Chartered Institute
of Ergonomics
& Human Factors

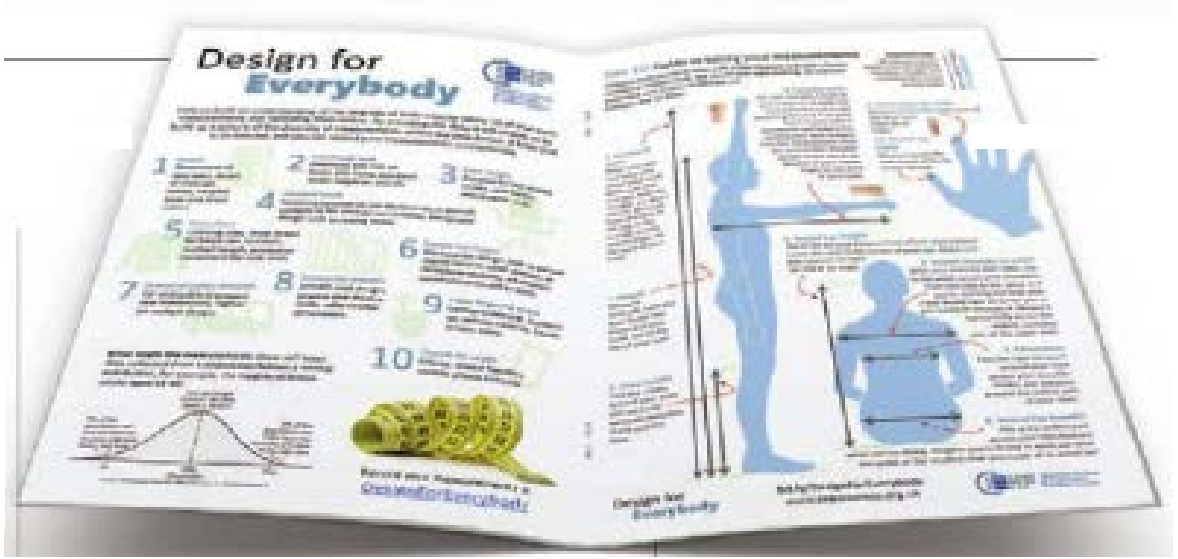
CIEHF President's Project: Design for EveryBody

Update 26th March 2021

AMANDA WIDDOWSON, PRESIDENT

TRUSTED & GLOBAL & INSIGHT

Contents



Project objectives

1. Develop initial up-to-date anthropometric data that facilitates enhanced diversity in design

2. Attract funding to develop a more comprehensive, anthropometric data-set

3. Increase public awareness of the CIEHF and how our work benefits society

   - Enhance demand for HF and uptake of HF work

Background 1/2: October 2019

Anthropometric standards needed an update and lacked evidence of diversity

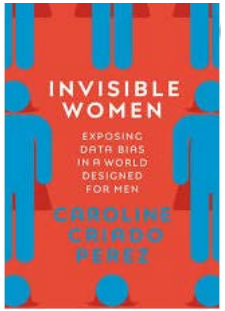
- **DEFSTAN 00-251 Technical Guide (1.1)** for Anthropometry: People size
  - Due a 5 year update
  - Based on data from 2013 and earlier
    - ‘draws heavily on … DEFSTAN 00-250 Part 3, Section 9’
  - 311 women and 2,159 men
  - Ethnicity limited to Ghurka data

- **ISO/TR7250-2**: *Statistical summaries of body measurements from individual ISO populations*, 2010, excludes UK data
- **Adult Data**, Dti, University of Nottingham, approximately 20 years’ old
- Later, *Peoplesize 2020* includes 2018 data from a UK Government health survey (ethnicity or sex sample sizes not reported)

Background 2/2

Public interest in diversity and design

- Caroline Criado Perez 2019 book "The Invisible Woman – exposing data bias in a world designed for men"
- CIEHF quote in her newsletter 15th February 2021
  - Resulted in 80% spike in responses
- "Me Too" movement
- Ill-fitting PPE – became more topical during COVID-19 pandemic



Human factors professionals can help!

Closing the data gap of the week

Here is some good news! The Chartered Institute of Ergonomics and Human Factors is running a project called "Design for Everybody", and yes everybody does actually include women this time. They are even sex-disaggregating their data! Imagine!

So let's help them out: they are asking everyone (and just to be clear everyone does also include men) to take ten simple body measurements and enter them into this online form. It will take about ten minutes and you can be completely anonymous. So get measuring! Who knows, it might even result in PPE that actually protects workers.

Approach – Data collection

Selected 10 measures

1. Stature (height) *(clearance, bed length)*
2. Overhead reach *(handrails)*
3. Knee (popliteal) height *(chair design)*
4. Forward reach *(workstation controls)*
5. Chest/bust *(PPE e.g. stab vests)*
6. Seated eye-height *(workstation displays)*
7. Seated shoulder breadth *(seat dimensions)*
8. Seated hip breadth *(seat dimensions)*
9. Index fingertip width *(touch-screens)*
10. Thumb-tip width *(phones)*

Measurement walk-in centres at CIEHF events, members' offices, shopping centres etc.

- Postponed because of COVID-19 social-distancing restrictions

Online data collection launched 29th April 2020

Approach – Online data collection (ongoing)

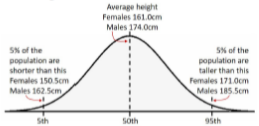
Design for Everybody

Chartered Institute of Ergonomics & Human Factors

Help us build an understanding of the diversity of body sizes by taking 10 of your own measurements and recording them online. By providing this data it will enable us to build up a picture of the diversity of measurements within the population. It takes just 5-10 minutes and you can record your measurements anonymously.

1. **Height** – Dimensions of doorways, length of massage tables, hospital beds and ships' cabins.
2. **Overhead reach** – Overhead grip rails on buses and trains, overhead locker height on aircraft.
3. **Knee height** – Distance to foot pedals in cars, seat height adjustment range.
4. **Forward reach** – Reaching controls on car dashboards, in aircraft cockpits or for emergency switches, equipment design such as rowing boats.
5. **Chest/bust** – Clothing sizes, chest straps for heart rate monitors, seatbelt length, protective equipment like stab vests.
6. **Seated eye height** – Workstation design such as power station control room displays or aeroplane cockpits, wheelchair communication aid screens.
7. **Seated shoulder breadth** – Car and public transport seat dimensions, fighter jet cockpit design.
8. **Seated hip breadth** – Aircraft seat design, cinema and theatre seats, rollercoaster dimensions.
9. **Index fingertip width** – Laptop keyboards, buttons on remote controls, touch screen icons.
10. **Thumb tip width** – Gloves, scissor handles, mobile phone buttons.

What might the measurements show us? Most data collected from a population follows a normal distribution, for example, the heights of British adults aged 19-65:

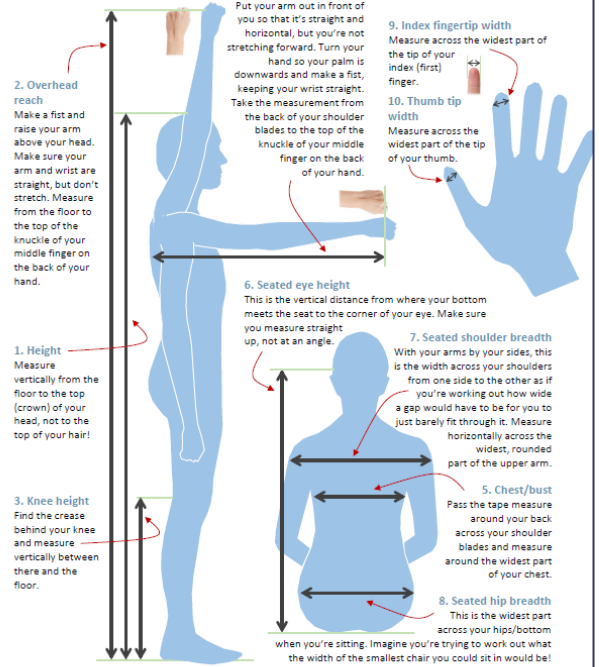


Record your measurements at DesignForEverybody

Take 10! Guide to taking your measurements

Measurements should be taken with a tape measure and with a family member or friend to help. You should wear light clothing, for example underwear and a t-shirt or shirt but not a jumper, and no shoes.

Important note: All measurements, (apart from chest/bust) should be straight and not follow the curves of your body!



1. **Height** – Measure vertically from the floor to the top (crown) of your head, not to the top of your hair!
2. **Overhead reach** – Make a fist and raise your arm above your head. Make sure your arm and wrist are straight, but don't stretch. Measure from the floor to the top of the knuckle of your middle finger on the back of your hand.
3. **Knee height** – Find the crease behind your knee and measure vertically between there and the floor.
4. **Forward reach** – Put your arm out in front of you so that it's straight and horizontal, but you're not stretching forward. Turn your hand so your palm is downwards and make a fist, keeping your wrist straight. Take the measurement from the back of your shoulder blades to the top of the knuckle of your middle finger on the back of your hand.
5. **Chest/bust** – Pass the tape measure around your back across your shoulder blades and measure around the widest part of your chest.
6. **Seated eye height** – This is the vertical distance from where your bottom meets the seat to the corner of your eye. Make sure you measure straight up, not at an angle.
7. **Seated shoulder breadth** – With your arms by your sides, this is the width across your shoulders from one side to the other as if you're working out how wide a gap would have to be for you to just barely fit through it. Measure horizontally across the widest, rounded part of the upper arm.
8. **Seated hip breadth** – This is the widest part across your hips/bottom when you're sitting. Imagine you're trying to work out what the width of the smallest chair you could sit in would be!
9. **Index fingertip width** – Measure across the widest part of the tip of your index (first) finger.
10. **Thumb tip width** – Measure across the widest part of the tip of your thumb.

Design for Everybody

bit.ly/DesignForEverybody
www.ergonomics.org.uk

Chartered Institute of Ergonomics & Human Factors

Design for Everybody

Chartered Institute of Ergonomics & Human Factors

Please take your 10 measurements as accurately as you can in centimetres and enter them here in this form, together with the additional information we need.

* denotes required information

First name
We assign your entry a number but a name is nice too!

Sex *
Select

Sex self-describe
If self-describe, please elaborate.

Age *

Nationality *
Select

Ethnic origin *
Select

1. Height

2. Overhead reach

3. Knee height

4. Forward reach

5. Chest/ bust

6. Seated eye height

7. Seated shoulder breadth

8. Seated hip breadth

9. Index finger width

10. Thumb width

TRUSTED GLOBAL INSIGHT

Reliability testing for remote data collection

5 males and 5 females each completed 2 sets of 10 measurements at same time over 5 days using DFE guide

- Self-measurements
- Assisted measurements

Results

- Intra-Class Correlation Coefficients (ICC) analysed (each measure was repeated 5 times)
- Most measures had high reliability (next slide)

Design for Everybody

Test Group Data Collection

Person 1

Time of day measurements are recorded:

Gender:

Body Mass Index (see https://www.nhs.uk/live-well/healthy-weight/bmi-calculator/):

Instructions

Download the guide to the measurements from https://bit.ly/DesignForEverybody

Take each of the 10 measurements in one session at the same time of day for 5 consecutive days. Measure yourself (Person 1, self-measures) and someone else in your household (Person 2, assisted measures). They should also measure themselves (Person 2, self-measures) and you (Person 1, assisted measures).

Record the results in the tables below, together with gender and BMI.

#	Measure	Self-measures (in cm)					Assisted measures (in cm)				
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
1	Height										
2	Overhead reach										
3	Knee height										
4	Forward reach										
5	Chest/bust										
6	Seated eye height										
7	Seated shoulder breadth										
8	Seated hip breadth										
9	Index fingertip width										
10	Thumb tip width										

Test-re-test reliability results

ICC values between 0.75 and 0.90 indicate good reliability

Most measures had high reliability except:

- Male knee height (self & assisted)
- Female knee height (assisted)
- Female seated hip breadth (self)
- Female index fingertip width (self & assisted)
  - Female index fingertip width was too similar between subjects using a tape-measure
  - Would need to measure in mm, using a more accurate tool (e.g. calliper) to discern differences amongst females in this measure
  - Pooling male & female index fingertip data showed high reliability (0.92)

#	Measure	Self-measures (in cm)	Assisted measures (in cm)
	Males		
1	Height	0.98	0.98
2	Overhead reach	0.98*	0.93*
3	Knee height	0.35	0.52
4	Forward reach	0.72	0.96
5	Chest/bust	0.99	0.99
6	Seated eye height	0.96*	0.94*
7	Seated shoulder breadth	0.91	0.93
8	Seated hip breadth	0.95	0.69
9	Index fingertip width	0.93*	0.85*
10	Thumb tip width	0.99*	0.97*
	Females		
1	Height	0.97	0.98
2	Overhead reach	0.80*	0.81*
3	Knee height	0.88	0.28
4	Forward reach	0.96	0.98
5	Chest/bust	0.99	0.99
6	Seated eye height	0.98*	0.99*
7	Seated shoulder breadth	0.82	0.87
8	Seated hip breadth	0.09	0.81
9	Index fingertip width	-0.38*	0.15*
10	Thumb tip width	0.79*	0.99*

** Based on 4 males & 4 females (1 male & 1 female excluded)*

Reliability Results Report

Online Survey Results

29TH APRIL 2020 TO 26TH MARCH 2021

TRUSTED GLOBAL INSIGHT

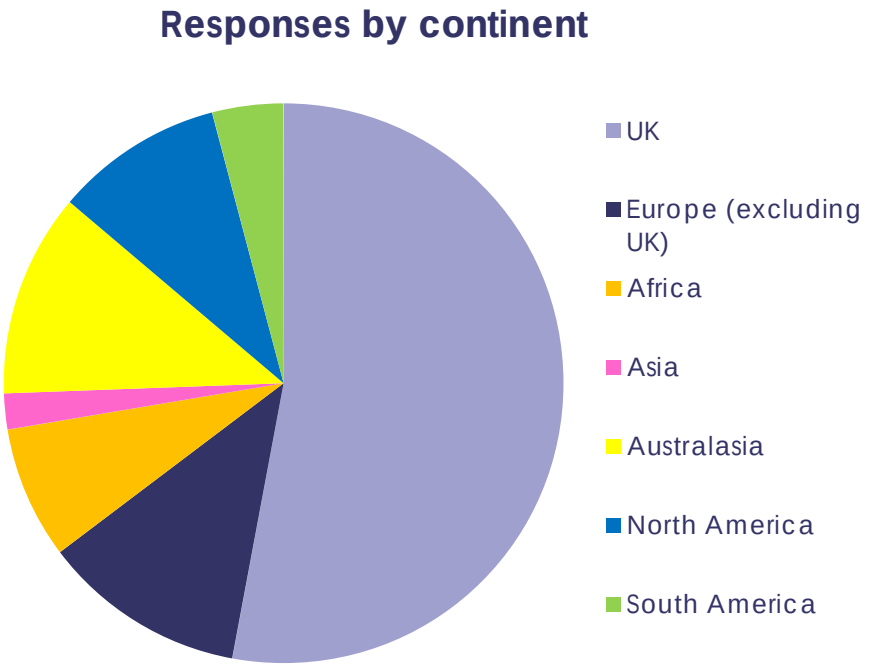
Total survey responses: Nationality

Total number of people who submitted measurements: 304

Originality intended as UK survey

Nationality (largest 5)

- British 59%
- Canadian 6%
- American 4%
- Mexican 3%
- Irish 3%



Total survey responses: Sex and Age

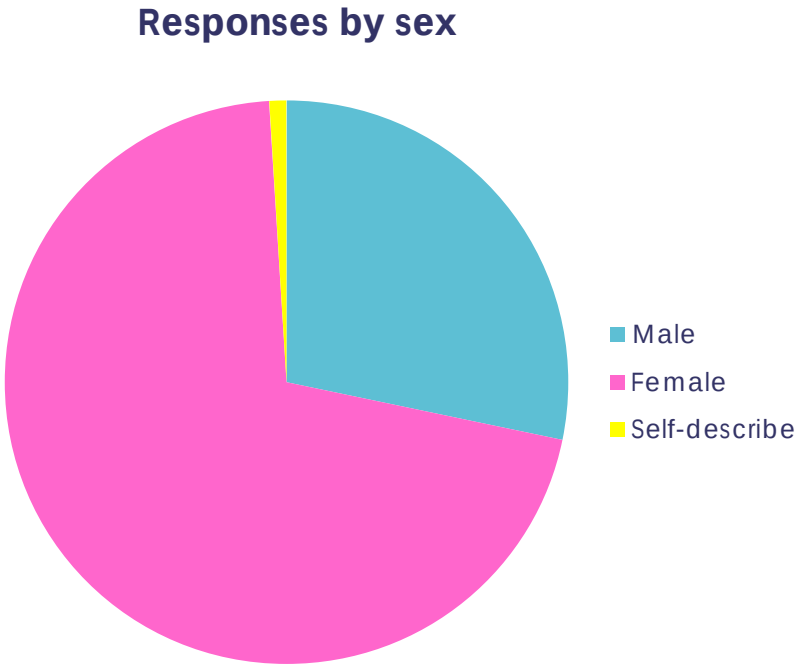
Total number of people who submitted measurements: 304

*Sex**

- Female 210 (71%)
- Male 81 (28%)
- Self-describe 3 (1%)
- **excluding 10 children (5 male; 5 female)*

Average age (years)*

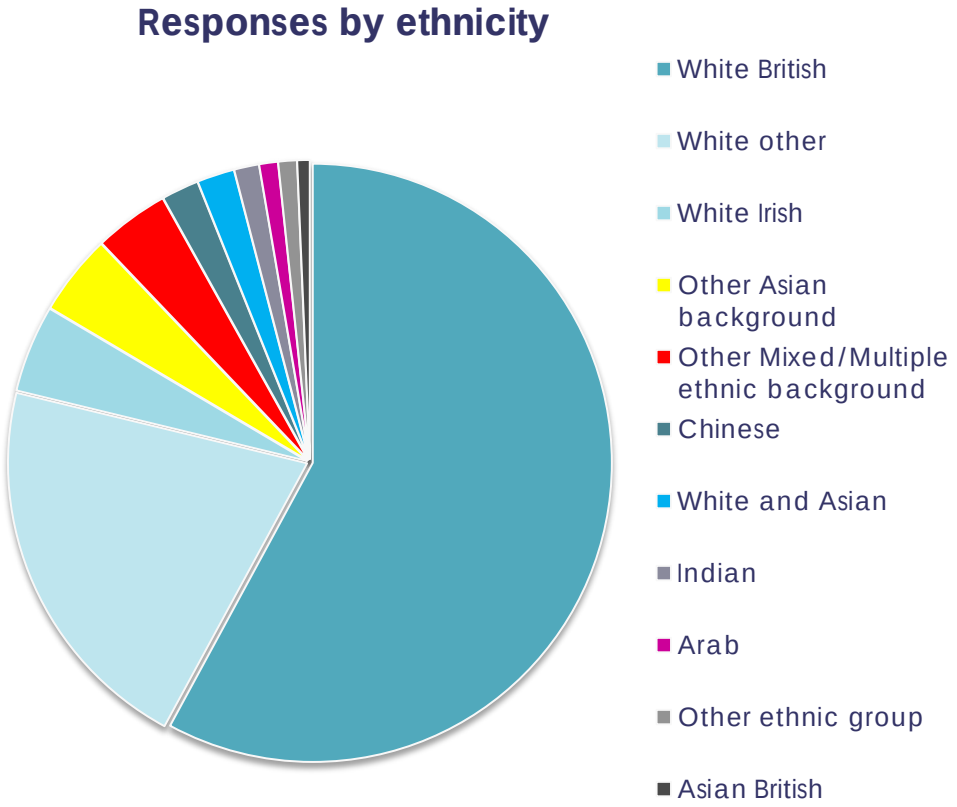
- Female 38.5
- Male 38
- Self-describe 26
- **excluding 10 children (age 5-17)*



Total survey responses: Ethnicity

Ethnicity number of responses

- White British: 57%
- White other: 20%
- White Irish: 5%
- Other Asian: 4%
- Mixed ethnic background: 4%
- Chinese 2%
- White and Asian 2%
- Indian 1%
- Arab 1%
- Asian British: 1%
- Other ethnic group 1%
- Bangladeshi, Black African, Pakistani, Vietnamese, White & black African, White & black Caribbean: each <1%



Percentiles (cm): Adult female (all nations)

Total sample size: 210 (71%)

Age (years)

- Average 38.5
- Range 18 to 76

ID	1. Height	2. Overhead reach	3. Knee height	4. Forward reach	5. Chest/ bust	6. Seated eye height	7. Seated shoulder breadth	8. Seated hip breadth	9. Index finger width	10. Thumb width
Mean	165.0	202.3	46.6	68.9	94.9	88.5	46.3	45.2	1.7	2.0
SD	7.6	13.2	4.9	10.7	11.5	20.3	10.5	12.5	0.4	0.4
Number of responses	210.0	184.0	208.0	201.0	168.0	163.0	206.0	206.0	189.0	190.0
3rd Percentile	150.7	177.5	37.4	48.8	73.2	50.3	26.5	21.7	1.0	1.3
5th Percentile	152.5	180.5	38.6	51.2	75.9	55.0	29.0	24.5	1.1	1.4
50th percentile (median)	165.0	203.0	46.0	69.0	93.3	79.0	44.3	43.1	1.6	2.0
95th Percentile	177.6	224.0	54.6	86.5	114.0	121.9	63.6	65.9	2.3	2.7
97th Percentile	179.3	227.0	55.7	89.0	116.6	126.6	66.0	68.8	2.4	2.8

Percentiles (cm): Adult male (all nations)

Total sample size: 81 (28%)

Age (years)

- Average 38
- Range 20 to 77

ID	1. Height	2. Overhead reach	3. Knee height	4. Forward reach	5. Chest/ bust	6. Seated eye height	7. Seated shoulder breadth	8. Seated hip breadth	9. Index finger width	10. Thumb width
Mean	177.1	216.9	50.2	76.0	100.8	81.9	48.6	41.1	1.8	2.3
SD	14.2	19.1	7.2	9.4	12.3	12.3	8.5	10.2	0.3	0.4
Number of responses	81.0	77.0	80.0	81.0	52.0	79.0	79.0	78.0	76.0	76.0
3rd Percentile	150.3	181.0	36.7	58.4	77.6	58.8	32.7	21.9	1.2	1.6
5th Percentile	153.6	185.4	38.3	60.5	80.5	61.6	34.6	24.3	1.3	1.7
50th Percentile (median)	178.0	215.0	50.0	77.5	102.0	80.0	49.0	39.5	1.8	2.2
95th Percentile	200.6	248.4	62.0	91.5	121.1	102.2	62.6	57.9	2.3	2.8
97th Percentile	203.9	252.8	63.6	93.7	123.9	105.0	64.6	60.2	2.4	2.9

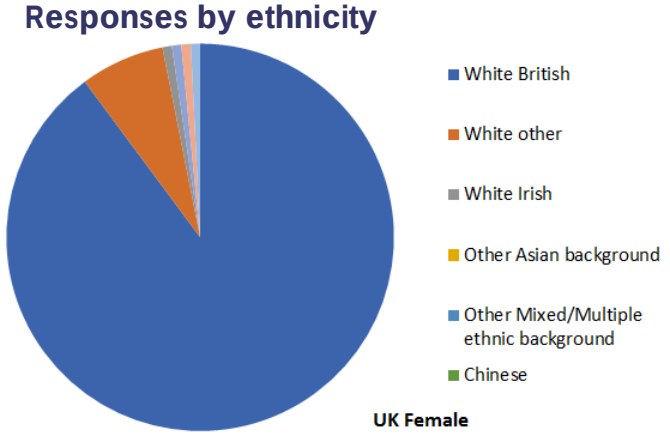
Percentiles (cm): UK adult female

Total sample size 128 (74%)

Age (years)

- Average 42.9
- Range 18 to 73

Ethnicity 90% White British



UK Female	1. Height	2. Overhead reach	3. Knee height	4. Forward reach	5. Chest/ bust	6. Seated eye height	7. Seated shoulder breadth	8. Seated hip breadth	9. Index finger width	10. Thumb width
Mean	164.9	202.4	46.6	69.1	96.5	78.2	45.8	45.8	1.7	2.1
SD	7.2	12.0	4.6	7.9	11.8	11.0	8.2	11.5	0.3	0.4
Number of responses	128.0	111.0	127.0	122.0	106.0	71.0	125.0	126.0	116.0	117.0
3rd percentile	151.4	179.9	37.9	54.3	74.3	57.6	30.3	24.2	1.1	1.4
5th percentile	153.0	182.6	39.0	56.1	77.0	60.1	32.2	26.8	1.2	1.5
50th percentile (median)	165.0	203.0	46.0	70.0	94.0	76.0	44.0	44.0	1.7	2.0
95th percentile	176.7	222.1	54.2	82.2	116.0	96.3	59.3	64.7	2.3	2.7
97th percentile	178.4	224.8	55.3	84.0	118.7	98.8	61.2	67.3	2.4	2.8

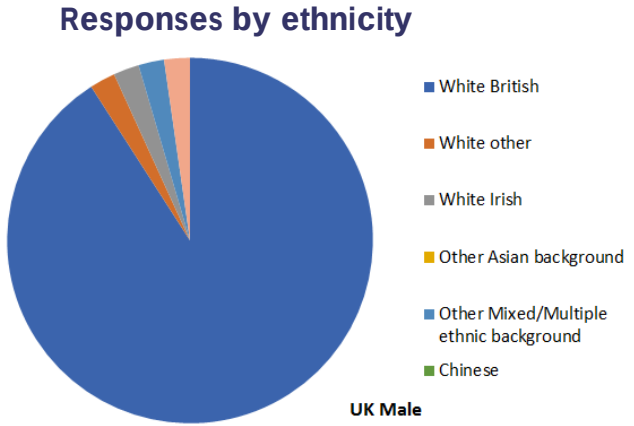
Percentiles (cm): UK adult male

Total sample size 44 (26%)

Age (years)

- Average 46.8
- Range 20 to 77

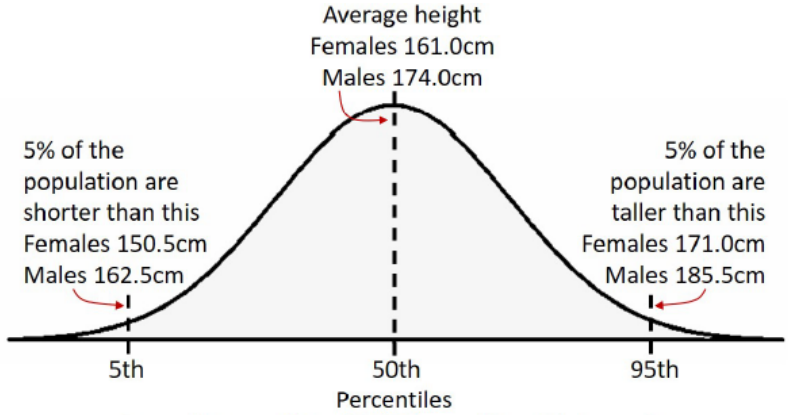
Ethnicity 91% White British



UK Male	1. Height	2. Overhead reach	3. Knee height	4. Forward reach	5. Chest/ bust	6. Seated eye height	7. Seated shoulder breadth	8. Seated hip breadth	9. Index finger width	10. Thumb width
Mean	179.1	217.7	50.3	77.5	102.6	83.1	49.5	41.7	1.9	2.3
SD	9.6	18.4	4.2	6.9	12.0	12.6	5.5	10.6	0.3	0.3
Number of responses	44.0	43.0	44.0	44.0	38.0	41.0	43.0	43.0	41.0	41.0
3rd percentile	161.0	183.2	42.4	64.5	80.1	59.4	39.2	21.8	1.3	1.7
5th percentile	163.2	187.4	43.4	66.1	82.9	62.3	40.4	24.2	1.4	1.8
50th percentile (median)	178.5	217.0	50.3	78.0	103.5	80.5	49.0	40.0	1.9	2.3
95th percentile	195.0	248.0	57.2	88.9	122.4	103.8	58.6	59.2	2.4	2.8
97th percentile	197.2	252.3	58.2	90.4	125.2	106.7	59.8	61.7	2.5	2.9

Future aims

- **Continue online data collection data collection (survey remains open)**
- **Face-to-face data collection - measuring at CIEHF events, in workplaces, etc.**
  - When social-distancing restrictions allow
  - Pack for volunteers
- **Public promotion to raise awareness of HF**
- **Seek sponsorship for more detailed set of measures and potentially more sophisticated application for data collection**



Source: Bodyspace (3rd ed) 2006; Pheasant, S. and Haslegrave, C.