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# Energy Expenditure of Grade Four School Children in Western Australia.

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## INTRODUCTION

A composite team from the Public Health Service, the West Australian Institute of Technology, and the Graylands Teachers College conducted surveys on grade 7 children in 1974, and grade 4 children in 1975. The intention of the surveys was to find some relationship between the energy expenditure and the energy intake of each age group. As there is little information concerning the activity patterns of West Australian children the findings of these surveys would serve as a basis for more detailed reports into the physical fitness, activity and dietary balance of children in today's changing society.

The study reported below is of the 1975 survey conducted on grade 4 children.

## SOURCE OF THE DATA

363 grade 4 boys and girls from eleven Western Australian primary schools were used in the survey. The schools were selected to represent a cross section of socio-economic groups in the state. The sample included two "disadvantaged schools", six metropolitan state primary schools, one state country primary school, one independent girls primary school, and one independent boys primary school. No attempt was made to select a random sample of Western Australian schools, and no attempt was made to select a random sample within the schools.

## TESTS

### *Anthropometric Data.*

Heights and weights were taken according to Clark (1967, p. 98). Subjects wore physical education shorts and shirts, and were bare footed. Height was recorded in centimetres and weight in kilograms. Surface area was determined from height weight charts (Pyke and Brown, 1968, pp. 382 - 385), and was recorded in square metres.

Skinfold measures were taken according to Yuhasz, (1962). Four sites on the right hand side of the subject were used, and the results were recorded in millimetres.

1. Abdomen - a pinch taken vertically and level with the navel.
2. Suprailiac - a pinch taken laterally in line with the iliac crest.
3. Triceps - a pinch taken vertically at the mid - point between the shoulder and the elbow.
4. Subscapular - a pinch taken in line with the inferior medial border of the scapular.

### *Energy Expenditure.*

Energy expenditure was calculated for a period of 24 hours.

Subjects recorded the time spent on various activities during the school day, 9.00 a.m. to 3.30 p.m. Similar information was recorded separately for the period from 3.30 p.m. to 9.00 a.m. the following day.

The activities listed were allocated to one of 5 categories, based on those used by Durnin, (1971, pp. 133 - 135). The categories were sleeping, sitting, sitting - standing, light work, and heavy work.

The energy expended during sleep was assumed to be approximately equal to the basal metabolic rate (Durnin and Brockway, 1959, p. 44), and was calculated from Mayo Foundation Normal Standards, using the height and weight of each subject, with an adjustment for age (Pyke and Brown, 1968, pp. 382 - 385). The mean energy expenditure for sleeping was found to be 1.73 kilocalories/kg/hr.

The energy expenditure during activity was based on oxygen utilization in children as shown by Bar-Or et al, (1971, pp. 108 - 113), Skinner et al, (1971, pp. 24 - 28), and Hermansen and Oseid, (1971, pp. 18 - 23). On the basis that one litre of oxygen is approximately equivalent to 5 kilocalories (Astrand and Rodahl, 1970, p. 436) a nine year old child would expend 15 kilocalories/kg/hr in performing maximal work, 3.5 kilocalories/kg/hr performing light work, 2.1 kilocalories/kg/hr sitting - standing, and 1.9 kilocalories/kg/hr sitting.

Using the weight of each child and the time spent in each category of activity, the energy was calculated for the 24 hour period.

### *Administration.*

Testing teams were drawn from physical education students at Graylands Teachers College. Each team consisted of two students who were responsible for the administration of all tests at one school. Before the survey preliminary orientation sessions were conducted to establish tester reliability.

Approval to conduct the survey was obtained from the Director of Primary Education, and from the principal of each school. Parental approval was obtained for each child who participated in the survey.

Testing teams visited the schools prior to the survey date to familiarize themselves with class-room procedures, and to explain the test administration to class teachers.

On the first day of the survey, testing teams collected anthropometric data and activity records for the period 9.00 a.m. to 3.30 p.m.

On the second day, testing teams collected activity records for the period 3.30 p.m. to 9.00 a.m.

Children were given guidelines to assist them in completing forms, and were encouraged to seek help from the testing teams and their parents.

## RESULTS

A summary of the results are listed in Table 1.

The mean age of the children was 9 years and 1 month.

The mean height of 132.5 cm, for boys, falls on the 50th percentile in the tables issued by the Australian Department of Health (Australian Department of Health, 1975, p. 16), and the mean weight of 29.28 kg, for boys falls on the 25th percentile.

The mean height for girls, 130.8 cm, falls on the 50th percentile of the tables, and the mean weight for girls, 29.42, falls on the 55th percentile.

TABLE 1  
GRADE 4 CHILDREN

| School                   | N    |        | Mean Height cm |        | Mean Weight kg |        | Mean BMR |        |
|--------------------------|------|--------|----------------|--------|----------------|--------|----------|--------|
|                          | Male | Female | Male           | Female | Male           | Female | Male     | Female |
| Beckenham                | 18   | 20     | 131.9          | 131.8  | 28.22          | 26.74  | 50.03    | 49.35  |
| East Victoria Park       | 11   | 9      | 121.8          | 123.4  | 28.64          | 29.28  | 46.65    | 43.39  |
| Graylands                | 14   | 17     | 134.8          | 135.1  | 29.29          | 28.5   | 53.71    | 49.38  |
| Hale                     | 19   |        | 136.2          |        | 33.92          |        | 56.99    |        |
| Merredin                 | 20   | 15     | 132.4          | 123.2  | 27.04          | 25.76  | 48.64    | 46.32  |
| Methodist Ladies College |      | 8      |                | 129.0  |                | 30.75  |          | 45.84  |
| North Lake               | 13   | 18     | 132.5          | 130.6  | 28.85          | 28.96  | 51.46    | 47.21  |
| Rossmoyne                | 18   | 19     | 135.1          | 132.9  | 29.82          | 30.65  | 56.85    | 49.54  |
| Swanbourne               | 30   | 22     | 134.5          | 135.6  | 26.6           | 29.1   | 50.54    | 50.5   |
| Whiteside                | 18   | 20     | 131.3          | 131.1  | 27.35          | 28.23  | 51.24    | 47.05  |
| Winterfold               | 27   | 27     | 134.1          | 132.2  | 32.00          | 31.59  | 53.82    | 49.34  |
|                          | 188  | 175    | 132.5          | 130.8  | 29.28          | 29.42  | 52.16    | 48.31  |
|                          |      |        | 131.8          |        | 29.36          |        | 51.11    |        |

The mean energy expenditure for boys was found to be 1890.4 kilocalories, which was below the recommended dietary allowance of 2200 kilocalories, and the mean energy expenditure for girls, which was found to be 1838.1 kilocalories, was below the recommended dietary allowance of 2100 kilocalories (National Health and Medical Research, 1971, pp. 9 - 12).

During the day the children spent an average of 10.4 hours sleeping, 3.05 hours sitting, 6.18 hours sitting - standing, 1.06 hours performing light work, and 3.3 hours doing heavy work.

An average of 533 kilocalories were expended during sleep, 136 kilocalories were expended sitting, 358 kilocalories were expended sitting - standing, 109 kilocalories were expended doing light work, and 732 kilocalories were expended performing heavy work. The mean expenditure of kilocalories for boys and girls was found to be 1868.6.

The expenditure of calories and the total skinfold measures were calculated for school and sex at the Public Health Services computing centre, Perth. Means for these measures are listed in Table 11.

TABLE 11  
GRADE 4 CHILDREN

| School                   | Mean Expenditure of Kilocalories |        | Mean Total Skinfold |        |
|--------------------------|----------------------------------|--------|---------------------|--------|
|                          | Male                             | Female | Male                | Female |
| Beckenham                | 1835.8                           | 1921.5 | 31.0                | 41.4   |
| East Victoria Park       | 1867.8                           | 1918.5 | 27.1                | 32.3   |
| Graylands                | 1949.2                           | 1690.6 | 26.9                | 40.6   |
| Hale                     | 2060.8                           |        | 44.9                |        |
| Merredin                 | 1756.7                           | 1624.6 | 17.9                | 20.4   |
| Methodist Ladies College |                                  | 1993.5 |                     | 44.6   |
| North Lake               | 2058.1                           | 1802.6 | 34.9                | 56.3   |
| Rossmoyne                | 2020.6                           | 2035.0 | 24.6                | 38.4   |
| Swanbourne               | 1822.7                           | 1865.9 | 29.9                | 32.8   |
| Whiteside                | 1537.4                           | 1513.5 | 24.4                | 35.4   |
| Winterfold               | 2030.0                           | 2017.9 | 42.9                | 77.4   |
| Mean                     | 1890.4                           | 1838.1 | 31.04               | 44.2   |
|                          | 1686.6                           |        | 37.4                |        |

## DISCUSSION

Tanner (1973, pp. 145 - 146), indicated a secular trend towards increased height and weight, and earlier physical maturity of children. When the results of the present survey are compared to those in 1908 (Blackburne, 1980, p. 15), 1939 (Goodes, 1942, p. 9), 1940 and

1947 (Patrick, 1951, pp. 324 – 31), 1955 (Report of the Commissioner of Public Health, 1955, P. 77), 1956 (Lane, 1956, pp. 451 – 3), and 1972 (Australian Department of Health, 1975, p. 16), it would seem that this trend could exist in Western Australia (Table 111).

TABLE 111

| Year            | 9 Years   |           |           |           | 11 – 12 Years |           |           |           |
|-----------------|-----------|-----------|-----------|-----------|---------------|-----------|-----------|-----------|
|                 | Boys      |           | Girls     |           | Boys          |           | Girls     |           |
|                 | Height cm | Weight kg | Height cm | Weight kg | Height cm     | Weight kg | Height cm | Weight kg |
| 1908 (9-10 Yrs) | 128.2     | 26.8      | 126.5     | 26.5      | 142.5         | 34.8      | 141.7     | 34.8      |
| 1939            | 130.3     | 26.5      | 129.5     | 26.4      | 144.5         | 34.9      | 146.6     | 36.7      |
| 1940            | 130.2     | 26.5      | 129.5     | 26.4      | 144.8         | 34.9      | 146.7     | 36.7      |
| 1947            | 130.2     | 27.49     | 130.2     | 27.55     | 144.5         | 34.9      | 147.3     | 37.4      |
| 1955            | 132.7     | 28.9      | 131.4     | 30.0      | 147.3         | 38.8      | 150.5     | 41.1      |
| 1956            |           |           |           |           | 145.0         |           |           |           |
| 1972            | 132.0     | 29.4      | 130.9     | 29.0      | 146.8         | 39.3      | 148.6     | 41.0      |
| 1975            | 132.5     | 29.28     | 130.8     | 29.4      | 151.9         | 41.4      | 151.2     | 43.8      |

If this assumption is accepted, it follows that a population of bigger children advanced in physical development, would consume more food and expend greater amounts of energy. The results of recent surveys do not indicate that this is occurring in Western Australia. Grade 7 children investigated in 1974 (Longelaan, Henzell, and Adams, 1974, and grade four children investigated in 1975 (Longelaan, Henzell, and Adams, 1975), had food intakes below the recommended dietary allowances for their ages, and in both cases the energy expenditure was found to be less than the energy intake (Table 1V). No comparative data on skinfold measures is available for West Australian children, however, Durnin (1971), and Durnin et al (1974), in studies of adolescent children in Scotland, found a trend towards decreased energy intake, as well as an increase in fat deposition.

TABLE 1V

|       | GRADE 4 |                        |        |                    | GRADE 7 |                        |        |                    |
|-------|---------|------------------------|--------|--------------------|---------|------------------------|--------|--------------------|
|       | Fat     | Energy in Kilocalories |        |                    | Fat     | Energy in Kilocalories |        |                    |
|       | mm      | Intake                 | Output | Recommended Intake | mm      | Intake                 | Output | Recommended Intake |
| Boys  | 31.0    | 2089                   | 1890.4 | 2200               | 32.4    | 2525                   | 1851   | 2900               |
| Girls | 44.2    | 2050                   | 1838.1 | 2100               | 27.8    | 2262                   | 1789   | 2500               |

From the results of this survey it seems that further investigations with more precise measures are warranted in the case of children in Western Australia. A sample representative of the state should be selected from year 1 children, and changes in activity patterns, dietary patterns and energy expenditure observed on a longitudinal basis. As children could not be expected to maintain the quality of diary described by Garrow (1974, p.52), the record should be compiled by a trained observer. Indirect calorimetry as described by Durnin and Brockway (1959, pp. 41 – 53) should be used to determine the energy expenditure in the common activities, lying, sitting, standing, walking and running.

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