ENERGY REQUIREMENTS AND PHYSICAL ACTIVITY LEVEL OF ACTIVE ELDERLY PEOPLE IN RURAL AREAS OF CUBA

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Abstract

Obesity and non-insulin dependent diabetes mellitus (NIDDM) are common in the Third Age and increasing in Cuba. Among the life-style changes associated with increased prevalence of obesity and its related disorders, diet and activity patterns are prime candidates. The transition to this life-style model may induce a decrease in the energy needs. There is an urgent need for tools which have been validated for measuring diet and physical activity in nutritional studies in the developing world, but also a more urgent need for reference values for the total energy requirements of healthy elderly people. Regular physical activity reduces the likelihood to develop diseases that characterise the metabolic cardiovascular syndrome. Previous studies done in Havana showed values of physical activity level (PAL) which are lower than the reported for elderly subjects. Elderly people living in rural areas use to have physical activity levels which differ from the observed in urban areas. With the purpose of estimating the energy requirements, a group of 40 apparently healthy people older than 60 years of age living in a rural mountain community will be submitted to a medical, epidemiological, dietary, anthropometric and insulin resistance study. Physical activity will be determined by questionnaire and by the calculation of the PAL from the basal metabolic rate (BMR) and total energy expenditure (TEE) measured with the doubly-labelled water method (DLW). Associations with the prevalence of insulin resistance and obesity will be assessed.

1. SCIENTIFIC BACKGROUND AND SCOPE OF THE PROJECT

Estimates show that in year 2000, 41 million of elderly people will live in Latin America. In year 2025, 93.33 million of human beings will have more than 60 years of age. In countries like Cuba, Chile and Mexico an accelerated ageing process is taking place and there is also a shift in demographic and epidemiological outcomes that are linked to nutrition changes.

In Cuba the reduced mortality and fertility and a remarkable change in the age structure (Table I) is coincident with an advanced stage of the epidemiological transition, where chronic diseases appear simultaneously with deficitary diseases. These changes are often accompanied by a sedentary lifestyle and a reduction of the TEE, which could promote weight gain.

A reduction in physical activity reduces obviously the TEE of the individuals. This is considered an important factor in the reduction of the energy requirement in the elderly [1]. Cross-sectional observations suggest that the transition from traditional to modern lifestyle may have induced a decrease in daily energy expenditure of 1-2 MJ/d [2]. The regular participation in physical activity is known to control the body weight, to reduce the glycogen stores and to increase sympathetic nervous system activity, therefore a shift towards a sedentary lifestyle includes a reduction in the potential for the regulation of the energy, carbohydrate and lipid metabolism; on that way the maintenance of the energy and macronutrient balance can take place without an increase of the glucose and non-esterified fatty acid concentrations.

Syndrome X, glucose intolerance syndrome or metabolic cardiovascular syndrome are terms used to describe a cluster of disorders linked to insulin resistance with the potential risk of glucose intolerance and eventual diabetes. The specific disorders found in the metabolic cardiovascular syndrome include hipertriacylglycerolaemia, raised LDL and reduced HDL-cholesterol, hypertension, central (intra-abdominal) obesity and reduced insulin secretion with impaired glucose tolerance, which is an early and fundamental feature of the syndrome [3]. Physical activity reduces the likelihood to develop diseases associated with excess circulating substrates that characterise the metabolic cardiovascular syndrome. According to recent results, the TEE is a major determinant of the risk of having this syndrome [4,5]. Some recent evidences are also presented which support the deficiency of vitamin D as a possible risk factor of this syndrome [6]. Glucose intolerance is strongly associated with low physical activity [7,8,9,10,11,12,13], however, in one of the prospective epidemiological studies, which support this affirmation, a critical method has been used to quantify exactly the physical activity and the TEE. The physical activity of the elderly in rural areas is usually higher.

The energy cost of the normal daily activities increases with age [14,15]. This reduced efficiency may be one of the reasons of the slow down of older individuals, which also contributes to a

negative energy balance, weight loss and some degrees of undernutrition. Coronary heart disease (CHD), obesity and NIDDM, chronic diseases related with the ageing process and modifications of the lifestyle often leading to circulatory failure are becoming a significant problem also in Cuba (Table II). Modifications of the Cuban diet occurred in the 90s in relation to macro and micronutrients directly related with the etiology of some of the most relevant chronic diseases in the health picture of the country.

There exists an imbalance between energy intake and energy expenditure in elderly people. The scientific evidence about energy requirement in the elderly is variable. This variability is often generated by the data of energy intake and requirements, but most important than that is the diversity of the physical activity patterns in the elderly population.

The changes of the BMR and physical activity are the most important components of the TEE. BMR reflects the energy requirements for maintenance of the intracellular environment and the mechanical processes of respiration and cardiovascular function. This account generally for 60-75% of the TEE. [16]. The equation proposed by Shofield *et al* [17] and included in the report of the FAO/WHO/UNU Expert Consultation [18] should be less appropriated for the elderly. BMR is generally 10-20% less in old people because of reduced muscle mass and increased fat mass with ageing [19].

The WHO, the US National Research Council and the Department of Health of the United Kingdom have used the factorial method for the estimation of the energy requirements [20], but this method underestimate the energy requirements basically because of the difficulty for the classification and quantification of the physical activity. According to the last FAO/WHO/UNU Expert Committee [18], the energy requirements should be preferably determined by the measurement of the TEE than by the observation of dietary intakes. Of all the existing methods, the isotopic measurement of the TEE in free living persons, using the doubly labelled procedure is the most accurate method at the present.

An evaluation of recent DLW studies in adults over 60 years of age of developed countries have shown a PAL value of 1.61 for men and 1.63 for women. According to these results the energy requirements of the elderly population should be underestimated by the international organisations [21]. An analysis of 574 measurements of the TEE with the DLW method in elderly people of affluent societies has shown a PAL value of 1.62 for women from 65-74 years of age and a reduction to 1.48 for women older than 75 years. The values for men were 1.61 and 1.54. This analysis included persons with different levels of physical activity [22].

Using the DLW method a mean PAL value of 1.59 was measured in free living women of Havana City in 1998. The data showed a great variability (Table III) [23]. The mean value did not differ from the one used in the energy allowances for the Cuban population (1.60) [24].

Cross-sectional studies have shown an inverse association of physical activity with the prevalence of clinical diagnosed diabetes mellitus [25,26]. Physical inactivity is proposed as a risk factor for the incidence of diabetes, independent of body weight [27,28]. An association between physical activity and diabetes has been found in elderly subjects [29,30].

2. METHODS

a) A random sample of 250 subjects older than 60 years of age from the rural community will be invited to participate in the study.

b) Information about medication use, medical history, smoking habits and family history will be obtained by means of questionnaires.

c) Health status will be assessed by medical diagnosis. Measurement of blood pressure. Hypertension will be defined as blood pressure > 160/95 mm Hg and/or currently on treatment for hypertension.

d) Body composition by anthropometry and bioelectrical impedance

e) BMR determined by ventilated hood (Deltatrac, Sensor Medics, USA) or estimated with the Shofield equations

f) Energy intake measurements by the 3-day weighing method

g) Biochemical study:
   - Blood samples taken at overnight fast (no food intake after 11:00 p.m., and 30 and 120 minute following oral glucose. Plasma glucose measured using the hexokinase (E.C. 2.7.1.1) method.

- Insulin resistance diagnosis by Galvin Index. Glucose tolerance test and insulin measurements by RIA.
- Serum cholesterol (Bayer Diagnostics, Basingstoke, Hants, UK).
- HDL-cholesterol (Low HDL-cholesterol defined as being < 0.91 mmol/l in men and < 1.17 in women)
- Triglycerides (Hypertriacylglycerolaemia defined as fasting serum triacylglycerol of > 2.82 mmol/l)
- LDL-cholesterol calculated according to the Friedewald formula

3. PROPOSED WORK

Approximately 250 elderly people of the mountain community "Las Terrazas" in western Cuba will be selected for the study. The population of that community differs from Cuban elderly people:

a) they are classified as rural inhabitants of Cuba but they live in a concentrated area in the mountains with most of the facilities of urbanisation.

b) they use to work in activities related with ecological tourism and reforestation

c) labours related with the assistance of an ecological reserve; their physical activity level is usually higher than that of the elderly people living in Cuban cities.

The selected elderly subjects will be submitted to a medical, epidemiological and anthropometric study. In 40 of them, classified as apparently healthy, the physical activity will be assessed once by a questionnaire or by the direct measurement of their PAL values. TEE will be measured by the DLW method and BMR by ventilated hood or estimated with the Shofield equations.

The aim of the study will be the evaluation of the energy requirements of apparently healthy elderly people living in rural areas where the PAL values should be higher. A comparison of the incidence of obesity and insulin resistance will be made according to the physical activity levels estimated by questionnaire or by the direct measurement of the PAL values. Associations of the incidence of insulin resistance and obesity with low sustained or short vigorous physical activity will be evaluated.

REFERENCES

[1] DURNIN, J.V.G.A., LEAN, M.E.J., Nutrition-consideration for the elderly, In Textbook of Geriatric Medicine and Gerontology, (BROCKLEHURST, J.C. TALLIS, R.C. FILLIT, H.M., Eds), Churchill Livingstone London (1992) 592-611.

[2] SINGH, J., PRENTICE, A.M., COWARD, W.A., ASHFORD, J., SAWYER, M. WHITEHEAD, R.G., Energy expenditure of Gambian women during peak agricultural activity measured by doubly-labelled water method, Br. J. Nutr, **62** (1989) 315-329.

[3] REAVEN,G.M., The fourth musketeer-from Alexander Dumas to Claude Bernard, Diabetologia, **38** (1995) 3-13.

[4] WAREHAM, N.J., *et al.*, A quantitative analysis of the relationship between habitual energy expenditure, fitness and the metabolic cardiovascular syndrome, Br. J. Nutr, **80** (1998) 235-241.

[5] TREMBLAY, A., Physical activity and metabolic cardiovascular syndrome, Invited commentary, Br. J. Nutr, **80** (1998) 215-216.

[6] BOUCHER, B.J., Inadequate vitamin D status: Does it contribute to the disorders comprising syndrome "X"?

[7] HELMRICH, S.P., RAGLAND, D.R., LEUUNG, R.W., PAFFENBARGER, R.S., Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus, New Engl. J. Med, **325** (1991) 147-152.

[8] MANSON, J.E., *et al.*, Physical activity and incidence of non-insulin-dependent diabetes mellitus in women, Lancet, **338** (1991) 774-778.

[9] MANSON, J.E., *et al.*, A prospective study of exercise and incidence of diabetes among US male physicians, J. Am. Med. Assoc, **268** (1992) 63-67.

[10] BURCHFIELD, C.M., *et al.*, Physical activity and incidence of diabetes: The Honolulu heart program, Am. J. Epidemiol, **141** (1995) 360-368.

[11] PERRY, I.J., WANNAMETHEE, S.G., WALLKER, M.K., THOMPSON, A.G., WHINCUP, P.H., Prospective study of risk factors for development of non-insulin-dependent diabetes in middle aged British men, Br. Med. J, **310** (1995) 560-564.

[12] LYNCH, J., *et al.*, Moderately intense physical activities and high levels of cardio-respiratory fitness reduce the risk of non-insulin-dependent diabetes mellitus in middle-aged men, Arch. Intern. Med, **156** (1996) 1307-1314.

[13] HAAPANEN, N., MILUNPALO, S., VUORI, I., OJA, P., PASANEN, M., Association of leisure time physical activity with the risk of coronary heart disease hypertension and diabetes in middle-aged men and women, Int. J. Epidemiol, **26** (1997) 739-747.

[14] DURNIN, J.V.G.A., Energy intake, energy expenditure and body composition in the elderly, Nutrition, immunity and illness in the elderly (CHANDRA, R.K., De.) Pergamon Press, New York (1985) 19-33.

[15] BASSEY, E.J., HARRIES, U.J., Normal values for handgrip strength in 920 men and women aged over 65 years, and longitudinal changes over 4 years in 620 survivors, Clin. Sci, **84** (1993) 331-337.

[16] HORAN, M.A., PENDLETON, N., The relationship between ageing and disease, Rev. Clin. Gerontol, **5** (1995) 125-141.

[17] SHOFIELD, W.N., SHOFIELD, C., JAMES, W.P.T., Basal metabolic rate - Review and prediction together with an annotated bibliography of source material, Hum. Nutr. Clin. Nutr, **39C, Suppl 1** (1985) 5-41.

[18] WORLD HEALTH ORGANIZATION, Energy and protein requirements, Report of a Joint FAO/WHO/UUNU Expert Consultation, Technical Report Series 724, Geneva (1985).

[19] MUNRO, H.N., SUTER, N.M., RUSSEL, R.M., Nutritional requirement of the elderly. Ann. Rev. Nutr, **7** (1987) 23-49 .

[20] JOUNG, V.R., Macronutrients needs in the elderly, Nutr. Rev, **50** (1992) 454-462.

[21] ROBERTS, S.B., Energy requirements of older individuals, Eur. J. Clin. Nutr, **50** (1996) S112-S118.

[22] BLACK, A.E., COWARD, W.A., COLE, T.J., PRENTICE, A., Human energy expenditure in affluent societies: An analysis of 574 doubly-labelled water measurements, Eur. J. Clin. Nutr, **50** (1996) 72-92.

[23] BAYLEY, H., JONES, P., HERNANDEZ ESTRADA, G.M., PORRATA, C., MONTERREY, P., Energy expenditure by the doubly labelled water method in free-living Cuban women of 60-70 years of age from Havana City, 1998 (in preparation).

[24] PORRATA, C., HERNANDEZ, M., ARGUELLES, J.M., PROENZA, M., Recommended dietary allowances for the Cuban population, Rev. Cubana Alim. Nutr, **6** (1992) 132-141.

[25] DOWSE, G.K., ZIMMET, P.Z., KING, H., Relationship between prevalence of impaired glucose tolerance and NIDDM in a population, Diabetes Care, **14** (1991) 968-974.

[26] TAYLOR, R., *et al.*, Physical activity and prevalence of diabetes in Melanesian and Indian men in Fiji, Diabetologia, **27** (1984) 578-582.

[27] HELMRICH, S.P., *et al.*, Physical activity and reduced occurrence of non-insulin dependent diabetes mellitus, N. Engl. J. Med, **325** (1991) 147-152.

[28] BURCHFIELD, C.M., *et al.*, Physical activity and incidence of diabetes: The Honolulu heart program, Am. J. Epidemiol, **141**, 360-368.

[29] RODRIGUEZ, B.L., *et al.*, Impaired glucose tolerance, diabetes and cardiovascular disease risk factor profiles in the elderly, Diabetes Care, **19** (1996) 587-590.

[30] MOOY, J.M., *et al.*, Prevalence and determinants of glucose intolerance in a Caucasian population, The Hoorn Study, Diabetes Care, **18** (1995) 1270-1273

TABLE I. CUBAN POPULATION BY AGE GROUP (1997)

	GLOBAL VALUES		MALES		FEMALES	
AGE GROUP	Total	%	Total	%	Total	%
0 - 4	740 223	6.7	382 088	6.9	358 135	6.5
5 - 9	896 698	8.1	460 526	8.3	436 172	7.9
10 - 14	808 514	7.3	413 879	7.5	394 635	7.2
15 - 19	709 031	6.4	362 362	6.6	346 669	6.3
20 - 24	956 015	8.7	483 656	8.7	472 359	8.6
25 - 29	1 124 731	10.2	566 358	10.2	558 373	10.1
30 - 34	1 133 625	10.3	564 201	10.2	569 424	10.3
35 - 39	793 956	7.2	393 511	7.1	400 445	7.3
40 - 44	690 482	6.3	340 495	6.2	349 987	6.4
45 - 49	663 229	6.0	327 482	5.9	335 747	6.1
50 - 54	593 866	5.4	292 073	5.3	301 793	5.5
55 - 59	498 572	4.5	247 945	4.5	250 627	4.5
60 - 64	389 497	3.5	193694	3.5	195 803	3.6
65 - 74	591 927	5.4	291 491	5.3	300 436	5.5
75 - 84	340 911	3.1	161 383	2.9	179 528	3.3
85y +	107 325	1.0	48 102	0.9	59 223	1.1
	60y +	13.0		12.6		13.5
TOTAL	11 038 602	100.0	5 529 246	100.0	5 509 356	100.0

TABLE II. MORTALITY RATES BY CAUSES IN CUBA (1970-1997) (ALL AGE GROUPS) (RATES per 100 000 inhabitants)

Disease	Code Nr	1970	1980	1990	1996	1997
Heart diseases	410 - 14	148.6	166.7	173.6	206.3	197.1
Malignant Tumours	410	98.9	106.6	114.9	137.4	137.6
Cerebrovascular diseases	430 - 8	60.3	55.3	56.9	72.2	69.2
Accidents	-	36.1	38.0	43.0	51.6	49.4
Influenza and Pneumonia	140 - 208	42.1	38.6	25.5	40.4	45.3
Vascular Diseases	-	23.0	23.5	-	31.9	31.0
Diabetes mellitus	250	9.9	11.1	19.1	23.5	18.4
Suicide	-	11.8	21.4	18.4	18.3	18.4
Cirrhosis and other chronic liver diseases	571.3-9	6.7	5.8	7.8	8.4	8.5
Bronchitis, emphysema, asthma	-	12.5	7.0	9.8	9.4	6.6

TABLE III. DIETARY ENERGY ALLOWANCES FOR CUBAN WOMEN (60-70 years of age). TEE CALCULATED ACCORDING TO FAO/WHO/UNU 1985 [16]. TEE MEASURED BY THE DLW-METHOD. PAL Values. (Collaborating study between the Institute of Nutrition in Havana and the School of Human Nutrition and Dietetics of the Mc Gill University, Montreal, Canada, Feb. 1998)

Subject	Age (years)	Cuban Daily Energy Allowance [1] (BMR X 1.60) (MJ/d)	BMR[a] (MJ/d) [15]	Energy Intake (MJ/d)	Daily Energy Allowance FAO/WHO/UNU 1985 (BMR x 1,51) (MJ/d) (21)	TEE by the DLW - method (MJ/d)	PAL Value (TEE/BMR)
A	67	8.56	5.3504	4.28	8.09	6.86	1.28
B	65	8.19	5.1224	3.05	7.73	6.34	1.24
C	61	8.36	5.2250	5.72	7.89	8.56	1.64
E	62	7.32	4.5752	3.97	6.91	8.74	1.91
G	67	7.92	4.9510	8.20	7.48	7.24	1.46
I	63	7.28	4.5524	4.36	6.87	5.88	1.29
J	67	8.43	5.2668	5.92	7.95	8.59	1.63
L	67	6.84	4.2750	6.54	6.46	7.89	1.84
M	67	7.05	4.4042	5.67	6.65	6.75	1.53
N	70	6.96	4.3510	5.46	6.57	5.90	1.36
P	69	7.43	4.6436	8.85	7.01	10.51	2.26
Mean ± SD		7.67 ± 0.64 [a]	4.79 ± 0.4	5.63 ± 1.76 [b]	7.24 ± 0.60 [a]	7.57 ± 1.43[a]	1.59
Median		7.42 [a]	4.64	5.67 [b]	7.01 [a]	7.2 [a]	
Interval		6.83 - 8.56	4.28 - 5.35	3.05 - 8.85	6.45 - 8.07	5.88 - 10.51	1.24 - 2.26

(Means with different superscripts are significantly different $\alpha = 0.05$)

[1]Recommended Dietary Allowances for the Cuban Population [24].
[a]BMR (MJ/d) = 0,038 (kg body weight) + 2,755 [18].