ABSTRACT. Objective. Although anthropometry is widely regarded as the technique of choice for the evaluation of dysmorphic features among children, it is only rarely used in clinical practice. Possible reasons for this are the limited access of pediatricians to appropriate reference values and the time-consuming way measurements must be plotted onto growth charts. This article describes a computer program that overcomes these problems and greatly facilitates the use of anthropometric measurements in pediatric medicine.

Design. A computer program for PalmOS-based, handheld computers that compares entered anthropometric measurements with age- and gender-matched reference values was developed. The software is distributed free of charge and can be downloaded (www.medgen.unizh.ch/abase/).

Results. The ABase software contains age- and gender-matched reference values for 18 anthropometric measures frequently used for the evaluation of dysmorphic children. The proband’s age is automatically calculated from the entered birth date and can be corrected for prematurity. Entered measurements are compared with the internal reference values; the results are displayed as percentile ranks or $z$ scores and are plotted on digital growth charts.

Conclusions. The presented software makes anthropometric reference values easily accessible on the ward or in the clinic and greatly reduces the time needed to plot the measurements onto growth charts. This should promote more widespread use of anthropometry in pediatric medicine. Pediatrics 2004;114:e333–e336. URL: http://www.pediatrics.org/cgi/content/full/114/3/e333; anthropometry, dysmorphology, handheld computers, PDA.

The diagnosis of genetic syndromes is based on the recognition of subtle morphologic anomalies, which in their entirety produce a syndrome’s characteristic appearance. Dysmorphic features are usually evaluated by clinical inspection and reported with descriptive terms such as “low-set ears” or “wide-set eyes.” However, this practice is highly subjective. The wide range of morphologic variations in the normal population often makes it difficult to draw clear distinctions between normal and abnormal findings. Furthermore, clinical impressions can be misleading. For example, the depressed nasal bridge of children with Down syndrome gives the impression of widely spaced eyes, whereas actually their eyes are set closer than in the normal population. Not surprisingly, many physicians are uneasy with the interpretation of minor morphologic anomalies and rightly so, because even specialists often disagree regarding the presence or absence of minor anomalies among dysmorphic children.1

Anthropometry is a simple, noninvasive, inexpensive technique that circumvents these problems. Measurements recorded for a patient can be compared with reference values obtained for the normal population, and any deviations from the normative values can be objectively expressed as percentile ranks or $z$ scores. Measurements can be declared abnormal if they fall outside a predefined range, such as $>2$ SD above or below the mean or outside
the 5th to 95th percentile range. There is widespread agreement that this is the technique of choice for the evaluation of dysmorphic features.2–4

Despite all of these benefits, anthropometry is rarely used in clinical practice. This is probably attributable to practical reasons; appropriate growth charts for the various body dimensions are not readily available on the ward or in the clinic, and taking the measurements and plotting them on the charts is time-consuming. To overcome both problems, I have developed ABase, a computer program for handheld computers that compares entered anthropometric measurements with a database of age- and gender-matched reference values, calculates the percentile rank, and displays the result either as text or as a digitized growth chart.5 Although the program was originally developed as a tool for clinical geneticists, I became aware that most dysmorphic children are initially evaluated by pediatricians. The aim of this article is thus to illustrate the use of ABase in the evaluation of a dysmorphic child.

**METHODS**

ABase (for anthropometric database) can be downloaded free of charge at www.medgen.unizh.ch/abase. The software runs on handheld computers based on the PalmOS operating system (PalmOne Inc, Milpitas, CA) (Fig 1) PalmOS (version 3.5 or higher), the MathLib shared library, and 88 kB of free RAM are required. Installation instructions are given on the website. Table 1 provides an overview of the available growth charts. The references chosen are all in common use in pediatrics and clinical genetics.2–4 For more details on how the charts were calculated, see ref 5.

**RESULTS**

Figures 2 through 5 illustrate how to use the software. After launching the program, the user is asked to enter the proband’s gender and birth date (Fig 2). ABase calculates and displays the proband’s age in years and months (or weeks, for infants up to 12 weeks of age). If the individual is <2 years of age, then correction for gestational age is offered. After choosing a chart (Table 1), the user is taken to a second screen, where the measurements can be entered (Fig 3). Tapping the “i” symbol in the upper right corner of the screen reveals additional information on each measurement (eg, explanation of abbreviations, measuring technique, landmarks, data sources, and covered age range). When the user taps the “Calculate” button (or simply selects another field), the program compares the entered measurements with the age- and gender-matched reference values in its database and calculates the corresponding percentile rank. If a measurement falls beyond the 1st or 99th percentile, then the z score is displayed instead (z scores represent multiples of the SD; for example, a measurement that is 3 SD above the mean has a z score of 3). Tapping the small pen symbol that appears behind the percentile rank brings up a graphical representation of the result (Fig 4). The 5th, 25th, 50th, 75th, and 95th percentiles of the reference population are displayed on the chart by default, but other percentiles can be chosen from the preferences menu. The scale of the chart is auto-

### TABLE 1. Available Charts

<table>
<thead>
<tr>
<th>Chart</th>
<th>Measurements</th>
<th>Age Range</th>
<th>Reference</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Height</td>
<td>0–20 y</td>
<td>7</td>
<td>L, M, S</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>0–20 y</td>
<td>7</td>
<td>L, M, S</td>
</tr>
<tr>
<td></td>
<td>Head circumference</td>
<td>0–3 y</td>
<td>7</td>
<td>L, M, S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td>Great Britain</td>
<td>Height</td>
<td>33 wk to 20 y</td>
<td>9</td>
<td>L, M, S</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>23 wk to 20 y</td>
<td>9</td>
<td>L, M, S</td>
</tr>
<tr>
<td></td>
<td>Head circumference</td>
<td>23 wk to 18 y</td>
<td>9</td>
<td>L, M, S</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Height</td>
<td>0–20 y</td>
<td>10</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>0–20 y</td>
<td>10</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Head circumference</td>
<td>1 mo to 6 y</td>
<td>10</td>
<td>M, SD</td>
</tr>
<tr>
<td>Eyes</td>
<td>Inner canthal distance (ICD)</td>
<td>0–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Outer canthal distance (OCD)</td>
<td>0–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Palpebral fissure length (PFL)</td>
<td>0–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td>Ears</td>
<td>Ear length (EL)</td>
<td>1–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Ear width (EW)</td>
<td>1–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Ear rotation (ER)</td>
<td>1–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td>Nose</td>
<td>Nose length (NL)</td>
<td>0–92 y</td>
<td>11</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Nasal protrusion (NP)</td>
<td>0–92 y</td>
<td>11</td>
<td>M, SD</td>
</tr>
<tr>
<td>Mouth</td>
<td>Mouth width (MW)</td>
<td>0–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td>Palpebral fissure length (PFL)</td>
<td>0–22 y</td>
<td>8</td>
<td>M, SD</td>
</tr>
<tr>
<td>Chest</td>
<td>Internipple distance (IND)</td>
<td>0–16 y</td>
<td>12</td>
<td>M, SD</td>
</tr>
<tr>
<td>Hands</td>
<td>Hand length (HL)</td>
<td>27–41 wk</td>
<td>13</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–16 y</td>
<td>12</td>
<td>M, SD</td>
</tr>
<tr>
<td>Feet</td>
<td>Foot length (FL)</td>
<td>27–41 wk</td>
<td>14</td>
<td>M, SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–18 y</td>
<td>15</td>
<td>M, SD</td>
</tr>
</tbody>
</table>

Reference values are either defined by mean and standard deviation (M, SD) or L, M, S parameters. The LMS method is an advanced statistical procedure to estimate percentiles.16
matically adapted to avoid crowding. The proband’s measurement is indicated by a blinking dot. Tapping anywhere on the screen takes the user back to the previous screen. Other measurements for the same individual can be assessed by choosing a different chart from the main menu (Fig 5). The individual’s age and gender are preserved. Measurements for a different individual can be entered after choosing “New Individual” from the main menu. The basic charts, which contain the measurements for height, weight, and head circumference, offer 2 additional features. First, because several good references exist, the user can choose between reference values for the United States/Canada, Great Britain, or Switzerland (Table 1). The choice is saved in the program’s preferences and remembered the next time the program is run. Second, when the “Predict” button is tapped, the program calculates the proband’s target height on the basis of the parents’ height (midparental height + 6.5 cm for boys; midparental height – 6.5 cm for girls).

**DISCUSSION**

ABase greatly facilitates the use of anthropometric measurements for the evaluation of dysmorphic children. Handheld computers are small enough to be carried in a shirt pocket on the ward or in the clinic and thus make the growth charts available wherever they are needed. Having the computer perform the percentile rank calculations is not only faster but also more accurate than manually plotting the measurements on paper-based growth charts. Percentile ranks or z scores obtained this way can be analyzed more extensively by using more advanced techniques such as pattern profiling and discriminant analysis, which can effectively lead to the diagnosis of dysmorphic syndromes on the basis of anthropometric measurements alone. As an example, Moore et al identified 6 craniofacial measurements that could differentiate individuals with and without prenatal alcohol exposure with 98% sensitivity and 90% specificity. Such examples demonstrate that anthropometry is a powerful tool for the evaluation of
dysmorphic children. I hope that ABase will make this tool more widely available.

REFERENCES
Computer-Aided Anthropometry in the Evaluation of Dysmorphic Children
Andreas Zankl
Pediatrics 2004;114;e333
DOI: 10.1542/peds.2004-0045

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