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A longitudinal study of the growth of matched pairs of vegetarian and omnivorous children, aged 7–11 years, in the North-West of England

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Objective: To assess the ability of a meat free diet to support normal growth of children.
Design: A one year longitudinal observational case—comparison study of growth.
Setting: Children were recruited mainly through schools from Merseyside and all measurements were taken in their homes.
Subjects: Fifty 'free-living' children following meat free diets, aged 7–11 y (expected to be pre-pubertal), were compared with a control group of 50 omnivores matched for age, sex and ethnic group.
Intervention: None.
Main outcome measures: Height, weight, upper arm skinfold thicknesses and mid-upper arm circumference measurements were taken at baseline and one year later. The increments over one year were each analysed using a multiple stepwise regression model which derived predicted increments controlled for a variety of factors other than the diet factor.
Results: Of all the anthropometric measurements examined only the predicted height increment of the vegetarians was slightly greater than that of the omnivores (difference in predicted height increment = 0.47 cm, $P = 0.05$). This difference was only apparent after allowing for father's height, maternal smoking habit and number of siblings. A tendency for the vegetarians to be leaner than the omnivores was not significant at the 5% level and both the vegetarian and omnivorous groups lay close to the 50th percentiles for both height and weight (Child Growth Foundation, 1994).
Conclusions: The results suggest that these children who followed a meat free diet and conventional lifestyles grew at least as well as children who ate meat.
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Descriptors: vegetarian diet; growth; children

Introduction

The number of people claiming to be vegetarian is increasing and may be 5% of the UK population or three million people (Realeat, 1995). Many are young people including children (Realeat, 1995) and concern has been expressed about the adequacy of meat-free diets especially their ability to support normal growth (Francis, 1986; Kaplan and Toshima, 1992; Thomas, 1994) The reasons given for a possible adverse effect on growth include possible deficiencies of protein, specific amino acids, iron, zinc, a range of B vitamins and low energy intake (as a consequence of consuming a high fibre, low fat diet). The evidence is conflicting and complex since there is not a single vegetarian diet. At one end of the spectrum are those who avoid red meat only, near the middle are those who avoid all animal flesh but consume dairy products and/or eggs and/or fish and at the other extreme are those who not only eat no animal products whatsoever but also avoid some (and occasionally many) plant foods. This paper primarily concerns those who follow the middle of this range of dietary habits who will be referred to simply as vegetarians for convenience.

There is little doubt that vegan macrobiotic children do not grow as well as their omnivorous peers or in relation to growth charts (van Staveren *et al*, 1985) and have lower than expected weights and heights from about 6–8 months of age. Follow-up showed that those who began to eat dairy products and/or fish exhibited catch-up growth suggesting that a lacto-ovo-pesco vegetarian diet can support rates of growth well above normal (Dagnelie *et al*, 1994).

Sabate *et al* (1991) recorded the diet and growth of 1765 children aged 7–18 y. The vegetarian seventh day adventist (SDA) children were taller than their meat eating SDA peers (2.5 cm boys and 2.0 cm girls) even after adjusting for age, parental height, socio-economic factors and the intake of other food groups. In another study of 17 SDA vegetarians aged between 11–12 y, Tayter and Stanek (1989) found the mean height of the boys to be above the 50th centile but their weights only above the 30th centile. The girls however, had mean heights at the 45th centile but weights at the 50th. The conclusions are limited by the very small sample size and cross-sectional study design.

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Herbert (1985) found 191 vegetarian Indian children aged 3–6 y, on average to be taller than 123 omnivores. The cost of food may have favoured a vegetarian diet by allowing more energy to be purchased and other factors could not be ruled out, for example sanitation. In contrast, Rona *et al* (1987) studied Asian vegetarian and omnivorous children in England but found no differences in weight for height or triceps skinfold between the vegetarians and meat-eaters. Vegetarian girls tended to be shorter but only in the Urdu group was this significant. There have been few other studies of the diet, nutritional status or growth of vegetarian children although Nelson *et al* (1993) found UK vegetarians more likely to be anaemic (25%) than omnivores (9%).

There have therefore, been few studies of the growth of vegetarian children (who consume dairy products and/or fish), especially beyond the pre-school years (Kaplan and Toshima, 1992), none in the UK and no longitudinal studies. Those vegetarians who include dairy products in their diet, may be leaner but are less likely to show lower than expected growth compared with omnivores than vegans. Adequacy of growth seems to hinge around the presence of dairy products in the diet but many other non-dietary factors can influence growth including: parent's height (Muller, 1976), puberty (Eveleth and Tanner, 1976), socio-economic group (Rona *et al*, 1978), smoking status of parents (Rona *et al*, 1981), season (Cole, 1993), mother's age (Goldstein, 1971), number of siblings (Goldstein, 1971; Rona *et al*, 1981), ethnicity (Rona and Chinn, 1986) and psychosocial adversity (Skuse *et al*, 1994). The level of physical activity may also affect growth. Only a fully controlled study design could determine the particular effect of a meatless diet on the growth of children, the value of which would be severely limited by its artificial nature. The main purpose of this study was to compare the growth of vegetarian children who were living an otherwise 'normal' lifestyle with omnivores closely matched for a variety of factors known to influence growth.

Methods

Subjects

The children were recruited in the Liverpool area by advertising in health food shops, vegetarian society publications and a Hindu temple and with the help of school nurses and head teachers. Criteria for inclusion in the study were that the child was 'healthy', initially in the age range 7–11 y and had followed a 'vegetarian' diet for at least three months. A vegetarian diet was defined as one which may include dairy products, eggs and occasionally fish, but no meat or meat products. 'Healthy' was defined as having no history of any illness considered likely to affect growth or diet.

On entry into the study each vegetarian child was asked to introduce an omnivorous friend of the same age, ethnic group and sex. In this way it was hoped to obtain a control group matched for these three factors with similarities for a variety of other physical and social factors. The dietary intake and growth of each 'matched' pair of children were measured longitudinally for a period of 1 y; all data were collected from the children in their homes (the dietary data is published elsewhere: Nathan *et al*, 1996).

Each family was interviewed using a structured questionnaire to obtain information regarding social class (occupation of head of household and house and car ownership) and health related behaviour of parents and child (smoking and visits to doctor and dentist). The occupation of the head of household was used to attribute socio-economic group (Table 1); I and II were professional and managerial occupations, IIIa and b were clerical and technical (skilled), IV were manual (partly skilled) occupations and 'others' were manual (unskilled), unemployed or retired (Registrar General, 1991). In addition, parents were also asked to report their own heights and weights.

Anthropometric measurements

Height, weight, mid upper arm circumference and biceps and triceps skinfold measurements were taken at baseline and after one year. All measurements were taken in the child's home by the same person (IN). Height was measured to the nearest 0.1 cm, using a portable stadiometer (Cranlea, Birmingham), which was attached to a wooden platform. The child was asked to remove shoes and stand on the platform which was placed against a door. The child's heels, shoulders and back of head were touching the door and the head was held with the eyes in the straight ahead position. A spirit level attached to the arm of the stadiometer ensured that it was horizontal whilst the reading was taken at the highest point. Weight was measured to the nearest 0.1 kg using electronic scales (Soenhle, CMS, London) positioned on the platform after removing shoes and heavy outer clothing layers only. Most measurements were taken in the late afternoon (after emptying bladders) and which of each pair was measured first was entirely fortuitous. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. Upper mid-arm circumference (MAC) was measured using a steel tape measure (Holtain, Cardiff) and triceps and biceps skinfolds using Harpenden skinfold callipers (Holtain, Cardiff). Upper mid-arm muscle circumference (MAMC) was calculated (Thomas, 1994) as: mid-arm circumference—$3.142 \times$ triceps skinfold). The non-dominant arm was used throughout and the procedures recommended by the Airlie Consensus Conference Committee (Lohman *et al*, 1991) were followed as closely as possible. The accuracy of instruments was checked at regular intervals throughout the study. Pilot studies were undertaken to develop reliability in all techniques, for example mean (se) difference in duplicate measurements of height of children ($n = 15$, interval 3 d) was 0.2 (0.23) cm. Anthropometric measurements were compared with current standards (Child Growth Foundation, 1994).

Statistical analysis

The data were analysed using paired *t*-tests for continuous variables, and the McNemar test to assess differences in proportions between pairs of vegetarians and omnivores in answers for questions in the questionnaire. Additionally, changes in anthropometric measurements were analysed using regression models.

Changes in anthropometric measurements were transformed by taking natural logarithms which more closely satisfied the necessary assumptions of normally distributed errors with constant variance. The forward stepwise model selection procedure was used to add to a regression model for change in logged anthropometric measurements which included terms for pairing and diet pattern. The pairing term was a factor which included allowance for all the variables for which the children were matched; sex, age and ethnic group. The diet pattern factor related to whether the children were vegetarian or not and so embraced *any* differences between these two groups; dietary or otherwise.

This reflects the aim of this study to investigate the global effects of being vegetarian on growth (and not, for example, specific effects of individual nutrients).

The following variables were selected as possible explanatory variables for the regression model: smoking status of mother, smoking status of father (in both cases whether currently smoking any amount or not), socio-economic group, whether the child was bottle or breast fed (regardless of duration), weight of father, weight of mother, height of father, height of mother, number of siblings, weight at baseline, height at baseline, mid-arm circumference at baseline, biceps at baseline and triceps at baseline. Variables were accepted into the model if the significance level for inclusion was less than 5%. The fit of the model was verified by plotting the residuals.

The fits of the regression models were summarised by calculating predicted means that is, what the means of the data would have been if the vegetarian and omnivore groups had been exactly matched with respect to all of the explanatory variables (Genstat 5 Committee, 1987).

Results

Sixty three vegetarian children were recruited to the study but only 52 could find an omnivorous friend willing to volunteer. During the course of the study 2 vegetarian children began to eat meat and were therefore excluded from the analysis and one vegetarian child became the only vegan in the study. Forty three of the vegetarians had not eaten meat for over one year, 2 for between 6–12 months and the remaining 5 for between 3–6 months. None of the girls had reached menarche at the outset of the study but no other assessment of puberty was made.

Table 1 shows a comparison between the two groups. The study intervals were identical and subjects were matched for age ($n = 11$ aged 7; 14 aged 8; 8 aged 9; 14 aged 10 and 3 aged 11 y), sex (29 female pairs, 21 males) and race (two pairs of Hindu children completed the study). The pairs of children were very similar in other ways apart from the three factors for which they were matched. Forty pairs of families were in the same socio-economic groups, another six pairs were in a neighbouring group, and the remaining pairs were in categories more than 1 group different. The sample was skewed towards high socio-economic groups with 52 families from groups I and II. The parents of vegetarians and omnivores were similarly aged (Table 1) and there was no significant difference between the two groups with regard to the number of parents who smoked: mothers (12 vegetarian and 14 omnivore) and fathers (9 vegetarian and 14 omnivore). Four vegetarian children and 8 omnivorous children came from single parent families but all mothers were present. Data on four of the absent fathers, all of omnivorous children, were available but otherwise data concerning fathers is incomplete (data is available for a maximum of 48 pairs of fathers).

The only differences between the two groups were that the vegetarian children were a little less likely to be from families that owned a car, fathers were more likely to walk/cycle to work, vegetarian children were more likely to have been on holiday in the previous year and to have been breast fed. Although there were no differences in the height of mothers or fathers of vegetarians compared to parents of omnivores they were lighter and had lower BMIs (Table 1).

In comparison with growth charts (Child Growth Foundation, 1994), the mean height and weight measurements of both groups lay near the 50th percentiles at both the baseline measurement and the follow-up one year later. There were no significant differences (paired *t*-tests) in initial or final measurements for any of the anthropometric measurements taken (Tables 2 and 3). On average, however, all measurements (initial and final) of upper mid-arm circumference and mid-arm muscle circumference, BMI and skinfolds of the vegetarians were slightly lower than those of the omnivores.

The vegetarian children grew in height slightly more than the omnivorous children. The predicted mean height increment (Table 2) in the vegetarian group was signifi-

Table 1 A comparison of the two groups (mean s.d.), $n = 50$ except where stated

Study interval (y)		*Vegetarians 1.01 (0.02)*	*Omnivores 1.01 (0.02)*	*P 0.48*
Socio-economic group (*n*):				
I and II		26	26	
IIIa and b		13	13	
IV		2	6	
Other		9	5	
Children:				
Age (y)		9.1 (1.5)	9.4 (1.4)	0.12
Mothers:				
Age (y)		38.5 (5.5)	38.8 (4.9)	0.77
Height (m)		1.599 (0.061)	1.599 (0.072)	0.99
Weight (kg)		58.2 (9.16)	62.7 (11.99)	0.03
BMI		22.7 (2.83)	24.6 (5.16)	0.02
Fathers:				
Age (y)		40.0 (5.6)	40.9 (5.6)	0.35 $n = 48$
Height (m)		1.751 (0.065)	1.744 (0.074)	0.81 $n = 48$
Weight (kg)		74.0 (7.37)	79.2 (13.67)	0.04 $n = 46$
BMI		24.3 (2.00)	26.0 (3.97)	0.02 $n = 46$
Family own car:	yes	29	38	
	no	21	12	0.03
Child been on holiday:	yes	45	36	
	no	5	14	0.03
Child breast fed	yes	45	32	
	no	5	18	0.004
Father walks/cycles to work ($n = 37$)	yes	9	2	
	no	28	35	0.02

Table 2 Weight, height and BMI of vegetarian and omnivore children. (sds are given for initial, final and changes in measurements and sems for predicted mean $\log_e$ changes, all confidence intervals are for 95% ranges)

	Vegetarians	*Omnivores*	*Difference between means*		*P*
Initial weight (kg)	29.74 (6.17)	30.75 (6.96)	− 1.01	(CI − 2.64, 0.61)	0.22
Final weight (kg)	33.83 (7.49)	34.83 (8.36)	− 1.00	(CI − 2.97, 0.97)	0.31
Change (kg)	4.09 (2.09)	4.08 (2.17)	0.01	(CI − 0.73, 0.75)	0.97
Predicted mean $\log_e$ (final wt/initial wt)	0.12601 (0.00689)	0.12144 (0.00689)	0.00457	(CI − 0.01491, 0.02405)	0.64
Predicted change (kg)	3.99	3.97	0.02	(CI − 0.45, 0.74)	
Initial height (mm)	1.3259 (0.0995)	1.3325 (0.0915)	− 0.0066	(CI − 0.0270, 0.0138)	0.52
Final height (m)	1.3907 (0.1045)	1.3930 (0.0965)	− 0.0023	(CI − 0.0233, 0.0188)	0.83
Change (cm)	6.48 (1.52)	6.05 (1.36)	0.43	(CI − 0.10, 0.97)	0.11
Predicted mean $\log_e$ (final ht/initial ht)	0.04789 (0.00125)	0.04427 (0.00132)	0.00362	(CI 0.00011, 0.00713)	0.05
Predicted change (cm)	6.50	6.03	0.47	(CI 0.01, 0.95)	
Initial BMI	16.76 (1.91)	17.12 (2.23)	− 0.36	(CI − 1.13, 0.40)	0.35
Final BMI	17.32 (2.42)	17.73 (2.65)	− 0.41	(CI − 1.35, 0.53)	0.38
Change	0.57 (0.95)	0.61 (0.95)	− 0.04	(CI − 0.42, 0.33)	0.82
Predicted mean $\log_e$ (final BMI/initial BMI)	0.03051 (0.00693)	0.03272 (0.00693)	− 0.00221	(CI − 0.02181, 0.01739)	0.82
Predicted change	0.52	0.57	− 0.05	(CI − 0.37, 0.30)	

In all cases $n = 50$ for both groups.

Table 3 Arm circumference and skinfold measurements of vegetarian and omnivore children (sds are given for initial, final and changes in measurements and sems for predicted mean $\log_e$ changes, all confidence intervals are for 95% ranges)

	Vegetarians	*Omnivores*	*Difference between means*		*P*
Initial mid-arm circumference (cm)	20.10 (2.46)	20.42 (2.91)	− 0.26	(CI − 1.10, 0.59)	0.55
Final mid-arm circumference (cm)	20.88 (2.72)	21.47 (3.26)	− 0.59	(CI − 1.60, 0.42)	0.25
Change (cm)	0.87 (1.01)	1.05 (0.91)	− 0.20	(CI − 0.60, 0.20)	0.32
Predicted mean $\log_e$ (final MAC/initial MAC)	0.03631 (0.00548)	0.05159 (0.00548)	− 0.01528	(CI − 0.03123, 0.00067)	0.07
Predicted change (cm)	0.74	1.08	− 0.34	(CI − 0.62, 0.01)	
Initial mid-arm muscle circumference (cm)	17.11 (1.63)	17.30 (2.20)	− 0.132	(CI − 0.733, 0.469)	0.66
Final mid-arm muscle circumference (cm)	17.58 (2.20)	17.99 (2.42)	− 0.409	(CI − 1.131, 0.314)	0.26
Change (cm)	0.55 (1.10)	0.69 (0.90)	− 0.18	(CI − 0.64, 0.27)	0.42
Predicted mean $\log_e$ (final MAMC/initial MAMC)	0.02468 (0.00831)	0.04316 (0.00809)	− 0.01848	(CI − 0.04218, 0.00522)	0.11
Predicted change (cm)	0.43	0.76	− 0.33	(CI − 0.76, 0.09)	
Initial triceps (mm)	9.71 (3.81)	9.96 (3.64)	− 0.34	(CI − 1.76, 1.08)	0.63
Final triceps (mm)	10.53 (3.24)	11.10 (3.75)	− 0.57	(CI − 1.92, 0.77)	0.40
Change (cm)	1.04 (2.71)	1.15 (2.05)	− 0.03	(CI − 1.11, 1.05)	0.96
Predicted mean $\log_e$ (final triceps/initial triceps)	0.1336 (0.0304)	0.1215 (0.0301)	0.0121	(CI − 0.0716, 0.0958)	0.51
Predicted change (mm)	1.39	1.29	0.10	(CI − 0.68, 0.99)	
Initial biceps (mm)	5.82 (2.41)	6.01 (2.46)	− 0.15	(CI − 1.04, 0.74)	0.74
Final biceps (mm)	5.84 (2.13)	6.55 (2.65)	− 0.71	(CI − 1.66, 0.23)	0.13
Change (mm)	0.12 (1.81)	0.55 (1.41)	− 0.43	(CI − 0.17, 0.30)	0.24
Predicted mean $\log_e$ (final biceps/initial biceps)	0.0333 (0.0306)	0.0887 (0.0301)	− 0.0554	(CI − 0.1412, 0.0304)	0.19
Predicted change (mm)	0.20	0.56	− 0.36	(CI − 0.78, 0.18)	

cantly larger than that predicted for the omnivores (difference in mean height increment = 0.47 cm). The explanatory variables for the height measurement included in the regression model were: pairing, diet pattern, mother's smoking status, father's height and number of siblings (Table 4) which together accounted for 31% of the variance in height increment.

Three of the children did not wish to have triceps skinfolds taken at the initial visit and two neither biceps nor MAC and were excluded from measurements of change in skinfolds and arm circumference and the stepwise regression. They were not excluded from the final measurements for skinfolds and arm circumference which accounts for the discrepancies between calculated initial and final measurements (Table 3). Apart from height, there were no differences in the increments of any of the anthropometric variables even after allowing for a variety of factors (Tables 2 and 3); the regression models are shown in Table 4. Only the increment for mid-arm circumference tended towards being greater in the omnivores.

Discussion

This study is a unique longitudinal study of the growth of vegetarian children who were likely to be pre-pubertal. In addition, although two pairs of children were Hindu, no other child was affiliated to any group, or followed a religion that advocated a wholly vegetarian diet. It is not possible to choose a random sample of vegetarian children (since no register exists) but this was a study of children following conventional lifestyles. The eating habits of the two groups were very different (Nathan *et al*, 1996); the omnivores consumed on average 88 g of meat products per day with 23 g fish products whilst the vegetarians consumed no meat products and on average only 5 g fish products per day. The sample was predominantly from the higher socio-economic groups, which reflects the prevalence of vegetarianism. Herbert (1985) has pointed out that the effect of a vegetarian diet may be social class specific but in this study the two groups were comparable. That the parents of the vegetarian children were leaner, less

Table 4 Regression models for increments in anthropometric measurements

Response variable	*Explanatory variables* (*with coefficients where appropriate*)
$\log_e$ (final weight/initial weight)	Pairing
	Diet (omnivore)[a] (−0.00457)
$\log_e$ (final height/initial height)	Pairing
	Diet (omnivore) (−0.00337)
	Mother not smoking (−0.01169)
	Father's height (0.000518)
	More than 2 children (−0.00700)
$\log_e$ (final BMI/initial BMI)	Pairing
	Diet (omnivore) (0.00221)
$\log_e$ (final MAC/initial MAC)	Pairing
	Diet (omnivore) (0.01492)
	Father's weight (−0.001093)
$\log_e$ (final MAMC/initial MAMC)	Pairing
	Diet (omnivore) (0.0194)
	Mother's weight (−0.001993)
$\log_e$ (final Triceps/initial Triceps)	Pairing
	Diet (omnivore) (−0.0293)
	Shortest period duration breast feeding (0.164)
	Mid-length period breast feeding (−0.295)
	Longest period breast feeding (−0.0357)
$\log_e$ (final Biceps/initial Biceps)	Pairing
	Diet (omnivore) (0.0563)

[a] This indicates that the parameter estimate was for the effect of being an omnivore relative to the effect of being vegetarian.

likely to own a car and more likely to have been on holiday suggests that these families may be more active.

The results show that even after allowing for a variety of confounding factors these vegetarian children grew a little taller than matched children who ate meat. The two groups appeared to be very well matched which greatly enhanced the power of the study by 'allowing' for a large number of factors known to influence growth. The sample size however was small and precise pubertal status was unknown. Most of the variance in growth (69%) was unaccounted for which may be because of the number of single parents (unknown parental height), imprecise estimates of parental height and lack of information on birth weight and birth order. It may also represent many other sources of variation which cannot be modelled with the present state of knowledge. The model can still be regarded as adequate despite the lower percentage of variance accounted for because of the randomness of the unexplained variation (as displayed by plots of the residuals from the fitted model against fitted values). This study suggests that vegetarian children grow at least as well as children who eat meat which is in agreement with other studies, but it does not conclusively confirm the suggestion that vegetarian children are leaner than their omnivorous peers (Sabate *et al*, 1991; van Staveren *et al*, 1985; Tayter and Stanek, 1989).

The age range of the children was chosen to try to avoid the onset of puberty which is especially difficult to assess and by the time the overt signs appear marked acceleration in growth may have already occurred (Tanner, 1955a). It is feasible that some children may have begun the pubertal growth spurt during the study but this could not be assessed which limits the findings. If the vegetarians commenced puberty before the omnivores this might account for the difference in growth observed. The meat-eaters however, like their parents, tended to be heavier, suggesting a very slightly more advanced 'biological age' (Tanner, 1955b) and hence, perhaps, an earlier onset of puberty; other studies suggest that vegetarian girls reach puberty later than omnivores (Sabate *et al*, 1992; Tayter and Stanek, 1989) the health consequences of which are not clear. If the omnivores were biologically older the real magnitude of the difference in growth may be much greater. The final height achieved would be of great interest and hopefully this will be measured in due course.

The difference in growth was apparent only after allowing for father's height, mother's smoking habits and numbers of siblings. The children of taller fathers grew more, having more siblings was associated with less growth but, curiously, having a mother who smoked was associated with greater growth in both the vegetarian and omnivorous children. Smoking may be associated with higher maternal energy intake (Bolton-Smith *et al*, 1993) which could lead to children eating a little more. Indeed, it was found that children of mothers who smoked did consume on average 420 kJ (100 kcal) per day (5% of total energy intake) more, than the children of mothers who did not smoke. This small difference in energy intake was not statistically significant (t-test, $P > 0.05$) but if real, could account for the observed growth difference over the one year period. It has been noted that the proportion of energy intake devoted to growth is very small (3%) (Hackett *et al*, 1984).

The dietary and nutritional intakes of the children are reported elsewhere (Nathan *et al*, 1996); the vegetarians did consume more fibre and less energy (marginally), protein, zinc and vitamin B12 (on average all met current recommendations) but intakes of iron, fat were similar. The dietary pattern factor did help to explain the height increment but it possibly represents the combined influence of a wide variety of variables including intake of nutrients. Specific effects of particular nutrients could not be identified which is not surprising since the estimation of nutrient intake of individuals is imprecise and only gross effects would be revealed. Furthermore a one year study is relatively short and diet related differences may develop slowly since small differences over a long period could have an appreciable effect on growth. The study of young Dutch macrobiotic children (Dagnelie *et al*, 1994) confirmed that dietary factors do influence growth but only if the range of foods is very restricted to exclude all animal products.

Seventh day adventists (SDA), are the most extensively studied group of vegetarians and do seem to be taller (Sabate *et al*, 1990) but they are unique in many ways apart from diet. They are well educated with regard to the pitfalls of a vegetarian diet, and are encouraged to follow a health orientated lifestyle by abstaining from smoking and alcohol (Beeson *et al*, 1989). In such studies it is difficult to disentangle the effect of health benefits due to diet from those as a result of other health related behaviours. In this study of pairs of children who were similar with regard to a wide variety of physical and social factors, whose parents had similar attitudes to 'health', the vegetarians grew slightly more. This shows that the vegetarian diets were at least as capable of supporting growth as the omnivorous diets.

The care needed to ensure that a vegetarian diet is well-planned has been recognised by many professional bodies (American Dietetic Association, 1988; British Dietetic Association, 1995). Nevertheless, the results of this study suggest that the vegetarian diets consumed by children in this group were adequate to sustain growth to at least the same degree as that of omnivores.

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