Abstract

Estimating energy intake (EI) of a child by using a diet history interview (DHI) method may be a challenge because of difficulty for the child to remember what has been eaten as well as to report portion sizes. The aim of this research was to validate reported EI from a DHI in children classified as overweight or obese by comparing the reported EI to total energy expenditure (TEE) measured by 2 objective measures. Eighty-five 10.5-± 1.1-y-old overweight and obese children, with help from 1 or 2 parents, reported their EI 2 wk retrospectively in a DHI. Reported EI was compared with TEE, as measured by SenseWear armband (n = 85) and the doubly-labeled water (DLW) method (n = 21), during the same period as the DHI. Reported EI was underestimated by 14% when validated against both the armband and DLW method. Underestimation did not differ between boys and girls. However, the EI of obese children was underestimated by 22%, which is twice the rate as for the overweight children (95% CI: 0.55, 3.08). Underestimated EI was negatively correlated with BMI (r = −0.38; P = <0.01) as well as age (r = −0.21; P = 0.05). EI is underestimated to a higher extent among children with higher BMI and higher age when using a DHI method. The findings show the importance of validating dietary intake of children in general and in overweight and obese children in particular. J. Nutr. 139: 522–527, 2009.

Introduction

There are a number of systematic errors associated with the assessment of dietary intake (1). The most common error, regardless of what dietary assessment method used, is under-reported energy intake (EI). Increased BMI is one important factor shown to be associated with under-reporting among adults as well as adolescents (2–5). Many errors that are associated with dietary assessments are the same among children and adults. However, when assessing the dietary intake of children, there are some specific differences that should be considered. A child’s cognitive capacity is not fully developed, which may affect his or her ability to remember and assess portion sizes for consumed food (6). Further, it is important to consider whether participating parents or caregivers have influenced the data collection in any way and consequently influencing the reported EI (7).

Dietary records are one of the most commonly used methods to assess the EI of children. For practical reasons, dietary records usually cover only a few days. Consequently, it is difficult to make an accurate assessment of a person’s habitual intake unless repeated records are made. An alternative to record a person’s habitual intake is to use a retrospective method such as a diet history interview (DHI) method.

There are different methods for assessing the validity of reported dietary intake, one of which is to compare reported EI against measured total energy expenditure (TEE) (1). All validation methods of reported EI are based on the assumption that EI equals TEE when the body weight of the subject is stable during the study period. At present, the doubly-labeled water (DLW) method is considered to be the “gold standard” for assessing TEE (8). It is an objective method that can be used in a nonrestrictive environment for the participant.

Expense and the need for special laboratory equipment are limitations of the DLW method. Objective alternatives for assessment of TEE are registration of body movements (e.g. accelerometers and pedometers) or recording the physiological effects of body movements (e.g. heart rate monitoring) (1). The SenseWear armband (BodyMedia) is a portable device that can measure TEE based on data from a 2-axis accelerometer and from 4 different sensors capturing skin temperature, near-body temperature, heat flux, and galvanic skin response. With data collected from the armband and information about the participant’s age, gender, weight, and height, TEE can be calculated through...
algorithms in the software program InnerView Professional (version 5.1).

To accurately draw conclusions about dietary intake and its effect on children’s health, it is important to assess the validity of reported intake. The present study therefore aimed to evaluate the validity of a DHI by comparing the reported EI of overweight and obese children with 2 objective assessment methods of TEE.

**Subjects and Methods**

**Subjects.** Children were recruited to a 2-y intervention study focusing on food and physical activity habits. To be included in the study, the child had to be born between 1995 and 1998, live in or near the northern Swedish town of Umeå, be overweight or obese, have access to the Internet, and have no chronic diseases that affect metabolic variables or no attention deficit disorder diagnosis. Overweight and obesity was defined according to the International Obesity Task Force’s age- and sex-specific BMI limits (9). The cutoff limit used to classify a child as overweight was an age- and sex-specific BMI that corresponded with an adult BMI of 25–29.9 kg/m² and, for obesity, a BMI of ≥ 30 kg/m². Invitations were sent to all families (n = 6290) with children born between 1995 and 1998 living in the following 5 communities in northern Sweden: Umeå, Nordmaling, Vännäs, Robertsfors, and Bjurbom. A total of 112 children were interested in participating, but only 105 children fulfilled the inclusion criteria. The 7 children who did not fulfill the inclusion criteria were excluded because of the following reasons: chronic diseases that affect metabolic variables, attention deficit disorder diagnosis, no access to Internet, or not classified as overweight or obese. In 2006 the prevalence of overweight and obesity among 10-y-old children in Umeå was 23% (10), which means that 6.4% of the possible overweight and obese children were willing to participate in the study and fulfilled the inclusion criteria. The 105 children were then randomized into 1 intervention group and 1 reference group. Before the baseline measurements were made, 12 children dropped out and 93 children were left to participate in the baseline measurements. The intervention group was comprised of 21 girls (43%) and 28 boys (57%), whereas the reference group included 24 girls (55%) and 20 boys (45%). The same anthropometric, biochemical, dietary, and physical activity measurements were made in both groups. However, children in the intervention group also participated in an intervention program aimed at achieving lifestyle changes in food and physical activity habits.

Written informed consent was obtained from parents and verbal consent was ascertained from each child through the parents. All children were individually coded and all data were anonymous. The study was approved by the Regional Research Ethics Review Board, Faculty of Medicine, Umeå University, Umeå, Sweden and followed the ethical principles of the Helsinki Declaration as revised in 1983.

**DHI.** DHI were performed between October 2006 and June 2007 to obtain information about the children’s habitual food intake during the preceding 2 wk before any intervention commenced in the intervention group. One of the 93 children chose not to participate in the DHI; thus, 92 interviews were conducted. Each interview was conducted on 1 occasion with the child and 1 or 2 parents. In 73 of the 92 interviews the child’s mother participated, in 16 interviews the child’s father participated, and in 3 interviews both parents participated. All interviews were conducted at Umeå University, except 2, which were conducted in the children’s homes. Each interview lasted for 1–2 h and started with questions about the child’s general meal pattern on weekdays and weekend days, respectively. The interview then proceeded with detailed questions about all food items consumed during the previous 2 wk. Because Swedish school children are offered free school lunch, a list of the meals that had been served in each child’s school during the previous 2 wk was shown to help the child to remember. Portion sizes of each food item and dish eaten by the child were described with the help of food portion photographs (11), household measurements, standard weights of food items, or bags of rice in different volumes. All questions were primarily directed to the child; however, parents contributed with information when they felt it was needed. The first author conducted 73 of the interviews and a trained nutritionist completed the 19 remaining interviews.

Reported food intake was entered into the dietary analysis program Dietist XP version 3.0 (Kost och Näringsdata AB) to calculate the EI of each child. Dietist XP was based on the Swedish Food composition database (version 2008–03–06). Food items and dishes that did not exist in the database were replaced with a similar food item or dish existing in the database. If no similar food item or dish could be identified, information about the energy and nutrient content of the specific food or dish was manually entered into the database and used.

**The SenseWear armband.** Twenty-two randomly selected children were instructed to wear the armband during the same 14 d that the DHI covered. The rest of the group (n = 71) was instructed to wear the armband for 4 d, which included 2 weekdays and 2 weekend days. The children were instructed to start wearing the armband the night before the first measuring day and to take it off the morning after the last measuring day. The armband was worn on the back of the right upper arm and each child was instructed to wear it at all time except when in contact with water, e.g. showering, swimming, or when participating in other water activities. The software program InnerView Professional (version 5.1), together with information about age, gender, weight, and height of each child, was used to calculate the TEE from the armband’s registrations. Reported EI from the DHI was then compared against the mean daily estimate of TEE.

In total, 85 of the 92 children participating in DHI were included in the data analysis of TEE measured by the armband. Four children had worn the armband < 19 h/d each measuring day and were excluded, because this was considered too short. Three more children were excluded from the analysis because their weight had become normal between the time of inclusion and baseline measurements. One of these normal-weight children was also excluded from the group of 22 randomly selected children instructed to wear the armband for 14 d. Of the 85 children, a majority (n = 69) wore the armband for 4 d, 12 children for 3 d, 3 children for 2 d, and 1 child for 1 d. The mean wearing time of the children (n = 64) instructed to wear the armband for 4 d was 3.70 ± 0.63 d. The mean wearing time of the 21 children who wore the armband for 14 d was 12 ± 2.4 d. From the 14-d armband registration, 4 d (2 weekdays and 2 weekend days) were selected to be included in the data analysis. The 4 d were selected in any of the 3 combinations (Thursday, Friday, Saturday, and Sunday; Friday, Saturday, Sunday, and Monday; or Saturday, Sunday, Monday, and Tuesday), so that all the days of the week were represented.

Physical activity level (PAL), which is TEE divided by the basal metabolic rate (BMR) of a person, was used to express the child’s degree of activity in relation to the BMR (12). PAL can be used to estimate the accuracy of reported energy expenditure. In the same way, the quotient of EI:BMR can be used to estimate the accuracy of reported EI. PAL and EI:BMR should be equal if the person is weight stable during the measurement period.

**DLW method.** Validation studies have shown that the precision of the DLW method when measuring TEE is 2–8%, depending on the isotope dose and the duration of the elimination period (13). When measuring TEE with the DLW method in children, it should be taken into account that they are growing and that a few percent of EI is stored as new tissue. However, for a short period of 14 d, it is reasonable to assume that EI = TEE (14). TEE was measured with the DLW method in 21 randomly selected children (11 girls and 10 boys), 9 from the intervention group and 12 from the reference group. Each child collected 3 baseline urine samples the days before the administration of an oral dose of DLW corresponding to 0.12 g 2H and 0.25 g 18O per kg estimated body water (13,15). The dose bottle was rinsed with tap water, which also was ingested by the child. For the following 2 wk, 5 urine samples were collected at 12 and 24 h and 8, 13, and 14 d after dose administration. The body weight of each child, to the nearest 0.1 kg in light clothing, was measured with a body scale (AJ Medical) before the oral dose was ingested and after the last urine sample had been collected 14 d later. All children were healthy during the measurement period and were instructed not to drink water from any place other than their home community.

Urine samples were stored at 18°C until analyzed by isotope ratio MS (Aqua Sira) (16). The TEE was calculated using Schoeller et al.’s
equation (13) and the respiratory quotient was set at 0.85 (17). DHI was performed the day after the last urine sample was collected to cover the same 14 d that TEE was measured using the DLW method. Reported EI from the DHI was compared with the mean daily estimate of TEE using the DLW method.

**Statistical analysis.** Statistical analysis was conducted using SPSS for Windows version 15.0. For normally distributed variables, Student’s t test for independent and paired samples was used to test differences. The Student’s t test for independent samples was used to test differences between groups including different participants, e.g. baseline characteristics between boys and girls, as well as intervention and control group. Differences in reported EI and measured TEE in the same participants at different occasions were tested with a Student’s t test for paired samples. When testing for differences in nominal variables, such as the proportion of overweight and obesity, the chi-square test for independence was used. Results were considered significant if a 2-tailed P-value was < 0.05. A Bland and Altman plot was used to analyze agreement between reported EI and measured TEE (18). In the text, values are presented as mean ± SD and 95% CI.

**Results**

The age of the 85 children included in the data analysis of TEE measured with the armband varied between 8.3 and 12.4 y old and the distribution of girls and boys was 48 and 52%, respectively (Table 1). Of the participating children, 75% were overweight and 25% were obese. The proportion of obese children did not differ between girls and boys (P = 0.280) or between the intervention and reference groups (P = 0.280). Baseline characteristics did not differ between boys and girls or between intervention and reference groups. Furthermore, the 85 children did not differ from the 21 children who participated in the data analysis of DLW measurements in sex, age, weight, length, or BMI (data not shown).

**Validation against SenseWear armband.** The mean difference between reported EI and measured TEE is illustrated in a Bland and Altman plot. There was a significant underestimation in the reported EI by 14% in the whole group (Table 2), which corresponds to 1.73 ± 2.63 MJ/d (95% CI: 1.16, 2.30) (Fig. 1). Of the 85 children, 15 (18%) reported an EI within ±5% of the individually measured TEE with the armband, which corresponds to ±0.55 MJ (range 10.35–11.48 MJ). Eleven (13%) children reported an EI < 5% (≥11.45 MJ) and 59 (69%) reported an EI < 5% (<10.35 MJ) compared with the individually measured TEE. Four children were outside the ±2 SD interval, and the EI of 2 of them was underestimated to a great extent (Fig. 1). These children had a PAL of 2.22 and 2.68 (data not shown), respectively, compared with the mean PAL of the group of 1.68 ± 0.28. If the 4 d of TEE measurements were not representative of these 2 children’s usual physical activity habits, it would look as though EI was underestimated even though it was not.

The EI of boys was underestimated by 16% (Table 2), which corresponds to 2.05 ± 2.91 MJ/d (95% CI: 1.16, 2.93), and the EI of girls was underestimated by 12%, which corresponds to 1.39 ± 2.28 MJ/d (95% CI: 0.67, 2.10). However, underestimation did not differ between boys and girls (95% CI: −1.80, 0.47) or between the reference and intervention group (95% CI: −1.42, 0.86). The EI of the intervention group was underestimated by 14%, which corresponds to 1.86 ± 2.96 MJ/d (95% CI: 0.96, 2.41 MJ/d) (95% CI: 0.67, 2.10).

**TABLE 2** Validation of reported EI against measured TEE by SenseWear armband in overweight and obese children participating in a DHI

<table>
<thead>
<tr>
<th></th>
<th>All subjects</th>
<th>Girls</th>
<th>Boys</th>
<th>Reference group&lt;sup&gt;4&lt;/sup&gt;</th>
<th>Intervention group&lt;sup&gt;5&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>85</td>
<td>41</td>
<td>44</td>
<td>41</td>
<td>44</td>
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<tr>
<td>BMR&lt;sup&gt;2&lt;/sup&gt;</td>
<td>6.53 ± 0.84</td>
<td>6.49 ± 0.81</td>
<td>6.65 ± 0.85</td>
<td>6.52 ± 0.77</td>
<td>6.54 ± 0.91</td>
</tr>
<tr>
<td>EI&lt;sub&gt;ref&lt;/sub&gt;</td>
<td>9.20 ± 1.94</td>
<td>9.11 ± 1.88</td>
<td>9.29 ± 2.02</td>
<td>9.23 ± 2.01</td>
<td>9.17 ± 1.91</td>
</tr>
<tr>
<td>TEE&lt;sub&gt;SW&lt;/sub&gt;</td>
<td>10.9 ± 2.11</td>
<td>10.5 ± 1.66</td>
<td>11.3 ± 2.41</td>
<td>10.8 ± 1.58</td>
<td>11.0 ± 2.53</td>
</tr>
<tr>
<td>EI&lt;sub&gt;ref&lt;/sub&gt;/BMR</td>
<td>1.42 ± 0.30</td>
<td>1.44 ± 0.31</td>
<td>1.40 ± 0.30</td>
<td>1.43 ± 0.34</td>
<td>1.40 ± 0.27</td>
</tr>
<tr>
<td>TEE&lt;sub&gt;SW&lt;/sub&gt;/BMR</td>
<td>1.68 ± 0.28</td>
<td>1.66 ± 0.30</td>
<td>1.70 ± 0.26</td>
<td>1.67 ± 0.27</td>
<td>1.69 ± 0.29</td>
</tr>
<tr>
<td>EI&lt;sub&gt;ref&lt;/sub&gt;/TEE&lt;sub&gt;SW&lt;/sub&gt;</td>
<td>0.86 ± 0.21</td>
<td>0.88 ± 0.21</td>
<td>0.84 ± 0.20</td>
<td>0.87 ± 0.21</td>
<td>0.86 ± 0.21</td>
</tr>
</tbody>
</table>

<sup>1</sup>Values are means ± SD. Genders and subgroups did not differ.
<sup>2</sup>BMR was calculated according to Dietz et al. (19).
<sup>3</sup>EI<sub>ref</sub>, Reported EI; TEE<sub>SW</sub>, TEE measured by SenseWear.
<sup>4</sup>Girls, n = 22; boys, n = 19.
<sup>5</sup>Girls, n = 19; boys, n = 25.

**FIGURE 1** Difference between reported EI in overweight and obese children (n = 85) participating in a DHI and TEE measured by a SenseWear armband, against the mean of the 2 variables. The correlation coefficient was −0.08 (P = 0.44) and the linear regression equation y = −0.29 + 0.14.”

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and the EI of the reference group underestimated by 13%, corresponding to 1.18 MJ/d (95% CI: 0.91, 2.72), and the EI of the reference group underestimated by 16%, which corresponds to 1.82 MJ/d (95% CI: 0.07, 3.08). Furthermore, the underestimation of EI was negatively correlated with BMI ($r = -0.38, P < 0.01$). This indicates that the EI of children with a higher BMI is underestimated to a higher extent than in children with a lower BMI. There was a negative correlation between the underestimation of EI and age ($r = -0.21, P = 0.05$) of the child, indicating that EI of older children is underestimated to a higher extent than in younger children.

**Validation against DLW.** The mean difference between reported EI and measured TEE is illustrated in a Bland and Altman plot (Fig. 2). There was a significant underestimation in the reported EI by 14% in the whole group (Table 3), which corresponds to 1.66 ± 1.76 MJ/d (95% CI: 0.86, 2.45) (Fig. 2). Of the 21 children, 3 (14%) reported an EI within ±5% of the individually measured TEE with the DLW method, which corresponds to ±0.54 MJ (range 10.23–11.31 MJ). Two (10%) of the children reported an EI > 5% (>10.23 MJ) and 16 (76%) reported an EI < 5% (<11.31 MJ) compared with the individually measured TEE.

The EI of boys was underestimated by 17% (Table 3), which corresponds to 1.94 ± 1.54 MJ/d (95% CI: 0.84, 3.04), and the EI of girls was underestimated by 11%, which corresponds to 1.40 ± 1.97 MJ/d (95% CI: 0.07, 2.72). However, the underestimation did not differ between boys and girls (95% CI: $-2.17, 1.08$) or between the reference and intervention group (95% CI: $-1.94, 1.37$). The EI of the intervention group was underestimated by 16%, which corresponds to 1.82 ± 1.18 MJ/d (95% CI: 0.91, 2.72), and the EI of the reference group was underestimated by 13%, corresponding to 1.18 ± 2.13 MJ/d (95% CI: 0.18, 2.89). Furthermore, underestimation did not differ between the 16 children who were overweight and the 5 children who were obese (95% CI: $-1.64, 2.21$).

**TABLE 3** Validation of reported EI against measured TEE by the DLW method in overweight and obese children participating in a DHI

<table>
<thead>
<tr>
<th>All subjects</th>
<th>Girls</th>
<th>Boys</th>
<th>Reference group</th>
<th>Intervention group</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$</td>
<td>21</td>
<td>11</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>BMR, MJ</td>
<td>6.49 ± 0.84</td>
<td>6.53 ± 0.84</td>
<td>6.45 ± 0.87</td>
<td>6.27 ± 0.71</td>
</tr>
<tr>
<td>EI$_{rep}$, MJ/d</td>
<td>9.12 ± 1.66</td>
<td>9.24 ± 1.46</td>
<td>8.98 ± 1.70</td>
<td>7.95 ± 1.73</td>
</tr>
<tr>
<td>TEE$_{DLW}$, MJ/d</td>
<td>10.8 ± 1.66</td>
<td>10.6 ± 1.77</td>
<td>10.9 ± 1.61</td>
<td>10.6 ± 1.95</td>
</tr>
<tr>
<td>EI$_{rep}$/BMR</td>
<td>1.42 ± 0.26</td>
<td>1.43 ± 0.24</td>
<td>1.40 ± 0.29</td>
<td>1.46 ± 0.28</td>
</tr>
<tr>
<td>TEE$_{DLW}$/BMR</td>
<td>1.67 ± 0.27</td>
<td>1.65 ± 0.33</td>
<td>1.70 ± 0.18</td>
<td>1.70 ± 0.30</td>
</tr>
<tr>
<td>EI$<em>{rep}$/TEE$</em>{DLW}$</td>
<td>0.86 ± 0.16</td>
<td>0.89 ± 0.19</td>
<td>0.83 ± 0.13</td>
<td>0.87 ± 0.20</td>
</tr>
</tbody>
</table>

1 Values are means ± SD. Differences between genders and subgroups were tested with Student’s $t$ test for independent samples. Genders and subgroups did not differ.
2 BMR was calculated accordingly to Dietz et al. (19).
3 $EI_{rep}$, $TEE_{rep}$, TEE measured by the DLW method.
4 Girls, $n = 7$; boys, $n = 5$.
5 Girls, $n = 4$; boys, $n = 5$.

**Discussion**

We evaluated the validity of a DHI by comparing reported EI with 2 objective methods of TEE. Reported EI was underestimated by 14% when validated against both the armband and DLW method. Our findings also show that the EI of children with a higher BMI and who were older was underestimated to a higher extent than in children with a lower BMI and a younger age.

**Validity of reported EI.** Previous validation studies of different dietary assessment methods used to assess EI in children and adolescents have shown that EI is underestimated when compared with TEE measured by DLW method (2,19,20). The underestimation was 18–22% when using a 7-d weighed dietary record (2), 12% when using a 7-d dietary record based on household measures (21), and 14% when using a 24-h recall (2). One of the few FFQ that has been validated in children and adolescents against the DLW method showed a nonsignificant ($P = 0.91$) overestimation of EI by 2% (22).

So far, only a few studies have validated reported EI of children and/or adolescents participating in a DHI against TEE measured with the DLW method (14,23,24) and none of the studies was specifically undertaken with children who were overweight or obese. Livingstone et al. (14) reported a variation in the estimation of reported EI for children participating in a DHI by $-2$ to +14% where the aim of the interview was to record the usual weekly meal and snack intake. A second study showed an underestimation by 12% between reported EI using a DHI method (divided into 2 interviews covering food intake 3 wk retrospectively) and TEE measured with the DLW method in a group of Swedish adolescents (23). A third study showed good agreement [nonsignificant difference ($P = 0.42$) of −4%] between reported EI using a DHI method (based on a questionnaire covering habitual meal pattern retrospectively) and TEE measured with the DLW method in a group of Swedish adolescents (24). One explanation for the different results in the studies mentioned may be that there is no standardized technique for conducting a DHI. The period covered by the interview, as well as

![FIGURE 2](https://academic.oup.com/jn/article-abstract/139/3/522/4670370/520/160042)    

**FIGURE 2** Difference between reported EI in overweight and obese children ($n = 21$) participating in a DHI and TEE measured by the DLW method, against the mean of the 2 variables. The correlation coefficient was $-0.026 (P = 0.912)$ and the linear regression equation $y = -1.38 - 0.033x$.
implementation of the interview and dietary analysis programs, differs between studies.

Along with the choice of dietary assessment method, the characteristics of the subjects being measured may also affect the validity of the results. The increased underestimation among children with a higher BMI in this study is in agreement with other studies where both normal weight and overweight children have been included (2,3). However, this association has been more frequently investigated in adults than in children (25,26). In adults, the desire for weight reduction as well as dieting are 2 important factors that have been associated with increased underestimation. Concurring with previous research, the present study indicated that an older age (14,21) as well as a higher BMI (2,3) are associated with a higher degree of underestimation. The explanation of the association between age and under-reporting is still unclear, but there are some points to consider. For example, an increased EI with a less continuous food pattern in combination with a larger number of meals eaten away from home may partly explain the increased underestimation with increased age of the child. Further, when a child gets older, there is the increased awareness and interest in the own body to consider, as well as a conscious and/or unconscious desire not to report foods that are known to be unhealthy.

In this study, EI was underestimated by 14% and the discrepancy between reported EI and measured TEE could possibly be explained by interview characteristics. Toward the end of the interviews, it was often difficult to motivate the children to actively participate in the interview. The interviews lasted for ~1–2 h and the duration may have had a wearying effect on many of the children and contributed to less accurate reporting. However, in these situations, the parent often took a more active role in not only reporting what the child had eaten but also in prompting the child. By comparison with parents taking a more passive role, this may have increased the reporting of food intake. Similar parental behavior has been noticed in interview situations in a previous study where they mainly contributed by prompting and adding details about what the child had eaten (7).

Difficulties assessing portion sizes could also contribute to underestimation of EI in the present study. It was difficult for the children to estimate the amount they consumed of some food items, e.g. sweets, chips, and popcorn. Not only were these food items often consumed irregularly, making it harder to remember how much had been eaten, but they are also voluminous and low in weight, factors associated with less accurate estimates of consumed amounts (27). As these kinds of food items are often eaten from a bowl or a bag with other people, this might also have contributed to difficulties in estimating the amount eaten. The consequence of difficulties in assessing high energy-dense foods may be that consumed amounts are underestimated, which in turn may have a great effect on the validity of the reported EI, because these food items contribute to a considerable proportion of the EI of children (28).

Measurement of TEE. In adults, the armband has shown good agreement when validated against the DLW method (29), but there are no published studies where the armband has been validated regarding TEE against the DLW method in children. One strength of the present study is that both the DHI and the measurements of TEE, with the armband and DLW method, covered the exact same time period. There were no significant differences between the underestimation in reported EI when comparing with TEE from either the armband or the DLW method. This indicates that the armband may be a valid measuring device of TEE in a group of overweight and obese children. However, to draw conclusions about the armband's validity, more research is needed. If the armband proves to be a valid device to measure TEE in overweight or obese children, it would be a much cheaper alternative to the DLW method as an objective measurement of TEE.

One limitation of this study was that TEE was measured with the armband for only 4 d, whereas the DHI covered 14 d. If the 4 d when TEE was measured were not representative, they might not be comparable to the 2-wk period that the DHI covered. Another limitation of the study was that the group of children participating in the measurements of TEE with DLW method was fairly small (n = 21) as a consequence of the expense. This makes statistical comparisons of groups within the intervention and control group, e.g. gender and overweight and obesity, difficult.

The present study is important because it shows that EI is underestimated to a higher extent for children with a higher BMI. The results can be used to evaluate reported dietary intake of overweight and obese children. Further, the study confirms the importance of validating reported dietary intake so that inaccurate conclusions about dietary intake can be avoided.

The EI of overweight and obese children was underestimated by 14% when using a DHI method compared with measured TEE. Furthermore, the EI of children with a higher BMI and who were older was underestimated to a greater extent than children with a lower BMI and a younger age.

Acknowledgments
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References


