



Original/*Ancianos*

Factors related to total energy expenditure in older adults (Chile)

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Abstract

Aim: to assess Total Energy Expenditure (TEE) in healthy Chilean institutionalized or independently older people

Methods: twenty seven young (27-30 years), 27 institutionalized (> 65 years old) and 27 free-living older (> 65 years old) participants were studied. Body composition was estimated by dual energy X-ray absorptiometry. Physical activity energy expenditure (AEE) and TEE were assessed using Actiheart accelerometers. The Mini Nutritional Assessment (MNA) was applied and Timed Up and Go (TUG) was measured.

Results: AEE was 171, 320 and 497 kcal/day in institutionalized, free living older and young participants, respectively ($p < 0.01$ between young and older participants). Both absolute TEE and TEE/RMR was higher in young people. Multiple regression analysis accepted age, MNA and TUG as significant predictors of AEE ($r^2 = 0.24$ $p < 0.01$).

Conclusion: AEE and PAL were lower among older people, with no differences by institutionalization.

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Key words: *Actiheart. Body composition. Heart rate. Older people. Total Energy Expenditure.*

FACTORES RELACIONADOS CON EL GASTO ENERGÉTICO TOTAL EN ADULTOS MAYORES (CHILE)

Resumen

Objetivo: evaluar el Gasto Energético Total (GET) en ancianos sanos que viven institucionalizados o independientes en Chile.

Método: se evaluaron veintisiete jóvenes (27-30 años), 27 adultos mayores institucionalizados (> 65 años) y 27 ancianos independientes (> 65 años). Se midió la composición corporal utilizando absorciometría bifotónica de rayos X. Se calculó el gasto energético por actividad física (GEAF) y el gasto energético total (GET) utilizando acelerómetros Actiheart; se aplicó Mini Nutritional Assessment (MNA) y se midió el Timed Up and Go (TUG).

Resultados: el GEAF fue 171, 320 y 497 kcal/día en ancianos institucionalizados, independientes y jóvenes, respectivamente ($p < 0,01$ entre jóvenes y ancianos). Tanto el valor absoluto de GET como GET/GER fue más alto entre los jóvenes. El análisis de regresión múltiple aceptó la edad, el MNA y el TUG como predictores significativos de GEA ($r^2 = 0,24$ $p < 0,01$).

Conclusion: el GEAF y el nivel de actividad física (PAL) fueron más bajos en los adultos mayores, sin diferencias por institucionalización.

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Palabras clave: *Actiheart. Composición corporal. Frecuencia cardíaca. Ancianos. Gasto Energético Total.*

Introduction

Resting metabolic rate (RMR) is responsible for 60–80% of Total Energy Expenditure (TEE) and is primarily responsible for the maintenance of organismal homeostasis. RMR is most often coupled with

measurements of body composition (fat mass and fat-free mass) as an adjustment parameter, because the amount of fat-free mass typically explains >60% of daily RMR¹. The decreases of lean body mass (LBM) and total body water accompanied by an increase of body fat are the most relevant changes of body composition in the old aged, leading to a reduction of the RMR, estimated in about 2% per decade. This decline is closely linked with the decrease in whole-body fat-free mass, which is composed of metabolically active tissues and organs².

The most variable component of daily energy expenditure is the thermic effect of physical activity. Activity energy expenditure (AEE) derives from vo-

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litional exercise and non-exercise activity thermogenesis. It is the less studied component of TEE in the old aged³.

AEE comprises as little as 15% of daily energy expenditure in sedentary older adults and up to 50% of daily energy output in highly active older adults⁴. Total Energy expenditure may be accurately assessed from longer-term, strictly controlled intake-balance diet studies and doubly labelled water analyses. However, it is unrealistic to use these time-consuming, labour intensive, costly methods in clinical and community settings. Physical activity can be also assessed using self-report measures, which are easy to apply but may not capture activity patterns throughout the day accurately. The disadvantage of this technique is the recall bias, and in older adults in particular, self-report may also be influenced by fluctuation in health status, mood, depression, anxiety or cognitive ability⁵. In addition, self-report physical activity measures designed for younger adults have been shown to be inaccurate when applied to older adults, particularly underestimating the performance of light and moderate intensity activities⁶.

Accelerometers are electronic motion sensors that generate an electric charge in response to a mechanical force such as acceleration⁷ and provide information of the amount, frequency and duration of physical activity⁸. If these devices are combined with heart rate monitors they become a good alternative to measure physical activity expenditure in free living old aged individuals. Studies have validated and demonstrated the potential use of accelerometers and heart rate monitors to estimate energy expenditure using double labelled water and indirect calorimetry as gold standards⁹.

The aim of this study was to assess TEE using a device that combines an accelerometer with a heart rate monitor in a group of healthy Chilean old aged and its association with body composition, physical activity level, nutritional and functional status and age.

Methods

Three groups of subjects were selected (81 total, 67 women and 14 men): 27 young (27-30 years), 27 institutionalized old aged (>65 years old) and 27 free-living old aged (>65 years old), from Santiago, Chile. All of them met the inclusion criteria which were absence of severe organ failure, any terminal diseases, decompensated metabolic illnesses and use of medications that could interfere with energy expenditure. (beta adrenergic, corticosteroids), chronic smoking, people unable to climb the first steps of stair without a break, chronic obstructive pulmonary disease with dyspnea, hospitalization within three months prior to the study, involuntary weight loss of >2 kg in the last three months, physical handicaps that might interfere with body composition measurements (amputation, paralysis, etc.), acute medical treatment and people

who suffered long periods of starvation in some moment of their life.

All volunteers agreed to participate through a written informed consent and were subjected to the following assessments:

1. Each one underwent anthropometric measurements (weight, height, calf and mid-arm circumference),
2. Time up and go (TUG) assessment, according to previously described methods¹⁰.
3. Mini Nutritional Assessment (MNA)¹¹ (24) and Mini Mental State Examination (MMSE)¹² Scores.
4. Body composition measurement using Double X ray Absorptiometry (DEXA) in an iDEXA equipment (Lunar, General Electric).

An actiheart[®] device was placed after locating a place in the anterior chest with a good electrocardiographic recording. Participants were instructed to pursue a normal life while wearing the device and it was left for at least 72 hours during the week. Total Energy Expenditure, was calculated using data recorded by the Actiheart, using the software provided by the manufacturer. Using a branched equation model that considers movements and heart rate, REE was estimated from the Schofield equations 1984 (>60 yr: M (0.049 x weight) + 2.459, F: (0.038 x weight + 2.755). Total Energy Expenditure (TEE) was then calculated as the sum of calculated AEE plus Resting Energy Expenditure (REE). Diet Induced Thermogenesis (DIT) was estimated as 10% of the sum of REE + AEE. The physical activity level (PAL) was calculated as the ratio TEE/REE.

Statistical analysis: Was performed using Stata 10 for Windows (StataCorp LP, 4905 Lakeview Drive College Station, TX 77845, USA). Since most variables had a non-normal distribution, according to Shapiro-Wilk test for normality, data are expressed as median (interquartile range). Kruskal Wallis test was used to compare groups and Pearson Correlation coefficient for correlations.

Results

Two older subjects (one living in a nursing home and one living in the community) had to be excluded from the analysis due to faulty Actiheart recordings that were unreliable for estimation of AEE. Gender, age, anthropometry, geriatric assessment scales and body composition of participants is shown in table 1. Both groups of older subjects were comparable in terms of age, gender distribution and geriatric scores. Body mass index was significantly lower among younger participants, but no differences between groups of older subjects were observed. Total fat mass was significantly higher among older people living in nur-

sing homes. The latter had significantly lower MMSE and TUG scores than their free living counterparts (Table I).

Median AEE was 171, 320 and 497 Kcal/day among nursing home residents, free living older people and young people, respectively ($p < 0.01$ between young and old participants). TEE and the PAL were also higher among young participants. No significant difference in energy expenditure parameters was observed between both groups of old aged or between genders (Table II).

A univariate analysis showed that, among older people, AEE correlated with TUG and MNA ($r = -0.27$ $p = 0.05$ and $r = 0.33$ $p = 0.01$, respectively). A multiple regression analysis accepted age, TUG and MNA as significant predictors of AEE with an overall r^2 of 0.24 ($p < 0.01$)

Discussion

As expected, this study shows that AEE and thus calculated TEE was lower among the old aged. However no differences between institutionalized and free living participants were detected. Age and MNA was significantly associated with this variable. This study provides measured total/resting energy expenditure ratios, which can be used to calculate total energy requirements in older subjects

We measured AEE using Actiheart accelerometers, a measurement system is less accurate than doubly labeled water¹³, but provides a good estimate that can be used reliably for clinical studies. Although this method has not been compared with doubly labeled water me-

asurements in adults, at least in children, there is an acceptable degree of agreement between the latter and Actiheart¹⁴. Among adults, Actiheart has been compared with indirect calorimetry to estimate activity energy expenditure, with good results¹⁵. However another study, in young adults, performing different activities, showed that Actiheart underestimated AEE¹⁶.

The estimation of AEE in older adults has been a matter of controversy. There is consensus that REE decreases in this age group along with a reduction in fat free mass¹⁷, the main determinant of energy expenditure. However, there is no consensus concerning the influence of a reduction of physical activity in this age group, as compared to young subjects. Previous studies, performed in rural Chilean older subjects, determined a mean activity energy expenditure of 542 Kcal/day. However, the activity levels of subjects living in a rural environment are usually higher than those of their urbanized counterparts¹⁸. Therefore, this value cannot be used in urban older subjects. Another study, performed in Pittsburgh, United States using double labeled water, reports much higher levels of AEE in free living healthy older subjects, ranging from 576 Kcal/day in women to 769 Kcal/day in men, with TEE/REE ratios ranging from 1.68 to 1.72¹⁹, which more than doubles our results.

The discrepancies between our results and those reports could be caused by a real difference in levels of physical activity between our participants and those of the Pittsburgh study or because Actiheart devices may underestimate the physical activity level, as discussed before. The first possibility has support on field surveys performed previously by the Ministry of Health in Chile, reporting extremely low levels of physical activity among adults, that is even lower among sub-

Table I
General features of studied subjects

	A: Institutionalized older people (n=26)	B: Free living older people (n=26)	C: Young adults (n=27)	Significant differences§
Gender (males/females)	4/22	4/22	6/21	
Age	82 ± 4.6	82 ± 4.5	27 ± 1.8	C vs A y B
Weight (kg)	62.25 (59.2-68.5)	61.1 (55.5-72.6)	60.7 (51.2-69.3)	
Height (cm)	155 ± 0.08	158 ± 0.07	163 ± 0.09	C vs A y B
Body mass index (kg/mt ²)	26.9 ± 3.29	25.3 ± 3.50	22.9 ± 2.74	C vs A y B
Arm circumference (cm)	27.1 (26.3-29)	27.05 (25 - 28.5)	27 (25-30.4)	
Calf circumference (cm)	34.1 (33-36)	34.3 (31.7-37.2)	35.5 (34-37)	
Fat free mass (kg)	34.6 (31.7-36.6)	35.4 (32.8-39.5)	36.9 (32.9-47.9)	
Fat mass (kg)	25.7 ± 5.05	23.08 ± 7.12	19.39 ± 5.34	C vs A
Mini mental score	28 (27-29)	29 (28-30)	30 (30-30)	C vs A vs B
Mini nutritional assessment	26.5 (25-27.7)	27.5 (26.5-28)	27 (25.5-28)	
Timed up and go (seconds)	9.9 (9.27-12.1)	7.7 (6.8-9.3)	5.0 (4.5-5.8)	C vs A vs B

§ Kruskal Wallis $p < 0.05$ or less
() interquartile range

Table II
Energy expenditure of studied subjects

	A <i>Institutionalized older people (n=26)</i>	B <i>Free living older people (n=26)</i>	C <i>Young adults (n=27)</i>	<i>Significant differences</i>
Resting energy expenditure (Kcal/day)	1223 (1202-1289)	1212.5 (1162-1317)	1385 (1244-1568)	C vs A and B
Activity energy expenditure (Kcal/day)	171 (127-374)	320 (209-374)	497 (382-697)	C vs A and B
Dietary induced thermogenesis (Kcal/day) [§]	161 (148-184)	170 (159-186)	216 (184-245)	C vs A and B
Total energy expenditure (Kcal/day)	1616 (1483-1847)	1706 (1593 - 1862)	2162 (1849-2455)	C vs A and B
Physical activity level [†]	1.27 (1.27-1.41)	1.38 (1.29-1.45)	1.5 (1.41-1.58)	C vs A and B

[§] = Estimated as 10% of total energy expenditure

[†] = Estimated as the ratio total/resting energy expenditure

[§] = Kruskal Wallis $p < 0.05$ or less

() *interquartile range*

jects aged over 65 years²⁰. The low levels of physical activity among Chilean older subjects detected in this study would be an important risk factor for the development of functional limitations in the future, considering epidemiological and experimental evidence demonstrating the positive effects of exercise among older people²¹.

The second possibility, that Actiheart devices underestimate AEE, could be a weakness of the present investigation, requiring further confirmation. TEE is calculated by these devices through the estimation of REE, using formulas that are fairly accurate but with known limitations²². DIT is theoretically estimated thus, only AEE is derived from actual registries of movements and heart rate data. Since there are previous reports indicating that these devices can underestimate expenditure, the results of this study must be interpreted cautiously²³. However, as mentioned it does not invalidate the demonstration of a significant fall in AEE associated with ageing.

The association between MNA and activity energy expenditure is noteworthy. MNA is a relatively simple geriatric assessment score, that contains items related to nutritional status, but it also evaluates functional capacity²⁴. It has a good prognostic value for mortality among hospitalized older people and for future disability among free living subjects²⁵. Therefore, the association herein described is probably related to the capacity of MNA to assess also functional capacity. This asseveration is supported by the association between activity energy expenditure and TUG. This is a parameter that directly assesses functionality²⁶ and has been proposed to define frailty among older subjects²⁷. Therefore, AEE in older subjects is related to their functional capacity. This is a relatively obvious association since it is logical that subjects with limitations would move less and expend less energy²⁸.

Body composition parameters had no association with activity energy expenditure. This is in contradiction with other reports showing that sarcopenia has a direct influence in the level of activity of older subjects²⁹. However, it is important to remember, that the association of fat free mass, functional status and mobility is relatively weak and the latter parameter is associated with other variables such as pain and fear of falls³⁰.

Measurements were taken during summer, considering that this climate would be better to measure activity. However, during the study, we realized that the old aged had lower activity due to suspension of municipal activities. Therefore, it may be possible, that AEE in free-living old aged could be even higher than institutionalized.

In summary, this study found very low levels of activity energy expenditure in healthy older subjects. These results must be confirmed with other measurements of energy expenditure such as indirect calorimetry or double labeled water.

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Key Points

1. The TEE, TEE/RMR, AEE and PAL in older were lower than young people. There isn't, effect with of institutionalization.

2. Institutionalized people had Fat mass higher, without differences in fat free mass compared with free living participants

3. MNA and TUG were significant predictors of AEE

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