Are the proposed limits of energy intake:basal metabolic rate and dietary nitrogen:urinary nitrogen ratios suitable for validation of food intake?

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The validity of 7 d weighed records of diet obtained for pre-menopausal Mexican women was assessed by two independent methods: the energy intake:BMR (EI:BMR) and the dietary N:urinary N (DN:UN). For the latter, complete urine collections are required and completeness was assessed from measurements of *para*-aminobenzoic acid (PABA) excretion. There were forty-six adult female subjects in the study, thirty-four were from Mexico City and twelve were from a rural population in the Central Highlands, Mexico. However, data were rejected from five urban women for whom the PABA excretion data suggested incomplete urine collection on four or more days. BMR was measured with Oxylog portable O_2 consumption meters, and physical activity level was assessed from a self-completed activity diary. An approximate relationship between the EI:BMR ratio and the DN:UN ratio suggested that the rejection limits on the EI:BMR ratio recommended by Goldberg *et al.* (1991) are wider than the limits on the DN:UN ratio recommended by Bingham & Cummings (1985). Using the recommended cut-off points for EI:BMR but wider limits for DN:UN, twenty-one and twenty-five women respectively had acceptable intake records by the two methods, and sixteen of them by both methods. In conclusion the modification of the DN:UN limits to 0·92 and 1·70 to set acceptable intake values makes the use of measurements of N and energy balance comparable. Urine values with PABA recoveries greater than 100 ± 15 % should be rejected, as should UN values validated by less than 3 d.

Validation: Food intake: Methodology

An ongoing problem in nutritional research is the uncertain validity of methods for assessing habitual food intake. The 7 d weighed diet record method is often the reference method, as it uses prospectively collected data with precise information on quantity and food type (Bingham *et al.* 1988). To validate it in free-living individuals is difficult, because it relies on information supplied by the subjects. Validation against some external criterion should therefore be built into the protocol of any planned dietary surveys (Bingham & Cummings, 1985).

Isaksson (1980) proposed the use of 24 h urinary N excretion (UN) to validate protein intake; cut-off limits for the UN:dietary N (DN) ratio of 0·7–0·9 were proposed by Bingham & Cummings (1985). Completeness of urine collections may be assessed reliably by the *para*-aminobenzoic acid (PABA) method (Bingham *et al.* 1983). Doubly-labelled water (^{18}O and ^2H) measurements of energy expenditure (EE) have been used to assess bias in estimates of energy intake (EI) as measured by the 7 d weighed diet record procedure. These studies have highlighted the problem of under-reporting.

Goldberg *et al.* (1991) proposed validating intakes by detecting unlikely values of the EI:BMR ratio, which we call intake physical activity level (IPAL), assuming a common value for physical activity level (PAL) of $1·55 \times$ BMR. Using this approach, Black *et al.* (1991) found that 64 % of published studies using dietary intake records fell below acceptable values for this ratio. These workers

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compared the EI:BMR and UN:DN methods in several groups of subjects, and found a correlation of -0.48 ($P < 0.01$) between the two methods. They concluded, however, that the EI:BMR ratio was more useful for identifying under-reporting at the group level, especially if there is knowledge of PAL (Black *et al.* 1997). Under-reporting is common in Western studies, and is more common in subjects with a high BMI and for those with a lower income or educational level (Heitmann, 1993; Briefel *et al.* 1997; Pryer *et al.* 1997; Johansson *et al.* 1998; Johnson *et al.* 1998; Voss *et al.* 1998; Kretsch *et al.* 1999). There are few reported studies using the EI:BMR or UN:DN methods to assess the validity of dietary records in Latin America. A study in economically disadvantaged women in urban Colombia found that dietary records agreed well with EE (Dufour *et al.* 1999).

A direct estimate of PAL is gained for each subject from a weighted average of the PAL ratings for each activity. We denote this estimate as activity PAL (APAL). If both IPAL and APAL are good estimates of PAL, then IPAL should approximate APAL. The existence of a good relationship between IPAL and APAL may therefore lead to a test that is superior to that obtained by assuming a common value of PAL. Here, we report the outcome of applying the EI:BMR and UN:DN methods to validate food intake records kept by Mexican women.

Materials and methods

Selection of subjects

Forty-nine free-living, healthy, non-pregnant, non-lactating Mexican women aged 20–45 years were chosen for the study. They were not taking oral contraceptives or receiving drugs known to interfere with the PABA procedure for determining complete 24 h urine collection (Bingham & Cummings, 1983). All were invited to participate and gave their informed consent to the study protocol, which had been approved by the Ethical Committee of the National Institute of Nutrition in Mexico (INNSZ). Thirty-six subjects, either employees at the INNSZ or students from the School of Nutrition, were recruited in Mexico City. The remaining thirteen subjects were from a rural community, Solis, located 200 km from Mexico City in the Central Highlands, with a population of 44 000. The INNSZ has a Nutritional and Health Control Centre there, which helped in the recruitment and compliance of volunteers. The rural and urban surveys were run in parallel during the months of May to July 1993, but a further 3 months (October to December) were needed for the urban women. Two of the urban subjects who provided insufficient urine samples and one rural subject who showed evidence of thyrotoxicosis were excluded. Thus, the analysis relates to forty-six subjects only, thirty-four urban and twelve rural. Moreover, as a result of validation tests reported here, the urine samples of five urban women were deemed incomplete, so the major analysis was based on forty-one subjects, twenty-nine from urban and twelve from rural communities.

Study design

During the study, subjects kept daily records of food intake for 1 week and kept an activity diary. Subjects collected 24 h urine samples during this week for assessment of urinary N output. Subjects underwent anthropometric assessment and had their BMR recorded.

The data reported here came from a study of the differences in energy and protein intakes between women from urban and rural communities in a developing country. The two groups differ markedly in their work patterns and their exposure to western-style foods. It was expected that the urban women would have a lower energy and protein intake than the rural women. For most purposes in this study all subjects may be considered as a single group; however, occasionally the two groups are reported separately to highlight differences.

Assessment of dietary intake

All subjects were provided with portable digital scales (Soehnle; CMS Weighing Equipment Ltd, London, UK) accurate to ± 2 g and asked to continue their usual habits but to weigh and record all food and drink consumed and any leftovers. An accurate description of every food eaten, including the brand of food product, method of cooking, etc., was requested. Details of recipes were recorded when food composition tables for dishes were not available. On these occasions the weight of raw ingredients, of the cooked food and of the individual portion were also recorded. Occasionally, for example for restaurant meals, a descriptive record was used. Rural subjects were supplied with watches for timing the PABA doses and meal times. Before the study period, volunteers received verbal and written instructions, and they attended both a demonstration of the procedure and some practice sessions. Each diary was checked daily so that errors, omissions and doubtful data could be identified. The records were coded and 10 % of the food records were entered in duplicate to verify the reproducibility of the data entry procedure.

Urine collections and their validation

Subjects were provided with two 2 litre polypropylene bottles containing preservative (5 g boric acid), a jug and a funnel for the 24 h collections. These usually started between 05.30 and 07.00 hours and completed 24 h urine samples were collected by the researchers. Samples were stored and frozen at $-20°C$ in plastic containers.

Completeness of the urine collections was assessed by the PABA check method (Bingham *et al.* 1983). Subjects were provided with 80 mg tablets of PABA to be taken with meals three times per d. The subjects recorded the timing of the PABA doses. Urine was analysed for total N by the Kjeldahl technique and for PABA by the Bratton & Marshall (1939) colorimetric method as described by Bingham *et al.* (1983).

Anthropometry

At the beginning and end of the 7 d period subjects were weighed to the nearest 50 g, wearing light clothing but not

shoes, while in the fasted state, on a digital scale (Digi; CMS Weighing Equipment Ltd). Height was measured using a portable stadiometer (CMS Weighing Equipment Ltd) as decribed by Weiner & Lourie (1969). BMI was calculated as weight (kg)/height (m)^2. Skinfold thicknesses (biceps, triceps, subscapular and suprailiac) were measured, in triplicate, by one observer with a Holtain caliper (Holtain Ltd, Crymmych, Wales, UK) to the nearest 0·2 mm. Measurements were taken on the left-hand side of the body with the subject standing in a relaxed position. Body fat was derived from the equations given by Durnin & Womersley (1974).

Assessing energy expenditure: BMR

For each subject, BMR was determined at the beginning of the 7 d period. BMR values were derived from O_2 consumption (VO_2) measured with Oxylog portable O_2 consumption meters (PK Morgan, Gillingham, Kent, UK). Subjects were asked to fast from 19.00 hours the evening before measurement and to refrain from strenuous activity for the 24 h period before measurement. Urban women were requested to arrive at the Metabolic Unit at 06.00 hours on the day of measurement where they lay down and rested for 30 min before O_2 consumption was assessed. Rural women stayed overnight in the accommodation facilities at the Nutritional and Health Control Centre in Solis.

O_2 consumption was assessed while the subjects lay at rest for 20 min. Basal EE (kcal/min) was calculated from the formula EE (kcal/min) $= 5 \times VO_2$ (litres/min) (EE(kj/min) $= 20·92 \times VO_2$ (litres/min)) as described in the manufacturer's manual. The two meters had been calibrated by measuring energy expenditure simultaneously over 15 min by both Oxylog meter and Deltatrac ventilated hood (Datex Ltd, Instrumentation Corporation, Helsinki, Finland) in twenty healthy subjects. The 2,MBM-200 Deltatrac equipment was calibrated by combusting weighed amounts of ethanol. The EE estimated by the two Oxylog meters was significantly higher than that estimated by the Deltatrac method ($P < 0.05$). The estimates of BMR were therefore corrected for these biases by multiplying by 0·959 and 0·906 for meters one and two respectively, on the basis of direct comparisons of both methods and with separate assessments of the two Oxylog meters. Separate estimates of BMR were derived from weight and height using the equations given by Schofield et al. (1985) and adopted by Food and Agriculture Organization/World Health Organization/United Nations University (1985).

Physical activity level

Subjects were provided with diaries in which they recorded their activities in 15 min intervals. The most frequent activities of women in both the rural and urban areas, and specific activity codes were determined and printed in the diaries to aid recording. When a subject undertook an uncoded activity, a special note was made. A detailed explanation of the coding activity system was given to each volunteer and a sample diary was used for a practical

exercise before the recording started. These recorded activities were used to estimate the average PAL expressed as estimated EE:BMR ratio (Food and Agriculture Organization/World Health Organization/United Nations University, 1985) by taking the EE value of each activity expressed as a ratio to BMR as set out in the tables from James & Schofield (1990) and multiplying this value by the measured BMR and the 15 min time interval involved in the activity analysis. We refer to this overall 24 h estimate as APAL.

Data analysis

Energy and protein intakes were calculated from Mexican food composition tables (Bourges et al. 1992). For the energy balance method, IPAL = EI:BMR ratios were calculated and compared with cut-off values (Goldberg et al. 1991) to obtain for each individual an evaluation of the validity of the reported EI as a measure of habitual EI. For an individual assessed over a 7 d period, the reported cut-off value is 1·14 when the BMR has been assessed; this value drops to 1·10 if the BMR has been estimated using the equations of Schofield et al. (1985). Goldberg et al. (1991) were concerned only with under-reporting, but we wished also to check for possible over-reporting. Using the same assumption of a true PAL value of 1·55 and the same variance components an upper limit of 2·11 was obtained.

Results for four urban women who collected less than three samples containing 80–120 % PABA were excluded. Of the remaining samples, mean UN was calculated for those samples containing 85–115 % PABA. On the basis of between and within subject variance components and analysis, these limits yielded a smaller standard error for UN than either the limits of 90–110 % or 80–120 %. Twelve rural and twenty-nine urban women had satisfactory urine collections as judged on this basis.

Results

The general characteristics of the twelve rural and thirty-four urban women are shown in Table 1. The two groups were well matched for age, height, weight, BMI, BMR, % body fat and/or fat-free mass. Tables 2–5, however, are based on only the twelve rural and twenty-nine urban

Table 1. General characteristics of rural and urban Mexican women
(Mean values and standard deviations)

	Rural (n 12)		Urban (n 34)	
	Mean	SD	Mean	SD
Age (years)	27	5·5	27	6·9
Height (m)	1·58	0·04	1·57	0·05
Weight (kg)*	59·0	7·6	58·8	8·23
Weight change (kg/7 d)	−0·146	0·904	0·235	0·660
BMI (kg/m^2)	23·6	2·9	24·0	3·74
Fat (%)	31·3	3·6	31·1	4·10
FFM (kg)	40·4	3·4	40·3	3·8
BMR obs (MJ/d)	5·90	0·094	5·81	0·210
BMR est (MJ/d)	5·69	0·080	5·78	0·137

FFM, fat-free mass; obs, observed; est, estimated.
* Initial weight.

Table 2. Daily intakes of nutrients, urinary nitrogen, and intake and activity physical activity levels in urban and rural Mexican women*

(Mean values with their standard errors)

	Urban (*n* 29)		Rural (*n* 12)		Rural:Urban value	
	Mean	SE	Mean	SE	Mean	SE
Energy (MJ)	7·29	0·43	9·24	0·78	1·27	0·13
Dietary protein (g)	62·2	4·8	75·5	9·7	1·21	0·18
Fat (g)	65·0	3·5	71·1	7·0	1·09	0·12
Cholesterol (mg)	231·7	16·2	321·4	24·5	1·39	0·14
Total NSP (g)	11·4	0·86	15·1	1·21	1·32	0·15
Urinary nitrogen (g)	8·22	0·27	9·15	0·58	1·11	0·08
UN:DN	0·92	0·059	0·85	0·086	0·92	0·11
IPAL	1·266	0·086	1·575	0·149	1·24	0·14
APAL	1·656	0·034	1·898	0·054	1·15	0·04

UN, urinary nitrogen, DN, dietary nitrogen; IPAL, intake physical activity level; APAL, activity physical activity level.
* For details of procedures, see p. 726.

Table 3. Variance components within and between subjects, for dietary intake data, plus urinary nitrogen, urinary:dietary nitrogen ratio, and intake and activity physical activity level*

(Coefficients of variation)

	Within (between days)	Between subjects
Energy	0·332	0·265
Dietary protein	0·441	0·341
Fat	0·477	0·289
Cholesterol	0·349	0·281
Total NSP	0·428	0·315
Urinary nitrogen	0·219	0·171
UN:DN	0·454	0·337
IPAL	0·337	0·317
APAL	0·130	0·086

UN, urinary nitrogen; DN, dietary nitrogen; IPAL, intake physical activity level; APAL, activity physical activity level.
* For details of procedures see p. 726.

women who had satisfactory urine collections. The food records entered in duplicate gave good reproducibility within an error of 0·05 %. Mean values for dietary intakes and their standard errors are presented in Table 2. Also given are mean values with standard errors for UN, UN:DN, IPAL = EI:BMR (observed) and mean reported APAL. EI of the rural women were about 20 % greater than those of the urban women although their body weights were similar. The higher EI is reflected in activity, the mean APAL was some 15 % greater for the rural than for the urban women. The rural women also had higher means for protein intake and for UN. There was no significant difference between the two groups in the mean UN:DN ratios, which were both ≥ 0·85 suggesting no great bias of the intake data.

Within and between subject components of variation, expressed as CV, are presented in Table 3. Both within and between subject components are high for all intake variables. They are high too for the UN:DN ratio, being greatly affected by the variation in DN. The CV for UN is substantially smaller. The variance components for APAL are much smaller than those for IPAL, the latter being affected by variations in EI. Protein intakes were, as expected, highly correlated with EI (Table 3) so that the protein:energy ratio (mean values: urban 14·4, rural 13·9) had a between subject CV of only 15·4 %, substantially lower than that for either EI or protein intake.

Since the CV for UN is much lower than that for DN and the correlation between the two variables is small, the CV for UN:DN is large, like that for DN. In consequence, relatively few women have mean UN:DN ratios falling between the limits 0·7 and 0·9 often used to validate intakes of protein. Slightly more than half the values lying outside lie above, the rest lie below. Other variables, such as weight gain, tend to have a low correlation with UN:DN (Table 4) and are therefore unlikely to provide an explanation for the wide range of values observed for UN:DN.

Table 4. Between subject correlation coefficients for dietary intake data, activity physical activity level, urinary nitrogen, urinary:dietary nitrogen ratio, intake and activity physical activity level, and weight gain*

	Energy	Dietary protein	Fat	Cholesterol	NSP	Urinary nitrogen	UN:DN	IPAL	APAL
Dietary protein	0·92								
Fat	0·84	0·82							
Cholesterol	0·93	0·79	0·59						
Total NSP	0·43	0·28	0·19	0·53					
Urinary nitrogen	0·34	0·30	0·20	0·31	0·03				
UN:DN	0·76	0·86	0·74	0·65	0·27	−0·22			
IPAL	0·96	0·91	0·84	0·87	0·33	0·24	0·80		
APAL	0·10	0·03	0·03	0·20	0·11	−0·02	−0·20	0·08	
Weight gain	−0·09	−0·08	−0·05	−0·14	−0·18	−0·06	−0·05	−0·03	0·00

DN, dietary nitrogen; UN, urinary nitrogen; IPAL, intake physical activity level; APAL, activity physical activity level.
* For details of procedures, see p. 726. All data except for weight gain were transformed by logarithms (39 d.f.).

Table 5. Agreement of classification of Goldberg *et al.* (1991) intake physical activity level and dietary:urinary nitrogen with adjusted limits*

		IPAL rating			
		Under	Accept	Over	Total
DN:UN rating	Under	8	2	0	10
	Accept	8	16	1	25
	Over	0	3	3	6
	Total	16	21	4	41

IPAL, intake physical activity level; DN, dietary nitrogen; UN, urinary nitrogen.
* Forty-one Mexican women were classified by both methods (see p. 726 for details).

Energy analyses

The interpretation of IPAL values may be affected by whether the values are derived from BMR values that were measured or estimated from the Schofield *et al.* (1985) equations. Checks revealed no major discrepancy and we restrict attention primarily to observed BMR.

The mean value for IPAL in the urban group of 1·30 (Table 2) suggests that, on average, the women may be under-reporting their EI, because the mean value falls below both the limits suggested by Goldberg *et al.* (1991). Although the rural women have a higher mean IPAL than acceptable by the Goldberg criteria, comparison of IPAL and APAL values suggests that any bias in reporting is similar for both groups.
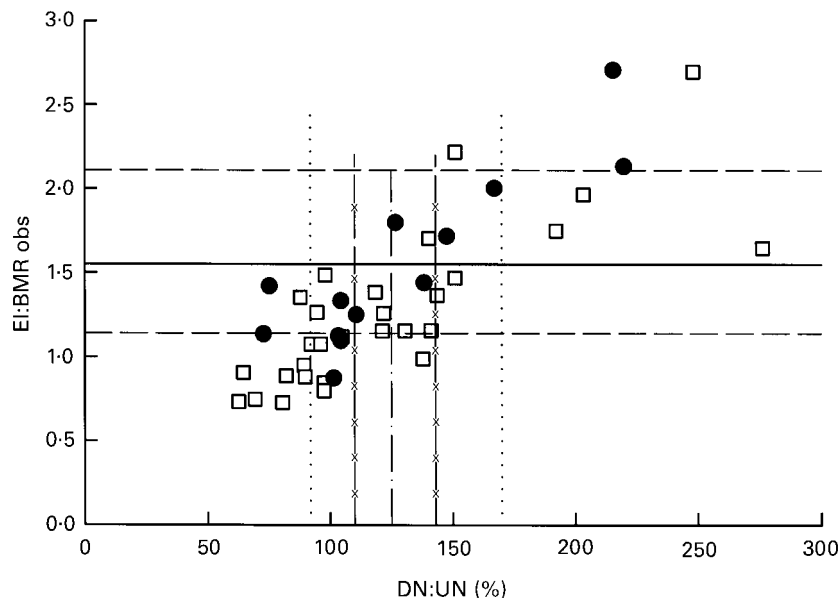
The variability of EI is high and, as a consequence, so is the variability of IPAL. Using the method of Goldberg *et al.* (1991) to provide cut-off limits for high values of PAL

yields a cut-off of 2·11 as the upper limit for IPAL estimates. As was observed with UN:DN, the IPAL values for some subjects lie outside this critical range. Again, as can be seen from the correlations in Table 4, no variable, such as weight change, is highly correlated with IPAL, so the variation has no obvious explanation. Both IPAL and APAL are estimates of PAL and might be expected to show a strong correlation but, in practice, the correlation (0·08) does not differ significantly from zero.

In the present study, both IPAL and UN:DN performed in a similar manner as indicators of intake reporting, and had values lying both above and below the normally 'acceptable' range. However, we prefer to re-express UN:DN as its inverse, DN:UN to allow direct comparisons of these values with other indices of intake. The relationship between IPAL and DN:UN is shown in Fig.1, along with 'reporting limits' 1·15 and 2·11 for IPAL plus 'limits' 1·11 and 1·43 for DN:UN. In addition, limits 0·92 and 1·70 are given for DN:UN (for the justification, see later). The observed regression equation relating DN:UN to IPAL was:

$$DN:UN = 0.063 \ (\text{SE} = 0.178)$$

$$+ 0.86 \ (\text{SE} = 0.121) \ IPAL.$$

In Table 5 each subject was classified as under-reporting, unbiased or over-reporting according to both the IPAL criteria and the DN:UN criteria with wider limits. The table shows good agreement between the methods, with twenty-seven of the forty-one subjects being classified the same by both methods and none being classified as over-reporting by one method and under-reporting by the other.

Fig. 1. Relationship between intake physical activity level (IPAL; energy intake (EI):BMR observed (BMR Obs)) and dietary nitrogen (DN):urinary nitrogen (UN) in urban (□) and rural (●) populations. (—), Target value for EI:BMR obs (1·55, Goldberg *et al.* 1991); (– – –), reporting limits for IPAL (over-reporting 2·11, under-reporting 1·14; (–·–), target value for DN:UN (125 %); (–×–), (……) reporting limits for DN:UN (over-reporting 143 %, under-reporting 111 %, Bingham *et al.* 1985; over-reporting 170 %, under-reporting 92 %, Goldberg *et al.* 1991).

Discussion

Comparison of intake physical activity levels and dietary nitrogen:urinary nitrogen methods to validate reporting of intake

Although it is usual to report UN:DN, we prefer to report the inverse of this ratio, DN:UN. The inversion has three effects: (1) the input variable DN is now the numerator, so overestimates of intake will yield large values of the ratio; (2) ratios tend to have neater statistical properties when the variable forming the denominator has the smallest CV; (3) because intakes of energy and protein are very variable relative to BMR and UN respectively, the relationship between IPAL and DN:UN behaves not unlike a 'scaled' version of the relationship between EI and protein intake, and is essentially linear (Fig. 1).

Study of the relationship shows that the Goldberg *et al.* (1991) reporting limits for IPAL are very much 'wider' than the limits DN:UN ratios of 1·11 and 1·43 (equivalent to UN:DN limits of 0·7 and 0·9). Limits for the two sets of variables may be brought into line as follows. Roughly speaking, the optimum mean value for DN:UN is 1·25 and that for IPAL is 1·55. The relationships may be crudely represented by a line joining the origin to this point, i.e. DN:UN = 0·81 × IPAL (compare this with the slope of the regression line, which approximates to DN:UN = 0·86 × IPAL). The limits for DN:UN may then be taken as the limits for IPAL multiplied by 0·81, i.e. 0·92 and 1·70 respectively. This will make the two approaches comparable on average but individual data sets will still differ.

Classifying the subjects as under-reporters and over-reporters in this way leads to the results shown in Table 5. It is noteworthy that twenty-seven of the forty-one subjects were classified in the same way by both methods, and that no subject was identified as under-reporting by one method and over-reporting by the other.

Improving the sensitivity of intake physical activity level by using the activity physical activity level assessment

One of the weaknesses of the Goldberg *et al.* (1991) approach is the assumption that all individuals are assumed to have the same mean value for PAL of 1·55. However, this mean is likely to differ between individuals and between communities. In this investigation, the mean APAL for the rural group was significantly greater than that for the urban group, reflecting more physical activity for the former. Thus, we should possibly have used greater reporting limits for the rural group. Moreover, IPAL and APAL should, in theory, be very similar, and so the IPAL: APAL ratio can be used to indicate whether an individual's intake is different from that expected. This would prove superior to the Goldberg approach if the values of APAL and IPAL show a strong positive correlation with each other. However, the correlation coefficient (Table 5, *r* 0·02) is extremely small, indicating that for these data the Goldberg approach is superior. Nonetheless, the difference between the mean values of APAL for the two communities suggests that allowing greater limits for the rural group might prove advantageous.

Variation in intake

A feature of the present study is the very marked variation both between and within subjects for the intake data, and this applies to all the intake variables and carries through to the DN:UN and IPAL values. The variation within subject may not be much greater than we should expect for the within subject CV for EI is estimated at 33 % (Table 3) whereas Bingham (1987) estimates an average value for this coefficient at 23 %. The between subject variation does, however, appear to be large. Black *et al.* (1991) suggest an average value for the between subject CV for PAL to be about 12·5–13·5 %, whereas the value for IPAL reported here is 32 %. The reasons for these large variations are not clear. It is tempting to attribute the variation to mis-reporting by the subjects. However, such a conclusion is not entirely convincing. Although the general concern with weighed intake studies has been the presence of substantial bias due to under-reporting, in the present study both under- and to a lesser extent, over-reporting (under-eating) appear to be present. Two other reasons for the marked variation deserve consideration. First, the observed variation may reflect genuine variation in intake. There is, however, little *a priori* evidence that the intakes for Mexicans are substantially more variable than those for more temperate regions. In addition, if such large differences in intake are genuine, then they should be reflected as weight changes or changes in UN or APAL values, but none of these variables appeared to be related to intake. Second, the nutritive values of some important foods may be wrong; a subject periodically including such a component in their diet would appear to have variable intakes. Checks have failed to reveal such errors but the possibility cannot be dismissed.

By using the PABA procedure to check for completion of urine collections, some were rejected. The remaining data indicated a spread of reporting levels possibly including both under- and over-reporting. However, it was felt that simple checks had provided a reasonably unbiased comparison between two groups of Mexican women.

Conclusions

The use of weighed food intake records and activity diaries to calculate IPAL:APAL values in conjunction with slightly different cut-off limits to be applied to determine acceptable PABA recoveries are suggested to represent an acceptable modification of existing methods for measurement of N and energy balance.

The large variability within and between subjects implies that the number of subjects and the number of observations per subject should be large if precise results are required. It is also suggested that urine values with PABA recoveries greater than 100 ± 15 % should be rejected, as should UN values validated by less than 3 d. There is merit in making the limits proposed for the EI:BMR and DN:UN ratios compatible. The usual tendency to reject under-reporters should be accompanied by a rejection of over-reporters whenever these occur.

We are well aware that the field of dietary intake

assessment is a far from exact science, so we were anxious to ensure that we were able to make meaningful measurements of food intake. This is important for our planned studies of rural *v.* urban communities and the effects of nutrition transition on dietary habits.

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