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Letter to the Editor

Growth Charts for Young Children With Neurofibromatosis 1 (NF1)

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Short stature and macrocephaly are more common in children with neurofibromatosis 1 (NF1) than in the general population. The cause of these growth alterations is unknown in most cases, but monitoring growth in affected children assists in detection of complications such as optic glioma and hydrocephalus. Clementi et al. [1999] developed growth charts for NF1 patients 2 to 18 years old. We have made similar charts from cross-sectional data obtained from the National NF Foundation International Database (NFDB). These are available from http://mendel.medgen.ubc.ca/friedmanlab. We also developed standard growth charts for total body length (TBL), weight, and occipitofrontal head circumference (OFC) in NF1 patients between 3 and 36 months old.

TBL, weight, and OFC measurements of 336 Caucasian NF1 patients between 3 and 36 months old were obtained from 19 centers contributing data to the NFDB [Friedman et al., 1993]. Patients with clinical findings that could affect measurements were excluded. Analysis of variance was used to determine if significant differences exist among age- and sex-standardized measurements from major contributing centers.

Standard population norms were obtained from studies by the National Center for Health Statistics and the Fels Institute [Hamill et al., 1977; Najjar and Rowland, 1987]. NF1 patients were divided into sex and age groups whose medians correspond to those of the charts for population norms. Centiles were plotted and smoothed using SAS (SAS Institute, Cary, NC, 1996) by producing a cubic spline that minimizes a linear combination of the sum of squares of the residuals of fit and the integral of the square of the second derivative [Reinsch, 1967].

TBL, weight, and OFC centiles by age are shown in Figures 1a–2c. Median TBL is 1–2 cm lower, weight is 0.5–1 kg lower, and OFC is 1–2 cm greater in NF1 patients than in the standard pediatric growth charts. We were concerned that geographic differences [Meredith, 1971] and lack of consistent methodology among centers might increase the variability of our sample and diminish the usefulness of these growth charts. However, ANOVA for heterogeneity among major contributing centers of the NFDB revealed no heterogeneity for TBL ($P = 0.39$) and OFC ($P = 0.31$) in these children.

The contributors to the NFDB are specialized NF1 clinics, and the patients that visit them are likely to be more severely affected than NF1 patients in general. However, TBL, weight, and OFC are not among the cardinal features by which NF1 is diagnosed [NIH, 1988], so it is unlikely that the children we studied differ greatly with respect to these measurements from the NF1 population as a whole.

Charts from standard populations provide a useful reference to follow growth in children. However, once the diagnosis of NF1 has been made charts specific to NF1 are more useful for detection of deviation from the expected growth pattern for that child. Deviation of a child's growth from the NF1 standards may indicate the effect of a specific disease feature such as optic glioma or hydrocephalus. NF1-specific charts may also provide reassurance to families and their physicians that an affected child's growth, although outside the "normal" range on standard pediatric growth charts, is actually normal for a child with NF1. The charts presented here provide an appropriate standard for monitoring growth in young children with NF1.

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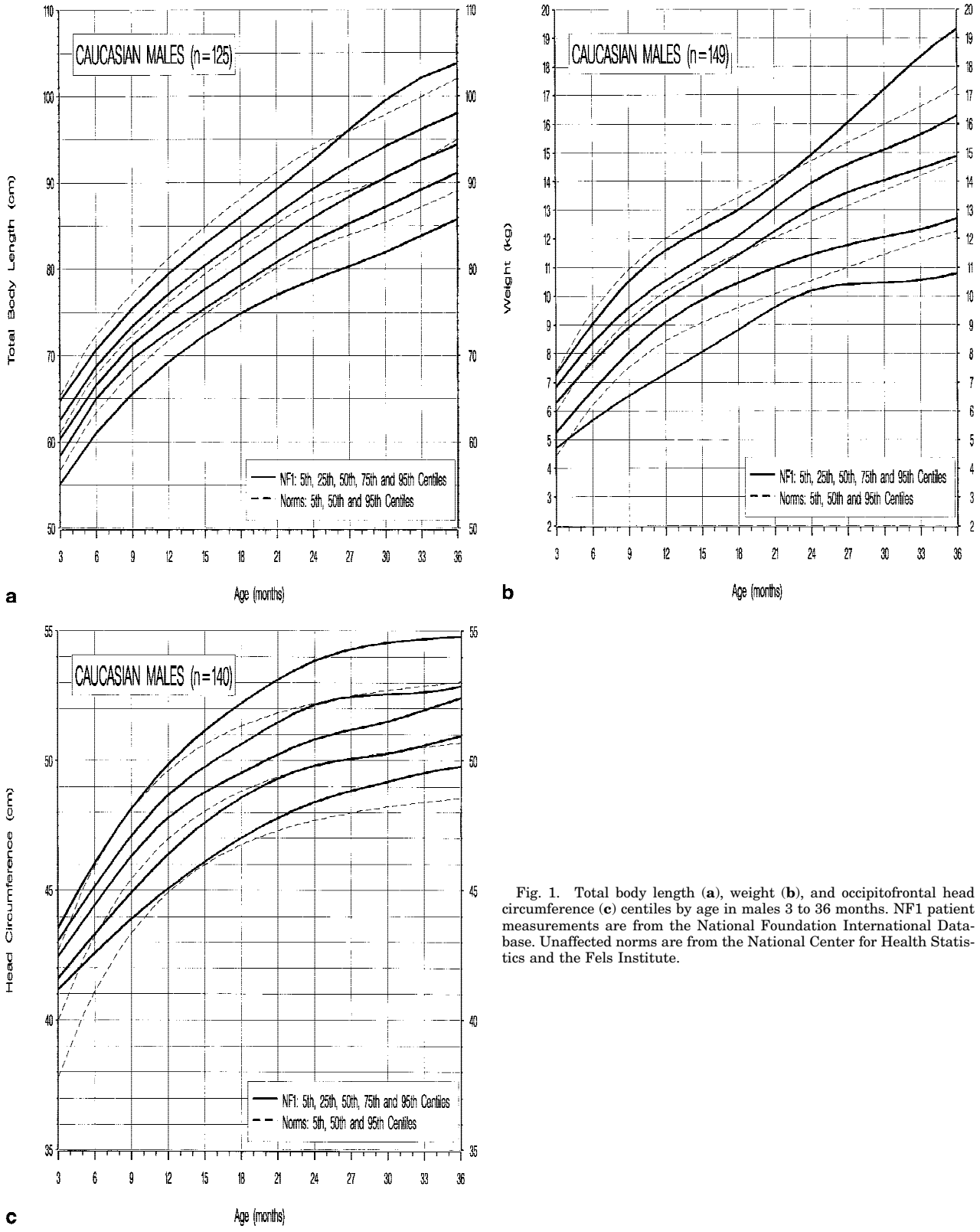

Fig. 1. Total body length (**a**), weight (**b**), and occipitofrontal head circumference (**c**) centiles by age in males 3 to 36 months. NF1 patient measurements are from the National Foundation International Database. Unaffected norms are from the National Center for Health Statistics and the Fels Institute.

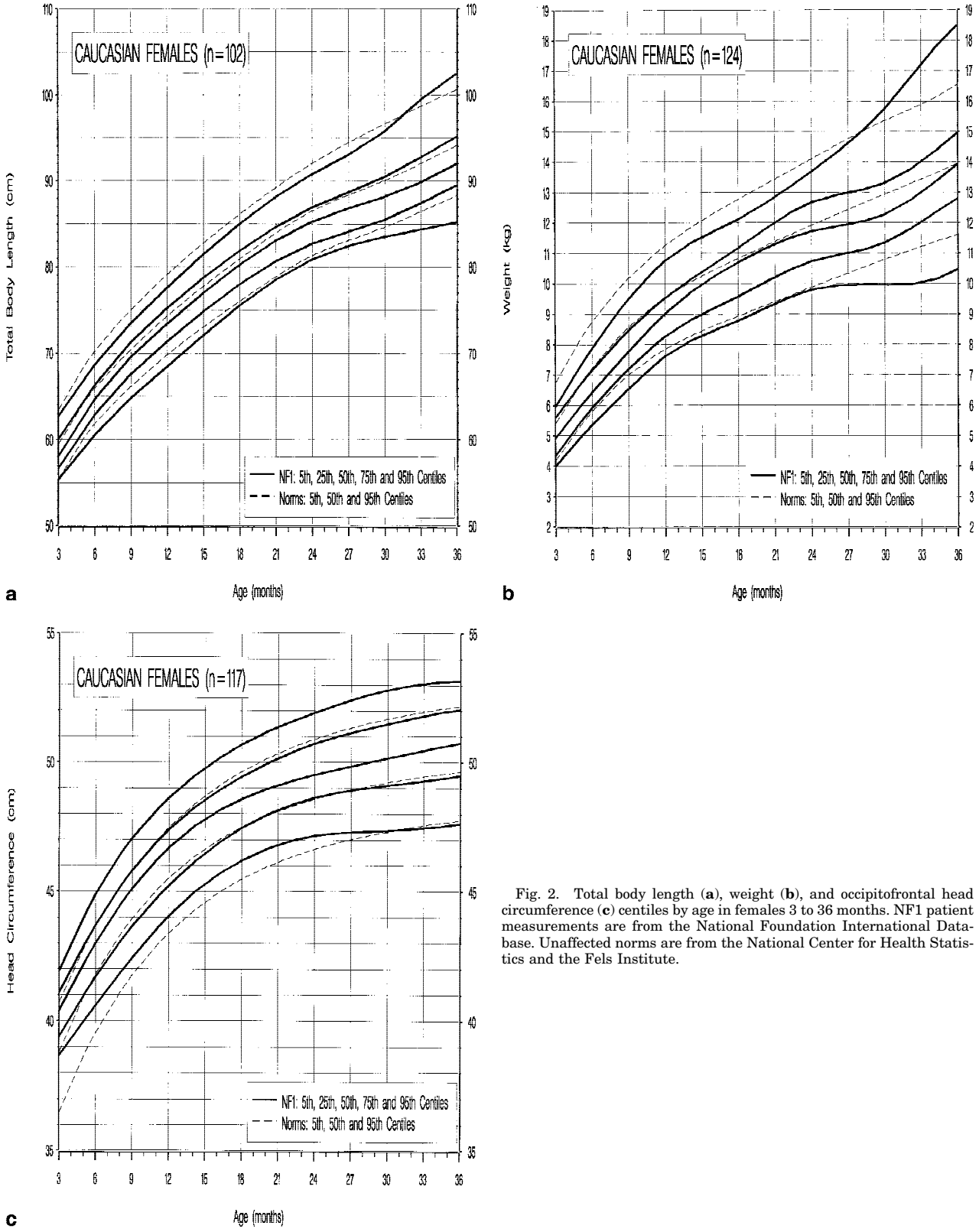

Fig. 2. Total body length (**a**), weight (**b**), and occipitofrontal head circumference (**c**) centiles by age in females 3 to 36 months. NF1 patient measurements are from the National Foundation International Database. Unaffected norms are from the National Center for Health Statistics and the Fels Institute.

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