PD CEN/TR 13387-1:2015

BSI Standards Publication

Child use and care articles — General safety guidelines

Part 1: Safety philosophy and safety assessment

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National foreword

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Child use and care articles - General safety guidelines - Part 1: Safety philosophy and safety assessment

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European foreword

This document (CEN/TR 13387-1:2015) has been prepared by Technical Committee CEN/TC 252 “Child use and care articles”, the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TR 13387:2004.

CEN/TR 13387 comprises the following five parts:

— Safety philosophy and safety assessment (CEN/TR 13387-1);

— Chemical hazards (CEN/TR 13387-2);

— Mechanical hazards (CEN/TR 13387-3);

— Thermal hazards (CEN/TR 13387-4);

— Product information (CEN/TR 13387-5).

Introduction

This is a revision of CR 13387 first published in 1999. It is a non-normative CEN publication which provides guidance information on common hazards that should be taken into consideration when developing safety standards for child use and care articles.

A general safety philosophy and safety assessment methodology is given in Part 1 of these guidelines together with a collection of anthropometric data.

Chemical hazards are addressed in Part 2. The chemical risk associated with the use of materials for the construction, coating and/or packaging of child use and care articles that may affect children's health are considered.

Mechanical hazards are addressed in Part 3. "Mechanical hazard" is a general designation for physical factors which may give rise to injury due to the mechanical properties of products or parts of products.

Thermal hazards are addressed in Part 4. "Thermal hazards" include hazards associated with flammability and the burning characteristics of materials, contact with hot and cold surfaces, liquids and food, contact with flames, contact with products that melt on heating and overheating or exposure of a child to very low and very high temperatures.

Product information which should be supplied with a child use and care article is addressed in Part 5. "Product information" covers all the documentation and information that should be supplied to ensure the safe use of the product and also the safety of the child using the product.

These guidelines deal with hazards that are common to child use and care articles. They have been drawn-up by a working group of experts set up by CEN TC 252 with the prime objective of harmonizing the approach to hazard and risk assessment and injury prevention. The guidelines give recommendations on preventive safety measures to avoid injuries that could be caused by child use and care articles. If the child use and care article has a protective function, this has to be effective; additionally the product itself has to cause no injury to the child.

The standards being drafted by CEN/TC 252 are for child use and care articles intended for children from birth to 48 months of age who form a very vulnerable group in society. Up to 18 months of age the development of knowledge takes place through the combined use of sensory and motor skills, i.e. children learn to see, hear, taste, smell and feel. Their movements are aimed at achieving familiarity with their environment. As children become older they achieve increased muscular control and balance. Even up to 48 months of age children are unpredictable in their behaviour. Special consideration has to be given to the fact that these children cannot understand how to avoid risks and thus are involuntarily exposed to them.

Child use and care articles constitute a group with large variations between the different products. However many safety hazards associated with this diverse group of products are very similar. These guidelines identify many of these safety hazards and give details that enable similar safety principles to be applied to the drafting of standards across the group of products.

The information given in these guidelines reflects the state of the art at publication. Standards and regulations will continuously be developed. Other sources may also provide useful information for the reader.

How to use these guidelines

The safety requirements and test methods given are intended to give guidance and to lead to consistency when writing safety standards for child use and care articles. It is recommended to use these guidelines when drafting standards.

In addition, these guidelines can assist those with a general professional interest in child safety.

The safety requirements detailed do not constitute an exhaustive set that can be applied to all child use and care articles. The application to particular products should be evaluated by experts.

In these guidelines rationales are given to explain the potential hazard. Wherever possible, requirements, test equipment and test methods are given which can be used when drafting standards. The terminology in these guidelines is not the one required for standards:, the word *'shall'* has to be used in standards, not *'should'* as given in these guidelines.

CEN/TC 252 is, wherever possible when writing new standards or revising existing standards, drafting their standards on a hazard based format (see for example EN 16120:2012+A1:2014 and EN 1930:2011).

The different parts of the CEN/TR 13387 should enable working groups to draft their standards in a hazard based format by proceeding in the following way:

— identification of the hazards and assessment of the risk;

— definition of the requirements to address an identified hazard and risk;

— definition of relevant test methods to check that the requirements are met;

— provision of an Annex which indicates the rationale for the inclusion of the requirements.

1 Scope

This Technical Report, contains the general safety philosophy and a guideline on safety assessment that experts are recommended to use when drafting standards.

It also contains an Annex A with a collection of available anthropometric data and details of the abilities of children from birth to 48 months of age.

The general safety philosophy given in this part is based on the principle that child use and care articles should be designed to be safe.

Children with special needs have not been taken into account while drafting these guidelines. ISO/IEC Guide 71 should be consulted to ascertain any further requirements to address the hazards and risks associated with children with special needs.

These guidelines do not cover all types of hazards and risks, such as inappropriate use of products, inadequate supervision of children and products used in a non-domestic situation.

Attention is drawn to the importance of ensuring that all other potential hazards relevant to the product are fully addressed e.g. hygiene, the effects of electrical power etc., where other safety standards may apply.

2 General safety

Safety is often a balance between being safe from injury and the other demands of a child use and care article, for example, ensuring that the item is fit for purpose as well as meeting consumers' needs and expectations.

Attention should be paid to:

— the child's stage of development (ability, weight, age, etc.);

— the intended or foreseeable use of the product, bearing in mind a child's unpredictable behaviour. This unpredictable behaviour exposes children to injury in ways that differ from those of adults, making children a particularly vulnerable group in society;

— the hazard presented by the product in the environment where the product is used.

Child use and care articles should be designed to be safe. Hazards should be eliminated wherever possible. For cases where a hazard cannot be eliminated or sufficiently minimized – by design or safeguards – product related information should be given. However product related information should not be used as an alternative to safe design.

Where the function of a product or part of a product changes by virtue of its use and is beyond the scope of child use and care articles, appropriate requirements should be applied. An example may be a high chair that can be converted into a normal chair.

3 Terms and definitions

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

3.1
harm
injury or damage to the health of people, or damage to property or the environment

3.2
hazard
potential source of harm

3.3
risk
combination of the probability of occurrence of harm and the severity of that harm

Note 1 to entry: The probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event, and the possibility to avoid or limit the harm.

3.4
hazard characterisation
quantitative evaluation of the nature of the adverse health effects following exposure to a risk source(s)

3.5
hazard identification
identification of a risk source(s) capable of causing adverse effect(s)

3.6
risk analysis
systematic use of available information to identify hazards and to estimate the risk

3.7
risk evaluation
procedure based on the risk analysis to determine whether tolerable risk has been exceeded

3.8
risk assessment
overall process comprising a risk analysis and a risk evaluation

Note 1 to entry: In practical terms this means the evaluation, including the identification of the related uncertainties, of the likelihood and severity of an adverse effect(s) following exposure under defined means to a risk source(s).

3.9
safety
freedom from risk which is not tolerable

3.10
intended use
use in accordance with information provided together with a product or system, or, in the absence of such information, by generally understood patterns of usage

4 Accident data

Available accident and injury data should be consulted. The absence of an accident history cannot be a good reason for an automatic presumption of a low level of risk. Other factors should be taken into account, particularly when the possible severity of injury is high.

Appropriate data may not be available for many reasons, including the absence or ineffectiveness of a data collection system, the time delay in collating and presenting statistics, changes in product design and use conditions etc. For example, historical information related to a product or material used in a hot climate may not apply to its use in colder countries or vice versa.

5 Hazard and risk assessment

5.1 Introduction

The approach to hazard risk assessment described in this clause should ensure that the major hazards are assessed when considering child safety within standards.

This clause details a process to identify non-chemical hazards and to assess the risks of injury to children associated with child use and care articles. The assessment of chemical hazards and risks is included in CEN/TR 13387-2.

When developing a new child use and care article safety standard or revising an existing one or working with a standard where child safety needs to be addressed, it is necessary to conduct a hazard and risk assessment. This involves gathering together information from a variety of sources such as accident data, RAPEX and recall notifications, expert opinion and other reliable sources of information. Additionally, reference should be made to relevant child safety guidelines, publications and safety standards.

The hazard risk assessment methodology described in this clause is intended to be used during development or revision of standards; it is not designed to be used solely during product development or for assessment of products on the market.

5.2 Methodology

Separate hazard and risk assessment tables are provided for mechanical hazards, thermal hazards and other non-chemical hazards.

All three tables list the known hazards that have been identified through review of available guides and standards. Additional hazards not listed in the tables may be associated with certain product categories and should also be considered.

Before the hazard and risk assessment tables can be completed, all available data, such as accident data, RAPEX and recall notifications, expert opinion and other reliable sources of information require analysis. There is also a need to fully review the products available and to understand how children will interact with the product. It is also necessary to understand the type of injuries that can occur and how they are caused, as well as how accidents themselves occur and the likely outcomes.

Each table contains the same headings which are explained below:

— The hazard list, based on CEN/TR 13387-3, CEN/TR 13387-4, CEN Guide 12 and ISO/IEC Guide 50.

— The hazard identification column utilizes available accident data, RAPEX and recall notifications, reported incidents, expert opinion and other reliable sources of information to identify the hazards associated with a product.

— The hazard analysis column indicates the worst-case scenario should an accident occur with the indicated hazard.

— The risk level column indicates the level of risk.

— The risk management measures column identifies those hazards addressed in other similar safety standards, as well as providing the following three options for dealing with the hazard:

  — include safety requirements to address the hazard; or

  — include product information to address the hazard; or

  — there is no need to address the hazard.

  The decision on which option should be taken is based on the information entered in the row and whether or not the hazard is considered a high, medium or low risk.

  Hazards resulting in high or medium risk should be addressed within the standard by safety requirements. Hazards resulting in low risk should be addressed in the standard by safety requirements, providing they do not conflict with the requirements for high or medium risk. Product information should be used to address any hazard that cannot be suitably addressed by safety requirements.

— The comments column is used to explain the rationale and considerations for the decisions indicated in the table and should be systematically filled in for each item in the tables.

Once all the relevant data has been analysed it should be easy to complete the relevant hazard risk analysis table by placing an indication in the relevant boxes. With all the relevant boxes completed in each row of each table it should be possible to draw a conclusion on the level of risk involved with the hazard, as well as what action is needed to address the hazard in the safety standard.

Table 1 — Mechanical hazards

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Hazards from gaps and openings:																
- Entrapment of head and neck																
- Entrapment of fingers																
- Entrapment of limbs																
Hazards due to moving parts, i.e. shearing and compression																
Hazards due to crushing																
Hazards due to protrusions																
Entanglement in cords, ribbons and parts used as ties																
Ingestion hazards																

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Choking hazards																
Hazards from plastic decals or sheeting																
Hazards from packaging materials																
Hazardous edges																
Hazardous points and wire																
Hazards from inadequate stability																
Hazards from inadequate structural integrity																
Hazards from inadequate protective barrier function																
Hazards from inadequate protective restraint systems																
Falling hazards due to footholds																

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Hazards due to inadequate size																
Hazards due to inadvertent release of attachment mechanisms																

Table 2 — Thermal hazards

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Hazards due to flash effect																
Hazards due to flame propagation																
Hazards from the melting behaviour of materials																
Hazards from contact with flames																
Hazards from hot and cold surfaces																
Hazards from hot and cold liquids and food																
Hypothermia and hyperthermia hazards																

Table 3 — Other non-chemical hazards

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Suffocation hazards due to an enclosed space																
Hazardous heights (falls)																
Hazards from moving or rotating objects																
Hazards from noise																
Drowning hazards																
Hazards from suction, i.e. suction cups																
Electric shock hazards																
Radiation hazards																
High intensity or concentrated light																
Biological hazards																

Hazard list	Hazard identification						Hazard analysis				Risk level	Risk management measures				Comments
	Accident data	RAPEX	Recalls	Reported incidents	Product reports	Expert opinion	Minor or reversible injuries	Serious and reversible or minor and irreversible injuries	Serious and irreversible injuries	Death	L (Low) – M (Medium) – H (High)	Hazard addressed by another similar safety standard or a previous version	Hazard to be addressed by safety requirements	Hazard to be addressed by product information	Hazard not to be addressed	
Explosion hazards																
Inadequate protective function																
Inadequate information																

Annex A
(informative)

Anthropometric data and abilities of children from birth to 48 months

A.1 General

This annex provides tables of anthropometric data and abilities of children from birth to 48 months related to risks. It presents a compilation of data available in current literature. Only sources that explain the method by which the measurements were taken, and of which the sample size was large enough to give reliable results have been selected.

Because the difference between European populations is relatively small for children up to 48 months, only one source for each measurement has been used.

NOTE 1 The European populations are fairly homogenous (Eveleth and Tanner 1990). At 12 months the maximum difference in mean of length of boys is 3 cm. At 48 months this is about 3,5 cm. The maximum difference in mean of weight is 0,8 kg at 12 months, and 1,6 kg at 48 months. These differences are small compared to the ones within one age group.

NOTE 2 This annex provides an overview of data sources available at the time of publication of CEN/TR 13387–1:2015. The listed data may not represent the data of the actual European population, but can be taken as reference when defining safety requirements.

If possible the mean value, standard deviation, the 5th and the 95th percentile are given.

When these data are used in safety requirements a safety margin should be included. This safety margin depends on the required safety level.

The data given in the tables are taken from different publications listed in A.8.

Additional data can be obtained from the report: CHILDATA, the handbook of Child Measurements and Capabilities (Consumer Safety Unit, Department of Trade and Industry, UK). This document gives an overview of the most important data sources for child safety.

A.2 Terms and definitions related to anthropometric data

A.2.1
standard deviation (sd)
parameter of the normal distribution used to indicate the amount of variance in an attribute. Approximately 68 % of a population will lie within the mean ± 1 × sd

A.2.2
5th percentile (P5)
value of a normal distributed variable which covers the smallest 5 % of the population. Exactly 5 % of a population is smaller than the P5-value

A.2.3
95th percentile (P95)
the value of a normal distributed variable which covers 95 % of the population. Exactly 5 % of a population is bigger than the P95-value

A.3 Recommendations for use of data

As a principle the most onerous situations should be taken into account. Maximum data for the biggest child in the age group and minimum data for the smallest child should be used depending on which one gives the most onerous situation. Some examples are given in A.4 and Figure A.1 shows the difference between the P5/P95 values.

Most anthropometric data are provided at the P5 and P95 values and not the minimum and maximum values, for example P1 and P99. To derive the minimum or maximum value from the P5 and P95 data you need to calculate a value of the Standard deviation (sd) that is subtracted from or added to the P5 or P95 values. To do this use sd scores or z scores, which are given in Table A.1. To obtain the sd figure determine the difference between z values, that is subtract the z value for P5 or P95 from the z value for P1 or P99. This difference between the z values is then used to determine the P1 and P99 values by multiplying the sd by this value and then subtracting or adding this figure to the P5 or P95 values. The following examples show the calculations:

P1 z value = −2,33	P99 z value = 2,33
P5 z value = −1,64	P95 value = 1,64
∴ −2,33-(−1,64) = −0,69	∴ 2,33–1,64 = 0,69

It is recommended that 0,7 rather than 0,69 is used in the following formula to determine the minimum and maximum vales to be used. Therefore 0,7 × sd is subtracted from P5 and 0,7 × sd added to P95 to obtain the minimum and maximum values.

Table A.1 — Standard deviation scores - *p* and *z* values of the normal distribution

p	*z*	*p*	*z*	*p*	*z*	*p*	*z*
1	−2,33	26	−0,64	51	0,03	76	0,71
2	−2,05	27	−0,61	52	0,05	77	0,74
3	−1,88	28	−0,58	53	0,08	78	0,77
4	−1,75	29	−0,55	54	0,10	79	0,81
5	−1,64	30	−0,52	55	0,013	80	0,84
6	−1,55	31	−0,50	56	0,15	81	0,88
7	−1,48	32	−0,47	57	0,18	82	0,92
8	−1,41	33	−0,44	58	0,20	83	0,95
9	−1,34	34	−0,41	59	0,23	84	0,99
10	−1,28	35	−0,39	60	0,25	85	1,04
11	−1,23	36	−0,36	61	0,28	86	1,08
12	−1,18	37	−0,33	62	0,31	87	1,13
13	−1,13	38	−0,31	63	0,33	88	1,18
14	−1,08	39	−0,28	64	0,36	89	1,23
15	−1,04	40	−0,25	65	0,39	90	1,28
16	−0,99	41	−0,23	66	0,41	91	1,34
17	−0,95	42	−0,20	67	0,44	92	1,41
18	−0,92	43	−0,18	68	0,47	93	1,48
19	−0,88	44	−0,15	69	0,50	94	1,55
20	−0,84	45	−0,13	70	0,52	95	1,64
21	−0,81	46	−0,10	71	0,55	96	1,75
22	−0,77	47	−0,08	72	0,58	97	1,88
23	−0,74	48	−0,05	73	0,61	98	2,05
24	−0,71	49	−0,03	74	0,64	99	2,33
25	−0,67	50	0	75	0,67		
p		***z***		***p***		***z***	
2,5		−1,96		97,5		1,96	
0,5		−2,58		99,5		2,58	
0,1		−3,09		99,9		3,09	
0,01		−3,72		99,99		3,72	
0,001		−4,26		99,999		4,26	
z = standard deviation or *z* score *P* = percentile							

This is copied from CHILDATA, ADULTDATA and OLDER ADULTDATA as published by the DTI.

A.4 Applications

A.4.1 Accessibility

To calculate the accessibility area of a child in different situations the size of the tallest child in the age group should be taken into account. The accessibility area is dependent on the position of the child. It can be lying, sitting or standing. Besides the margin mentioned in A.3, a margin should be added to cover the dynamic reach of children. Most measurements are taken in a static position of the subject.

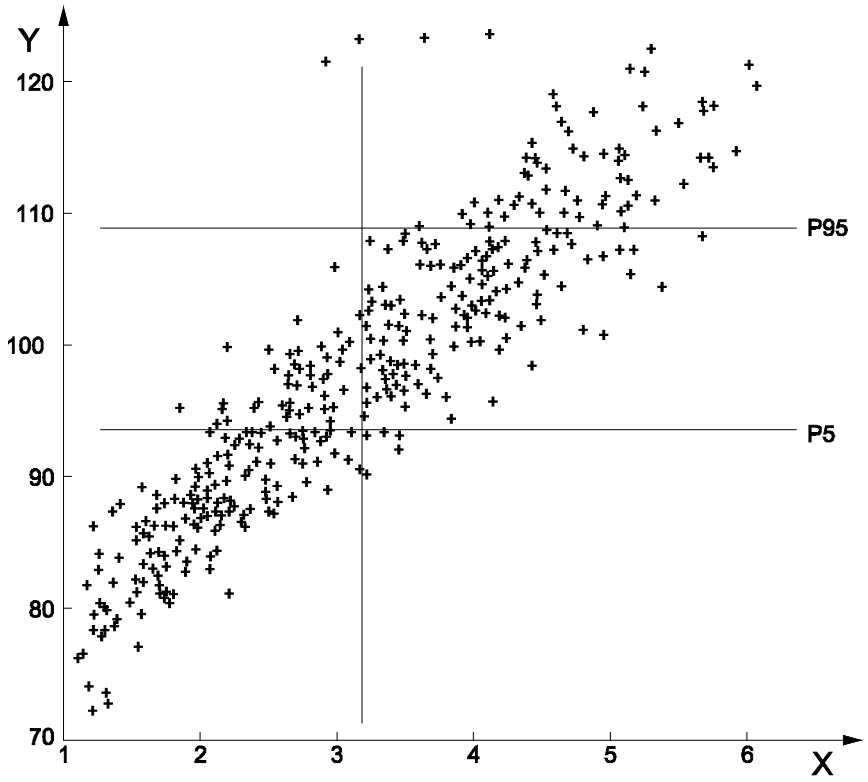
A.4.2 Openings

An entrapment hazard is present when an opening is large enough to be entered by a child, and too small to get out again. In practice these openings will be tested by means of test probes. Anthropometric data are necessary to determine the size and shape of these probes.

To determine if a body part can enter an opening, a probe, which represents the smallest child, is needed. To determine if a body part can get out, a probe representing the largest child is needed.

A.4.3 Structural integrity

When using force exertion data it should be noted that the standard deviation of these measurements is very high, which means that the differences between children are relatively large. The data given in A.6 are all static force exertions. For estimation of dynamic forces a dynamic force factor should be added.



Key

X stature, cm

Y stature, cm

Figure A.1 — Scatter diagram and P5/P95 of the stature (source Steen-bekkers 1989). The marked area shows which part of the population is covered by the P5-P95 36 to 48 months

A.5 Tables with body dimensions

Table A.2 — Weight, length and centre of gravity of the body

	Dimensions (kg, mm or %)									
	Age group (months)	**0–1**	**0–3**	**3–6**	**6–9**	**9–12**	**12–18**	**18–24**	**24–36**	**36–48**
1 weight (kg)	**mean**	3,5	5,3	6,7	8,4	9,2	10,9	12,2	14,3	16,5
	sd	-	1,0	1,0	1,0	1,1	1,2	1,2	1,8	2,0
	P5	2,8	3,7	5,2	6,5	7,5	8,8	10,5	11,8	13,8
	P95	4,3	6,5	8,2	10,0	10,9	12,7	14,5	17,5	20,1
2 body length or statue (mm)	**mean**	500	588	639	705	744	796	850	933	1013
	sd	20	35	36	30	32	40	40	46	45
	P5	465	520	584	647	687	740	799	865	946
	P95	535	631	701	750	794	862	930	1016	1098
3 a centre of gravity (% of length)	**mean**					58,5				
	sd					1,9				
	P5					55,3				
	P95					61,5				
3 b centre of gravity, seated (% of sitting height)	**mean**		49,0	47,5	45,5	44,0	42,5	41,0	39,0	38,0
	sd		4	3	3	3	3	3	2	2
	P5		42,4	42,6	40,6	39,1	37,6	36,1	35,7	34,7
	P95		55,6	52,5	50,5	49,0	47,5	46,0	42,3	41,3

NOTE 1 Weight data for newborn children. Hayes 1983. Length data: Pheasan 1988. It should be noted that length measurement of newborn children may not be accurate.

NOTE 2 The centre of gravity is expressed as a percentage of the straight body length measured from the reference plane. It is approximately the same for all ages.

Table A.3 — Standing/lying dimensions

Dimension (mm)	Age group (months)							
	0–3	**3–6**	**6–9**	**9–12**	**12–18**	**18–24**	**24–36**	**36–48**
4 inside leg length mean	189	223	247	271	293	330	362	413
sd	18	17	17	17	17	21	21	27
P5	162	198	219	242	266	295	326	371
P95	218	248	271	307	325	359	3950	454
5 chest depth mean	95	106	108	111	117	122	129	134
sd	8	8	9	9	9	8	8	9
P5	80	87	92	95	100	108	117	122
P95	106	115	118	126	129	137	143	153
6 chest breadth mean	122	138	147	151	158	163	158	164
sd	13	8	11	12	11	12	12	11
P5	100	122	125	132	138	144	136	143
P95	147	151	162	170	175	185	174	182
7 shoulder breadth mean	176	200	203	212	225	232	241	253
sd	13	15	16	14	13	13	14	12
P5	146	171	175	185	198	210	219	237
P95	194	217	228	230	244	255	263	276
8 hip breadth mean	128	140	150	155	161	170	181	189
sd	15	14	15	14	12	12	11	10
P5	110	123	130	135	143	153	164	173
P95	147	160	170	175	182	190	199	205
9 hip depth mean	77	89	93	96	98	99	-	-
sd	12	11	11	11	10	10	-	-
P5	57	72	77	78	82	84	-	-
P95	98	108	113	115	116	117	-	-
10 chest circumference mean	377	434	457	471	491	507	512	535
sd	36	24	24	17	22	23	25	29
P5	318	391	420	441	453	469	471	490
P95	433	471	495	501	524	541	553	582
11 thigh circumference mean	199	252	266	271	282	291	297	320
sd	28	26	26	21	20	25	25	29
P5	156	211	232	240	247	253	260	274
P95	245	293	302	308	315	331	339	367
NOTE Measurements are taken in lying position for children up to 18 months.								

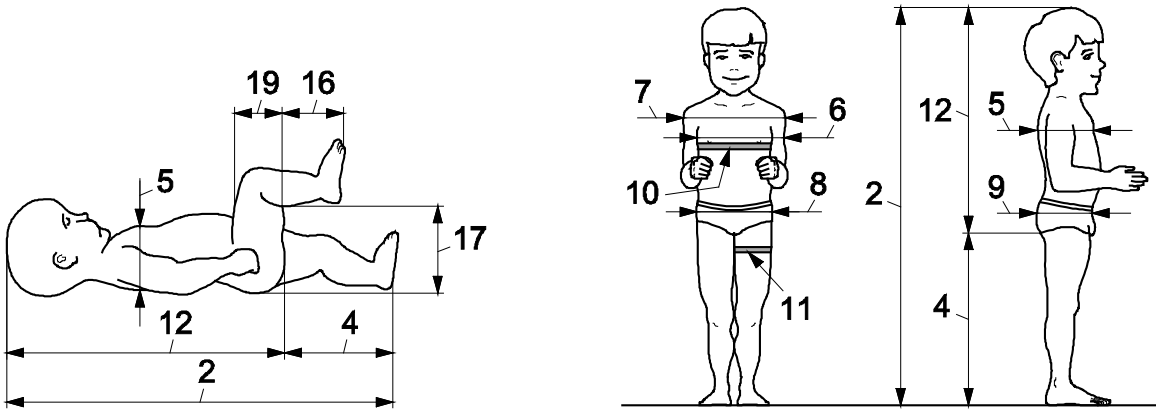


Figure A.2

Table A.4 — Sitting dimensions

	Dimensions (mm)								
	Age group (months)	**0–3**	**3–6**	**6–9**	**9–12**	**12–18**	**18–24**	**24–36**	**36–48**
12 sitting height	**Mean**	391	423	457	476	494	515	549	574
	sd	28	24	23	22	21	24	25	24
	P5	347	375	423	433	456	469	513	536
	P95	430	458	500	507	527	549	589	619
13 shoulder height sitting	**Mean**	-	-	-	-	302	314	334	352
	sd	-	-	-	-	20	16	21	19
	P5	-	-	-	-	273	282	303	321
	P95	-	-	-	-	334	340	371	383
14 shoulder-elbow length	**Mean**	109	123	131	145	157	162	179	193
	sd	9	10	12	10	9	10	14	12
	P5	93	107	108	123	134	142	159	174
	P95	124	138	147	156	164	174	198	215
15 hip breadth sitting	**Mean**	-	-	-	-	174	184	191	200
	sd	-	-	-	-	12	12	14	13
	P5	-	-	-	-	157	163	170	179
	P95	-	-	-	-	193	206	216	220
16 popliteal height	**Mean**	112	122	134	145	184	202	224	253
	sd	12	11	12	10	16	12	16	18
	P5	87	107	111	128	160	182	199	223
	P95	123	140	155	163	200	220	252	281

17 buttock-popliteal length	**Mean**	121	136	151	168	199	219	244	266
	sd	19	16	16	18	19	16	17	17
	P5	97	113	124	140	160	190	214	238
	P95	155	164	175	190	219	240	271	294
18 buttock-foot length	**Mean**	231	268	299	338	365	415	508	567
	sd	19	24	23	25	25	34	32	35
	P5	197	234	257	285	319	361	460	513
	P95	260	303	335	375	405	465	552	632
19 thigh clearance	**Mean**	52	59	62	69	70	72	80	82
	sd	7	9	9	9	10	10	9	10
	P5	39	43	45	47	53	54	56	60
	P95	62	70	75	82	85	90	96	99

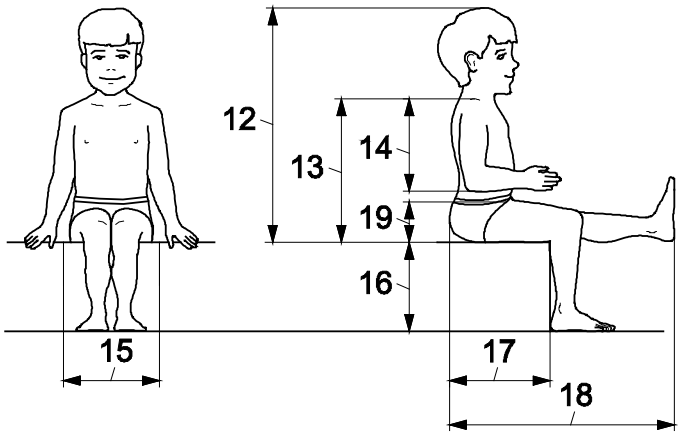


Figure A.3

Table A.5 — Hand and foot dimensions

	Dimensions (mm)								
	Age group (months)	**0–3**	**3–6**	**6–9**	**9–12**	**12–18**	**18–24**	**24–36**	**36–48**
20 hand length	**Mean**	68	74	80	89	93	95	102	109
	sd	6	6	5	6	6	6	7	7
	P5	54	61	70	76	80	86	92	98
	P95	76	83	86	97	100	105	114	121
21 hand diameter	**Mean**	36	38	40	41	44	46	46	47
	sd	3	3	3	3	3	3	3	3
	P5	32	35	35	38	38	42	42	42
	P95	42	42	45	45	48	52	52	52
22 hand thickness	**Mean**	13	13	14	14	15	16	16	16

	sd	3	2	3	3	3	3	2	2
	P5	10	10	10	10	11	11	13	13
	P95	17	17	19	19	19	19	19	20
23 fist breadth	**Mean**	42	46	49	51	54	55	57	59
	sd	4	5	4	5	6	5	5	6
	P5	34	37	42	43	45	46	49	50
	P95	48	53	54	58	61	61	65	67
24 thumb breadth	**Mean**	9	9	10	11	11	11	13	13
	sd	1	1	1	1	1	1	1	1
	P5	7	7	9	10	10	10	11	11
	P95	10	10	11	12	12	13	14	15
25 little finger breadth	**Mean**	7	7	8	8	8	8	9	9
	sd	1	1	1	1	1	1	1	1
	P5	6	6	6	6	6	7	8	8
	P95	8	8	9	9	9	10	10	11
26 foot length	**Mean**	86	90	99	106	124	131	146	158
	sd	5	8	7	7	9	8	9	9
	P5	76	78	90	96	111	118	133	145
	P95	92	102	115	117	144	144	159	176
27 foot breadth	**Mean**	37	39	42	45	52	56	59	63
	sd	4	4	4	4	4	5	5	5
	P5	32	34	36	39	45	48	52	55
	P95	43	47	50	53	59	64	67	70

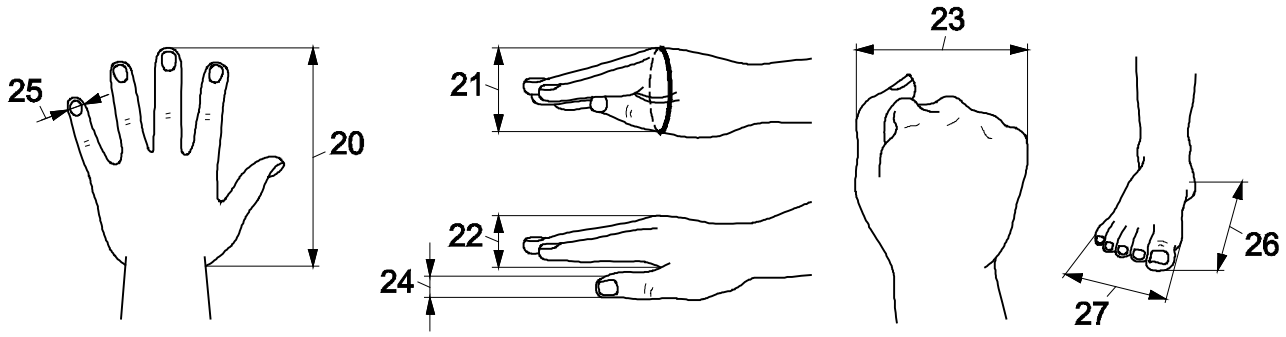


Figure A.4

Table A.6 — Head dimensions

	Dimensions (kg or mm)								
	Age group (months)	**0–3**	**3–6**	**6–9**	**9–12**	**12–18**	**18–24**	**24–36**	**36–48**
28 estimated head weight (kg)	**Mean**	1,2	1,7	1,8	2,0	2,2	2,3	2,5	2,7
	P5	1,0	1,3	1,5	1,6	1,8	1,9	2,1	2,2
	P95	1,5	2,0	2,2	2,4	2,6	2,8	3,0	3,2
29 head length	**Mean**	139	154	158	163	168	172	174	178
	sd	6	6	6	6	6	6	7	7
	P5	128	141	149	154	159	162	163	165
	P95	146	163	170	174	176	182	184	189
30 head breadth	**Mean**	106	117	123	125	128	130	133	135
	sd	5	5	5	6	4	5	5	5
	P5	100	105	110	115	119	122	124	127
	P95	115	125	129	134	136	139	141	143
31 head height	**Mean**	136	145	151	158	163	168	174	180
	sd	10	8	9	9	8	8	9	9
	P5	118	125	132	144	150	155	160	162
	P95	148	157	163	172	175	180	187	195
32 chin to crown length	**Mean**	161	177	180	189	193	198	205	211
	sd	6	7	7	7	7	7	7	7
	P5	148	162	170	177	182	186	195	199
	P95	170	186	191	200	205	210	218	224
33 head circumference	**Mean**	395	435	448	461	478	485	500	510
	sd	14	16	13	14	15	15	16	15
	P5	370	403	428	440	454	460	474	484
	P95	420	457	466	485	503	510	524	535
34 neck breadth	**Mean**	57	61	63	65	67	69	70	73
	sd	5	6	5	5	6	5	6	5
	P5	46	49	53	56	58	60	61	64
	P95	63	69	70	73	75	77	80	82
35 neck circumference	**Mean**	214	214	218	219	219	223	237	241
	sd	21	11	19	13	12	12	12	14
	P5	182	192	187	186	186	205	213	217
	P95	247	234	247	239	235	240	253	260

36 mouth breadth	**Mean**	-	-	-	-	-	-	32	34
	sd	-	-	-	-	-	-	4	4
	P5	-	-	-	-	-	-	26	28
	P95	-	-	-	-	-	-	37	39

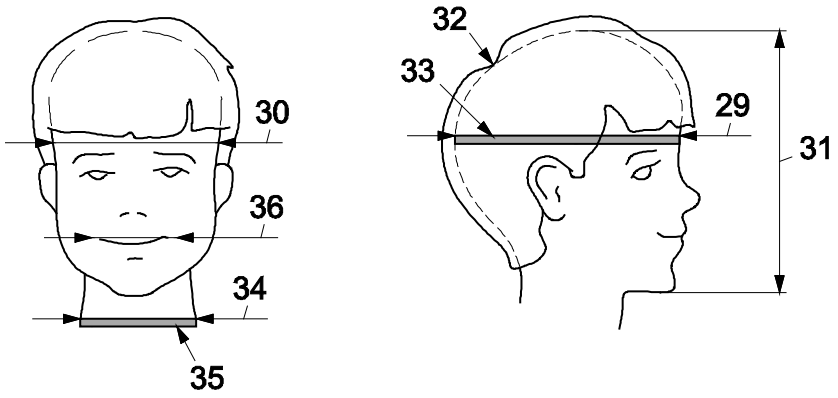


Figure A.5

Table A.7 — Functional measurements

	Dimensions (mm)				
	Age group (months)	**12–18**	**18–24**	**24–36**	**36–48**
37 grip reach forward	**mean**	-	-	378	411
	sd	-	-	31	36
	P5	-	-	340	371
	P95	-	-	446	476
38 grip reach (stretched)	**mean**	497	546	677	751
	sd	65	55	61	49
	P5	416	450	574	667
	P95	570	647	770	836
39 reaching height standing	**mean**	869	945	1059	1170
	sd	57	39	63	64
	P5	774	888	955	1075
	P95	962	1014	1161	1271
40 reaching height sitting	**mean**	579	621	683	740
	sd	36	28	43	44
	P5	525	574	618	667
	P95	633	633	750	819
41 step height	**mean**	245	266	340	392
	sd	41	44	55	65
	P5	180	208	258	293
	P95	325	351	426	487
42 grip circumference	**mean**	60	62	68	75
	sd	8	8	6	7
	P5	50	50	59	63
	P95	74	70	78	86

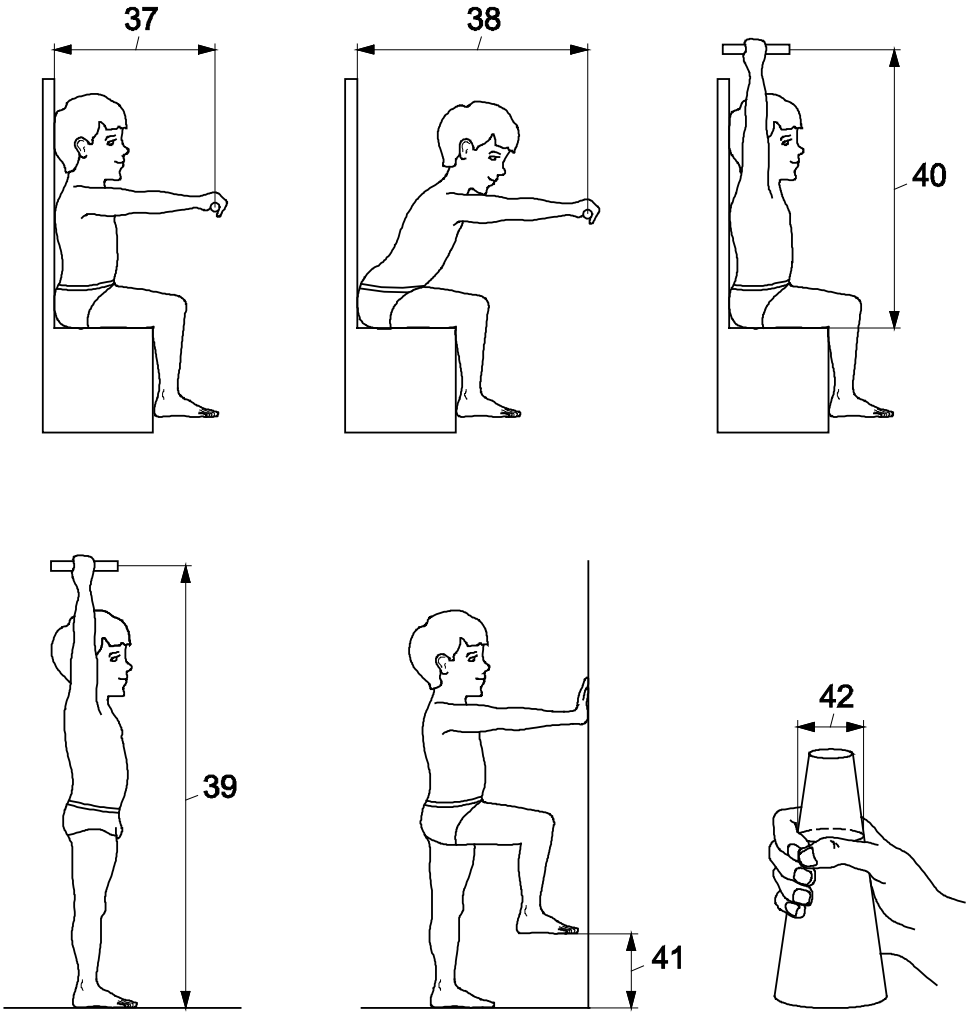


Figure A.6

A.6 Tables with force measurements

Table A.8 — Pulling with full hand (Brown 1973, *n* = 100)

age (months)	pull force (N)		
	mean	P5	P95
24–36	97	48	169
36–48	122	67	184

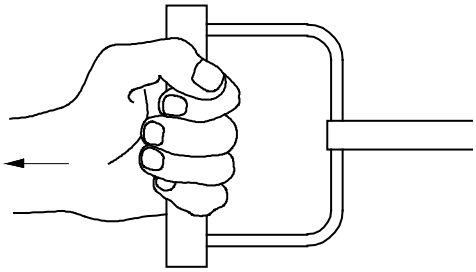


Table A.9 — Pushing with full hand (Brown 1973, *n* = 100)

age (months)	push force (N)		
	mean	P5	P95
24–36	56	30	97
36–48	78	33	128

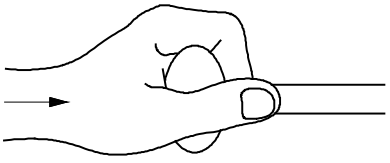


Table A.10 — Grip strength (Owings 1977, *n* = 40)

a (mm)	age (months)	grip strength (N)		
		mean	P5	P95
20	30–42	31	14	46
	42–54	41	23	63
30	30–42	50	28	78
	42–54	67	43	96
40	30–42	49	24	83
	42–54	67	38	96
50	30–42	43	-	-
	42–54	60	28	88

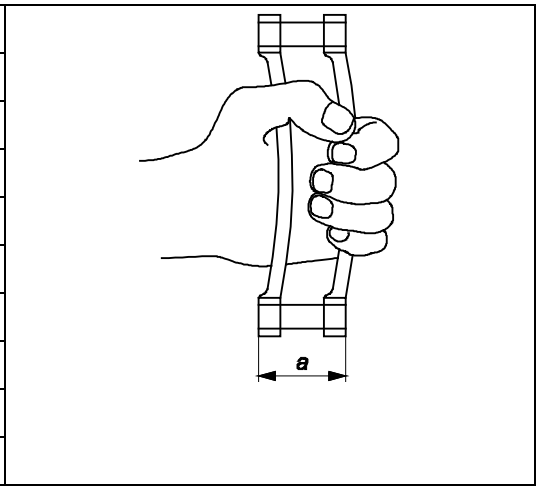


Table A.11 — Three-point pinch strength (Owings 1977, *n* = 40)

a (mm)	age (months)	pinch strength (N)	
		mean	Sd
20	30 to 42	21	4
	42 to 54	26	5
50	30 to 42	24	6
	42 to 54	29	7

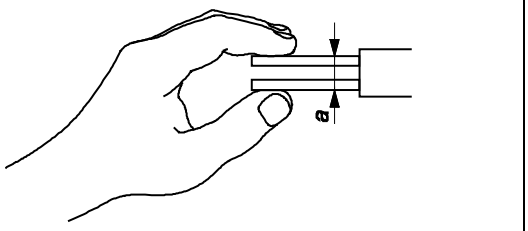


Table A.12 — Five-point pinch strength (Owings 1977, *n* = 40)

a (mm)	age (months)	pinch strength (N)	
		mean	sd
20	30 to 42	25	7
	42 to 54	29	5
50	30 to 42	28	8
	42 to 54	32	9

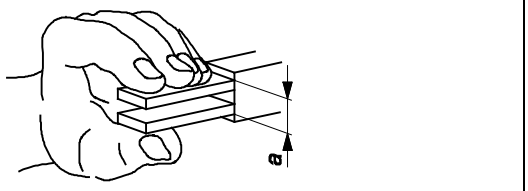


Table A.13 — Summary of bite strength data found in literature (Wu Y 1978)

age (months)	maximum bite strength (N)
0 to 18	111
18 to 36	222
> 36	445

$$P1 = mean - 2,33 \times sd \quad \text{(A.1)}$$

$$P5 = mean - 1,65 \times sd \quad \text{(A.2)}$$

$$P95 = mean + 1,65 \times sd \quad \text{(A.3)}$$

$$P99 = mean + 2,33 \times sd \quad \text{(A.4)}$$

A.7 Abilities of children

Table A.14 — Overview of the development of children from birth to 4 years

Age months	Ability that may occur	Development linked to risks
0 to 3	Birth reflexes, startle, palmar grasp, rooting, crawling reflex	Strong need for sucking, can hold head up for only a few seconds, risk of suffocation
3 to 6	Can turn over from back to stomach, actively gripping objects	Risk of crushing and squeezing
6 to 9	Voluntary crawling and creeping, sitting without support	Can both crawl away and grip things, increased risk for choking on foreign objects and poisoning
9 to 12	Supported walking, can arise from a back-lying position	Can pull down hot pans and heavy objects
12 to 15	Walking without support, can use spoon, can build a tower of 2 blocks	
15 to 18	Can walk backwards, can walk up the stairs, can take clothes off	Can climb on small chair and fall off, likes to put fingers in small holes, risk for electric shock, burns and scalds from hot liquids
18 to 24	Climbs on furniture to look out of windows, can build tower of 8 blocks	
24 to 36	Can run well, rides on tricycle, turn door handles, can put on a piece of clothing	Trains body by fast movements, likes to walk stairs, the child's abilities are often over-estimated by the adults, uses tools like chair to reach window
36 to 48	Can hop, can recognize colours, can dress without supervision	Knows how to reach things that are stored in e.g. high cupboard, risk for poisoning, cutting and burning

Table A.15 — Ability to climb fences (Nixon 1979)

Age group (months)	% of children able to climb fence height (mm)			
	600	900	1 200	1 400
24 to 36	21	0	0	0
36 to 48	88	53	20	0

A.8 Sources of data

Publications used as source of data for Tables A.2 to A.7

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Hayes A., L. Dayly, N.G. O'Brien, D. MacDonald. *Anthropometric Standards for Irish Newborn*. Irish Medical Journal, 76(2) February, 60-70, 1983.

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Snyder R.G., M.L. Spencer, C.L. Owings, L.W. Schneider. *Physical characteristics of children as related to death and injury for consumer product design and use.* Report no UM-HSRI-B1-75-5. CPSC, Washington DC, USA, 1975.

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Schneider L.W., R.J. Lehman, M.A. Pflug, C.L. Owings. *Size and shape of the head and neck from birth to four years*. University of Michigan, Transportation Research Institute, 2901 Baxter Rd., Ann Arbor, Michigan, 1986

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Publications used as source of data for Tables A.8 to A.13 and A.14 to A.15

Brown W.C. and Buchanan C.J. 1973. *A study of the strength capabilities of children ages two through six*.

Owings C.L., Norcutt R.H., Snyder R.G., Golomb D.H. and Lloyd K.Y. 1977. *Gripping strength measurements of children for product safety design.*

Krogman W.M. 1971. *The manual and oral strength of American white and negro children, ages 3-6 years.* Closure Committee of Glass Manufacturers Institute.

Wu Y C, 1978. *An evaluation of children's biting strength for toy safety*.

Nixon, J,W., J.H. Pearm and G.M. Petrie, 1979. *Childproof Safety Barriers. An ergonomic study to reduce child trauma due to environmental hazards.* Australian Peadiatric Journal, Vol 15, p 260-262.

Dimension		**0 to 24 months**	**24 to 48 months**		
		Source	**N**	**Source**	**n**
1	Weight	Steenbekkers 1989	30	Steenbekkers 1993	80
	Birthweight	Hayes 1983	8050		
2	Stature	Steenbekkers 1989	30	Steenbekkers 1993	80
3	Centre of gravity	Snyder 1975	100	Snyder 1975	
4	Inside leg length	BSI 7231	80	BSI 7231	140
5	Chest depth	Schneider e.a. 1986	30	Steenbekkers 1993	80
6	Chest breadth	Snyder e.a. 1977	30	Snyder e.a. 1975	65
7	Shoulder breadth	Schneider e.a. 1986	30	Steenbekkers 1993	80
8	Hip breadth	Steenbekkers 1989	30	Steenbekkers 1993	80
9	Hip depth	Snyder 1975	100/20	-	
10	Chest circumference	BSI 7231	80	BSI 7231	140
11	Thigh circumference	BSI 7231	80	BSI 7231	140
12	Sitting height	Snyder e.a. 1977	30	Steenbekkers 1993	80

13	Shoulder height sitting	Steenbekkers 1989	50	Steenbekkers 1993	80
14	Shoulder-elbow length	Snyder e.a. 1977	30	Snyder e.a. 1975	65
15	Hip breadth sitting	Steenbekkers 1989	50	Steenbekkers 1993	80
16	Popliteal height	Steenbekkers 1989	30	Steenbekkers 1993	80
17	Buttock-popliteal length	Steenbekkers 1989	30	Steenbekkers 1993	80
18	Buttock-foot length	Snyder e.a. 1977	30	Steenbekkers 1993	80
19	Thigh clearance	Snyder e.a. 1977	30	Snyder e.a. 1975	65
20	Hand length	Snyder e.a. 1977	30	Snyder e.a. 1975	65
21	Hand diameters	Steenbekkers 1989	30	Steenbekkers 1993	80
22	Hand thickness	Steenbekkers 1989	30	Steenbekkers 1993	80
23	Fist breadth	Snyder e.a. 1977	30	Snyder e.a. 1975	80
24	Thumb breadth	Snyder e.a. 1977	30	Steenbekkers 1993	80
25	Little finger breadth	Steenbekkers 1989	30	Steenbekkers 1993	80
26	Foot length	Steenbekkers 1989	30	Steenbekkers 1993	80
27	Foot breadth	Steenbekkers 1989	30	Steenbekkers 1993	80
28	Head length	Schneider e.a. 1986	30	Steenbekkers 1993	80
29	Head breadth	Schneider e.a. 1986	30	Steenbekkers 1993	80
30	Head height	Schneider e.a. 1986	30	Steenbekkers 1993	80
31	Chin to crown length	Schneider e.a. 1986	30	Steenbekkers 1993	80
32	Head circumference	Schneider e.a. 1986	30	Steenbekkers 1993	80
33	Neck breadth	Schneider e.a. 1986	30	Snyder e.a. 1975	65
34	Neck circumference	Schneider e.a. 1986	30	Snyder e.a. 1975	65
35	Mouth breadth	Snyder e.a. 1977	65		
36	Grip reach forward	Snyder e.a. 1977	65		
37	Grip reach forward (stretched)	Steenbekkers 1989	50	Steenbekkers 1993	80
38	Reaching height standing	Steenbekkers 1989	50	Steenbekkers 1993	80
39	Reaching height sitting	Steenbekkers 1989	50	Steenbekkers 1993	80
40	Step height	Steenbekkers 1989	50	Steenbekkers 1993	80
41	Grip circumference	Steenbekkers 1989	50	Steenbekkers 1993	80

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[4] ISO/IEC Guide 51, *Safety aspects — Guidelines for their inclusion in standards*

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[6] *Childata, the handbook of child measurements and capabilities*, Department of Trade and Industry, London, UK 2002 URN 02/799

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