Supplementary Information

Total energy expenditure is repeatable in adults but not associated with changes in body composition

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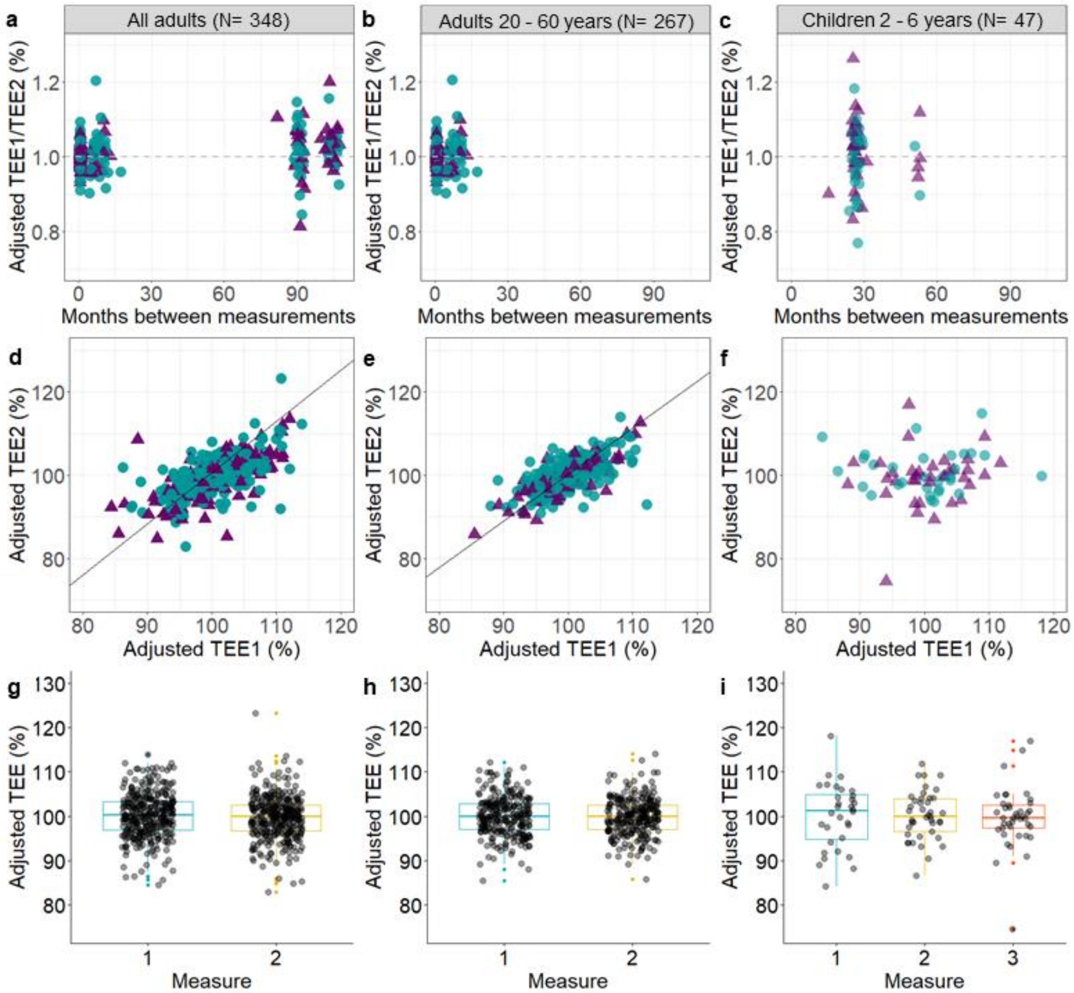
Supplementary Note 1

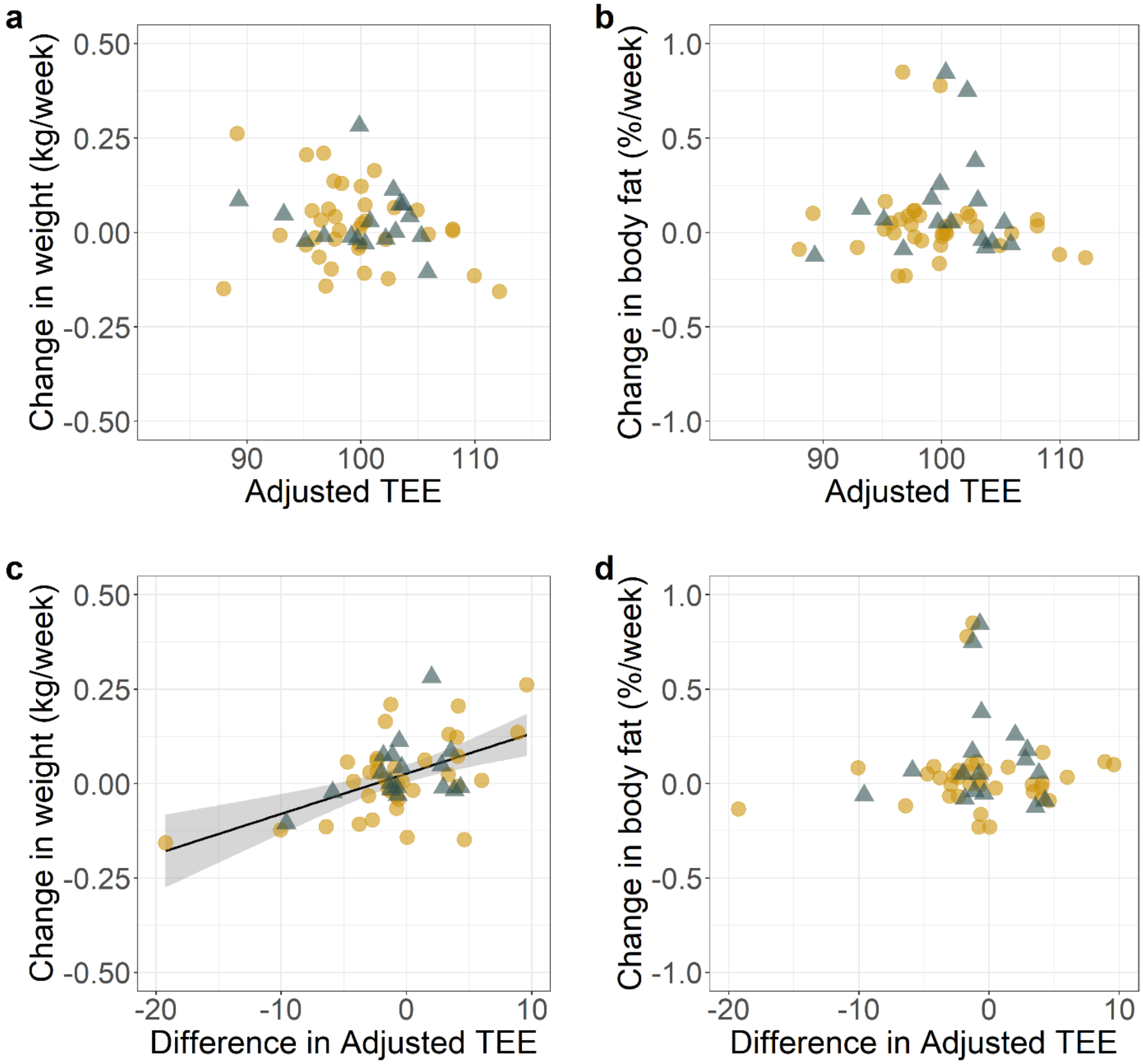
Repeatability using adjusted total energy expenditure (TEE)

We computed a predicted total energy expenditure TEE from a multiple regression model with TEE as the dependent variable and FFM, FM, age, and sex as independent variables. We calculated adjusted TEE by dividing observed TEE by predicted TEE and multiplying the value by 100. Thus, an adjusted TEE of 120% indicates an observed measured TEE that is 20% greater than predicted from body composition variables. Adults had an average ± SD adjusted TEE1/TEE2 ratio of 1.006 ± 0.042 (range: 0.814 – 1.203). Adults aged 20-60 y had a ratio of 1.002 ± 0.034 (range: 0.902 – 1.207) and children had a ratio of 1.004 ± 0.085 (range: 0.754 – 1.261). Repeatability of TEE (estimated as adjusted TEE1/TEE2) did not change with increasing time between both TEE measurements (Supplementary Fig. 1a-c).

Confirming the results of the mixed effects modeling approach, adjusted TEE1 correlated with adjusted TEE2 (Pearson's product-moment correlation: $r_p = 0.63$, $P < 0.0001$) for all adults (Supplementary Fig. 1d) and for the subset of adults aged 20 – 60 y (Pearson's product-moment correlation: $r_p = 0.69$, $P < 0.0001$; Supplementary Fig. 1e). In contrast, adjusted TEE1 did not correlate with adjusted TEE2 (Pearson's product-moment correlation: $r_p = 0.07$, $P = 0.55$) in children (Supplementary Fig. 1f). The difference between adjusted TEE1 and adjusted TEE2 was statistically significant for the entire adult sample (Paired t test: t = 2.472, df = 347, P = 0.013, Cohen’s d = 0.13 (95% CI = 0.01 – 0.23); Supplementary Fig. 1g), but not for adults aged 20 – 60 y (t = 0.867, df = 266, P = 0.38, Cohens’ d = 0.05 (95% CI = -0.06 – 0.18); Supplementary Fig. 1h) or for children (Paired t test for children with 2 measurements: t = -0.906, df = 26, P = 0.373, Cohens d = -0.17 (95% CI = -0.5 – 0.25); repeated measures ANOVA for children with 3 measurements: F = 0.59, P = 0.45; Supplementary Fig. 1i). While some comparisons of TEE1 and TEE2 achieved statistical significance, the differences were notable for being small. The difference in adjusted TEE between repeated measurements for each subject was 0.46 ± 4.24% (range: -22.7 – 16.9%), and the absolute difference was 3.08 ± 2.94% (range: 0.001 – 22.7%) in adults. The difference in adjusted TEE between repeated measurements at ages 2 and 4 was -0.87 ± 10.5% (range: -29.9 – 15.4%) for each subject and the absolute difference was 8.01 ± 6.76% (range: 0.02 – 29.9%). The difference in adjusted TEE was -0.02 ± 9.4% (range: -32.7 – 20.7%) between ages 4 and 6 and the absolute difference was 6.46 ± 6.76% (range: 0.15 – 32.7%).



Supplementary Fig. 1. Repeatabilitiy of total energy expenditure (TEE) measurements. a-c Relationship between adjusted TEE1/TEE2 and the time between measuremnts. Dashed lines indicate where adjusted TEE1 and TEE2 are identical (at 1.0). **d-f** Relationship between adjusted TEE1 and TEE2 (blue circles are females and purple triangles are males, lines show reduced major axis regression line). **d** Adjusted TEE1 correlated with adjusted TEE2 (Pearson's product-moment correlation: $r_p = 0.63$, $P < 0.0001$) in all adults. **e** Adjusted TEE1 correlated with adjusted TEE2 (Pearson's product-moment correlation: $r_p = 0.69$, $P < 0.0001$) in adults aged 20 – 60 y. **g-i** Comparison of adjusted TEE between repeated TEE measurements (grey circles show individual data points). Boxplot center line represents the median, lower and upper box limits represent the 1st and 3rd quartile (IQR), whiskers minimum and maximum values of nonoutlier data (±1.5 × IQR) and outliers are indicated by small filled circles. **g** Adjusted TEE1 differed statistically from adjusted TEE2 (Paired t test: $t = 2.472$, $df = 347$, $P = 0.013$, Cohen's $d = 0.13$; TEE of 348 adults was measured twice, resulting in a total of 696 TEE measurements). **h** Adjusted TEE1 did not differ from adjusted TEE2; TEE of 267 adults was measured twice, resulting in a total of 534 TEE measurements. **i** Adjusted TEE measurements did not differ between measurements. Measure 1 is equivalent to age 2 (N = 32 TEE measurements), measure 2 to age 4 (N = 41 TEE measurements), and measure 3 to age 6 (N = 41 TEE measurements).



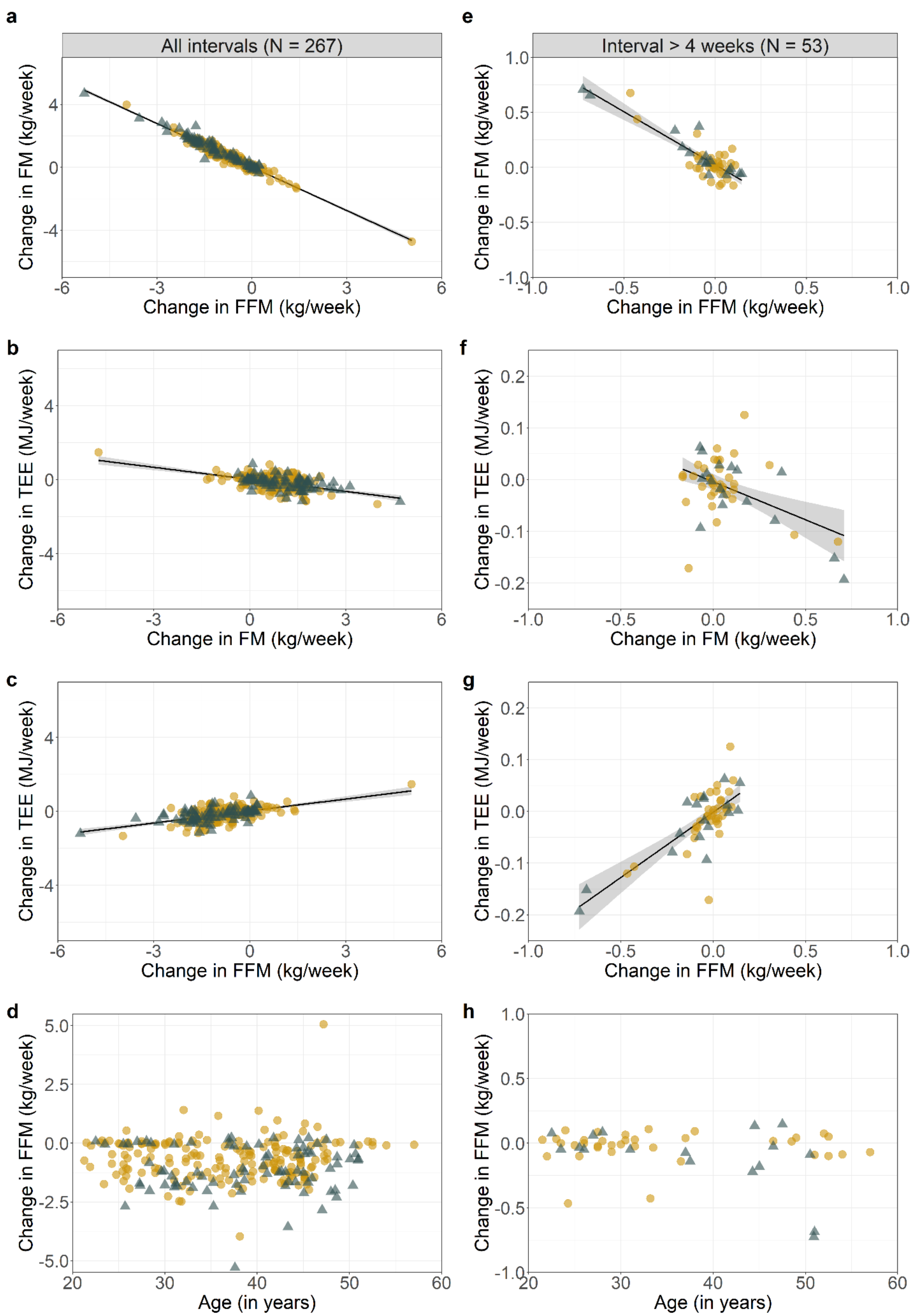
Supplementary Fig. 2. Relationship between adjusted total energy expenditure (TEE), the difference in adjusted TEE between measurements and changes in body weight and body fat percentage. Relationship between adjusted TEE (MJ/d; adjusted for FFM, FM, age and sex) at the first measurement and **a** changes in body weight and **b** changes in body fat percentage until the second TEE measurement. Relationship between the difference in adjusted TEE between measurements and **c** changes in body weight (linear regression line is shown and shaded area indicates 95% CI) and **d** changes in body fat percentage until the second TEE measurement in a subset including adults 20 – 60 y (N = 53 subjects) for which TEE measurements that were at least 4 wk apart (time interval: 29.1±12.8 weeks; yellow circles present females and grey triangles present males).

Supplementary Note 2

Does TEE predict subsequent changes in weight or body composition?

To examine if TEE predicts changes in body weight or body fat percentage, we calculated changes in body weight (kg/wk), FFM (kg/wk), FM (kg/wk), body fat percentage (% FM/wk) and TEE (MJ/wk) as the change in each measurement divided by the time that elapsed between both TEE measurements. Among adults 20 – 60 y, mean change in body weight between the two TEE measurements was -0.04 ± 0.21 kg/wk (range: -0.98 – 0.84 kg/wk), and the mean change in % body fat was 1.05 ± 1.26 % fat/wk (range: -6.57 – 6.16 % fat/wk). There was a strong negative correlation between change in FFM and change in FM (r_p = -0.97, P < 0.0001; Supplementary Fig. 3a). Change in adjusted TEE was negatively correlated with change in FM (r_p = -0.53, P < 0.0001; Supplementary Fig. 3b) and positively with change in FFM (r_p = 0.56, P < 0.0001; Supplementary Fig. 3c). Change in body weight primarily reflected loss of FFM (r_p = 0.34, P < 0.0001), as very few subjects exhibited an increase in FFM between time 1 and time 2 (Supplementary Fig. 3a). Age was not correlated with change in FFM (r_p = -0.003, P = 0.95; Supplementary Fig. 3d).

Changes in weight, FM and body fat percentage per week were smaller when using a subset of adults 20 – 60 y (N = 53 individuals) for which the interval between repeated TEE measurements was longer than 4 weeks (range: 4.43 – 68.57 weeks) (change in weight: 0.02 ± 0.09 kg/week, range: -0.15 – 0.28 weeks; change in FM: 0.07 ± 0.19 kg/week, range: -0.16 – 0.70 kg/week; change in % fat: 0.07 ± 0.23 % fat/week, range: -0.23 – 0.85 % fat/week) compared to when TEE measurements were collected within 4 weeks (range: 1.85 – 3.71 weeks) of each other (change in weight: -0.05 ± 0.22 kg/week, range: -0.97 – 0.84 weeks; change in FM: 0.91 ± 0.92 kg/week, range: -4.73 – 4.70 kg/week; change in % fat: 1.29 ± 1.29 % fat/week, range: -6.57 – 6.15; N = 207 individuals). Change in body weight did not correlate with change in FFM (r_p = 0.06, P = 0.65), and very few subjects exhibited an increase in FFM between time 1 and time 2 (Supplementary Fig. 3e). The mean change in % body fat was 0.07 ± 0.23 % fat/wk (range: -0.23 – 0.85 % fat/wk). There was a negative correlation between change in FFM and change in FM (r_p = -0.86, P < 0.0001; Supplementary Fig. 3e). Change in adjusted TEE was negatively correlated with change in FM (r_p = -0.48, P = 0.0002; Supplementary Fig. 3f) and positively correlated with change in FFM (r_p = 0.74, P < 0.0001; Supplementary Fig. 3g). Age was not correlated with change in FFM (r_p = -0.22, P = 0.10; Supplementary Fig. 3h).


a
All intervals (N = 267)
Change in FM (kg/week)
4
0
-4
-6
-3
0
3
6
Change in FFM (kg/week)
e
Interval > 4 weeks (N = 53)
1.0
0.5
0.0
-0.5
-1.0
Change in FM (kg/week)
-1.0
-0.5
0.0
0.5
1.0
Change in FFM (kg/week)
b
Change in TEE (MJ/week)
4
0
-4
-6
-3
0
3
6
Change in FM (kg/week)
f
0.2
0.1
0.0
-0.1
-0.2
Change in TEE (MJ/week)
-1.0
-0.5
0.0
0.5
1.0
Change in FM (kg/week)
c
Change in TEE (MJ/week)
4
0
-4
-6
-3
0
3
6
Change in FFM (kg/week)
g
0.2
0.1
0.0
-0.1
-0.2
Change in TEE (MJ/week)
-1.0
-0.5
0.0
0.5
1.0
Change in FFM (kg/week)
d
5.0
2.5
0.0
-2.5
-5.0
Change in FFM (kg/week)
20
30
40
50
60
Age (in years)
h
1.0
0.5
0.0
-0.5
-1.0
Change in FFM (kg/week)
20
30
40
50
60
Age (in years)

Supplementary Fig. 3. Relationship between changes in body composition and changes in total energy expenditure (TEE) and age-related changes in FFM. a - d Changes in body composition between repeated measurements in all adults aged 20 – 60 years (N = 267 subjects; time interval: 7.4 ± 12.2 weeks). **e - h** Changes in body composition between repeated measurements in a subset of adults (N = 53 subjects) for which the interval between repeated TEE measurements was longer than 4 weeks (time interval: 29.1 ± 12.8 weeks). **a, e** Relationship between changes in fat-free mass (FFM) and fat-mass (FM). **b, f** Relationship between changes in FM and adjusted TEE (adjusted for FFM, FM, age and sex). **c, g** Relationship between changes in FFM and adjusted TEE. **d, h** Relationship between age at the midpoint between both measurements and changes in FFM (yellow circles present females and grey triangles present males). **a - c** and **e - g** lines represent linear regression lines and the shaded areas indicate the 95% confidence intervals.

Supplementary Table 1. Results of multiple regression models to assess which factors influence total energy expenditure (TEE). We included fat-free mass (FFM), fat mass (FM), age and sex (female vs male) as explanatory variables. We ln-transformed TEE, FFM, and FM for these models. **a** Results for the model including all adults (N = 348 individuals), **b** results for the model including only adults aged 20 - 60 years (N = 267 individuals), and **c** results for the model including children aged 2 - 6 years (N = 47 individuals).

		Estimate	SE	t	P	Adjusted R^2
a All adults	Intercept	-0.776	0.137	-5.667	<0.0001	0.654
	lnFFM	0.820	0.038	21.531	<0.0001	
	lnFM	0.002	0.014	0.128	0.898	
	Age	-0.003	0.000	-10.057	<0.0001	
	Sex[Male]	-0.010	0.015	-0.634	0.526	
b Adults 20-60 years	Intercept	-0.657	0.147	-4.483	<0.0001	0.668
	lnFFM	0.771	0.040	19.505	<0.0001	
	lnFM	-0.014	0.014	-0.955	0.340	
	Age	0.001	0.001	1.039	0.299	
	Sex[Male]	0.003	0.016	0.167	0.867	
c Children 2-6 years	Intercept	-0.499	0.175	-2.851	0.0052	0.765
	lnFFM	0.820	0.086	9.579	<0.0001	
	lnFM	0.010	0.022	0.465	0.643	
	Age	-0.008	0.013	-0.643	0.521	
	Sex[Male]	0.042	0.021	2.043	0.0435	

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This group authorship contains the names of people whose data were contributed into the IAEA DLW database by the analysis laboratory but they later could not be traced, or they did not respond to emails to assent inclusion among the authorship. The list also includes some researchers who did not assent inclusion to the main authorship because they felt their contribution was not sufficient to merit authorship.

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