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Major influences on median energy and nutrient intakes among teenagers: a Tasmanian survey

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1. This report explores the characteristics that influenced median intakes of energy and ten nutrients in a representative sample of 1055 adolescents (11–16 years) in Tasmania, Australia.

2. Among girls, the characteristic with greatest influence on intakes was different for different nutrients. Thus, median intakes of fat, iron, thiamin and niacin-equivalent were lower in heavier, fatter girls. Girls from larger families consumed more riboflavin, while girls with poorly educated mothers consumed less vitamin A. Girls who regularly took vitamin supplements had higher median intakes of (food-derived) calcium.

3. Among boys the increase of intakes of energy and nutrients with age overshadowed the influence of other characteristics.

4. Among younger boys the characteristic with greatest influence varied. Those with highly educated fathers had lower median intakes of energy and carbohydrate; those who exercised vigorously consumed more fat; those who smoked 'heavily' (> 10 cigarettes in the previous week) consumed more thiamin and niacin-equivalent.

5. Among older boys the characteristic with greatest influence varied. Those who drank 'heavily' (> five glasses in the previous week) had higher intakes of energy and fat. Those from professional–managerial households consumed more thiamin.

6. For vitamin C, there was no sex difference in intakes. Social status had the greatest influence, with children from professional–managerial households eating more.

7. Food choices underlying these differences in energy and nutrient intakes were explored.

Despite recent interest in links between diet and disease (Gori, 1979; Richard, 1980; Spiller & Freeman, 1981), surprisingly little is known about dietary variations within western communities. Such information would be useful both to the epidemiologist and the practitioner of preventative medicine. However, only a handful of studies (e.g. Samuelson *et al.* 1971; Cook *et al.* 1973) have attempted to examine the effects of a range of personal characteristics on dietary intakes.

A recent survey of high-school students (ages 11–16 years) in Tasmania obtained 24 h diet records, along with a range of other information about each respondent. To assess the information, the author used distribution-free statistical methods to identify those characteristics which had the strongest impact (in statistical terms) on intakes of energy and nutrients. The effect of these characteristics on food choices was also explored.

MATERIALS AND METHODS

Students in grades 7–10 (modal ages 12–15 years) in Tasmanian schools were sampled, by a two-stage cluster technique. Subjects completed a 24 h diet record (Woodward *et al.* 1981), and a questionnaire on physical, socio-economic and behavioural characteristics (see p. 22). In all, 1055 usable replies were obtained, a response rate of 81%.

As described by Woodward *et al.* (1981), the diet record was used to estimate 24 h intakes of energy and 10 nutrients. These estimated intakes were found to be consistent with those of previous studies on this age group in Australia; further confirmation has since been provided by a recent South Australian survey (Baghurst & Record, 1983).

Physical characteristics

Students were requested to state their sex, age (at last birthday), height (without shoes) and weight (without shoes or blazer). From their information, fatness was calculated as kg/m² (without correction for the weight of clothing).

The sex and age distributions of the samples were consistent with official values for grades 7–10 (Australian Bureau of Statistics, 1980). Several percentiles (10th, 50th and 90th) of height and weight in the sample were similar to those for comparable groups in other recent Australian surveys (Jones *et al.* 1973; Court *et al.* 1976).

Socio-economic characteristics

School type. There were five categories: district schools, rural government high schools, urban government high schools, Catholic schools and non-Catholic private schools. Comparison with official statistics indicated that the samples were reasonably representative, with mild over-sampling of district and Catholic school students (Woodward *et al.* 1981).

Social status. Based on respondents' description of the job of the main income earner, social status was categorized by the five-point scale of Broom *et al.* (1965). The distribution in the sample appeared reasonably consistent with information on the Australian male workforce at the 1976 census (see Woodward *et al.* 1981).

Educational attainment of father and mother. This was categorized as: did not complete high school, completed high school but no further study, further study after completing high school. Comparison with census information on age of leaving school and on attainment of a post-school qualification (Australian Bureau of Statistics, 1979) suggested that the parents of our respondents were reasonably representative of Tasmanian adults, with some over-representation of the more educated.

Family size. This was defined as the total number of brothers and sisters. Census information on the number of children per household is biased by the moving-out of older siblings. A better indication of sibling numbers is gained from census information (Australian Bureau of Statistics, 1979) on the number of children per (ever-)married woman in the age group 30–55 years (the likely age group for mothers of high-school students): the estimated distribution of family size in Tasmania based on these findings agrees well with the distribution in the sample.

Behavioural characteristics

Alcohol usage was categorized, by questions about consumption in the previous 7 d and in the past, as never, at least once in the past (but not last week), not more than five glasses in the past week, or more than five glasses in the past week. Smoking was similarly categorized as never, at least once in the past (but not last week), not more than 10 cigarettes in the past week, or more than 10 cigarettes in the past week. Usage of vitamin supplements was categorized as regular (daily or every second day), occasional, or never. Usage of analgesics (the questionnaire used the terms 'aspirin or other pain-killer', and included a list of common proprietary lines) was categorized as none in the previous 7 d, one to four doses this week, or more than four doses this week. For all these characteristics, distributions in the sample were similar (in so far as comparison was possible) to those obtained for Hobart high-school students by Lewis & Rayner (1978).

Exercise was categorized (by the respondents) as being, on average, < 0.5 h/d, about 0·5 h/d, about 1 h/d, about 2 h/d, > 2 h/d. No comparable information is available for Australians in this age group.

Why use median-based methods?

It has been conventional in dietary surveys to summarize group intakes in terms of mean values, and to assess differences between groups using methods based on the comparison of mean values (e.g. *t* test, analysis of variance, regression). Provided that values follow a 'normal' distribution, this approach is satisfactory: the mean is easily interpreted (50% of values are below it), and mean-based comparisons may be validly applied.

In the present study, however, distributions of energy and nutrient intakes were markedly non-normal. (This was not unexpected: Egger & Hermus (1980) comment that non-normal distributions are 'the rule rather than the exception' for dietary intakes.) This made interpretation of the mean difficult, and prevented valid application of mean-based comparisons. A possible remedy was to find a mathematical 'transformation' that would convert intakes to a normal distribution. In the present study, several transformations were tried but none achieved satisfactory normalization.

An alternative approach was therefore adopted, using the median to summarize group intakes, and the median test (Conover, 1971*a*) to assess differences between groups. No matter what the shape of the distribution, the median always has a clear and simple interpretation (in all cases, 50% of values are below the median) and the median test may always be validly applied. Although relatively unfamiliar to many nutritionists, the use of the median and the median test is perfectly orthodox among statisticians, and appropriate computer programs are available in the standard packages.

These 'distribution-free' or 'non-parametric' techniques also minimize the problem of suspect, extreme values. Surveys often yield a small number (estimated at 1–2% in the present study) of records suspected of under- or over-statement of intakes, and these tend to cluster near the low and high ends of the distribution. If transformation is used to normalize values for mean-based techniques, these suspect values may lead to the choice of an inappropriate transformation, and hence cause misleading inferences to be drawn. By contrast, median-based techniques are virtually unaffected by small numbers of suspect, outlier values. (The median test has another advantage over the mean-based tests, although this advantage was not exploited in the present paper. Mean-based tests can be applied only to analysis of average intakes. However, the median test is easily converted to the quantile test, so that analyses can be made in relation to any chosen percentile (Conover, 1971*b*). A later report in this series looks at characteristics affecting the 25th percentile (an indicator of intakes in the lower part of the range of values) and the 75th percentile (an indicator of intakes in the upper part of the range).)

'Explanatory variables' (EV)

A technical statistical problem arose from the varied types of personal characteristics in the present study. Some had only two categories (e.g. sex); some had several categories, with no obvious ranking order (e.g. school type); some had several categories, with an obvious ranking order (e.g. smoking); some were 'continuous' (e.g. height). There was no obvious yardstick by which the impacts of these heterogeneous types of characteristics on intakes could be uniformly compared, whether using mean-based or median-based comparisons.

The solution adopted was to translate all these characteristics to a two-category format (EV). The EV used are listed in Table 1. For most characteristics, more than one EV was created. However, not all possible binary divisions were used; the choice of divisions was based on intuitive expectations of likely influences.

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Table 1. *Definition of the explanatory variables (EV) used in the analysis*

1 EV based on physical characteristics	2 EV based on behavioural characteristics	3 EV based on socio-economic characteristics
Age	Alcohol usage	Social status
A1 $\leqslant$ 12 years *v.* $\geqslant$ 13 years	DR1 Never *v.* the rest	SS1 Professional–managerial *v.* the rest
A2 $\leqslant$ 13 years *v.* $\geqslant$ 14 years	DR2 Not this week *v.* the rest	SS2 Professional–managerial–clerical *v.* the rest
A3 $\leqslant$ 14 years *v.* $\geqslant$ 15 years	DR3 > Five glasses this week *v.* the rest	SS3 Labourers and semi-skilled *v.* the rest
		SS4 Labourers *v.* the rest
Height	Smoking	Father's education
H1 Below 33rd percentile for group *v.* the rest	SM1 Never *v.* the rest	EF1 Did not complete high school *v.* the rest
H2 Below 66th percentile for group *v.* the rest	SM2 Not this week *v.* the rest	EF2 Further study after high school *v.* the rest
	SM3 > Ten cigarettes this week *v.* the rest	
Weight	Vitamin supplements	Mother's education
W1, W2 } Defined analogously to H1, H2	VI1 Never *v.* the rest	EM1, EM2 } Defined analogously to EF1, EF2
	VI2 Regular *v.* the rest	
Fatness	Analgesics	Family size
F1, F2 } Defined analogously to H1, H2	AN1 None this week *v.* the rest	FS1 $\leqslant$ One sibling *v.* the rest
	AN2 > Four doses this week *v.* the rest	FS2 $\leqslant$ Two siblings *v.* the rest
Sex	Exercise	School type
Sex Boys *v.* girls	EX1 < 0·5 h/d *v.* the rest	ST1 District schools *v.* the rest
	EX2 $\leqslant$ 0·5 h/d *v.* the rest	ST2 Rural *v.* urban
	EX3 $\leqslant$ 1 h/d *v.* the rest	ST3 Government *v.* non-government
	EX4 $\leqslant$ 2 h/d *v.* the rest	ST4 Catholic *v.* the rest
		ST5 Non-Catholic private *v.* the rest

Identification of 'dominant' EV

Initially the author assessed, using the median test, the impact of each EV (separately) on median intakes of energy and each nutrient (separately). For most substances more than one EV had a significant impact.

This finding raised problems of interpretation. Consider the results for energy, as an example. Several EV had a significant impact; the impact of sex was the strongest (boys ate more than girls), followed by alcohol usage ('heavier' drinkers (DR3) ate more than others). As sex had the greatest impact, we accept that boys ate more than girls. But how do we interpret the impact of DR3? (*a*) Did drinking have a similar impact on energy intake in both sexes? (*b*) Did drinking have no impact on energy intake in either sex? (Most of the 'heavier' drinkers were boys, who would be expected to eat more than girls; hence a spurious statistical impact for drinking could occur.) (*c*) Did drinking have an impact in one sex only? ('Heavier' drinking might lead boys to eat more, but not have such an effect among girls.) The simplest way to decide between such possibilities is to divide the sample on the basis of the EV with greatest impact (the 'dominant' EV); in this case, we divide on the basis of sex into two distinctive groups, boys and girls. We then assess the impact of each EV (separately) in each of the two distinctive groups (separately). Thus, if (*a*) were valid, we would expect similar impacts for DR3 in each group; if (*b*), no impact in either group; if (*c*), an impact in one group only. (For simplicity, the discussion has been based on only two EV. However, the principles may be extented to the multiple EV case, with similar conclusions.)

These considerations led to the development of an efficient data-exploration strategy. Median intakes of energy and the 10 nutrients were assessed separately. For each substance, the median test was used to identify those EV which had a statistically significant impact ($P < 0{\cdot}01$) on median intakes. If one or more EV had a significant impact, the EV with the greatest impact was designated the 'dominant' EV, and the sample was divided (on the basis of that EV) into two distinctive groups; the analysis was then repeated for each distinctive group. If no EV had a significant impact, the sample was not divided, and the analysis for that substance was terminated.

Statistical significance

Only those differences having $P < 0{\cdot}01$ were considered significant because the conventional $P < 0{\cdot}05$ level would entail too many false positive results with the multiple comparisons used in this approach. If $0{\cdot}001 < P < 0{\cdot}01$, the difference was described as moderate; if $0{\cdot}0001 < P < 0{\cdot}001$, the difference was strong; if $P < 0{\cdot}0001$, the difference was very strong.

In many instances, such terms as impact or influence are used to refer to a significant difference found with particular EV. The author fully recognizes that a statistical impact of this nature demonstrates only an association, rather than a causal link. However, these terms provide a convenient verbal shorthand.

Food categories

Some analyses examined intakes of food categories, the quantity of food in each category being expressed as MJ provided by that category. The categories were linked to the 'basic five' (cereals, fruit and vegetables, meat, milk, and butter–margarine) used in Australian nutrition education. They were the following.

Cereals. This comprised 'plain' cereals, such as bread, breakfast cereals (if they had < 100 g sucrose/kg), plain biscuits, scones, pancakes and maize. Because most of the butter–margarine consumed is spread on plain cereals, this category included such spreads. (Sweet biscuits, sucrose-rich breakfast cereals, cakes and puddings were allocated to the 'miscellaneous' category.) Median intakes were 2·5 MJ for boys and 1·7 MJ for girls.

Fruits and vegetables. This included all fruits and vegetables (except maize and legumes) and their juices. (Jams and fruit pies were allocated to 'miscellaneous'.) Median intakes were 1·6 MJ for both sexes.

Meat. This included meats of mammal origin, poultry and seafoods, eggs, legumes (except green peas and green beans), nuts and peanut butter, pies and stews having one of these as a major ingredient. Median intakes were 2·4 MJ for boys and 1·8 MJ for girls.

Dairy. This included milk, cheese, and yoghurt. (Ice-cream was allocated to 'miscellaneous'. Butter and margarine, if spread on plain cereals, were allocated to 'cereals'; if used in cooking, they were allocated to the appropriate category for that food, usually 'miscellaneous'.) Median intakes were 1·5 MJ for boys and 1·0 MJ for girls.

Miscellaneous. This included all items not allocated to the four preceding categories. Major items included 'sweet' cereals, soft drinks, ice-cream and confectionery, soups, sauces, alcohol, proprietary lines of the Milo and Vegemite types. Median intakes were 2·2 MJ for boys and 1·9 MJ for girls.

RESULTS

An earlier report has already presented a summary of intakes, in relation to two characteristics: age and sex (Woodward *et al.* 1981). This report extends the analysis to include all fifteen of the personal characteristics recorded.

Median intakes of energy and nutrients (excluding vitamin C)

Boys ate more than girls. As described on p. 25, the impact of each EV was assessed on median intakes of energy and each nutrient. The dominant EV was sex, for energy and all the nutrients (except vitamin C); its impact was very strong. Boys ate more than girls.

To explore the food choices underlying this sex difference, the author aggregated the foods eaten into five categories (see p. 25), and used the median test to assess the impact of sex on median intakes (as MJ) of each food category. If the two sexes ate similar diets, the only difference being that boys ate a larger quantity, we would expect the EV sex to have a very strong impact on intakes of all five food categories. The findings did not quite fit this simple pattern: boys gave relatively less emphasis to fruit and vegetables and to miscellaneous foods than girls. Thus, the EV sex had a very strong impact on intakes of dairy, meat and cereal foods. It had only a moderate impact on miscellaneous foods, and no significant impact on fruits and vegetables.

Older boys ate more than younger boys. As shown in Table 2, EV based on age (or the closely related characteristic, height) were dominant for energy and all nutrients (except vitamin C): older boys ate more than younger boys.

(The trend in median intakes with age was confirmed, using Kendall's rank-correlation statistic τ, for intakes *v.* age. The standard formula (Conover, 1971*c*) was adjusted (B. Brown, personal communication) to allow for ties in the age variable. A zero value for τ would imply that intakes did not vary with age (Maritz, 1981). With the exception of Ca ($\tau = 0{\cdot}07$, $P \sim 0{\cdot}06$), τ-values for energy and nutrients were significantly different from zero, ranging between $\tau = 0{\cdot}11$ ($P \sim 0{\cdot}003$) for riboflavin and $\tau = 0{\cdot}17$ ($P < 0{\cdot}00001$) for fat.)

The dominant EV varied, and hence the definition of older and younger. Thus for energy and most nutrients, younger meant $\leqslant$ 12 years; for carbohydrate, $\leqslant$ 13 years; for thiamin and niacin-equivalent, $\leqslant$ 1·67 m.

This discrepancy of definition was clarified by plotting median intakes against age: two examples are shown in Fig. 1. For energy (as for most nutrients), intakes jumped between 12 and 13 years, but were relatively constant thereafter. For carbohydrate (and thiamin and niacin-equivalent), intakes increased more gradually from 12 to 14 years, and then remained fairly constant.

Table 2. *Median intakes of energy and several nutrients among boys in Tasmanian high schools*

(Boys ⩽ 12 years comprised 25% of boys in the sample, boys ⩽ 13 years 48%, boys ⩽ 1·67 m 67%. Where an explanatory variable appears in parentheses, it was dominant for that nutrient in that distinctive group)

(*a*) A1 dominant	Boys	Impact of A1	Boys ⩽ 12 years	Boys ⩾ 13 years
Energy (MJ)	11·4	***	10·0 (EF2)	11·8 (DR3)
Protein (g)	93	**	80	97
Fat (g)	120	***	99 (EX4)	125 (DR3)
Iron (mg)	16·1	**	14·4	16·8
Calcium (g)	0·95	**	0·81	1·00
Riboflavin (mg)	3·1	*	2·6	3·2
Vitamin A (mg)	1·15	**	0·91	1·20
(*b*) A2 dominant	Boys	Impact of A2	Boys ⩽ 13 years	Boys ⩾ 14 years
Carbohydrate (g)	335	***	305 (EF2)	354
(*c*) H2 dominant	Boys	Impact of H2	Boys ⩽ 1·67 m	Boys > 1·67 m
Thiamin (mg)	1·9	**	1·7 (SM3)	2·1 (SS1)
Niacin-equivalent	37	**	35	43

A1, ⩽ 12 years *v.* ⩾ 13 years; A2, ⩽ 13 years *v.* ⩾ 14 years; H2, height below 66th percentile for boys *v.* other boys; EF2, father did further study after high school *v.* the rest; DR3, drank more than five glasses of alcoholic beverage this week *v.* the rest; EX4, exercised ⩽ 2 h/d *v.* the rest; SM3, smoked more than 10 cigarettes this week *v.* the rest; SS1, professional–managerial households *v.* the rest.

* $0.001 < P < 0.01$, ** $0.0001 < P < 0.001$, *** $0.00001 < P < 0.0001$.

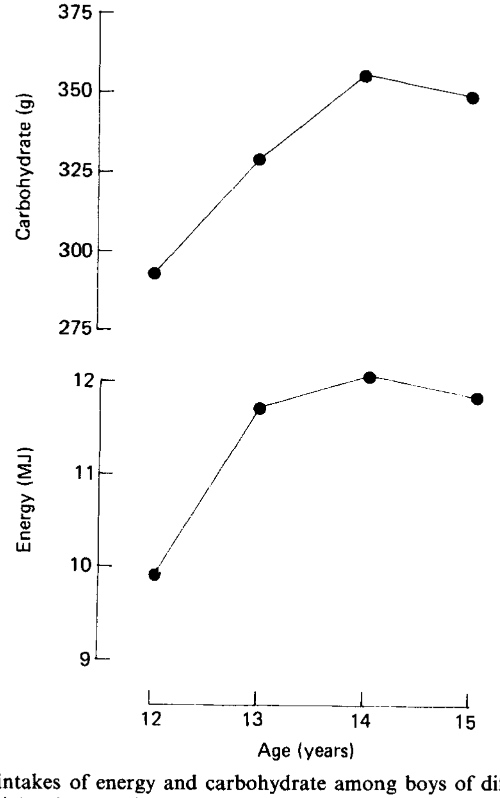

Fig. 1. Median daily intakes of energy and carbohydrate among boys of different ages. It should be noted that median heights increased linearly with age: 12 years 1·52 m, 13 years 1·59 m, 14 years 1·65 m, 15 years 1·73 m.

In terms of food choices, the older boys gave relatively less emphasis to dairy, meat and miscellaneous foods. Intakes of these three categories were not influenced by A1, A2 or H2. Intakes of fruit and vegetables increased with age (A1 had a strong impact, A2 a moderate one), as did intakes of cereal foods (A1 and H2 had moderate impacts, A2 a strong one). These levels of impact suggest that cereal intakes increased more gradually than fruit and vegetable intakes.

Among younger boys, various EV were dominant. Father's educational attainment (EF2) was dominant for energy and carbohydrate intakes among younger boys, its impact being moderate. The 31% of younger boys who had a father educated past high-school level consumed less energy (8·7 MJ) and carbohydrate (274 g) than other younger boys (10·5 MJ and 334 g).

Exercise (EX4) was dominant for fat intakes, its impact being moderate. The 18% of younger boys who exercised more than 2 h/d had greater fat intakes (125 g) than other younger boys (96 g).

Smoking (SM3) was dominant for thiamin and niacin-equivalent, its impact being moderate. The 7% of younger boys who smoked more than ten cigarettes that week consumed more thiamin (2·7 mg) and niacin-equivalent (52 mg) than other younger boys (1·7 and 34 mg).

The EV SM3 had a moderate impact on intake of fruit and vegetables: thus the greater thiamin and niacin-equivalent intakes among 'heavier' smokers would seem to be associated with greater intakes of fruit and vegetables. However, EF2 and EX4 had no significant impact on food categories, so that the observed differences in intakes of energy, carbohydrate and fat must be attributed to differences of emphasis within the five broad food categories.

No EV studied had a significant impact on median intakes of protein, Fe, Ca, riboflavin or vitamin A among younger boys.

Among older boys, various EV were dominant. Alcohol usage (DR3) was dominant for energy (with a strong impact) and fat (moderate impact). About 18% of older boys drank more than five glasses that week. They had higher energy (13·4 MJ) and fat (153 g) intakes than other older boys (11·6 MJ, 122 g). (As only about 2% of older boys reported drinking on the survey day itself, the greater energy intakes of the 'heavier' drinkers cannot be attributed to the energy content of the alcoholic beverages consumed.)

Social status (SS1) was dominant for thiamin, its impact being moderate. The 30% of older boys who came from professional–managerial backgrounds consumed more thiamin (2·4 mg) than other older boys (1·9 mg).

Neither DR3 nor SS1 had a significant impact on median intakes of the five food categories studied. The observed differences in energy and nutrient intakes must therefore be attributed to differences in emphasis within these categories.

No EV had a significant impact on median intakes of protein, Fe, Ca, riboflavin, vitamin A, carbohydrate or niacin-equivalent among older boys.

Among girls, various EV were dominant. Results are summarized in Table 3. No EV had a significant impact on median intakes of energy, protein or carbohydrate. EV related to weight/fatness (W1, F1, F2) were dominant for thiamin, niacin-equivalent, Fe and fat: intakes decreased as weight/fatness increased. These dominant EV had a strong (W1, F2) or moderate (F1) impact on miscellaneous foods; F2 had a moderate impact on cereals. These decreases in nutrient intakes were therefore associated with lower intakes of miscellaneous foods and, for Fe, cereal foods. (The miscellaneous foods included fat-rich items such as ice-cream and confectionery, and also various sweetened cereals that contain appreciable amounts of Fe, thiamin and niacin-equivalent.)

EV related to socio-economic background (FS2, EM1) were dominant for two nutrients: girls from large families ate more riboflavin, and daughters of less educated mothers ate

Table 3. *Median intakes of energy and several nutrients among girls in Tasmanian high schools*

(Light, thin and plump girls each comprised 33% of girls in the sample, as did those with mothers who did not complete high school. Regular consumers of vitamin supplements comprised 28%, and those from large families 76%. Where an explanatory variable appears in parentheses, it was dominant for that nutrient in that distinctive group.)

(*a*) No EV dominant	Girls			
Energy (MJ)	8·9			
Protein (g)	71			
Carbohydrate (g)	269			
(*b*) W1 dominant	Girls	Impact of W1	Light girls	Other girls
Thiamin (mg)	1·4	*	1·6	1·3 (SS2)
Niacin-equivalent (mg)	29	*	32	28
(*c*) F1 dominant	Girls	Impact of F1	Thin girls	Other girls
Iron (mg)	12·2	*	13·7	11·5
(*d*) F2 dominant	Girls	Impact of F2	Non-plump girls	Plump girls
Fat (g)	91	*	95	80
(*e*) VI2 dominant	Girls	Impact of VI2	Regular users of vitamin supplements	Other girls
Calcium (g)	0·72	*	0·84 (FS2)	0·66 (ST3)
(*f*) FS2 dominant	Girls	Impact of FS2	Large family	Small family
Riboflavin (mg)	2·3	*	2·4	2·0
(*g*) EM1 dominant	Girls	Impact of EM1	Better educated mother	Less educated mother
Vitamin A (mg)	0·87	*	0·93 (SS1)	0·74

W1, weight < 45 kg *v.* the rest; F1, fatness $< 18·5$ kg/m^2 *v.* the rest; F2 fatness $> 20·7$ kg/m^2 *v.* the rest; VI2, regular consumers of vitamin supplements *v.* the rest; FS2, $\leqslant$ two siblings *v.* the rest; EM1, mother did not complete high school *v.* the rest.

* $0·001 < P < 0·01$.

less vitamin A. These differences were not paralleled by differences in intakes of our broad food categories, and presumably reflected different emphases within these categories.

Unexpectedly, the dominant EV for Ca (VI2) reflected usage of vitamin supplements: regular users consumed more Ca. (The estimates of nutrient intakes did not include the nutrient contents of such supplements.) VI2 also had a moderate impact on one food category: regular users consumed more dairy foods.

For three nutrients, the distinctive groups in Table 3 were not homogeneous. Within these groups, the dominant EV (all of which had a moderate impact) were as follows. Family size (FS2) was dominant for Ca among girls who regularly took vitamin supplements. The 73% who came from large families (i.e. > two siblings) ate more Ca (0·92 g) than those from smaller families (0·63 g). They also ate more dairy products. School type (ST3) was dominant for Ca among girls who did not take vitamin supplements regularly. The 26% who came from non-government schools consumed more Ca (0·74 g) than those from government schools (0·62 g). This difference was not paralleled by differences in the broad food categories. Social status (SS2) was dominant for thiamin among girls who were 'not light': the 44% who came from 'white-collar' households ate more (1·5 mg) than those from other households (1·3 mg). Social status (SS1) was also dominant for vitamin A among girls whose mothers had completed high school; the 32% from professional–managerial households ate more (1·08 mg) than the others (0·88 mg). Neither of these differences was paralleled by differences in intakes of food categories.

Median intakes of vitamin C

Vitamin C behaved quite differently from energy and other nutrients. Sex had no significant impact. The dominant EV was SS1, its impact being strong. The children from professional–managerial households ate more vitamin C (124 mg) than other children (90 mg). This difference was not paralleled by differences in intakes of food categories, but presumably reflected different emphases in the fruit and vegetable category.

DISCUSSION

Comparison with other surveys

The present study has looked at the impact of a variety of personal characteristics. In doing so, it has undertaken an analysis more extensive than any previously carried out on either Australian or overseas populations. So, quite apart from any issue of methodology or possible population differences, there is simply no published report against which to assess these findings fully.

However, published information on adolescents provides support for some of the findings. Comparisons presented are necessarily suggestive rather than rigorous: other studies have looked at different sets (usually fairly restricted) of EV and different age ranges, and have not often presented tests of statistical significance.

Effect of sex. Other investigators have noted that boys eat more energy and nutrients than girls, from about 11 years onwards (Lubbe, 1973; van Schaik & Kenter, 1973; Myres & Kroetsch, 1978; United States National Center for Health Statistics, 1979; Boggio & Klepping, 1981; Stolley *et al.* 1982; Baghurst & Record, 1983). Inspection of their values suggests that sex differences in vitamin C intake are less marked than for other nutrients.

Sex differences in food intakes have been less widely studied. Boys appear to eat more bread, meat and dairy products than girls, but differences in fruit, vegetables and empty-energy items seem less marked (van Schaik & Kenter, 1973; Myres & Kroetsch, 1978; Boggio & Klepping, 1981). For snacks, American boys prefer bread, meat or milk, while girls prefer fruit or candy (Huenemann *et al.* 1968).

These results appear consistent with those from the present study.

Effect of age. Other investigators have also noted that intakes of energy and nutrients increase with age among adolescent boys, but not girls (Lubbe, 1973; United States National Center for Health Statistics, 1979). The effect of age on food choices has apparently not been studied previously in adolescents.

Effect of weight/fatness. Huenemann (1972) reported that, among teenage girls, intakes of energy and several nutrients declined as percentage body fat increased. These results are consistent with those in the present study for certain nutrients.

Effect of socio-economic characteristics. Other investigators report that the children of well-educated, high-status, high-income families tend to have higher intakes of energy and nutrients (Cook *et al.* 1973; Myres & Kroetsch, 1978; Khoury *et al.* 1981) and differ somewhat in food choices (Samuelson *et al.* 1971; Haley *et al.* 1977; Myres & Kroetsch, 1978) from other children. Their findings are broadly consistent with ours. However, there is a discordant finding (perhaps reflecting concern about obesity) in that younger Tasmanian boys ate less energy and carbohydrate if their fathers were well educated.

The influence of family size is not consistent in the literature. According to Dutch (van Schaik & Kenter, 1973) and Swedish (Samuelson *et al.* 1971) studies, this factor has little impact on energy and nutrient intakes or on food choices. However, a British study (Cook *et al.* 1973) reported a significant impact for certain nutrients. The present study noted an impact for riboflavin and Ca among girls.

Effect of behavioural characteristics. The present study noted impacts for smoking, alcohol usage, usage of vitamin supplements and exercise for specific nutrients in particular distinctive groups. No other investigator seems to have looked at the effects of such characteristics in adolescents.

Some groups 'at risk' for particular nutrients

The primary focus in the present paper has been to identify the major influences on intakes of energy and nutrients. However, comparison of the estimates of median intakes with the official Australian recommendations (National Health and Medical Research Council, 1971) allows an approximate assessment of dietary adequacy. For most nutrients, median intake was comfortably above the recommended intake for all the distinctive groups identified. However, for energy and three nutrients, the median was below the recommended level (or almost below it) in some of the distinctive groups. In such cases, approximately 50% (or more) of respondents consumed less than the recommended level on the survey day. Even allowing for intra-individual variations and the margin of safety included in the recommendations, these groups deserve careful scrutiny.

Fe. For girls, the recommendation is 12 mg. In our sample, the median for girls (12·2 mg) only just exceeded this level. As girls became 'fatter', their intakes declined; the median for 'not-thin' girls (11·5 mg) was actually below the recommended level. This finding is disturbing. The body changes in girls at adolescence lead to an increase in subcutaneous fat. Girls classed as 'not thin' were therefore more likely to have reached menarche, and so would require more Fe, not less.

The difference in Fe intake between 'thin' and 'not-thin' girls seemed to be associated with a decreased intake of 'miscellaneous' and cereal foods by the 'not-thin' girls. While decreased emphasis on the 'miscellaneous' foods (e.g. sweetened cereals and 'empty-energy' items) might be sensible, the decrease in cereal products was less wise. Cereals can be a useful source of Fe, especially in a population with high vitamin C intakes.

Ca. Two groups of girls had median intakes only just above the recommended level (0·6 g): girls from small families who regularly took vitamin supplements (0·63 g), and girls at government schools who did not regularly take vitamin supplements (0·62 g). The former group comprised approximately 8% of girls, the latter 54%.

These groups also had lower intakes of dairy products than other girls. The reasons are unclear. Regular use of vitamin supplements might reflect 'health-consciousness', but why was its impact so dependent on family size? In any case, the importance of Ca (and therefore dairy products) in adolescent growth would seem to need more emphasis among girls.

Vitamin A. Among girls generally, median intake (0·87 mg) was comfortably above the recommended level (0·725 mg), but girls with poorly educated mothers had median intakes (0·74 mg) just above. Such mothers may have been less influenced by written nutrition propaganda or formal instruction about nutrition.

Energy. Median intakes were below the recommended level (10·5 MJ for girls, 12·2 MJ for boys) for almost all the distinctive groups identified for energy. (The one exception was older boys who were 'heavier' drinkers.) Widespread deficiencies in energy intakes have not been reported in Australia, and our estimates of energy intake are consistent with those of other Australian surveys. It would seem that the current recommendations are rather generous.

A plea for more-detailed diet surveys

Diet surveys are potentially valuable for epidemiological research and for preventative medicine programmes. Their usefulness is considerably enhanced if they examine the effects of a range of personal characteristics on intakes of energy, nutrients and foods. The extra effort put into collecting information is small (although it is wise to use the expertise of a sociologist in collecting personal information). Suitable statistical methods for analysis of such data are readily available; the approach used in the present paper is simple to perform and to interpret, and avoids the technical statistical problems of other methods.

By using this approach, it has been possible to discern some of the major influences on energy and nutrient intakes in a population of early adolescents. Some of these influences (e.g. sex difference, and effect of age among boys) were not unexpected, in the light of earlier studies. However, some other influences (e.g. effects of smoking, alcohol and vitamin supplementation) were unexpected. Tasmanians may perhaps be an unusual breed, but it would be interesting to follow up these findings in other populations.

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