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Body composition and physical activity patterns of Indonesian elderly with low body mass index

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Body composition and physical activity of institutionalised elderly were studied. Forty elderly subjects were divided into two groups according to their body mass index (BMI). One group (n=20) had BMI < 17 kg/m^2 (low BMI) and was defined as having chronic energy deficiency (CED), and the other group (n=20) had BMI values between 22.0 to 25.0 kg/m^2 (BMIs generally regarded as healthy). Body composition was measured using skinfold thicknesses and bioelectrical impedance analysis (BIA). The Durnin and Womersley[1] equation was used to estimate fat mass (FM) from the sum of four skinfold thicknesses, namely biceps, triceps, subscapular and suprailiac. With BIA, two formulae were adopted to calculate fat free mass (FFM); they were the Lukaski[2] and Deurenberg[3] equations. These three formulae were compared. The physical activity level (PAL) was estimated on the basis of recorded daily physical activity patterns, and calculation of energy expenditure was based on a report by FAO/WHO/UNU[4].

Skinfold assessment provided the highest value for FM estimation, and BIA using Deurenberg's[3] equation (BIA-H) gave the lowest value. The average of FM obtained by the three methods in elderly with low and normal BMI were 4.9 ± 2.5 kg and 16.7 ± 3.2 kg, respectively. The discrepancy between Lukaski[2] and Deurenberg[3] equations was less as FM increased.

The elderly with low BMIs had very low fat mass. Nevertheless, thin elderly had the same level of physical activity (1.3 x BMR) as those with apparently healthy BMIs. The BMI cut off point to define CED was not sensitive enough to detect any physical consequences of low BMI in Indonesian elderly as this may reflect PALs which are overall very low. Comparable investigation of non-institutionalised elderly is needed. This study is the first to assess the functional significance of BMI in Southeast Asian elderly.

Key words: Body composition, elderly, physical activity, body mass index, Indonesia, bioelectrical impedance, chronic energy deficiency, ethnicity

Introduction

In many Southeast Asian countries, continuous economic growth in recent decades has led to improved living conditions for large parts of the population. Partly, this improvement has resulted in increased life expectancy. In Indonesia, life expectancy has increased from an average of 43 years in 1965 to 60 years in 1989 for males, and respectively from 45 to 63 years for females[5,6]. With increased life expectancy, the proportion of elderly in the population has increased, but so far, in Indonesia, little information is available on the health and nutritional status of elderly individuals.

Body mass index (BMI) is an easily measurable nutritional status indicator `for adults. A BMI of less than 18.5 has been proposed to indicate chronic energy deficiency (CED) in adults[7]. It is claimed that adults with BMIs below 18.5 have low levels of energy expenditure, whereas those with BMIs lower than 17 have added health risk and further reduction in physical work capacity and daily energy expenditure[7]. This classification could be used to screen populations or individuals for different purposes[8]. Although the validity of the classification has been studied[9], further investigation of its general applicability for different populations is recommended[8]. Testing of the validity and usefulness of the BMI classification could be done by studying the relationship between BMI and actual body composition, and by investigating its relationship to functional indicators such as daily activity patterns.

A previous survey among Indonesian urban elderly indicated that 33% had a BMI<18.5 and 15% had a BMI<17.0[10]. Considering this high prevalence of low BMI individuals, CED may be a public health problem amongst Indonesian elderly, or alternatively, the BMI cut-off point to define CED may not be valid for Indonesian elderly. It is important to know what physical consequences arise in Indonesian elderly with low BMI values.

The present study compared the body composition and physical activity patterns of elderly subjects of low BMI with their counterparts of normal BMI.

Methods

Subjects

The study was carried out in East-Jakarta. Subjects were selected among elderly living in three nursing homes. Selection criteria were age and BMI. All subjects were older than 60 years. Twenty subjects were selected with a BMI below 17, and 20 elderly were selected with a BMI between 22 to 25. None of the subjects suffered from overt disease and all were able to walk and dress unaided.

Anthropometric and body composition assessments

Body weight (BW) was measured using a platform model electronic weighing scale (Seca 770, Hamburg, Germany). Subjects were weighed barefoot with minimum clothing (no correction was made for clothing). Measurements were taken two hours after breakfast and the weight was recorded to the nearest 0.1 kg.

Height (HT) was measured to the nearest 0.1 cm using a

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microtoise. Subjects stood barefoot on a flat horizontal surface, their head held in the Frankfurt plane, and with their heels, buttocks, shoulders touching the wall. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2).

Armspan (AS) was measured to the nearest 0.1 cm using a 2 m long ruler fixed horizontally to the wall. Subjects were measured with their chest to the wall, their arms held horizontally at the level of their shoulders, and stretched to the maximum with the palms to the wall.

Body composition was assessed through measurements of skinfold thicknesses. Skinfold thickness at sites of biceps (BSF), triceps (TSF), subscapular (SSF) and suprailiac (HSF) were measured on the left side of the body using a Holtain caliper (Holtain Ltd, Crymych, UK) and for each subject, the average of two measurements was recorded. Total body fat (TBF) was estimated using the equation of Durnin and Womersley[1]. All measurements were carried out by the same researcher (DNI).

Bioelectrical impedance analysis (BIA)

BIA was also undertaken to assess body composition. Body resistance and reactance were measured with the subject in a supine position with limbs away from the trunk as described by Lukaski[11] with a bioelectrical impedance analyser (RJL Systems, Inc., BIA-101, Detroit, MI, USA). Measurements were made at about 9:00 AM and the subjects were asked not to eat beforehand (no instructions were given regarding the drinking of water). Fat-free mass (FFM) was calculated using equations of Lukaski and Deurenberg. Fat mass (FM) was calculated as the difference between body weight and FFM.

Physical activity assessment

Physical activity level (PAL)[12] was calculated on the basis of recorded daily physical activity patterns, using minute-to-minute registration[13]. Recording was performed by trained research assistants, who stayed with the subjects during two consecutive days from 8 AM to 8 PM. It was explained empathically to the subjects that they should continue to carry out their habitual daily tasks while the assistants were present. The recall method was used to determine activities carried out when the assistants were not present. Each day, the period of time (minutes) spent on each activity was calculated and the results were averaged over the two days. The PAL was calculated using estimated energy costs of each category of activities, based on values published by the World Health Organization[4]. Furthermore, on the same days as the recording of the physical activity patterns, a pace-counter (Caltrac) was used to estimate the level of physical activity of the subjects. The pace-counter was attached around the subject's waist for 24 hours per day, and was only taken off when the subject took a bath.

Results

Selected physical characteristics of the subjects are presented in Table 1. The gender proportion was similar for both groups. The age, height, armspan, and the ratio of height/armspan did not differ significantly between the groups. Body weight and BMI of the subjects with BMI<17 were especially low with mean values of 34.9 and 15.6, respectively. The waist-hip ratio (WHR) in subjects with BMI<17 was significantly lower ($P<0.01$) than those with a BMI>22. As was to be expected, the sum of skinfolds of the subjects with a BMI<17 was significantly lower than those whose BMI was between 22-25. The biceps + triceps/suprailiac + subscapular ratio, an indicator of fat distribution on extremities vs trunk, was 0.75 ± 0.14 and 0.69 ± 0.18 for the thin and fatter elderly (P= 0.22), respectively.

Results of the FM assessment by skinfold measurements and by BIA are presented in Table 2. Available BIA equations use subject's HT as a denominator to estimate the length of the conductor. However, due to the osteoporotic process in the elderly, height may not be a valid denominator. Despite unavailability of an appropriate denominator in the elderly, we tried to rationalise BIA equations by using AS as a surrogate denominator for HT.

The skinfold technique provided the highest value in FM estimation and BIA using Deurenberg's equation (BIA2-H) gave the lowest value. The averages of FM given by the three methods in the elderly with low and normal BMI were 4.9 ± 2.5 kg and 16.7 ± 3.2 kg, respectively. The FM of the low BMI group was very low. The average FFM given by the three methods was 29.4 ± 4.5 kg in low BMI subjects and 36.0 ± 6.0 kg in normal BMI subjects. The relative differences between skinfold and BIA2-H in normal BMI group were smaller than those in the low BMI group.

Table 1. Selected physical characteristics of Indonesian elderly with low and normal BMI.

Variable	BMI<17 (n= 20)	BMI>22 (n= 20)
Sex	6 M; 14 F	5 M; 15 F
Age (y)	65.80 ± 4.70	64.40 ± 2.90
Weight (kg)	34.90 ± 3.80†	52.70 ± 5.30†
Height (cm)	149.60 ± 6.40	150.90 ± 8.00
Armspan (cm)	156.40 ± 8.10	155.40 ± 6.30
Height/Armspan	0.96 ± 0.03	0.97 ± 0.03
BMI(kg/m^2)	15.60 ± 1.40†	23.10 ± 0.80†
Waist circumference (cm)	59.70 ± 4.10†	79.40 ± 7.30†
Hip circumference (cm)	77.20 ± 3.20†	91.70 ± 5.20†
WHR	0.77 ± 0.05†	0.87 ± 0.07†
MUAC (cm)	20.10 ± 2.00†	28.40 ± 2.40†
BSF (mm)	4.00 ± 1.80†	14.50 ± 11.70†
TSF (mm)	6.40 ± 2.50†	17.00 ± 4.10†
SSF (mm)	7.40 ± 2.30†	22.70 ± 5.50†
HSF (mm)	6.50 ± 2.30†	21.60 ± 6.40†
Total skinfolds (mm)	24.40 ± 7.90†	75.80 ± 18.90†

†Difference between groups $P < 0.01$. Values are mean ± SD.

Table 2. Fat mass (FM) of Indonesian elderly with low and normal BMI assessed by different methods.

Method	BMI<17 (n= 20)	BMI>22 (n= 20)
BIA1-H (Lukaski)	5.60 ± 2.30	15.90 ± 3.30
BIA2-H (Deurenberg)	1.40 ± 2.90	14.40 ± 3.90
BIA1-AS (Lukaski, armspan)	3.60 ± 2.70	14.30 ± 3.40
BIA2AS(Deurenberg, armspan)	-0.10 ± 4.50	13.40 ± 4.20
Skinfold	7.60 ± 2.30	19.70 ± 2.50

Values are in mean ± SD (kg) The formulae used were:
Lukaski: $FFM = 0.734Ht^2/R + 0.096\ Xc + 0.116\ Wt + 0.878\ G - 4.033$
Deurenberg: $FFM = 0.652Ht^2/R + 3.8\ G + 10.9$
Ht=height or armspan (cm), Xc=reactance (ohm), Wt=weight(kg) R=resistance (ohm), G=Gender (1 for male, 0 for female).

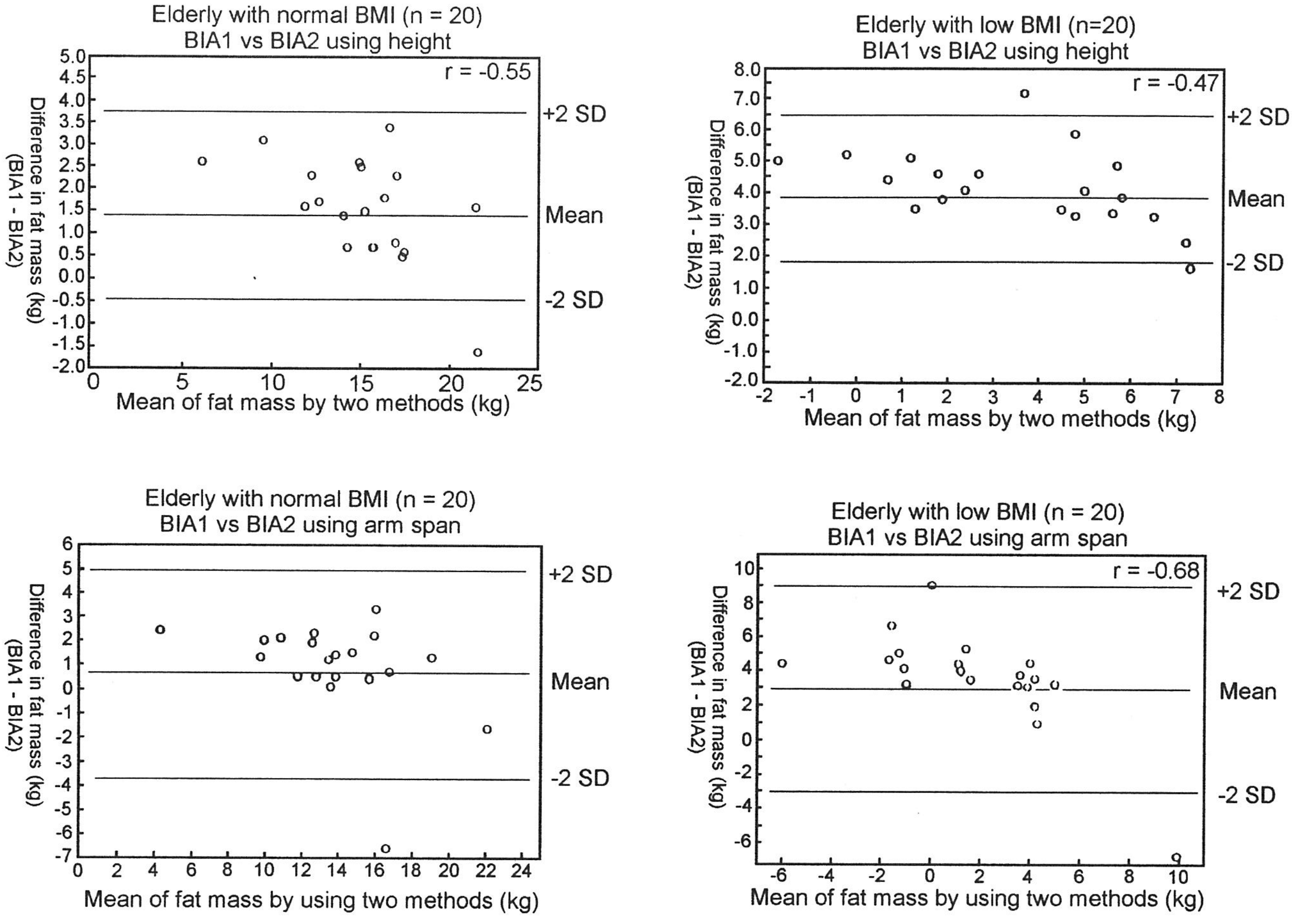
Table 3. Daily activities (min) of Indonesian elderly with low and normal BMI.

Activity	BMI<17 (n= 20)	BMI>22 (n= 20)
Resting and relaxing (min)	1080	1083
Low energy cost activity (min)	153	160
Washing, dressing (min)	23	20
Walking (min)	92	99
Other (min)	92	78

Table 4. Energy expenditure of Indonesian elderly with low and normal BMI.

Energy exp.	BMI<17 (n= 20)	BMI>22 (n= 20)	P
PAL (BMR)	1.31 ± 0.09	1.30 ± 0.09	ns
Caltrac	186.00 ± 68.00	175.00 ± 70.00	ns

Figure 1. Difference in fat mass vs mean fat mass for estimates from BIA1 and BIA2 using height (BIA1-H and BIA2-H) and armspan (BIA1-AS and BIA2-AS).



The agreement between the two equations of BIA derived from height (BIA1-H vs BIA2-H) and derived from armspan (BIA1-AS vs BIA2-AS) are shown by plots of the difference between the 2 methods against their means (Figure 1). The average difference in FM assessed by BIA1-H vs BIA2-H was 4.2 ± 1.2 kg (P= 0.035; r= -0,47) in elderly with low BMI and 1.5 ± 1.1 kg (P= 0.013; r= -0.55) in elderly with normal BMI. The average difference in FM assessed by BIA1-AS vs BIA2-AS were 3.7 ± 2.9 kg (P= -0.001, r= -0.68) in the low BMI group and 0.9 ± 2.1 kg (P= 0.09; r= -0.39) in the normal BMI group.

Table 3 presents physical activity patterns of both groups and the time (min) spent on each activity based on a two-day observation. No significant differences in the time spent on activities were observed between the low and normal BMI groups. The energy expenditure of the subjects with low and normal BMI is shown in Table 4. PAL calculation did not provide significant differences in energy expenditure between the two groups. Caltrac calculation has demonstrated that elderly subjects with low BMI tended to have higher energy expenditure than their counterparts with normal BMI.

Discussion

The general applicability of the CED definition for different populations, especially the Indonesian elderly, is, for the first time, tested in this study. An indication to pursue this issue was ascertained by Woo et al[14], who reported that the BMI of elderly Chinese was lower than that of other elderly with different ethnic backgrounds, namely Caucasian, Maori and Scandinavian. The 50th percentile BMI values for the Chinese elderly fell on the 25th percentile BMI values for the Caucasian elderly in United Kingdom. Wang et al[15] supported the notion that, despite lower BMI values, Asians had a higher percentage of body fat, which was more centrally distributed, than did Caucasians.

Skinfold measurements gave the highest assessment of FM, followed by the Lukaski and Deurenberg BIA equations. The same result was found by the McNeill G et al[16] study among British women where BIA gave a lower assessment of FM than 7 site skinfolds. In spite of this, Eaton et al[17] found that BIA and skinfold assessment gave similar average values. Different reductions in skin elasticity among elderly may be responsible. Extra cellular water (ECW) is best predicted by impedance at frequencies of 5 kHz and total body water (TBW) at higher frequencies[18]. Since the ratio ECW/TBW increases with age, the use of low frequency adversely affects TBW accuracy.

The differences between the Lukaski and Deurenberg equations are less in elderly with normal BMI than with low BMI. The elderly with normal BMI have closer results than do the thin elderly. The differences between the two equations varied by a negative (-) significant correlation coefficient. Therefore, the discrepancy between the Lukaski and Deurenberg equations decreases with greater fat mass.

For BIA, length of the conductor may not be well assessed with height due to osteoporotic compression of vertebrae, kyposis or loss of disc height. But this study found that substitution of armspan for height provided higher standard error (SE) in low and normal BMI (14.7% and 12.0%, respectively) than using height (9.8% and 6.3%, respectively).

Physical activity level was very low (1.3 x BMR), with no significant difference between thin and normal elderly. Low physical activity may be due to increased body weight in the elderly[19]. The thin elderly who had CED had the same activity as those with normal BMI. The current PAL could be the result or the cause of their current weight. This question could be addressed by retrospective analysis of their body weight and activity, but, preferably, by a prospective study. Perhaps the thin elderly reduced their physical activity spontaneously as an adaptation in energy balance[20]. The low PAL score of the reflected most activities being relatively low energy household activities.

The high correlation between Caltrac and PAL (r= 0.55, p= 0.0002) indicates the likely validity of the physical activity result. Caltrac has very high inter-instrument reliability, and had significant correlation with heart rate monitoring and physical activity recall[21].

Conclusion

This study found that using skinfolds and BIA assessment, the thin elderly had very low fat mass. Both the thin and the normal BMI elderly had low physical activity levels, so the study of non-institutionalised elderly is needed to compare this result.

The validation of elderly body composition methods is necessary. BMI has been proposed to classify adult CED, however, research on use of BMI in the elderly is still needed.

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印度尼西亞低體重指數老年人的體成分及體育與運動模式

本文對養老院的老人的體成分及體育活動進行了研究. 將四十位老年人按體重指數分爲兩組, 一組(20例)的體重指數小于17 kg/m^2(低 BMI 組)爲慢性熱量缺乏組 (CED), 另一組(20例)BMI在22.0－25.0 kg/m^2(通常認爲是健康的BMI範圍). 體成份可以通過皮褶厚度及生物電阻抗分析 (BIA) 來計算. 體脂含量可利用二頭肌、三頭肌、肩胛下角及髂前上棘的皮褶厚度, 采用Durnin和Womersly的公式來計算; 瘦體塊 (FFM) 可以根據生物電阻抗, 利用Lukaski和Deurenberg公式計算. 三個公式可以一起使用, 體育活動水平 (PAL) 可根據每日運動記錄進行評估, 而熱量消耗則可根據 FAO/WHO/UNU 的報告進行計算.

采用皮褶計算出的體脂含量爲最大 估計值, 采用生物電阻抗 Deurenberg 的公式計算出的體脂含量爲最小值估計值. 通過三種方法得出的體脂含量的平均值在低BMI組及正常組分別爲 4.9 ±2.5公斤和16.7±3.2公斤, 隨着體脂的增加Lukaski 與 Deurenberg 公式 之間的不符合率 減小.

低 BMI 組的老人體脂非常低, 但他們與 BMI 正常的老人的運動水平是一樣的(1.3 × 基礎代謝率). 在印尼老人中, 用BMI值低來確定CED不能測出低BMI對身體的影響, 因爲這可能會表現在總體運動量很低. 因而在不住養老院的老人中進行有可比性的研究是很有必要的. 該研究是首次對東南亞老年人進行的 BMI 功能差异的研究.

References

1. Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfolds thickness measurements on 481 men and women from 16 to 72 years. Br J Nutr 1974: 32: 77-97.
2. Lukaski HC, Johnson PE, Bolonchuk WW, Lykken GI. Assessment of fat free mass using bioelectrical impedance measurements of the human body. Am J Clin Nutr 1985; 41: 810-7.
3. Deurenberg P, Westrate JA, van der Kooy K. Body composition changes assessed by bioelectrical impedance measurements. Am J Clin Nutr 1989; 49: 401-3.
4. WHO/FAO/UNU. Energy and protein requirements. Report of a joint expert consultation. WHO Technical Report Series No 724. Geneva: WHO, 1985.
5. World Bank. World Development Report 1991. The challenge of development. Geneva: Oxford University Press, 1991.
6. World Bank. World Development Report 1992. Development and the environment. Geneva: Oxford University Press, 1992.
7. James WPT, Ferro-Luzzi A, Waterlow JC. Definition of chronic energy deficiency in adults. Eur J Clin Nutr 1988; 42: 969-81.
8. James WPT, GCN Mascil-Taylor, NG Norgan, BR Bristian, PS Shetty, A Ferro-Luzzi. The value of arm circumference measurements in assessing chronic energy deficiency in third world adults. Eur J Clin Nutr. 1994. 48, 883-894.
9. Ferro-Luzzi A, Sette S, Franklin M, James WPT. A simplified approach to assessing adult chronic energy deficiency. Eur J Clin Nutr 1992; 46: 173-86.
10. Rabe B. Cross-sectional study of the nutritional status of the elderly in a suburban community of Jakarta, Indonesia [thesis]. Jakarta: University of Indonesia, 1994.
11. Lukaski HC, Bolonchuk WW. Estimation of body fluid volumes using tetrapolar bioelectrical impedance measurements. Aviat-Space-Environment-Med, 1988Dec; 59 (12): 1163-9.
12. James WPT, Schofield EC. Human energy requirements. London: Oxford University Press, 1990.
13. Durnin JVGA, Passmore R. Energy, work and leisure. London: Heinemann educational books Ltd:, 1967.
14. Woo J, Ho SC, Donnan SPB, Swaminathan RS. Nutritional status of healthy, active Chinese elderly. Br J Nutr 1988; 60: 21-8.
15. Wang J, Thornton JC, Russell M, Burastero S, Heymsfield S, Pierson RN. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparison of anthropometric measurements. Am J Clin Nutr 1994; 60: 23-8.
16. McNeill G, Fowler PA, Maughan RJ, McGaw BA, Fuller MF, Gvozdanovic S. Body fat in lean and overweight women estimated by six methods. Br J Nutr 1991; 65: 95-104.
17. Eaton AW, Isreal RG, O'Brief KF, Hortobagyi I, McCammon MR. Comparison of four methods to assess body composition in women. Eur J Clin Nutr 1993; 47: 353-60.
18. Visser M, Deurenberg P, van Staveren WA. Multi-frequency bioelectrical impedance for assessing total body water and extracellular water in elderly subjects. Eur J Clin Nutr 1995; 49: 256-66.
19. Voorrips LE. Diet and physical activity as determinants of nutritional status in elderly women [thesis]. Wageningen: Department of Human Nutrition, Wageningen Agricultural University, 1992.
20. Schultink JW, Van Raaij JMA, Hautvast JGAJ. Seasonal weight loss and metabolic adaptation in rural Beninese women : The relationship with body mass index. Br J Nutr 1993; 70: 689-700.
21. Sallis JF, Buono MJ, Roby JJ, Carlson D, Nelson J. The Caltrac accelerometer as a physical activity monitor for school-age children. Med Sci Sport Exercise 1990; 22: 698-703.