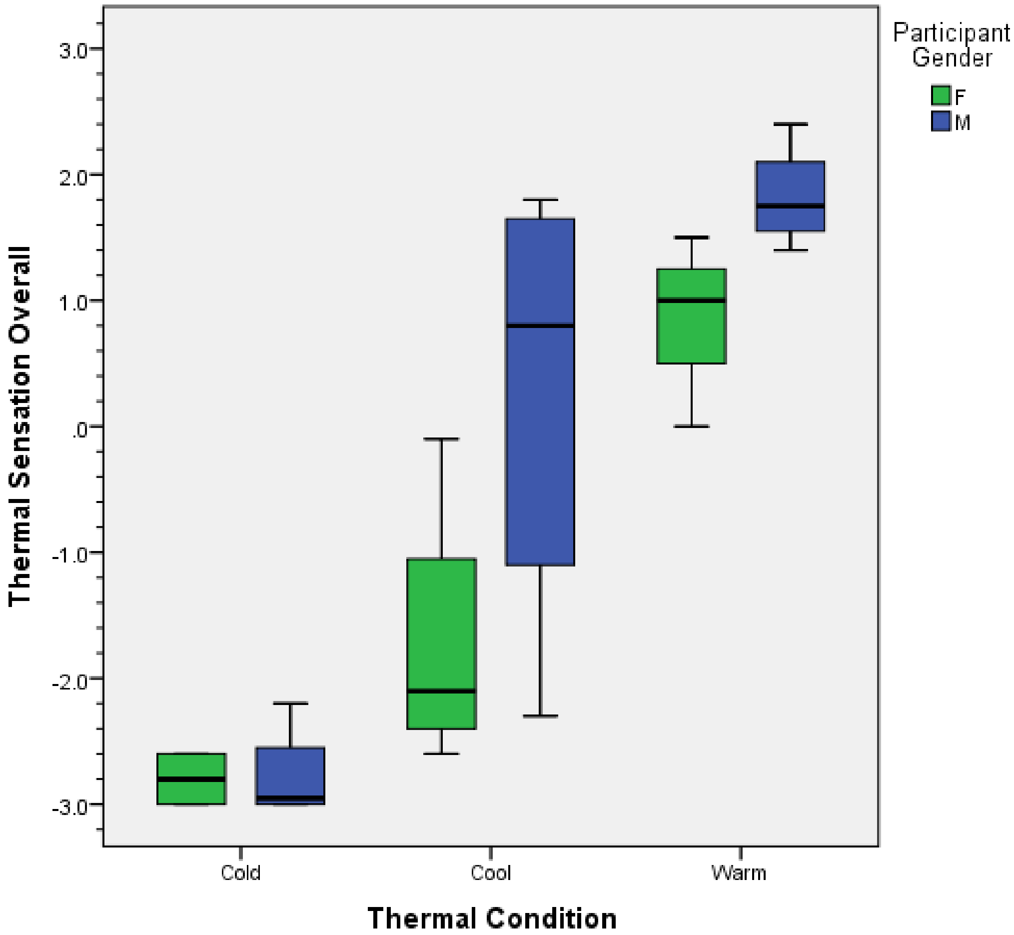
i) Box Plots showing overall thermal sensation in all thermal conditions



As expected, the medians suggest that the warmer the thermal condition, the higher the overall thermal sensation (OTS).

There appears to be a lot more variability in Cool conditions than either Cold or Warm, with OTS over a much larger range and inter-quartile range.

ii) Box Plots showing overall thermal sensation in thermal conditions by gender



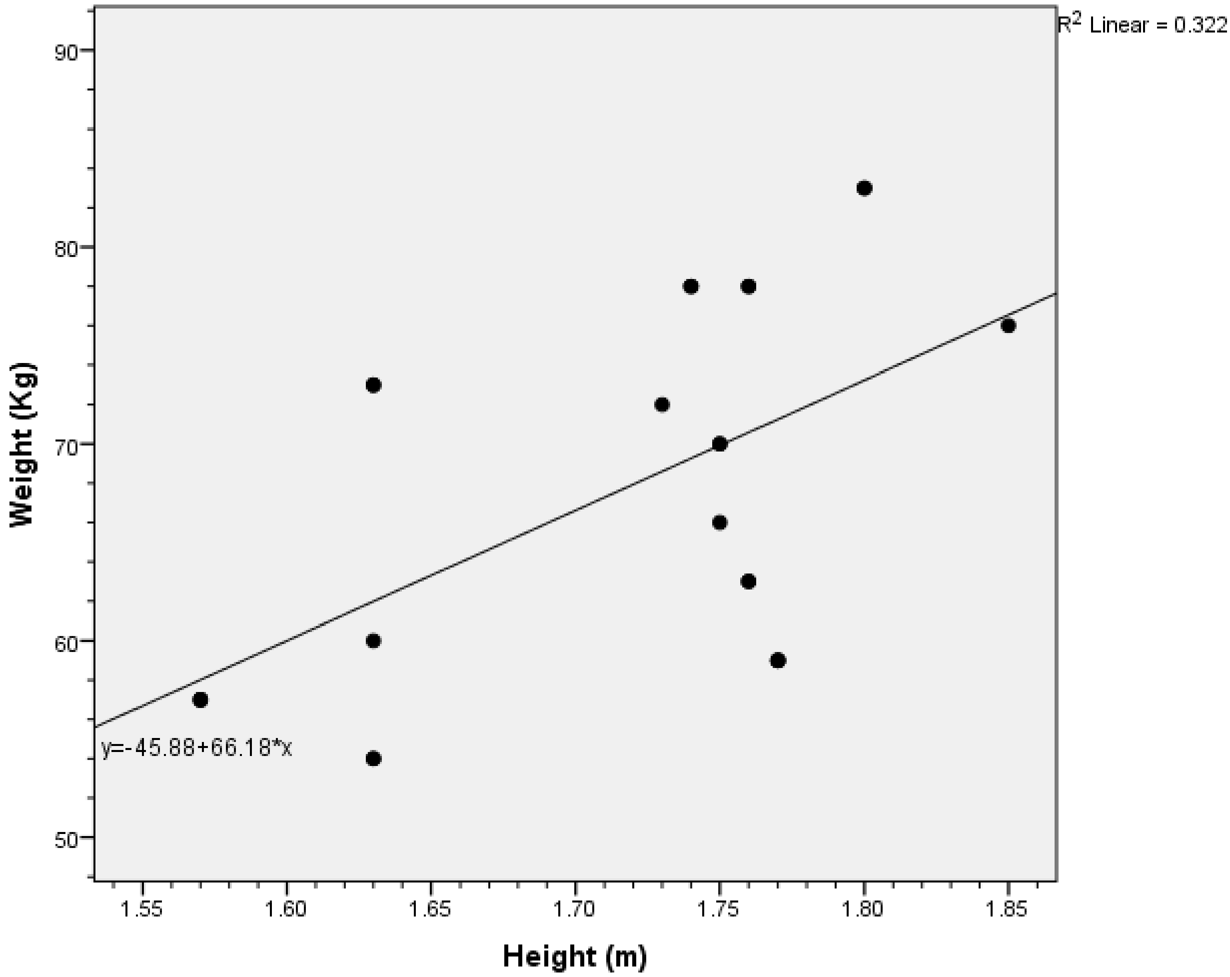
The median OTS is lower for female participants for both Cool and Warm conditions.

There is a larger range of male responses than female in Cool.

For the cold condition, all participants appear to have exhibited similar OTS.

Males appear to have both higher and more variable OTS.

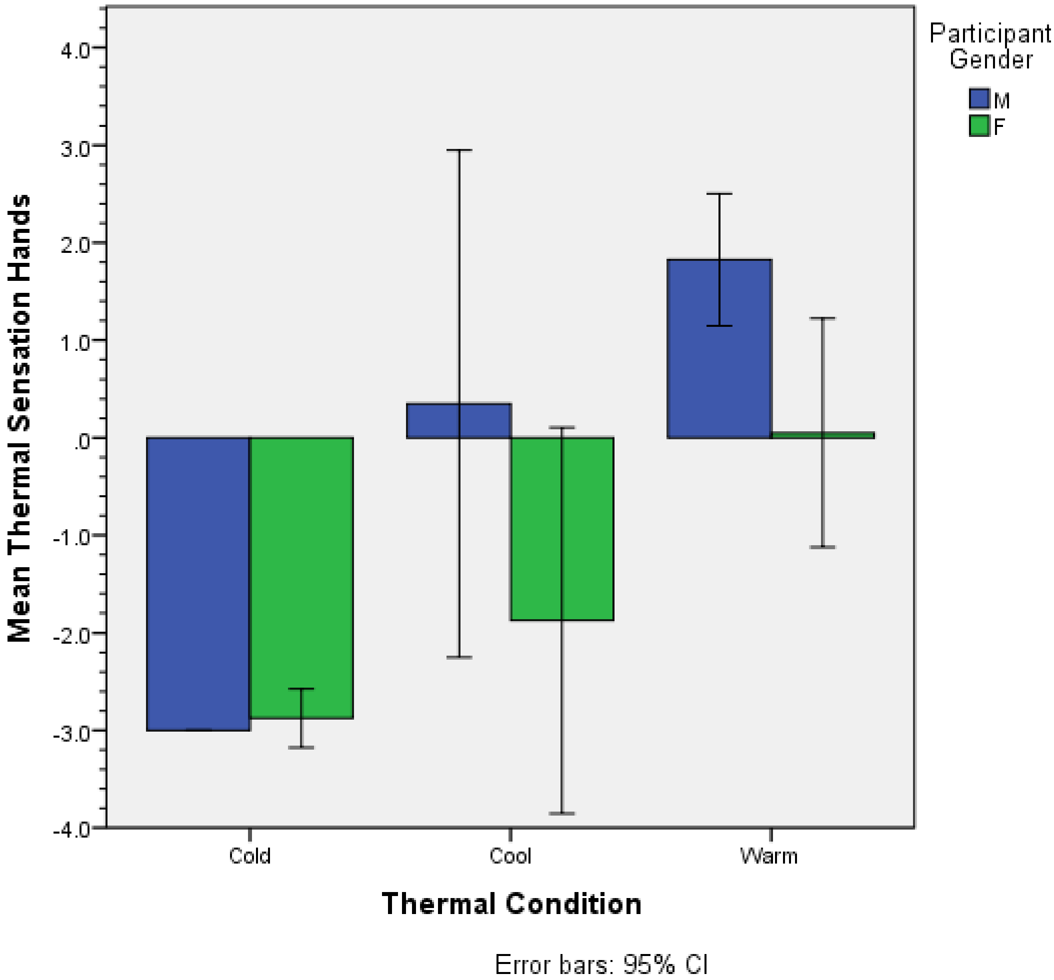
iii) Scatter plot showing relationship between height and weight



There appears to be a positive correlation between weight and height – the taller someone is, the more likely they are to weigh more.

R^2 = .322, thus 32.2% of the variance in weight can be accounted for by the height (and vice versa).

iv) Bar chart showing the thermal sensation of hands in thermal conditions by gender

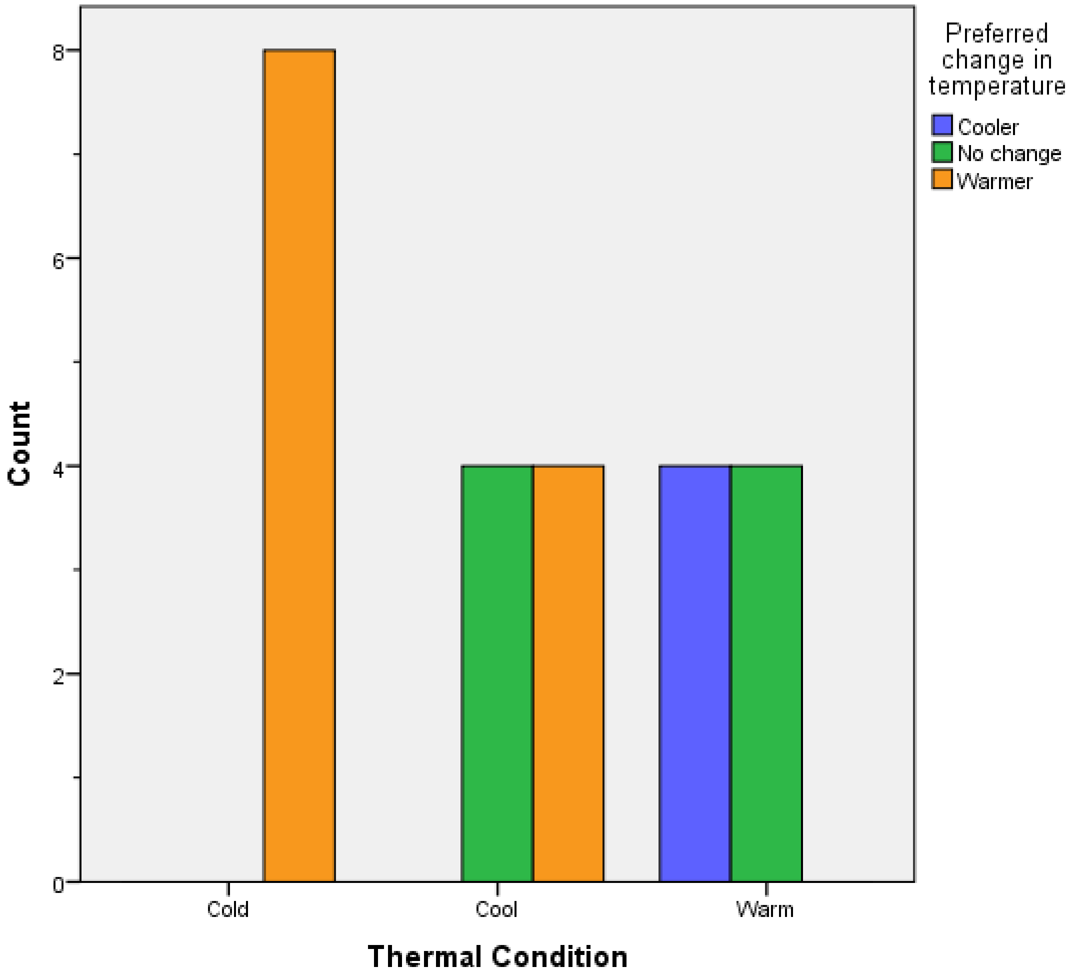


There is minimal difference in thermal sensation of hands (HTS) between genders in Cold.

The mean HTS was greater for males in Cool and Warm

Very large confidence interval for Cool, and not small for Warm – the population value is less precisely estimated.

v) Bar chart showing preferred change in temperature for thermal conditions



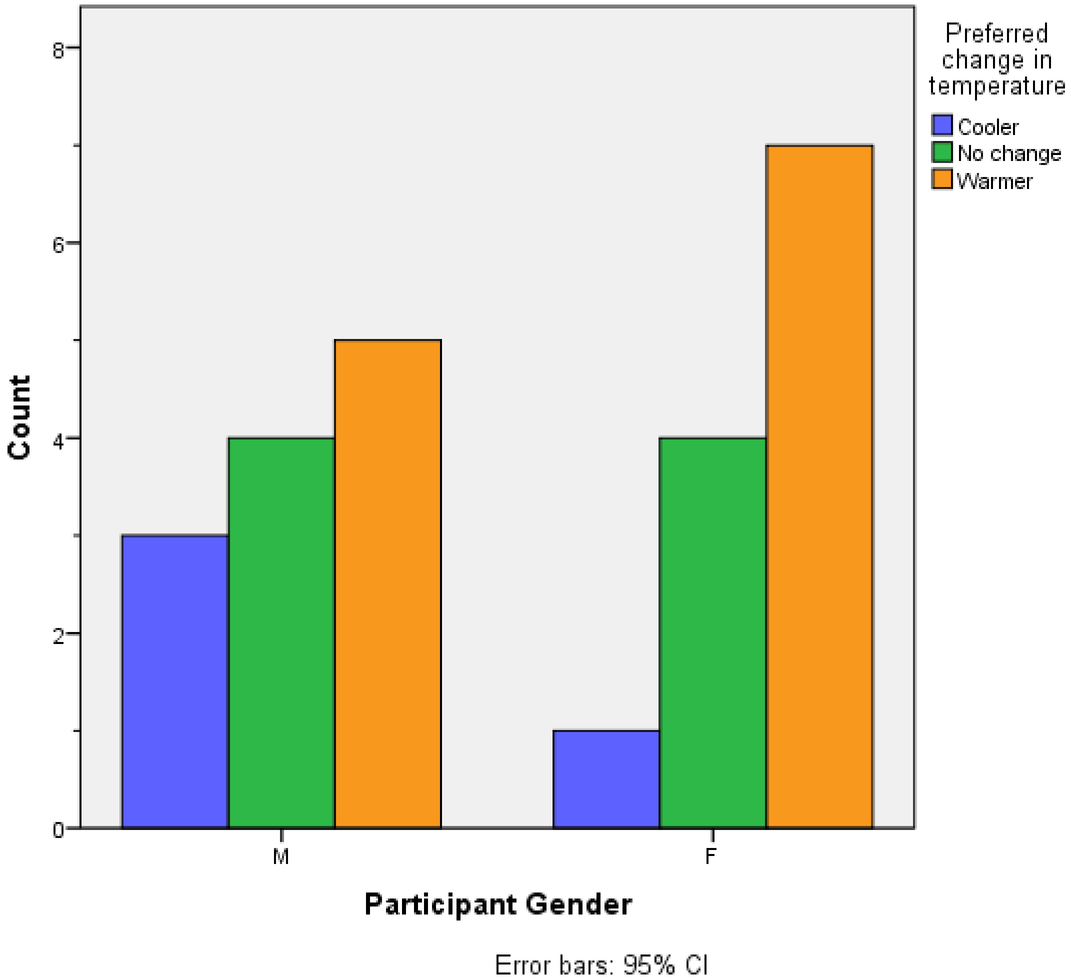
All in Cold would prefer a warmer environment.

Half in Cool (4/8) preferred warmer, half no change.

Half in Warm preferred cooler, half no change.

The ideal temperature for the most people would most likely be between the temperatures of Cool and Warm.

vi) Bar chart showing preferred change in temperature by gender



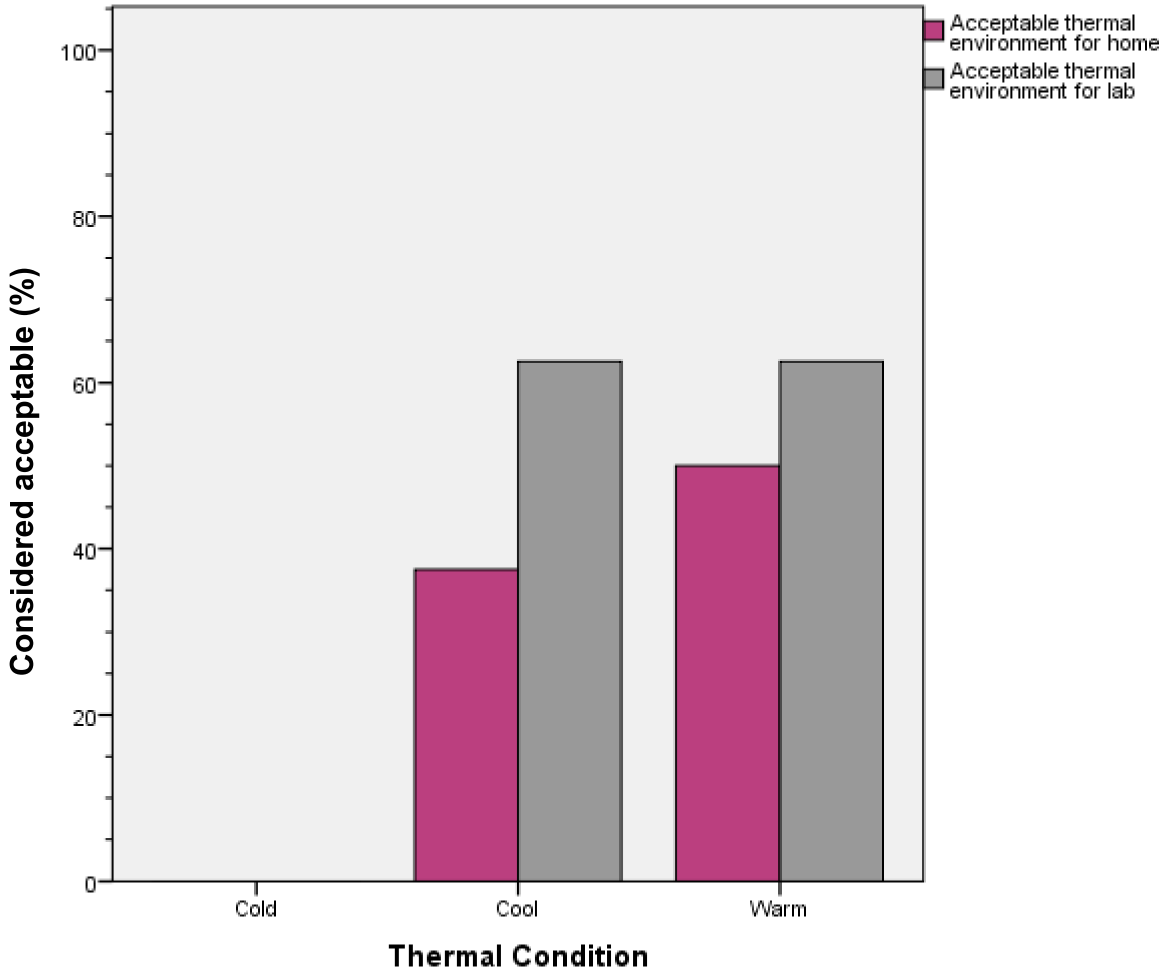
Males were more evenly split in their preferred change. More men would prefer a cooler environment

On only 1 occasion a female would prefer cooler, whereas many preferred a warmer environment.

Equivalent numbers would like no change.

Women tend to prefer warmer environments, whereas some men prefer them cooler.

vii) Bar chart showing opinion on which thermal environments would be acceptable for home and in the lab

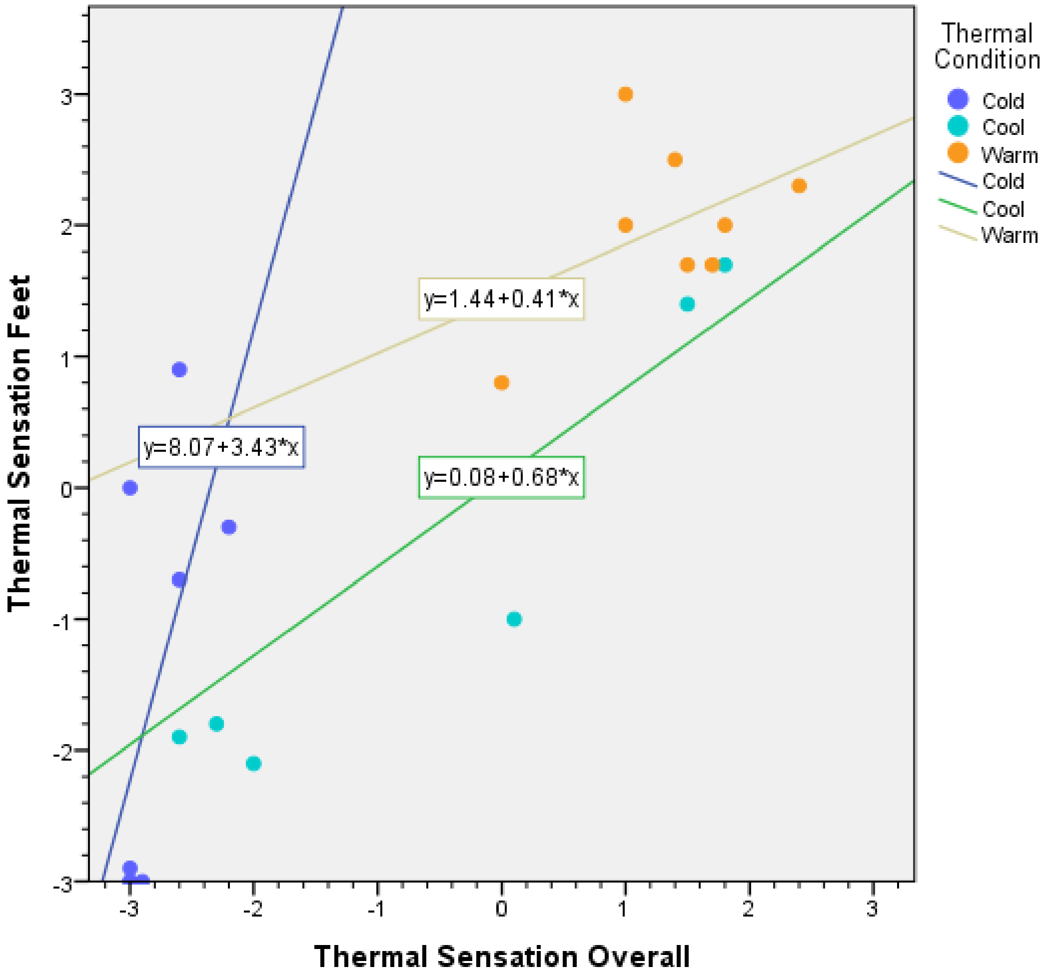


Nobody found the Cold condition acceptable for either environment.

A greater percentage of participants found the thermal environment acceptable in the lab compared to how they predicted they would feel at home

People more tolerant of uncomfortable thermal conditions that are too cool in laboratory setting.

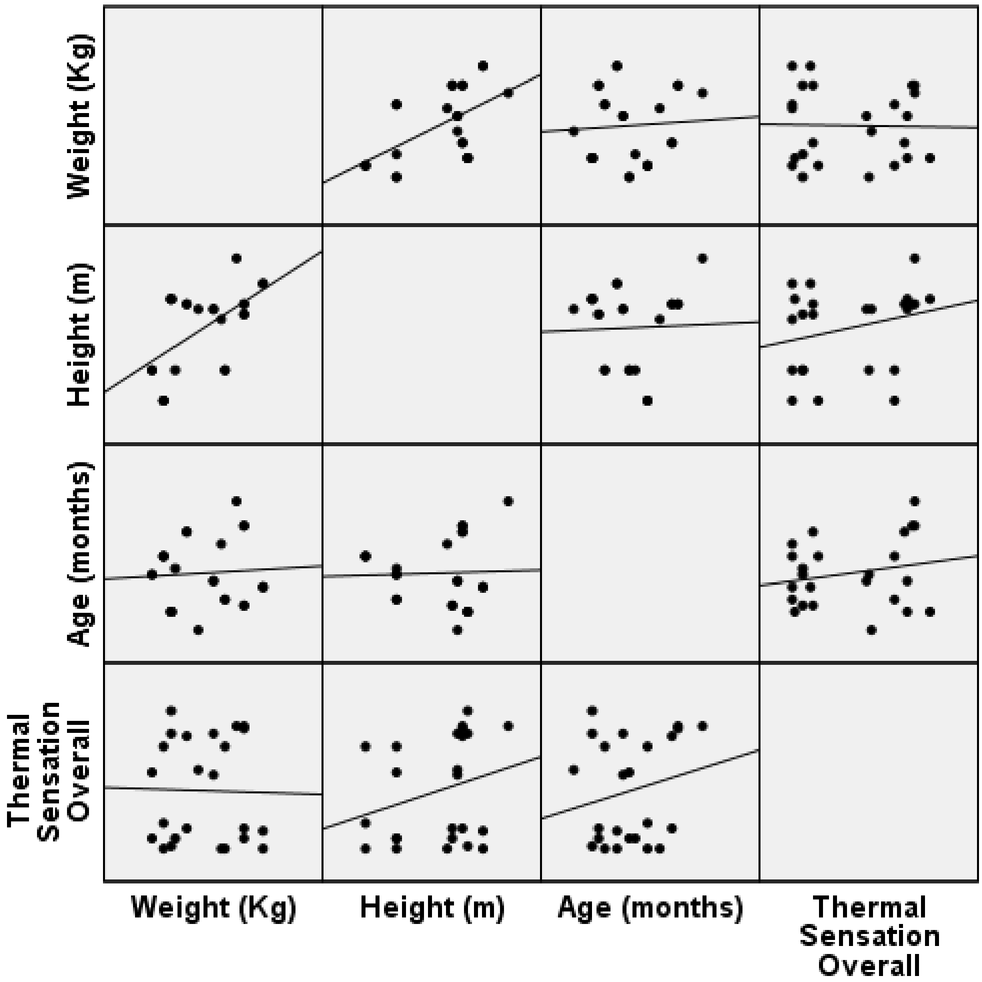
viii) Scatterplot showing the relationship between thermal sensation overall and thermal sensation in the feet grouped by thermal condition



All relationships appear to be positive – the higher the thermal sensation overall, the higher the feet thermal sensation (FTS).

Although no causality has been demonstrated, it seems as though when the overall body is colder, smaller changes have to be made to the overall temperature to drastically affect foot temperature.

ix) Scatterplot matrix showing relationships between height, weight, age and overall thermal sensation



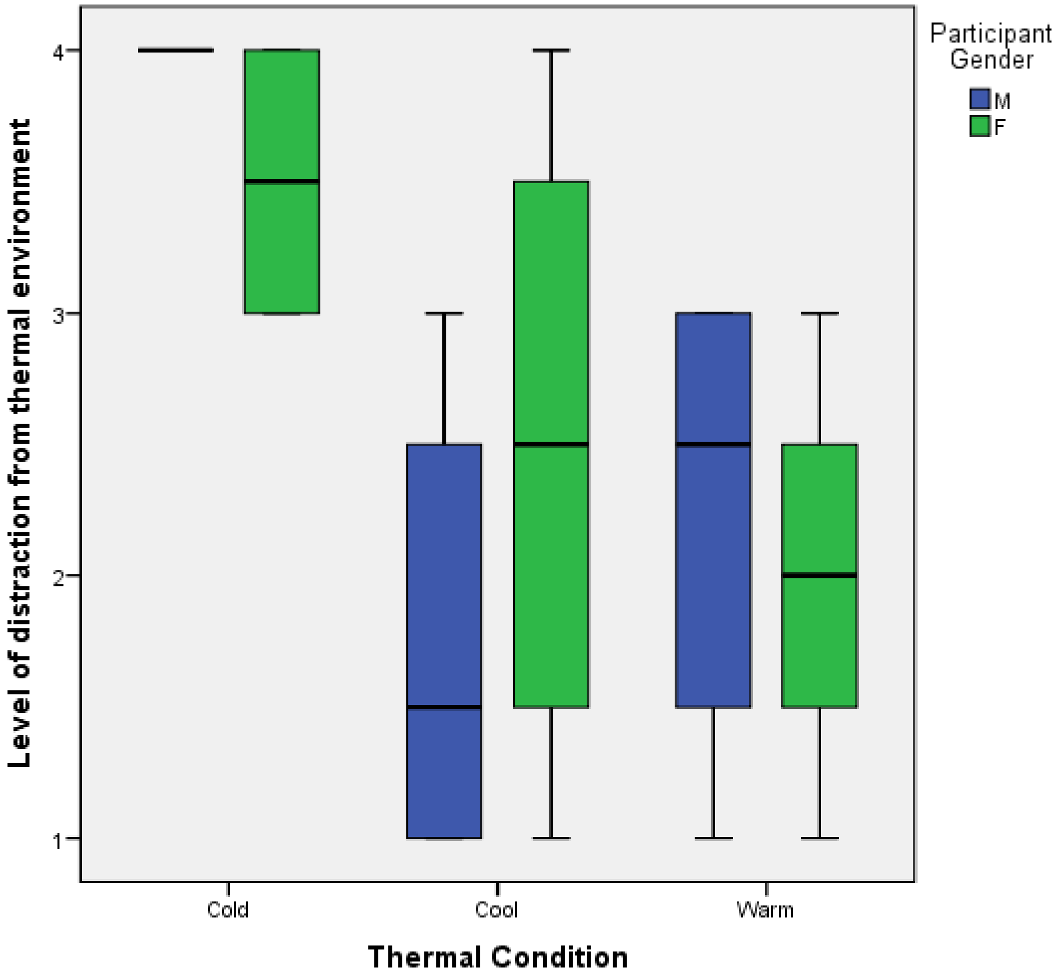
Height and age appear to correlate positively with OTS – the older or taller the participant, the warmer they felt.

Weight appears to have either no/ a slightly negative correlation with OTS.

Height and weight are again positively correlated.

Height and weight have no/a slightly positive correlation with age.

x) Box plots showing distraction level in thermal conditions by gender



The males all found Cold very distracting, whereas the median female found it between distracting and very distracting.

The median female was more distracted than the median male in Cool. Females spanned the full range of distraction levels in this condition.

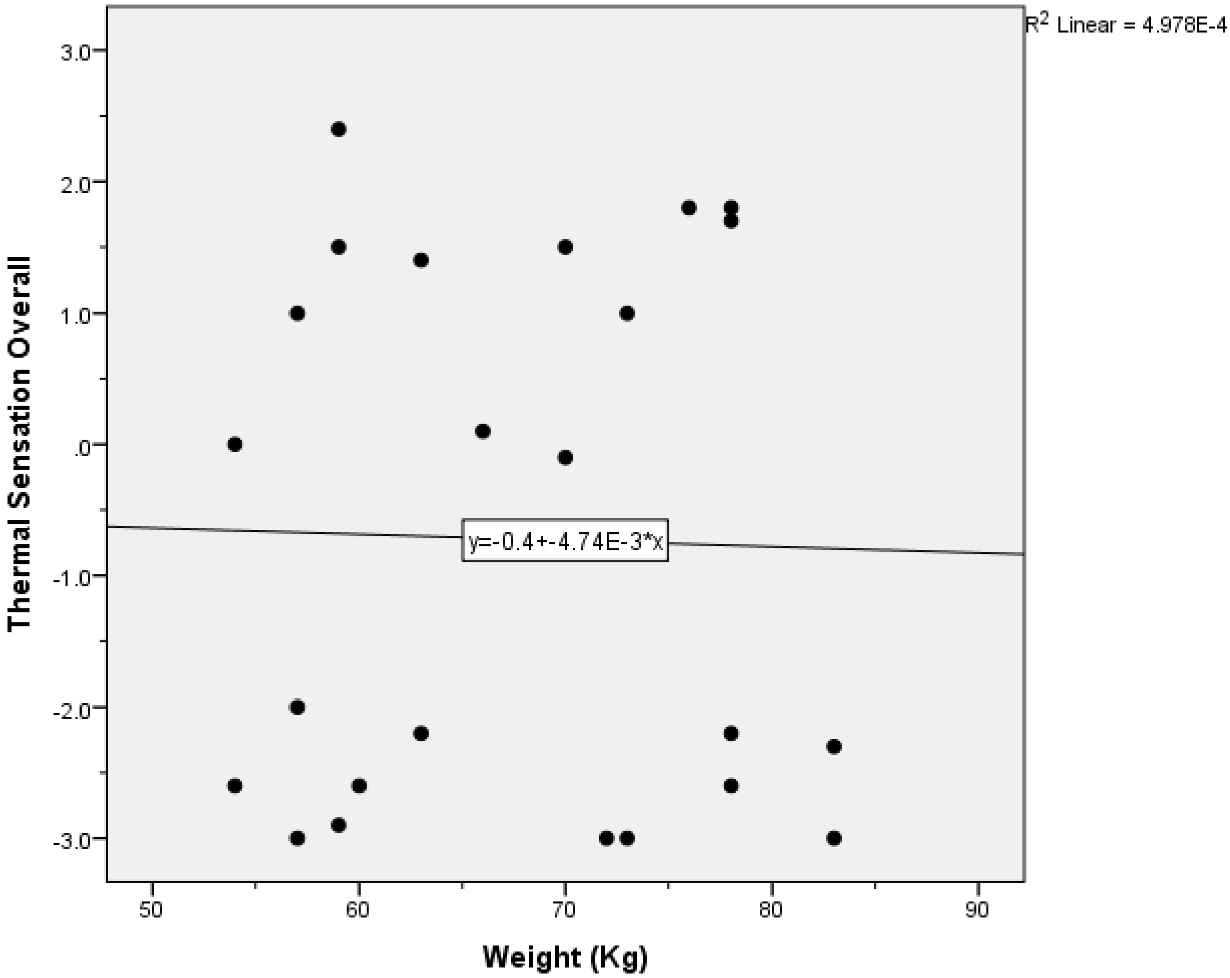
Males and females were more similar in finding Warm approximately slightly distracting.

Question 3: Data Analysis and interpretation

i) Correlation

a) Pearson's r

Scatterplot showing relationship between weight and overall thermal sensation



Correlations

					Weight (Kg)	Thermal Sensation Overall
Weight (Kg)	Pearson Correlation				1	-.022
	Sig. (2-tailed)					.918
	N				24	24
	Bootstrap[c]	Bias			0	-.004
		Std. Error			0	.208
		BCa 95% Confidence Interval	Lower		.	-.403
			Upper		.	.363
Thermal Sensation Overall	Pearson Correlation				-.022	1
	Sig. (2-tailed)				.918	
	N				24	24
	Bootstrap[c]	Bias			-.004	0
		Std. Error			.208	0
		BCa 95% Confidence Interval	Lower		-.403	.
			Upper		.363	.

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

The strength of the relationship is given by the correlation coefficient r=-.22, a weak negative relationship.

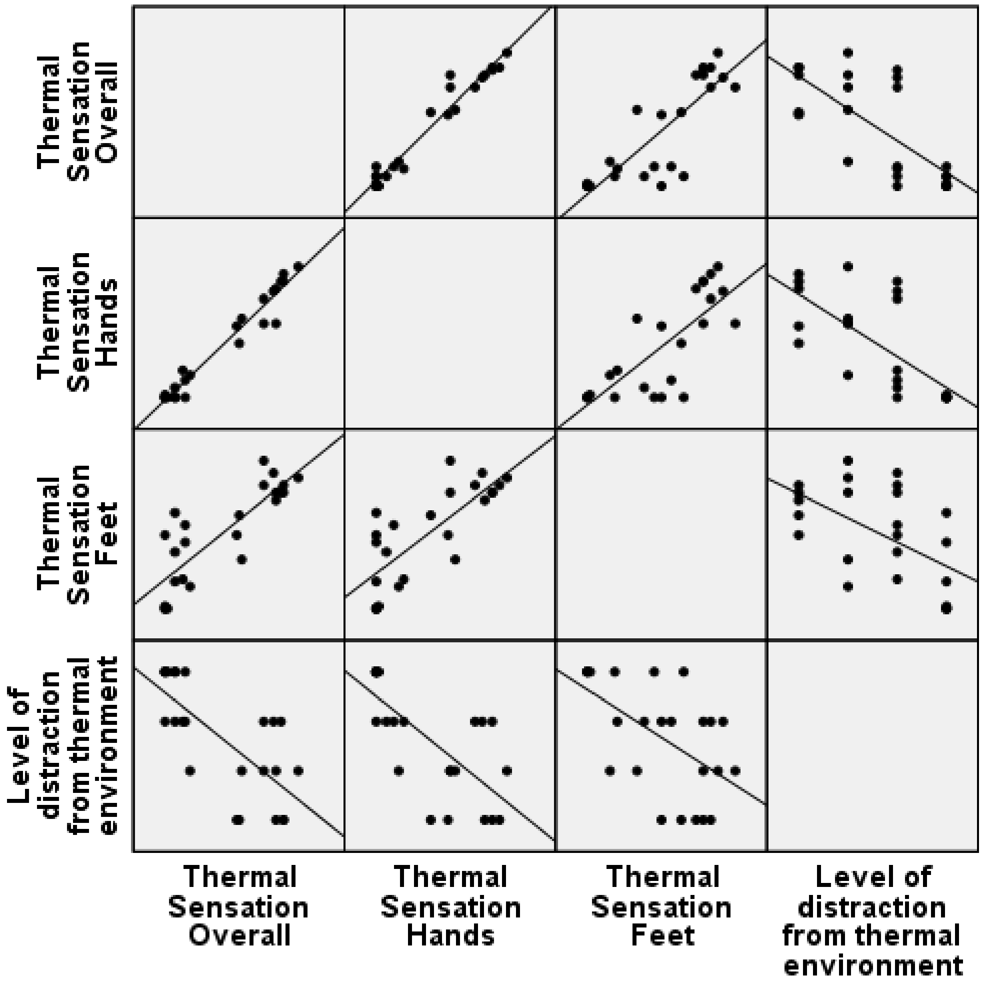
The variance accounted for is given by r^2=-.22^2=.0484. 4.84% of the variance is accounted for – very little practical effect.

The 2-tailed statistical significance p=.918 is not significant.

95% bootstrap confidence interval: -.403 to .363 – crosses zero, so not a genuine relationship.

b) Spearman's rho

Scatterplot matrix showing relationships between overall-, hands-, and feet-, -thermal sensation; and distraction level



Correlations

					Thermal Sensation Overall	Thermal Sensation Hands	Thermal Sensation Feet	Level of distraction from thermal environment
Spearman's rho	Thermal Sensation Overall	Correlation Coefficient			1.000	.938**	.816**	-.740**
		Sig. (2-tailed)			.	.000	.000	.000
		N			24	24	24	24
		Bootstrap[c]	Bias		.000	-.009	-.021	.016
			Std. Error		.000	.042	.075	.095
			BCa 95% Confidence Interval	Lower	.	.843	.674	-.880
				Upper	.	.981	.890	-.486
	Thermal Sensation Hands	Correlation Coefficient			.938**	1.000	.755**	-.757**
		Sig. (2-tailed)			.000	.	.000	.000
		N			24	24	24	24
		Bootstrap[c]	Bias		-.009	.000	-.018	.017
			Std. Error		.042	.000	.095	.112
			BCa 95% Confidence Interval	Lower	.843	.	.530	-.924
				Upper	.981	.	.878	-.469
	Thermal Sensation Feet	Correlation Coefficient			.816**	.755**	1.000	-.546**
		Sig. (2-tailed)			.000	.000	.	.006
		N			24	24	24	24
		Bootstrap[c]	Bias		-.021	-.018	.000	.019
			Std. Error		.075	.095	.000	.150
			BCa 95% Confidence Interval	Lower	.674	.530	.	-.782
				Upper	.890	.878	.	-.182
	Level of distraction from thermal environment	Correlation Coefficient			-.740**	-.757**	-.546**	1.000
		Sig. (2-tailed)			.000	.000	.006	.
		N			24	24	24	24
		Bootstrap[c]	Bias		.016	.017	.019	.000
			Std. Error		.095	.112	.150	.000
			BCa 95% Confidence Interval	Lower	-.880	-.924	-.782	.
				Upper	-.486	-.469	-.182	.

**. Correlation is significant at the 0.01 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Correlation Coefficients

	Hands	Feet	Distraction
Overall	.938	.816	-.740
Hands		.755	-.757
Feet			-.546

2-tailed Significance Levels

	Hands	Feet	Distraction
Overall	<.001	<.001	<.001
Hands		<.001	<.001
Feet			.006

All measures statistically significant with alpha=.05 (or as SPSS notes under the table, alpha=.01)

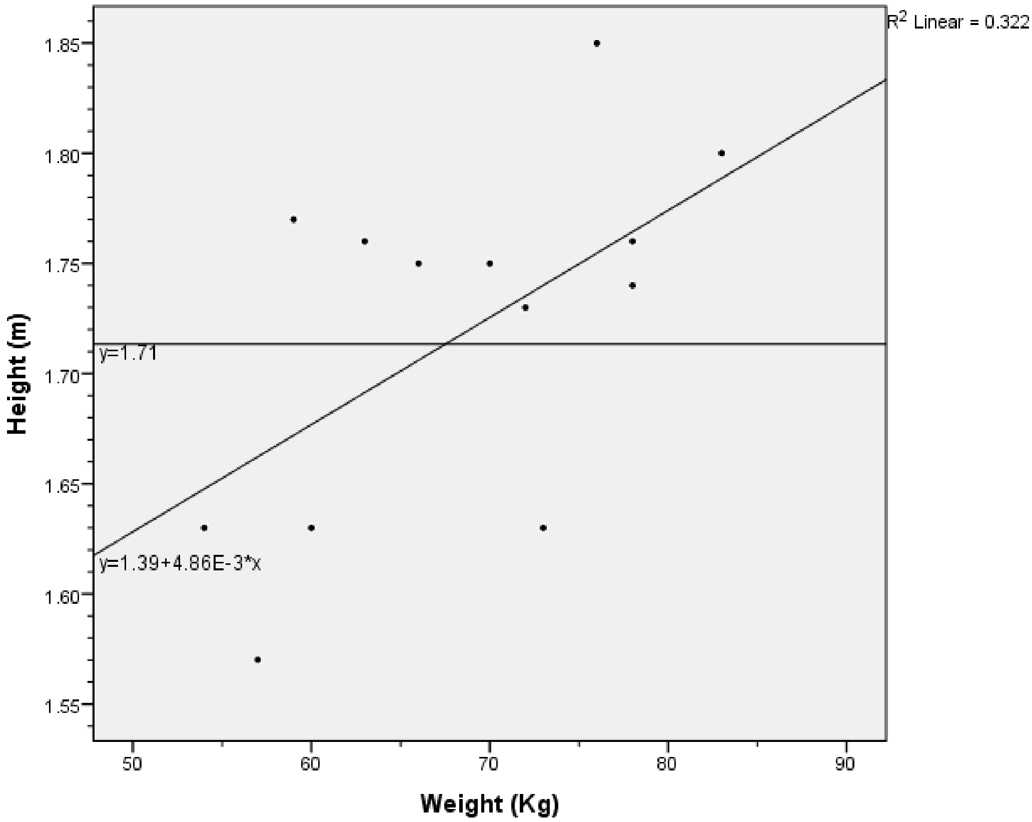
Confidence Intervals

	Hands	Feet	Distraction	Genuine
Overall	.843 – .981	.674 – .890	-.880 – -.486	Yes: both < 0
Hands		.530 – .878	-.924 – -.469	Yes: both < 0
Feet			-.782 – -.182	Yes: both < 0

ii) Regression

a) Linear

Scatter plot showing relationship between height and weight



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.567[a]	.322	.291	.06893	.322	10.436	1	22	.004

a. Predictors: (Constant), Weight (Kg)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.385	.103		13.506	.000
	Weight (Kg)	.005	.002	.567	3.230	.004

a. Dependent Variable: Height (m)

The significance of the weight parameter of the model is given by p=.004 < alpha=.05, and therefore can be considered statistically significant. The constant has p<.001 < alpha=.05, and so is also statistically significant.

R^2 is .322 for the sample and estimated .291 for the population – 29.1% (population) / 32.2% (sample) of variation in height is accounted for by variation in weight.

Height = .005*Weight + 1.385

b) Hierarchical

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.267[a]	.071	.029	2.0006	.071	1.685	1	22	.208
2	.979[b]	.958	.954	.4367	.887	440.755	1	21	.000
3	.979[c]	.959	.952	.4428	.001	.426	1	20	.521
4	.984[d]	.968	.961	.3986	.010	5.681	1	19	.028

a. Predictors: (Constant), Height (m)

b. Predictors: (Constant), Height (m), Thermal Sensation Hands

c. Predictors: (Constant), Height (m), Thermal Sensation Hands, Level of distraction from thermal environment

d. Predictors: (Constant), Height (m), Thermal Sensation Hands, Level of distraction from thermal environment, Preferred change in temperature

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	-12.055	8.740		-1.379	.182	-30.182	6.071
	Height (m)	6.615	5.096	.267	1.298	.208	-3.953	17.184
2	(Constant)	2.121	2.024		1.048	.306	-2.087	6.330
	Height (m)	-1.116	1.172	-.045	-.953	.352	-3.553	1.320
	Thermal Sensation Hands	1.009	.048	.992	20.994	.000	.909	1.109
3	(Constant)	2.216	2.057		1.077	.294	-2.075	6.507
	Height (m)	-1.070	1.190	-.043	-.899	.379	-3.552	1.413
	Thermal Sensation Hands	.978	.069	.961	14.237	.000	.835	1.121
	Level of distraction from thermal environment	-.076	.117	-.043	-.653	.521	-.321	.168
4	(Constant)	1.309	1.891		.692	.497	-2.648	5.266
	Height (m)	-.434	1.104	-.017	-.393	.699	-2.745	1.877
	Thermal Sensation Hands	.742	.117	.729	6.360	.000	.498	.986
	Level of distraction from thermal environment	-.153	.110	-.085	-1.387	.182	-.384	.078
	Preferred change in temperature	-.586	.246	-.220	-2.383	.028	-1.100	-.071

a. Dependent Variable: Thermal Sensation Overall

Given the above parameters:

Thermal Sensation Overall = -.434*Height + .742*Thermal Sensation Hands – .153*Level of distraction – .586*Preferred Change in temperature + 1.309

However not all of these values are statistically significant. With alpha=.05, height ($p=.699>.05$) and distraction level ($p=.182>.05$) are not significant. Only HTS ($p<.001<.05$) and preferred change in temperature ($p=.028<.05$) are statistically significant, and so are the only 2 variables that should be used for a prediction model.

Analysis of Variance

One-Way Independent ANOVA

ANOVA

Thermal Sensation Overall

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	78.282	5	15.656	17.062	.000
Within Groups	16.518	18	.918		
Total	94.800	23			

The difference between groups is highly significant (p<.001<alpha=.05)

From the Bonferroni post-hoc test, all group pairs were significantly different except:

Cold-female – Cold-male

– Cool-female

Cool-female – Cold-male

Warm-female – Warm-male

– Cool-male

One-Way Independent ANCOVA

Tests of Between-Subjects Effects

Dependent Variable: Thermal Sensation Overall

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	78.738[a]	6	13.123	13.890	.000	.831
Intercept	.612	1	.612	.647	.432	.037
Height	.456	1	.456	.483	.496	.028
Condition	71.993	5	14.399	15.240	.000	.818
Error	16.061	17	.945			
Total	107.270	24				
Corrected Total	94.800	23				

a. R Squared = .831 (Adjusted R Squared = .771)

There is still a significant difference (p<.001<.05) in OTS after controlling for Height of participant. Partial Eta Squared shows 81.8% of variance is explained. The covariate is not significant (p=.496<.05).

Levenes's test of equality of error variances is significant (p=.033<alpha=.05), so the assumptions of the ANCOVA are violated.

Two-Way Independent ANOVA

Tests of Between-Subjects Effects

Dependent Variable: Thermal Sensation Overall

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	78.282[a]	5	15.656	17.062	.000
Intercept	12.470	1	12.470	13.590	.002
Thermal	68.476	2	34.238	37.311	.000
Gender	5.900	1	5.900	6.430	.021
Thermal * Gender	3.906	2	1.953	2.128	.148
Error	16.518	18	.918		
Total	107.270	24			
Corrected Total	94.800	23			

a. R Squared = .826 (Adjusted R Squared = .777)

Both gender (p=.021) and thermal condition (p<.001) are significant (<.05).

The gender*thermal condition interaction is not significant (p=.148>.05). Gender does not change how much one's OTS is affected by thermal condition.

(Levenes's test of equality of error variances is significant, violating ANOVA's assumptions)

Abstract

The aim of this laboratory experiment was to investigate the thermal comfort responses of different groups of people exposed to Warm, Cool and cold conditions with particular emphasis on gender. One group of 4 males and 4 females was exposed for 1 hour to Warm office type conditions (29.0 ^{o}C) and another of 4 males and 4 females was exposed to Cool office type conditions (18.5 ^{o}C). A further group of 4 males and 4 females was exposed to cold conditions (5.0 ^{o}C). At the end of the 1 hour session, participants completed a questionnaire providing personal details and ratings related to their thermal sensation, acceptance and satisfaction.

Correlation analysis showed no significant relationship between weight and OTS of participants (r=-.022, 95% BCa CI[-4.03,.363], p=.918), but showed significant relationships between OTS and HTS (rho=.938, 95% BCa CI[.843,.981], p<.001), OTS and FTS (rho=.816, 95% BCa CI[.674,.890], p<.001), OTS and distraction (rho=-.740, 95% BCa CI[-.880,-.486], p<.001), HTS and FTS (rho=.755, 95% BCa CI[.530, .878], p<.001), HTS and distraction (rho=-.757, 95% BCa CI[-.924,-.469], p<.001), and FTS and distraction (rho=-.546, 95% BCa CI[-.782,-.182], p=.006).

Hierarchical multiple regression provided the following equation for overall thermal sensation (-3 to 3) (Y) as a function of Height (metres) (A), hands thermal sensation (-3 to 3) (B), level of distraction (1-4) (C) and preferred change in temperature (-1, 0, 1) (D). Y=-.434A+.742B–.153C–.586D+1.309 (R^2=0.968). The significant predictors of OTS are HTS (p<.001) and preferred change in temperature (p=.028).

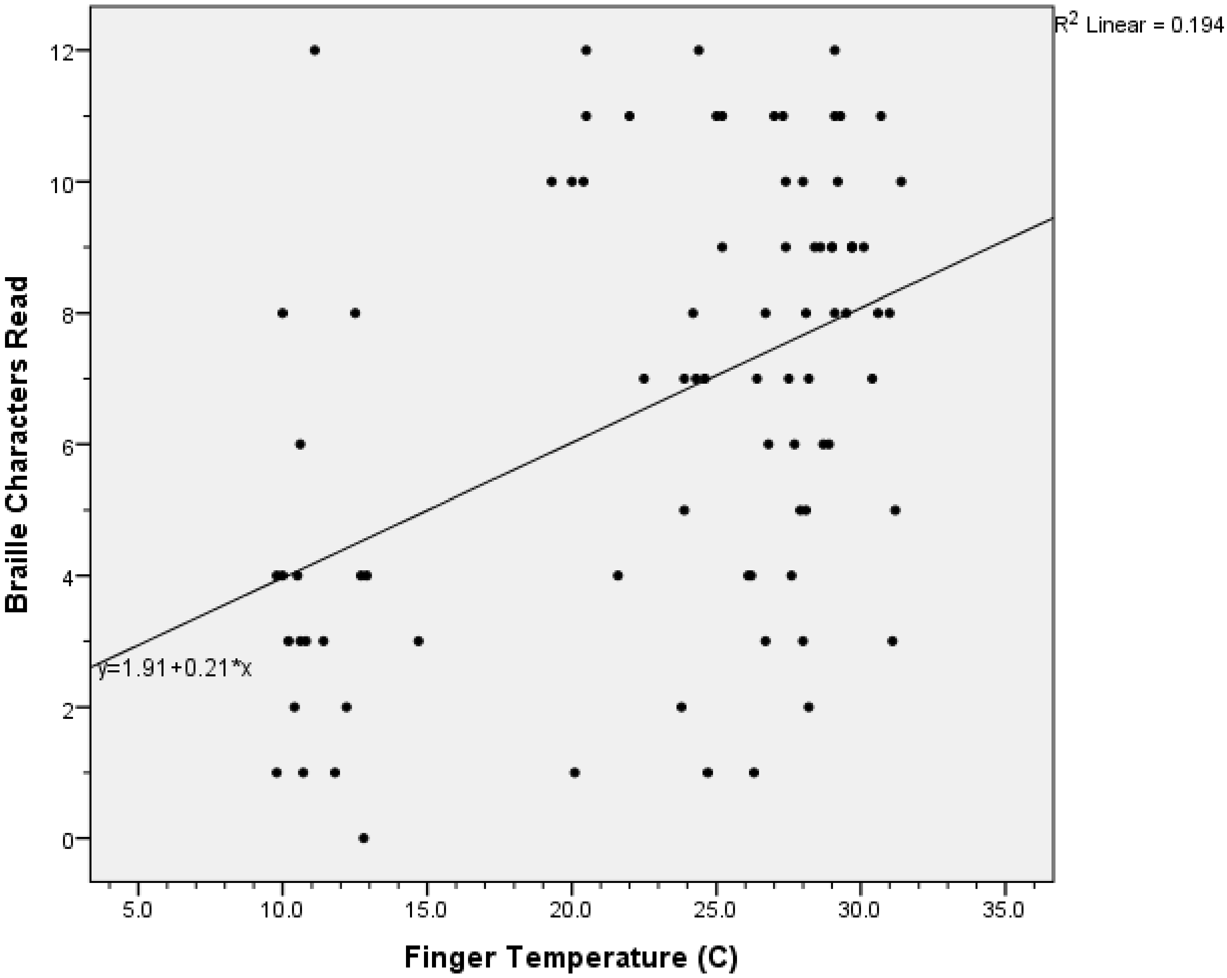
A one-way independent ANOVA showed that there were significant differences in OTS of thermal condition-gender groups. $F(5,18)=17.062$, $p<.001$. A one-way independent ANCOVA showed this remained significant after adjusting for height, $F(5, 17)=15.24$, $p<.001$, partial eta squared = .818. There was no relationship between height and condition ($p=.496$) and the ANCOVA violated its assumption of equality of error variances. A two-way independent ANOVA showed a significant main effect of thermal condition on OTS ($F(2,18)=37.311$, $p<.001$) and gender on OTS ($F(1,18)=6.43$, $p=.021$), but there were no thermal*gender interactions ($F(2,18)=2.128$, $p=.148$) and the ANOVA violated its assumption of equality of error variances.

Thermal environment affects OTS, and OTS, HTS, FTS and distraction all strongly correlate.

Part B: Ergonomics Investigation into manual dexterity and the ability to identify Braille characters in Warm, Cool and Cold environments

5) Data presentation and interpretation

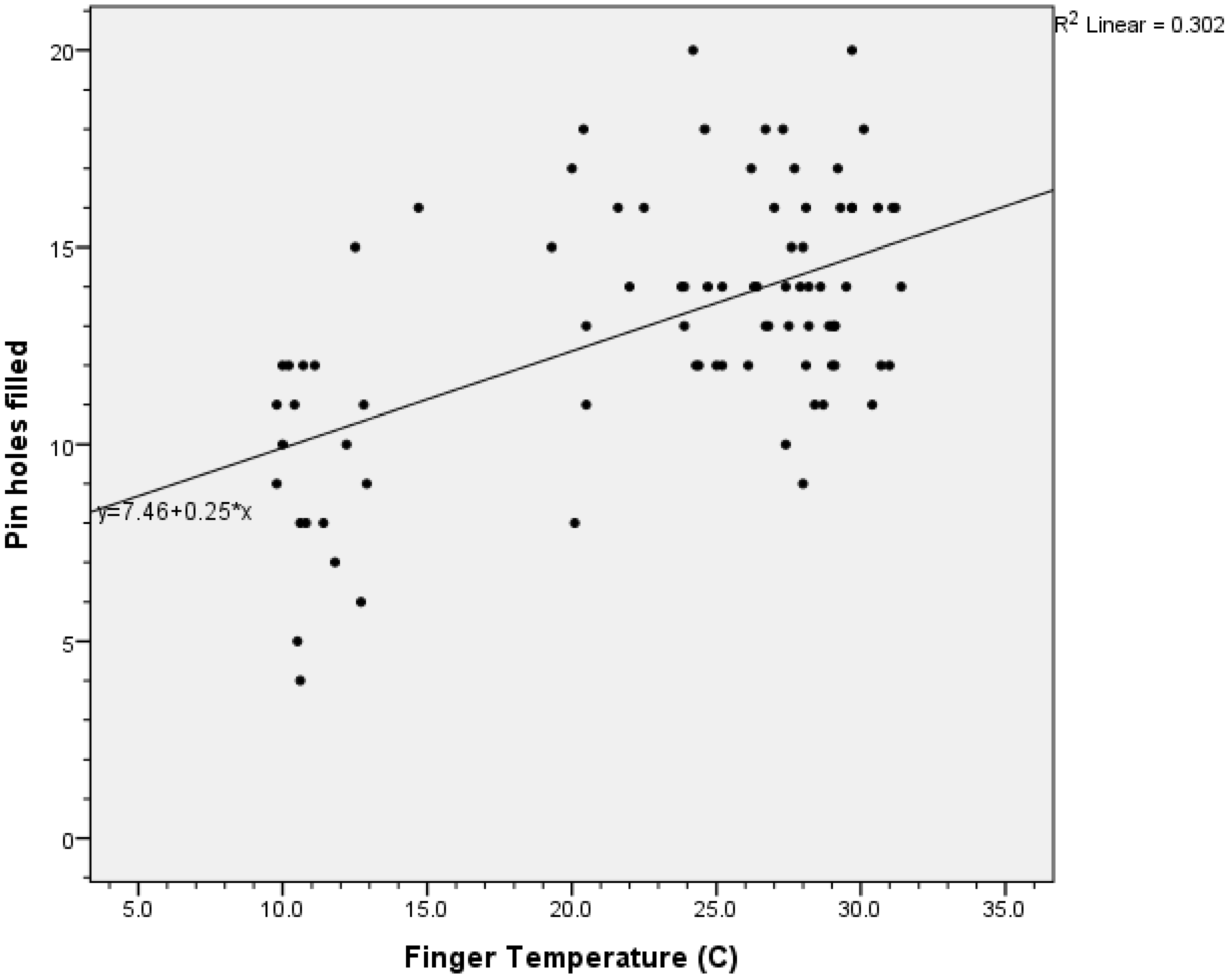
i) Scatterplot showing the relationship between finger temperature and Braille identification performance



As finger temperature increases, so does number of braille characters read.

Lots of variance in braille characters read, 19.4% accounted for by finger temperature

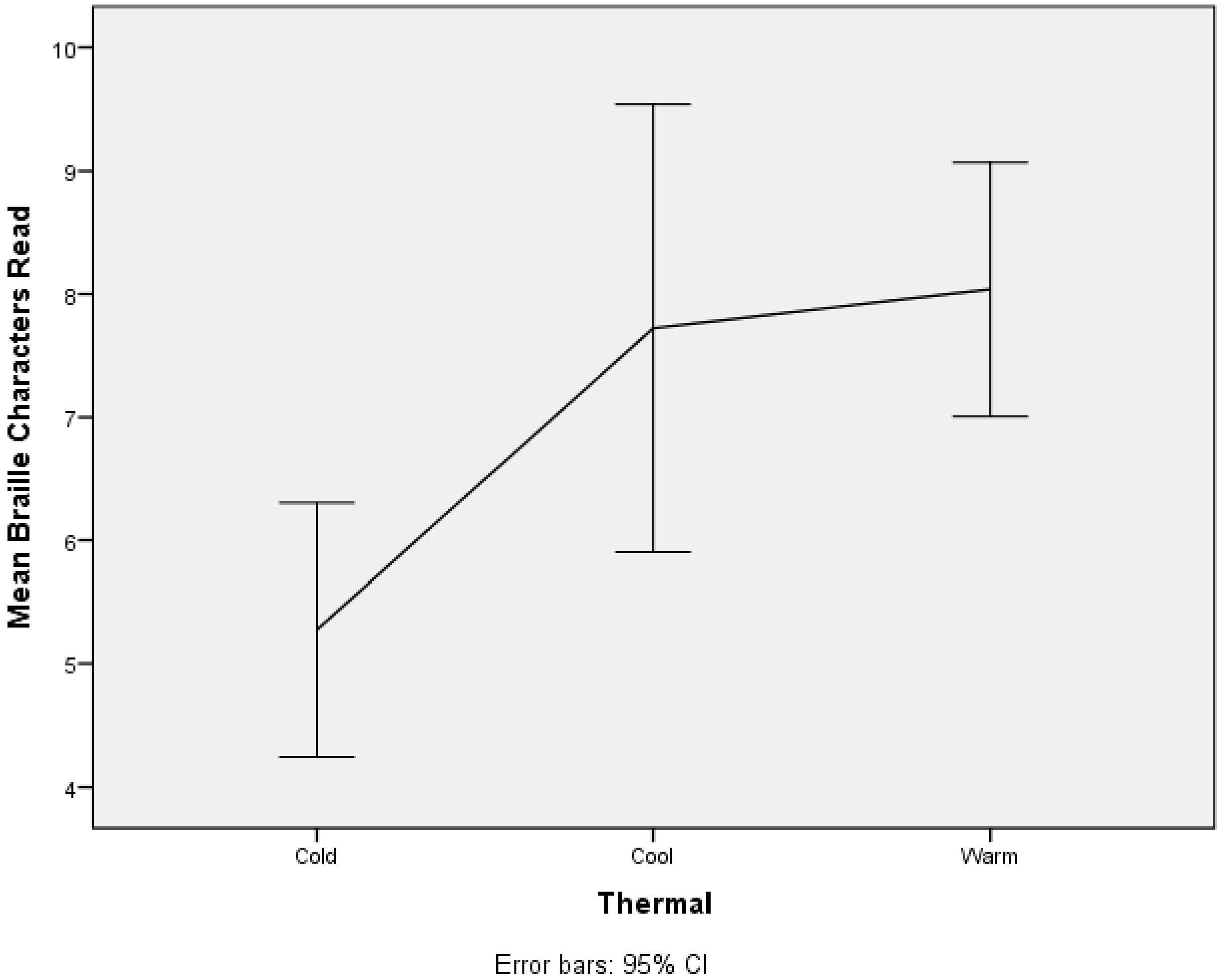
ii) Scatterplot showing the relationship between finger temperature and pin-hole filling performance



As finger temperature increases, so does performance in number of pin hole filled.

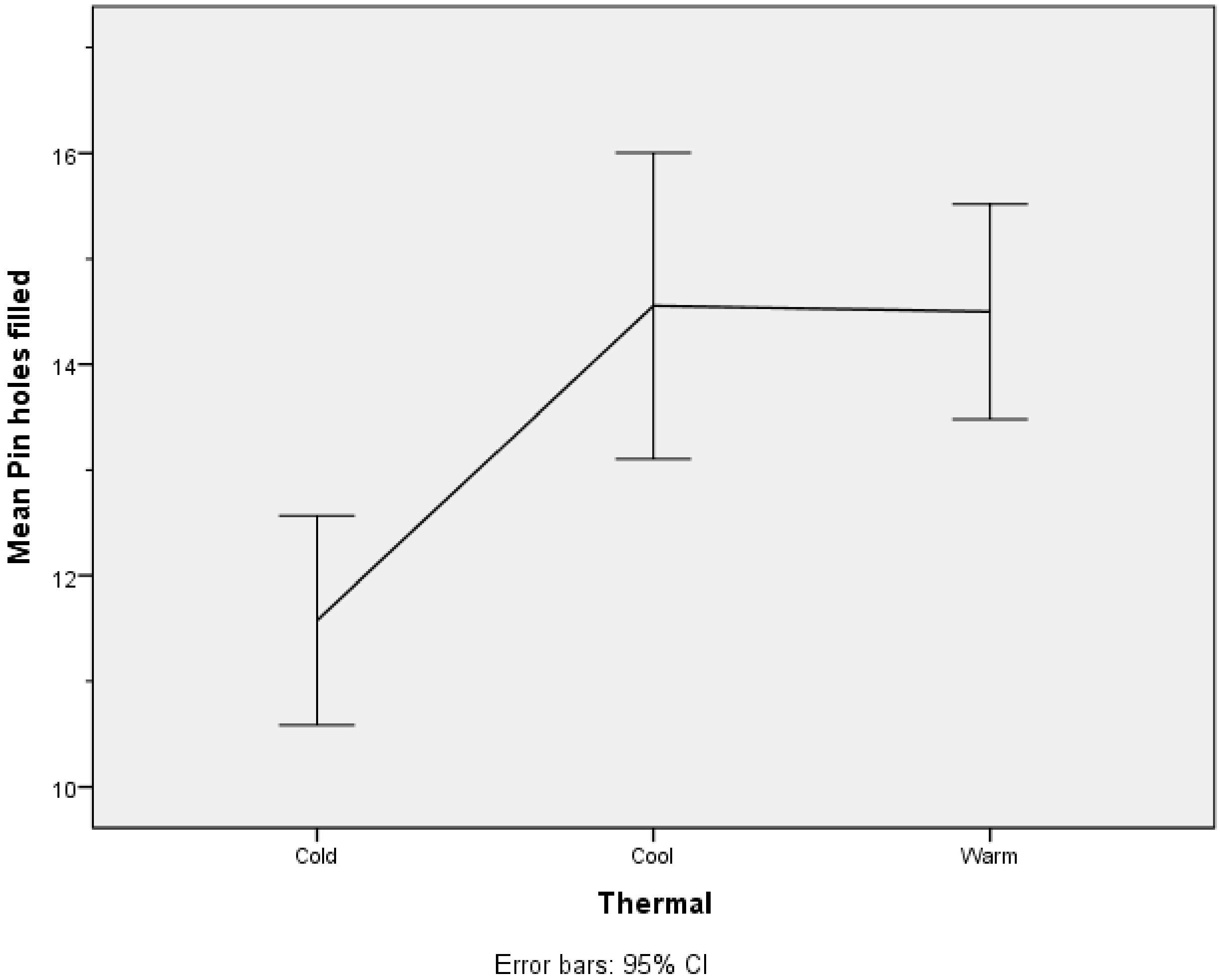
30.2% of the variance in performance is accounted for by finger temperature.

iii) Line diagram showing the effect of thermal condition on braille reading performance



The warmer the thermal environment, the higher the mean number of braille characters read. There is a greater difference between cold and cool than cool and warm (steeper gradient).

iv) Line diagram showing the effect of thermal condition on pin-hole filling performance



The warmer the thermal environment, the higher the mean number of pin holes filled in a minute, at least up to a certain point – there is a large positive difference cold to cool, and a small negative difference cool to warm

6) Data analysis and interpretation

Tests of Between-Subjects Effects

Dependent Variable: Braille Characters Read

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	191.669[a]	5	38.334	3.990	.003	.204
Intercept	3510.943	1	3510.943	365.470	.000	.824
Gender	30.479	1	30.479	3.173	.079	.039
Thermal	81.565	2	40.783	4.245	.018	.098
Gender * Thermal	9.007	2	4.503	.469	.628	.012
Error	749.319	78	9.607			
Total	4661.000	84				
Corrected Total	940.988	83				

a. R Squared = .204 (Adjusted R Squared = .153)

Levene's F (3.990) is significant (.003<.05), violating the assumptions of the two-way independent ANOVA.

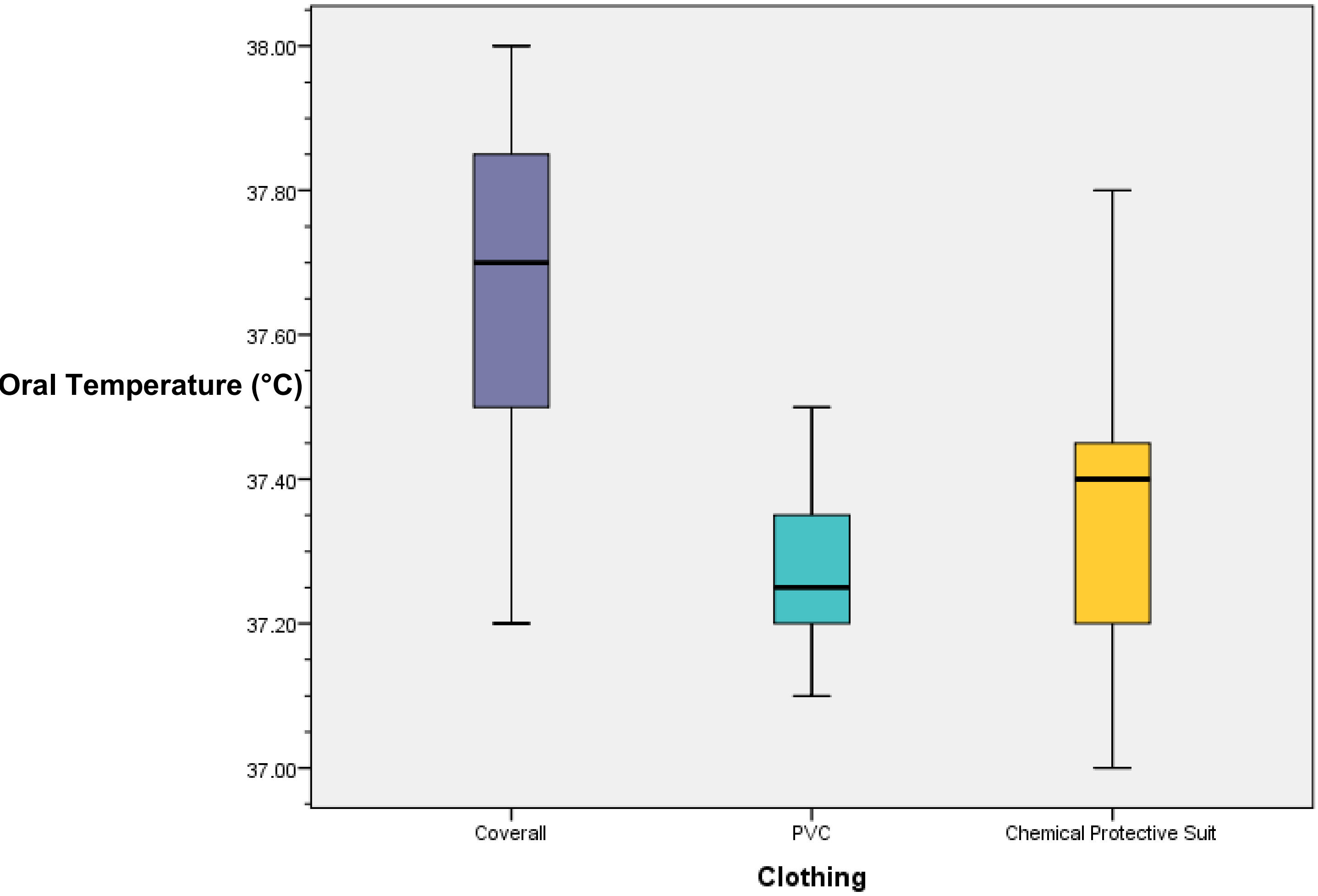
If that is disregarded, thermal condition is significant (p=.18<.05); gender is not (p=.079>.05), and gender*thermal interaction is also not (p=.628>.05).

Temperature affects braille-reading performance, and there is no effect of gender, at any temperature.

Ergonomics Investigation into physiological and subjective responses to stepping in hot conditions for three types of clothing.

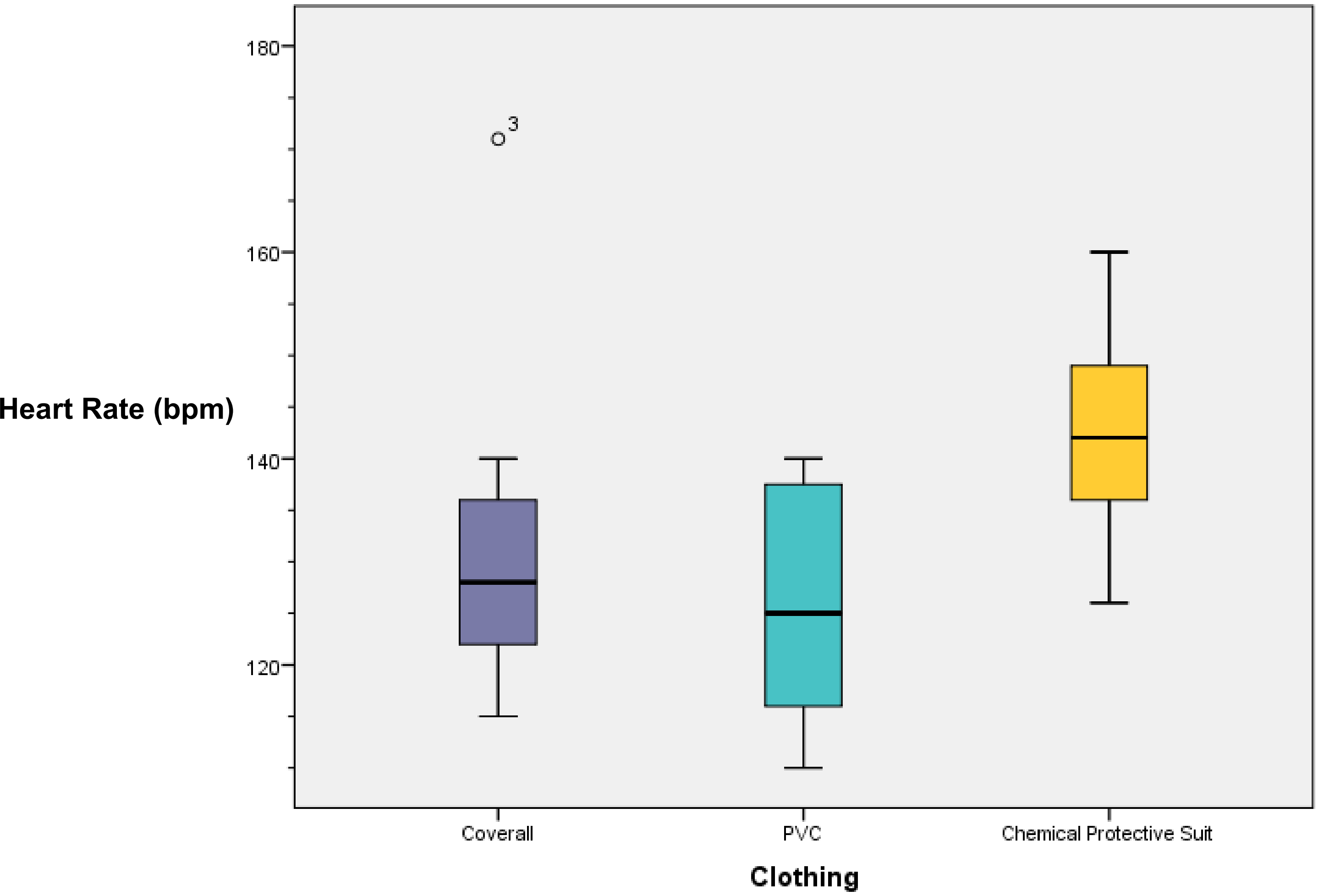
i) Box plots

a) Box plot showing oral temperature with different clothing while stepping



Thermal strain in terms of oral temperature appears different over the three conditions – the median is higher in the coverall condition than the other 2, particularly compared to PVC.

b) Box plot showing heart rate with different clothing while stepping

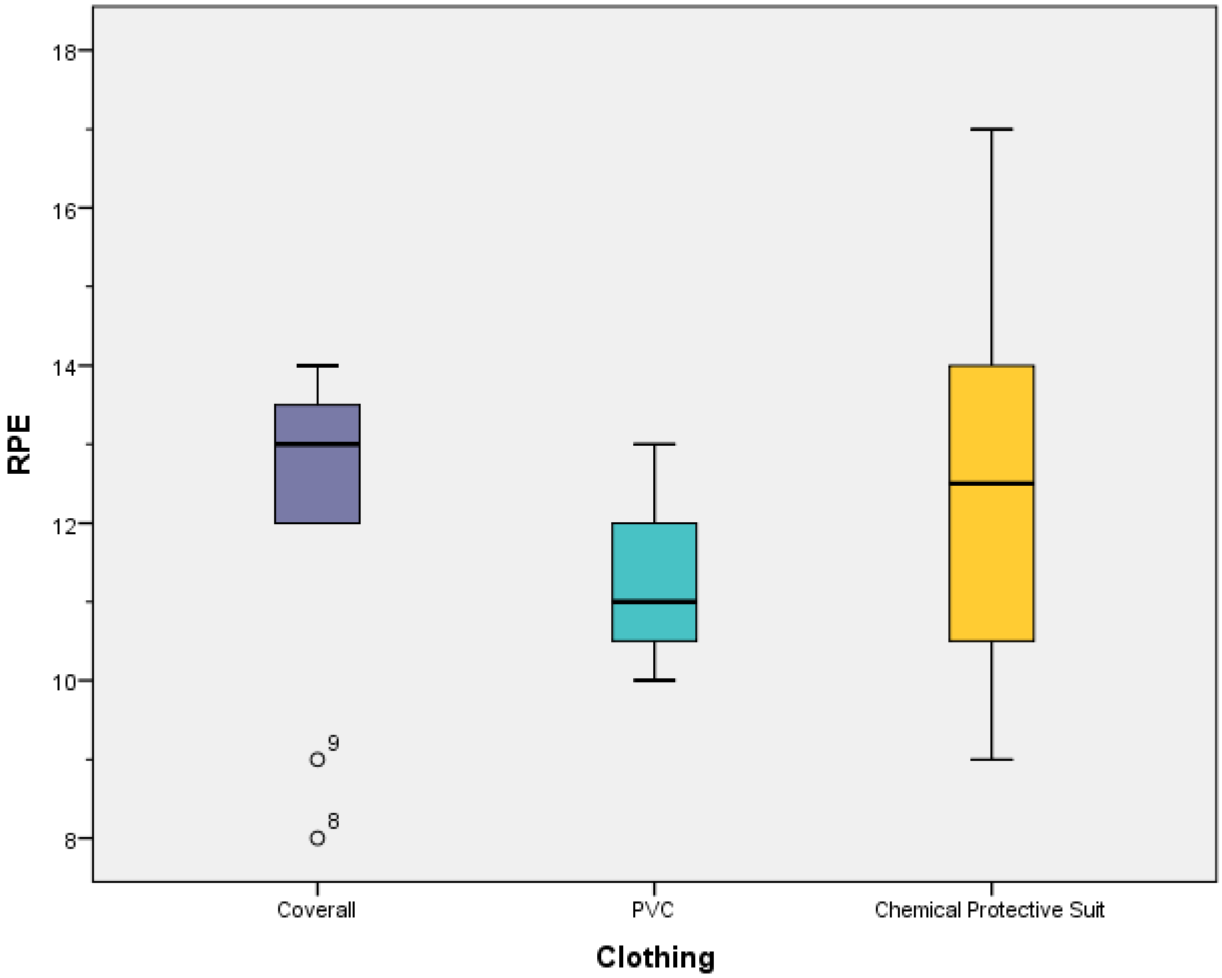


[Above plot modifies [17] from (assumed typo) 1106 to 116]

Thermal strain in terms of heart rate appears different over the three conditions – the median is higher in the chemical protective suit condition than the other 2.

As a suspected outlier, [3] is probably not so high because of the coverall, but a confluence of external factors. Either way, it is deserving of more study.

c) Box plot showing RPE with different clothing while stepping



Thermal strain in terms of heart rate appears different between Coverall and PVC – the medians are quite different with not very much crossover. This would make the strain different over the three conditions.

ii) Repeated Measures ANOVA

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Clothing_Type	Sphericity Assumed	.994	2	.497	10.655	.001
	Greenhouse-Geisser	.994	1.446	.687	10.655	.002
	Huynh-Feldt	.994	1.607	.618	10.655	.002
	Lower-bound	.994	1.000	.994	10.655	.008
Error(Clothing_Type)	Sphericity Assumed	1.026	22	.047		
	Greenhouse-Geisser	1.026	15.910	.064		
	Huynh-Feldt	1.026	17.681	.058		
	Lower-bound	1.026	11.000	.093		

Mauchly's sphericity test is not significant (p=.090) – no assumption violated. The epsilon tests≈1.

Clothing type has significant (p=.001<alpha=.05) effect on oral temperature. Only the coverall-PVC pair is significant (p<.001<.05 (Bonferroni adjustment)). Choice of clothing when active in hot environments requires careful attention.