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Supplement: About the influence of social status on the body measurements of school children – A non-literal translation of the dissertation "Über den Einfluss der sozialen Lage auf die Körpermaße von Schulkindern. Müller & Steinicke, München" written by Mordchaij Dikanskis (1914)

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Interesting attempts to determine whether and to what extent social deprivation has an influence on the physical development of young individuals have often been undertaken. In most cases, children of the same age, but from different social classes, were measured in certain districts, especially in terms of body length and weight, and the mean values of the two were compared. On the one hand, children from elementary schools, orphanages, vacation-colonies, etc. were compared with regulars of the educational institutions preferred by the "higher" classes (middle-class schools, grammar schools etc.) on the other. Such surveys are available from Germany and abroad. Table 1 (prepared from information provided by L. Hoesch-Ernst) gives an overview of the results. In each column of this table, the mean value for the respective body measurement of children of the "higher" classes is listed in the first place, that of children of the "lower" classes in second place; the result of the subtraction, then, gives the difference attributed to the social influence. This difference, as can be observed, is almost remarkably positive, in length as well as in weight, in boys as well as in girls, in each of the ages and each of the countries. It has been concluded that the unfavourable social conditions of the poor population affect the growth in length and weight of children. According\breaktitlepage to Rietz, this impairment is a developmental delay. The children of the affluent are, so to speak, ahead of their less well-off peers in development. That the latter lag behind is attributed partly to poverty and the associated deprivations of food and care, as well as to overexertion, and partly to the "childhood diseases raging among the youth of the poorer classes" (Rietz).

However, if one takes a closer look at the data, it becomes obvious that the results of the observers differ from each other. The differences found are partly small (e.g., Bowditch and Mac Donald), partly large (Pagliani, Rietz), partly clearly increasing with age (Roberts, Michailoff), partly decreasing (Hertel) and partly fluctuating irregularly.

Thus, the presented question seemed to be worth further exploration. Such a study was attempted based on material about Munich elementary school children, which was collected by the author in cooperation with some colleagues. The procedure of this collection is reported in the two previous publications by Riedel and Skibinsky.

The author proceeded to compare the schoolchildren belonging to different social classes in a different way than had been done before. He did not simply compare the regulars of a "higher" school with those of an elementary school or suburban school, but sorted the entire material from three Munich elementary schools, whose visitors belong to different social classes, according to the occupation of the parents. Of course, it will happen that in some individual cases the "standard of life" in the household of the student, which is the focus, will be over- or underestimated. However, we consider this procedure to be superior to the usual one – at least for our conditions in Munich, where, due to the often exemplary building and operating conditions of the public elementary schools, a considerable number of children of wealthy people can be found in many of them.

In any case, with a fair degree of certainty, two social classes could be identified from the total number of counter cards, namely the rich and affluent middle class (Class I) and the working class (Class III). The rest were kept as middle class (II). The procedure of this allocation is explained by the following examples. Class I was assigned children of Pharmacists, Doctors, Bank Officials, Railway Administrators, Builders, Delicatessens, Railway Secretaries, Factory Owners, General Managers, Innkeepers, House Owners, Hotel Owners, Engineers, Inspectors, Painters, Chapel Masters, 'Higher' Teachers, Master Craftsmen, Officers, Privateers, Professors, etc. Class II was assigned to the children of assistants of the various trades, of hired hands, clerks, servants, factory workers, unskilled workers, invalids, coachmen, waiters, day labourers, watchmen, road workers, switchmen, etc., and also most illegitimate children. Children of foremen, accountants, chauffeurs, printers, electricians, field weavers, hairdressers, gardeners, janitors, plumbers, machinists, small tradesmen, postmen, postal workers, guards, tramway conductors, etc. are included in class II.

Herr Professor I. Kaup, the lecturer for social medicine at the local university, had the kindness to give me advice on this assignment, for which I would like to thank him at this point.

The present contributions to the question should differ from those of the predecessors mainly by the fact that they do not limit themselves to the calculation and comparison of the mean values, but present the totality of the values themselves clearly and comparably. This is made possible by the methods of the 'collective measure theory'. Which advantages these methods have, compared to the simple calculation of arithmetic mean values or compared to the indication of maximum and minimum values, has been explained in the already quoted publications of Riedel and Skibinsky, as well as in many other places, so it does not need further explanation here.

The author is at a disadvantage to his predecessors because his material includes only the enrolment period itself, not the higher stages of development. For the school enrolment age, however, this material is much larger than most other surveys. Measurements and weightings of older children were unfortunately not available, or not in sufficient numbers. However, especially the age at which children start school has often been ignored. About the influence of the social environment on physical development in the 6th and 7th year of life, the youngest researcher (Rietz) brings, in addition to his data, only those of Bowditch. I added Axel-Key's data to both series and converted all the material to naked weight to make it comparable with my own. The overview for this youngest age can be seen in Table II. Here, one can see differences in principle, too. According to Axel-Key, the below-average size of working-class children in Sweden does not exist at the time of school enrolment but develops only during school attendance (see also the curves in the author's original report) – whereas in Berlin, according to Rietz, it is already present in school recruits as a result of developmental retardation that arose in early childhood and only persists during the school period. Presumably, however, these differences are only due to differences in methodology and material procurement.

Finally, the present surveys differ from (most of) the earlier ones in that the body measurements are strictly net values (surveyed without shoes and clothes) and they are also reduced to certain age groups, namely to the age of exactly 6 or 7 years. All predecessors have included "n years old" children in the group, per language usage. Consequently, those who were more than n and less than n+1 years old were included, too. With such a procedure, however, one is not able to relate the calculated average body measurements to any particular age group and runs the risk of comparing unequal data. The assumption that the children examined are evenly distributed over the age range between n and n+1 years, i.e. that they have a mean age of $n+\frac{1}{2}$ years, must by no means apply to the school recruits.

The material was processed in the following way: firstly, the individual cases, and/or counter cards were distributed into the status classes I to III (according to the procedure explained above), within this distribution they fell again into two age groups (6 and 7 years). Thus, 6 number series were obtained for each sex. The variation of these number series was now to be represented according to the rules of the 'collective measure theory'. For this purpose, the mean values, the error sum squares – and from these the parameters of the Gaussian curve (h), were calculated. The procedure is described in detail in the repeatedly cited works of Riedel and Skibinsky.

The ordinate values for the construction of the error curve itself had been determined by Riedel and Skibinsky using error integral tables. I used another method, namely the direct calculation from the Gaussian curve equation; and with the application of certain tricks, my method does not prove to be time-consuming.

When constructing the Gaussian curve, the following is of note: The unit of measurement of the abscissa axis is the same as the unit of measurement of the corresponding body dimension, i.e. for body length the centimetre, for bodyweight the kilogram. If in the adjacent Figure 1 the division at the abscissa axis had been made according to such units, then, for example, the abscissa of the curve point $M1 = XO_1 = 3$, that of the point $M2 = XO_2 = 4$.

The y of the Gaussian equation expresses the probability that any individual case of the series concerning the considered character, e.g. the body length or bodyweight, falls into that one unit wide step, the centre, which is given by the value x. If, for exam-

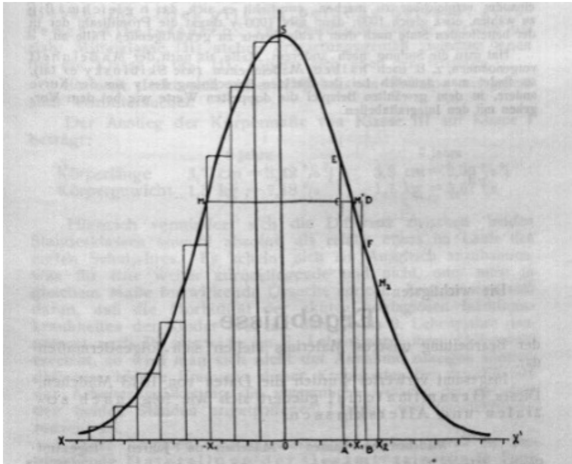


Fig. 1. Beispiel einer Gauss-Kurve.
XX¹ Abszissenachse O Nullpunkt
OS Ordinatenachse S Scheitelpunkt
M_1, M_2 Zwei Kurvenpunkte (M_1 hier der Inflexionspunkt)
$O X_1 = x_1$, $X_1 M_1 = y_1$ Coordinaten von M_1

Figure 1 An example of a Gaussian curve.

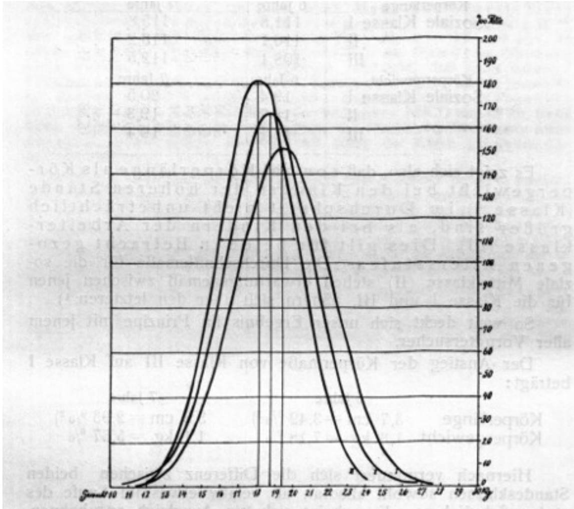


Fig. 2. Variation des Körpergewichts sechsjähriger Mädchen dreier verschiedener Standesklassen, dargestellt durch die aus dem Zahlenmaterial berechneten Gaussischen Kurven.

Figure 2 Variation of body weight of six-year-old girls of three different social status classes, represented by the Gaussian curves calculated from numerical material.

ple, in the case represented by the above figure, the x1 = XO_1 = 3, then by substituting this value 3 into the Gaussian equation, one would obtain y1, which expresses the probability that any single case of variation concerning the body dimension in question is located within the boundaries A and B (AB = one unit of measurement).

If one does not want to express this probability, but the proportional absolute number to the total of n cases to be expected within the unit of measurement in question, one has only to calculate nx. To make the Gaussian curve of different variation series comparable with each other, it is recommended to choose the n evenly, approximately equal to 1000; then 1000 y directly indicates the per mill number of cases to be expected in the respective stage according to the error law.

If one has made the increments according to other dimensions than the unit of measurement, e.g. according to half units of measurement (as Skibinsky did), then one will of course find other values when calculating the y directly from the curve, in the chosen example it would be double the values as in the procedure with the integral tables.

Results

The main results of analysing our material are as follows. In total, the data of 1843 girls were utilized. This total material is divided into social and age groups as summarized in Table 2.

The arithmetic means of body measurements in these 6 groups are summarized in Table 3.

It can be seen that both body length and body weight are on average not inconsiderably greater in the children of the higher classes (Class I) than in the children of the working class (III). This is true for both considered age groups. The average measurements for the social middle class (II) are, as expected, between those for classes I and II, but close in on the latter.

So far, our result is the same as that of all the preliminary examiners. The increase in body measurements from class II to class I is summarized in Table 4.

According to this, the difference between the two classes decreases somewhat in absolute and relative terms in the course of the first school year. A balance seems to

Table 2 Social and age groups of the data of 1843 girls.

Social calss	Girls age 6	Girls age 7	Total number
I	174 = 18.3%	176 = 19.7%	350
II	246 = 25.9%	281 = 31.5%	527
III	530 = 55.8%	436 = 48.8%	956
	950 = 100%	893 = 100%	1843

Table 3 Arithmetic means of body measurements.

Body height	Social class	Age 6	Age 7
	I	111.8	115.8
	II	110.1	113.2
	III	108.1	112.5
Body weight	Social class	Age 6	Age 7
	I	19.4	20.5
	II	18.7	19.3
	III	18.1	19.4

Table 4 Increase in body measurements from class II to class I.

	Age 6	Age 7
Body height	3.7 cm = 3.42%[1]	3.3 cm = 2.93%[1]
Body weight	1.3 kg = 7.18%	1.1 kg = 5.67%

[1] Referring to the body measurement of the class III = 100.

be approaching, which speaks for a cause that lies further back in time and does not continue to have an effect or does not have an effect to the same extent as before. If one remembers that the morbidity of acute contagious infectious diseases of children reaches its peak only at the age of 5 to 9 (in total, according to Prausnitz, at the age of 7), one will not be able to assume that a higher frequency of these diseases in the children of the working population is the essential cause of the differences in length and weight found between the two classes. This data is substantially supplemented by the comparative presentation of the total variation in the form of Gaussian curves.

Concerning bodyweight (of the 6-year-old girls), reference is made to Figure 2 and the general table (A).

Here one sees on the uniform abscissa scale the 3 curves relating to social class I, II and III. For the explanation of this representation for readers not familiar with the collective measure theory, the following is of note: The base of the figure carries a scale of the body weight, divided into kilogram units. On the left are the lowest weight values found in the total material, on the right the highest. Above this scale, the Gaussian curves rise in their characteristic symmetrical form, doubly curved in each half and asymptotic towards the base.

The height of the individual curve points above the base is measured at a vertical scale and gives the relative number – in our case the per mill number – of encountered cases in the weight increment. If, for example, a vertical line erected above the base point ”23” intersects the curve I at a height that approximately corresponds to the point ”60” on the height scale, it means: out of 1000 6-year-old girls of social class I (status of the wealthy), one had a bodyweight of about 23kg (ie.: more than 22.5 and less than 23.5kg) Or, if the perpendicular above the base point ”17” reaches the curve II at the height point ”130”, it means: 130 per mil of the 6-year-old female school children belonging to the middle class had a bodyweight of about 17kg.

The curves consistently start flat and end low again, i.e.: the lowest and the highest values of the body weight are relatively rare and become rarer and rarer the more they approach the absolute maximum and the minimum, respectively. The curves, becoming steeper at the beginning, rise and reach a certain peak; i.e.: the occurrence of weight values approaching the average becomes more frequent the more this approach occurs, and the frequency reaches its maximum, the peak value, for weights grouped around the arithmetic mean itself. These are the characteristics common to all "random" variations, encompassed by the law of errors, whose geometrical expression is the Gaussian curve and whose mathematical expression is the Gaussian equation.

If we now compare the three curves of the three different status classes among each other, we find the following:

1. Curves III to I shift on the basis in toto more and more to the right; i.e. not only the average values of the bodyweight become higher with the ascending status of the child's parents, but in the entire variation the influence of weight through social conditions expresses itself evenly. For each of the lower weight classes, there are fewer cases in class I, for each of the high weight classes more cases than in class II or even III.

2. Although curves III to I unmistakably show a common form-type, as they belong to the same "family of curves", they differ in that curve III rises steepest and reaches the highest peak, while curve I remains flatter and has a lower peak; and curve II occupies quite exactly a middle position. The relative frequency of the most frequent weight values thus decreases and that of the rarer values increases with ascending status, or in other words: the variation becomes wider the higher the social status of the children or child parents is.

The procedure according to the collective measure theory provides exact measurement figures for the width of the variation. As such, for example, can be considered

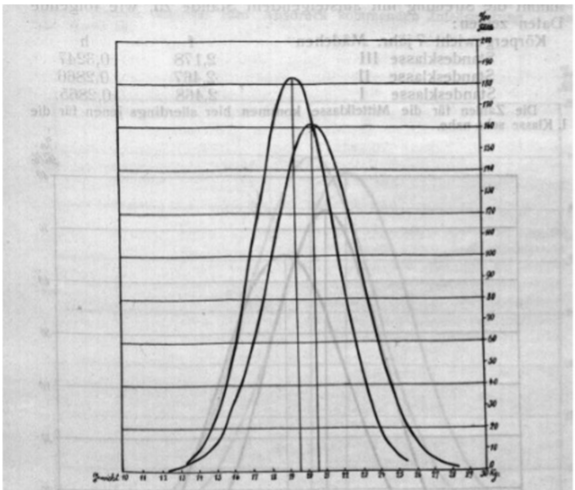


Fig. 3. Variation des Körpergewichts siebenjähriger Mädchen zweier verschiedener Standesklassen, dargestellt durch die aus dem Zahlenmaterial berechneten Gaussischen Kurven.

Figure 3 Variation in body weight of seven-year-old girls of two different status classes represented by the Gaussian curves calculated from numerical material.

the average deviation of the single value, which is calculated from the error sum of squares δ^2 and the total number of cases n can be calculated according to the formula

$$f = \sqrt{\frac{\sum \delta^2}{n-1}}$$

This value f, which, by the way, can also be seen on the curve diagram (half the width of the curve at the height of its inflexion point) amounts to the following for the variation of the bodyweight of the 6-year-old girls in our case:

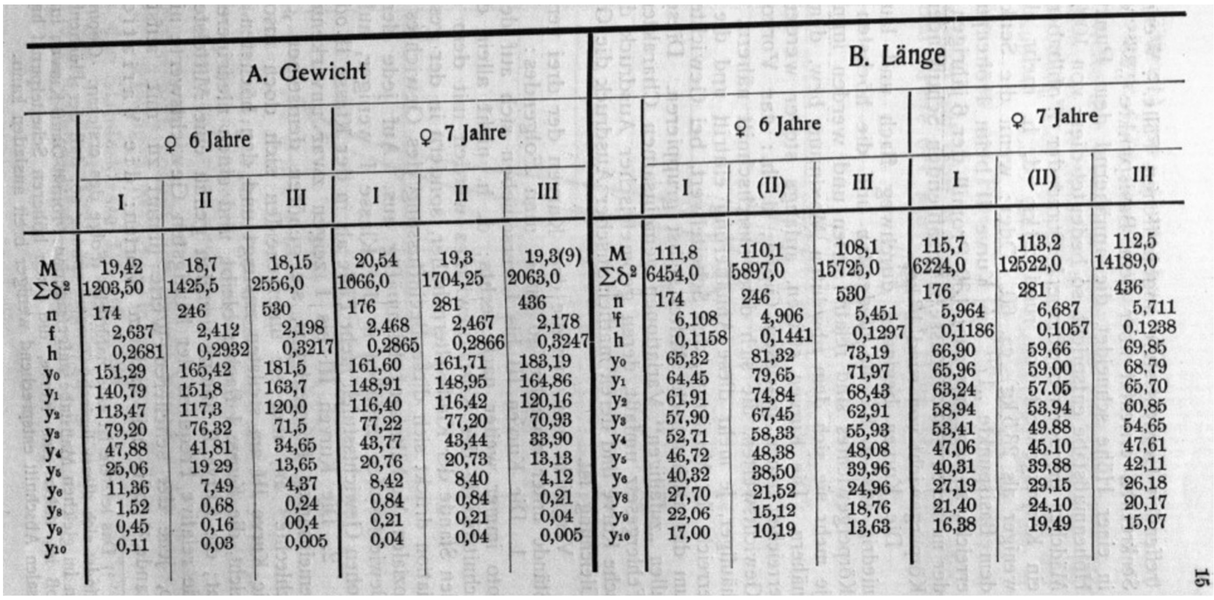
- in social class III 2,198
- in social class II 2,412
- in social class I 2,637;

So, it indeed shows a regular increase. The parameter of the Gaussian curves (h) behaves reciprocally, which is also called the precision constant of the variation.

Its values in our example are the following:

- for social class III 0,3217
- for social class II 0,2932
- for social class I 0,2681

Completely analogous ratios result when comparing the variation of body weight in the higher age group of girls (7 years),



	A. Gewicht					
	♀ 6 Jahre			♀ 7 Jahre		
	I	II	III	I	II	III
M	19,42	18,7	18,15	20,54	19,3	19,3(9)
$\Sigma\delta^2$	1203,50	1425,5	2556,0	1066,0	1704,25	2063,0
n	174	246	530	176	281	436
f	2,637	2,412	2,198	2,468	2,467	2,178
h	0,2681	0,2932	0,3217	0,2865	0,2866	0,3247
y_0	151,29	165,42	181,5	161,60	161,71	183,19
y_1	140,79	151,8	163,7	148,91	148,95	164,86
y_2	113,47	117,3	120,0	116,40	116,42	120,16
y_3	79,20	76,32	71,5	77,22	77,20	70,93
y_4	47,88	41,81	34,65	43,77	43,44	33,90
y_5	25,06	19 29	13,65	20,76	20,73	13,13
y_6	11,36	7,49	4,37	8,42	8,40	4,12
y_8	1,52	0,68	0,24	0,84	0,84	0,21
y_9	0,45	0,16	00,4	0,21	0,21	0,04
y_{10}	0,11	0,03	0,005	0,04	0,04	0,005

	B. Länge					
	♀ 6 Jahre			♀ 7 Jahre		
	I	(II)	III	I	(II)	III
M	111,8	110,1	108,1	115,7	113,2	112,5
$\Sigma\delta^2$	6454,0	5897,0	15725,0	6224,0	12522,0	14189,0
n	174	246	530	176	281	436
f	6,108	4,906	5,451	5,964	6,687	5,711
h	0,1158	0,1441	0,1297	0,1186	0,1057	0,1238
y_0	65,32	81,32	73,19	66,90	59,66	69,85
y_1	64,45	79,65	71,97	65,96	59,00	68,79
y_2	61,91	74,84	68,43	63,24	57.05	65,70
y_3	57,90	67,45	62,91	58,94	53,94	60,85
y_4	52,71	58,33	55,93	53,41	49.88	54,65
y_5	46,72	48,38	48,08	47,06	45,10	47,61
y_6	40,32	38,50	39,96	40,31	39,88	42,11
y_8	27,70	21,52	24,96	27,19	29,15	26,18
y_9	22,06	15,12	18,76	21,40	24,10	20,17
y_{10}	17,00	10,19	13,63	16,38	19,49	15,07

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Figure 4 Overview-Table: Data on variation in body measurements by social position. A. Weight, B. Length (divided into 6 and 7 years respectively).

which is shown in Figure 3. Here, too, the variation increases with increasing age, as the following data shows in Table 6.

However, the numbers for the middle class come very close to those for the I. class.

Concerning the variation of body length, about the same could be found. Here, too, the Gaussian curves shift to the right in toto with ascending class. Again, the variation is much wider in the wealthy class (I) than in the working class (III). This is true in both age groups, as can be seen in figures 4 and 5 and the figures of the overview table (B).

The data obtained for the social middle-class II also takes an intermediate position if the two age classes are considered together; otherwise, however, they deviate from the rule – probably as a result of a random bias expressed in the relatively small material.

Table 6 Variation of increases.

Body weight of 7-year-old girls	f	h
Social class III	2.178	0.3247
Social class II	2.467	0.2866
Social class I	2.468	0.2865

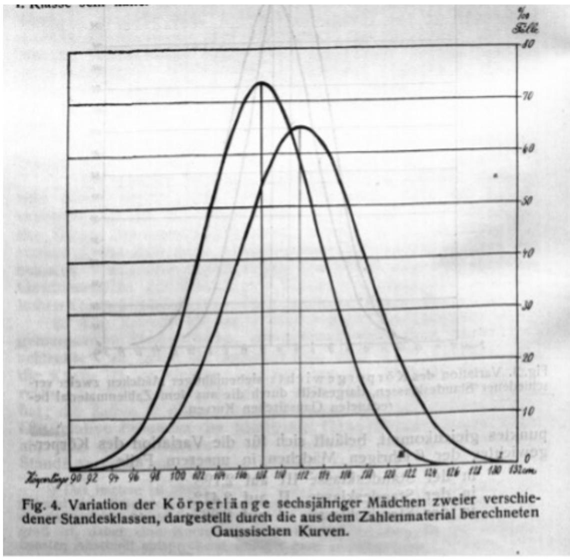

Figure 5 Variation of body length of six-year-old girls of two different status classes, represented by the Gaussian curves calculated from numerical material.

To make the range of variation of different series comparable among themselves, it has been suggested to express it as a percentage of the mean value of the body measure concerned. If we proceed in this way, we obtain the following indices of the range of variation (see Table 7), which

Table 7 Indices of the range of variation.

Variation of	Girls	Class I	Class III
Body height	Age 6	5.46% >	5.04%
	Age 7	5.16% >	5.05%
Body weight	Age 6	13.58% >	12.11%
	Age 7	12.02% >	11.23%

are quite comparable among themselves $(\frac{100\,f}{M})$.

Here, as expected, bodyweight turns out to be the far more variable measure compared to body length. Furthermore, the difference in the range of variation of the two body measurements by social position is also clearly visible in this table.

How, then, may the limitation of the range of variation in the social lower-class be explained? It seems to us quite probable that this has nothing at all to do with the social situation as such, but is due to the greater homogeneity of the material in the working-class population in terms of ethnicity and nation. There is no doubt that in the wealthy circles (among officers, civil servants, higher teachers, artists,

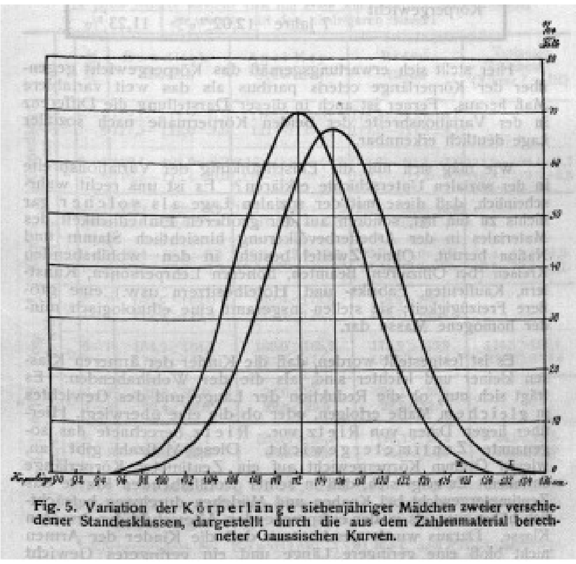

Figure 6 Variation of body length of seven-year-old girls of two different status classes, represented by the Gaussian curves calculated from numerical material.

merchants, factory and hotel owners, etc.) there is greater freedom of movement; overall, they constitute an ethnologically less homogeneous mass.

It has been observed that the children of the poorer classes are smaller and lighter than those of the more affluent. The question now is whether the reduction in length and weight occur to the same extent, or whether one predominates. Data on this is available from Rietz. Rietz calculated the so-called centimetre weight. This measure indicates how many grams of body weight is allotted to one centimetre of body length. It shows that in his affluent class, the bodyweight of boys and girls was consistently considerably higher than in the corresponding age group of the poorer class. From this, it was concluded that children of the poor have not only a shorter length and a lower weight, but are also ”worse developed”. Samosch refers to the children of the well-to-do as ”better off in that respect.” This does not change, even if one replaces the gross weights (Rietz) with net weights (by subtracting the weight of clothing) and then converting the data of Rietz and other authors, as is done in Table 8. The centimetre weight is almost without exception – also according to the author’s surveys – lower in the working class.

The assumption that the proportionality of these children is disturbed compared to the wealthy in the sense of a lower development of width, that those are, in a word, leaner and more slender, is an inaccurate one. The weight in centimetres cannot be used to compare the body proportions of individuals of different heights if one does not want to run the risk of great deception. This has been extensively justified and shown by Matusiewicz and others. In the present case, the centimetre weight was also misleading. If one calculates a measure for the length-weight ratio, which is not subject to the objections made by the mentioned author, unlike, for example, the

		Alter	Bowditch-Boston	Axel Key-Schweden	Rietz-Berlin	Verfasser München ** (Klasse I u. III)
Körperlänge in cm (L)	♂	6—7	112,1—111,2=0,9	116—116=0	118,3—113,6=4,7	
		7—8	117,5—116,0=1,5	121—117=4	122,0—117,2=4,8	
	♀	6—7	112,1—109,9=2,2	(113)—(115)=(—2)	(119,0)—111,9=(7,1)	111,8—108,1=3,7
		7—8	116,3—115,4=0,9	116—117=—1	122,7—117,3=5,4	115,8—112,5=3,3
Körpergew. in kg*1000 (P)	♂	6—7	19,0—18,8=0,2	18,9—20,1=—1,2	(20,5)—18,5=(2,0)	
		7—8	20,8—20,4=0,4	21,0—20,7=0,3	21,8—19,9=1,9	
	♀	6—7	18,4—18,1=0,3	19,1—19,0=0,1	20,7—18,0=2,7	19,4—18,1=1,3
		7—8	20,0—19,7=0,3	19,9—20,4=—0,5	22,4—19,9=2,5	20,5—19,4=1,1
cm-gewicht $\frac{P}{L}$	♂	6—7	169,5 > 169,0	162,9 < 173,3	173,3 > 166,6	
		7—8	177,0 > 175,9	173,6 < 176,9	178,7 > 169,8	
	♀	6—7	164,2 < 164,7	169,0 > 165,2	173,9 > 160,9	173,5 > 167,4
		7—8	172,0 > 170,7	171,5 < 174,4	182,6 > 169,6	177,0 > 172,4
Livi Index $\frac{100\sqrt[3]{P}}{L}$	♂	6—7	23,8 < 23,9	23,0 < 23,4	(23,1) < 23,8	
		7—8	23,4 < 23,6	22,8 < 23,5	22,9 < 23,1	
	♀	6—7	23,6 < 23,7	(23,7) > (23,2)	(23,1) < 23,4	24,0 < 24,3
		7—8	23,3 < 23,4	23,3 = 23,3	23,0 < 23,1	23,6 < 23,9

Figrue 7 Original table of mean body measurements comparatively collected from school recruits of different social classes. (In each category, the first number refers to the socially higher, the second to the lower status).

Livi index, one finds exactly the opposite. The Livi index, as can be seen in the lowest bars of Table II, is almost without exception, according to calculations from all available surveys, including ours, smaller in the children of the affluent class than in the children of the working class, i.e. the latter are the relatively bulkier, by no means the leaner.

This fact does not seem to be without significance for the whole question of undersizedness in social misfortune. It opens the possibility to consider that it is perhaps not at all or only partly a "developmental disorder" in this class; it could also be the predominant plus variation in the socially "higher" classes that is atypical, attributable to certain environmental influences. An increased, but on average not completely proportional, i.e. somewhat one-sided precipitated growth in length does not have to mean a particularly advantageous moment in the physical development of the wealthy class.

If one calculates the centimetre weight on a larger number of individual cases, one easily recognizes the influence which the absolute body length value has on the size of the index. The high centimetre weights are generally found in individuals with greater body length – completely independent of true body proportions. If the Livi indices are calculated individually in the same way, the factor of absolute length is nearly eliminated. However, it is not completely eliminated. It is still somewhat noticeable in the opposite direction to the centimetre weight. The taller individuals tend to have a lower Livi index. This becomes also explainable if one remembers the elevation originating from Quételet that with proportional development of the human body the second potency of the bodyweight increases with the fifth potency of the body length. Accordingly, one arrives at the following overview (see Table 8).

It can be seen that a much smaller error than one makes when using the centimetre weight for the comparison of unequal-sized individuals, can be caused by the application of the Livi index in the opposite direction. The closest one gets to the actual physiological conditions is several

Table 8 Overview of relations between quantities.

	by centimetre weight	for the Livi index and the Pirquet index	n the proportional development of the human being
The square of the body weight is put into relation.	second power of the body length	sixth power of body length	fifth power of the body length

measurements, which are based on the relation $\frac{p^2}{L^5}$. Therefore, as a precaution, such a measure $100 \cdot \frac{p^2}{L^5}$ was also used for our data, to verify the behaviour of the two social classes.

The result was

- for the 6 year old girls in class I 2,155 < in class II 2,219
- for the 7 year old girls in class I 2,018 < in class II 2,089

As can be observed, this does not principally change the above conclusion that the children of class III are on average relatively broader, more massive, than the children of class I.

In the following series, Pirquet's indices $\frac{p^2}{L^5}$, which are in principle related to Livi's, but are instead reciprocal and potentiated, were calculated according to Rietz's figures (and ours), including the later developmental stages. It can be seen that the reciprocal index is consistently greater for the children of the wealthy than for those of the poor in the first years of school. Only in the later years does a reversal occur for both sexes. This, too, is fully in line with the relationships described above.

The authors of the present material in its undivided entirety (Riedel and Skibinsky) were able to compare the Gaussian curves with observed variation polygons. By separating into three social classes, as it is done here, the material becomes too small to be able to supply useful variation polygons. Here the Gaussian curve can be a valuable substitute.

In a certain direction, however, it seemed to be of interest to let the original figures speak for themselves, namely about the question of the variation symmetry. Riedel's polygonal figures do not show any considerable and lawful asymmetry, which the author particularly emphasizes, because the opposite finding would be a certain indication that the variation does not follow the Gaussian error law, at least not the law in its original version. (The logarithmic extension of the Gaussian law according to Fechner, however, results in asymmetric curves). Riedel checks the symmetry of his polygons purely geometrically using the arithmetic mean ordinate as the symmetry axis. Deviating from this, I use the ordinate of the most frequent (densest) value as the symmetry axis; this separates the total number of cases into plus variants and minus variants; each of these two groups was counted separately, adding one-half of the representatives of the densest value itself. The number of individuals falling to the right and left of this centre line was then expressed as a percentage of the total series. With this procedure, I first examined the total material according to its representation by Riedel (body length) and Skibinsky (body weight) in both age groups separately (but without differentiation of the sexes) and further, in the same way, additionally also the material of the female children eliminated by me, whereby the classes I and II had to be taken together for the increase of the absolute number of the cases. The result of these surveys is shown in the following table III. It can be seen that the plus variants are more frequent than the minus variants, but that the differences are usually smaller when

Table 9 Comparison of Pirquet's indices from Rietz's figures and from ours.

	Age	Rietz	Age	author
	Year	Class: Class: affluent working class		Class Class I II
Boys	6-7	74,2 > 72,9		
	7-8	76,6 > 74,5		
	8-9	78,7 > 76,8		
	9-10	81,2 > 78,8		
	10-11	81,7 > 81,3		
	11-12	82,0 > 82,6		
	12-13	82,9 = 82,5		
	13-14	82,1 > 83,0		
Girls	6-7	74,9 > 71,5		
	7-8	76,0 > 74,7		
	8-9	78,8 > 77,4		
	9-10	80,9 > 79,1	6	71,96 > 69,79
	10-11	77,8 < 81,0	7	75,52 > 73,43
	11-12	81,8 < 82,5		
	12-13	79,7 < 81,1		
	13-14	81,6 < 82,7		

using larger amounts of material. The considerable differences, as they seem to exist e.g. with the bodyweight of the 6-year-old girls in class I + II, as well as in class III, must be addressed as "coincidental", since they would have to otherwise become noticeable with the total material about both sexes. Therefore, greater significance cannot be attributed to the figures in the table, which are not printed in bold. They do, however, show one thing, which was the author's main concern, namely, that in no case do the minus variants become more prominent in the class of working-class children and exceed the plus variants more than in the other social classes or in total.

Such a stronger surpassing could have been assumed, at best, a priori – although probably only due to an obvious mistake in thinking. The variation polygon of the body dimensions is shifted to the left on the abscissa axis in case of social disfavour,

Table 10 Data on the question of the symmetry of the variation polygon. Comparative frequency of minus and plus variations.

		body height		body weight	
		minus-variants	plus-variants	minus-variants	plus-variants
Total material (both sexes)	6-year-olds	47.95%	52.05%	46.53%	53.47%
	7-year-olds	46.05%	53.95%	46.36%	53.64%
Girls: social class I and II	6-year-olds	49.76%	50.24%	38.81%	61.19%
	7-year-olds	47.70%	52.30%	46.61%	53.39%
Girls: social class III	6-year-olds	46.23%	53.77%	34.91%	65.09%
	7-year-olds	39.91%	60.09%	45.41%	54.59%

but not at all asymmetrically deformed in the sense that it would be narrower on the minus variant side, or fall off more steeply. In the same way, it is shifted, but not formed differently, if one turns the Galton's random apparatus a little bit around its longitudinal axis, or if one shoots at the target with a sideways carrying rifle.

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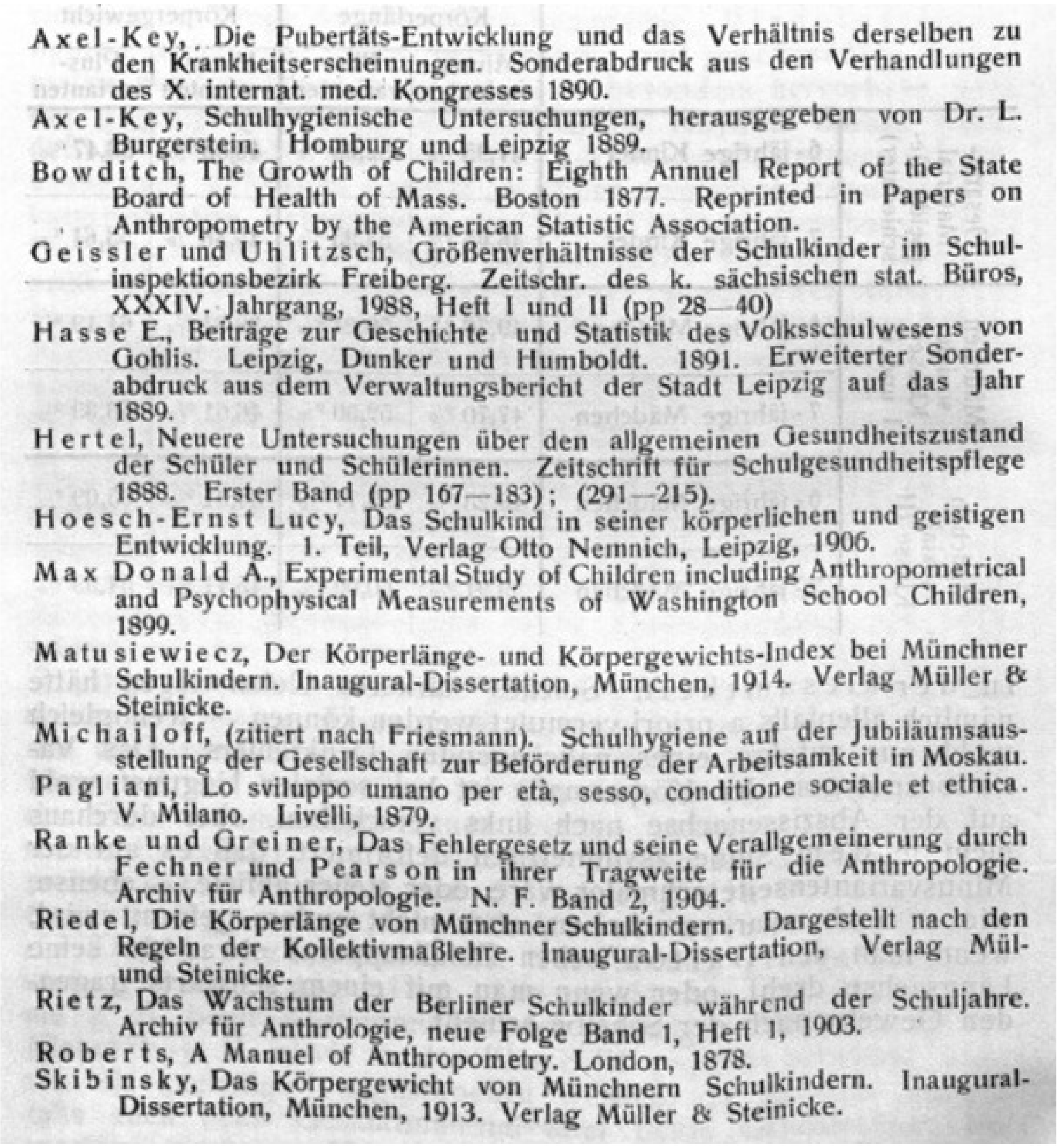
Appendix

Literature used in Dikanski (1914)



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Curriculum vitae

Mordchaj Dikanski, born in Kharkov (Russia) on June 29, 1890, attended since 1905 the Warsaw V. Humanistic Grammar School. In 1909 he was enrolled at the University of Munich.

Table 1 Overview of mean body measurements. comparatively collected from schoolchildren of different social classes. (In each category: the first figure refers to the socially higher, the second to the lower status).

		Age	Bowditsch 1877 America (Boston)	Pagliani 1879 Italy (Turin)	Roberts 1879 England	Axel Key 1889 Sweden	Hertel 1888 Denmark	Michailoff Russia	Geißler und Uhlitzsch 1888 Germany (Freiberg)	Hasse 1891 Germany (Gohlis)	Mac Donald 1899 America (Washington)	Rietz 1903 Germany (Berlin)
Body height in cm	Boys	8 - 9	122.2 – 121.2 = 1.0	122.0 – 115.9 = 7.0		126 – 122 = 4		117.8 – 117.7 = 0.1	119.7 – 117.4 = 2.5	120.5 – 118.6 = 1.9	121.7 – 121.1 = 0.6	127.3 – 121.4 = 5.9
		9 - 10	127.1 – 126.4 = 0.7	125.4 – 120.0 = 5.4	135.6 – 128.4 = 7.2	131 – 125 = 6		122.8 – 121.9 = 1.8	125.0 – 119.9 = 5.1	126.0 – 122.9 = 3.1	126.8 – 125.8 = 1.0	131.2 – 126.5 = 4.7
		10 - 11	132.5 – 131.0 = 1.5	128.5 – 125.6 = 2.9	139.4 – 130.9 = 8.5	133 – 129 = 4	141 – 133 = 8	130.9 – 126.6 = 4.3	128.3 – 125.6 = 2.7	130.9 – 128.0 = 2.9	132.1 – 130.1 = 2.0	135.7 – 130.9 = 4.8
		11 - 12	136.8 – 135.1 = 1.7	133.6 – 128.5 = 5.1	144.6 – 134.7 = 9.9	136 – 134 = 2	143 – 138 = 5	135.6 – 129.6 = 6.0	132.3 – 130.0 = 2.3	134.2 – 131.7 = 2.5	135.9 – 133.9 = 2.0	149.5 – 135.3 = 4.2
		12 - 13	142.1 – 139.5 = 2.6	137.0 – 132.0 = 5.0	149.3 – 142.2 = 7.1	140 – 137 = 3	146 – 143 = 3	140.1 – 133.9 = 6.2	137.6 – 134.8 = 2.8	139.2 – 137.8 = 1.4	140.6 – 139.3 = 1.3	145.4 – 139.7 = 5.7
		13 - 14	147.7 – 144.5 = 3.2	142.5 – 138.6 = 3.9		144 – 142 = 2		145.4 – 137.9 = 7.5	143.0 – 138.3 = 4.7	141.2 – 140.5 = 0.7	144.5 – 143.2 = 1.3	150.6 – 144.7 = 5.9
	Girls	8 - 9	121.3 – 120.6 = 1.2	120.2 – 111.8 = 8.4		123 – 121 = 2		116.4 – 117.6 = 1.2	119.1 – 116.3 = 2.8	120.5 – 116.4 = 4.1	121.3 – 119.6 = 1.7	127.2 – 121.7 = 5.5
		9 - 10	127.5 – 125.2 = 2.3	124.8 – 118.0 = 6.8		127 – 125 = 2		119.6 – 121.6 = 2.0	124.2 – 120.4 = 3.8	126.0 – 133.2 = 2.8	125.2 – 124.4 = 0.8	131.0 – 125.0 = 6.0
		10 - 11	131.3 – 130.3 = 1.0	130.6 – 124.2 = 6.4		132 – 130 = 2		125.0 – 125.1 = 0.1	129.7 – 125.2 = 4.5	130.2 – 128.1 = 2.1	130.8 – 129.0 = 1.8	135.7 – 130.6 = 5.1
		11 - 12	136.4 – 135.7 = 0.7	133.5 – 130.3 = 3.2		137 – 134 = 2		129.7 – 128.5 = 1.2	134.2 – 130.3 = 3.9	135.1 – 133.4 = 1.7	135.9 – 134.0 = 1.9	141.2 – 135.7 = 5.5
		12 - 13	142.7 – 141.5 = 1.2	139.4 – 135.2 = 4.2		143 – 140 = 3		132.9 – 133.1 = 0.2	138.3 – 135.7 = 2.6	142.0 – 138.4 = 3.6	142.4 – 141.1 = 1.3	147.8 – 140.8 = 7.0
		13 - 14	149.1 – 147.4 = 1.7	146.4 – 138.5 = 7.9		148 – 146 = 2		138.3 – 137.8 = 0.5	145.8 – 140.7 = 5.1	147.2 – 144.3 = 2.9	148.5 – 146.5 = 1.8	152.1 – 148.1 = 4.0
Body weight in kg	Boys	8 - 9	22.8 – 22.4 = 0.4	22.7 – 20.5 = 2.2		26.2 – 25.8 = 0.4		22.0 – 22.2 = 0.2		25.2 – 24.3 = 0.9	23.3 – 23.4 = 0.1	26.2 – 23.33 = 2.9
		9 - 10	25.0 – 24.8 = 0.2	25.7 – 21.8 = 3.9	28.8 – 28.3 = 0.6	29.3 – 26.3 = 3.0		24.1 – 23.4 = 0.7		27.9 – 26.1 = 1.8	25.7 – 25.3 = 0.4	27.8 – 25.7 = 2.1
		10 - 11	27.7 – 27.3 = 0.4	27.5 – 24.4 = 3.1	31.1 – 29.5 = 1.6	30.3 – 28.7 = 1.6	33.0 – 30.5 = 2.5	27.7 – 25.9 = 1.8		28.5 – 28.2 = 0.3	28.1 – 27.7 = 0.4	30.6 – 27.6 = 3.0
		11 - 12	30.0 – 29.1 = 0.9	20.7 – 26.0 = 4.7	34.3 – 31.3 = 3.0	32.2 – 33.6 = 1.4	35.0 – 33.0 = 2.0	30.5 – 28.3 = 2.2		31.6 – 30.6 = 1.0	30.3 – 29.7 = 0.6	33.1 – 30.0 = 3.1
		12 - 13	33.6 – 31.7 = 1.9	30.0 – 28.0 = 2.0	37.8 – 33.2 = 4.6	34.5 – 33.0 = 1.5	37.5 – 36.0 = 1.5	33.3 – 29.8 = 3.5		35.3 – 34.2 = 1.1	33.1 – 32.8 = 0.3	37.1 – 32.9 = 4.2
		13 - 14	37.0 – 34.8 = 2.2	25.5 – 31.5 = 4.0		37.6 – 36.0 = 1.6		37.6 – 31.6 = 6.0		36.5 – 35.7 = 0.7	36.1 – 35.8 = 0.3	41.6 – 36.5 = 5.1
	Girls	8 - 9	22.3 – 21.9 = 0.4	22.8 – 18.5 = 4.3		25.0 – 23.2 = 1.8		21.3 – 21.3 = 0.0		24.6 – 23.8 = 0.8	22.5 – 22.3 = 0.2	26.1 – 23.3 = 2.8
		9 - 10	24.9 – 24.0 = 0.9	25.1 – 20.9 = 4.2		26.9 – 25.5 = 1.4		22.0 – 23.2 = 1.2		27.1 – 25.8 = 1.3	24.2 – 24.1 = 0.1	27.8 – 24.7 = 3.1
		10 - 11	26.9 – 26.2 = 0.7	27.3 – 23.4 = 3.9		29.4 – 28.0 = 1.4	31.0 – 30.0 = 1.0	25.6 – 25.0 = 0.6		28.5 – 28.2 = 0.3	26.7 – 26.4 = 0.3	32.1 – 27.5 = 4.6
		11 - 12	29.8 – 28.7 = 1.1	28.5 – 26.0 = 2.5		21.9 – 30.5 = 1.4	34.0 – 33.0 = 1.0	27.3 – 27.1 = 0.2		32.7 – 31.0 = 1.7	29.4 – 28.7 = 0.7	34.4 – 30.3 = 4.1
		12 - 13	33.9 – 32.8 = 1.1	31.8 – 28.5 = 3.3		35.9 – 33.9 = 2.0	38.5 – 35.5 = 3.0	30.3 – 28.9 = 1.4		36.5 – 34.7 = 1.8	33.1 – 32.9 = 0.3	40.5 – 34.4 = 6.1
		13 - 14	38.3 – 37.1 = 1.2	37.6 – 31.4 = 6.2		39.6 – 37.7 = 1.9		36.5 – 31.9 = 4.9		40.2 – 48.0 = 2.2	38.2 – 36.6 = 1.6	43.1 – 39.3 = 3.8
Clothing state			without clothes	with clothes	without clothes	with clothes	with clothes	clothes?		without outerwear	clothes?	with summer clothes