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Letter to the editor

Fat-free mass from two prediction equations for bioelectrical impedance analysis in a large German population compared with values in Swiss and American adults

To the Editor:

In a recent issue of the journal, Kyle et al. [1] compared fat-free mass (FFM) and body fat derived from bioelectrical impedance measurements (BIA) in Swiss and US adults. The basis of this comparison were the data from the Geneva study for healthy Swiss subjects aged 15 to 98 y [2] and the nationally representative data from the National Health and Nutrition Examination Survey (NHANES III) for US adults [3]. FFM was calculated from BIA equations developed by Kyle et al. [4] and Sun et al. [5].

The authors found that the NHANES and Geneva BIA equation estimated FFM equally well in men. For women they found discrepancies and surprisingly similar FFM values for Swiss women as for US women, who have higher values in weight and body mass index (Table 1).

We questioned if one would get similar results for German men and women, whose mean values of weight and body mass index are nearer to the NHANES population than are the values of Swiss people. We cross-applied both body composition prediction models to a subsample of BIA raw data of a large German population. The anthropometric data of these German men and women are given in Table 1 (signed as German 2). Although our data could not be seen as representative in terms of statistical randomization, mean weight and body mass index are near to the representative data for Germans from the German Mikrozensus 2003 [6] (signed as German 1 in Table 1). For women we found a good correlation between FFM from Geneva and NHANES III equation (Figs. 1B and 1D). For men there was a trend for increasing differences between FFM estimated from both equations with advancing FFM (Figs. 1A and 1C).

Regarding the age group–related changes of FFM, our findings are similar to those of Kyle et al. [1] in terms of shape of age dependence. They reflect well the greater weight of German men and women. But in contrast our data resulted in FFM value sets from both equations, which differ more for men than for women (Fig 2). There is no

Table 1
Mean values weight and body mass index of Swiss, US, and German men and women

Age, y	Weight, kg				BMI, kg/m^2			
	Swiss*	US_{NHANES}*	German 2‡	German 1†	Swiss*	US_{NHANES}*	German 2‡	German 1†
Men								
20–29	73.4 ± 9.1	79.2 ± 16.6	82.4 ± 16.5	78.2	23.1 ± 2.3	25.1 ± 4.9	25.0 ± 4.6	24.1
30–39	75.0 ± 9.4	84.0 ± 17.1	84.0 ± 11.5	82.4	23.9 ± 2.5	26.5 ± 4.6	25.4 ± 2.9	25.6
40–49	75.5 ± 9.6	86.0 ± 17.0	84.0 ± 11.8	83.9	24.5 ± 2.6	27.3 ± 4.9	26.1 ± 3.1	26.4
50–59	74.9 ± 9.9	86.9 ± 15.0	83.8 ± 13.5	83.9	24.9 ± 2.9	27.8 ± 4.6	26.3 ± 4.0	27.0
60–69	74.4 ± 10.0	84.9 ± 14.7	83.1 ± 15.5	83.1	25.3 ± 3.0	27.6 ± 4.2	27.2 ± 4.7	27.2
Women								
20–29	58.9 ± 7.4	63.2 ± 14.3	67.1 ± 12.5	63.1	21.4 ± 2.3	23.6 ± 5.1	23.6 ± 4.2	22.4
30–39	59.0 ± 8.3	69.1 ± 18.0	68.2 ± 9.8	65.8	21.7 ± 2.7	25.5 ± 6.5	24.1 ± 3.1	23.6
40–49	59.7 ± 8.7	70.7 ± 16.8	69.2 ± 10.3	67.5	22.4 ± 2.9	26.6 ± 6.5	25.2 ± 3.4	24.6
50–59	61.8 ± 9.2	73.9 ± 17.4	69.4 ± 10.0	69.8	23.5 ± 3.2	28.0 ± 6.4	25.4 ± 3.5	25.7
60–69	63.1 ± 10.4	70.3 ± 15.1	71.3 ± 9.7	70.9	24.8 ± 3.8	27.2 ± 5.6	26.7 ± 3.5	26.5

BMI, body mass index; NHANES, National Health and Nutrition Examination Survey.
Mean values ± standard deviation.
NHANES, National Health and Nutrition Examination Survey.
* Kyle et al. [1].
† Mikrozensus fuer die Bundesrepublik Deutschland 2003 [6].
‡ Unpublished data.

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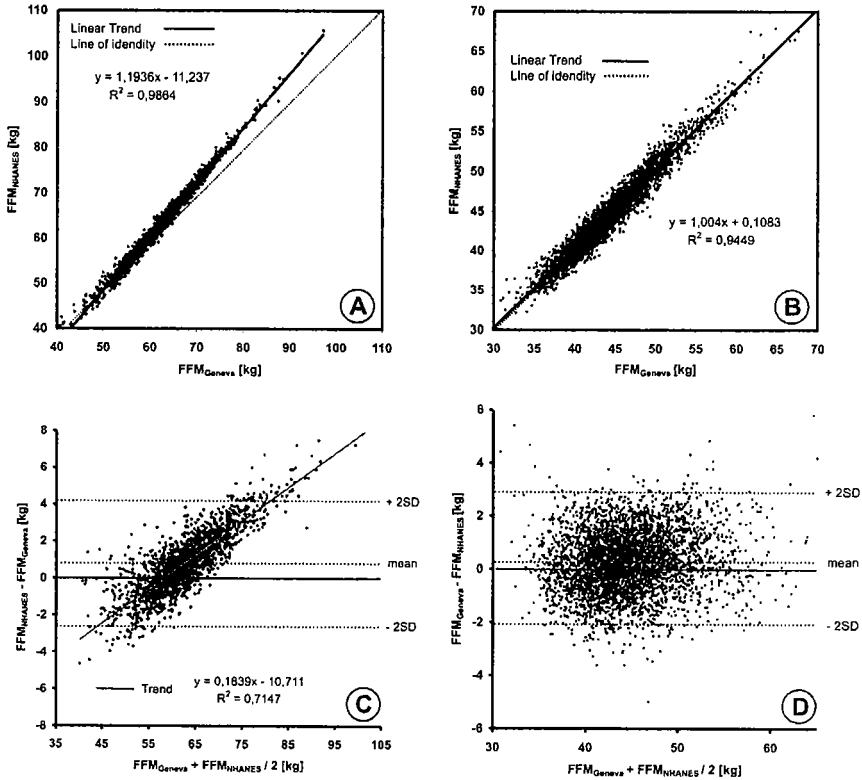

Fig. 1. Fat-free mass (FFM) from Geneva versus National Health and Nutrition Examination Survey (NHANES) bioelectrical impedance measurement equation (A and B) and corresponding Bland-Altman plots (C and D) for 1,790 German men (*left*), age 20 to 80 y, body mass index (BMI) 15.4 to 53.5; and 3,623 women (*right*), age 20 to 80 y, BMI 14.9 to 40.0.

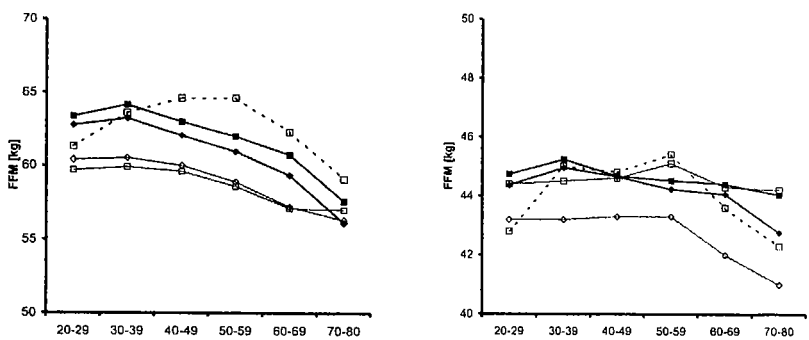

Fig. 2. Fat-free mass (FFM) for US (dotted lines), Swiss (gray lines), and German (solid black lines) men (*left*) and women (*right*) from Geneva (diamonds) and National Health and Nutrition Examination Survey bioelectrical impedance measurements equation (squares) by 10-y age groups from 20 to 80 y.

clear reason for this difference, but some additional findings may contribute possible explanations.

Individual follow-up estimations of FFM during 3 to 4 y show contrasting situations for women, but not for men. In some cases we see FFM time plots with $FFM_{NHANES} > FFM_{Geneva}$ or vice versa (in some individuals FFM time curves from the equations cross), depending on individual low or high reactance (Xc) values (plots not shown here). This is a result of the fact that unlike the NHANES equation of Sun et al [5], the Geneva equation of Kyle et al. [4] contains a reactance-dependent term.

Reactance, Xc, which reflects dielectric behavior influenced by cell membranes, depends largely on f_c, the characteristic frequency, at which Xc reaches a maximum.

It seems that the individual value of f_c differs from the usually used 50 kHz (single-frequency BIA) for women more than for men (80.1 ± 17.2 and 57.0 ± 8.4 kHz, respectively) [7]. Measurements far away from f_c will result in greater sensitivity of Xc to related physiologic changes. A change of fluid distribution for instance does change f_c, which in turn changes Xc. This may in part account for some differences between the Geneva and NHANES body composition prediction models.

Although an Xc-dependent BIA equation may be more sensitive for changes of Xc not related to changes of body weight, it gives the chance to get more body composition–relevant information, if the physiologic background for changes of f_c and reactance is better understood.

This example may show that it could help to line out specific differences between body composition prediction equations if using reference data from a large data pool. Internet available raw data including additional relevant information (ethnic group, physical activity, general health status) would enhance the possibility of checking BIA equations for different subpopulations looking for specific parameters under question.

From the suggestion of the authors [1] that free Internet-based access of data from the large published studies could aid in promoting the use of reference data by investigators and clinicians using BIA, we were inspired and started to build up a pool of some 10 000 BIA raw data of German people, and we invite you to participate and enhance this biadata project.

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