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Processed pork is the most frequently consumed type of pork in a survey of Australian children

Deborah J. Nolan-Clark [a,*], *Elizabeth P. Neale* [a], *Karen E. Charlton* [b]

[a] *Landmark Nutrition Pty Ltd., Wollongong, New South Wales, Australia*
[b] *School of Health Sciences, University of Wollongong, Wollongong, New South Wales, Australia*

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ABSTRACT

Pork represents a core food that provides key nutrients to the diet. Dietary guidelines recommend limiting processed meat intake because of adverse health outcomes. The aims of this study were to describe pork consumption, assess the contribution of pork to nutrient intakes, and compare anthropometric characteristics between pork consumers and nonconsumers in a survey of Australian children. We hypothesized that pork consumption will contribute to intakes of key nutrients and that the weight status of children who consume pork will be similar to nonconsumers. This study involved a secondary analysis of the 2007 Australian National Children's Nutrition and Physical Activity Survey. Pork and pork-containing dishes were identified and classified as fresh or processed pork. The contributions of pork to nutrient intakes were calculated. Weight, waist circumference, and body mass index were compared between pork consumers and nonconsumers. Data from 4487 children were available for use. Of this sample, 2245 reported consuming pork, 14% (n = 310) of whom consumed fresh pork, whereas 93% (n = 2084) consumed processed pork. All types of pork contributed to intakes of protein, niacin, and zinc. In addition, fresh pork contributed to intakes of thiamine, long-chain omega-3, phosphorous, and potassium. Total and processed pork contributed 12.2% and 13.0% of sodium, respectively. There were no significant differences between weight, waist circumference, and body mass index in consumers and nonconsumers of total, fresh, or processed pork. In a survey of Australian children, processed pork was the most frequently consumed form of pork, suggesting a deviation from dietary guidelines.

1. Introduction

Pork represents a core food within many cuisine contexts. It is a good source of dietary protein and many essential vitamins and minerals including thiamine, niacin, pantothenic acid, pyridoxine (vitamin B_6), cobalamin (vitamin B_{12}), selenium, zinc, and phosphorous. Pork is also a source of riboflavin, biotin, and potassium [1]. Secondary analyses of the National Health and Nutrition Examination Survey conducted in the United States found that fresh pork accounted for 27% to 31% of total protein, selenium, and thiamine intake and 13% to 21% of total phosphorous, potassium, zinc, riboflavin, niacin, vitamin B_6, and vitamin B_{12} intake in pork consumers [2].

There is some evidence that pork may be beneficial in the maintenance of healthy weight through mechanisms such as increased satiety and energy expenditure, compared with other protein sources. A 6-month pilot study conducted in 164 overweight adults found that a diet containing up to 1 kg of

Abbreviations: AI, Adequate Intake; BMI, body mass index; EAR, Estimated Average Requirement; FSANZ, Food Standards Australia and New Zealand.

* *Corresponding author.* Landmark Nutrition Pty Ltd, 2500, Wollongong, New South Wales, Australia. Tel.: +61 242443547.
E-mail address: deborah@landmarknutrition.com (D.J. Nolan-Clark).

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lean pork per week resulted in significant reductions in weight, body mass index (BMI), and measures of body fat compared with habitual diet [3]. Furthermore, consumption of a diet rich in pork protein for 4 days resulted in a larger increase in the 24-hour energy expenditure of participants compared with diets rich in carbohydrate or soy protein [4]. An acute study in humans also found that pork increased the secretion of the gut hormone peptide YY (increases feelings of fullness) to a greater extent than either beef or chicken [5].

Although a number of studies have highlighted the health benefits associated with pork intake, these studies only examined health outcomes associated with consumption of fresh pork rather than the processed variety. Compared with fresh pork, processed pork products such as bacon and sausage tended to be higher in sodium and saturated fat [1]. High intakes of processed meats including pork variants have been associated with an increased risk of all-cause mortality in adults [6]. Thus, Australian Dietary Guidelines support the inclusion of lean meat such as pork in the diet but specifically recommend limiting consumption of processed and cured meats [7].

Despite these dietary recommendations, there is little information available on the consumption of fresh and processed pork in Australian children. This may be particularly of concern when considering that dietary habits and behaviors formed during early childhood are highly influential in the development of food consumption patterns that are maintained throughout the lifespan [8–10]. Food preferences are influenced through repeated exposure to foods, modeling of parental behavior, and genetics [11,12].

Data regarding consumption patterns of any form of pork in Australian children are outdated. Secondary analyses from Australian national surveys of dietary intake conducted in 1985 and 1995 and regional surveys conducted in 1994 and 2003 reported that children consumed an average of 7.4 to 44.3 g/d of pork, which varied according to age and sex [13]. However, the rapidly changing nature of the food supply requires the analysis of more recent and nationally representative dietary survey data to gain a clear understanding of current pork consumption patterns and related health outcomes in Australian children.

The aims of this study were to describe pork consumption patterns in a survey of Australian children, assess the contribution of fresh and processed pork products to overall nutrient intakes, and compare anthropometric characteristics between consumers and nonconsumers of pork. These analyses used the 2007 Australian National Children's Nutrition and Physical Activity survey, the most recent nationwide survey on the dietary intakes and eating habits of Australian children. In this study, we hypothesized that pork consumption will contribute to intake levels of key nutrients such as thiamin, niacin, and long-chain omega-3 polyunsaturated fatty acids and that the weight, waist circumference, and weight status of children who consume pork will be similar to nonconsumers.

2. Methods and materials

2.1. Participants and study design

This study involved a secondary analysis of the 2007 Australian National Children's Nutrition and Physical Activity Survey, which was conducted between February and August 2007 and included 4487 children aged 2 to 16 years [14]. Children were randomly selected to participate in the survey from all Australian states and territories via random digit dialing. Dietary data were collected via 2 standardized, computer-based, 24-hour recalls (the first via a face-to-face interview, the second via a telephone interview), which collected data on all dietary intakes over the 24 hours preceding the assessment. For children aged 2 to 8 years, the 24-hour recall was completed by their primary caregiver, whereas children 9 years and older completed the 24-hour recall themselves. Nutrient intakes were determined by converting dietary data obtained from a specially developed nutrient database (AUSTNUT2007) that was developed by Food Standards (Australia and New Zealand FSANZ) [15]. Physical activity was measured through use of the Multimedia Activity Recall for Children and Adolescents, a validated 24-hour recall for participants aged 9 to 16 years [16] and via use of pedometers for children aged 5 to 16 years.

Ethics approval for the survey from which these data were obtained was granted by the ethics committees of Commonwealth Scientific and Industrial Research Organisation and the University of South Australia, which are both registered with the National Health and Medical Research Council.

In this secondary analysis, pork and pork-containing dishes were identified from the survey data set using the FSANZ food name [15]. Pork products were classified as either "fresh pork" (including FSANZ 5-level code "Pork"), "processed pork" (including FSANZ 5-level codes "Bacon," "Ham," "sausage"), or "mixed dishes containing fresh or processed pork" (including FSANZ 5-level codes "Pork, Bacon, Ham Stew, Casserole, Stir Fry With Gravy or Sauce Only"; "Pork, Bacon, Ham Stew, Casserole, Stir Fry With Cereal Products"; "Pork, Bacon, Ham, Crumbed, Battered, Meatloaf Or Patty Type With Either Cereal and/or Vegetable"). Where possible, mixed dishes containing pork were classified as containing either "fresh" or "processed pork" and additional products that might contain other sources of pork (including FSANZ 5-level codes "Frankfurts and Saveloys," "Processed Delicatessen Meat, Red," ie, salami and devon) were investigated to identify pork products and categorized accordingly.

For mixed dishes containing pork or meat products that contained pork, the percentage of pork was calculated using the AUSNUT 2007 recipe file [17]. Because recipes were not available for a number of pork-containing products, including spam and devon, these were assumed to be 100% pork. Products that contained less than 5% pork were excluded from further analysis because they provided a minimal contribution of pork intake. This method was used previously by Murphy et al [2].

Survey participants were classified as either pork consumers or nonconsumers, and the proportion of children consuming pork was identified. Further differentiations were made regarding consumption of fresh and/or processed pork. Owing to some children consuming both fresh and processed pork, it was not possible to define children as being exclusively a fresh or processed pork consumer.

2.2. Statistical analyses

The mean, SD, median, and interquartile range of consumption of total pork and categories of pork were calculated using average intake data from the two 24-hour dietary recalls and expressed as grams per day. Normality of continuous variables was determined by assessing their distribution using histograms. Where possible, variables that were not normally distributed were transformed via log transformation.

Total, fresh, and processed pork consumption was compared between male and female participants and between age groups via the Mann-Whitney test and Kruskal-Wallis test, respectively. Where significant differences in pork consumption between age groups were identified, post hoc Mann-Whitney tests with Bonferroni adjustment were used to identify the source of the variation.

Differences in demographic characteristics between consumers and nonconsumers were assessed using χ^2 tests with post hoc analyses with Bonferroni adjustment performed to identify the source of the variation. Characteristics considered included sex, age range, ethnicity, and living in an urban area. Differences in the backgrounds of consumers and nonconsumers, as well as their primary caregiver, were also compared for Aboriginal or Torres Strait Islander status, region of birth, highest level of education, and combined annual income.

Nutrient intakes were adjusted for total energy using the residuals method outlined by Willett [18]. Energy-adjusted nutrient intakes were compared between pork consumers and nonconsumers using independent *t* tests for normally distributed variables and the Mann-Whitney *U* test for variables that did not have a normal distribution, after log transformation.

The contribution of pork (total, fresh, and/or processed variants) to intakes of key nutrients was calculated as a proportion of total daily nutrient intake and also expressed as a proportion of age- and sex-related nutrient reference values. Where available, nutrient intakes from pork were compared with the Estimated Average Requirements (EARs), which is the most appropriate method of assessing the adequacy of nutrient intakes in groups [19]. Where an EAR did not exist, the Adequate Intake (AI) of the nutrient was used as a reference value.

One-way between-group analyses of covariance were conducted to determine whether pork consumption was associated with the anthropometric measures of body weight and waist circumference. Age, sex, and total kilojoule intake were included as covariates in the analysis. Owing to data quality issues in the pedometer data, for the purposes of this analysis, only Multimedia Activity Recall for Children and Adolescents data were used to quantify physical activity. Therefore, the model was repeated for participants aged 9 to 16 years with physical activity as an additional covariate.

Preliminary analyses of data were conducted to ensure that there was no violation of the assumptions of linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariate.

χ^2 Tests were performed to determine whether the proportion of individuals classified as normal, overweight, obese, underweight, and very underweight, according to age- and sex-specific BMI [20], was significantly different between pork consumers and nonconsumers.

All statistical analyses were conducted using the Statistical Package for Social Sciences Version 17.0 (SPSS Inc., Chicago, IL). Statistical tests were considered significant at the α level of less than .05.

3. Results

3.1. Pork consumption in survey participants

A total of 4487 children were compliant with meeting the survey protocols. Of this number, 50.0% (n = 2245) of children reported eating a type of pork on at least 1 of the 2 days of recall. Within the sample reporting consumption of pork, 14% (n = 310) of children reported consumption of fresh pork, whereas 93% (n = 2084) reported consumption of processed pork. Percentages exceed 100% because some children reported eating both processed and fresh pork varieties.

Data were further classified to determine mean intakes of total, fresh, and processed pork in the total sample (n = 4487) and for just pork consumers (n = 2245; Table 1).

When these data were analyzed by age category in only pork consumers, children in the 14- to 16-year-old age group had the highest median intake of pork at 29.7 (15.0-52.5) g/d, compared with 16.4 (10.0-31.9) g/d for 2- to 3-year-olds, 24.2 (13.4-41.5) g/d for 4- to 8-year-olds, and 23.7 (12.5-40.1) g/d for 9- to 13-year-olds ($P < .005$). Similarly, children aged 14 to 16 years consumed the greatest amount of processed pork ($P < .005$). There was no significant difference between the amounts of fresh pork consumed by each age group (data not shown). Of all pork types, ham made up the greatest proportion of intake (42.9%), followed by bacon (16.3%) and processed meat that consisted of pork products, such as devon and salami (16.1%).

Vegetable products and dishes were the most frequently reported accompaniment to any type of pork consumed; however, variations were seen in the types of pork and the accompaniments, for example, with vegetables making up 44.1% of accompanying foods consumed with fresh pork and 18.8% of foods accompanying processed pork. Other foods accompanying processed pork were cereals and cereal

Table 1 – Pork consumed by Australian children in the 2007 Australian National Nutrition and Physical Activity Survey by category of pork

Pork category	Total sample (n = 4487)			Pork consumers (n = 2245)		
	Mean ± SD	Median	IQR	Mean ± SD	Median	IQR
All pork (g)	16.1 ± 26.6	0.43	0.00-23.5	32.2 ± 29.9	23.4	12.5-41.3
All fresh pork (g)	3.2 ± 15.7	0.00	0.00-0.00	6.4 ± 21.8	0.00	0.00-0.00
All processed pork (g)	12.9 ± 21.0	0.00	0.00-20.0	25.8 ± 23.5	20.0	10.0-35.0

Values are mean grams of pork consumed per day. IQR, interquartile range.

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Table 2 – Intakes of key nutrients in pork consumers and nonconsumers

	Consumers (n = 2245)	Nonconsumers (n = 2242)	P
Energy (kJ)	8169.6 ± 2611.9	7850.2 ± 2622.1	<.005 [a]
Protein (g)	80.6 ± 17.7	76.9 ± 17.1	<.005 [a]
Total fat (g)	68.5 ± 12.3	66.1 ± 11.7	<.005 [a]
Sugar (g)	116.1 ± 31.5	120.2 ± 30.5	<.005 [a]
Carbohydrate (g)	236.9 ± 31.9	246.1 ± 29.8	<.005 [a]
Fiber (g)	19.8 ± 5.9	20.5 ± 6.5	<.005 [a]
Iron (mg)	10.8 ± 3.9	11.4 ± 5.5	<.005 [a]
Thiamin (mg)	1.7 (1.3-2.3)	1.7 (1.3-2.4)	.74 [b]
Saturated fat (g)	30.9 ± 7.3	29.6 ± 7.4	<.005 [a]
MUFA (g)	23.9 ± 5.6	22.9 ± 5.1	<.005 [a]
PUFA (g)	8.6 ± 3.1	8.7 ± 3.2	<.07 [a]
LC n-3 PUFA (mg)	84.5 (50.6-141.5)	83.7 (47.2-145.9)	.58 [b]
Cholesterol (mg)	233.8 ± 101.2	207.6 ± 94.7	<.005 [a]
Riboflavin (mg)	2.41 (1.8-3.1)	2.5 (1.9-3.3)	<.005 [b]
Niacin (mg)	41.6 (35.5-48.9)	41.5 (34.8-49.1)	.36 [b]
Phosphorous (mg)	1358.9 ± 252.9	1325.0 ± 255.0	<.005 [a]
Magnesium (mg)	275.5 ± 61.9	279.3 ± 64.1	<.05 [a]
Zinc (mg)	9.9 (8.6-11.6)	9.7 (8.2-11.4)	<.005 [b]
Potassium (mg)	2636.6 ± 613.8	2670.7 ± 604.7	.06 [a]
Iodine (μg)	128.0 ± 50.8	130.9 ± 51.4	.06 [a]
Sodium (mg)	2552.7 ± 714.9	2239.9 ± 672.9	<.005 [a]

Values are means ± SD or median (interquartile range). All values are adjusted for total energy intake.
MUFA, monounsaturated fat; PUFA, polyunsaturated fat; LC n-3 PUFA, long-chain omega 3 polyunsaturated fatty acids.
[a] Independent *t* test.
[b] Mann-Whitney *U* test.

products such as bread, rice and pasta (18.6%), and milk products (14.1%).

3.2. *Nutritional intake associated with pork consumption*

Pork consumers had significantly higher intakes of energy, total fat, saturated fat, cholesterol, and sodium, as well as significantly higher intakes of protein, phosphorous, and zinc compared with nonconsumers (Table 2). Pork consumers had significantly lower intakes of carbohydrate, sugar, fiber, iron, monounsaturated fat, and riboflavin compared with nonconsumers.

All pork contributed substantially to the total median intakes of a number of nutrients in consumers, for example, protein (7.2%), thiamin (6.2%), zinc (6.0%), and niacin (5.8%). Pork also contributed to total intakes of sodium (12.2%) and cholesterol in pork consumers (7.4%).

Fresh pork contributed substantially to the total intakes of thiamin (15.0%), protein (13.0%), long-chain omega-3 polyunsaturated fatty acids (including eicosapentaenoic acid, eicosatrienoic acid, docosapentaenoic acid, docosahexaenoic acid; 12.4%), niacin (10.0%), zinc (9.3%), phosphorous (6.7%) potassium (5.6%), and cholesterol (13.1%) of children reporting fresh pork consumption. Although for children reporting consumption of processed pork, this type of pork contributed to intakes of protein (6.3%), zinc (5.4%), niacin (5.2%), sodium (13.0%), and cholesterol (6.5%).

Regarding the contribution of pork to nutrient reference values [19], median intakes of any type of pork contributed substantially to the EAR or AI for a number of nutrients including niacin (31.9% of EAR), protein (24.8%), thiamin (17.2%), zinc (13.7%), and phosphorous (10.1%; Table 3). Fresh pork contributed substantially to intakes of niacin (52.6% of EAR), protein (44.7%), thiamin (41.3%), zinc (21.0%), long-chain omega-3 polyunsaturated fatty acids (14.4%), phosphorous (13.0%), and riboflavin (12.2%), whereas processed pork

Table 3 – Percentage contribution (%) of total pork to total nutrient intakes and to the EAR or AI, in pork consumers

Nutrients	% Contribution to total intakes	% Contribution to EAR or AI
Energy	2.5 (1.4-4.6)	N/A
Protein	7.2 (3.9-12.7)	24.8 (13.1-45.8)
Total fat	3.8 (1.8-7.6)	N/A
Sugar	0.0 (0.0-0.1)	N/A
Carbohydrate	0.0 (0.0-0.1)	N/A
Fiber	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Calcium	0.3 (0.2-0.7)	0.4 (0.2-0.9)
Iron	2.6 (1.3-5.0)	4.9 (2.6-9.7)
Thiamin	6.2 (2.8-12.2)	17.2 (8.4-32.3)
Saturated fat	3.1 (1.4-6.4)	N/A
MUFA	5.1 (2.5-10.5)	N/A
PUFA	2.6 (1.3-5.5)	N/A
LC n-3 PUFA	1.3 (0.1-5.0)	1.6 (0.2-5.1)
Cholesterol	7.4 (3.9-13.4)	N/A
Riboflavin	2.5 (1.2-5.1)	9.4 (4.3-18.0)
Niacin	5.8 (3.2-10.5)	31.9 (16.9-58.4)
Phosphorous	5.0 (2.9-8.7)	10.1 (5.4-18.6)
Magnesium	2.3 (1.2-4.2)	4.0 (2.0-7.6)
Zinc	6.0 (3.3-10.7)	13.7 (7.6-25.2)
Potassium	2.9 (1.6-5.2)	2.9 (1.6-5.2)
Iodine	0.9 (0.3-2.0)	1.5 (0.5-3.0)
Sodium	12.2 (6.9-19.8)	N/A

Values are median (interquartile range) percentage contribution.
N/A, no EAR or AI exists for this nutrient; MUFA, monounsaturated fat; PUFA, polyunsaturated fat; LC n-3 PUFA, long-chain omega 3 polyunsaturated fatty acids.

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contributed to intakes of niacin (28.7%), protein (22.5%), and thiamin (15.2%; Table 4).

3.3. *Demographic characteristics of pork consumers and nonconsumers*

When demographic characteristics were compared between pork consumers and nonconsumers, post hoc χ^2 test suggested that there was a significantly lower proportion of children consuming pork in the 2- to 3-year-old age group, compared with the 4- to 8-year-old age group (χ^2_1 = 10.4, $P <$ .001). A significantly lower proportion of children who consumed pork had a primary caregiver born in Africa or the Middle East, in comparison with those with a primary caregiver born in Australia (χ^2_1 = 11.5, $P < .001$). Similarly, a significantly lower proportion of children who consumed pork had a primary caregiver born in Africa or the Middle East than Europe and the United Kingdom (χ^2_1 = 18.2, $P < .001$). A significantly higher proportion of children who consumed pork had a combined family income before tax of $78 000 and above than did nonconsumers, compared with the $31 200 to $77 999 bracket ($\chi^2_1$ = 8.8, $P < .001$). Frequency and proportion of demographic characteristics where significant differences between consumers and nonconsumers were found are shown in Table 5.

No significant differences were found between pork consumers and nonconsumers with regard to sex, place of residence, or Aboriginal or Torres Strait Islander status of either the children or their primary caregivers. There was also no difference between the groups regarding the highest level of education attained by the child's primary caregiver (data not shown).

A significantly higher proportion of fresh pork consumers had a primary caregiver born in Asia, in comparison with Australia (χ^2_1 = 66.7, $P < .001$), Oceania and Antarctica (χ^2_1 = 12.8, $P < .01$), or Europe and the United Kingdom (χ^2_1 =49.2, $P < .001$). Conversely, a significantly lower proportion of processed pork consumers had a primary caregiver born in Asia compared with those with a primary caregiver born in Australia (χ^2_1 = 27.3, $P <$ .001) or Europe and the United Kingdom (χ^2_1 = 21.8, $P < .001$; Table 5). There were no significant differences in sex, rural residence, Aboriginal or Torres Strait Islander Status, income, or education level found between consumers and nonconsumers of fresh or processed pork (data not shown).

3.4. *Anthropometric characteristics and pork consumption*

After adjusting for the categorical variable sex and the continuous variables of age and total kilojoule intake, no significant differences were found between pork consumers and nonconsumers for body weight ($F_{1,4482}$ = 0.30, P = .58, η^2 = 0.58) and waist circumference ($F_{1,4482}$ = 0.01 P = .93, η^2 = 0.00).

In a separate model that included only the 9- to 16-year-old age group, for whom physical activity level data were available in addition to the other covariates, there were still no significant differences found between pork consumers and nonconsumers for body weight ($F_{1,2191}$ = 0.30, P = .58, η^2 = 0.00) and waist circumference ($F_{1,2191}$ = 0.10 P = .75, η^2 = 0.00).

According to their age- and sex-specific BMI, 77% of children were categorized as "normal" weight, 17.0% were

Table 4 – Percentage contribution (%) of fresh and processed pork to total nutrient intakes and to the EAR or AI

Nutrients	% Contribution to total intakes in fresh pork consumers (n = 310)	% Contribution to EAR or AI in fresh pork consumers (n = 310)	% Contribution to total intakes in processed pork consumers (n = 2084)	% Contribution to EAR or AI in processed pork consumers (n = 2084)
Energy	3.3 (2.0-5.2)	N/A	2.3 (1.3-4.2)	N/A
Protein	13.0 (7.8-19.0)	44.7 (25.2-68.8)	6.3 (3.6-10.9)	22.5 (12.3-39.4)
Total fat	3.5 (1.7-6.7)	N/A	3.5 (1.7-7.2)	N/A
Sugar	0.0 (0.0-0.0)	N/A	0.0 (0.0-0.1)	N/A
Carbohydrate	0.0 (0.0-0.0)	N/A	0.0 (0.0-0.1)	N/A
Fiber	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Calcium	0.5 (0.2-1.0)	0.56 (0.3-1.0)	0.3 (0.2-0.6)	0.4 (0.2-0.8)
Iron	2.7 (1.5-4.9)	4.7 (2.8-8.9)	2.4 (1.2-4.6)	4.5 (2.5-8.8)
Thiamin	15.0 (8.8-24.0)	41.3 (22.4-67.3)	5.3 (2.5-9.9)	15.2 (7.4-26.5)
Saturated fat	3.1 (1.5-6.1)	N/A	2.8 (1.3-6.0)	N/A
MUFA	4.1 (2.0-7.9)	N/A	4.8 (2.3 –10.0)	N/A
PUFA	3.7 (1.8-7.2)	N/A	2.3 (1.2-4.8)	N/A
LC n-3 PUFA	12.4 (5.3-26.4)	14.4 (8.2-26.5)	0.8 (0.0-2.9)	1.2 (0.0-3.1)
Cholesterol	13.1 (7.6-22.1)	N/A	6.5 (3.7-11.1	N/A
Riboflavin	3.5 (1.9-6.7)	12.2 (7.2-19.8)	2.2 (1.1-4.6)	8.5 (4.0-15.9)
Niacin	10.0 (6.1-15.8)	52.6 (31.6-81.5)	5.2 (3.0-9.0)	28.7 (16.0-49.7)
Phosphorous	6.7 (3.9-10.2)	13.0 (7.4-20.5)	4.6 (2.7-7.6)	9.0 (5.1-16.6)
Magnesium	3.5 (2.0-5.6)	5.8 (3.4-10.2)	2.0 (1.1-3.6)	3.6 (1.8-6.8)
Zinc	9.3 (5.6-14.7)	21.0 (12.1-34.5)	5.4 (3.1-9.4)	5.4 (3.1-9.4)
Potassium	5.6 (3.9-8.7)	5.5 (3.3-9.1)	2.5 (1.4-4.4)	2.6 (1.5-4.4)
Iodine	0.3 (0.2-0.6)	0.5 (0.3-0.8)	1.0 (0.3-2.0)	1.6 (0.6-3.1)
Sodium	1.1 (0.6-1.7)	N/A	13.0 (7.7-20.4)	N/A

Values are median (interquartile range) percentage contribution.
N/A, no EAR or AI exists for this nutrient; MUFA, monounsaturated fat; PUFA, polyunsaturated fat; LC n-3 PUFA, long-chain omega 3 polyunsaturated fatty acids.

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Table 5 – Frequency (n) and proportion (%) of selected demographic characteristics of total pork, fresh pork and processed pork consumers and nonconsumers

Characteristic	Consumers (n = 2245)		Nonconsumers (n = 2242)		χ^2 Test
	n	%	n	%	
Total pork					
• Primary carer's region of birth					χ^2_6 = 19.4, P = .00
- Australia	1768	78.8	1779	79.4	
- Oceania and Antarctica	79	3.5	78	3.5	
- Europe and UK	241	10.7	188	8.4	
- Asia	90	4.0	89	4.0	
- North America	18	0.80	23	1.0	
- South America	11	0.49	10	0.5	
- Africa and Middle East	38	1.7	75	3.4	
• Family's annual income before tax					
- $78 000 and above	1064	50.0	959	45.2	χ^2_3 = 10.1, P = .02
- $31 200-$77 999	825	38.8	903	42.5	
- $1-$31 199	229	10.8	252	11.9	
- Nil or negative income	10	0.5	9	0.42	
Fresh pork					
• Primary carer's region of birth					
- Australia	223	71.9	1545	79.9	χ^2_6 = 75.9, P < .005
- Oceania and Antarctica	14	4.5	65	3.4	
- Europe and UK	23	7.4	218	11.3	
- Asia	39	12.6	51	2.6	
- North America	5	1.6	13	0.7	
- South America	1	0.32	10	0.52	
- Africa and Middle East	5	1.6	33	1.7	
Processed pork					
• Primary carer's region of birth					
- Australia	1653	79.3	115	71.4	χ^2_6 = 34.0, P < .005
- Oceania and Antarctica	69	3.3	10	6.2	
- Europe and UK	230	11.0	11	6.8	
- Asia	71	3.4	19	11.8	
- North America	16	0.77	2	1.2	
- South America	10	0.48	1	0.62	
- Africa and Middle East	35	1.7	3	1.9	

categorized as overweight, 5.5% were categorized as obese, and 4.7% were categorized as either underweight or very underweight. Overall, there were no differences in the proportion of individuals in the BMI categories normal, overweight, obese, underweight, and very underweight between pork consumers and nonconsumers (χ^2_4 = 0.44, P = .98). Similarly, no differences in the proportion of individuals in BMI categories were found between either fresh pork or processed pork consumers and nonconsumers (χ^2_4 = 3.5 [P = .48] and χ^2_4 = 0.44 [P = .98]).

4. Discussion

This study provides a detailed analysis of Australian children's intake of fresh and processed pork, with regard to overall nutrient intake and anthropometric measurements. Findings from this study suggest that consumption patterns of this food do not correspond with dietary recommendations. Australian dietary guidelines recognize the positioning of pork as a core food in the diet and encourage intakes of lean meats such as fresh pork as part of a healthy diet and to meet energy requirements for a healthy body weight [7]. The guidelines, consistent with epidemiologic data showing an increased risk of all-cause mortality [21] and colorectal cancer [22] associated with processed meat intake (including bacon, ham, and sausages), advise that this food group be limited. However, to assess compliance with science-based dietary guidelines, it is important to differentiate between types of meat products consumed within particular meat categories. To date, national and regional surveys have not used this approach [13]. This secondary analysis observed an overwhelming preference for the dietary inclusion of processed pork such as ham and bacon rather than fresh pork varieties. The proportion of children reporting intake of fresh pork in this survey was similar to the finding that 10% of American adults consumed either fresh or fresh lean pork, using secondary analysis from National Health and Nutrition Examination Survey data [2]. However, that study did not describe consumption of processed pork.

The contribution of pork to intakes of key nutrients has been highlighted in this study, particularly for protein, thiamin, zinc, and niacin. Fresh pork tended to contribute higher amounts of these positive nutrients, as well as long-chain omega-3 polyunsaturated fatty acids, to overall intakes when compared with consumers of processed pork. Similar favorable influences of fresh pork consumption to intakes of protein, thiamin, and selenium have been reported for adult consumers of fresh pork compared with nonconsumers in America, with pork contributing 27%, 29%, and 31 % of these nutrients, respectively [2]. Thus, it appears that consumption of fresh pork in children may be an important way to increase dietary variety without adversely affecting nutrient intake.

Although consumption of any type of pork contributed substantially to intakes of protein, thiamin, zinc, and niacin in pork consumers, it also contributed to intakes of sodium and cholesterol, which likely reflects the preference for processed pork in this study sample. Processed pork contributed a substantial amount of sodium to the diets of children consuming these products. Diets higher in sodium have been associated with a significantly increased stroke and cardiovascular disease risk in a meta-analysis of prospective studies inclusive of data from 177 025 individuals [23]. Given that variation in salty taste preferences is mostly influenced by learned experiences and dietary exposure throughout childhood [24], repeated intakes of processed pork may predispose children to a preference for foods with a higher salt content. This theory, however, has not been tested in the context of specific types of salty foods.

The overall dietary and demographic context should be considered when examining consumption patterns from a single type of food, pork in this case. Previous research has shown that higher intakes of unprocessed red meat (including pork), chicken, and fish is associated with higher intakes of vegetables in Australian women [25] owing to traditional cuisine patterns that include meat as part of a main meal. In the current study, although both fresh and processed pork were commonly accompanied by vegetable products and dishes, this accompaniment was more frequent for fresh pork, with vegetable products and dishes making up a greater proportion of the accompanying foods reportedly consumed with fresh pork, in comparison with processed pork. This may suggest that fresh pork consumption is associated with a healthier dietary intake overall; however, this was not assessed in the present study.

Healthier dietary intakes have been associated with a higher socioeconomic status [26]. Pertinent to the present study, Rohrmann et al [21] reported that Europeans with high intakes of processed meat were less likely to have a university degree in comparison with those with low intakes of processed meat. In contrast to these findings, there did not appear to be any variations in socioeconomic factors including education and level of income between fresh and processed pork consumers and nonconsumers. This finding may reflect the cultural and geographical heterogeneity between European and Australian populations.

As a country with a diverse and multicultural population, cultural and religious factors are likely to influence intake of pork products in Australian children. This was seen in the present study, whereby a lower proportion of children from Middle Eastern and African backgrounds reported intake of any pork. Such countries have a large Islamic population, which may discourage intake of pork products [27]. A cultural influence on the type of pork consumed was also evident, with a higher proportion of children from an Asian background reporting intakes of fresh pork in comparison with those with a primary caregiver from Australia, Europe, or the United Kingdom. This is consistent with dietary intake data from many Asian regions that report higher intakes of fresh pork than other meats [28], thus suggesting that fresh pork in particular may be an important component of Asian cuisine.

Compared with other meat sources [29], pork intake in Australian children is relatively low. One possible contributing factor influencing this observation may be the relatively low usage of pork in foodservice outlets in Australia, compared with poultry and beef [30]. However, definitive reasons for comparatively lower pork intakes overall are unknown. Qualitative research in adults conducted in European countries suggests that some consumers view pork as being suitable for a variety of dishes, pleasant tasting, accessible, and good value for money [31,32]. Conversely, others believe that alternative protein sources such as poultry are less expensive and healthier than pork [33]. Although limited Australian data suggest that children's preferences may influence their parent's purchasing behavior in relation to meat [34], no known research has examined perceptions of pork consumption specifically related to children or the potential motivators and barriers that specifically influence children's pork intake.

In relation to anthropometric characteristics of pork consumers, despite having greater overall intakes of energy, total fat, and saturated fat than children who did not consume pork, there were no differences in body weight, waist circumference, or age- and sex-specific BMI after controlling for confounders. Based on these findings and those described above, we accept the hypothesis that pork consumption contributed to intakes of key nutrients such as thiamin, niacin, and long-chain omega-3 polyunsaturated fatty acids and that the weight, waist circumference, and weight status of children who consume pork were similar to nonconsumers.

In the present study, no differences in weight status were found between children who reported consumption of fresh and processed pork. Although information on energy expenditure is not available, a possible explanation for this anomaly may be that pork has a favorable role in terms of increasing energy expenditure. Mikkelsen et al [4] found that a diet rich in pork protein resulted in a greater increase in 24-hour expenditure in adults than carbohydrate or soy protein; however, no such evidence is available for children. Furthermore, although similar anthropometric characteristics seen in fresh and processed pork consumers may contradict the positioning of processed pork as a less healthy option in dietary guidelines, as previously mentioned, this may be a result of overall dietary habits of which pork consumption is only a minor contributor. However, it should be noted that the cross-sectional nature of the survey analyzed makes it difficult for inferences to be made regarding the long-term impact of pork consumption on anthropometric indices.

Although using nationally representative dietary data [14] was a definite strength of this study, a potential limitation was the use of an average of two 24-hour recalls to estimate food consumption data with regard to pork intakes. As with most national dietary surveys, the dietary assessment method of choice was repeated 24-hour dietary recalls, which may not reflect habitual dietary intake and may be influenced by memory bias [35]. Other authors have investigated the contribution of red meat, described as beef/veal/lamb to nutrient intakes, using the same survey data [29]. In that analysis, only single-day data were used, with the results weighted to

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correct for the nonproportionate sampling methodology of the main survey. Unlike in our study, these authors aimed to generalize their findings to the Australian population, with the weighting factors based on age, sex, and region (state/territory and capital city/rest of state) [36]. We did not aim to describe the distribution of population-level pork intake in children, but rather to assess the contribution of pork meat and pork-containing products to overall nutrient intakes, as consumed in the Australian context. To address our research question, we compared children who consumed pork with those who did not, at least on each of the 2 survey days. Many participants (50 %) reported no consumption of pork, either fresh or processed, on the survey days, which would result in skewed intake data. This is a commonly used method to investigate the contribution of various foods and food groups to nutrient intakes. For example, the contribution of milk and milk-based drinks to calcium intake and other nutrients using the same survey data adopted the same method [37].

Another limitation relates to quantification of the amount of pork consumed. Owing to the lack of recipes indicating the breakdown of components present for a number of processed pork products in the FSANZ recipe database [16], pork content in these products was assumed to be 100% pork. Therefore, it is possible that actual pork consumption in this category may have been overestimated.

In a nationally representative sample of Australian children, half reported consuming any type of pork during the survey period, with processed pork (notably ham and bacon) making up most of pork products consumed. Only 14% of pork consumers reported eating fresh pork, which suggests that dietary behavior in relation to this core food is not reflective of current dietary guidelines that recommend limiting consumption of processed meat. In this study, processed pork contributed a substantial amount of sodium to the diet; however, overall consumption of pork favorably influenced the nutrient intakes of consumers by contributing to intakes of protein, thiamine, niacin, and zinc. Findings from this study suggest that pork is an important core food for the delivery of essential nutrients in the diets of Australian children. In particular, intakes of fresh pork should be encouraged to ensure that the nutritional benefits of this food can be obtained while still ensuring compliance with dietary guidelines to limit processed meat intake.

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