

accurately and separately from NSP. To group together values for NSP and lignin as a single figure will diminish the utility of either measurement.

Turning to methods, our concerns over the AOAC procedure (3) relate to a number of problems:

1) It gives very different values for dietary fiber to that using more accurate gas-liquid chromatography (GLC) methods (8, 9). Moreover the values are unpredictably different. A recent study of the AOAC procedure (10) showed 30–40% of the total dietary fiber present in fast foods such as hamburgers and fish fingers to be in the nonvegetable fraction. It is surely important that all methods in current use give the same overall values for dietary fiber including quick methods suitable for application in the food industry and more detailed methods for use in research.

2) The amount of starch included can be varied readily by food processing and thus the method, if used for regulatory purposes, is open to exploitation. For example, freshly cooked potato contains no resistant starch but on cooling ~2.5 g/100 g dry matter is formed, equivalent to an increase of 40% in the initial dietary fiber figure. Further cycles of cooling and heating will increase this even more (6). By the AOAC procedure a significant amount of the dietary fiber measured in cooled or freeze-dried samples will not be present in the food as eaten.

3) It gives only a single value for dietary fiber, which is of limited use in predicting the physiological effects of fiber, which vary according to source. Furthermore, it is unable to identify materials such as cellulose added to foods but which can be determined using GLC measurements simply by comparing the pattern of monosaccharides in the prepared food with that of the natural product.

4) Finally Asp et al suggest that the AOAC procedure has advantages in terms of simplicity and speed. This is not the case. The Englyst colorimetric procedure (11) is quicker and requires no specialized laboratory equip-

ment and overall values are identical with that obtained using GLC. The performance of the AOAC procedure, even in experienced hands, is not without problems (3).

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References

1. Trowell H, Southgate DAT, Wolever TMS, Leeds AR, Gassul MA, Jenkins DJA. Dietary fiber redefined. *Lancet* 1976;1:967.
2. Englyst HN, Trowell H, Southgate DAT, Cummings JH. Dietary fiber and resistant starch. *Am J Clin Nutr* 1987;46:873–4.
3. Prosky L, Asp N-G, Furda I, DeVries JW, Schweizer TF, Harland BF. Determination of total dietary fiber in foods and food products: collaborative study. *J Assoc Off Anal Chem* 1985;68:677–9.
4. Chapman RW, Sillery JK, Graham MM, Saunders DR. Absorption of starch by healthy ileostomates: effect of transit time and of carbohydrate load. *Am J Clin Nutr* 1985;41:1244–8.
5. Wolever TMS, Cohen Z, Thompson LU, et al. Ileal loss of available carbohydrate in man: breath hydrogen method with direct measurement using a human ileostomy model. *Am J Gastroenterol* 1986;81:115–22.
6. Englyst HN, Cummings JH. Digestion of polysaccharides of potato in the small intestine of man. *Am J Clin Nutr* 1987;45:423–31.
7. Trowell H, Burkitt D, Heaton K, eds. *Dietary fibre, fibre-depleted foods and disease*. London: Academic Press, 1985.
8. Cummings JH, Englyst HN. The development of methods for the measurement of 'dietary fibre' in food. In: Morton ID, ed. *Cereals in a European context*. Chichester: Ellis Horwood, 1987:188–220.
9. Cummings JH, Englyst HN, Wood R. Determination of dietary fibre in cereals and cereal products—collaborative trials. I Initial trial. *J Assoc Publ Analysts* 1985;23:1–35.
10. Deelstra H, Van Dael P, Van Cauwenbergh R. Fast determination of total dietary fiber in fast food. Part of Euro Food proceedings. Norway, 1987:220–5.
11. Englyst HN, Hudson GJ. Colorimetric method for routine measurement of dietary fibre as non-starch polysaccharides. A comparison with gas-liquid chromatography. *Food Chem* 1987;24:63–76.

Three limitations of the body mass index

Dear Sir:

There appear to be no limits to the possibilities for expanding on the three limitations of body mass indices (BMIs), as evidenced by editorial comments (1) and correspondence (2–6) over the past 16 mo. However, with one exception (4), this correspondence has not given sufficient attention to the one communication (7) on this subject that was primarily intended to present original results of data analysis in an effort to help shed light (not heat) on this subject of concern to epidemiologic studies. On the one hand, the several shortcomings of the BMI (eg, age and sex variations in the correlations of BMIs to body composition [MS Micozzi, TM Harris, unpublished observations, 1988]) are not limited to the three

limitations that have been under discussion. On the other hand, depending upon the uses to which BMIs are intended to be put and how they are calculated (7), at least one of these three limitations (viz, lack of independence of BMI from stature 1) can be readily eliminated in epidemiologic studies.

The goal of having an index of weight that is independent of stature is valid and important for assessing risk factors for chronic diseases. A BMI that is independent of stature will be highly correlated to weight as well as to indirect measures of body fatness and lean body mass. To the extent that stature and weight can be measured reliably, and there exist large data sets including stature and weight, BMI will be utilized by epidemiologists and will be useful as a population risk factor. However, there

must be an appreciation that BMI reflects frame size and lean body mass as well as body fat per the discussions in the references (MS Micozzi, TM Harris, unpublished observations, 1988) (1-7). Of course, for that matter, simple weight is a direct reflection (the sum) of body fat and lean body mass as well as frame size and stature. At least the BMI allows the contribution of stature to weight to be eliminated for comparative purposes in population groups.

There should be some care given to identification of proponents and opponents of the BMI. Any scientist who objectively studies BMIs and comments upon their characteristics is making scientific observations and reporting them and should not necessarily be criticized for being a proponent or advocate. For example, the eulogy on the BMI delivered by MacLaren (2) (Garn's only appropriate response [3] being "Amen!") was eloquent but did not greatly advance the goals of epidemiology. Conversely, pointing out the technical limitations of BMIs does not necessarily make one an opponent (6), either.

The use of BMI is not bad or wrong. It carries considerably less scientific information than does reliably measured body density (6) or full sets of skinfold, body-circumference, and bone-breadth measurements. The interpretation by epidemiologists of BMI as a pure measure of fatness is incorrect. Otherwise, the BMI, like any

other tool, remains useful in populations as long as its use is appropriate to the goals of a study, its characteristics are understood, and its limitations are clearly stated.

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References

1. Garn SM, Leonard WR, Hawthorne VM. Three limitations of the body mass index. *Am J Clin Nutr* 1986;44:996-7(editorial).
2. McLaren DS. Three limitations of the body mass index. *Am J Clin Nutr* 1987;46:121(letter).
3. Garn SM. Reply to letter by McLaren. *Am J Clin Nutr* 1987;46:121(letter).
4. Micozzi MS, Albanes D. Three limitations of the body mass index. *Am J Clin Nutr* 1987;46:376-7(letter).
5. Garn SM, Leonard WR, Hawthorne V. Reply to letter from Micozzi [sic] and Albanes. *Am J Clin Nutr* 1987;46:377-8(letter).
6. Garrow, JS. Three limitations of the body mass index. *Am J Clin Nutr* 1988;47:533(letter).
7. Micozzi MS, Albanes D, Jones DY, Chumlea NC. Correlations of body mass indices with weight, stature, and body composition in men and women in NHANES I and II. *Am J Clin Nutr* 1986;44:725-31.

