TECHNICAL REPORT

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Basic human body measurements for technological design —

Part 4: Expected performance of skilled anthropometrists

Définitions des mesures de base du corps humain pour la conception technologique —

Partie 4: Performances attendues des anthropométristes qualifiés

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Foreword

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This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

A list of all parts in the ISO 7250 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Anthropometric data used for technological design have been included in many ISO product standards. There are several standards such as ISO 15535 that refer to a skilled or experienced anthropometrist but give no clear information on what is a skilled or experienced anthropometrist. The skill of an anthropometrist forms the most important part of quality control of anthropometric data. The information provided by this document complements the lack of existing standards and can help developers and users of anthropometric databases.

Basic human body measurements for technological design —

Part 4: Expected performance of skilled anthropometrists

1 Scope

This document describes the knowledge and skill required for an experienced anthropometrist who serves as a measurer in anthropometric surveys or a planner of an anthropometric survey. This document also describes methods to quantify the skill of anthropometrists and to report their performance.

This document is not a textbook or manual for anthropometry but can be useful for those who plan and conduct anthropometric surveys as well as designers and technologists who utilize anthropometric data. Methods described in this document can also be applicable to measurements other than those described in ISO 7250-1.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
anthropometrist
person who takes scientifically accurate measurements of the human body according to traditional methods

3.2
inter-observer measurement error
difference between the measurements taken on the same participant by different measurers

3.3
intra-observer measurement error
difference between the repeated measurements taken on the same participant by the same measurer

3.4
anatomical landmark
point clearly defined on the body that can be used for determining anthropometric measurements

[SOURCE: ISO 20685-1:2018, 3.6]

3.5
landmarking
placement of an anatomical landmark point on the skin of a participant by palpating the underlying bone and/or observing the surface shape of anatomical structures

3.6
bias
systematic difference between two sets of measurements on the same participant group by different measurers

4 Background

Different factors influence the quality of anthropometric data by the type of data as shown in Table 1. In the traditional methods, instruments are simple and easy to calibrate. Body posture is a part of the definition of a measurement item and is controlled by the measurer when taking measurement. Since the time duration required for taking a manual measurement is very short, the influence of the body sway is negligible. Therefore, the skill of the measurer in landmarking and measuring is the main cause of errors in the traditional methods. Reducing errors in landmarking is essential for reducing errors in measurements.

Since the human body is not a rigid object, it is impossible to give the true value to a human body. Therefore, the accuracy of the human body measurement cannot be evaluated. Only the precision of measurement can be evaluated for manual measurements.

Skill of anthropometry can be obtained only through training. The aim of training is to reduce intra- and inter-observer measurement errors. The goal of training is to make a trainee into an experienced anthropometrist. However, self-training that relies solely on textbooks, standards or other material can lead to inaccurate landmarking procedures that result in biased landmark positions. Periodic training with an experienced anthropometrist is necessary.

Scan-derived measurements are influenced by more factors than the 1-D measurements obtained by the traditional methods. The protocol for quality control of scan-derived measurements is already standardized (see ISO 20685-1 and ISO 20685-2), except for the protocol for evaluating the performance of software for automatically calculating landmark positions or measurements.

Table 1 — Factors that can influence the quality of anthropometric data

<table>
<tr><th colspan="2" rowspan="2">Factor</th><th rowspan="2">Traditional body measurement</th><th colspan="3">Scan-derived measurements</th></tr>
<tr><th>Body measurement</th><th>Landmark coordinate</th><th>Surface shape</th></tr>
<tr><td rowspan="5">Tool</td><td rowspan="2">Hardware</td><td>Accuracy of instrument</td><td colspan="3">N/A</td></tr>
<tr><td>N/A</td><td colspan="3">Accuracy of scanner system hardware</td></tr>
<tr><td rowspan="3">Software</td><td rowspan="3">N/A</td><td colspan="3">Performance of scanner system software (e.g. data merging)</td></tr>
<tr><td colspan="2">Performance of landmarking software</td><td>N/A</td></tr>
<tr><td>Performance of measurement calculation software</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="6">Human</td><td rowspan="2">Measurer</td><td colspan="3">Skill of landmarking</td><td>N/A</td></tr>
<tr><td>Skill of measurement</td><td colspan="3">N/A</td></tr>
<tr><td rowspan="2">Operator</td><td>N/A</td><td colspan="2">Skill of deciding landmark position from a marker</td><td>N/A</td></tr>
<tr><td>N/A</td><td>Skill of operating measurement calculation software</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Participant</td><td colspan="4">Repeatability of the posture</td></tr>
<tr><td>N/A</td><td colspan="3">Body sway during scan</td></tr>
</table>

5 Knowledge expected for experienced anthropometrists

5.1 General

Experienced anthropometrists are expected to be able to measure measurements of ISO 7250-1 with small intra-observer measurement errors, to obtain reliable statistics from the measured data, and to plan an anthropometric survey. Measuring, obtaining statistics and planning an anthropometric survey require different types of knowledge. They are listed in the following clauses.

5.2 Landmarking and measurement

The knowledge required for landmarking and measurement includes definitions of landmarks, procedure to decide positions of landmarks and place the landmarks, how to use and care for instruments, definitions of measurement items, and procedure to take measurements. They are listed in the following clauses. More information is available from published textbooks on anthropometry, manual for a survey, or standards.

5.2.1 Basic knowledge on human anatomy

Basic knowledge on human anatomy is necessary for understanding the definition of landmarks and their positions in the human body. Some landmarks are defined on a specific position on a bone (e.g. spinous process), and some measurements are defined using names of a specific position of a bone (e.g. styloid process).

Some landmarks defined on the tip of a bone are easier to palpate when the participant bends a joint. However, the participant is in the posture for measurement when the measurer puts a mark on the skin. This is because when the joint bends, the skin slides on the bone, and the relative position of the bone and skin changes.

5.2.2 Correct posture of participant

Participant posture is part of the definition of a measurement. Correct posture is essential because when the posture changes, the size of a dimension can also change. For example, shoulder (biacromial) breadth becomes smaller when arms are abducted; foot dimensions are smaller when participant is sitting rather than standing; waist circumference is smaller when the abdominal muscles are tight; stature becomes smaller when participant is not standing erect or larger when participant is in supine position.

The measurer needs to understand the definition of posture and to instruct the participant properly for him or her to take the correct posture.

5.2.3 Landmarking

When plural measurements defined using the same landmark are measured, position of the landmark is marked on the skin so that the same location is used for all measurements. An easily removable and non-toxic marker is used. An eyeliner pencil is often used for this purpose. The size and shape of the mark are such that it is easily recognized as a point on the skin, and clearly different from moles.

5.2.4 Instruments and small articles

Instruments used are listed in ISO 7250-1. Small articles used for defining lines or landmarks used in the apparel are listed in ISO 8559-1:2017, 4.2.

Safety of the participant is the matter of first priority. Measurer needs to take care of the pointed tip of the arm of anthropometer or sliding calipers.

Two arms of a large sliding caliper need to be the same length when it is used to measure a point-to-point distance.

Measurer covers the tips of a spreading caliper with fingertips to control the pressure on the participant skin.

Always use flat-tip-jaws of a sliding caliper. Never use pointed-tip-jaws for measuring people.

When a tape measure is wrapped around the participant, the zero point of the tape measure overlaps the scale on the tape measure [see Figure 1 a)]. Since the circumference of the trunk influenced by breathing, the participant is naturally breathing when measured.

When a body scanner is used for obtaining body dimensions, the accuracy of scan-derived body dimensions needs to be evaluated according to the protocol described in ISO 20685-1:2018, Clause 5.

a) Proper b) Not proper

Figure 1 — How to wrap a tape measure around participant

5.2.5 Role of the assistant

The measurer and the assistant work together as a team. The assistant helps the measurer in many ways as described below. The measurer needs to give proper instructions to the assistant to get effective help from the assistant.

The measurer reads aloud a measurement value, and the assistant writes down the number on the data sheet. In order to avoid mistakes in reading and/or hearing, the assistant repeats aloud the number before writing it down. When the number is clearly irregular, the assistant asks the measurer to take another measurement.

The assistant helps the measurer by watching if the anthropometer is vertical and by adjusting the position of the anthropometer when necessary. When a large circumference of the trunk such as chest circumference is measured, the assistant holds the tape measure at the back of the participant so that the position of the tape measure is horizontal and to avoid the tape measure slipping down.

The assistant also watches if the posture of the participant is correct (e.g. the head is oriented in the Frankfurt plane).

Basically, the assistant works according to the instructions of the measurer. However, it helps to reduce the time required for measurement if he or she can act as necessary without instruction from the measurer. If the assistant has knowledge on anthropometry, it helps to play his or her role properly.

5.2.6 Anthropometric data sheet

Anthropometric data sheets are designed so that there are blanks for all necessary information. Measurement items are ordered to minimize the required time for measurements and to minimize the errors due to mistakes. Recommended background data on the survey are listed in ISO 15535:2023, 7.2. Necessary background information items on each participant are listed in ISO 15535:2023, Annex B. An example data sheet is in ISO 15535:2023, Annex C.

5.3 Planning an anthropometric survey

5.3.1 Participants

The target population (gender, age range and other background as necessary) and the number of participants are selected according to the purpose of the survey. A method to estimate the number of participants required to have a particular confidence at 5th and 95th percentiles is described in ISO 15535:2023, Annex A.

The method of recruiting participants is selected.

5.3.2 Measurement items

Measurement items are selected according to the purpose of the survey and landmarks necessary to take these measurements are confirmed. Instruments and small articles necessary for landmarking and measurement are selected.

The time required for measuring one participant is estimated.

5.3.3 Measurers and assistants

When the number of measurement items is too large for one measurer, the measurement items are divided into several groups and each group of measurement items are allocated to a different measurer. This reduces the burden on measurers and assistants and saves time for measurement since more participants can be measured at the same time.

The number of measurers and assistants are selected considering the load on each measurer and measurement items are allocated to each measurer. The number of participants measured in one day is estimated.

One or more persons other than measurers and assistants are necessary to guide participants and to handle unexpected events during survey.

5.3.4 Space

The space is prepared for obtaining informed consent, changing room, measuring room and resting room in case participants become ill.

Separate or partitioned measuring booths are prepared for each measuring team for protecting the privacy of the participants.

5.3.5 Schedule of survey

The number of days more than sufficient is estimated to measure all participants.

5.3.6 Clothing of participants

According to ISO 7250-1:2017, 4.1, “the participant shall be nude or shall wear only minimal clothing and shall be bareheaded and without shoes”. Culturally permissible clothing suitable for the purpose of the survey is selected. Conditions of desirable scanning attire are described in ISO 20685-1:2018, Annex A.

Different sizes of clothing that satisfy participants belonging to the target population are prepared.

A decision is made on whether the clothing is washed and reused or used only once. If reused, extra clothing for use is prepared while other clothes are being washed.

Loose clothing to wear is prepared while the participant moves to the next booth if necessary.

5.3.7 Ethical considerations

Many institutions have an ethical committee for the purpose of protecting the rights of the participants. A plan of an anthropometric survey is reviewed and approved by an institutional ethical committee. Issues such as the following are considered when planning an anthropometric survey.

a) Protection of participants

Participants wear only minimal clothing during anthropometry. The space for anthropometry is designed to protect the privacy of the participant.

The measurement time is minimized so that the participant does not get tired. Resting time is inserted between sessions as necessary.

A place for rest is prepared in case the participant becomes ill.

b) Informed consent

Informed consent is obtained from each participant before starting measurement.

c) Protection of measurers and assistants

Tight schedule is avoided so that the working time in a day is not too long for measurer-assistant teams. Resting time is inserted between sessions if necessary.

When many measurement items are taken, and multiple measurers participate, measurements are allocated appropriately to measurer-assistant teams to reduce the burden on each team.

d) Gender

Best practice is that measurers and assistants are of the same gender as the participant.

5.4 Data editing

It is inevitable that measurements collected by the traditional methods have irregular values caused by mistakes. These irregular values are corrected or removed before statistical analysis. Procedure for data editing is standardized in ISO 15535:2023, Annex F.

Most of the errors caused by mistakes are not outliers that exceed the mean ±3 standard deviations. Such errors cannot affect the mean but can affect statistics such as correlation coefficient. To identify such irregular values, procedure using a scatter diagram as described in ISO 15535:2023, Annex F is necessary.

6 Quantifying measurement errors

6.1 General

The skill of a measurer can be quantified by using indicator(s) of intra-observer measurement error. Comparability between two measurers can be also quantified using some of these indicators. The protocol described in ISO 20685-1:2018, Clause 5 is applicable to evaluate the comparability of measurements taken by two different measures.

6.2 Intra-observer measurement error

Indicators of intra-observer measurement error can be obtained through an experiment, in which an observer measures each of n participants twice. In the experiment, sufficient time is inserted between the two measurements in order to avoid the measurer remembering the former value.

Measurement of participant-i measured by a measurer, x_i, can be described as Formula (1),

$$x_i = M + P_i + O + e_i \tag{1}$$

where

M is the mean of the population;

P_i is the characteristic of participant-i;

O is the bias of the observer;

e_i is random error.

Intra-observer error, the difference between two repeated measurements of participant-i measured by the measurer, is d_i, and described by Formula (2).

$$d_i = x_{i1} - x_{i2} = e_{i1} - e_{i2} \quad (2)$$

where

x_{i1} is the first measurement;

x_{i2} is the second measurement.

Since M, P_i and O are cancelled out, the intra-observer error depends only on the random error, and mean of d_i is 0. However, variance of d_i is not 0.

The magnitude of the intra-observer error is often quantified by mean absolute difference (MAD), described as Formula (3), where n is the number of participants.

Another indicator of the intra-observer error is technical error of measurement (TEM) calculated as Formula (4). TEM is the square root of the variance of random error. Both MAD and TEM are described in the unit of measurement (mm or kg).

$$\overline{X}_{\text{absdiff}} = \sum |d_i| / n \quad (3)$$

$$S_{\text{diff}} = \sqrt{[\sum (d_i^2)/2n]} \quad (4)$$

where

$\overline{X}_{\text{absdiff}}$ is the mean absolute difference, MAD;

S_{diff} is the technical error of measurement, TEM;

n is the number of participants.

The percentage of random error variance is calculated by dividing the square of TEM by the square of the standard deviation of measurement x.

Correlation coefficient between repeated measurements represents the linear relationship between the two repeated measurements and can be used to quantify the intra-observer error.

When random error is very small, MAD, TEM and %REV are close to 0, while correlation coefficient between repeated measurements is close to 1.

6.3 Inter-observer measurement error

Indicators of the inter-observer error are obtained through an experiment, where two observers measure each of n participants once. The difference between two measurements of participant-i taken by observer-1 and observer-2, d_i, is described as Formula (5). Since the inter-observer error includes bias between the two measurers [O_1 −O_2 in Formula (5)], the inter-observer measurement error is always larger than the intra-observer measurement error.

$$d_i = M + P_i + O_1 + e_{i1} - (M + P_i + O_2 + e_{i2}) = (O_1 - O_2) + (e_{i1} - e_{i2}) \quad (5)$$

where

M	is the mean of the population;
P_i	is the characteristic of participant-i;
O_1	is the error specific to observer-1;
O_2	is the error specific to the observer-2;
e_{i1}	is the random error for measurement of participant-i measured by observer-1;
e_{i2}	is the random error for measurement of participant-i measured by observer-2.

Magnitude of inter-observer error can be quantified using MAD and TEM. Correlation coefficient between the measurements taken by two different observers can be used to represent the linear relationship between the two sets of measurements, but it does not reflect the magnitude of bias, the systematic difference between the two observers.

In the case of inter-observer measurement errors, comparability between measurers is most important. Comparability between two measurers can be evaluated according to ISO 20685-1:2018, Clause 5. The number of participants necessary for evaluation, evaluation criteria and evaluation protocol are described in ISO 20685-1:2018, 5.3.

When several measurers participate in an anthropometric survey for taking the same measurement items, the comparability of measurements is evaluated before the survey.

6.4 Errors in landmarking

Intra- or inter-observer errors in landmarking can be quantified as the distance between the marks made at two landmarkings. The intra-observer error is quantified when both marks are made by the same measurer, while the inter-observer error is quantified when the two marks are made by different measurers.

By using a marker pen with ink visible only under the black light at the first landmarking and using an eyeliner pencil under the ordinary light at the second landmarking, the first mark can be invisible to the second measurer.

Direction of error affects the magnitude of measurement error. For example, error in antero-posterior direction will not have much effect on shoulder height but can have significant effect on biacromial breadth.

7 Report

Evaluation results of intra-observer measurement errors include MAD, TEM, %REV, and correlation coefficient between repeated measurements for each measurement item. Annex A shows an example report of intra-observer measurement error experiment.

Evaluation results on inter-observer measurement errors include MAD, TEM, %REV, correlation coefficients between two measurers, and evaluation results of comparability according to ISO 20685-1:2018. Annex B shows an example report of an inter-observer measurement error experiment.

Evaluation results on intra- or inter-observer errors in landmarking include mean and standard deviation of distance between two marks made on the same landmark. Annex C shows an example report of intra-observer errors in landmarking.

Annex A
(informative)

Example report of intra-observer measurement errors

Table A.1 and Table A.2 show example reports of evaluation of intra-observer measurement errors. Table A.1 shows the information on the experiment. Table A.2 shows the evaluation results.

Table A.1 — Example report of evaluation of intra-observer measurement errors — Information on the experiment

Date and place of experiment	1994-08-29. First measurements were taken in the morning and the second measurements in the afternoon. National Institute of Bioscience and Human Technology, Tsukuba, Japan
Number of measurers	Seven measurers participated. Measurer-1 and Measurer-2 are well experienced. Measurers-4, -5, and -7 took a training course. Measurers-3 and -6 had only short experience.
Number of measurement items by measurer	208 measurement items Measurer-1: 35 head measurements Measurer-2: 34 hand and foot measurements, and took foot outline (8 measurements were later obtained from the foot outline) Measurer-3: weight, maximum height and 20 circumference and surface distance measurements Measurer 4: 28 measurements taken with an anthropometer Measurer-5: 30 breadth, length, and depth measurements Measurer-6: 11 functional lengths, 17 circumference, and 4 skinfold thickness measurements Measurer-7: 27 measurements with participant sitting
Participants (number, background)	12 young male adults
Information of report	2021-09-29, prepared by M. Kouchi
Reference	[5]

Table A.2 — Example report of evaluation results of intra-observer measurement errors

Measurement in ISO 7250-1:2017		MAD mm	TEM mm	%REV	Correlation coefficient	Measurer
6.1.1	Body mass	N/A				
6.1.2	Stature	2,00	2,47	0,1	1,00	4
6.1.3	Eye height [a]	6,00	5,03	0,7	0,99	4
6.1.4	Shoulder height	3,75	3,18	0,3	1,00	4
6.1.5	Elbow height	3,83	3,30	0,6	0,99	4
6.1.6	Iliac spine height, standing	4,33	4,11	0,9	0,99	4
6.1.7	Crotch height	4,92	4,24	1,2	0,99	4
6.1.8	Tibial height	3,86	3,08	2,1	0,98	4
6.1.9	Chest depth, standing [b]	2,92	2,64	3,0	0,97	5
6.1.10	Body depth standing	N/A				
6.1.11	Chest breadth, standing [b]	5,38	4,60	8,0	0,92	5
6.1.12	Hip breadth	2,75	2,30	2,0	0,98	5
6.2.1	Sitting height, erect	3,50	3,00	0,8	0,99	7
6.2.2	Eye height, sitting [a]	5,42	4,65	2,0	0,98	7
6.2.3	Cervicale height, sitting	3,08	2,76	0,9	0,99	7
6.2.4	Shoulder height, sitting	4,83	4,31	2,4	0,98	7
6.2.5	Elbow height, sitting	7,17	6,03	5,8	0,94	7
6.2.6	Shoulder-elbow length	1,79	1,50	0,9	0,99	5
6.2.7	Shoulder (biacromial) breadth	2,25	1,99	1,3	0,99	5
6.2.8	Shoulder (bideltoid) breadth	3,67	3,51	2,6	0,97	5
6.2.9	Elbow-to-elbow breadth	8,79	8,72	8,7	0,91	5
6.2.10	Hip breadth, sitting	2,08	2,07	1,2	0,99	5
6.2.11	Popliteal height, sitting	4,83	3,95	3,8	0,96	7
6.2.12	Thigh clearance	2,50	2,71	5,7	0,94	7
6.2.13	Knee height, sitting	3,17	2,80	1,5	0,99	7
6.2.14	Abdominal depth, sitting [c]	4,00	3,63	3,5	0,97	7
6.2.15	Thorax depth	2,21	2,16	1,8	0,98	5
6.2.16	Buttock-abdomen depth, sitting	4,58	3,82	5,1	0,95	7
6.3.1	Hand length (stylion) [d]	1,63	1,42	2,6	0,97	2
6.3.2	Palm length [d]	1,38	1,14	3,9	0,96	2
6.3.3	Hand breadth at metacarpals [e]	0,75	0,63	2,8	0,97	2
6.3.4	Index finger length	0,83	0,68	2,9	0,97	2
6.3.5	Index finger breadth, proximal	0,25	0,32	4,6	0,95	2
6.3.6	Index finger breadth, distal	0,21	0,31	3,1	0,97	2

[a] Measured to entocanthion.

[b] Measured at the nipple level.

[c] Arms were held up.

[d] Measured from wrist crease.

[e] Hand breadth, diagonal.

[f] Measured using a foot measuring box.

[g] Nasion-gnathion.

[h] From the wall against which the olecranon was pressed.

[i] Measured at just below the gluteal fold.

Table A.2 *(continued)*

Measurement in ISO 7250-1:2017		MAD mm	TEM mm	%REV	Correlation coefficient	Measurer
6.3.7	Foot length [f]	0,75	0,69	0,4	1,00	2
6.3.8	Foot breadth [f]	1,04	1,01	3,8	0,96	2
6.3.9	Head length	0,88	0,75	1,2	0,99	1
6.3.10	Head breadth	0,29	0,37	0,4	1,00	1
6.3.11	Face length (menton-sellion) [g]	1,96	1,76	7,9	0,92	1
6.3.12	Head circumference	1,08	1,02	0,5	1,00	1
6.3.13	Sagittal arc	2,50	2,25	2,2	0,98	1
6.3.14	Bitragion arc	1,83	1,63	1,6	0,98	1
6.3.15	Thumb length	0,92	0,75	3,4	0,97	2
6.3.16	Thumb breadth	N/A				2
6.3.17	Hand thickness	0,75	0,66	6,2	0,94	2
6.3.18	Hand breadth including thumb	1,08	0,91	3,4	0,97	2
6.3.19	Arm circ. flexed	1,92	2,12	0,7	0,99	3
6.3.20	Forearm circ. flexed	N/A				
6.4.1	Wall-acromion distance	5,42	4,21	11,2	0,89	6
6.4.2	Grip reach	6,33	5,98	3,5	0,97	6
6.4.3	Elbow-wrist length [h]	3,42	2,94	5,7	0,94	6
6.4.4	Elbow-grip length [h]	4,17	3,67	6,4	0,94	6
6.4.5	Fist (grip axis) height	N/A				
6.4.6	Forearm-fingertip length	1,38	1,19	0,4	1,00	6
6.4.7	Buttock-popliteal length (seat depth)	8,75	7,32	11,5	0,89	7
6.4.8	Buttock-knee length	6,92	5,71	5,3	0,95	7
6.4.9	Neck circumference	2,23	1,91	1,2	0,99	6
6.4.10	Chest circumference	5,83	5,16	0,9	0,99	6
6.4.11	Waist circumference	8,83	7,56	1,7	0,98	6
6.4.12	Wrist circumference	2,50	2,10	7,5	0,93	3
6.4.13	Thigh circumference [i]	3,25	2,75	0,5	1,00	6
6.4.14	Calf circumference	2,75	2,13	0,8	0,99	6

[a] Measured to entocanthion.

[b] Measured at the nipple level.

[c] Arms were held up.

[d] Measured from wrist crease.

[e] Hand breadth, diagonal.

[f] Measured using a foot measuring box.

[g] Nasion-gnathion.

[h] From the wall against which the olecranon was pressed.

[i] Measured at just below the gluteal fold.

Annex B
(informative)

Example report of inter-observer measurement errors

Table B.1 and Table B.2 show an example report of evaluation of inter-observer measurement errors. Table B.1 shows the information on the experiment. Table B.2 shows the evaluation results.

Table B.1 — Example report of evaluation of inter-observer measurement errors — Information on the experiment

Date and place of experiment	1994-08-31. National Institute of Bioscience and Human Technology, Tsukuba, Ibaraki, Japan
Measurers	6 (4 experienced and 2 non-experienced) measurers participated. Results of two experienced measurers are reported
Measurement items	32 measurement items were selected so that different instruments were used. Results of 16 measurements with the same or similar definitions with those from ISO 7250-1 are reported
Participants	27 young adult males
Information of report	2021-09-29, prepared by M. Kouchi
Reference	[6]

Table B.2 — Example report of evaluation results for inter-observer measurement errors

Measurement item of ISO 7250-1		MAD mm	TEM mm	R	Confidence interval of mean difference mm		Comparability
					Lower limit	Upper limit	
6.1.2	Stature (body height)	5,07	4,11	0,996	0,46	2,86	Yes
6.1.6	Iliac spine height, standing	5,93	5,08	0,988	-6,13	-3,40	No
6.1.7	Crotch height	9,85	8,22	0,980	6,01	9,27	No
6.1.12	Hip breadth, standing	3,04	2,54	0,988	-0,12	1,56	Yes
6.2.1	Sitting height (erect)	6,59	6,15	0,971	2,31	5,41	No
6.2.7	Shoulder (biacromial) breadth	9,44	7,47	0,966	7,62	9,82	No
6.2.8	Shoulder (bideltoid) breadth	2,85	2,53	2,852	0,72	2,27	Yes
6.2.15	Thorax depth	2,96	2,52	0,988	-1,29	0,45	Yes
6.3.9	Head length	1,54	1,30	0,976	0,48	1,43	Yes
6.3.11	Face length [a]	2,61	2,32	0,874	-2,02	-0,42	No
6.3.19	Arm circumference flexed	5,19	4,83	0,994	3,48	5,56	No
6.4.8	Buttock-knee length	5,91	5,67	0,963	-4,56	-1,16	Yes
6.4.9	Neck circumference	4,81	4,21	0,974	-0,90	1,71	Yes
6.4.10	Chest circumference	18,00	13,68	0,990	11,82	16,38	No
6.4.11	Waist circumference	9,85	8,25	0,994	-1,21	3,49	Yes
6.4.14	Calf circumference	4,59	4,34	0,978	0,19	2,75	Yes

[a] Measured from nasion to gnathion.