Validity of instruction leaflets for parents to measure their child's weight and height at home

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VALIDITY OF INSTRUCTION LEAFLETS FOR PARENTS TO MEASURE THEIR CHILD'S WEIGHT AND HEIGHT AT HOME

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Abbreviations

CLB: Centre for Pupils Counseling (Centrum voor Leerlingenbegeleiding in Dutch)

BMI: Body Mass Index

WHO: World Health Organization

SPSS: Statistical Package for the Social Sciences

Yrs: years

SD: Standard Deviation

CI: Confidence Interval

ICC: Intraclass Correlation Coefficient

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"What's Known on This Subject;

Evidence has shown difficulties and inaccuracy in parental estimates/reports of children's weight and height values. However, slightly better accuracy could be obtained if parents would measure the child's weight and height at home.

What This Study Adds"

Instruction folders for parents to accurately measure their child's weight and height at home were developed and validated. These convenient instruction folders were proven to improve the classification of children into BMI-categories derived from parental weight and height reports/measurements.

Abstract

Objectives: To compare the validity of parent-reported height, weight and BMI values of children (4-10 y-old), when measured at home by means of newly developed instruction leaflets in comparison with simple estimated parental reports.

Design: Intervention study with control and intervention group.

Setting: Belgian children and their parents recruited via schools.

Participants: 164 Belgian children (53% male; Participation rate 62%).

Intervention: Parents completed a questionnaire including questions about the height and weight of their child. Parents in the intervention group received instruction leaflets to measure their child's weight and height. Classes were randomly allocated to the intervention and control groups. Nurses measured height and weight following standardised procedures.

Outcome measures: Weight, height and BMI category of the child derived from the index measurements and the parental-reports.

Results: Mean parent-reported weight was slightly more underestimated in the intervention group than in the control group relative to the index weights. However, for all 3 parameters (weight, height & BMI), correlations between parental reports and nurse measurements were higher in the intervention group. Sensitivity for underweight and overweight/obesity were respectively 75% and 60% in the intervention group, and 67% and 43% in the control group.

Weighed kappa for classifying children in the correct BMI-category was 0.30 in the control group while 0.51 in the intervention group.

Conclusions: Although mean parent-reported weight was slightly more underestimated in the intervention than in the control group, correlations were higher and there was considerably less misclassification into valid BMI-categories for the intervention group. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement and that diagnostic measures could be improved by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Article focus

▪ Can the accuracy of parent-reported height, weight and BMI values of children (4-10 y-old) be improved when measured at home by means of instruction leaflets in comparison with simple estimated parental reports?

Key messages

▪ Parent-reported weight and height values are insufficiently accurate for classifying preschool children as being underweight, overweight or obese.

▪ Diagnostic measures could be improved by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Strengths and limitations of this study

▪ This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports.

▪ An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

▪ The criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Introduction

With a growing interest in childhood obesity as a factor in child morbidity and adult diseases[1], valid measures of childhood weight and height are of interest to many researchers. Because of logistical difficulties and financial costs involved in directly measuring weight and height of children in a survey, such data are often proxy-reported (e.g. by parents)[2-6]. Previous studies focusing on the validity of parent-reported weight and height values in children have shown fairly poor accuracy of parentally reported values for classifying children into BMI-categories of underweight, overweight and obesity status[7-9]. From a recent review of the literature, Himes concluded that proxy measures for directly measured BMI, such as self-reports or parental reports of height and weight, are much less preferred and should only be used with caution and awareness of the limitations, biases, and uncertainties of these measures[10]. Nevertheless, because direct measurements of weight and height are costly and time consuming, large surveys in childhood populations are likely to continue to use parent-reported values. A practical solution to improve the validity of these parent reports might be to ask parents to measure the weight and height of their children at home and to provide the parents with instructions concerning how to measure their child in an accurate way. A previous study demonstrated relatively better accuracy when parents reported that they had measured their child's weight and height at home (using unspecified methods) compared with parents who estimated their child's body size without taking measurements[11]. To date, however, we are unaware of any studies evaluating the

usefulness and validity of instruction leaflets for parents concerning how to measure the weight and height of their child at home.

The aim of the present study was to develop and validate user-friendly instruction leaflets for parents to measure their child at home using their own measurement instruments (scale and ruler). Furthermore, we compared the validity of parent-reported weight and height values of their child after being measured at home using the newly developed instruction leaflets in comparison with parents who did not receive the instruction leaflets. We also compared the accuracy of the parent reports for classifying children into BMI categories, using international BMI cut-off values for underweight, overweight, and obesity.

Methods

Study population

Subjects were residents in the region of Ghent, a medium sized city in Belgium. A sample of 4–10 year-old children was recruited using a multistage cluster sampling technique. First, three school committees were randomly selected in the region of Ghent and they all agreed to participate (a school committee manages/governs one or more schools). In total, these three school committees included five different school residences/locations. All 17 (pre-)school classes in these five schools were selected as final cluster units. All the children from these 17 selected classes were invited to participate (only the eldest child in case of brothers/sisters) between September 2011 and July 2012. Eight classes were allocated to the intervention group,

in which parents received instruction folders describing how to measure their child's weight and height accurately at home. Nine classes were allocated to the control group in which parents only received a questionnaire but no instruction folders describing how to measure their children.

Instruction folder/leaflet for measuring children's weight and height at home

Instruction folders illustrating and describing how to measure children's weight and height at home were developed in close collaboration with paediatricians and experts in anthropometric measurements. A preliminary draft of these leaflets was pilot tested in a convenience sample of 28 children and was modified afterwards considering the feedback from the parents who used the leaflets. The final instruction folders are available in **Annexes 1 & 2**. Written informed consent from the child's parent and the staff member performing the measurements in the attached instruction folders was obtained prior to the photography.

Questionnaire and self-reported anthropometry

No protocol or instructions were provided for measuring the child at home in the control group. Information about the child (e.g., gender, age) and his or her parents (e.g., age, gender and parental education levels) was obtained via a self-administered parental questionnaire. Parents were also asked to report the weight and height of their child in this questionnaire. In addition, they were asked to report if they actually measured their child's weight and height prior to

reporting, or if they estimated the values without their own measurement. Furthermore they were asked to report the time of the day when the measurements were performed as weight tends to increase, while height tends to decrease during the day[12-14]. The parents in the intervention group were asked if they had used the instruction folders (**Annex 1 & 2**) during the measurements or not.

Anthropometric measurements

This study was conducted in collaboration with Centers for Pupils Counselling ('Centrum voor Leerlingenbegeleiding' (CLB) in Dutch). Preventive health care and standardized medical examinations are performed at the CLBs at certain ages determined by law, including weight and height measurements. All the children participating in this study were examined and measured by a CLB nurse (3 different CLB nurses) in a standardized way (according to the protocol 'VWVJ & Vlaamse Groeicurven').[15] For these measurements, children were only wearing underwear. Weight was recorded to the nearest 0.1 kg, using an electronic weighing scale (Seca 841) and height was measured to the nearest 0.1 cm in standing position, using a rigid stadiometer (Seca 220). The stadiometer was checked for accuracy and the scale was calibrated before examination. In this manuscript the weight and height measurements performed by CLB nurses are indicated as 'INDEX' measured weight and height.

Procedures

The school directors of the selected schools approved the study protocol and gave permission to run the study in their school. The directors of the schools and the teachers of the classes participating in the study were given detailed information and instructions about the study.

The teachers of the participating classes were asked to distribute the questionnaire (including the instruction leaflets in the intervention group only) among the parents of the children about 14 days before the planned medical examination in the CLB. An informed consent was attached, in which parents were informed and invited to participate in the study, without being aware that validation of anthropometric measurements was part of the study. The completed questionnaires and the signed informed consents were returned to the school in a sealed envelope. Nurses at the CLB-centers were not allowed to open the sealed envelopes to be sure that they were not influenced by the parent-reported weights and heights.

All procedures were conducted according to the principles expressed in the Declaration of Helsinki and the Ethical Committee of the Ghent University Hospital granted ethical approval for the study.

Statistical analysis

BMI (kg/m²) was calculated from parent-reported and INDEX measured heights and weights. Underweight, overweight, and obesity were identified using age- and gender-specific international (International Obesity Task Force (IOTF)) cut-off points.[16 17]

Differences in mean parent-reported and INDEX measured weight, height and BMI, and corresponding differences in prevalence of underweight, overweight and obesity were assessed using paired t-test and McNemar's test, respectively. Limits of agreement were estimated from the SD of differences from the index measurements (mean difference ± 1.96SD), considering the measurements derived from the CLB nurses as index measurements. Intraclass correlation coefficients between measured and reported values were calculated as a measure of overall association.

When identifying underweight, normal weight, overweight, and obesity, misclassification was defined as discordance between BMI-categories, determined by parent-reported and parent-measured BMI versus nurse-measured BMI. The weighted kappa statistic was calculated to determine agreement between parent-reported and measured index BMI-status adjusted for chance, using a linear set of weights [18]. Kappa values <0.20 are often considered as "poor"

agreement, 0.21 to 0.40 as "fair" agreement, 0.41 to 0.60 as "moderate" agreement, 0.61 to 0.80 as "good" agreement, and 0.81 to 1.00 as "excellent" agreement.[18]

Sensitivity was defined as the proportion of children categorized into a certain BMI-category (e.g. overweight) based on measured BMI that was also categorized into the same BMI-category when using parent reports (true positives). Specificity was defined as the proportion of children assigned as not having a certain BMI status (e.g. overweight) when using measured index BMI that was also not assigned to that same BMI-category when using the parent-reported data (true negatives).

The Statistical Package for the Social Sciences (SPSS) for Windows Version 20 was used for data management and all statistical analyses. Unless reported differently, a P-value of 0.05 (two-sided) was used as the threshold for statistical significance.

Results

A total of 266 (pre-)school children were officially registered in the 17 sampled classes in 5 different schools. Complete questionnaires were returned for 164 children (62%). These children had a mean age of 6.8 years (SD 1.4 y) and an age range from 4.0 to 9.9 years (15.2% 4.0 to 5.9 y; 60.4% 6.0 to 7.9 y; 24.4% 8.0 to 9.9 y).

Both sexes were similarly represented in the study (47% girls) and 51% of the children who participated were included in the intervention group (Table 1). Only 63% of the intervention group parents reported they made the effort to measure their child's weight and height according to the instruction folders distributed. Therefore, the authors will present results for two intervention comparisons:

1) The total sample of 164 cases (all 83 intervention versus 81 control); and 2) the select group of children from the intervention group whose parents reported that weight and height was measured at home according to the instructions given in the folders that were distributed (52 intervention versus 81 control).

Insert Table 1

Overall, 78% of the questionnaires analyzed were answered by the mother of the child, with relatively more in the control group (81.5%) than in the intervention group (74.7%) (**Table 1**). About 45% of the children had been measured in the evening and about 1/3 in the morning (the remaining in the afternoon). Relatively more parents reported measuring their child's weight and height at home in the intervention group than in the control group (**Table 1**). However, a chi-square test comparing the proportions of parents measuring indicated that this difference was not significantly different between control and intervention groups (p=0.219 and p=0.208 for weight and height measurements, respectively).

When comparing the socio-economic variables in **table 1** between the intervention and control groups, our results showed slightly higher educated levels of the person who reported the child's weight and height in the control group than in the intervention group. However, these education levels were not significantly different between control and intervention group (p=0.217).

From **Table 2** it can be seen that no significant differences were found in mean height reported by the parents compared with the mean height measured by the CLB nurse (Index Measured) for both the intervention groups and the control group. However, the mean weight reported by the parents was significantly underestimated in comparison with the weight measured by the CLB nurse, in both segments of the intervention group. This resulted in a significant underestimation of mean BMI reported by the parents from the total intervention group compared with the BMI calculated from the INDEX data (**Table 2**). Mean differences between means of parent-reported and measured BMI were, however, not significantly different from INDEX measurements when parents measured their child's weight and height according to the instruction folders distributed in the intervention group.

For each dimension (weight, height and BMI), the ICC correlations with INDEX measurements were higher in the group of children whose parents measured their body parameters at home according to the instruction folder compared with the children in the control group. Also the Pearson correlation coefficients between index measured and reported weight, height and BMI-

values indicate that the associations were strongest in the intervention group compared to the control group (see **Table 2**). Correction for the time of the day when the children had been measured improved all correlations slightly (in both control and intervention group). Though correlations remained higher for the intervention compared to control group, and was highest in the group of children from the intervention group whose parents used the instruction folders (data not shown).

Insert table 2

For the three body dimensions (weight, height and BMI), much larger limits of agreement were found for the control group compared to the intervention group: -4.14 to 3.46 in control group versus -2.89 to 2.31 in intervention group (**Figure 1**).

Insert Figure 1

Misclassification analysis indicated that more children were grossly misclassified in the control group than in the two segments of the intervention group, while fewer children were classified correctly (**Table 3**). The percentage of grossly misclassified children was lowest in the intervention when using only the children whose parents using the instruction folders to measure their child's weight and height. These patterns are reflected in the relative values of the weighted

kappa statistics, being highest (0.60) for the group of children whose parents reported using the instruction folders to measure their child's weight and height.

Insert table 3

The validity tests for classifying underweight, overweight and obesity from the parent-reported weight and height, using the INDEX measurements as the criterion, are shown in **Table 4**. The sensitivity for identifying the presence of underweight, overweight and obesity status, based on parent-reported BMI, compared with measured BMI, was lowest in the control group. Also, specificity was lowest in the control group for overweight and obesity, but not for underweight. The kappa statistic shows that agreement for underweight, overweight and obesity between parent-reported and index measured values was always higher in the intervention group than in the control group.

Insert table 4

Discussion

Principal findings

The mean measurements for height, weight, and BMI of children obtained from parents are very similar to those obtained from well-trained clinic staff. Nevertheless, there is evidence of some small average bias, particularly in child weight, even if parents reported using the measurement instruction leaflets. Although the mean parent-reported weight was slightly more underestimated in the intervention group (that received the instruction leaflet for measuring weight) than in the control group relative to the index weights, the correlations between the parental reports and the index measurements were higher in the intervention group than in the control group. Furthermore, there was considerably less misclassification into valid BMI-categories for the whole intervention group, and especially for that segment who reported using the instruction leaflets. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement. A more in depth look at the data revealed that for parental estimations of the child's body weight, indeed both under- and overestimations of the real weight appeared, while parental measurements of their child's weight (using their own scale) were mainly underestimated, revealing systematically underestimation of true weight when using home scales. Although, these systematic underestimations might be responsible for the decreased accuracy in estimating the mean weight of the children when using parental measurements, these systematic errors do not influence the ranking of the children according to

their body weight, what explains the better correlations and diagnostic measurements (data not shown).

Our results in Flemish families indicate that a large proportion of parents in the control group reported that they measured their children, even without the additional instruction provided by the leaflets distributed as the intervention. While the intervention appears to have increased the proportion of parents who measured their children, the main net effect seems to have been to reduce the amount of random errors relative to the index measurements, i.e., that the leaflets help standardize parental measurements relative to accepted protocols.

Comparison with previous studies

In a previous validation study in 2006 among Flemish preschoolers the authors already highlighted the weak validity of parent reported weight and height values for classifying preschool aged children in BMI categories[7]. These results were recently confirmed by other researchers in German children[19]. More exhaustive analyses of the validity study of parent-reported weight and height among preschool aged children in Flanders revealed that parent reported values were more accurate when parents made the effort to weigh and measure their child at home than when children's weight and height were guessed at by the parents[11]. An exhaustive review of Himes also revealed the doubtful validity of parent reported weight and

height values for classifying children as underweight, overweight or obese[10]. Himes also highlighted the importance of motivating the parents to measure their child's weight and height at home in an attempt to improve these parental reports as these parentally reported weight and height values will remain the main body fatness indicators in many large-scale surveys where measurements by trained researchers are not feasible because of the high cost involved.

To our knowledge no other studies have evaluated the validity of instruction folders to improve the validity of parent reported weight and height measurements further. Therefore the authors were not able to compare these validity results obtained in this intervention study with other studies.

Strengths and limitations

This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports. An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

Some limitations of this study are worth noting. Data were available only for children whose parents completed the questionnaire. Children who were measured by a CLB nurse but whose

parents did not complete the questionnaire were excluded from the analyses. It is possible that respondents were more willing, or more able, than non-respondents to provide accurate assessments of their children's weight and height. Therefore, the errors between parentally reported and measured weight and height in this sample may be underestimates of the true errors, since almost 40% of the parents refused to complete the questionnaire. However, to help minimize underestimation of the errors, the subjects were not aware of the future intended comparison between reported and measured values.

In this study the criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Future research should investigate the validity of these instruction folders further for use in large-scale multi-centric studies where standardization of the measurements is very important but where INDEX measurements by trained staff members are not feasible.

Conclusion

In conclusion, our results demonstrate the degree of inaccuracy of parent-reported weight and height values in classifying preschool children as being underweight, overweight or obese. However, the important differences found between parent-measured weight and height values when using the newly developed instruction folders compared with parent-estimated values, suggest the importance of motivating and instructing the parents to measure their child at home when the study design includes the use of parent reports for weight and height values of their children at least when aiming to classify the children in the correct BMI-category. The instruction folders developed and validated in this study can serve as an example for future large-scale surveys in children that rely on parental weight and height reports.

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Contributors' Statement

The original idea for the analyses came from IH & JHH. CB & ES developed the instruction folders and did all of the data management and analysis under the supervision of IH, TDV & JHH. IH led on the writing of the paper but all co-authors contributed importantly to the different drafts of the paper and suggested analysis for the manuscript. ADK supervised the local fieldworkers. DDB, SDH, PP & NS assisted in the conceptualization of the study and in the interpretation of the results. All authors have read the final version of the manuscript before submission.

References

1 Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998;101:518-25.

2 Huybrechts I, Matthys C, Pynaert I, De Maeyer M, Bellemans M, De Geeter H et al. Flanders preschool dietary survey: rationale, aims, design, methodology and population characteristics. *The Archives of Public Health* 2008;66:5-25.

3 Akinbami LJ, Ogden CL. Childhood overweight prevalence in the United States: the impact of parent-reported height and weight. *Obesity (Silver Spring)* 2009;17:1574-80.

4 Bloom B, Cohen RA, Vickerie JL, Wondimu EA. Summary health statistics for U.S. children: National Health Interview Survey, 2001. *Vital Health Stat 10* 2003;1-54.

5 Dey AN, Schiller JS, Tai DA. Summary health statistics for U.S. children: National Health Interview Survey, 2002. *Vital Health Stat 10* 2004;1-78.

6 Blumberg SJ, Olson L, Osborn L, Srinath KP, Harrison H. Design and operation of the National Survey of Early Childhood Health, 2000. *Vital Health Stat 1* 2002;1-97.

7 Huybrechts I, De Bacquer D, Van Trimpont I, De Backer G, De Henauw S. Validity of parentally reported weight and height for preschool-aged children in Belgium and its impact on classification into body mass index categories. *Pediatrics* 2006;118:2109-18.

8 Scholtens S, Brunekreef B, Visscher TL, Smit HA, Kerkhof M, Jongste JC et al. Reported versus measured body weight and height of 4-year-old children and the prevalence of overweight. *Eur J Public Health* 2007;17:369-74.

9 Akerman A, Williams ME, Meunier J. Perception versus reality: an exploration of children's measured body mass in relation to caregivers' estimates. *J Health Psychol* 2007;12:871-82.

10 Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics* 2009;124:S3-22.

11 Huybrechts I, Himes JH, Ottevaere C, De Vriendt T, De Keyzer W, Cox B et al. Validity of parent-reported weight and height of preschool children measured at home or estimated without home measurement: a validation study. *BMC Pediatr* 2011;11:63.:63.

12 Tillmann V, Clayton PE. Diurnal variation in height and the reliability of height measurements using stretched and unstretched techniques in the evaluation of short-term growth. *Ann Hum Biol* 2001;28:195-206.

13 Siklar Z, Sanli E, Dallar Y, Tanyer G. Diurnal variation of height in children. *Pediatr Int* 2005;47:645-8.

14 Routen AC, Edwards MG, Upton D, Peters DM. The impact of school-day variation in weight and height on National Child Measurement Programme body mass index-determined weight category in Year 6 children. *Child Care Health Dev* 2011;37:360-7.

15 Vrije Universiteit Brussel, Laboratorium voor Antropogenetica. *Growth Charts Flanders 2004*, 2004.

16 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-3.

17 Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007;335:194.

18 Altman DG. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991.

19 Brettschneider AK, Ellert U, Schaffrath RA. Comparison of BMI derived from parent-reported height and weight with measured values: results from the German KiGGS study. *Int J Environ Res Public Health* 2012;9:632-47.

Tables and Figures

Table 1: description of the study populations

	% Total population (n=164)	% Control Group (n=81)	% Total Intervention group (n=83)	% Measuring Intervention group * (n=52)
Person who completed questionnaire				
Father	18.4	14.8	21.7	19.2
Mother	78.0	81.5	74.7	80.8
Other	0.6	1.2	0.0	0.0
Missing	3.0	2.5	3.6	0.0
Method used to report weight and height				
Weight measured at home	76.9	72.7	81.0	100
Height measured at home	68.8	64.1	73.4	100
Time of the day when the parents measured their child's weight and height				

Morning	31.3	33.3	30.3	35.4
Afternoon	22.9	24.6	21.2	16.7
Evening	45.8	43.1	48.5	47.9
Birth country child				
Belgium	84.1	82.7	85.5	86.5
Other country	12.2	14.8	9.6	9.6
Missing	3.7	2.5	4.8	3.8
Educational level proxy				
Lower secondary education	8.5	9.8	7.2	7.7
Higher secondary education	22.0	16.1	27.8	19.2
Higher education (e.g.	31.2	30.9	31.3	38.4

bachelor)				
University degree (e.g. master degree)	35.9	39.5	32.5	34.6
Missing	2.4	3.7	1.2	0.0
Income allows family to buy healthy food				
Sufficiently	81.1	80.2	81.9	82.7
Mostly sufficiently	12.8	16.0	9.6	9.6
Seldom sufficiently	1.2	0.0	2.5	3.8
Insufficiently	1.8	1.2	2.4	1.9
Missing	3.1	2.6	3.6	1.9

* children from the intervention group whose weight and height had been measured at home according to the instructions given in the folders that were distributed

Table 2 - Accuracy of parent-reported weight and height among preschool children: comparing intervention with control group.

Reporting method used by parents	Parent reported Mean (SD)	Index Measured Mean (SD)	Difference Mean (SD)	*P**	Intraclass correlation ICC	95% CI	Pearson correlation
Weight (kg) (control group) (n=81)	24.6 (5.6)	25.0 (6.0)	-0.43 (2.3)	0.095	0.918	(0.875-0.947)	0.922
Weight (kg) (intervention group) (n=83)	23.7 (5.9)	24.4 (5.9)	-0.69 (1.9)	0.002	0.939	(0.898-0.962)	0.945
Weight (kg) (intervention group following instructions) (n=52)	23.6 (6.3)	24.2 (6.2)	-0.63 (1.5)	0.004	0.965	(0.932-0.981)	0.970
Height (cm) (control group) (n=81)	123.6 (8.9)	123.0 (8.4)	0.57 (5.1)	0.317	0.823	(0.738-0.882)	0.824

Height (cm) (intervention group) (n=83)	121.3 (10.8)	121.5 (11.1)	0.20 (3.4)	0.581	0.952	(0.926-0.968)	0.952
Height (cm) (intervention group following instructions) (n=52)	120.6 (10.9)	121.2 (11.1)	-0.63 (2.9)	0.125	0.964	(0.938-0.979)	0.965
BMI (kg/m²) (control group) (n=81)	16.0 (2.4)	16.3 (2.1)	-0.3 (1.9)	0.108	0.633	(0.483-0.747)	0.641
BMI (kg/m²) (intervention group) (n=83)	15.9 (2.4)	16.3 (2.3)	-0.4 (1.5)	0.017	0.772	(0.662-0.848)	0.783
BMI (kg/m²) (intervention group following instructions) (n=52)	16.0 (2.4)	16.3 (2.3)	-0.3 (1.3)	0.140	0.826	(0.716-0.896)	0.830

* According to the Paired samples t-test

ICC: Intraclass correlation coefficient

Table 3 - Cross-classification analyses for parent-reported (measured versus estimated) and accurately measured (by school nurse) BMI-categories*.

	Reported versus measured BMI				
	Same category	Adjacent category	Extreme category	Weighted kappa	
Parental report	(%)	(%)	(%)	(95% CI)	
Control group (n=81)	65.4	29.6	5.0	0.30	(0.07 to 0.54)
Intervention group (n=83)	73.5	25.3	1.2	0.51	(0.28 to 0.74)
Intervention group following instructions (n=52)	78.8	19.2	1.9	0.60	(0.30 to 0.81)

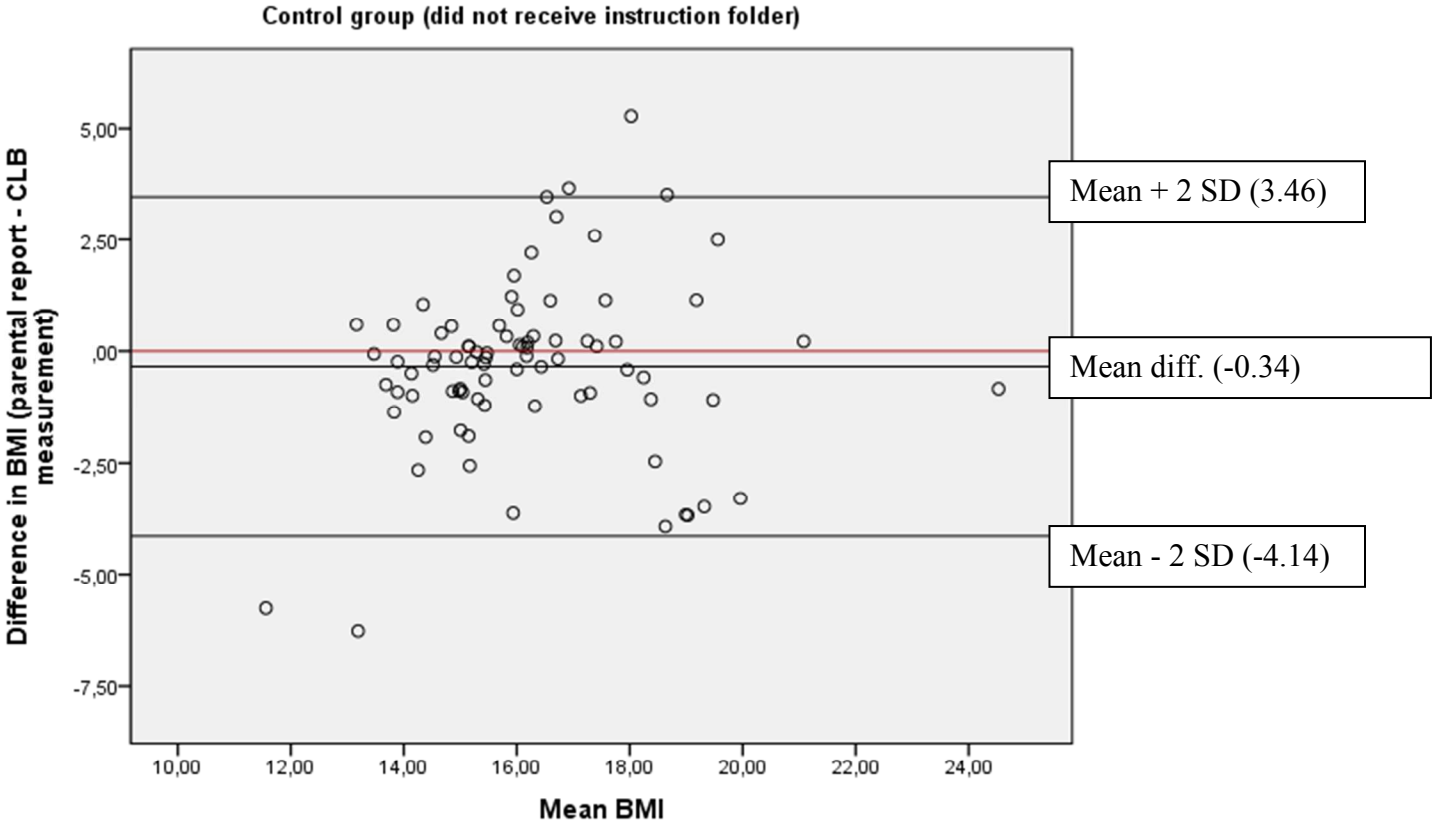
* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Table 4 - Diagnostic values of parent-reported (measured versus estimated) height and weight in detection of BMI-categories*

Reporting method used by parents	Sensitivity % (95% CI)			Specificity % (95% CI)			Kappa Statistic (95% CI)		
	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions
Underweight	67 (20.7 to 93.8)	75 (30.0 to 95.4)	67 (20.7 to 93.8)	87 (77.9 to 92.8)	85 (75.3 to 91.0)	86 (73.3 to 92.9)	0.22 (-0.25 to 0.69)	0.26 (-0.16 to 0.67)	0.27 (-0.26 to 0.80)
Overweight/ Obese	43 (21.3 to 67.4)	60 (35.7 to 80.1)	70 (39.6 to 89.2)	89 (79.9 to 94.8)	96 (87.8 to 98.4)	98 (87.6 to 99.5)	0.33 (-0.02 to 0.68)	0.60 (0.25 to 0.95)	0.73 (0.30 to 1.16)

* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Control group (n=81); Intervention group (n=83); Intervention group following instructions (n=52)



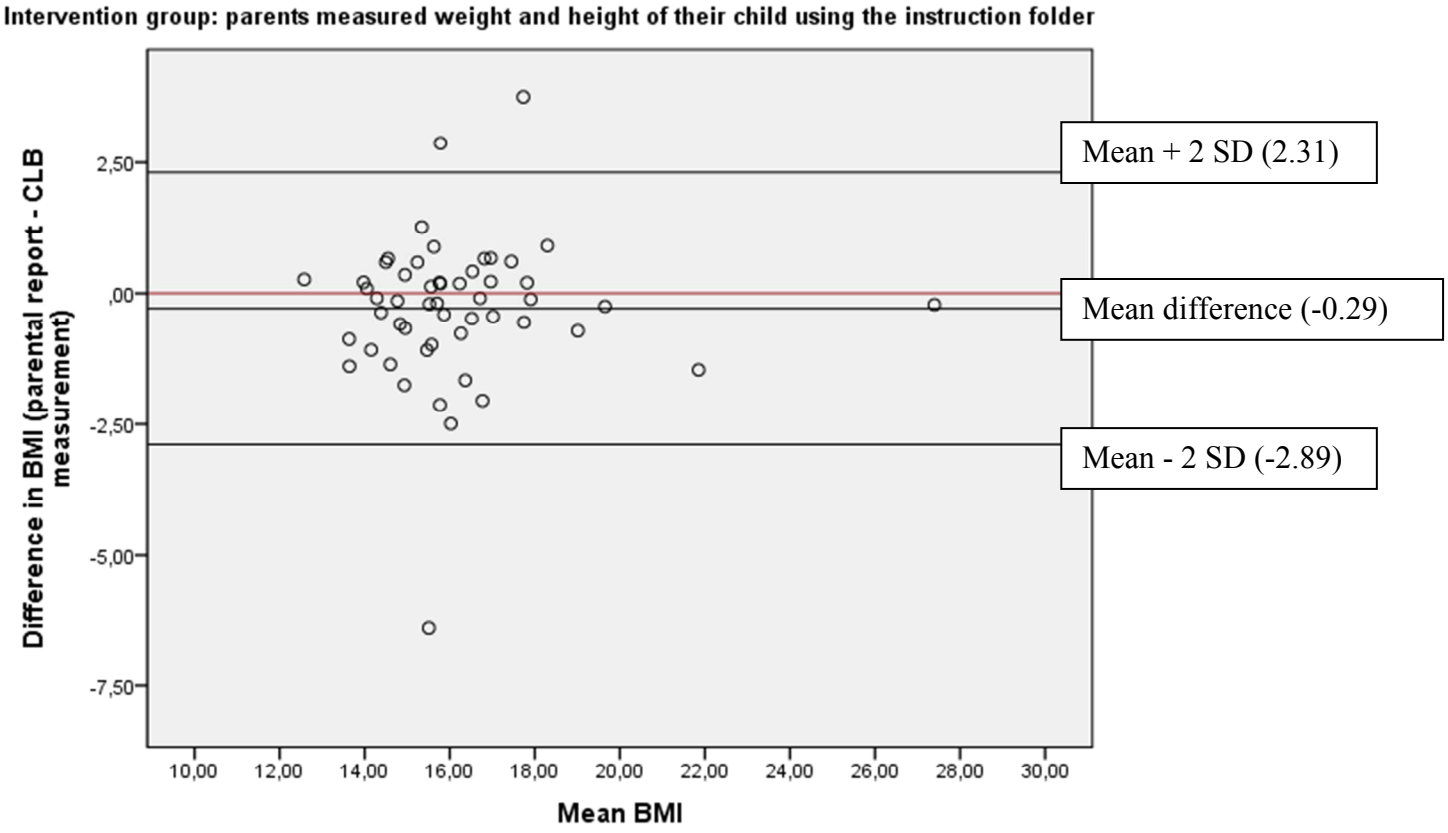


Figure 1: Bland & Altman plot including the mean difference and limits of agreement for BMI in the control group (n=81) and in the intervention group (n=52) respectively.

Weighing a child

If children are at least two years old, you can weigh them with a regular scale.

Material:

A scale ranging from 0 to 120 kilogram (0 to 265 pounds) and a subdivision of at least 500 grams (1.1 pounds).

Points of attention:

1 kilogram is equal to 2,205 pounds.

Preferably use an electronic scale. Alternatively a scale with dial can be used.

Position your scale on a flat and hard surface (no carpet).

Make sure that the child only wears underwear.

The measurement is done barefooted, so footwear and socks are removed.

Read the weight from the scale as accurate as possible without rounding.

Technique :

Place the scale on a hard surface.

Turn on the scale and wait until a zero appears on the screen.

Ask the child to step onto the scale, without leaning against something. Tell him/her to stand with his/her weight evenly distributed on the measurement platform.

Wait a few moments (make sure they don't shift their weight) and read the result.

Read the weight from the scale
(be as accurate as possible).

KAHO

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Instructions to weigh and measure children

(age 2 and older)

Measuring children's height

Material:

A tape measure of minimum 2000 mm (80 inches) and a straight wall.

Points of attention:

The measurement is done barefoot, so footwear and socks are removed.

Hairpins and braids/tails , which can disrupt the measurement are removed.

Make sure that the child is wearing light clothing, no pull, shirt or jacket.

The figure is not rounded but always noted down to the last full mm or inch.

Technique:

The child is placed centrally, facing away from the wall.

The arms are hanging relaxed at the sides of the child's body.

The heels, calves, buttocks and shoulders are touching the wall.

The heels are on the ground, the feet at an angle of about 45 ° against each other, so that the heels touch each other.

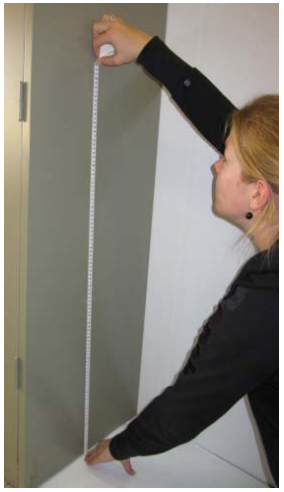
With young children it may be necessary to briefly press their feet so that the bottom of the heels always remains in contact with the ground.

Ask your child to stand up as tall as possible (maintaining a firm posture), without standing on his/her toes.

Hold the head with one hand so that the child looks straight forward and bring the other hand up against the crown. (see previous picture)

Let the child step away carefully from under your hand and mark that spot on the wall with a pencil.

Let the tape unwind from the place where you've put the mark, down to the floor. Measure the distance between the mark and the floor. Read the figure down to the last full inch.



STARD checklist for reporting of studies of diagnostic accuracy
(version January 2003)

Section and Topic	Item #		On page #
TITLE/ABSTRACT/ KEYWORDS	1	Identify the article as a study of diagnostic accuracy (recommend MeSH heading 'sensitivity and specificity').	1, 2, 3, 4
INTRODUCTION	2	State the research questions or study aims, such as estimating diagnostic accuracy or comparing accuracy between tests or across participant groups.	7
METHODS			
Participants	3	The study population: The inclusion and exclusion criteria, setting and locations where data were collected.	7, 8, 10
	4	Participant recruitment: Was recruitment based on presenting symptoms, results from previous tests, or the fact that the participants had received the index tests or the reference standard?	7 & 10
	5	Participant sampling: Was the study population a consecutive series of participants defined by the selection criteria in item 3 and 4? If not, specify how participants were further selected.	7 & 10
	6	Data collection: Was data collection planned before the index test and reference standard were performed (prospective study) or after (retrospective study)?	10
Test methods	7	The reference standard and its rationale.	9
	8	Technical specifications of material and methods involved including how and when measurements were taken, and/or cite references for index tests and reference standard.	7-10
	9	Definition of and rationale for the units, cut-offs and/or categories of the results of the index tests and the reference standard.	11
	10	The number, training and expertise of the persons executing and reading the index tests and the reference standard.	9
	11	Whether or not the readers of the index tests and reference standard were blind (masked) to the results of the other test and describe any other clinical information available to the readers.	10
Statistical methods	12	Methods for calculating or comparing measures of diagnostic accuracy, and the statistical methods used to quantify uncertainty (e.g. 95% confidence intervals).	11
	13	Methods for calculating test reproducibility, if done.	-
RESULTS			
Participants	14	When study was performed, including beginning and end dates of recruitment.	7
	15	Clinical and demographic characteristics of the study population (at least information on age, gender, spectrum of presenting symptoms).	12
	16	The number of participants satisfying the criteria for inclusion who did or did not undergo the index tests and/or the reference standard; describe why participants failed to undergo either test (a flow diagram is strongly recommended).	7 & 12
Test results	17	Time-interval between the index tests and the reference standard, and any treatment administered in between.	10
	18	Distribution of severity of disease (define criteria) in those with the target condition; other diagnoses in participants without the target condition.	Not applicable
	19	A cross tabulation of the results of the index tests (including indeterminate and missing results) by the results of the reference standard; for continuous results, the distribution of the test results by the results of the reference standard.	Table 3
	20	Any adverse events from performing the index tests or the reference standard.	Not applicable
Estimates	21	Estimates of diagnostic accuracy and measures of statistical uncertainty (e.g. 95% confidence intervals).	Tables 3 & 4 and Figure 1
	22	How indeterminate results, missing data and outliers of the index tests were handled.	No missing data for INDEX measures

	23	Estimates of variability of diagnostic accuracy between subgroups of participants, readers or centers, if done.	13-16 (see also tables 3-4)
	24	Estimates of test reproducibility, if done.	-
DISCUSSION	25	Discuss the clinical applicability of the study findings.	21

Validity of instruction leaflets for parents to measure their child's weight and height at home

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Secondary Subject Heading:	Diagnostics, Research methods, Communication
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VALIDITY OF INSTRUCTION LEAFLETS FOR PARENTS TO MEASURE THEIR CHILD'S WEIGHT AND HEIGHT AT HOME

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Running title: Instructions to measure child weight and height

Key words: Instruction folder, BMI, weight, height, validity, children

Word Count abstract: 291

Total word count currently 2997

Number of tables: 4

Number of figures: 1

Number of references: 19

Abbreviations

CLB: Centre for Pupils Counseling (Centrum voor Leerlingenbegeleiding in Dutch)

BMI: Body Mass Index

WHO: World Health Organization

SPSS: Statistical Package for the Social Sciences

Yrs: years

SD: Standard Deviation

CI: Confidence Interval

ICC: Intraclass Correlation Coefficient

Abstract

Objectives: To compare the validity of parent-reported height, weight and BMI values of children (4-10 y-old), when measured at home by means of newly developed instruction leaflets in comparison with simple estimated parental reports.

Design: Intervention study with control and intervention group.

Setting: Belgian children and their parents recruited via schools (multistage cluster sampling design).

Participants: 164 Belgian children (53% male; Participation rate 62%).

Intervention: Parents completed a questionnaire including questions about the height and weight of their child. Parents in the intervention group received instruction leaflets to measure their child's weight and height. Classes were randomly allocated to the intervention and control groups. Nurses measured height and weight following standardised procedures up to 2 weeks after parent-report.

Outcome measures: Weight, height and BMI category of the child derived from the index measurements and the parental-reports.

Results: Mean parent-reported weight was slightly more underestimated in the intervention group than in the control group relative to the index weights. However, for all 3 parameters (weight, height & BMI), correlations between parental reports and nurse measurements were

higher in the intervention group. Sensitivity for underweight and overweight/obesity were respectively 75% and 60% in the intervention group, and 67% and 43% in the control group. Weighed kappa for classifying children in the correct BMI-category was 0.30 in the control group while 0.51 in the intervention group.

Conclusions: Although mean parent-reported weight was slightly more underestimated in the intervention than in the control group, correlations were higher and there was considerably less misclassification into valid BMI-categories for the intervention group. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement and that diagnostic measures could improve by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Article focus

▪ Can the accuracy of parent-reported height, weight and BMI values of children (4-10 y-old) be improved when measured at home by means of instruction leaflets in comparison with simple estimated parental reports?

Key messages

▪ Parent-reported weight and height values are insufficiently accurate for classifying preschool children as being underweight, overweight or obese.

▪ Diagnostic measures could be improved by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Strengths and limitations of this study

▪ This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports.

▪ An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

▪ The criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Introduction

With a growing interest in childhood obesity as a factor in child morbidity and adult diseases[1], valid measures of childhood weight and height are of interest to many researchers. Because of logistical difficulties and financial costs involved in directly measuring weight and height of children in a survey, such data are often proxy-reported (e.g. by parents)[2-6]. Previous studies focusing on the validity of parent-reported weight and height values in children have shown fairly poor accuracy of parentally reported values for classifying children into BMI-categories of underweight, overweight and obesity status[7-9]. From a recent review of the literature, Himes concluded that proxy measures for directly measured BMI, such as self-reports or parental reports of height and weight, are much less preferred and should only be used with caution and awareness of the limitations, biases, and uncertainties of these measures[10]. Nevertheless, because direct measurements of weight and height are costly and time consuming, large surveys in childhood populations are likely to continue to use parent-reported values. A practical solution to improve the validity of these parent reports might be to ask parents to measure the weight and height of their children at home and to provide the parents with instructions concerning how to measure their child in an accurate way. A previous study demonstrated relatively better accuracy when parents reported that they had measured their child's weight and height at home (using unspecified methods) compared with parents who estimated their child's body size without taking measurements[11]. To date, however, we are unaware of any studies evaluating the

usefulness and validity of instruction leaflets for parents concerning how to measure the weight and height of their child at home.

The aim of the present study was to develop and validate user-friendly instruction leaflets for parents to measure their child at home using their own measurement instruments (scale and ruler). Furthermore, we compared the validity of parent-reported weight and height values of their child after being measured at home using the newly developed instruction leaflets in comparison with parents who did not receive the instruction leaflets. We also compared the accuracy of the parent reports for classifying children into BMI categories, using international BMI cut-off values for underweight, overweight, and obesity.

Methods

Study population and design

Subjects were residents in the region of Ghent, a medium sized city in Belgium. A sample of 4–10 year-old children was recruited using a multistage cluster sampling technique. First, three school committees were randomly selected in the region of Ghent and they all agreed to participate (a school committee manages/governs one or more schools). In total, these three school committees included five different school residences/locations. All 17 (pre-)school classes in these five schools were selected as final cluster units. All the children from these 17 selected classes were invited to participate (only the eldest child in case of brothers/sisters) between September 2011 and July 2012. Eight classes were allocated to the intervention group,

in which parents received instruction folders describing how to measure their child's weight and height accurately at home. Nine classes were allocated to the control group in which parents only received a questionnaire but no instruction folders describing how to measure their children.

Instruction folder/leaflet for measuring children's weight and height at home

Instruction folders illustrating and describing how to measure children's weight and height at home were developed in close collaboration with paediatricians and experts in anthropometric measurements. A preliminary draft of these leaflets was pilot tested in a convenience sample of 28 children and was modified afterwards considering the feedback from the parents who used the leaflets. The final instruction folders are available in **Annexes 1 & 2**. Written informed consent from the child's parent and the staff member performing the measurements in the attached instruction folders was obtained prior to the photography.

Questionnaire and self-reported anthropometry

No protocol or instructions were provided for measuring the child at home in the control group. Information about the child (e.g., gender, age) and his or her parents (e.g., age, gender and parental education levels) was obtained via a self-administered parental questionnaire. Parents were also asked to report the weight and height of their child in this questionnaire. In addition, they were asked to report if they actually measured their child's weight and height prior to

reporting, or if they estimated the values without their own measurement. Furthermore they were asked to report the time of the day when the measurements were performed as weight tends to increase, while height tends to decrease during the day[12-14]. The parents in the intervention group were asked if they had used the instruction folders (**Annex 1 & 2**) during the measurements or not.

Anthropometric measurements

This study was conducted in collaboration with Centers for Pupils Counselling ('Centrum voor Leerlingenbegeleiding' (CLB) in Dutch). Preventive health care and standardized medical examinations are performed at the CLBs at certain ages determined by law, including weight and height measurements. All the children participating in this study were examined and measured by a CLB nurse (3 different CLB nurses) in a standardized way (according to the protocol 'VWVJ & Vlaamse Groeicurven').[15] For these measurements, children were only wearing underwear. Weight was recorded to the nearest 0.1 kg, using an electronic weighing scale (Seca 841) and height was measured to the nearest 0.1 cm in standing position, using a rigid stadiometer (Seca 220). The stadiometer was checked for accuracy and the scale was calibrated before starting the examination of each class of children. In this manuscript the weight and height measurements performed by CLB nurses are indicated as 'INDEX' measured weight and height.

Procedures

The school directors of the selected schools approved the study protocol and gave permission to run the study in their school. The directors of the schools and the teachers of the classes participating in the study were given detailed information and instructions about the study.

The teachers of the participating classes were asked to distribute the questionnaire (including the instruction leaflets in the intervention group only) among the parents of the children about 14 days before the planned medical examination in the CLB. An informed consent was attached, in which parents were informed and invited to participate in the study, without being aware that validation of anthropometric measurements was part of the study. The completed questionnaires and the signed informed consents were returned to the school in a sealed envelope. Nurses at the CLB-centers were not allowed to open the sealed envelopes to be sure that they were not influenced by the parent-reported weights and heights.

All procedures were conducted according to the principles expressed in the Declaration of Helsinki and the Ethical Committee (EC) of the Ghent University Hospital granted ethical approval for the study. The EC has read and approved the study protocol and all the documents that were handed out to the participants (including the informed consent form).

Statistical analysis

BMI (kg/m²) was calculated from parent-reported and INDEX measured heights and weights. Underweight, overweight, and obesity were identified using age- and gender-specific international (International Obesity Task Force (IOTF)) cut-off points.[16 17]

Differences in mean parent-reported and INDEX measured weight, height and BMI, and corresponding differences in prevalence of underweight, overweight and obesity were assessed using paired t-test and McNemar's test, respectively. Limits of agreement were estimated from the SD of differences from the index measurements (mean difference ± 1.96SD), considering the measurements derived from the CLB nurses as index measurements. Intraclass correlation coefficients between measured and reported values were calculated as a measure of overall association. All analyses were also performed while correcting for the cluster design (using mixed models) and gave similar results. However, as the proportion of variance between clusters to the total variance was less than 0.5%, the final results have not been corrected for cluster design.

When identifying underweight, normal weight, overweight, and obesity, misclassification was defined as discordance between BMI-categories, determined by parent-reported and parent-measured BMI versus nurse-measured BMI. The weighted kappa statistic was calculated to

determine agreement between parent-reported and measured index BMI-status adjusted for chance, using a linear set of weights [18]. Kappa values <0.20 are often considered as "poor" agreement, 0.21 to 0.40 as "fair" agreement, 0.41 to 0.60 as "moderate" agreement, 0.61 to 0.80 as "good" agreement, and 0.81 to 1.00 as "excellent" agreement.[18]

Sensitivity was defined as the proportion of children categorized into a certain BMI-category (e.g. overweight) based on measured BMI that was also categorized into the same BMI-category when using parent reports (true positives). Specificity was defined as the proportion of children assigned as not having a certain BMI status (e.g. overweight) when using measured index BMI that was also not assigned to that same BMI-category when using the parent-reported data (true negatives).

The Statistical Package for the Social Sciences (SPSS) for Windows Version 20 was used for data management and all statistical analyses. Unless reported differently, a P-value of 0.05 (two-sided) was used as the threshold for statistical significance.

Results

A total of 266 (pre-)school children were officially registered in the 17 sampled classes in 5 different schools. Complete questionnaires were returned for 164 children (62%). These children

had a mean age of 6.8 years (SD 1.4 y) and an age range from 4.0 to 9.9 years (15.2% 4.0 to 5.9 y; 60.4% 6.0 to 7.9 y; 24.4% 8.0 to 9.9 y).

Both sexes were similarly represented in the study (47% girls) and 51% of the children who participated were included in the intervention group (Table 1). Only 63% of the intervention group parents reported they made the effort to measure their child's weight and height according to the instruction folders distributed. Therefore, the authors will present results for two intervention comparisons:

1) The total sample of 164 cases (all 83 intervention versus 81 control); and 2) the select group of children from the intervention group whose parents reported that weight and height was measured at home according to the instructions given in the folders that were distributed (52 intervention versus 81 control).

Insert Table 1

Overall, 78% of the questionnaires analyzed were answered by the mother of the child, with relatively more in the control group (81.5%) than in the intervention group (74.7%) (**Table 1**). About 45% of the children had been measured in the evening and about 1/3 in the morning (the remaining in the afternoon). Relatively more parents reported measuring their child's weight and height at home in the intervention group than in the control group (**Table 1**). However, a chi-

square test comparing the proportions of parents measuring indicated that this difference was not significantly different between control and intervention groups (p=0.219 and p=0.208 for weight and height measurements, respectively).

When comparing the socio-economic variables in **table 1** between the intervention and control groups, our results showed slightly higher educated levels of the person who reported the child's weight and height in the control group than in the intervention group. However, these education levels were not significantly different between control and intervention group (p=0.217).

From **Table 2** it can be seen that no significant differences were found in mean height reported by the parents compared with the mean height measured by the CLB nurse (Index Measured) for both the intervention groups and the control group. However, the mean weight reported by the parents was significantly underestimated in comparison with the weight measured by the CLB nurse, in both segments of the intervention group. This resulted in a significant underestimation of mean BMI reported by the parents from the total intervention group compared with the BMI calculated from the INDEX data (**Table 2**). Mean differences between means of parent-reported and measured BMI were, however, not significantly different from INDEX measurements when parents measured their child's weight and height according to the instruction folders distributed in the intervention group.

For each dimension (weight, height and BMI), the ICC correlations with INDEX measurements were higher in the group of children whose parents measured their body parameters at home according to the instruction folder compared with the children in the control group. Also the Pearson correlation coefficients between index measured and reported weight, height and BMI-values indicate that the associations were strongest in the intervention group compared to the control group (see **Table 2**). Correction for the time of the day when the children had been measured improved all correlations slightly (in both control and intervention group). Though correlations remained higher for the intervention compared to control group, and was highest in the group of children from the intervention group whose parents used the instruction folders (data not shown).

Insert table 2

For the three body dimensions (weight, height and BMI), much larger limits of agreement were found for the control group compared to the intervention group: -4.14 to 3.46 in control group versus -2.89 to 2.31 in intervention group (**Figure 1**).

Insert Figure 1

Misclassification analysis indicated that more children were grossly misclassified in the control group than in the two segments of the intervention group, while fewer children were classified correctly (**Table 3**). The percentage of grossly misclassified children was lowest in the intervention when using only the children whose parents using the instruction folders to measure their child's weight and height. These patterns are reflected in the relative values of the weighted kappa statistics, being highest (0.60) for the group of children whose parents reported using the instruction folders to measure their child's weight and height.

Insert table 3

The validity tests for classifying underweight, overweight and obesity from the parent-reported weight and height, using the INDEX measurements as the criterion, are shown in **Table 4**. The sensitivity for identifying the presence of underweight, overweight and obesity status, based on parent-reported BMI, compared with measured BMI, was lowest in the control group. Also, specificity was lowest in the control group for overweight and obesity, but not for underweight. The kappa statistic shows that agreement for underweight, overweight and obesity between parent-reported and index measured values was always higher in the intervention group than in the control group.

Insert table 4

Discussion

Principal findings

The mean measurements for height, weight, and BMI of children obtained from parents are very similar to those obtained from well-trained clinic staff. Nevertheless, there is evidence of some small average bias, particularly in child weight, even if parents reported using the measurement instruction leaflets. Although the mean parent-reported weight was slightly more underestimated in the intervention group (that received the instruction leaflet for measuring weight) than in the control group relative to the index weights, the correlations between the parental reports and the index measurements were higher in the intervention group than in the control group. Furthermore, there was considerably less misclassification into valid BMI-categories for the whole intervention group, and especially for that segment who reported using the instruction leaflets. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement. A more in depth look at the data revealed that for parental estimations of the child's body weight, indeed both under- and overestimations of the real weight appeared, while parental measurements of their child's weight (using their own scale) were mainly underestimated, revealing systematically underestimation of true weight when using home scales. Although, these systematic underestimations might be responsible for the decreased accuracy in estimating the mean weight of the children when using parental measurements, these systematic errors do not influence the ranking of the children according to

their body weight, what explains the better correlations and diagnostic measurements (data not shown).

Our results in Flemish families indicate that a large proportion of parents in the control group reported that they measured their children, even without the additional instruction provided by the leaflets distributed as the intervention. While the intervention appears to have increased the proportion of parents who measured their children, the main net effect seems to have been to reduce the amount of random errors relative to the index measurements, i.e., that the leaflets help standardize parental measurements relative to accepted protocols.

Comparison with previous studies

In a previous validation study in 2006 among Flemish preschoolers the authors already highlighted the weak validity of parent reported weight and height values for classifying preschool aged children in BMI categories[7]. These results were recently confirmed by other researchers in German children[19]. More exhaustive analyses of the validity study of parent-reported weight and height among preschool aged children in Flanders revealed that parent reported values were more accurate when parents made the effort to weigh and measure their child at home than when children's weight and height were guessed at by the parents[11]. An exhaustive review of Himes also revealed the doubtful validity of parent reported weight and

height values for classifying children as underweight, overweight or obese[10]. Himes also highlighted the importance of motivating the parents to measure their child's weight and height at home in an attempt to improve these parental reports as these parentally reported weight and height values will remain the main body fatness indicators in many large-scale surveys where measurements by trained researchers are not feasible because of the high cost involved.

To our knowledge no other studies have evaluated the validity of instruction folders to improve the validity of parent reported weight and height measurements further. Therefore the authors were not able to compare these validity results obtained in this intervention study with other studies.

Strengths and limitations

This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports. An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

Some limitations of this study are worth noting. Data were available only for children whose parents completed the questionnaire. Children who were measured by a CLB nurse but whose

parents did not complete the questionnaire were excluded from the analyses. It is possible that respondents were more willing, or more able, than non-respondents to provide accurate assessments of their children's weight and height. Therefore, the errors between parentally reported and measured weight and height in this sample may be underestimates of the true errors, since almost 40% of the parents refused to complete the questionnaire. However, to help minimize underestimation of the errors, the subjects were not aware of the future intended comparison between reported and measured values.

In this study the criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Future research should investigate the validity and feasibility of these instruction folders further for use in large-scale multi-centric studies where standardization of the measurements is very important but where INDEX measurements by trained staff members are not feasible. Furthermore would it be important to get an idea on the time needed for such parental weight and height measurements at home (for instance via a feasibility study registering the time of the measurements). For proxy reporting that occur "on the spot" during a telephone or face-to-face

survey, instructions on measuring the child's height and weight would need to be given to the participants prior to the interview and could thus incur additional costs.

Conclusion

In conclusion, our results demonstrate the degree of inaccuracy of parent-reported weight and height values in classifying preschool children as being underweight, overweight or obese. However, the important differences found between parent-measured weight and height values when using the newly developed instruction folders compared with parent-estimated values, suggest the importance of motivating and instructing the parents to measure their child at home when the study design includes the use of parent reports for weight and height values of their children at least when aiming to classify the children in the correct BMI-category. The instruction folders developed and validated in this study can serve as an example for future large-scale surveys in children that rely on parental weight and height reports.

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Figure legend

Figure 1: Bland & Altman plot including the mean difference and limits of agreement for BMI in the control group (n=81) and in the intervention group (n=52) respectively.

Contributors' Statement

The original idea for the analyses came from IH & JHH. CB & ES developed the instruction folders and did all of the data management and analysis under the supervision of IH, TDV & JHH. IH led on the writing of the paper but all co-authors contributed importantly to the different drafts of the paper and suggested analysis for the manuscript. ADK supervised the local fieldworkers. DDB, SDH, PP & NS assisted in the conceptualization of the study and in the interpretation of the results. All authors have read the final version of the manuscript before submission.

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"What's Known on This Subject;

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Instruction folders for parents to accurately measure their child's weight and height at home were developed and validated. These convenient instruction folders were proven to improve the classification of children into BMI-categories derived from parental weight and height reports/measurements.

References

1 Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998;101:518-25.

2 Huybrechts I, Matthys C, Pynaert I, et al. Flanders preschool dietary survey: rationale, aims, design, methodology and population characteristics. *The Archives of Public Health* 2008;66:5-25.

3 Akinbami LJ, Ogden CL. Childhood overweight prevalence in the United States: the impact of parent-reported height and weight. *Obesity (Silver Spring)* 2009;17:1574-80.

4 Bloom B, Cohen RA, Vickerie JL, et al. Summary health statistics for U.S. children: National Health Interview Survey, 2001. *Vital Health Stat 10* 2003;1-54.

5 Dey AN, Schiller JS, Tai DA. Summary health statistics for U.S. children: National Health Interview Survey, 2002. *Vital Health Stat 10* 2004;1-78.

6 Blumberg SJ, Olson L, Osborn L, et al. Design and operation of the National Survey of Early Childhood Health, 2000. *Vital Health Stat 1* 2002;1-97.

7 Huybrechts I, De Bacquer D, Van Trimpont I, et al. Validity of parentally reported weight and height for preschool-aged children in Belgium and its impact on classification into body mass index categories. *Pediatrics* 2006;118:2109-18.

8 Scholtens S, Brunekreef B, Visscher TL, et al. Reported versus measured body weight and height of 4-year-old children and the prevalence of overweight. *Eur J Public Health* 2007;17:369-74.

9 Akerman A, Williams ME, Meunier J. Perception versus reality: an exploration of children's measured body mass in relation to caregivers' estimates. *J Health Psychol* 2007;12:871-82.

10 Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics* 2009;124:S3-22.

11 Huybrechts I, Himes JH, Ottevaere C, et al. Validity of parent-reported weight and height of preschool children measured at home or estimated without home measurement: a validation study. *BMC Pediatr* 2011;11:63.:63.

12 Tillmann V, Clayton PE. Diurnal variation in height and the reliability of height measurements using stretched and unstretched techniques in the evaluation of short-term growth. *Ann Hum Biol* 2001;28:195-206.

13 Siklar Z, Sanli E, Dallar Y, et al. Diurnal variation of height in children. *Pediatr Int* 2005;47:645-8.

14 Routen AC, Edwards MG, Upton D, et al. The impact of school-day variation in weight and height on National Child Measurement Programme body mass index-determined weight category in Year 6 children. *Child Care Health Dev* 2011;37:360-7.

15 Vrije Universiteit Brussel, Laboratorium voor Antropogenetica. *Growth Charts Flanders 2004*, 2004.

16 Cole TJ, Bellizzi MC, Flegal KM,et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-3.

17 Cole TJ, Flegal KM, Nicholls D, et al. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007;335:194.

18 Altman DG. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991.

19 Brettschneider AK, Ellert U, Schaffrath RA. Comparison of BMI derived from parent-reported height and weight with measured values: results from the German KiGGS study. *Int J Environ Res Public Health* 2012;9:632-47.

Tables and Figures

Table 1: description of the study populations

	% Total population (n=164)	% Control Group (n=81)	% Total Intervention group (n=83)	% Measuring Intervention group * (n=52)
Person who completed questionnaire				
Father	18.4	14.8	21.7	19.2
Mother	78.0	81.5	74.7	80.8
Other	0.6	1.2	0.0	0.0
Missing	3.0	2.5	3.6	0.0
Method used to report weight and height				
Weight measured at home	76.9	72.7	81.0	100
Height measured at home	68.8	64.1	73.4	100
Time of the day when the parents measured their child's weight and height				

Morning	31.3	33.3	30.3	35.4
Afternoon	22.9	24.6	21.2	16.7
Evening	45.8	43.1	48.5	47.9
Birth country child				
Belgium	84.1	82.7	85.5	86.5
Other country	12.2	14.8	9.6	9.6
Missing	3.7	2.5	4.8	3.8
Educational level proxy				
Lower secondary education	8.5	9.8	7.2	7.7
Higher secondary education	22.0	16.1	27.8	19.2
Higher education (e.g.	31.2	30.9	31.3	38.4

bachelor)				
University degree (e.g. master degree)	35.9	39.5	32.5	34.6
Missing	2.4	3.7	1.2	0.0
Income allows family to buy healthy food				
Sufficiently	81.1	80.2	81.9	82.7
Mostly sufficiently	12.8	16.0	9.6	9.6
Seldom sufficiently	1.2	0.0	2.5	3.8
Insufficiently	1.8	1.2	2.4	1.9
Missing	3.1	2.6	3.6	1.9

* children from the intervention group whose weight and height had been measured at home according to the instructions given in the folders that were distributed

Table 2 - Accuracy of parent-reported weight and height among preschool children: comparing intervention with control group.

Reporting method used by parents	Parent reported Mean (SD)	Index Measured Mean (SD)	Difference Mean (SD)	*P**	Intraclass correlation ICC	95% CI	Pearson correlation
Weight (kg) (control group) (n=81)	24.6 (5.6)	25.0 (6.0)	-0.43 (2.3)	0.095	0.918	(0.875-0.947)	0.922
Weight (kg) (intervention group) (n=83)	23.7 (5.9)	24.4 (5.9)	-0.69 (1.9)	0.002	0.939	(0.898-0.962)	0.945
Weight (kg) (intervention group following instructions) (n=52)	23.6 (6.3)	24.2 (6.2)	-0.63 (1.5)	0.004	0.965	(0.932-0.981)	0.970
Height (cm) (control group) (n=81)	123.6 (8.9)	123.0 (8.4)	0.57 (5.1)	0.317	0.823	(0.738-0.882)	0.824

Height (cm) (intervention group) (n=83)	121.3 (10.8)	121.5 (11.1)	0.20 (3.4)	0.581	0.952	(0.926-0.968)	0.952
Height (cm) (intervention group following instructions) (n=52)	120.6 (10.9)	121.2 (11.1)	-0.63 (2.9)	0.125	0.964	(0.938-0.979)	0.965
BMI (kg/m²) (control group) (n=81)	16.0 (2.4)	16.3 (2.1)	-0.3 (1.9)	0.108	0.633	(0.483-0.747)	0.641
BMI (kg/m²) (intervention group) (n=83)	15.9 (2.4)	16.3 (2.3)	-0.4 (1.5)	0.017	0.772	(0.662-0.848)	0.783
BMI (kg/m²) (intervention group following instructions) (n=52)	16.0 (2.4)	16.3 (2.3)	-0.3 (1.3)	0.140	0.826	(0.716-0.896)	0.830

* According to the Paired samples t-test

ICC: Intraclass correlation coefficient

Table 3 - Cross-classification analyses for parent-reported (measured versus estimated) and accurately measured (by school nurse) BMI-categories*.

	Reported versus measured BMI				
	Same category	Adjacent category	Extreme category	Weighted kappa	
Parental report	(%)	(%)	(%)	(95% CI)	
Control group (n=81)	65.4	29.6	5.0	0.30	(0.07 to 0.54)
Intervention group (n=83)	73.5	25.3	1.2	0.51	(0.28 to 0.74)
Intervention group following instructions (n=52)	78.8	19.2	1.9	0.60	(0.30 to 0.81)

* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Table 4 - Diagnostic values of parent-reported (measured versus estimated) height and weight in detection of BMI-categories*

Reporting method used by parents	Sensitivity % (95% CI)			Specificity % (95% CI)			Kappa Statistic (95% CI)		
	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions
Underweight	67 (20.7 to 93.8)	75 (30.0 to 95.4)	67 (20.7 to 93.8)	87 (77.9 to 92.8)	85 (75.3 to 91.0)	86 (73.3 to 92.9)	0.22 (-0.25 to 0.69)	0.26 (-0.16 to 0.67)	0.27 (-0.26 to 0.80)
Overweight/ Obese	43 (21.3 to 67.4)	60 (35.7 to 80.1)	70 (39.6 to 89.2)	89 (79.9 to 94.8)	96 (87.8 to 98.4)	98 (87.6 to 99.5)	0.33 (-0.02 to 0.68)	0.60 (0.25 to 0.95)	0.73 (0.30 to 1.16)

* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Control group (n=81); Intervention group (n=83); Intervention group following instructions (n=52)

VALIDITY OF INSTRUCTION LEAFLETS FOR PARENTS TO MEASURE THEIR CHILD'S WEIGHT AND HEIGHT AT HOME

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Abbreviations

CLB: Centre for Pupils Counseling (Centrum voor Leerlingenbegeleiding in Dutch)

BMI: Body Mass Index

WHO: World Health Organization

SPSS: Statistical Package for the Social Sciences

Yrs: years

SD: Standard Deviation

CI: Confidence Interval

ICC: Intraclass Correlation Coefficient

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"What's Known on This Subject;

Evidence has shown difficulties and inaccuracy in parental estimates/reports of children's weight and height values. However, slightly better accuracy could be obtained if parents would measure the child's weight and height at home.

What This Study Adds"

Instruction folders for parents to accurately measure their child's weight and height at home were developed and validated. These convenient instruction folders were proven to improve the classification of children into BMI-categories derived from parental weight and height reports/measurements.

Abstract

Objectives: To compare the validity of parent-reported height, weight and BMI values of children (4-10 y-old), when measured at home by means of newly developed instruction leaflets in comparison with simple estimated parental reports.

Design: Intervention study with control and intervention group.

Setting: Belgian children and their parents recruited via schools (multistage cluster sampling design).

Participants: 164 Belgian children (53% male; Participation rate 62%).

Intervention: Parents completed a questionnaire including questions about the height and weight of their child. Parents in the intervention group received instruction leaflets to measure their child's weight and height. Classes were randomly allocated to the intervention and control groups. Nurses measured height and weight following standardised procedures up to 2 weeks after parent-report.

Outcome measures: Weight, height and BMI category of the child derived from the index measurements and the parental-reports.

Results: Mean parent-reported weight was slightly more underestimated in the intervention group than in the control group relative to the index weights. However, for all 3 parameters (weight, height & BMI), correlations between parental reports and nurse measurements were

higher in the intervention group. Sensitivity for underweight and overweight/obesity were respectively 75% and 60% in the intervention group, and 67% and 43% in the control group. Weighed kappa for classifying children in the correct BMI-category was 0.30 in the control group while 0.51 in the intervention group.

Conclusions: Although mean parent-reported weight was slightly more underestimated in the intervention than in the control group, correlations were higher and there was considerably less misclassification into valid BMI-categories for the intervention group. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement and that diagnostic measures could ~~be~~ improve~~d~~ by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Article focus

▪ Can the accuracy of parent-reported height, weight and BMI values of children (4-10 y-old) be improved when measured at home by means of instruction leaflets in comparison with simple estimated parental reports?

Key messages

▪ Parent-reported weight and height values are insufficiently accurate for classifying preschool children as being underweight, overweight or obese.

▪ Diagnostic measures could be improved by encouraging parents to measure their children's weight and height at home by means of instruction leaflets.

Strengths and limitations of this study

▪ This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports.

▪ An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

▪ The criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Introduction

With a growing interest in childhood obesity as a factor in child morbidity and adult diseases[1], valid measures of childhood weight and height are of interest to many researchers. Because of logistical difficulties and financial costs involved in directly measuring weight and height of children in a survey, such data are often proxy-reported (e.g. by parents)[2-6]. Previous studies focusing on the validity of parent-reported weight and height values in children have shown fairly poor accuracy of parentally reported values for classifying children into BMI-categories of underweight, overweight and obesity status[7-9]. From a recent review of the literature, Himes concluded that proxy measures for directly measured BMI, such as self-reports or parental reports of height and weight, are much less preferred and should only be used with caution and awareness of the limitations, biases, and uncertainties of these measures[10]. Nevertheless, because direct measurements of weight and height are costly and time consuming, large surveys in childhood populations are likely to continue to use parent-reported values. A practical solution to improve the validity of these parent reports might be to ask parents to measure the weight and height of their children at home and to provide the parents with instructions concerning how to measure their child in an accurate way. A previous study demonstrated relatively better accuracy when parents reported that they had measured their child's weight and height at home (using unspecified methods) compared with parents who estimated their child's body size without taking measurements[11]. To date, however, we are unaware of any studies evaluating the

usefulness and validity of instruction leaflets for parents concerning how to measure the weight and height of their child at home.

The aim of the present study was to develop and validate user-friendly instruction leaflets for parents to measure their child at home using their own measurement instruments (scale and ruler). Furthermore, we compared the validity of parent-reported weight and height values of their child after being measured at home using the newly developed instruction leaflets in comparison with parents who did not receive the instruction leaflets. We also compared the accuracy of the parent reports for classifying children into BMI categories, using international BMI cut-off values for underweight, overweight, and obesity.

Methods

Study population and design

Subjects were residents in the region of Ghent, a medium sized city in Belgium. A sample of 4–10 year-old children was recruited using a multistage cluster sampling technique. First, three school committees were randomly selected in the region of Ghent and they all agreed to participate (a school committee manages/governs one or more schools). In total, these three school committees included five different school residences/locations. All 17 (pre-)school classes in these five schools were selected as final cluster units. All the children from these 17 selected classes were invited to participate (only the eldest child in case of brothers/sisters) between September 2011 and July 2012. Eight classes were allocated to the intervention group,

in which parents received instruction folders describing how to measure their child's weight and height accurately at home. Nine classes were allocated to the control group in which parents only received a questionnaire but no instruction folders describing how to measure their children.

Instruction folder/leaflet for measuring children's weight and height at home

Instruction folders illustrating and describing how to measure children's weight and height at home were developed in close collaboration with paediatricians and experts in anthropometric measurements. A preliminary draft of these leaflets was pilot tested in a convenience sample of 28 children and was modified afterwards considering the feedback from the parents who used the leaflets. The final instruction folders are available in **Annexes 1 & 2**. Written informed consent from the child's parent and the staff member performing the measurements in the attached instruction folders was obtained prior to the photography.

Questionnaire and self-reported anthropometry

No protocol or instructions were provided for measuring the child at home in the control group. Information about the child (e.g., gender, age) and his or her parents (e.g., age, gender and parental education levels) was obtained via a self-administered parental questionnaire. Parents were also asked to report the weight and height of their child in this questionnaire. In addition, they were asked to report if they actually measured their child's weight and height prior to

reporting, or if they estimated the values without their own measurement. Furthermore they were asked to report the time of the day when the measurements were performed as weight tends to increase, while height tends to decrease during the day[12-14]. The parents in the intervention group were asked if they had used the instruction folders (**Annex 1 & 2**) during the measurements or not.

Anthropometric measurements

This study was conducted in collaboration with Centers for Pupils Counselling ('Centrum voor Leerlingenbegeleiding' (CLB) in Dutch). Preventive health care and standardized medical examinations are performed at the CLBs at certain ages determined by law, including weight and height measurements. All the children participating in this study were examined and measured by a CLB nurse (3 different CLB nurses) in a standardized way (according to the protocol 'VWVJ & Vlaamse Groeicurven').[15] For these measurements, children were only wearing underwear. Weight was recorded to the nearest 0.1 kg, using an electronic weighing scale (Seca 841) and height was measured to the nearest 0.1 cm in standing position, using a rigid stadiometer (Seca 220). The stadiometer was checked for accuracy and the scale was calibrated before starting the examination of each class of children. In this manuscript the weight and height measurements performed by CLB nurses are indicated as 'INDEX' measured weight and height.

Procedures

The school directors of the selected schools approved the study protocol and gave permission to run the study in their school. The directors of the schools and the teachers of the classes participating in the study were given detailed information and instructions about the study.

The teachers of the participating classes were asked to distribute the questionnaire (including the instruction leaflets in the intervention group only) among the parents of the children about 14 days before the planned medical examination in the CLB. An informed consent was attached, in which parents were informed and invited to participate in the study, without being aware that validation of anthropometric measurements was part of the study. The completed questionnaires and the signed informed consents were returned to the school in a sealed envelope. Nurses at the CLB-centers were not allowed to open the sealed envelopes to be sure that they were not influenced by the parent-reported weights and heights.

All procedures were conducted according to the principles expressed in the Declaration of Helsinki and the Ethical Committee (EC) of the Ghent University Hospital granted ethical approval for the study. The EC has read and approved the study protocol and all the documents that were handed out to the participants (including the informed consent form).

Statistical analysis

BMI (kg/m²) was calculated from parent-reported and INDEX measured heights and weights. Underweight, overweight, and obesity were identified using age- and gender-specific international (International Obesity Task Force (IOTF)) cut-off points.[16 17]

Differences in mean parent-reported and INDEX measured weight, height and BMI, and corresponding differences in prevalence of underweight, overweight and obesity were assessed using paired t-test and McNemar's test, respectively. Limits of agreement were estimated from the SD of differences from the index measurements (mean difference ± 1.96SD), considering the measurements derived from the CLB nurses as index measurements. Intraclass correlation coefficients between measured and reported values were calculated as a measure of overall association. All analyses were also performed while correcting for the cluster design (using mixed models) and gave similar results. However, as the proportion of variance between clusters to the total variance was less than 0.5%, the final results have not been corrected for cluster design.

When identifying underweight, normal weight, overweight, and obesity, misclassification was defined as discordance between BMI-categories, determined by parent-reported and parent-measured BMI versus nurse-measured BMI. The weighted kappa statistic was calculated to

determine agreement between parent-reported and measured index BMI-status adjusted for chance, using a linear set of weights [18]. Kappa values <0.20 are often considered as "poor" agreement, 0.21 to 0.40 as "fair" agreement, 0.41 to 0.60 as "moderate" agreement, 0.61 to 0.80 as "good" agreement, and 0.81 to 1.00 as "excellent" agreement.[18]

Sensitivity was defined as the proportion of children categorized into a certain BMI-category (e.g. overweight) based on measured BMI that was also categorized into the same BMI-category when using parent reports (true positives). Specificity was defined as the proportion of children assigned as not having a certain BMI status (e.g. overweight) when using measured index BMI that was also not assigned to that same BMI-category when using the parent-reported data (true negatives).

The Statistical Package for the Social Sciences (SPSS) for Windows Version 20 was used for data management and all statistical analyses. Unless reported differently, a P-value of 0.05 (two-sided) was used as the threshold for statistical significance.

Results

A total of 266 (pre-)school children were officially registered in the 17 sampled classes in 5 different schools. Complete questionnaires were returned for 164 children (62%). These children

had a mean age of 6.8 years (SD 1.4 y) and an age range from 4.0 to 9.9 years (15.2% 4.0 to 5.9 y; 60.4% 6.0 to 7.9 y; 24.4% 8.0 to 9.9 y).

Both sexes were similarly represented in the study (47% girls) and 51% of the children who participated were included in the intervention group (Table 1). Only 63% of the intervention group parents reported they made the effort to measure their child's weight and height according to the instruction folders distributed. Therefore, the authors will present results for two intervention comparisons:

1) The total sample of 164 cases (all 83 intervention versus 81 control); and 2) the select group of children from the intervention group whose parents reported that weight and height was measured at home according to the instructions given in the folders that were distributed (52 intervention versus 81 control).

Insert Table 1

Overall, 78% of the questionnaires analyzed were answered by the mother of the child, with relatively more in the control group (81.5%) than in the intervention group (74.7%) (**Table 1**). About 45% of the children had been measured in the evening and about 1/3 in the morning (the remaining in the afternoon). Relatively more parents reported measuring their child's weight and height at home in the intervention group than in the control group (**Table 1**). However, a chi-

square test comparing the proportions of parents measuring indicated that this difference was not significantly different between control and intervention groups (p=0.219 and p=0.208 for weight and height measurements, respectively).

When comparing the socio-economic variables in **table 1** between the intervention and control groups, our results showed slightly higher educated levels of the person who reported the child's weight and height in the control group than in the intervention group. However, these education levels were not significantly different between control and intervention group (p=0.217).

From **Table 2** it can be seen that no significant differences were found in mean height reported by the parents compared with the mean height measured by the CLB nurse (Index Measured) for both the intervention groups and the control group. However, the mean weight reported by the parents was significantly underestimated in comparison with the weight measured by the CLB nurse, in both segments of the intervention group. This resulted in a significant underestimation of mean BMI reported by the parents from the total intervention group compared with the BMI calculated from the INDEX data (**Table 2**). Mean differences between means of parent-reported and measured BMI were, however, not significantly different from INDEX measurements when parents measured their child's weight and height according to the instruction folders distributed in the intervention group.

For each dimension (weight, height and BMI), the ICC correlations with INDEX measurements were higher in the group of children whose parents measured their body parameters at home according to the instruction folder compared with the children in the control group. Also the Pearson correlation coefficients between index measured and reported weight, height and BMI-values indicate that the associations were strongest in the intervention group compared to the control group (see **Table 2**). Correction for the time of the day when the children had been measured improved all correlations slightly (in both control and intervention group). Though correlations remained higher for the intervention compared to control group, and was highest in the group of children from the intervention group whose parents used the instruction folders (data not shown).

Insert table 2

For the three body dimensions (weight, height and BMI), much larger limits of agreement were found for the control group compared to the intervention group: -4.14 to 3.46 in control group versus -2.89 to 2.31 in intervention group (**Figure 1**).

Insert Figure 1

Misclassification analysis indicated that more children were grossly misclassified in the control group than in the two segments of the intervention group, while fewer children were classified correctly (**Table 3**). The percentage of grossly misclassified children was lowest in the intervention when using only the children whose parents using the instruction folders to measure their child's weight and height. These patterns are reflected in the relative values of the weighted kappa statistics, being highest (0.60) for the group of children whose parents reported using the instruction folders to measure their child's weight and height.

Insert table 3

The validity tests for classifying underweight, overweight and obesity from the parent-reported weight and height, using the INDEX measurements as the criterion, are shown in **Table 4**. The sensitivity for identifying the presence of underweight, overweight and obesity status, based on parent-reported BMI, compared with measured BMI, was lowest in the control group. Also, specificity was lowest in the control group for overweight and obesity, but not for underweight. The kappa statistic shows that agreement for underweight, overweight and obesity between parent-reported and index measured values was always higher in the intervention group than in the control group.

Insert table 4

Discussion

Principal findings

The mean measurements for height, weight, and BMI of children obtained from parents are very similar to those obtained from well-trained clinic staff. Nevertheless, there is evidence of some small average bias, particularly in child weight, even if parents reported using the measurement instruction leaflets. Although the mean parent-reported weight was slightly more underestimated in the intervention group (that received the instruction leaflet for measuring weight) than in the control group relative to the index weights, the correlations between the parental reports and the index measurements were higher in the intervention group than in the control group. Furthermore, there was considerably less misclassification into valid BMI-categories for the whole intervention group, and especially for that segment who reported using the instruction leaflets. This pattern suggests that most of the parental deviations from the index measurements were probably due to random errors of measurement. A more in depth look at the data revealed that for parental estimations of the child's body weight, indeed both under- and overestimations of the real weight appeared, while parental measurements of their child's weight (using their own scale) were mainly underestimated, revealing systematically underestimation of true weight when using home scales. Although, these systematic underestimations might be responsible for the decreased accuracy in estimating the mean weight of the children when using parental measurements, these systematic errors do not influence the ranking of the children according to

their body weight, what explains the better correlations and diagnostic measurements (data not shown).

Our results in Flemish families indicate that a large proportion of parents in the control group reported that they measured their children, even without the additional instruction provided by the leaflets distributed as the intervention. While the intervention appears to have increased the proportion of parents who measured their children, the main net effect seems to have been to reduce the amount of random errors relative to the index measurements, i.e., that the leaflets help standardize parental measurements relative to accepted protocols.

Comparison with previous studies

In a previous validation study in 2006 among Flemish preschoolers the authors already highlighted the weak validity of parent reported weight and height values for classifying preschool aged children in BMI categories[7]. These results were recently confirmed by other researchers in German children[19]. More exhaustive analyses of the validity study of parent-reported weight and height among preschool aged children in Flanders revealed that parent reported values were more accurate when parents made the effort to weigh and measure their child at home than when children's weight and height were guessed at by the parents[11]. An exhaustive review of Himes also revealed the doubtful validity of parent reported weight and

height values for classifying children as underweight, overweight or obese[10]. Himes also highlighted the importance of motivating the parents to measure their child's weight and height at home in an attempt to improve these parental reports as these parentally reported weight and height values will remain the main body fatness indicators in many large-scale surveys where measurements by trained researchers are not feasible because of the high cost involved.

To our knowledge no other studies have evaluated the validity of instruction folders to improve the validity of parent reported weight and height measurements further. Therefore the authors were not able to compare these validity results obtained in this intervention study with other studies.

Strengths and limitations

This is the first study investigating the validity of instruction folders for parents to accurately measure their child's weight and height at home by comparison with simple estimated parental reports. An important strength of this study is the high level of standardization in the reference measurements performed by the experienced and trained CLB nurses, and the inclusion of both parent-measured and parent-estimated child dimensions.

Some limitations of this study are worth noting. Data were available only for children whose parents completed the questionnaire. Children who were measured by a CLB nurse but whose

parents did not complete the questionnaire were excluded from the analyses. It is possible that respondents were more willing, or more able, than non-respondents to provide accurate assessments of their children's weight and height. Therefore, the errors between parentally reported and measured weight and height in this sample may be underestimates of the true errors, since almost 40% of the parents refused to complete the questionnaire. However, to help minimize underestimation of the errors, the subjects were not aware of the future intended comparison between reported and measured values.

In this study the criterion examination by the CLB nurses was performed about 2 weeks after completion of the questionnaire. As there might be up to 2 weeks between the two assessments, the true weight and height might change during this period. However, large changes, which might influence the present results, are unlikely to have occurred during that period.

Future research should investigate the validity and feasibility of these instruction folders further for use in large-scale multi-centric studies where standardization of the measurements is very important but where INDEX measurements by trained staff members are not feasible. Furthermore would it be important to get an idea on the time needed for such parental weight and height measurements at home (for instance via a feasibility study registering the time of the measurements). For proxy reporting that occur "on the spot" during a telephone or face-to-face

survey, instructions on measuring the child's height and weight would need to be given to the participants prior to the interview and could thus incur additional costs.

Conclusion

In conclusion, our results demonstrate the degree of inaccuracy of parent-reported weight and height values in classifying preschool children as being underweight, overweight or obese. However, the important differences found between parent-measured weight and height values when using the newly developed instruction folders compared with parent-estimated values, suggest the importance of motivating and instructing the parents to measure their child at home when the study design includes the use of parent reports for weight and height values of their children at least when aiming to classify the children in the correct BMI-category. The instruction folders developed and validated in this study can serve as an example for future large-scale surveys in children that rely on parental weight and height reports.

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Contributors' Statement

The original idea for the analyses came from IH & JHH. CB & ES developed the instruction folders and did all of the data management and analysis under the supervision of IH, TDV & JHH. IH led on the writing of the paper but all co-authors contributed importantly to the different drafts of the paper and suggested analysis for the manuscript. ADK supervised the local fieldworkers. DDB, SDH, PP & NS assisted in the conceptualization of the study and in the interpretation of the results. All authors have read the final version of the manuscript before submission.

References

1 Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998;101:518-25.

2 Huybrechts I, Matthys C, Pynaert I, De Maeyer M, Bellemans M, De Geeter H et al. Flanders preschool dietary survey: rationale, aims, design, methodology and population characteristics. *The Archives of Public Health* 2008;66:5-25.

3 Akinbami LJ, Ogden CL. Childhood overweight prevalence in the United States: the impact of parent-reported height and weight. *Obesity (Silver Spring)* 2009;17:1574-80.

4 Bloom B, Cohen RA, Vickerie JL, Wondimu EA. Summary health statistics for U.S. children: National Health Interview Survey, 2001. *Vital Health Stat 10* 2003;1-54.

5 Dey AN, Schiller JS, Tai DA. Summary health statistics for U.S. children: National Health Interview Survey, 2002. *Vital Health Stat 10* 2004;1-78.

6 Blumberg SJ, Olson L, Osborn L, Srinath KP, Harrison H. Design and operation of the National Survey of Early Childhood Health, 2000. *Vital Health Stat 1* 2002;1-97.

7 Huybrechts I, De Bacquer D, Van Trimpont I, De Backer G, De Henauw S. Validity of parentally reported weight and height for preschool-aged children in Belgium and its impact on classification into body mass index categories. *Pediatrics* 2006;118:2109-18.

8 Scholtens S, Brunekreef B, Visscher TL, Smit HA, Kerkhof M, Jongste JC et al. Reported versus measured body weight and height of 4-year-old children and the prevalence of overweight. *Eur J Public Health* 2007;17:369-74.

9 Akerman A, Williams ME, Meunier J. Perception versus reality: an exploration of children's measured body mass in relation to caregivers' estimates. *J Health Psychol* 2007;12:871-82.

10 Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics* 2009;124:S3-22.

11 Huybrechts I, Himes JH, Ottevaere C, De Vriendt T, De Keyzer W, Cox B et al. Validity of parent-reported weight and height of preschool children measured at home or estimated without home measurement: a validation study. *BMC Pediatr* 2011;11:63.:63.

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12 Tillmann V, Clayton PE. Diurnal variation in height and the reliability of height measurements using stretched and unstretched techniques in the evaluation of short-term growth. *Ann Hum Biol* 2001;28:195-206.

13 Siklar Z, Sanli E, Dallar Y, Tanyer G. Diurnal variation of height in children. *Pediatr Int* 2005;47:645-8.

14 Routen AC, Edwards MG, Upton D, Peters DM. The impact of school-day variation in weight and height on National Child Measurement Programme body mass index-determined weight category in Year 6 children. *Child Care Health Dev* 2011;37:360-7.

15 Vrije Universiteit Brussel, Laboratorium voor Antropogenetica. *Growth Charts Flanders 2004*, 2004.

16 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-3.

17 Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007;335:194.

18 Altman DG. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991.

19 Brettschneider AK, Ellert U, Schaffrath RA. Comparison of BMI derived from parent-reported height and weight with measured values: results from the German KiGGS study. *Int J Environ Res Public Health* 2012;9:632-47.

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Tables and Figures

Table 1: description of the study populations

	% Total population (n=164)	% Control Group (n=81)	% Total Intervention group (n=83)	% Measuring Intervention group * (n=52)
Person who completed questionnaire				
Father	18.4	14.8	21.7	19.2
Mother	78.0	81.5	74.7	80.8
Other	0.6	1.2	0.0	0.0
Missing	3.0	2.5	3.6	0.0
Method used to report weight and height				
Weight measured at home	76.9	72.7	81.0	100
Height measured at home	68.8	64.1	73.4	100
Time of the day when the parents measured their child's weight and height				

Morning	31.3	33.3	30.3	35.4
Afternoon	22.9	24.6	21.2	16.7
Evening	45.8	43.1	48.5	47.9
Birth country child				
Belgium	84.1	82.7	85.5	86.5
Other country	12.2	14.8	9.6	9.6
Missing	3.7	2.5	4.8	3.8
Educational level proxy				
Lower secondary education	8.5	9.8	7.2	7.7
Higher secondary education	22.0	16.1	27.8	19.2
Higher education (e.g.	31.2	30.9	31.3	38.4

bachelor)				
University degree (e.g. master degree)	35.9	39.5	32.5	34.6
Missing	2.4	3.7	1.2	0.0
Income allows family to buy healthy food				
Sufficiently	81.1	80.2	81.9	82.7
Mostly sufficiently	12.8	16.0	9.6	9.6
Seldom sufficiently	1.2	0.0	2.5	3.8
Insufficiently	1.8	1.2	2.4	1.9
Missing	3.1	2.6	3.6	1.9

* children from the intervention group whose weight and height had been measured at home according to the instructions given in the folders that were distributed

Table 2 - Accuracy of parent-reported weight and height among preschool children: comparing intervention with control group.

Reporting method used by parents	Parent reported Mean (SD)	Index Measured Mean (SD)	Difference Mean (SD)	*P**	Intraclass correlation ICC	95% CI	Pearson correlation
Weight (kg) (control group) (n=81)	24.6 (5.6)	25.0 (6.0)	-0.43 (2.3)	0.095	0.918	(0.875-0.947)	0.922
Weight (kg) (intervention group) (n=83)	23.7 (5.9)	24.4 (5.9)	-0.69 (1.9)	0.002	0.939	(0.898-0.962)	0.945
Weight (kg) (intervention group following instructions) (n=52)	23.6 (6.3)	24.2 (6.2)	-0.63 (1.5)	0.004	0.965	(0.932-0.981)	0.970
Height (cm) (control group) (n=81)	123.6 (8.9)	123.0 (8.4)	0.57 (5.1)	0.317	0.823	(0.738-0.882)	0.824

Height (cm) (intervention group) (n=83)	121.3 (10.8)	121.5 (11.1)	0.20 (3.4)	0.581	0.952	(0.926-0.968)	0.952
Height (cm) (intervention group following instructions) (n=52)	120.6 (10.9)	121.2 (11.1)	-0.63 (2.9)	0.125	0.964	(0.938-0.979)	0.965
BMI (kg/m²) (control group) (n=81)	16.0 (2.4)	16.3 (2.1)	-0.3 (1.9)	0.108	0.633	(0.483-0.747)	0.641
BMI (kg/m²) (intervention group) (n=83)	15.9 (2.4)	16.3 (2.3)	-0.4 (1.5)	0.017	0.772	(0.662-0.848)	0.783
BMI (kg/m²) (intervention group following instructions) (n=52)	16.0 (2.4)	16.3 (2.3)	-0.3 (1.3)	0.140	0.826	(0.716-0.896)	0.830

* According to the Paired samples t-test

ICC: Intraclass correlation coefficient

Table 3 - Cross-classification analyses for parent-reported (measured versus estimated) and accurately measured (by school nurse) BMI-categories*.

	Reported versus measured BMI				
	Same category	Adjacent category	Extreme category	Weighted kappa	
Parental report	(%)	(%)	(%)	(95% CI)	
Control group (n=81)	65.4	29.6	5.0	0.30	(0.07 to 0.54)
Intervention group (n=83)	73.5	25.3	1.2	0.51	(0.28 to 0.74)
Intervention group following instructions (n=52)	78.8	19.2	1.9	0.60	(0.30 to 0.81)

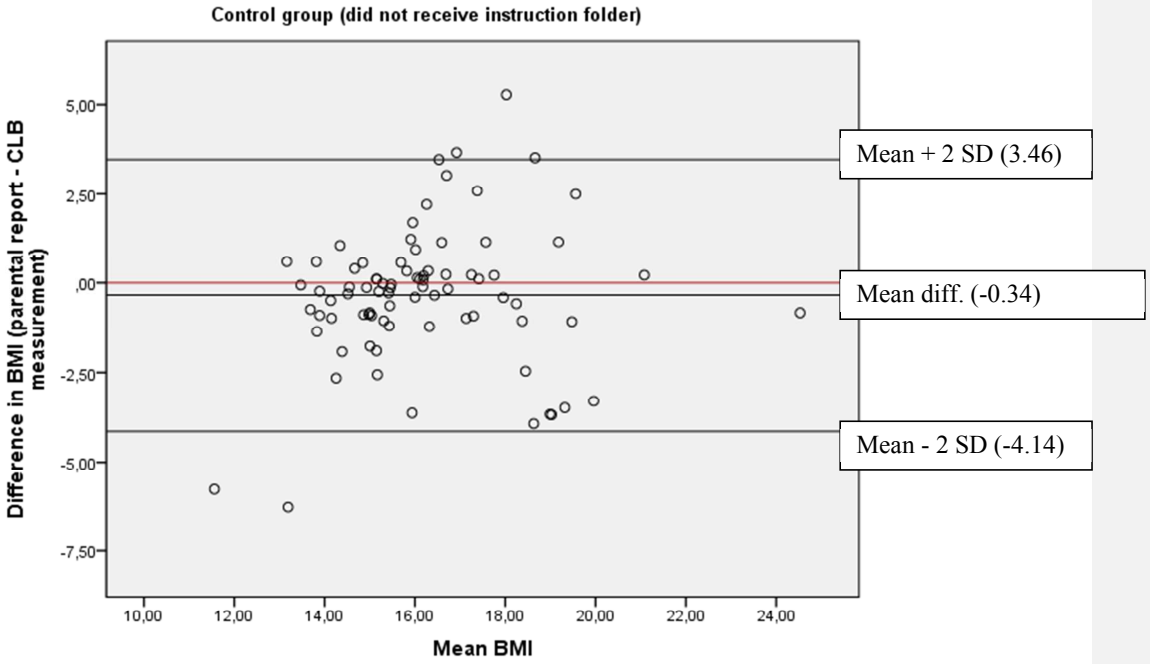
* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Table 4 - Diagnostic values of parent-reported (measured versus estimated) height and weight in detection of BMI-categories*

Reporting method used by parents	Sensitivity % (95% CI)			Specificity % (95% CI)			Kappa Statistic (95% CI)		
	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions	Control group	Intervention group	Intervention group following instructions
Underweight	67 (20.7 to 93.8)	75 (30.0 to 95.4)	67 (20.7 to 93.8)	87 (77.9 to 92.8)	85 (75.3 to 91.0)	86 (73.3 to 92.9)	0.22 (-0.25 to 0.69)	0.26 (-0.16 to 0.67)	0.27 (-0.26 to 0.80)
Overweight/ Obese	43 (21.3 to 67.4)	60 (35.7 to 80.1)	70 (39.6 to 89.2)	89 (79.9 to 94.8)	96 (87.8 to 98.4)	98 (87.6 to 99.5)	0.33 (-0.02 to 0.68)	0.60 (0.25 to 0.95)	0.73 (0.30 to 1.16)

* The IOTF cut-off values for determining underweight, normal weight, overweight, and obesity

Control group (n=81); Intervention group (n=83); Intervention group following instructions (n=52)



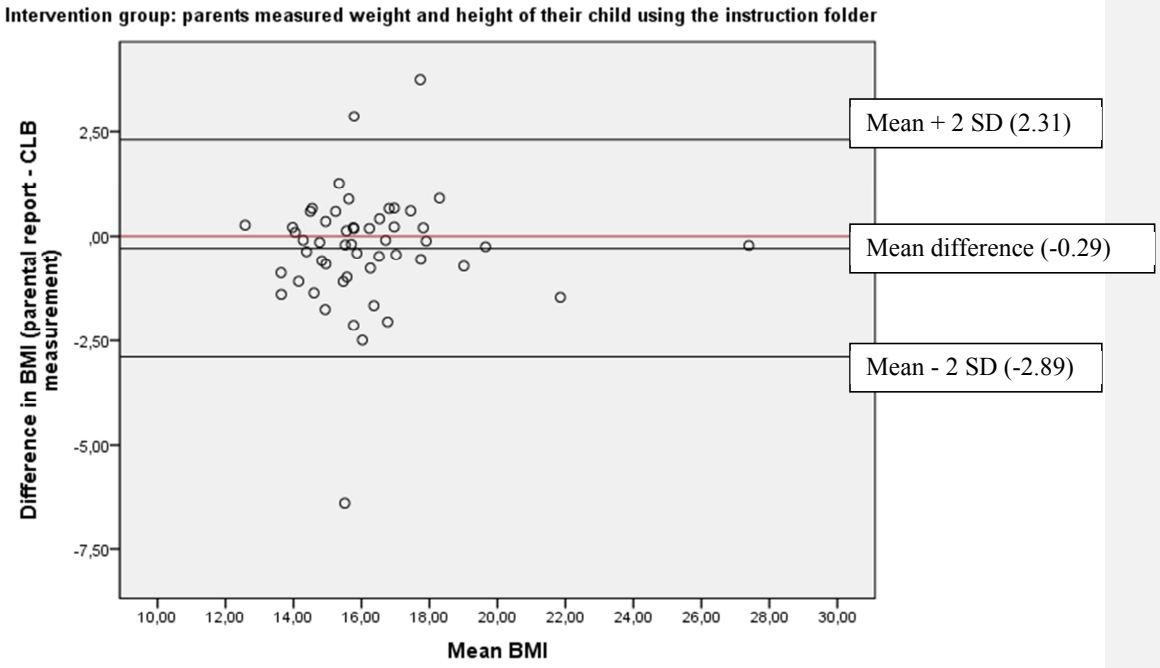


Figure 1: Bland & Altman plot including the mean difference and limits of agreement for BMI in the control group (n=81) and in the intervention group (n=52) respectively.

Weighing a child

If children are at least two years old, you can weigh them with a regular scale.

Material:

A scale ranging from 0 to 120 kilogram (0 to 265 pounds) and a subdivision of at least 500 grams (1.1 pounds).

Points of attention:

1 kilogram is equal to 2,205 pounds.

Preferably use an electronic scale. Alternatively a scale with dial can be used.

Position your scale on a flat and hard surface (no carpet).

Make sure that the child only wears underwear.

The measurement is done barefooted, so footwear and socks are removed.

Read the weight from the scale as accurate as possible without rounding.

Technique :

Place the scale on a hard surface.

Turn on the scale and wait until a zero appears on the screen.

Ask the child to step onto the scale, without leaning against something. Tell him/her to stand with his/her weight evenly distributed on the measurement platform.

Wait a few moments (make sure they don't shift their weight) and read the result.

Read the weight from the scale
(be as accurate as possible).

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Instructions to weigh and measure children

(age 2 and older)

Measuring children's height

Material:

A tape measure of minimum 2000 mm (80 inches) and a straight wall.

Points of attention:

The measurement is done barefoot, so footwear and socks are removed.

Hairpins and braids/tails, which can disrupt the measurement are removed.

Make sure that the child is wearing light clothing, no pull, shirt or jacket.

The figure is not rounded but always noted down to the last full mm or subdivision of the inch.

Technique:

The child is placed centrally, facing away from the wall.

The arms are hanging relaxed at the sides of the child's body.

The heels, calves, buttocks and shoulders are touching the wall.

The heels are on the ground, the feet at an angle of about 45 ° against each other, so that the heels touch each other.

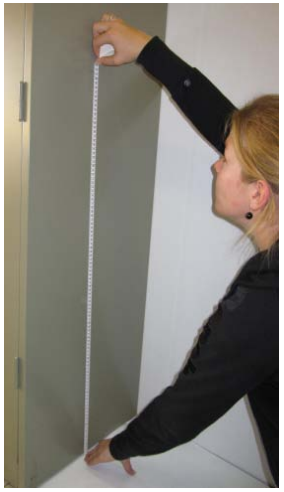
With young children it may be necessary to briefly press their feet so that the bottom of the heels always remains in contact with the ground.

Ask your child to stand up as tall as possible (maintaining a firm posture), without standing on his/her toes.

Hold the head with one hand so that the child looks straight forward and bring the other hand up against the crown. (see previous picture)

Let the child step away carefully from under your hand and mark that spot on the wall with a pencil.

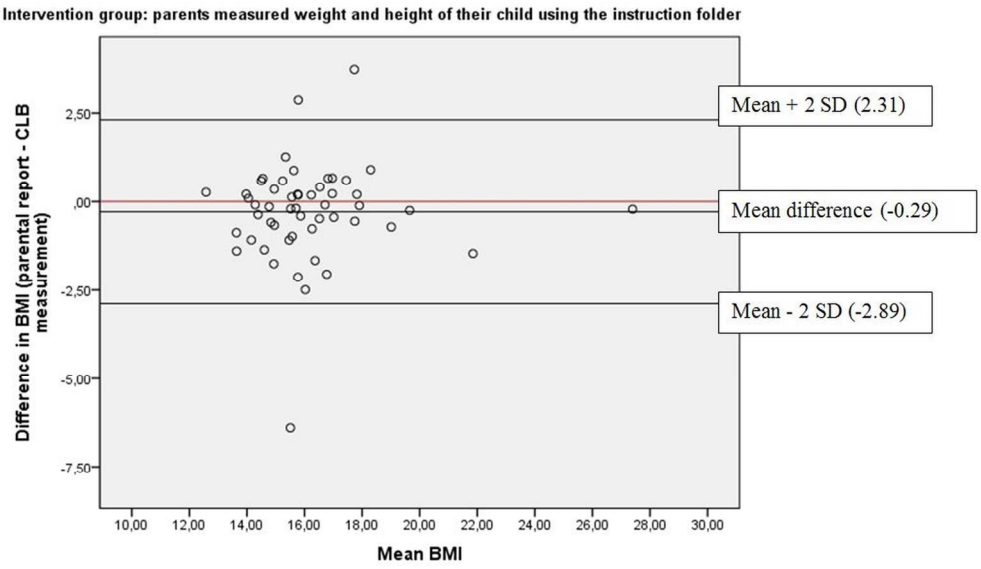
Let the tape unwind from the place where you've put the mark, down to the floor. Measure the distance between the mark and the floor. Read the figure down to the last full mm or subdivision of the inch.



STARD checklist for reporting of studies of diagnostic accuracy
(version January 2003)

Section and Topic	Item #		On page #
TITLE/ABSTRACT/ KEYWORDS	1	Identify the article as a study of diagnostic accuracy (recommend MeSH heading 'sensitivity and specificity').	1, 2, 3, 4
INTRODUCTION	2	State the research questions or study aims, such as estimating diagnostic accuracy or comparing accuracy between tests or across participant groups.	7
METHODS			
Participants	3	The study population: The inclusion and exclusion criteria, setting and locations where data were collected.	7, 8, 10
	4	Participant recruitment: Was recruitment based on presenting symptoms, results from previous tests, or the fact that the participants had received the index tests or the reference standard?	7 & 10
	5	Participant sampling: Was the study population a consecutive series of participants defined by the selection criteria in item 3 and 4? If not, specify how participants were further selected.	7 & 10
	6	Data collection: Was data collection planned before the index test and reference standard were performed (prospective study) or after (retrospective study)?	10
Test methods	7	The reference standard and its rationale.	9
	8	Technical specifications of material and methods involved including how and when measurements were taken, and/or cite references for index tests and reference standard.	7-10
	9	Definition of and rationale for the units, cut-offs and/or categories of the results of the index tests and the reference standard.	11
	10	The number, training and expertise of the persons executing and reading the index tests and the reference standard.	9
	11	Whether or not the readers of the index tests and reference standard were blind (masked) to the results of the other test and describe any other clinical information available to the readers.	10
Statistical methods	12	Methods for calculating or comparing measures of diagnostic accuracy, and the statistical methods used to quantify uncertainty (e.g. 95% confidence intervals).	11
	13	Methods for calculating test reproducibility, if done.	-
RESULTS			
Participants	14	When study was performed, including beginning and end dates of recruitment.	7
	15	Clinical and demographic characteristics of the study population (at least information on age, gender, spectrum of presenting symptoms).	12
	16	The number of participants satisfying the criteria for inclusion who did or did not undergo the index tests and/or the reference standard; describe why participants failed to undergo either test (a flow diagram is strongly recommended).	7 & 12
Test results	17	Time-interval between the index tests and the reference standard, and any treatment administered in between.	10
	18	Distribution of severity of disease (define criteria) in those with the target condition; other diagnoses in participants without the target condition.	Not applicable
	19	A cross tabulation of the results of the index tests (including indeterminate and missing results) by the results of the reference standard; for continuous results, the distribution of the test results by the results of the reference standard.	Table 3
	20	Any adverse events from performing the index tests or the reference standard.	Not applicable
Estimates	21	Estimates of diagnostic accuracy and measures of statistical uncertainty (e.g. 95% confidence intervals).	Tables 3 & 4 and Figure 1
	22	How indeterminate results, missing data and outliers of the index tests were handled.	No missing data for INDEX measures

	23	Estimates of variability of diagnostic accuracy between subgroups of participants, readers or centers, if done.	13-16 (see also tables 3-4)
	24	Estimates of test reproducibility, if done.	-
DISCUSSION	25	Discuss the clinical applicability of the study findings.	21



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