Camilla Schou Andersen
Postdoctoral Research Fellow, GENDINOB
Institute of Preventive Medicine, Copenhagen
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Validation of the anthropometric data in the 7-year follow-up

It was possible to validate the weight, height and waist circumference data in the 7-year follow-up in a small sub-sample of the cohort, due to collaboration with the school doctors in the Copenhagen Municipality. All children in Copenhagen come to an obligatory visit at the school doctor, when they enter school around 6 years of age. At this visit, weight, height and waist circumference are measured, and the doctors have reported this information for the children included in the Danish National Birth Cohort (DNBC).

Methods

The approach suggested by Bland & Altman[1], was used to validate the weight, height and waist data, where measurements from the school doctors were available from 2,191, 2,193 and1,597 children, respectively. There was an overlap with data from the DNBC on 1,178, 1,215 and 840 children, respectively.

The children's ages for the anthropometric measurements varied between the school doctors and DNBC, where the mean age (±SD) of measurements was 6.8 years (±0.4) with a range of 5.1-9.6 years from the school doctors, whereas it was 7.1 years (±0.3) with a range of 4.0-9.1 years in the DNBC ($p<0.000$). Therefore, residuals, obtained from simple linear regression models with weight, height or waist as outcome variables, exact age as exposure variable and sex (and height in the weight model) as covariates, were used in the analyses.

BMI was calculated to define overweight according to age- and sex specific cut-points[2]. Some of the weight and height measurements reported in the DNBC were from different dates, and BMI were only calculated if weight and height were measured no more than 30 days apart. This gave 1,122 children with calculated BMI from the DNBC.

Results

The mean values (±SD) and the range of the children's measurements are presented in Table 1. The overall agreements of the weight and height residuals from the two measurement methods are presented in Figure 1a, 1b and 1c.

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Table 1
Anthropometric data according to the two measurement methods

	DNBC		School Doctors	
Weight (kg)	24.9 (±3.7)	(15.0-55.0)	24.0 (±3.6)*	(15.4-51.7)
Height (cm)	125.9 (±5.5)	(101.5-142)	123.2 (±5.6)*	(104.0-146.0)
Waist (cm)	57.1 (±4.7)	(35.0-90.0)	56.2 (±4.3)*	(40.0-90.0)

Data are presented as mean values ±standard deviation and the range

P-values using studens t-test *:p-value<0.000

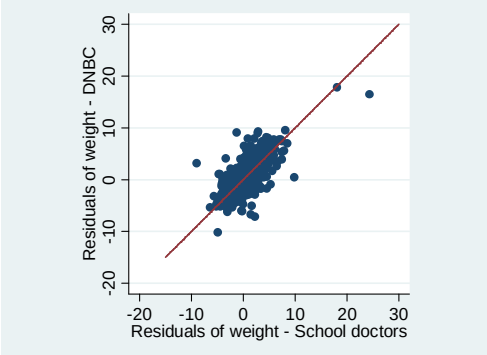

Figure 1a Scatterplot of weight residuals

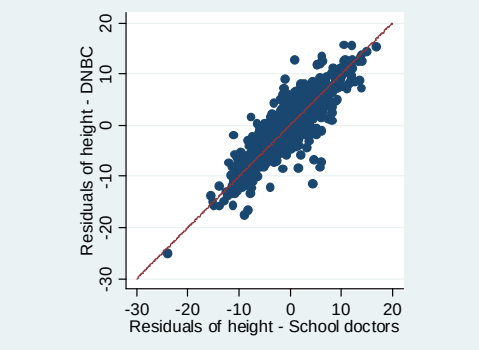

Figure 1b Scatterplot of height residuals

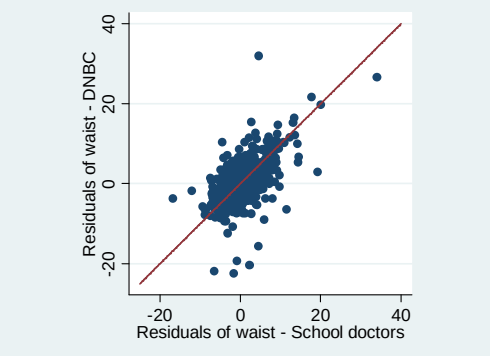

Figure 1c Scatterplot of waist residuals

The 95% limits of agreements were -3.5; 3.5 kg for the weight residuals, -4.8; 4.8 cm for the height residuals, and -8.0; 8.0 for the waist residuals (Figure 2a, 2b, 2c). This means that 95% of the differences between measurements obtained by the two methods are expected

to lie within these intervals. No systematic errors were found, such as increasing differences between the two measurements for increasing average of the two measurements. The differences in residuals were calculated by subtracting the DNBC measurements from the school doctor measurements. Thereby, all the negative residual values in the three BA plot represent differences where the DNBC measurement was lower than the school doctor measurement.

BA plot

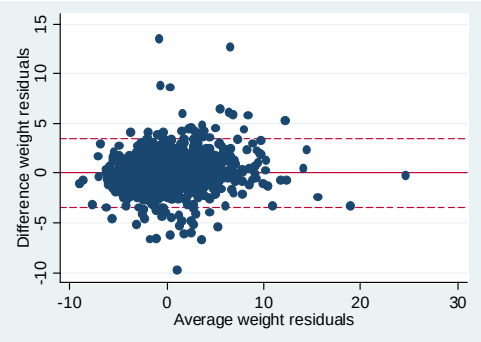

Figure 2a Bland-Altman plot of weight residuals

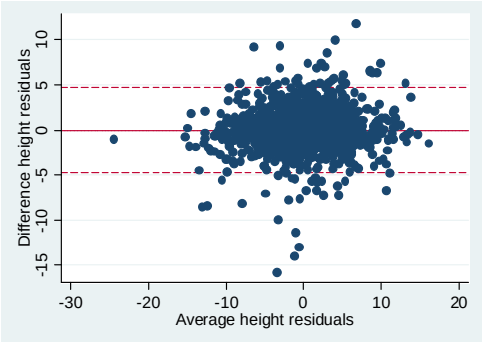

Figure 2b Bland-Altman plot of height residuals

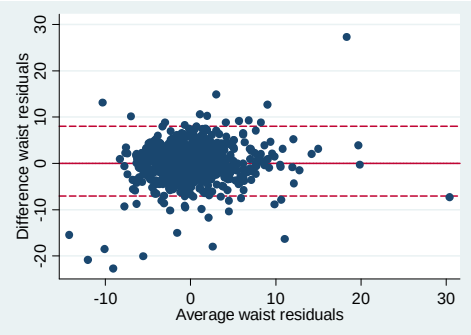

Figure 2c Bland-Altman plot of waist residuals

In additional analyses, extreme outliers were excluded, by visual inspection of histograms showing the differences in residuals. These exclusions narrowed in the 95% limits of agreements with 0.3 kg for weight, 0.4 cm for height and 1.4 cm for waist. The outliers in these plots are not necessarily outliers due to unrealistic high or low values, but outliers because the difference of the values obtained from the two measurements methods are large. For instance, some children in the DNBC had large waist circumferences of 75–90 cm, which however was in accordance with the measurements from the school doctors.

Analysing data merely on children from 6.5 to 7.5 years of age did not change the 95% limits of agreement noteworthy. Furthermore, no changes were observed when analysing data where measurements from school doctors and from the DNBC were obtained with no more than ½ year apart.

According to the measurements made by the school doctors, 9.7% of the children were overweight. This prevalence was 9.0% when using the data obtained by the parents (Table 1). The agreement between the two methods was 93%; kappa value (± SD) (0.57 (0.04)); sensitivity % (95% CI) (58,7% (48.9, 68.1)); specificity % (95% CI) (96.3% (95, 97.4)).

Out of the 45 children defined as overweight only by the school doctors, 42% were less than 0.5 unit BMI from being defined as overweight by the DNBC as well. Additionally, out of the 37 children defined as overweight only according to the DNBC, 43% were less than 0.5 unit BMI from being defined as overweight also by the school doctors.

Table 2
Overweight/normal weight according to the school doctors and the DNBC

	DNBC overweight	DNBC normal weight	Total
School overweight	64	45	109
School normal weight	37	976	1,013
Total	101	1,021	1,122

Comments

In this validation, we found no trend towards increasing differences of weight or height with increasing averages of weight or height between the measurements from school doctors and from the DNBC, which probably reflects the disagreements being random errors.

When calculating the degree of overweight, there was some discrepancy between the two methods, with a rather low sensitivity. However, almost half of the children categorized as overweight or normal weight by one method but not by the other method, had a BMI close to the cut-points of overweight status. This relates to the on-going discussion about the difficulties in defining overweight in children [3-5].

The measurements from the school doctors and from the DNBC were not performed at the same age. This would have been valuable, since weight and height change over time during

childhood. In the analyses, we have tried to overcome this by using the residuals. Furthermore, in the DNBC, the parents were asked to measure their child at the thinnest place around the waist, whereas the school doctors have a standard method where the measure the children horizontal at the belly button.

Still, we overall found the weight, height and waist measurements in the 7-year follow-up to be of valid quality.

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