Energy Metabolism in the Elderly

John V.G.A. Durnin

Institute of Physiology, University of Glasgow, Glasgow G12 8QQ, Scotland, United Kingdom

In a discussion of energy metabolism in the elderly, we ought to try to be modestly precise about what exactly is meant by the "elderly." There is enough individual variation among a group of elderly people who are all of the same age to create difficult problems and if we lump together the whole age range from 65 years onward (as is frequently done in tables of energy and nutrient requirements), it is really impossible to be precise about anything. We should start therefore by subdividing our group of elderly people, and a minimum subdivision—and probably not an adequate one—is into two groups, one being the "young elderly," aged from 65 to 74 years, and the other the "older elderly," who are people 75 years or older. Almost certainly in a few years' time, when the number of really old people becomes considerably increased, we shall have to have a subdivision of the "older elderly" into people from 75 up to 84 years, and from 85 onward.

It may also be useful to have a categorization, independent of age, for elderly people who are free-living and those who live permanently in institutions (i.e., residential homes, long-stay hospital wards, or nursing homes for the elderly).

However, having made those suggestions, it will soon become apparent that the relative absence of definitive data makes it difficult to use any type of subdivision at all adequately.

FACTORS INFLUENCING ENERGY METABOLISM IN THE ELDERLY

There are several factors that might be anticipated to exert some influence on energy, but only some of them have any specific practical importance for the elderly. First, energy expenditure may be affected by (a) basal metabolic rate (BMR), (b) diet-induced thermogenesis (DIT) or the thermic effect of food (TEF), (c) physical activity, (d) mechanical efficiency of movement, (e) body weight and body composition, (f) body temperature, (g) sympathetic nervous system, and (h) muscle fiber type. Second, the energy and nutrient intake may be modified by (i) digestion and absorption, (ii) carbohydrate, fat, and protein metabolism, (iii) energy intake altered because of fiber intake, and (iv) low energy intake interfering with protein metabolism.
The physiological significance of these variables will be examined, not in absolute terms—such as whether DIT is important in influencing the level of energy expenditure—but in terms of whether the impact differs in old compared to young people.

With that premise, it is possible to speculate (with the aid of such experimental evidence as is available, together with some sensible physiological extrapolation) on the role of these various factors with regard to their influence on total daily energy expenditure. Since energy (and therefore food) intake is normally adjusted to equal, more or less, energy expenditure, energy expenditure is basically the most important factor affecting the nutrition of the elderly. Ways in which the eight variables listed above might modify energy expenditure in the elderly will now be evaluated. Poehlmann and Horton (1) have recently written a helpful review of some aspects of this topic.

**Basal Metabolic Rate**

The BMR represents the essential amount of energy required for the physiological functions of the body at complete rest (postabsorptive, thermally neutral, lying relaxed in bed, etc). All tables of BMR show a progressive reduction from birth up to old age, and this is sometimes given precise quantitative values, such as "a 23% fall during adulthood." Presumably this decrease reflects both a reduction in relative activity of many or most organs and tissues in the body together with an actual diminution in the mass of some of these organs and tissues. The skeleton and skeletal muscle are particularly obvious examples.

However, it is clear that much individual variability must occur in the reduction in BMR, and the data available, which consist almost entirely of cross-sectional studies, do not allow us to be at all exact if we are concerned with individuals or with special groups. It is probable that the reduction in BMR is more a reflection of changing body composition with age (e.g., more fat and less muscle) than in any real age-related alteration of metabolism. Elderly people, at least up to a moderately advanced age (70–75 years or so), who have avoided these changes in body composition may well show little decrease in BMR. This contention is supported by the data of Keys et al. (2), Tzankoff and Norris (3), and indeed by almost all of the classical data of Benedict et al. (4).

The result is that although recent data quoted in a report on energy and nutrient requirements in the United Kingdom (5), which included the scanty results collated by Schofield et al. (6) on the elderly, together with data on 101 men in Glasgow aged 60 to 70 years (Durnin and Choudhry, unpublished) and 170 elderly Italian men and 180 Italian women (Ferro-Luzzi, unpublished), demonstrate an overall reduction of between 10% and 20% between 30 years of age and 75 plus (Table 1), many individuals will not necessarily fit into this pattern.
Energy Metabolism

Table 1. Basal metabolic rate and age

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Weight (kg)</th>
<th>BMR (kcal/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-60</td>
<td>74</td>
<td>1737</td>
</tr>
<tr>
<td>60-74</td>
<td>74</td>
<td>1582</td>
</tr>
<tr>
<td>75+</td>
<td>70</td>
<td>1405</td>
</tr>
</tbody>
</table>

19% reduction

<table>
<thead>
<tr>
<th>Women</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30-60</td>
<td>64</td>
<td>1386</td>
</tr>
<tr>
<td>60-74</td>
<td>64</td>
<td>1277</td>
</tr>
<tr>
<td>75+</td>
<td>60</td>
<td>1212</td>
</tr>
</tbody>
</table>

13% reduction

Body weights from ref. 17 and BMR calculated using formula in ref. 5.

Diet-induced Thermogenesis or Thermic Effect of Food

There is a certain amount of theoretical interest in discriminating between DIT and TEF, which is probably of minimal practical importance in man—certainly in the current context. They will be discussed here as if the terms were synonymous.

In certain situations, variations in DIT may have considerable long-term importance. For example, one factor conducive to the development of obesity might be a significantly low DIT, which usually amounts to about 10% of the energy available from the diet, and represents the energy involved in the processes of digestion, absorption, and metabolism. A low DIT means that proportionately less energy is dissipated in these processes and, over a lengthy period of perhaps many months or years, this small extra quantity might increase the likelihood of progressive fatness. However, the maximum difference from the average possible in a physiological state is likely to be no more than ±2% to 3% of total energy and is almost certainly of no significance for energy metabolism in the elderly.

Physical Activity

Physical activity is the variable likely to have most impact on differences in energy metabolism among elderly people. An excellent and extremely comprehensive review (quoting 1841 references!) of the varied aspects of physical activity in elderly people is contained in the book by Shephard (7).

Physical activity has many degrees of importance for the elderly. In simple nutritional terms, when physical activity increases, energy expenditure is also augmented and the energy required to replace that expenditure similarly becomes greater. Appetite will improve and the amount of food eaten is proportionately more. A secondary result of the increased intake of food is that there will also be a greater
intake of nutrients—protein, minerals, and some vitamins. The activity itself results in improved muscle tone, more muscle and joint mobility, an extension of social contacts, and a general increase in the feeling of "well-being."

There is an obvious decrease in the overall level of physical activity with aging but it is a complex process, and the interindividual variability is enormous. There is a great deal of subjective and indirect information implying that, on average, there may be a significant reduction in activity from young adulthood onward. However, since the great majority of adults in the industrialized countries do not appear to be very active at any age (compare the average energy requirements of the population), this reduction may not be of a large degree. Despite the apparent widespread popularity of jogging, aerobics, and so forth, the jogging fraternity has a highly selected socioeconomic composition and there do not appear to be many socially or economically disadvantaged people who jog, nor a high proportion of elderly people. There is also, certainly in the United Kingdom and also in the United States, a definite ethnic bias.

Capacity for Exercise

There is a certain amount of physiological information on the diminution in the capacity for physical exercise that occurs with aging. The classical experiments of Dill (8) on his own ability to exercise throughout much of his adult life up to an age in the late 60s, and two Swedish studies (9,10), demonstrate clearly that there is a considerable fall in maximal exercise capacity, in cardiac output, in stroke volume, and in maximal heart rate with aging. Blood volume and total hemoglobin do not appear to change.

The importance of these reductions as far as energy expenditure is concerned is that the stress of physical exercise is often largely a function of its proportion of the maximal exercise capacity (VO₂max). That is, if the VO₂max is the equivalent of 15 kcal/min, then activity at a level of 7 kcal/min is quite tolerable. If the VO₂max is 10 kcal/min, then an exercise at 7 kcal/min would be quite stressful. Therefore, elderly people with markedly reduced VO₂max would be unlikely to undertake voluntarily any physical activity of more than rather light degree. However, improvement in the ability to exercise can certainly still be accomplished in the elderly. A monograph published by the WHO (11) gives illustrations of what can be accomplished by training: 10% to 15% increases in VO₂max by men between 65 and 69 years, increases of 20% in vital capacity, improvements in lung diffusion, a lower systolic blood pressure, and greater strength. There may also be a considerable increase in the release of some of the adrenal and pituitary hormones.

Influence of Occupation

Occupation has an obvious relationship to physical activity, but is probably of little importance generally since most work situations in the industrialized countries
do not require a level of physical activity that would be stressful to an average healthy elderly person. Therefore, the main influence of occupation might, paradoxically, be whether or not the degree of physical activity actually increased on retirement. Studies on this have been continuing in Nottingham, England, for some years (12,13) with no clear-cut conclusions. As one might expect, the variability is such that some men actually increased their activity levels after retirement, increased their muscle mass, and decreased their fatness, although the general picture was mostly in the opposite direction. Female factory workers almost universally became less active after retirement.

**Influence of Degenerative Conditions**

There is another feature of aging that may restrict physical activity, and that is the increased liability to suffer from one or more of the degenerative diseases of the circulatory and respiratory systems and particularly of the bones and joints. It might appear that many elderly people are not active because it is unpleasant, uncomfortable, or even painful for them to move around.

The proportion of elderly people who suffer from joint disabilities sufficient to incapacitate or inhibit movement is unknown and probably varies considerably for different countries, climates, occupations, and so forth. However, some informative data have been published in the United States (14) by the Department of Health, Education and Welfare. Table 2 shows the "normal" population, the remainder being "sufferers." However, it should be pointed out that never more than 1% of the group had a "severe" grade of the condition. The possibility arises, therefore, that degenerative arthritic changes may not be so important for most people in inhibiting physical activity.

The general conclusion may be that, whereas there is a negative relationship of aging to physical activity, up to 70 years or so the trend will often be rather gradual, and will be affected by the standard of health and by the amount of activity in the previous lifestyle.

**TABLE 2. Percentage of "normal" men and women related to those moderately disabled with arthritis of knees, hips, and sacroiliac joints**

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Knees M</th>
<th>Knees F</th>
<th>Hips M</th>
<th>Hips F</th>
<th>Sacroiliac joints M</th>
<th>Sacroiliac joints F</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-44</td>
<td>98</td>
<td>98</td>
<td>100</td>
<td>—</td>
<td>99</td>
<td>—</td>
</tr>
<tr>
<td>55-64</td>
<td>92</td>
<td>89</td>
<td>97</td>
<td>96</td>
<td>96</td>
<td>99</td>
</tr>
<tr>
<td>65-74</td>
<td>86</td>
<td>75</td>
<td>94</td>
<td>96</td>
<td>98</td>
<td>98</td>
</tr>
</tbody>
</table>
Mechanical Efficiency of Movement

The reduction in the efficiency of movement and in the control of balance that are part of the normal aging process have been described in several papers [summarized by Shephard (7)]. Our own study (15) gives a fairly typical set of results (Table 3).

We compared two groups, each of 12 men, one aged 20 to 30 years and the other 55 to 76 years. They were similar except for their age, all of them being unskilled laborers working in the construction industry. They performed two grades of standardized exercise involving arm work, and walked at two levels of standard exercise on the treadmill. The experiment was designed in the form of a Latin square to minimize the effects of fatigue and of other uncontrollable variables. There were no significant differences in either of the two arm exercises between the young and the elderly men, although the exercises involved moderate and moderately heavy exertion. In the walking exercises, the older men expended 17% more in the lighter exercise and 21% more at the heavier work load. The elderly men thus seemed to have similar degrees of mechanical efficiency to the younger men if the exercise did not involve much gross body movement, but the larger muscle groups and the control of balance required by walking resulted in a marked decrease in efficiency and an increased energy expenditure, presumably due to a general diminution of neuromuscular coordination.

Body Weight and Body Composition

Alterations in body mass with aging are not well documented. Most cross-sectional data show decreases in height, which may be as much as 5 to 7 cm for some groups between 30 and 70 years of age. This seems to vary considerably with socioeconomic group and with occupation—larger differences in height occur with aging in industrial communities compared to rural populations, whereas professional groups from the more privileged socioeconomic classes appear to show little change. Alterations in weight seem more complex and differ between sexes, so that men appear to have a slightly lower body weight at 65 to 70 years than at 40 years of age, whereas women frequently show an increase in body weight over this period. In general, in both the
United States (16) and in the United Kingdom (17), data show that weight increases with age and height decreases, with weight stabilizing around the age of about 70 years in men and then gradually decreasing due to the progressive loss of skeletal muscle and also, probably, fat. This is in general true for the average population of both men and women in each country.

Most of such data on body composition have been obtained from cross-sectional studies (18–21), although there is a small amount of good longitudinal information (22). Brozek (23) also described a redistribution of fat, there being proportionately less fat in the subcutaneous compared to the truncal sites in older people, which we have also documented (24).

The net result of a gradual increase of body weight up to a certain age in the elderly is that for any given amount and type of activity, more energy will be expended by the elderly compared to a younger group of adults.

**Body Temperature**

It is theoretically possible that energy metabolism might be influenced by a basic reduction in core temperature that might occur in advanced age due to a reduction in tissue metabolism, but this has not to our knowledge been documented.

**Sympathetic Nervous System**

The possibility that sympathetic nervous system activity increases with aging and may be influenced by diet and exercise has been well reviewed (1), but the evidence is inconclusive and difficult to analyze (for many reasons, including methodological problems). Its exact relationship to energy metabolism in the elderly is probably of limited practical importance in the current context.

**Muscle Fiber Type**

There seems to be a selective loss of type II fibers in the elderly muscle, which may therefore reduce the muscle glycogen stores and result in a diminished strength of contraction (25), although this may be more a reflection of lower levels of physical activity than a true aging phenomenon. However, despite this change toward failing function, muscle strength is still capable of improvement from an appropriate exercise program, even up to a very advanced age (26).

**CONCLUSIONS REGARDING ENERGY EXPENDITURE**

The conclusions that can be made about the overall effect of the various factors analyzed above on energy expenditure in the elderly are limited. First of all, for present purposes any important influence likely to be exerted by DIT, body
temperature, sympathetic nervous system activity, and muscle fiber type can be largely eliminated. They are interesting to study but of little relevance here. BMR is possibly a major factor in reducing energy expenditure, especially over the age of 75 years. Alterations in physical activity may be of considerable importance and, in general, some reduction must almost certainly occur even before 70 years of age, although there will be large inter-individual variability and the state of health of the elderly person will obviously have much influence. Body weight and body composition are potentially able to affect energy expenditure, partly through changes in the fat-free mass but also because energy expenditure in any given activity is directly related to the cost of moving the body mass around. However, unless the alterations in body fatness (which is the variable that changes most) are fairly extreme, the final modification in energy expenditure may not be very marked.

The factor likely to have the major influence on average energy output will usually be physical activity, and therefore the way to prevent more than a minimal reduction with aging in total daily energy expenditure is to maintain an active lifestyle. Apart from the advantages of this for energy, there are the social, psychological, physiological and nutritional benefits to be obtained—greater physical mobility, increased social contacts, improved feelings of well-being, greater confidence, larger nutritional intake, increased bone density, and so forth.

MODIFICATIONS IN ENERGY METABOLISM RELATED TO INTAKE

Only brief mention will be made about topics under this general heading.

Digestion and Absorption of Nutrients

Another of the changes in function that is commonly believed to occur in the elderly, of some potential importance in nutrition, is relative malabsorption of foods. Good scientific evidence in favor of this is hard to come by. Southgate and Durnin (27) studied this as a by-product of assessing the energy values of protein, fat, and carbohydrate and measured, by chemical means and by bomb calorimetry, the total food eaten and the urine and feces excreted by groups of young and elderly men and women. The results showed no evidence of decreased efficiency of digestion and absorption with aging (Table 4).

Carbohydrate and Fat Metabolism

The proportions of carbohydrate and fat that supply the body with energy may have metabolic importance and could alter with aging, although no good evidence for this exists.
ENERGY METABOLISM

TABLE 4. Percentage availability of "energy," protein, fat, and pentosan

<table>
<thead>
<tr>
<th>Group</th>
<th>Energy</th>
<th>Protein</th>
<th>Fat</th>
<th>Pentosan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young men</td>
<td>96.6</td>
<td>89.6</td>
<td>96.4</td>
<td>95.3</td>
</tr>
<tr>
<td>Elderly men</td>
<td>96.8</td>
<td>91.4</td>
<td>95.1</td>
<td>96.8</td>
</tr>
<tr>
<td>Young women</td>
<td>96.5</td>
<td>92.1</td>
<td>96.7</td>
<td>93.9</td>
</tr>
<tr>
<td>Elderly women</td>
<td>96.0</td>
<td>92.9</td>
<td>94.6</td>
<td>97.8</td>
</tr>
</tbody>
</table>

* From ref. 27.

Energy Intake Altered Because of Dietary Fiber

It is possible, but unlikely in the case of the elderly, that someone may have a large intake of fiber and a relatively small total intake of nutrients in the diet, with the result that the digestion and absorption of the nutrients are interfered with; this can sometimes be serious enough to result in malnutrition, with the availability of carbohydrate, fat, and protein in the food being reduced to the extent that the total net energy is inadequate.

Low Energy Intake Interfering with Protein Metabolism

The proportion of protein relative to the total energy in the diet may be within normal limits, but if the total diet is inadequate in supplying the energy requirements, the protein may be used as a source of energy and therefore be insufficient for the normal requirements of protein metabolism. Since this situation is potentially not uncommon in the case of elderly people—perhaps living alone, with a poor appetite, and little inclination to prepare adequate meals—minor degrees of protein malnutrition might be expected, especially in the older groups of the elderly. The relatively large studies in the United Kingdom (28) and the United States (29) that might have uncovered these cases if they existed did not appear to show much evidence of malnutrition, but distinguishing minor degrees of protein inadequacy is difficult. The condition may therefore be more common than is apparent.

ACTUAL ENERGY EXPENDITURES

Although there are published data showing that some elderly men have high levels of energy expenditure—more than 3000 kcal/d (30,31)—what is of more immediate concern is the proportion of elderly people whose energy expenditure is so low that the energy intake to supply that quantity will lead to insufficient intake of nutrients. Even in a younger group of the elderly, there must be some anxiety about the level of nutrient intake. For example, a recent study in the United Kingdom (32) found that the mean energy intake of men aged 50 to 64 years was almost exactly the same
TABLE 5. Energy intake related to possible activity

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy intake of 60-yr-old woman</td>
<td>1610 kcal/d</td>
</tr>
<tr>
<td>Body weight</td>
<td>66 kg</td>
</tr>
<tr>
<td>BMR</td>
<td>1290 kcal/d</td>
</tr>
<tr>
<td>DIT (10% of intake)</td>
<td>160 kcal</td>
</tr>
<tr>
<td>BMR + DIT</td>
<td>1450 kcal</td>
</tr>
<tr>
<td>Energy for all activity</td>
<td>1610 - 1450 kcal</td>
</tr>
<tr>
<td>Housework (cooking, cleaning, etc.) costs approx.</td>
<td>1 kcal/min above BMR</td>
</tr>
<tr>
<td>2 h housework costs</td>
<td>120 kcal</td>
</tr>
<tr>
<td>Remainder</td>
<td>160 - 120 = 40 kcal</td>
</tr>
<tr>
<td>Need to spend all remaining 22 h of day lying in bed</td>
<td></td>
</tr>
</tbody>
</table>

DIT, diet-induced thermogenesis.

as that of men aged 25 to 34 years (2380 and 2440 kcal/day). The energy intakes of women of similar ages were also about the same (1610 and 1670 kcal/day). However, the actual level of intake of the women is surely a cause for some anxiety. An intake of 1600 kcal/day, when we allow for BMR and DIT, leaves such a small amount of energy for all the activities of the day that it implies an almost completely passive existence (Table 5).

Of even more concern is the proportion of these women who must be ingesting very low intakes of energy. If the mean energy intake is 1610 kcal/day, and the standard deviation is about 15%—a low-to-average percentage in these situations—about one-sixth of the whole population of women will have intakes between -1 and -2 SDs; that is, between about 1370 and 1130 kcal/day. These levels, if they represent the real situation, are surely indicative of a highly undesirable state.

It is clear that there is a considerable diversity of possible influences on energy metabolism in the elderly. This chapter has attempted to analyze their relative importance. We can do little to minimize the effects of some of these influences, but the one component capable of at least some modification in our daily life is physical activity. Its importance is surely great enough to warrant special consideration by all who are concerned with the present and future welfare of the elderly population.

REFERENCES

ENd ENERGY METABOLISM

Dr. Munro: If you were advising on recommended allowances for energy intakes at ages 65, 75, and 85 years, what would your figures be?

Dr. Durnin: A new UK report on energy and nutrient requirements has just been released (1). For the elderly we have suggested a blanket figure of 1.5 times the basal metabolic rate. This is equivalent to around 2000 kcal for men and 1800 to 1900 for women. Although this recommendation may in some instances be unrealistically high, we felt it better to overestimate the energy requirements of elderly people rather than to underestimate them.

Dr. Munro: In the abstract of a paper presented at the recent FASEB (Federation of American Societies for Experimental Biology) meeting in Atlanta (2), young adult men undertaking light activity had an average need of 3500 kcal per day based on double-labeled water. This is much higher that the predicted need of the young men (2900) given in the recent RDAs (3). What is your view, Dr. Durnin?

Dr. Durnin: There are two different methods involved in the double-labeled water technique for measuring total energy expenditure. One involves a relatively old-fashioned technique that has been used by geologists for years but produces accurate data. I am confident of the correctness of the results obtained using this technique. However, in recent years an automated mass spectrometry technique has been developed that in the hands of many people produces results that appear to be unreliable or systematically on the high side. These results seem just possible but are still much in excess of those that have been found in almost any other type of study. I have serious reservations in accepting that these results are valid.

Dr. Davies: We are used to thinking in terms of diminishing energy requirements with age and particularly with incapacity, but isn't it possible that energy expenditure may actually increase under these circumstances? I am thinking in particular of psychologically disturbed old people who are constantly on the move, and of incapacitated people struggling with crutches and frames.

Dr. Durnin: If you compare energy expended on a standard work load in people using these appliances, then it is higher than in people who are not disabled, but of course this does not mean that they are going to expend more energy overall because they will tend to limit their activities. Thus, I think it unlikely that there will be an increase in overall energy expenditure under these circumstances. I have no information on the psychologically disturbed but it is certainly possible that their energy expenditure is increased.

Dr. Ballard-Barbush: Are there any data on energy expenditure in Parkinson’s disease?

Dr. Hodkinson: We have recently published work (4) showing that resting energy expenditure in Parkinson’s disease is increased by about 25%.

Dr. Nestel: Is the reduction in resting metabolic rate with age largely accounted for by the reduction in fat-free mass or is it something more fundamental than this?

Dr. Durnin: There are few longitudinal studies. Brozek did one (5) where he followed men for about 30 years up to the age of 60 and found that he could explain the reduction in BMR almost entirely on the basis of changes in body composition, the more metabolically active tissues decreasing. On this basis there should be little change in BMR with advancing age if muscle bulk is retained by continued physical activity, and much of the loss of skeletal mass that occurs with aging could be prevented. However, there are only limited data on these points.

Dr. Berry: An increase in weight tends to occur after 60 to 65 years of age, at a time when there is a decrease in energy intake. Does this imply an even greater decrease in energy expenditure to account for the increase in weight, or is there a change in metabolic efficiency?
Dr. Durnin: The evidence that energy intake decreases much over this age range is rather slight. Most studies I am aware of that have compared 30-year-old and 60-year-old men have shown little change in overall intake, and sometimes a small increase with aging rather than a decrease. Thus, I don’t think there is any need to invoke changes in metabolic efficiency. A difference in intake over expenditure of as little as 100 kcal per day over 10 to 20 years will lead to enormous differences in body mass.

Dr. Guersry: Is the 20% increase in energy expenditure during standard exercise tests in the elderly the result of obesity or is it due to muscular inefficiency or change in fiber type?

Dr. Durnin: We matched the groups for body mass so that their weights were the same. My explanation is that the difference is mostly due to reduced mechanical efficiency of movement, which is probably the result of reduced efficiency of balance, a common problem of aging. The small extra movements required to maintain balance probably account for the increased energy expenditure.

Dr. Merritt: Given the observation of a rather low total energy expenditure in the elderly, particularly in women, and a concomitant decrease in lean mass as a proportion of total body weight, what are the implications for dietary composition and nutrient density for the healthy elderly population?

Dr. Durnin: I find it difficult to accept the data related to energy intakes because these have generally been obtained under conditions that are quite at variance with normal lifestyles. I cannot believe that an intake of 1,600 kcal/day really represents the mean intake of a population of women aged between 50 and 65 years. I am not suggesting that the results are wrong, but I dispute that they represent the normal food intake over a long period of time. I prefer to work from the necessary energy expenditure and extrapolate upward to derive an adequate overall intake. If you take BMR plus the energy expended over the number of hours spent standing or sitting in the day, or walking around doing very little work, plus perhaps a small amount of moderate physical activity, you come up with a figure of about 1.4 times the BMR. Allowing 1.5 times the BMR in this group of women gives an overall intake of about 1,900 kcal per day, and this represents a very sedentary population. Thus, I should have thought that women aged about 65 to 70 years should aim at an intake of 1,900 to 2,000 kcal, and this would usually imply an adequate intake of all the different nutrients.

Dr. van Staveren: What practical advice can you give about the amount of exercise an elderly person should take? How do you derive the figure of 1.5 times the BMR?

Dr. Durnin: To get up to 1.5 times the BMR you need to have a minimum of about 2 hours walking moderately, not walking very slowly. This can be split up into different periods. Some people respond well to being told that they must walk for 2 hours every day. Others might respond better to general encouragement to be as active as possible.

REFERENCES