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Size designation of clothes —

Part 3: Methodology for the creation of body measurement tables and intervals

Désignation des tailles des vêtements —

Partie 3: Méthodologie de création de barèmes de mensuration du corps et des intervalles

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 133, *Clothing sizing system — size designation, size measurement methods and digital fittings*.

A list of all parts in the ISO 8559 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

In order to size mass-produced clothes, the body size of the intended wearer has to be defined and identified with the nearest size on a table of sizes. In this garment-related system, the body size is defined by scales of the appropriate primary dimensions. A good degree of standardization is achieved by the establishment of open-ended size scales with (fixed or not) intervals in at least the primary control dimension for each garment type. Where body shape is characterized by two primary girth dimensions, the first is placed on fixed scale, while the second (the dependent variable) is not.

The processing of body measurement data as described in this document results in the grouping of body sizes appropriate to the studied population concerned. Examples of garment size tables are readily compiled from this information.

The frequency distribution of body sizes is a useful means of determining which body sizes are applicable to the bulk of the population. Consequently, systems can be adjusted, particularly in the case of waist girth for women's wear for which body shape is defined by dimensions other than the waist girth.

Distribution of body dimensions can change due to changes over time. However, it might not be necessary to update a size table if the products can accommodate the population. As the results of the sizing surveys of the different countries vary, the tables in this document provide the required flexibility.

As an application of the methodology, measurement tables, in conjunction with body shapes, can be used to produce fit mannequins (known as "dummies").

Size designation of clothes —

Part 3:
Methodology for the creation of body measurement tables and intervals

1 Scope

This document describes the principles of the establishment of tables for body measurements, defines the categories of tables (related to intervals), and lists the population groups (infants, girls, boys, children, women, men) and sub-groups to be used for developing ready-to-wear garments. The body measurement tables and intervals are mainly used by the clothing sector to make the development of well-fitting products easier and more accurate.

The described methodology is mainly based on the application of statistical analysis, using body dimension data. The statistical level has deliberately been kept to a low level in order for the content to be made readily comprehensible to the widest possible readership.

This methodology is applicable to various sets of body dimensions. It can be useful to determine intervals for the size designation as described in ISO 8559-2. Values in the tables in this document are examples.

Garment dimensions are not included in this document.

It is necessary to use a general approach providing inbuilt flexibility, in order to keep the whole sizing system capable of adapting to changes (e.g. demographic criteria), because body shape and proportions for any one targeted population group differ significantly.

NOTE ISO 15535 can be convenient for recording and organizing the population data.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8559-1, *Size designation of clothes — Part 1: Anthropometric definitions for body measurement*

ISO 8559-2, *Size designation of clothes — Part 2: Primary and secondary dimension indicators*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8559-1 and ISO 8559-2 and the following apply.

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

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

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

3.1
explanatory variable
input data that is used to calculate simple or multiple linear regression

3.2
dependent variable
input data that is used to calculate simple or multiple linear regression, with *explanatory variable(s)* (3.1)

3.3
interval
difference between the two adjoining values in a body measurement table

3.4
drop
<men> half difference between chest girth and waist girth, expressed in centimetres, with a negative value when the chest is smaller than the waist

4 Principles related to the methodology of the creation of the body measurement tables

4.1 General

In order to get a garment fitting correctly on a body, it is essential to collect the body dimension measurements. These measurements are useful to design the 2-dimensional garment pattern, which are to be assembled in garment production. These measurements are useful also to design the 3-dimensional garment, such as seamless knitted garments.

Within the clothing industry, when faced with the need to mass produce clothing articles intended to fit a population of varying morphologies, a series of body measurement tables are internally determined in order to design the appropriate clothing articles. The creation of body measurement tables is based on a statistical approach of the body dimensions of the population.

The producer/retailer strategy, taking into account its market location, its targeted population, etc. leads to the creation of its own body measurement tables. Nonetheless, whatever the basis of the body measurement tables, their creation is based on the same principles as described in this document.

Any regression formula calculated for one group of population is specifically applicable to this group and should not automatically be applied to other groups.

Annex A gives an overview of the clothing industry needs regarding the anthropometric data.

Annex B shows an example of a body measurement table content.

Annex D gives an overview of key statistical tasks.

4.2 Selection of the explanatory variables and the dependent variable (statistical methodology)

The explanatory variable refers to the selected variable input data in the measurement tables. They are mainly based on a dimension characterizing a body measurement (as defined in ISO 8559-1) or based on other body characteristics (e.g. body mass).

Annex C describes statistical models commonly used for the creation of body measurement tables.

The selection of the explanatory variable is based on various criteria:

— the two or more selected explanatory variables, representing body dimensions, shall be statistically independent and perpendicular: one representing the measurement on the vertical axis and the others that of width or girth (on the horizontal axis);

— a robust correlation does exist between the explanatory and dependent variables;

— based on the given ranges and/or intervals related to the development of clothing, the number of sizes is led by the combination of the chosen dimensions;

— the values of the measurements are easy to remember by the consumer.

The selection of the explanatory variables shall be carried out through various statistical studies, with the successive addition of dimensions to the statistical model. This allows the best combination of the dimensions for the explanatory variables and the dependent variable to be obtained.

It is important to take into consideration the following questions while selecting the explanatory and dependent variables in order to design and develop clothing that fits as many target consumers as possible.

a) What are the standard deviations of the dimensions selected as the dependent variable in relation with the dimension(s) selected as the explanatory variables?

b) What should be the relation between the standard deviations mentioned in a) and the tolerance of clothing fitting?

The selection of explanatory variable is usually from the few most important dimensions, such as height, chest girth, waist girth, hip girth.

And then multiple regressions lead to calculate a residual standard deviation, which provides information not explained by the combination of explanatory variable on the prediction of dependent variable. Lower is the residual standard deviation; more satisfactory is the combination of the main dimensions regarding the prediction of the related dependent variable. The residual standard deviation is comparable with the clothing fitting tolerances. The point is that the residual standard deviation leads to calculate a difference allowing for a measured value data, i.e. 95 % of concerned people at this value are placed in this difference, to be compared with the tolerances.

The dependent variable refers to the selected variable input data in the measurement tables that can be used with the explanatory variable. They are mainly based on a dimension characterizing a body measurement (as defined in ISO 8559-1).

The concept of the residual standard deviation, as mentioned in this sub-clause, is suitable for the dependent variable.

5 Categories of body measurement tables

5.1 "Statistic" tables

The creation of the body measurement tables, according to the principles as described in Clause 4 leads to obtaining tables which may be qualified as "statistic" tables.

The tabled dimensions, expressed in centimetres, are generally predicted data, which cannot be suitable for the clothing development. They are not adapted to the design process for ready to wear clothing industry (such as pattern creation, design software). In these tables, intervals are variable.

The content of a body measurement table is based on the explanatory variable, expressed as a body dimension (as defined in ISO 8559-1) and the series of the predicted dependent variable expressed as a body dimension (as defined in ISO 8559-1), see example in Annex B.

5.2 "Linearly smoothed" tables

Only processed data in the form of tables are used for the clothing development.

The first level is to linearly smooth the data to be adapted, for example, to the design software [Computer Assisted Design (CAD)], based on the choice of the value of the step. It means that in these tables, the interval within a sub-group is even. This action leads to "smoothed" tables (see example in Table 1).

Table 1 — Example of linear smoothing of data

	Sub-group 1					Sub-group 2				Sub-group 3	
	inter-val	**size #1**	**size #2**	**size #3**	**size #4**	**interval**	**size #5**	**size #6**	**size #7**	**interval**	**size #8**
waist girth (cm)	***variable***	50,0	51,5	54,2	56,0	***variable***	58,5	60,5	62,0	***variable***	65,0
	⇩		after linear smoothing			⇩				⇩	
waist girth (cm)	***2,0***	50,0	52,0	54,0	56,0	***2,5***	58,5	61,0	63,0	***3,0***	66,0

6 Choice of the data

6.1 General

In general, as mentioned in 4.2, the choice of the two independent explanatory variables is based on:

— as the length data: height, and

— as the circumference data: chest/bust girth, or waist girth, or hip girth.

Nonetheless the choice of two independent explanatory variables can be different in relation to the type of garment.

For example, in the case of trousers for men, the choice of the two-independent data can be inside leg length (as length data) and waist girth (as circumference data).

6.2 Homogeneous population: improvement in relation to sub-groups of the population

6.2.1 General

From measurement of a population, several groups can be defined so that each group is relatively homogeneous in morphology, in order to get more accurate and reliably predictable system and ensure a better match between the body measurement scales and the clothing fitting.

In order to get a more homogeneous population, additional statistical calculations are carried out to improve the value of R^2, i.e. closer and closer to the value 1.

NOTE 1 A value of R^2 greater than 0,8 is found to be satisfactory.

These additional statistical calculations are based on the determination of sub-groups, which can be based, for example, on the gender, body shape characteristics (e.g. drop values), height, body mass and age.

NOTE 2 Body Mass Index (BMI), which combines the body mass and height (body mass divided by height squared), is sometimes used to determine a sub-group.

NOTE 3 For infants, children, girls and boys, a sub-group based on "age" leads to too large a variation and therefore such a sub-group is not sufficiently homogeneous.

Explanatory variables mentioned in the following subclauses are examples of those commonly used for the creation of body measurement tables. When two explanatory variables are mentioned, the first variable represents the measure on the vertical axis and the second represents the measure on the horizontal axis (girth or width).

6.2.2 "Infants" group

Explanatory variables are height and waist girth.

Sleep bag: Explanatory variables are height and head girth.

Sub-group: mass.

6.2.3 "Children" group (girls and boys)

Explanatory variables are height and hip girth.

Sub-group: based on morphology (e.g. waist girth, BMI).

6.2.4 "Girls" group

Explanatory variables are:

— height and hip girth;

— height and bust girth.

6.2.5 "Boys" group

Explanatory variables are:

— height and waist girth;

— height and chest girth.

6.2.6 "Women" group

To fit the upper body, explanatory variables are height and bust girth.

To fit the lower body, explanatory variables are height, hip girth or waist girth.

For bras, explanatory variables are:

— height and under-bust girth;

— height and bust girth.

Sub-group: based on morphology (e.g. ratio between bust girth, waist girth and hip girth).

6.2.7 "Men" group

To fit the upper body, the usual selected explanatory variables are "height" and "chest girth" (see example in Annex B).

Especially for shirts, the selected explanatory variables can be "arm length" and "neck girth".

To fit the lower body, the usual selected explanatory variables are "height" and "waist girth".

The "men" sub-groups can be based on body shapes, known as "drop". The following drop values are commonly used:

a) Drop 16 to 10

b) Drop 8 to 6

c) Drop 4 to 2

d) Drop 0

e) Drop −2 to −4

7 Decisions on intervals and ranges

7.1 Intervals

In order to maintain maximum flexibility, it is left up to a company to choose the appropriate intervals.

7.2 Range

Range is calculated by using one half plus or half minus the interval from the explanatory variable.

EXAMPLE For a height (as explanatory variable) of 156 cm, the range of 154 to 158 cm leads to an interval of 4 cm (see Table 2).

Table 2 — Example of height range

Height	156	
Range	154	158
Interval	4	

7.3 Examples — Men

7.3.1 Explanatory variable based on height

In order to accommodate variations in height by company, body measurement tables are commonly based on 4 cm (example in Table 4) or 8 cm (example in Table 3) intervals.

Table 3 — Example for ranges for heights for men with 8 cm intervals with starting point of 156 cm

Dimensions in centimetres

Height	**156**		**164**		**172**		**180**		**188**		**196**		**204**	
Range	152	160	160	168	168	176	176	184	184	192	192	200	200	208
Intervals	***8***		***8***		***8***		***8***		***8***		***8***		***8***	

Table 4 — Example for ranges for heights for men with 4 cm intervals with starting point of 156 cm

Dimensions in centimetres

Height	**156**		**160**		**164**		**168**		**172**		**176**		**180**		**184**		**188**		**192**		**196**		**200**		**204**		**208**	
Range	154	158	158	162	162	166	166	170	170	174	174	178	178	182	182	186	186	190	190	194	194	198	198	202	202	206	206	210
Intervals	***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***		***4***	

7.3.2 Explanatory variable based on chest girth

In order to accommodate variations in chest girth by company, body measurement tables are commonly based on constant interval value (such as 4 cm – as shown in Table 5 – or 6 cm – as shown in Table 6) or are sometimes based on a combination of interval values (such as consecutive values of 6, 8, and 10 cm as shown in Table 7).

Table 5 — Example for ranges for chest girth for men with 4 cm intervals with starting point of 76 cm

Dimensions in centimetres

Mean value	76		80		84		88		92		96		100		104		108		112		116		120		124		128		132		136	
Range	74	78	78	82	82	86	86	90	90	94	94	98	98	102	102	106	106	110	110	114	114	118	118	122	122	126	126	130	130	134	134	138
Intervals	*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*		*4*	

Table 6 — Example for ranges for chest girth for men with 6 cm intervals with starting point of 76 cm

Dimensions in centimetres

Mean value	76		82		88		94		100		106		112		118		124		130		136	
Range	73	79	79	85	85	91	91	97	97	103	103	109	109	115	115	121	121	127	127	133	133	139
Intervals	*6*		*6*		*6*		*6*		*6*		*6*		*6*		*6*		*6*		*6*		*6*	

Table 7 — Example for ranges for chest girth for men with a combination of 6 cm, 8 cm and 10 cm intervals with starting point of 78 cm

Dimensions in centimetres

Mean value	78		84		90		96		102		110		120	
Range	75	81	81	87	87	93	93	99	99	105	106	114	115	125
Intervals	*6*		*6*		*6*		*6*		*6*		*8*		*10*	

Annex A
(informative)

Clothing industry needs related to anthropometric data

The following flowchart, Figure A.1 is intended for summarizing the needs of the clothing industry regarding the anthropometric data.

Figure A.1 — Needs of the clothing industry regarding the anthropometric data

Annex B
(informative)

Example of a body measurement table content

Selected explanatory variables: height and chest girth (intended for a targeted "men" group, upper body garments).

The following body measurement table, Table B.1, is based on the following explanatory variables: height (X_1) and chest girth (X_2). The body measurement table contains data only based on one value of height. Consequently, different tables have to be determined for each selected height. All values of the body dimensions are usually given in centimetres [13].

NOTE The letters in Table B.1 could refer to body landmarks and might be given with the body drawing (see example Figure B.1). Not all body measurements listed in Table B.1 or body measurement positions indicated on Figure B.1 are from ISO 8559-1.

Table B.1 — Example of body measurement table of "men" groups

Height at 181 cm		Sub-group 1 (Drop = 4)							Sub-group 2 (Drop = 3)							Sub-group 3 (Drop = 2)				
		Interval evolution	**range #1**	**range #2**	**range #3**	**range #4**	**range #5**	**range #6**	**Interval evolution**	**range #7**	**range #8**	**range #9**	**range #10**	**range #11**	**range #12**	**Interval evolution**	**range #13**	**range #14**	**range #15**	**range #16**
A	**Chest girth**	**4**	76	80	84	88	92	96	**4**	100	104	108	112	116	120	**4**	**124**	**128**	**132**	**136**
B	Waist girth	**4,4**	60,4	64,8	69,2	73,6	78	82,4	**4,4**	86,8	91,2	95,6	100	104,4	108,8	**4,9**	**113,7**	**118,6**	**123,5**	**128,4**
C	Hip girth	**3,4**	70,9	74,3	77,7	81,1	84,5	87,9	**3,1**	91	94,1	97,2	100,3	103,4	106,5	**3,1**	**109,6**	**112,7**	**115,8**	**118,9**
D	Seat girth	**3**	82,1	85,1	88,1	91,1	94,1	97,1	**2**	99,1	101,1	103,1	105,1	107,1	109,1	**1,6**	**110,7**	**112,3**	**113,9**	**115,5**
E	Thigh girth	**1,7**	45,3	47	48,7	50,4	52,1	53,8	**1,1**	54,9	56	57,1	58,2	59,3	60,4	**0,8**	**61,2**	**62**	**62,8**	**63,6**
F	Knee girth	**1**	31,9	32,9	33,9	34,9	35,9	36,9	**0,7**	37,6	38,3	39	39,7	40,4	41,1	**0,7**	**41,8**	**42,5**	**43,2**	**43,9**
G	Calf girth	**1,2**	30	31,2	32,4	33,6	34,8	36	**0,6**	36,6	37,2	37,8	38,4	39	39,6	**0,6**	**40,2**	**40,8**	**41,4**	**42**
H	Ankle girth	**0,6**	22,4	23	23,6	24,2	24,8	25,4	**0,4**	25,8	26,2	26,6	27	27,4	27,8	**0,3**	**28,1**	**28,4**	**28,7**	**29**
I	Front breast width	**1**	31	32	33	34	35	36	**1**	37	38	39	40	41	42	**0,9**	**42,9**	**43,8**	**44,7**	**45,6**
J	Back width	**1**	34	35	36	37	38	39	**1**	40	41	42	43	44	45	**0,9**	**45,9**	**46,8**	**47,7**	**48,6**
K	Head girth	**0,4**	55,3	55,7	56,1	56,5	56,9	57,3	**0,2**	57,5	57,7	57,9	58,1	58,3	58,5	**0,1**	**58,6**	**58,7**	**58,8**	**58,9**
L	Neck girth	**1,1**	32,1	33,2	34,3	35,4	36,5	37,6	**1,1**	38,7	39,8	40,9	42	43,1	44,2	**1**	**45,2**	**46,2**	**47,2**	**48,2**
M	Neck-base girth	**1,1**	38,8	39,9	41	42,1	43,2	44,3	**0,9**	45,2	46,1	47	47,9	48,8	49,7	**0,8**	**50,5**	**51,3**	**52,1**	**52,9**
N	Upper-arm girth	**1,1**	23,1	24,2	25,3	26,4	27,5	28,6	**0,7**	29,3	30	30,7	31,4	32,1	32,8	**0,5**	**33,3**	**33,8**	**34,3**	**34,8**

Table B.1 *(continued)*

Height at 181 cm		Sub-group 1 (Drop = 4)							Sub-group 2 (Drop = 3)							Sub-group 3 (Drop = 2)				
		Interval evolu-tion	**range #1**	**range #2**	**range #3**	**range #4**	**range #5**	**range #6**	**Interval evolu-tion**	**range #7**	**range #8**	**range #9**	**range #10**	**range #11**	**range #12**	**Interval evolu-tion**	**range #13**	**range #14**	**range #15**	**range #16**
O	Wrist girth	**0,5**	14,6	15,1	15,6	16,1	16,6	17,1	**0,3**	17,4	17,7	18	18,3	18,6	18,9	**0,2**	**19,1**	**19,3**	**19,5**	**19,7**
P	Shoul-der length	**0,1**	13,8	13,9	14	14,1	14,2	14,3	**0,03**	14,33	14,36	14,39	14,42	14,45	14,48	**0,03**	**14,51**	**14,54**	**14,57**	**14,6**
Q	Scye depth	**0,2**	22,5	22,7	22,9	23,1	23,3	23,5	**0,2**	23,7	23,9	24,1	24,3	24,5	24,7	**0,2**	**24,9**	**25,1**	**25,3**	**25,5**
R	Crotch-waist height	**0,4**	27,8	28,2	28,6	29	29,4	29,8	**0,3**	30,1	30,4	30,7	31	31,3	31,6	**0,2**	**31,8**	**32**	**32,2**	**32,4**
S	Back waist length	**0,1**	45,5	45,6	45,7	45,8	45,9	46	**0,1**	46,1	46,2	46,3	46,4	46,5	46,6	**0,1**	**46,7**	**46,8**	**46,9**	**47**
T	Shoul-der slope	**0**	22	22	22	22	22	22	**0**	22	22	22	22	22	22	**0**	**22**	**22**	**22**	**22**
U	Waist height	**0**	110	110	110	110	110	110	**0**	110	110	110	110	110	110	**0**	**110**	**110**	**110**	**110**
V	Outside leg length	**(+1)**	111	111	111	111	111	111	**(+1,2)**	111,2	111,2	111,2	111,2	111,2	111,2	**(+1,5)**	**111,5**	**111,5**	**111,5**	**111,5**
W	Cervical height	**0**	157	157	157	157	157	157	**0**	157	157	157	157	157	157	**0**	**157**	**157**	**157**	**157**
X	Crotch height	**−0,4**	82,2	81,8	81,4	81	80,6	80,2	**−0,3**	79,9	79,6	79,3	79	78,7	78,4	**−0,2**	**78,2**	**78**	**77,8**	**77,6**
Y	Waist-knee height	**0**	61,6	61,6	61,6	61,6	61,6	61,6	**0**	61,6	61,6	61,6	61,6	61,6	61,6	**0**	**61,6**	**61,6**	**61,6**	**61,6**
Z	Knee height	**0**	48,4	48,4	48,4	48,4	48,4	48,4	**0**	48,4	48,4	48,4	48,4	48,4	48,4	**0**	**48,4**	**48,4**	**48,4**	**48,4**
LB	Arm length	**0**	62,7	62,7	62,7	62,7	62,7	62,7	**0**	62,7	62,7	62,7	62,7	62,7	62,7	**0**	**62,7**	**62,7**	**62,7**	**62,7**

Table B.1 *(continued)*

Height at 181 cm		Sub-group 1 (Drop = 4)							Sub-group 2 (Drop = 3)							Sub-group 3 (Drop = 2)				
		Interval evolution	**range #1**	**range #2**	**range #3**	**range #4**	**range #5**	**range #6**	**Interval evolution**	**range #7**	**range #8**	**range #9**	**range #10**	**range #11**	**range #12**	**Interval evolution**	**range #13**	**range #14**	**range #15**	**range #16**
HT	Head height	**0**	24	24	24	24	24	24	**0**	24	24	24	24	24	24	**0**	**24**	**24**	**24**	**24**
ED	Front crotch length	**0,9**	30,7	31,6	32,5	33,4	34,3	35,2	**0,6**	35,8	36,4	37	37,6	38,2	38,8	**0,5**	**39,3**	**39,8**	**40,3**	**40,8**
EF	Back crotch length	**1,1**	37,5	38,6	39,7	40,8	41,9	43	**0,8**	43,8	44,6	45,4	46,2	47	47,8	**0,5**	**48,3**	**48,8**	**49,3**	**49,8**

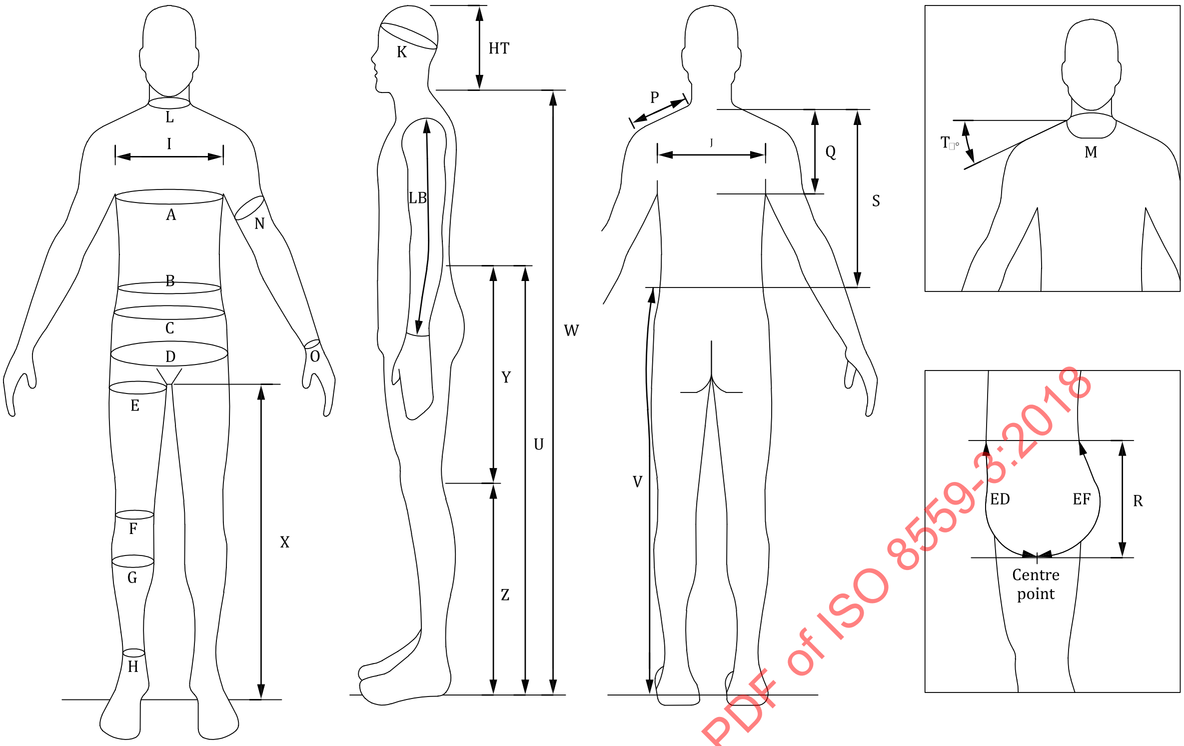

Figure B.1 — Body measurements in relation to Table B.1

Annex C
(informative)

Statistical models commonly used for the creation of body measurement tables

C.1 General

Body measurement tables are created based on a commonly used method in statistics: mainly simple or multiple linear regressions.

To achieve precise results, the multiple linear regression model with two explanatory variables is mainly carried out and this model is described in C.2. According to the needs (e.g. lower precision in comparison to the "two explanatory variables" model, the single linear regression model with one explanatory variable can be used and this model is described in C.3. Additional models are mentioned in C.4.

This technique allows to model the linear relationship between one or more explanatory variables (denoted X_i) and a dependent variable (denoted Y).

An explanatory variable can be based on a specific body dimension (or, even, a calculated value from a specific body dimension; e.g. logarithm of specific body dimension data).

The purpose of this method is twofold: to fit models that will help explain the dependent variable as a function of the explanatory variable and predict the values of measurements according to any value of the explanatory variable.

C.2 Multiple linear regression models with two explanatory variables

In the framework of multiple regressions, n observations (total number of individuals in the study population) are available to perform the following three calculations: the secondary surveying (or dependent variable to predict, called Y) and those two main measurements, denoted X_1 and X_2, characterized by continuous variables (the explanatory variables). The goal is to estimate Y by a linear combination of two explanatory variables X_1 and X_2.

The multiple linear regression models are as follows:

$$Y = \lambda + \alpha \times X_1 + \beta \times X_2 + \varepsilon$$

where

λ, α and β	are constants (model parameters: coefficients and regression constant);
ε	is the residuals.

This relation includes statistical "noise", which is characterized by the residuals. These residuals represent the difference between reality and representation (prediction) by the model.

The coefficients λ, α and β are determined by the weighted least squares method intended to minimizing the residuals.

However, the model is valid only if the adjustment and hypothesis of regression tests are checked.

The most important hypothesis to check is as follows: "errors (or residuals) are centred normally distributed (mean value equal to 0), have the same variance (homoscedasticity) and are not correlated between them."

Example: Based on the French survey carried out in 2006, a formula of "waist girth" (in cm), as the dependent variable Y, was calculated from "height" (in cm), as the first explanatory variable X_1 and "mass" (in kg) as the second explanatory variable X_2. The numerical formula was:

$$G_w = 131{,}835\,3 - 0{,}662\,4 \times h + 0{,}951\,4 \times m.$$

where

G_w is waist girth, in centimetres;

h is height, in centimetres;

m is mass, in kilogrammes.

Based on this numerical formula, the application for a person (175 cm and 80 kg) gives the following result: 92,027 3 rounded at (theoretically, i.e. predicted) 92 cm.

NOTE Another set of data (from specific groups of population, another national survey, etc.) will lead to other numerical coefficients.

C.3 Simple linear regression model (with one explanatory variable)

In the framework of single regressions, n observations (total number of individuals in the study population) are available to perform the following two calculations: the secondary surveying (or dependent variable to predict, called Y) and this main measurement, denoted X_1, characterized by continuous variable (the explanatory variable). The goal is to estimate Y by a linear combination of the explanatory variable X_1.

The single linear regression models are as follows:

$$Y = \lambda + \alpha \times X_1 + \varepsilon$$

where

λ and α are constants (model parameters: coefficients and regression constant);

ε is the residuals.

As explained in C.2, this relation includes statistical "noise", which is characterized by the residuals. These residuals represent the difference between reality and representation (prediction) by the model. The coefficients λ and α are determined by the weighted least squares method intended to minimize the residuals. The model is valid only if the adjustment and hypothesis of regression tests are checked. The most important hypothesis to check is as follows: "errors (or residuals) are centred normally distributed (mean value equal to 0), have the same variance (homoscedasticity) and are not correlated between them."

C.4 Alternative models

Multiple linear regression models with three explanatory variables have been found suitable for some surveys.

Annex D
(informative)

Tasks in statistics

D.1 General

This annex is drafted to give an overview of the key statistical tasks. It is intended for any readers having a basic knowledge in statistics. Further detailed information about statistic tools might be found with the help of skilled statisticians.

The flowchart in Figure D.1 summarizes the subsequent statistical tasks to be carried out leading to the creation of body measurement tables.

Figure D.1 — Flowchart of the statistical tasks leading to the creation of body measurement tables

D.2 Statistical tasks

D.2.1 Task 1 — Selection of the studied population

Within the framework of the creation of body measurement tables, it is necessary first to select the targeted population to be studied.

The consequence is that the statistical models are different according to the selected populations.

The body measurements are based on the body dimension definitions as given in ISO 8559-1.

The ranges of measurements are constructed in a particular division of populations to make them as homogeneous as possible regarding the morphology.