

## Short Communication

# Estimated intakes of meat and fish by children and adolescents in Australia and comparison with recommendations

Edward H. Clayton<sup>1,2\*</sup>, Tanya L. Hanstock<sup>3,4,5</sup> and Jane F. Watson<sup>6</sup>

<sup>1</sup>NSW Department of Primary Industries, Wagga Wagga Agricultural Institute, Pine Gully Road, Wagga Wagga, NSW 2650, Australia

<sup>2</sup>EH Graham Centre for Agricultural Innovation, an alliance between NSW Department of Primary Industries and Charles Sturt University, Wagga Wagga, NSW, Australia

<sup>3</sup>The Bipolar Program, Hunter New England Area Health Service, Newcastle, NSW, Australia

<sup>4</sup>School of Psychology, University of Newcastle, Callaghan, NSW, Australia

<sup>5</sup>School of Psychology, University of New England, Armidale, NSW, Australia

<sup>6</sup>School of Health Sciences, University of Newcastle, Callaghan, NSW, Australia

(Received 21 May 2008 – Revised 29 September 2008 – Accepted 29 September 2008 – First published online 5 December 2008)

Long-chain *n*-3 PUFA are considered important for cardiovascular health and brain development. Meat other than fish contributes significantly to total intakes of long-chain *n*-3 PUFA in adults; however, there are limited published data examining the intake of individual meat sources in children and adolescents in the Australian population. A review of literature was conducted using PubMed, Agricola and CAB Abstracts using the terms 'intake', 'beef', 'lamb', 'pork', 'poultry', 'fish', 'children' and 'adolescents' and using reference lists in published articles. Studies and surveys were identified that contained published values for intakes of meat or fish. Two national dietary surveys of children and adolescents were conducted in Australia in 1985 and 1995 and two regional surveys were conducted in Western Sydney and Western Australia in 1994 and 2003, respectively. Comprehensive data for the intake of individual meat sources were not reported from the 1995 survey, but estimations of intake were calculated from published values. Reported intakes of meat and fish are generally lower in females than males and tend to increase with age. Weighted mean intakes of red meat (beef plus lamb) across the three most recent studies were 67.3 and 52.2 g/d, respectively, for males and females aged between 7 and 12 years and 87.7 and 54.2 g/d, respectively, for males and females aged 12–18 years. These weighted intakes are within Australian guidelines and are likely to contribute significantly to total long-chain *n*-3 PUFA intake in children and adolescents in the Australian population.

### Meat: Fish: Children: Adolescents: Intake

Long-chain *n*-3 PUFA are associated with several health benefits in adults and children. There is growing evidence that long-chain *n*-3 PUFA may be beneficial in the treatment of several childhood and adolescent disorders such as asthma, depression and bipolar disorder<sup>(1)</sup>.

The National Health and Medical Research Council nutrient reference values for recommended intakes of long-chain *n*-3 PUFA in Australia and New Zealand<sup>(2)</sup> include EPA and DHA, which are found in high concentrations in fish, as well as docosapentaenoic acid, which is also found in relatively high concentrations in meat other than fish. Meat and, in particular, lean red meat including beef, veal and lamb, contributes significantly to total long-chain *n*-3 PUFA

intake in Australian adults<sup>(3)</sup>; however, there are limited published data available examining the contribution of meat to long-chain *n*-3 PUFA intake in Australian children and adolescents.

In order to estimate the contribution of meat to long-chain *n*-3 PUFA intake, it is necessary to know the intake of individual meat sources. Several studies have measured the intake of meat by Australian children and adolescents; however, the intake of individual meat sources is often not reported. The aim of the present review was to examine published intakes of meat and fish by children and adolescents in Australia and to estimate the intake of individual meat sources compared with recommended intakes.

**Abbreviations:** NDSSC, National Dietary Survey of Schoolchildren; NNS, National Nutrition Survey.

\* **Corresponding author:** Dr Edward Clayton, fax + 61 2 6938 1809, email Edward.Clayton@dpi.nsw.gov.au

## Methods

A review of studies and surveys containing published values for meat or fish intake in Australia was conducted using PubMed, Agricola and CAB Abstracts using the terms 'intake', 'beef', 'lamb', 'pork', 'poultry', 'fish', 'children' and 'adolescents' and using published reference lists. Internet searches were also conducted using web search engines such as Google™, Yahoo!Search®, Live Search and Ask™.

## Results

### *Reported intakes of meat and fish*

Two nationwide surveys of child and adolescent intakes were conducted in 1985 and 1995. Meat intake was also reported in two regional studies; one in Western Sydney in 1994 and one in Western Australia in 2003.

### *National Dietary Survey of Schoolchildren aged 10–15 years (1985)*

The first national survey of dietary intake was the National Dietary Survey of Schoolchildren (NDSSC)<sup>(4)</sup>. School children aged 10–15 years across all Australian states and territories (*n* 5224) completed a 1 d food record between May and October 1985<sup>(4)</sup>. Trained staff instructed students on how to complete food records and provided standard cup and spoon measures, rulers and diagrams to assist in estimating portion size.

Weighted average intakes of individual meat sources including mixed dishes (not including casserole gravy)<sup>(4)</sup> are reported in Table 1. Median intakes for all participants were presented in a separate publication<sup>(5)</sup> and were significantly lower than mean values. The median intake of total meat was 104 and 80 g/d for males and females, respectively, while the median intake of fish (fish and seafood) was 0 g/d for both males and females.

### *National Nutrition Survey (1995)*

As part of the 1995 National Nutrition Survey (NNS) the intake of children aged 8–18 years was estimated using a 24 h dietary recall interview<sup>(6)</sup>. Children aged 8–11 years undertook the interview with a trained nutritionist with the assistance of a parent or guardian; participants over the age of 11 years were interviewed without parental assistance. Mean intakes of individual meat sources were calculated from published values (see below). Again, median intakes were lower than mean values<sup>(5)</sup>. The median intake of total meat was 111 and 78 g/d for males and females, respectively, and the median intake of fish was 0 g/d for both males and females<sup>(5)</sup>.

### *Calculation of intake of individual meat sources from the 1995 National Nutrition Survey*

The original publication from the 1995 NNS<sup>(6)</sup> did not present data for the intake of individual meat sources. Intakes were calculated from original data and subsequent reports of red meat consumption<sup>(7)</sup>.

Total meat is defined as beef + veal + lamb + pork + bacon + ham + poultry including mixed dishes<sup>(6)</sup>, while red meat is defined as beef + veal + lamb including mixed

dishes<sup>(7)</sup>. The intake of total meat other than poultry was calculated from:

Intake of total meat other than poultry = intake of total meat – intake of poultry and mixed dishes (where poultry is the major component)<sup>(6)</sup>.

The intake of pork, ham and bacon was then calculated as:

Intake of pork + ham + bacon = intake of total meat other than poultry – intake of red meat<sup>(7)</sup>.

Finally, from the reported intake of red meat<sup>(7)</sup>, the intake of beef + veal or lamb was calculated using the proportion of red meat consumed as beef + veal reported in a similar population<sup>(8)</sup>:

Intake of beef + veal = intake of red meat<sup>(7)</sup> × (beef + veal) as a percentage of total red meat intake.

For example, the intake of beef + veal was 65.4 % of total red meat intake for males aged 8–11 years.

### *Survey of School Children in Western Sydney (1993–5)*

The meat intake of 999 children aged 1–16 years in Western Sydney was estimated using 4 d food records between 1993 and 1995<sup>(8)</sup>. Instructions for completing food records were provided by teachers and standard cup measures and rulers were provided to assist in portion size estimation. The total intake of beef, lamb, pork or poultry (g) over the 4 d recording period was presented only for those participants who reported consuming each meat source.

The authors could not be contacted to determine the percentage of participants who consumed each meat type, so an average consumption for all participants was calculated using an estimate of the percentage of participants consuming each meat type<sup>(6)</sup> (JF Watson, unpublished results). Values used were: beef, 77 %; lamb, 72 %; poultry, 77 %; pork, 70 %.

### *Survey of School Children in Western Australia (2003)*

The Child and Adolescent Physical Activity and Nutrition Survey (CAPANS) estimated the intake of 1494 school students aged 8–15 years in Western Australia. Intake was estimated using a 1 d food record with a similar protocol to the 1985 NDSSC<sup>(9)</sup>. Students not completing the food record undertook a 24 h recall. Beef, lamb or pork intake was calculated from reported intakes of total meat other than fish and poultry<sup>(9)</sup> using the proportions of each meat type reported in a similar population<sup>(8)</sup> (Table 1).

### *Recommended intakes*

The Australian Guide to Healthy Eating (AGHE)<sup>(10,11)</sup> recommends children aged 8–11 years consume 1–1.5 serves per d of lean meat, fish or poultry, while it is recommended that children aged 12–18 years consume 1–2 serves per d. The AGHE reports a serve of cooked beef, lamb, pork or chicken is 65–100 g and cooked fish is 80–120 g<sup>(10)</sup>. Standard serves of meat are also reportedly 135 g<sup>(12)</sup>.

The lower recommended intake of red meat for children aged 12–18 years calculated from the AGHE is one serve per d, three times per week at 65 g per serve, or approximately 27.9 g/d (Fig. 1). The upper recommended intake for these children is approximately 114.3 g/d (two serves per d; four times per week; 100 g per serve). Recommended intakes of

**Table 1.** Reported or calculated intakes of meat and fish (g/d) by children and adolescents in Australia

Study or survey	Year	Method	Sex	Age (years)	Subjects (n)	Reported or calculated mean intake (g/d)*					
						Beef	Lamb	Pork	Poultry	Total meat other than fish	Fish
1985 NDSSC <sup>(4)†</sup>	1985	1 d food record	Male	10–11	912	60.1	13.0	7.4	14.8	95.3	9.0
				12–15	1719	77.2	17.1	11.7	14.1	120.0	10.6
			Female	10–11	925	54.2	11.0	8.9	12.7	86.7	6.0
				12–15	1668	55.3	13.0	8.5	12.9	89.7	8.5
1995 NNS <sup>(6)</sup>	1995	24 h dietary recall	Male	8–11	385	34.7	18.3	33.7	30.0	116.7	14.5
				12–15	349	45.6	23.4	40.7	35.3	145.0	19.5
				16–18	215	54.2	27.8	44.3	65.5	191.8	13.8
			Female	8–11	354	20.4	19.6	27.0	31.4	98.4	12.8
				12–15	304	29.5	22.5	28.9	35.1	116.0	16.4
				16–18	218	29.5	22.5	34.8	41.7	128.5	17.8
Western Sydney <sup>(8)‡</sup>	1994	4 d food record	Male	7–9	109	31.8	25.0	19.3	35.8	111.9	–
				10–12	109	45.7	24.2	17.5	33.4	120.7	–
				14–16	87	73.9	37.9	41.1	65.6	218.6	–
			Female	7–9	137	29.3	17.5	14.9	35.7	97.4	–
				10–12	136	30.9	29.8	21.1	32.8	114.5	–
				14–16	109	37.5	28.7	26.9	39.5	132.6	–
Western Australia <sup>(9)</sup>	2003	1 d food record	Male	8–11	341	56.1	29.7	21.5	41.0	148.2	13.8
				12–15	398	64.9	33.3	36.1	58.9	193.3	7.5
			Female	8–11	352	32.1	30.9	21.9	48.8	133.7	19.5
				12–15	403	30.4	23.2	21.8	47.2	122.6	20.1

Meat intake in children and adolescents

NDSSC, National Dietary Survey of School children; NNS, National Nutrition Survey

\* Beef = beef + veal; lamb = lamb + mutton; total meat other than fish = beef + lamb + pork + poultry including mixed dishes; fish = fish + seafood.

† Total meat other than fish includes mixed dishes without casserole gravy but not take-away dishes.

‡ Number of participants in each age range calculated from the percentage of males and females in the overall sample.

fish were also calculated assuming fish is consumed one or two times per week.

*Summary of intake data and comparison with recommended intakes*

Weighted mean intakes of red meat and fish were calculated for studies conducted between 1994 and 2003 and compared with recommended intakes (Fig. 1).

**Discussion**

Estimated intakes of meat and fish by children and adolescents in Australia are available, in part, from four key studies. Differences in methods, including study population, number of days collected, portion size estimation and whether trained staff or teachers assisted with data collection, age ranges, categories of meat consumption and details of data reporting make it difficult to compare meat intake between studies. For example, the 1995 NNS is strengthened by the breadth of sample population across Australia compared with the regional sample in Western Sydney; however, it is weakened by the use of 24 h recalls compared with 4 d food records. Several assumptions about data and populations were required to allow comparison. Some limitations of the surveys conducted and calculations performed are briefly reviewed below.

*Comparison of methodology*

The studies reviewed used food records or 24 h recalls. Dietary intakes are underestimated using both methods, with greater under-reporting with increasing age<sup>(13)</sup>. Energy intake may be under-reported by as much as 20 % using food records and by a further 16 % using 24 h recalls<sup>(14)</sup>. One study<sup>(9)</sup> used a combination of 24 h recalls and food records, but did not report the proportion of methods used. Therefore, estimated intakes of total meat and fish (Table 1) are likely to underestimate actual intakes, particularly for adolescents.

Although food records and 24 h recalls capture rich information on food consumption, episodically consumed foods are not accurately measured<sup>(15)</sup> and may be underestimated in the studies reviewed. Although the Western Sydney study<sup>(8)</sup> collected multiple records, biases for variation and under-reporting may still remain<sup>(16)</sup>.

With the exception of 8- to 11-year-olds in the 1995 NNS, intakes for the studies reviewed were self-reported by participants. Children aged 8 years or older can reliably report their food intake<sup>(17)</sup> and the use of age-appropriate food

photographs<sup>(18)</sup> or portion size software<sup>(19)</sup> can improve the ability of children and adolescents to estimate portion size. However, children and adolescents may not accurately quantify portion sizes with standard household measures and diagrams used in the studies reviewed<sup>(20)</sup>. Individuals who eat larger portions may underestimate intake while those consuming smaller portions overestimate<sup>(21)</sup>. It is not possible to accurately determine the impact of portion size estimation on the intakes reported.

Differences between study populations may also influence reported intakes. For example, the prevalence of overweight and obese children and adolescents doubled to 25 % in New South Wales between 1985 and 1997<sup>(22)</sup> and participant BMI was higher in the 1995 NNS compared with the 1985 NDSSC. Overweight children and adolescents under-report energy intake by up to 40 % compared with their non-overweight peers<sup>(23)</sup>.

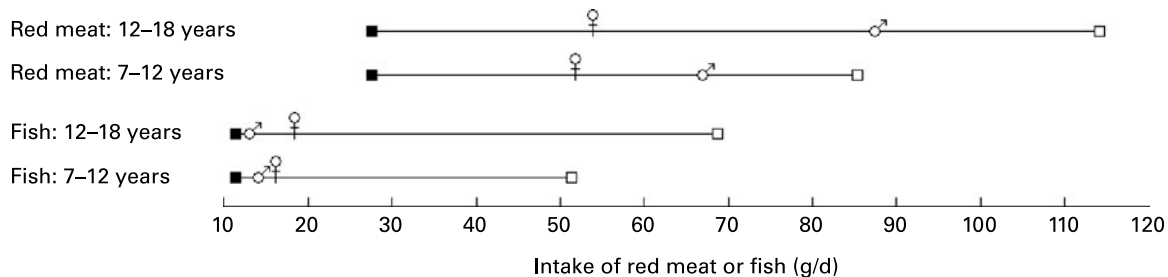
*Estimation of errors in the calculation of meat intake*

Calculated intakes of beef or lamb for the 1995 NNS are affected by the estimate of the proportion of red meat consumed as beef or lamb. Every 1 % overestimation of this proportion overestimates intake by approximately 1 % of reported red meat intake. For example, beef intake by males aged 16–18 years is overestimated by 0.82 g/d (1 % of 82 g/d) for every 1 % overestimation of beef as a proportion of red meat. Similarly, in the Western Australia study<sup>(9)</sup>, beef, lamb or pork intake is over- or underestimated by 1 % of total meat intake (other than poultry or fish) for every 1 % over- or underestimation of the proportion of each meat source.

In the Western Sydney study<sup>(8)</sup>, every 1 % overestimation of participants consuming each meat type overestimates calculated intake by approximately 1.2–1.4 %. For example, the intake of lamb by males aged 14–16 years is overestimated by 0.53 g/d (1.4 % of 37.9 g) if only 71 % instead of 72 % of participants consumed lamb.

Intakes of total fish and seafood were reported directly in three studies reviewed. However, intakes of different types of fish in these age ranges are not published. Long-chain *n*-3 PUFA concentrations are significantly higher in oily fish compared with non-oily fish<sup>(24)</sup>. Therefore, the contribution of fish to total long-chain *n*-3 PUFA intake cannot easily be determined.

There are currently no published data available examining the contribution of meat (other than fish) to long-chain *n*-3 PUFA intake in children and adolescents. However, as the intake of meat (Table 1) is similar to values reported in



**Fig. 1.** Mean estimated intakes (g/d) of red meat or fish by female (♀) and male (♂) children and adolescents in Australia<sup>(6,8,9)</sup> compared with lower (■) and upper (□) recommended intake ranges from the Australian Guide to Healthy Eating<sup>(10,11)</sup>.

adults<sup>(6)</sup>, meat may contribute significantly to total long-chain *n*-3 PUFA intake in young individuals in Australia similar to adults<sup>(3)</sup>. Similarly to fish, knowledge of the intake of individual meat cuts is also required in order to accurately estimate the contribution of meat to total long-chain *n*-3 PUFA intake.

#### Reported v. recommended intakes

Weighted mean intakes of red meat in the three most recent studies were within recommended intakes (Fig. 1). Similarly, reported intakes of fish meet target guidelines, although intakes were towards the lower level even if fish is recommended only once per week. While the intake of red meat and fish appear to be adequate in the age ranges examined, it is important to consider that the recommended ranges are very large and reported median intakes are also lower than mean intakes<sup>(5)</sup>.

#### Conclusions

Intakes of meat generally meet recommended guidelines for children and adolescents in Australia and may contribute significantly to total long-chain *n*-3 PUFA intake. Although there are several limitations to the estimations and calculations in the present review, many of these errors are small and may be lower than errors associated with the data collection methods themselves. Given changes in the prevalence of overweight and obesity, for example, there is a great need for a more updated survey of food consumption in children and adolescents in Australia.

#### Acknowledgements

We thank Dr Trent Watson, Dr Robert Taylor and Dr John Wilkins for valuable contributions in drafting and editing of the manuscript. This review was supported from in-kind contributions from the Hunter New England Area Health Service. The authors all contributed to the production of the manuscript. All contributed to the review of literature, data interpretation and drafting and review of the manuscript.

The authors of the present study do not have any commercial associations that might pose a conflict of interest in connection with this paper.

#### References

1. Clayton EH, Hanstock TL, Garg ML, *et al.* (2007) Long-chain omega-3 polyunsaturated fatty acids in the treatment of psychiatric illnesses in children and adolescents. *Acta Neuropsych* **19**, 92–103.
2. National Health and Medical Research Council (2006) *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes*. Canberra: Commonwealth of Australia.
3. Howe P, Meyer B, Record S, *et al.* (2006) Dietary intake of long-chain omega-3 polyunsaturated fatty acids: contribution of meat sources. *Nutrition* **22**, 47–53.
4. English R, Cashel KM, Lewis JL, *et al.* (1988) *National Dietary Survey of Schoolchildren Aged 10–15 Years. Report no. 1. Foods Consumed*. Canberra: Australian Government Publishing Service.
5. Cook T, Rutishauser IHE & Allsopp R (2001) *The Bridging Study – Comparing Results from the 1983, 1985 and 1995 Australian National Nutrition Surveys*. Canberra: Commonwealth of Australia.
6. McLennan W & Podger A (1999) *National Nutrition Survey – Foods Eaten, Australia*. Canberra: Australian Bureau of Statistics, Commonwealth Department of Health and Aged Care.
7. Baghurst K (1999) Red meat consumption in Australia: intakes, contributions to nutrient intake and associated dietary patterns. *Eur J Cancer Prev* **8**, 185–191.
8. Laing DG, Oram N, Burgess J, *et al.* (1999) The development of meat-eating habits during childhood in Australia. *Int J Food Sci Nutr* **50**, 29–37.
9. Glasson C, Read H, Hands B, *et al.* (2004) Food and nutrient intakes of Western Australian children and adolescents: Report of the Western Australian Child and Adolescent Physical Activity and Nutrition (CAPAN) Survey 2003. Perth: WA Department of Health. [http://www.beactive.wa.gov.au/resources\\_research\\_capans.asp](http://www.beactive.wa.gov.au/resources_research_capans.asp)
10. Smith A, Kellett E & Schermerlaib Y (1998) *The Australian Guide to Healthy Eating: Background Information for Nutrition Educators*, Publication no. 2361. Canberra: Commonwealth Department of Health and Family Services.
11. National Health and Medical Research Council (2003) *Dietary Guidelines for Children and Adolescents in Australia Incorporating the Infant Feeding Guidelines for Health Workers*. Canberra: Department of Health and Ageing.
12. Williams P (2007) Nutritional composition of red meat. *Nutr Diet* **64**, S113–S119.
13. Bandini LG, Cyr H, Must A, *et al.* (1997) Validity of reported energy intake in preadolescent girls. *Am J Clin Nutr* **65**, Suppl., 1138S–1141S.
14. Buzzard M (1998) 24-Hour recall and food record methods. In *Nutritional Epidemiology*, pp. 50–73 [W Willet, editor]. Oxford: Oxford University Press.
15. Subar AF, Dodd KW, Guenther PM, *et al.* (2006) The food propensity questionnaire: concept, development, and validation for use as a covariate in a model to estimate usual food intake. *J Am Diet Assoc* **106**, 1556–1563.
16. Black AE & Cole TJ (2001) Biased over- or under-reporting is characteristic of individuals whether over time or by different assessment methods. *J Am Diet Assoc* **101**, 70–80.
17. Riley AW (2004) Evidence that school-age children can self-report on their health. *Ambul Pediatr* **4**, 371–376.
18. Foster E, Matthews JN, Nelson M, *et al.* (2006) Accuracy of estimates of food portion size using food photographs – the importance of using age-appropriate tools. *Public Health Nutr* **9**, 509–514.
19. Foster E, Matthews JN, Lloyd J, *et al.* (2008) Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with children. *Br J Nutr* **99**, 175–184.
20. Livingstone MB & Robson PJ (2000) Measurement of dietary intake in children. *Proc Nutr Soc* **59**, 279–293.
21. Biró G, Hulshof KF, Ovesen L, *et al.* (2002) Selection of methodology to assess food intake. *Eur J Clin Nutr* **56**, Suppl. 2, S25–S32.
22. Booth ML, Chey T, Wake M, *et al.* (2003) Change in the prevalence of overweight and obesity among young Australians, 1969–1997. *Am J Clin Nutr* **77**, 29–36.
23. Domel SB (1997) Self-reports of diet: how children remember what they have eaten. *Am J Clin Nutr* **65**, Suppl., 1148S–1152S.
24. Sinclair AJ, Oon KS, Lim L, *et al.* (1998) The omega-3 fatty acid content of canned, smoked and fresh fish in Australia. *Aust J Nutr Diet* **55**, 116–120.