Food Standards Australia New Zealand

The 21st Australian Total Diet Study

A total diet study of sulphites, benzoates and sorbates

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Foreword

The Australian Total Diet Study (ATDS), formerly known as the Australian Market Basket Survey, is Australia's most comprehensive assessment of consumers' dietary exposure (intake) to a range of food chemicals including food additives, nutrients, pesticide residues, contaminants and other substances. The survey has been conducted approximately every two years, and this is the 21st such survey.

Past studies have consistently shown that Australian dietary exposures to pesticide residues and contaminants are well below Australian or international reference health standards and do not represent a public health and safety risk. Therefore, the scope and format of the study has been changed. In this and future studies, subsets of a broader range of chemicals found in food, including additives and nutrients, will be examined. The new smaller surveys will be conducted more frequently in response to the need for current information on the safety of substances in food. This change has allowed Food Standards Australia New Zealand (FSANZ) greater flexibility in focusing the study on specific food chemicals where further data on dietary exposure are desirable. The 21st ATDS estimates the dietary exposure of the Australian population to three specific food preservatives, namely sulphites, benzoates and sorbates. Representative foods believed to contain these preservatives were sampled and prepared to a 'table-ready' state before analysis, in order to provide realistic estimates of amounts of the preservatives in the food as consumed.

As in the 19th and 20th total diet studies, food consumption data derived from the 1995 National Nutrition Survey were used in the calculation of dietary exposures to the food preservatives.

This study provides valuable data that can be used for developing or amending food regulatory measures to ensure the protection of public health and safety. Data from previous studies were used by FSANZ during the Review of the Australian *Food Standards Code* and were integral to the development of the subsequent joint *Australia New Zealand Food Standards Code*.

Government food agencies in each State and the Northern Territory have provided invaluable assistance with this study and FSANZ acknowledges their very important contribution. A formal international expert peer reviewer was also engaged to evaluate the study and provided useful detailed comments.

I am pleased to present the 21st Australian Total Diet Study as part of Food Standards Australia New Zealand's commitment to protecting the public health and safety through a safe Australian food supply.

Rob Knowles

Rob Knowles

CHAIRMAN

Contents

Foreword .... **i**

Contents .... **ii**

Acknowledgments .... **v**

Abbreviations .... **vi**

Summary .... **vii**

The study vii

Results viii

Conclusion ix

Report recommendations .... **x**

Part A Background **11**

Sulphites 11

Benzoates 11

Sorbates 12

Origin of the study 12

Related food chemical surveillance activities in Australia 12

Comparison with other studies 13

Using information from the Total Diet Study 13

Part B Dietary Modelling **14**

What is dietary modelling? 14

Food consumption data 14

Food chemical concentration data 14

Estimating dietary exposure to food chemicals 17

Part C Results **20**

Introduction 20

Sulphites 21

Benzoates 29

Sorbates 35

References **40**

Part D Appendices **41**

Appendix 1: Definitions and glossary of terms 42

Appendix 2: 21st ATDS food survey 43

Appendix 3: Summary of analytical methods 53

Appendix 4: Mean food consumption and body weights 56

Appendix 5: Sulphites in food – results 59

Appendix 6: Benzoates in foods – results 65

Appendix 7: Sorbates in foods – results 70

List of Figures

Figure 1: Mean and 95th percentile upper bound estimated dietary exposure for consumers of sulphites as a percentage of the ADI (ADI=0.7 mg/kg bw) 24

Figure 2: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for young children aged 2-5 years 25

Figure 3: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for school children aged 6-12 years 25

Figure 4: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for teenagers aged 13-18 years 26

Figure 5: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for adults aged 19 years and over. 26

Figure 6: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for the population aged two years and over 27

Figure 7: Mean and 95th percentile upper bound estimated dietary exposure for consumers of benzoates as a percentage of the ADI (ADI=0-5 mg/kg bw) 30

Figure 8: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for young children aged 2-5 years 31

Figure 9: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for school children aged 6-12 years 31

Figure 10: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for teenagers aged 13-18 years 32

Figure 11: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for adults aged 19 years and over. 32

Figure 12: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for the population aged two years and over. 33

Figure 13: Mean and 95th percentile upper bound estimated dietary exposure for consumers of sorbates as a percentage of the ADI (ADI = 0-25 mg/kg bw). 36

Figure 14: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for young children aged 2-5 years 37

Figure 15: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for school children aged 6-12 years 37

Figure 16: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for teenagers aged 13-18 years 38

Figure 17: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for adults aged 19 years and over. 38

Figure 18: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for the population aged two years and over 39

List of Tables

Table 1: Limits of reporting 20

Table A1: Foods sampled in the 21st ATDS 43

Table A2: Food preparation instructions 44

Table A3: 21st ATDS survey foods and corresponding NNS food 49

Table A4: Sulphite statistical data on control samples used 53

Table A5: Benzoate and sorbates statistical data on control samples used 54

Table A6: Mean consumption by consumers of each food sampled in the 21st ATDS, for each age-gender group in grams per day, derived from the 1995 NNS 56

Table A7: Mean body weights in kilograms for each age-gender category examined in the 21st ATDS, derived from the 1995 NNS 58

Table A8: Mean, minimum and maximum levels of sulphites in foods analysed in the 21st ATDS 59

Table A9: Sulphite mean and 95th percentile estimated dietary exposures for each age-gender group 61

Table A10: Percentage contribution of foods to total sulphites exposure for each age-gender group 62

Table A11: International estimates of dietary exposure to sulphites 64

Table A12: Mean, minimum and maximum levels of benzoates in foods analysed in the 21st ATDS 65

Table A13: Benzoates mean and 95th percentile estimated dietary exposures for each age-gender group 67

Table A14: Percent contribution of foods to total benzoate exposure for each age-gender group 68

Table A15: Mean, minimum and maximum levels of sorbates in foods analysed in the 21st ATDS 70

Table A16: Sorbates mean and 95th percentile estimated dietary exposures for each age-gender group 72

Table A17: Percentage contribution of foods to total sorbate exposure for each age-gender group 73

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FSANZ would like to thank Dr Michael DiNovi and Dr Alison Edwards, Food and Drug Administration, United States of America, for their valuable assistance in peer reviewing this report.

Abbreviations

ADI	Acceptable Daily Intake
AMBS	Australian Market Basket Survey
ANZFA	Australia New Zealand Food Authority
ATDS	Australian Total Diet Study
DIAMOND	Dietary Modelling of Nutritional Data (FSANZ computer software program)
FAO	Food and Agriculture Organization
FSANZ	Food Standards Australia New Zealand
JECFA	Joint FAO/WHO Expert Committee on Food Additives
LOD	Limit of Detection
LOR	Limit of Reporting
LOQ	Limit of Quantification
mg/kg	milligrams per kilogram
mg/kg bw/d	milligrams per kilogram of body weight per day
NNS	National Nutrition Survey
NOEL	No Observable Effect Level
WHO	World Health Organization

Note: Definitions for some of these abbreviations can be found in Appendix 1.

Summary

Food Standards Australia New Zealand (FSANZ) is a bi-national statutory authority that develops food standards for composition and labelling that apply to all foods produced or imported for sale in Australia and New Zealand.

The primary role of FSANZ, in collaboration with others, is to protect the health and safety of Australians and New Zealanders through the maintenance of a safe food supply. Regular monitoring of the food supply for pesticide residues, contaminants, nutrients, additives and other substances is conducted in both Australia and New Zealand. In Australia, this monitoring is conducted by a number of Federal and State government agencies, including FSANZ. The Australian Total Diet Study (ATDS) (previously named the Australian Market Basket Survey) is part of this monitoring. New Zealand also conducts a total diet study, administered by the New Zealand Food Safety Authority.

The study

The purpose of the ATDS is to estimate the level of dietary exposure of the Australian population to a range of food chemicals including pesticide residues, contaminants, nutrients, additives and other substances that can be found in the food supply. In the ATDS, dietary exposure is estimated by determining the level of the substance in foods by laboratory analysis, and then combining this with the amount of food consumed, as determined in a separate study. In order to achieve more realistic dietary exposure estimates, the foods examined in the ATDS are prepared to a 'table ready' state before they are analysed. As a consequence, both raw and cooked foods are examined. This study estimated dietary exposure to three classes of preservatives, namely sulphites, benzoates and sorbates.

FSANZ coordinated the 21st ATDS, while Government food agencies in the States and Northern Territory purchased the food samples for their jurisdictions. Food samples for the Australian Capital Territory (ACT) were collected by FSANZ. Queensland Health Scientific Services carried out sample preparation and analyses.

Fifty-nine types of foods, representing mainly processed foods for which there are permissions to contain preservatives in the *Australia New Zealand Food Standards Code* (the Food Standards Code), were sampled during April and May 2003, and tested for the food preservatives sulphites, benzoates, and sorbates. In addition, minced meat, for which there are no additive permissions but State and Territory compliance data indicated illegal addition of sulphites, was sampled. The foods sampled included those that might be expected to show regional variation (regional foods), and those available nationwide and not expected to show regional variation (national foods). For each food, three samples were combined to give a composite sample that was chemically analysed to measure the levels of preservatives.

Diets for each individual in the representative age-gender groups were derived for exposure estimations, based on 24-hour diet recall food consumption data from the 1995 National Nutrition Survey (NNS). When using these data it should be noted that drawing conclusions about lifetime eating patterns from food consumption data derived from a single 24-hour diet recall, may lead to an over-estimation of dietary exposure. This over-estimation is magnified when considering 95th percentile consumers of the food chemical. More comprehensive data on multiple-day intakes, or frequency of consumption, may provide better estimates of long-term food consumption and dietary exposure.

Dietary exposure to each preservative was estimated using the food consumption data and the level of preservative present in each food. Results were calculated for 'consumers only', that is, those people who reported consuming food containing the chemical being assessed.

The dietary exposure estimates were calculated for a range of age-gender groups. These age-gender groups were young girls aged 2-5 years, young boys aged 2-5 years, school girls aged 6-12 years, school boys aged 6-12 years, teenage girls aged 13-18 years, teenage boys aged 13-18 years, adult females aged 19 years and over and adult males aged 19 years and over. In addition, dietary exposure was estimated for the entire female population aged two years and over and entire male population aged two years and over, representing a lifetime of exposure.

The estimated dietary exposure to each preservative from the Australian diet was compared to international reference health standards set by the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives (JECFA). The reference health standard for the food additives is the Acceptable Daily Intake (ADI). The ADI is the amount of a food additive that can be consumed on a daily basis over a lifetime without appreciable health risk.

There are a number of uncertainties inherent in the dietary exposure assessment, including assumptions made in the calculations, certain limitations of the laboratory test data and sampling, and the relevance of the food consumption data that were derived from the 1995 NNS. Despite these uncertainties, the exposure assessments represent the best estimate of dietary exposure for sulphites, benzoates and sorbates using the available data. These uncertainties, however, should be taken into consideration in any subsequent risk management strategy.

Results

Key results from this study were:

Sulphites

- Mean estimated dietary exposure to sulphites was less than or equal to 80% of the ADI for all population groups assessed.
- The mean estimated dietary exposure for the population aged two years and over, representing mean lifetime exposure, was approximately 35% of the ADI for males and 30% of the ADI for females.
- 95th percentile estimated dietary exposures exceeded the ADI for sulphites for nine of the 10 population groups assessed, ranging from approximately 85% of the ADI for teenage girls aged 13-18 years to approximately 280% of the ADI for young boys aged 2-5 years.
- 95th percentile estimated dietary exposure to sulphites for the population aged two years and over, representing lifetime exposure for a high consumer of sulphites, was approximately 130% of the ADI for males and females.
- Major foods contributing to dietary exposure to sulphites for children were beef sausages, dried apricots and cordial, and for adults were white wine, beef sausages and dried apricots.

Benzoates

- Mean estimated dietary exposure to benzoates was less than 50% of the ADI for all population groups assessed.
- Mean estimated dietary exposure for the population aged two years and over, representing mean lifetime exposure, was approximately 15% of the ADI for males and approximately 10% of the ADI for females.

- 95^{th} percentile estimated dietary exposures to benzoates exceeded the ADI for young boys (approximately 140%) and young girls (approximately 120%) aged 2-5 years, and was equivalent to the ADI for schoolboys aged 6-12 years. All other population groups were below the ADI for 95^{th} percentile estimated dietary exposures.
- 95^{th} percentile estimated dietary exposure to benzoates for the population aged two years and over, representing lifetime exposure for a high consumer of benzoates, was approximately 60% of the ADI for males and approximately 50% of the ADI for females.
- Major foods contributing to dietary exposure to benzoates for young children aged 2-5 years were cordial, non-cola soft drinks and orange juice. For all other age groups assessed, non-cola soft drinks were the greatest contributor to dietary exposure to benzoates.

Sorbates

- Mean and 95^{th} percentile estimated dietary exposure to sorbates was less than or equal to 40% of the ADI for sorbates for all population groups assessed.
- Mean estimated dietary exposure to sorbates for the population aged two years and over, representing mean lifetime exposure, was approximately 3% of the ADI for both males and females.
- 95^{th} percentile estimated dietary exposure to sorbates for the population aged two years and over, representing lifetime exposure for a high consumer of sorbates, was approximately 15% of the ADI for males and approximately 10% of the ADI for females.
- The major food contributing to dietary exposure to sorbates for all population groups assessed was orange juice.

Conclusion

The results of this total dietary study indicate that for the majority of the population in all age groups the dietary exposure to sulphite, benzoates and sorbates is well below the relevant reference health standard and there is no public health and safety risk from the consumption of a balanced diet which includes some foods containing sulphites, benzoates or sorbates.

The results, however, also indicate that in some age groups consumption of sulphites and benzoates (but not sorbates) may exceed the relevant reference health standard for a proportion of the population. Therefore, for individuals in these age groups whose dietary pattern leads to a high regular consumption of sulphites and benzoates, there is a potential public health and safety risk.

It should be noted, however, that dietary modelling used in this survey is conservative and is likely to lead to an overestimate of actual dietary exposure. The reference health standard (the ADI) is also conservative and contains a significant margin of safety. Nevertheless, while there is currently no clinical evidence that high dietary exposure to sulphites and benzoates can cause adverse effects in humans, exceeding the ADI is a concern and effectively reduces the margin of safety provided by the reference health standard.

Report recommendations

It is recommended that:

1. In order to better determine whether the ADI for sulphites is exceeded by some population groups, the 95th percentile estimated dietary exposures for sulphites should be further refined where possible, using NNS food frequency questionnaire data or other available techniques, to adjust the 24-hour recall data to better predict the usual consumption patterns over time.
2. Risk management options should be considered in order to reduce dietary exposure of the Australian population to sulphites.
3. In order to better determine whether the ADI for benzoates is exceeded by some population groups, the 95th percentile estimated dietary exposures for benzoates should be further refined where possible, using NNS food frequency questionnaire data or other available techniques, to adjust the 24-hour recall data to better predict the usual consumption patterns over time.
4. Risk management options should be considered to reduce dietary exposure of some population groups to benzoates.

Part A Background

Chemical preservatives are added to food during a range of food manufacturing processes to inactivate, retard or control the growth of yeasts, bacteria and moulds, thereby extending the useful 'shelf-life' of the treated food. Chemical preservatives have been used in food manufacturing for many years and provide important benefits to consumers, including the wider availability of a variety of different foods that are safe, convenient and cost effective.

Although the use of preservatives presents the community with significant benefits, there may be risks associated with their use. The safety of food additives, including preservatives, is monitored and assessed internationally by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). JECFA has established Acceptable Daily Intakes (ADIs) for most food additives. An ADI is defined by JECFA as an estimate of the amount of a food additive, expressed on a body weight basis, that can be ingested daily over a lifetime without appreciable health risk. In order to ensure the use of preservatives at levels that will result in dietary exposures below the ADI, FSANZ regulates the type of foods that may contain preservatives and the maximum levels at which preservatives may be added to these foods.

A review of all permitted food additives was undertaken as part of the review of the then Australian *Food Standards Code* and completed in 2000. During this review both sulphites and benzoates were identified as cause for concern because estimated dietary exposures for these preservatives had the potential to exceed the ADI for either the whole population or specific population groups. Consequently, it was recommended that sulphite and benzoate concentrations in food and estimated exposures should be monitored.

As a result of recommendations from the review of food additives, sulphites and benzoates were selected for assessment in the 21st ATDS. While sorbates were not identified as a potential cause for concern during the review, they were also included for assessment in the 21st ATDS, as there was little recent data on actual concentration levels in foods, and as additive permissions and uses, and analytical methods for sorbates are similar to those of benzoates.

Sulphites

Sulphur dioxide has been used since ancient times for its cleansing, disinfecting and purifying properties. In addition to acting as a preservative through the inhibition of microbial growth, sulphites also act to inhibit both enzymatic and Maillard type browning reactions. Sulphur dioxide and sodium and potassium sulphites, bisulphites and metabisulphites (collectively referred to as sulphites for the purposes of this report), are permitted food additives in specified foods in the *Food Standards Code*. Sulphites are widely permitted in such foods as wine, cordials, dried fruit and vegetables, and comminuted meat products. Sulphites are also produced by micro-organisms and may be present at low levels in many foods even where none has been added.

Benzoates

Benzoic acid is one of the oldest chemical preservatives used in the cosmetic, drug and food industries (Chipley, 1993, Deshpande et al, 1995). It occurs naturally at low levels in a range of foods including most berries (such as cranberries and bilberries), and other fruits, and dairy products (milk, cheese, yoghurt) (WHO IPCS, 2000). As it is the undissociated benzoic acid molecule that is responsible for antimicrobial activity, benzoic acid is a much more effective chemical preservative in acid foods than in neutral or alkaline foods (Chipley, 1993). Benzoic acid and its calcium, potassium and sodium salts (collectively referred to as benzoates for the purposes of this report) are permitted for use in Australia in a range of foods including fruit and vegetable juices, soft drinks, sauces and toppings, dairy and fat based desserts and dips, low joule jams, fruit wine, and ice confection sold in liquid form.

Sorbates

Sorbic acid is a naturally occurring compound and is one of the most widely used food preservatives worldwide (Deshpande et al, 1995). Sorbic acid acts to inhibit the growth of a wide spectrum of bacteria, moulds and yeasts. As with benzoates, the inhibitory action of sorbates increases in more acidic media. However, sorbates are effective food preservatives in moist foods up to a pH 6.5, giving it an advantage over other common food preservatives such as benzoates and propionates (Deshpande et al, 1995). Sorbic acid and its calcium, sodium and potassium salts (collectively referred to as sorbates) are permitted for use in a range of foods including cheese and cheese products, preserved fruit and vegetables, confectionery, bakery products, preserved meat and fish products, fruit and vegetable juices, soft drinks, wine, fruit wine, dairy and fat based desserts and dips, sauces and toppings.

Origin of the study

In Australia, the National Health and Medical Research Council (NHMRC), at its 68th session held in 1969, recommended that a 'market basket' survey be carried out to examine the levels of pesticide residues and contaminants in foods that constitute a significant part of the normal Australian diet.

The NHMRC conducted the first total diet survey in 1970. Another 15 surveys were conducted by the NHMRC before responsibility passed to the predecessor of FSANZ, the National Food Authority. The 21st ATDS is the sixth study to be conducted by FSANZ or its predecessors. Previous ATDSs were conducted approximately every two years, with sampling and analysis of foods taking place over 12 months, capturing seasonal variation in the food supply.

Past ATDSs consistently showed that Australian dietary exposures to pesticide residues and contaminants were well below international health standards and did not represent a public health and safety risk. Therefore, in 2003, FSANZ decided, in consultation with State and Territory Government food agencies, that the scope and format of the ATDS should change to consider a wider range of food chemicals, including additives and nutrients, with smaller surveys being conducted more frequently. The change in format of the ATDS has allowed FSANZ greater flexibility in focusing the study on food chemicals for which there may be concern that dietary exposures could exceed the reference health standard for some population groups, or where significant data gaps exist on chemicals in foods. Surveys of pesticide residues and contaminants will continue to be conducted on a regular but less frequent basis.

Related food chemical surveillance activities in Australia

The Australian Government, through the Department of Agriculture, Fisheries and Forestry, conducts two programs that collect information on the levels of pesticide residues, contaminants and other substances in foods:

- the National Residue Survey (NRS); and
- the Imported Food Program (IFP), conducted by the Australian Quarantine and Inspection Service (AQIS), which undertakes the surveillance of imported foods to ensure that they comply with the *Imported Food Control Act 1992* and the *Food Standards Code*.

The main aim of these programs is to monitor pesticide residues, contaminants and other substances in food commodities, in both export (NRS) and import (IFP) trade.

In addition to these programs, State and Territory health and agriculture authorities carry out regular sampling and analysis of foods for specific contaminants, pesticide residues, food additives and other food chemicals. These surveillance programs are usually targeted to investigate specific concerns and determine whether primary producers and food manufacturers are complying with relevant food regulations. The data generated through these surveillance programs are a valuable source of supplementary information on the food chemical status of foods.

Comparison with other studies

The ATDS differs from other surveys of food chemicals in the following ways:

- the ATDS estimates the dietary exposure to certain substances from the total diet to determine whether the level of exposure poses an unacceptable risk to human health. Other surveillance programs examine the level of chemicals in individual agricultural commodities or foods to determine compliance with food legislation but do not carry out a comprehensive examination of their significance in the diet; and
- the ATDS contrasts with other national surveys in that all ATDS food samples are prepared to a ‘table-ready’ state before they are analysed, that is, they are subjected to prescribed preparation or processing steps. As food storage and preparation is known to affect the concentration of some food chemicals, particularly sulphites, in the food, an analysis of prepared foods more accurately reflects the levels of the food chemicals of interest that are likely to be consumed.

Using information from the Total Diet Study

The revised format of the ATDS has allowed greater flexibility to target the studies to inform the food standard setting process. In conjunction with information from other sources, data from the ATDS provide information to be considered when reviewing, developing or amending food regulatory measures.

In addition, the results of the survey are a source of information for Australia’s contribution to the FAO/WHO Global Environmental Monitoring System (GEMS), which monitors food contamination internationally, JECFA, the Codex Committee on Food Additives and Contaminants, the Codex Committee on Pesticide Residues, and independent researchers in both government and non-government agencies.

Part B Dietary Modelling

What is dietary modelling?

Dietary modelling is a scientific systematic method for estimating the amounts of food chemicals a person or population may be eating. Food regulators have used dietary modelling techniques internationally for a number of years as part of the risk assessment process to determine if dietary exposure to specific food chemicals represents an unacceptable risk to public health and safety.

Dietary modelling is an important part of the ATDS as it translates analytical results for individual foods into dietary exposure estimates that can be compared to established reference health standards. The comparison of dietary exposure data to these health standards is crucial in identifying whether the estimated dietary exposure to food chemicals would potentially result in an unacceptable health risk to any population group.

A glossary of some terms used in determining safe exposures and regulatory limits for food chemicals is included in Appendix 1.

This dietary exposure assessment was conducted using dietary modelling techniques that combine **food consumption data** with **food chemical concentration data** to estimate the dietary exposure to the food chemical from the diet.

Food consumption data

Dietary modelling was conducted using food consumption data from the 1995 National Nutrition Survey that surveyed 13 858 Australians aged 2 years and above using a 24-hour food recall methodology.

Limitations associated with the food consumption data

Conducting dietary modelling based on 1995 NNS food consumption data provides the best estimate currently available of actual consumption of a food and the resulting estimated exposure to a food chemical. However, it should be noted that limitations exist within the NNS data. These limitations relate to the age of the data and the changes in eating patterns that may have occurred since the data were collected. Generally, consumption of staple foods such as fruit, vegetables, meat, dairy products and cereal products, which make up the majority of most people's diet, is unlikely to have changed markedly (Cook et al, 2001). However, there is uncertainty associated with the consumption of other foods where these may have changed in consumption since 1995, or where new foods on the market were not available in 1995.

Food chemical concentration data

Food chemical concentration data for use in the dietary modelling were derived by conducting a survey and analysing a range of foods that might be expected to contain the food chemicals of interest.

Conducting the food survey

The food survey for the 21st ATDS was coordinated by FSANZ and undertaken in cooperation with each of the Australian States' and the Northern Territory's Government food agencies. Each participating

State or Territory nominated a liaison officer to:

- provide advice in relation to the procedures for conducting the study;
- coordinate food sample collection, packaging and shipment to the nominated laboratory for analysis; and
- where appropriate, coordinate preparation of samples to a table ready state.

Food was sampled in each of the Australian States and two Territories[1] during April and May of 2003. Due to the large number of samples required, provision was made for purchasing to occur over several days. The collection period varied slightly for each State or Territory in order to stagger the arrival of samples at the analytical laboratory. Seasonal sampling of foods was not considered necessary for this ATDS as food preservative concentrations were unlikely to vary between seasons due to the nature of the use of food additives and the foods sampled (primarily processed foods).

Foods were collected by the jurisdictions and forwarded to the analytical laboratory as soon as practicable. All perishable samples were frozen prior to forwarding to the laboratory. Queensland, Western Australia and the Northern Territory provided sample preparation services in addition to sample collection. For the remaining jurisdictions sample preparation was undertaken by the analytical laboratory. All food samples were prepared in accordance to strict instructions. Perishable foods were prepared within 48 hours of arrival at the laboratory. However, where necessary, the preparation of frozen or shelf-stable foods was delayed, but carried out within a week of purchase.

The analytical laboratory undertook the chemical analysis of the foods in accordance with quality assurance procedures and the results were forwarded to FSANZ where the dietary exposures were estimated and the report prepared. Analytical methods are outlined in Appendix 3.

Foods included in the survey

As sulphites, benzoates and sorbates are specifically added to foods at the time of manufacture, foods were included in this study according to the following criteria:

- there was a permission for the use of one or all of the preservatives for that food category in Standard 1.3.1 – Food Additives, of the *Food Standards Code*;
- the food was the most commonly consumed in each food category, as shown by the 1995 National Nutrition Survey (NNS);
- the foods formed a major part of the diet of one or more subpopulations of Australians;
- the food contained high concentrations of the food chemical although consumption of the food may be low; and
- a food for which State and Territory compliance data showed consistent/persistent illegal addition of preservatives.

When constructing a total diet study, foods are generally selected to be representative of each major food group and consistent with a nutritionally acceptable diet. However, food preservatives are not permitted in most fresh meat, agricultural produce, or fruit and vegetables. Therefore, it was not necessary to ensure food selections for this study were representative of all major food groups in order to ensure a representative diet for food preservatives was selected.

The 59 foods surveyed in the 21st ATDS were chosen according to the above criteria and are set out in Appendix 2, Table A1. All the foods examined in the study were prepared to a ‘table ready’ state before analysis (refer to Appendix 2, Table A2 for details on food preparation instructions). For example, cordial

[1] Sample collection in the Australian Capital Territory was carried out by FSANZ.

was made up according to the manufacturers' instructions and hamburger patties, sausages and minced meat were dry fried until cooked through. In general, however, few of the foods surveyed in this study required additional preparation as the foods selected were available in a table ready form.

Foods were sampled according to a schedule that categorised them into national or regional foods. This ensured more samples were collected where there may be regional variation and allowed a better overview of the Australian diet.

Regional foods were defined as those foods that might be expected to show regional variation in manufacture. Regional foods included meat and meat products, beer and wine, bread and other bakery goods, dips and some cheese. Three composite samples of these foods, consisting of three purchases each, were collected in five capital cities, making 15 composite samples for each regional food.

National foods were defined as those foods that are available nationwide and are not expected to show regional variation. They are foods, such as table spreads, soft drinks and potato crisps, that are distributed nationwide from a small number of manufacturers. Three composite samples, consisting of three purchases each, were collected in three capital cities, making nine composite samples for each national food.

Not all foods sampled were tested for all three preservatives. Depending on additive permissions, each food was examined for one or more of the food additives.

Use of mean food chemical analytical concentration levels

In choosing a chemical concentration level for each food for use in dietary modelling, FSANZ chose the mean analytical level. Where a high number of results are below the LOD, the mean level is typically a more conservative indicator of the detected levels of the preservatives than the median level. In addition, food samples analysed for the ATDS are composites of three purchases, resulting in further averaging in the analytical result.

Assumptions relating to the analytical results

A number of assumptions have been made about the concentration of the food chemical in food samples where the analytical results were below the limit of reporting (LOR). For the purposes of this ATDS report a LOR equivalent to the limit of quantification (LOQ) was chosen for each preservative (refer to definitions in Appendix 1).

The Limit of Detection (LOD) for each of the food chemicals evaluated was 2 mg/kg. Given that the food chemicals assessed in this ATDS are specifically added to certain foods, it was assumed that the chemicals were not added and were not present when the analytical result was less than the LOD. Therefore, food chemical analytical results that were reported as less than LOD were assumed to be zero when calculating the mean concentrations of the chemicals in the foods.

Assumptions have also been made about analytical results reported as being between the LOD and the LOR. There is a lower degree of certainty associated with these results. However, it may not be reasonable to assume that the food chemical is not present in the food when the analytical results are between the LOD and the LOR. Results below the LOR could be anywhere between the LOD and the LOR. To allow for this uncertainty, two estimates of dietary exposure were calculated. The lower estimate ('lower bound') was calculated based on the assumption that food chemical concentrations between the LOD and LOR are equal to zero. The upper estimate ('upper bound') was calculated based on the assumption that food chemical concentrations between the LOD and LOR were all at concentrations equal to the LOR. The exposure estimates based on the lower bound and upper bound mean chemical concentrations are derived from different numbers of consumers of the food chemical and therefore, different distributions of individual exposures, resulting in different mean and 95^{th}

percentile exposures being derived. Consequently, the results based on the lower bound and upper bound concentrations cannot be presented as a range as they are not derived from the same population. For this study, there were relatively few analytical results reported between the LOD and LOR, resulting in little difference between lower and upper bound dietary exposure estimates.

Estimating dietary exposure to food chemicals

How is dietary modelling conducted?

DIAMOND (Dietary Modelling of Nutritional Data) is a computer program developed by FSANZ to computerise dietary modelling calculations. The amount of chemical in each food, derived from the food survey, is multiplied by the amount of food consumed, derived from the 1995 NNS, and summed over all foods assessed to determine the exposure to the chemical from the diet for each individual surveyed in the 1995 NNS.

Population statistics (mean and 95th percentile estimated exposures) for each age-gender group are then derived from the individuals' ranked exposures. To estimate dietary exposures on a per kilogram of body weight basis, each individuals' total dietary exposure to the food chemical from all foods is divided by their own body weight, the results for all individuals are ranked, and population statistics (mean and 95th percentile exposures) are then derived. A very small number of survey respondents did not provide a body weight. These respondents were not included in the ranked exposures for deriving population statistics based on body weight.

Once dietary exposure to the food chemical has been estimated and population statistics derived, these are compared to a reference health standard to assess the potential risk to human health, in this case the relevant Acceptable Daily Intake (ADI).

The primary benefit of using DIAMOND is that it enables dietary exposure assessments to be conducted using records from the NNS of reported food consumption for approximately 13,800 people of all ages (≥ 2 years of age) in place of 'average' diets, as were used in studies prior to the 19th ATDS. This means that dietary exposure is calculated for each individual in the survey before deriving mean and 95th percentile dietary exposure results for the age-gender group. The use of these food consumption data improves the reliability of the dietary exposure estimates to food chemicals and takes account of the different eating patterns of actual consumers.

Population groups evaluated

The population groups evaluated for the dietary modelling were reviewed prior to commencing the 20th ATDS. At that time the decision was made to use age-gender groups traditionally used in the ATDS to allow comparison of the 20th ATDS with previous studies. The population groups assessed were for specific age blocks, which meant that exposures for some age groups were not reported at all.

For the 21st ATDS, as the format of the study has been revised, it was appropriate to reassess the population groups for which estimated exposures were calculated. DIAMOND is capable of reporting estimated exposures for various age-gender combinations. Factors that were considered when deciding what population groups to assess were: groups that were likely to have the greatest exposure (usually this is young children, due to their high food consumption relative to body weight); the differences in exposure between population groups due to different food consumption patterns; and population groups that may be more at risk of adverse effects from the food chemical being evaluated.

The population groups reported in the 21st ATDS are: young girls aged 2-5 years and young boys aged 2-5 years to represent pre-primary school children; school girls aged 6-12 years; school boys aged 6-12 years; teenage girls aged 13-18 years; teenage boys aged 13-18 years; adult females aged 19 years and over; adult males aged 19 years and over; the female population aged two years and over; and the male population aged two years and over. The dietary exposure estimates for the population groups of females aged 2 years and over and males aged 2 years and over are assumed, for the purposes of this report, to be indicative of a lifetime of exposure to food chemicals.

Respondents versus consumers

Estimates of dietary exposure can be calculated for 'all respondents' and/or 'consumers only'. Respondents refers to all people included in the population group being assessed regardless of whether they were exposed to the food chemical or not; consumers refers to those people who reported consuming food containing the food chemical being assessed.

As this study included mainly processed foods for which there are food additive permissions, many of the most commonly eaten foods (for example, fresh fruit and vegetables, milk, most fresh meats) were not included. As a result, not all respondents in each population group were consumers of foods containing the chemicals being assessed. Therefore, results have been reported for consumers only, as this provides the most conservative estimate of dietary exposure, and estimates the risk for those people who are likely to be consuming the food chemical of interest.

Mapping

A major step in the dietary modelling process is matching (or mapping) the approximately 4 000 foods reported as consumed in the NNS to the 59 ATDS survey foods. This process assigns the levels of substances detected in the ATDS survey foods to the appropriate food consumption data to estimate dietary exposure to the substance. Given that the ATDS cannot survey all foods in the food supply, a single ATDS food (for example white bread) may be assumed to represent a whole group of foods (for example white bread, wholemeal bread, multigrain bread and all rolls, fancy breads and donuts). Recipes are used for mixed foods to assign their ingredients to the appropriate ATDS food (e.g. the proportion of dried apricots and apples in breakfast cereal). Food mapping is based on traditional nutritional groupings as well as possible additive use.

Food chemical permissions for the preservatives contained in the Food Standards Code apply to classifications of foods rather than individual foods. Therefore, a preservative concentration analysed in one food may be used to represent all foods with similar additive permissions within that classification.

Some food categories are not permitted to, and would not be expected to contain the food chemicals assessed and therefore were not mapped to the survey foods. These included most fresh food produce such as meat and fish (except minced meat), fruit, vegetables and milk.

Details of the survey foods and corresponding NNS foods are set out in Appendix 2, Table A3.

Food contribution calculations

The percentage contribution each food group makes to total estimated mean dietary exposure for each population group were calculated by dividing the sum of all consumers' exposures from one food group by the sum of all consumers' exposures from all foods containing the food chemicals assessed, and multiplying this by 100. Only foods containing the food chemicals at concentrations at or above the LOR were used in the calculation to estimate the percentage contribution each food group makes to total estimated exposures, as this provides the best indication of the food groups most likely to contribute to dietary exposure.

Limitations and assumptions relating to the dietary modelling

The aim of the dietary exposure assessment is to make as realistic an estimate of dietary exposure to the food chemical of interest as possible. However, where significant uncertainties in the data exist, conservative assumptions are generally used to ensure that the dietary exposure assessment does not underestimate exposure.

Limitations exist in the methods of estimating dietary exposure as well as in the data itself. For example, conclusions are drawn about lifetime eating patterns from food consumption data derived from a single 24-hour diet recall, generally leading to conservative dietary exposure estimates. More comprehensive data on multiple-day intakes, linked with frequency of consumption, may provide better estimates of long-term dietary exposure and food consumption.

A further limitation is the small number of foods and samples analysed. It is impossible to sample and analyse all foods. Therefore, foods are selected for analysis to represent the major foods in the Australian diet that are likely to contain the chemical of interest. While there are a small number of samples, the results are considered to be valid due to the random nature of the food sampling protocol.

Construction of the infant diet

There are no data available from the NNS on children under two years of age. For past total diet studies, an average model diet has been constructed for infants at 9 months of age, based on an extrapolation from the diet of a child at two years for solid foods, with an adjustment of the proportion of the total diet made up of milk. However, foods that are significant contributors of the food additives to a 2-year-old diet are not likely to be representative of foods consumed by 9-month-old infants. The construction of a theoretical 9-month-old diet by extrapolation from the 2-year-old NNS food consumption data was therefore not considered appropriate for this study.

Part C Results

Introduction

All analytical results for the preservatives sulphites, benzoates and sorbates are expressed in milligrams per kilogram (mg/kg) of the edible portion of food prepared for consumption unless otherwise stated. Information on the methods of analysis of the preservatives in the foods analysed is included in Appendix 3. The LORs for each preservative are given in Table 1.

Food consumption and body weight data for each of the age–gender groups are summarised in Appendix 4.

Preservatives are intentionally added only to those foods where there is a technological need; for other foods no preservative should be present. For this reason, foods reported as containing less than the LOD for sulphites, benzoates and sorbates were assumed to not contain the food chemical for the purposes of dietary exposure assessments. The following discussion of estimated dietary exposure results for sulphites, benzoates and sorbates refers to upper bound estimates only. Upper and lower bound estimated dietary exposure estimates, at the mean and 95th percentile, are reported for sulphites, benzoates and sorbates in Table A8 of Appendix 5, Table A12 of Appendix 6, and Table A15 of Appendix 7, respectively.

To reflect the uncertainties associated with the food consumption data, analytical data and dietary modelling methodology, estimated dietary exposures, as a percentage of the ADI, have been rounded. Values greater than 100% have been rounded to the nearest 10%, values between 10% and 100% have been rounded to the nearest 5%, and values less than 10% rounded to the nearest 1%.

When calculating the percentage contribution of individual foods to total food chemical exposure, lower bound results are used, where analytical results reported as being below the LOR are assumed to be zero. Using lower bound results provides the best indication of the food groups most likely to contribute to dietary exposure, as only foods where food chemical levels were reported at or above the LOR are included.

Foods that contribute 5% or more to sulphite, benzoate or estimated dietary exposure are included in the discussion of results. Details of foods that are contributors to sulphite, benzoate and sorbates estimated dietary exposures are included in Appendices 5, 6 and 7.

Table 1: Limits of reporting

Analyte	LOR (mg/kg)
Sulphites	5
Benzoates	10
Sorbates	5

Sulphites

During the review of the then Australian *Food Standards Code*, completed in 2000, all food additives underwent a risk assessment as part of the development of Standard 1.3.1 – Food Additives. Dietary exposure assessments were conducted for all additives with ADIs, including sulphites. The estimated dietary exposure for sulphites, based on proposed Maximum Permitted Levels (MPLs), exceeded the ADI. In order to refine the dietary exposure estimates, food manufacturers were requested to supply details of actual levels of use for the additive group. Once again, estimated dietary exposures for sulphites exceeded the ADI using manufacturers' use data. The conclusion made about sulphites dietary exposure from this review was that, in reality, estimated dietary exposures may not exceed the ADI due to a number of reasons, including degradation of sulphites over time due to their preserving action, and the fact that not all foods contain sulphites or contain them at the maximum permitted level, despite permissions for their use. However, it was recommended that sulphite concentrations in food and estimated exposures should be monitored.

Sulphur dioxide and sulphites were most recently re-evaluated by the Joint WHO/FAO Expert Committee on Food Additives (JECFA) in 1998 (WHO, 1999), where the previously allocated group ADI of 0.7 mg/kg bw/day for sulphites, expressed as sulphur dioxide, was maintained.

The 21st ATDS assessed total sulphites in a wide range of foods for which there were food additive permissions, and for minced beef for which there was known illegal addition of sulphites. The mean, maximum and minimum concentrations of sulphites found in the foods analysed are given in Table A8 of Appendix 5. The mean and 95th percentile estimated dietary exposures to sulphites for the population groups assessed are set out in detail in Table A9 of Appendix 5, and the comparison to the ADI is summarised in Figure 1.

Mean estimated dietary exposures for consumers of foods containing sulphites were below the ADI for all population groups assessed, ranging from approximately 20% of the ADI for teenage girls aged 13-18 years, to approximately 80% of the ADI for young boys aged 2-5 years. Mean estimated dietary exposure for the population aged two years and over, representing a lifetime of exposure, was approximately 35% of the ADI for males and 30% of the ADI for females.

95th percentile estimated dietary exposures exceeded the ADI for most population groups assessed, ranging from approximately 85% of the ADI for teenage girls aged 13-18 years, to approximately 280% of the ADI for young boys aged 2-5 years. 95th percentile estimated dietary exposure for the total population aged two years and over, representing a lifetime of exposure, was approximately 130% of the ADI for males and females.

The mean and 95th percentile dietary exposure estimates, per kilogram body weight, were highest for young children (aged 2-5 years and 6-12 years) because of their high food consumption relative to body weight and lower body weights.

The major foods contributing to sulphites dietary exposure varied between children and adults as detailed in Table A10 of Appendix 5 and summarised in Figures 2 through to 6. The major contributors to young children's (aged 2-5 years) exposure to sulphites were beef sausages (boys approximately 25%, girls approximately 35%), dried apricots (boys approximately 30%, girls approximately 15%) and cordial (boys approximately 20%, girls approximately 25%). Major contributors to sulphite exposure for school children aged 6-12 years were beef sausages (boys approximately 40%, girls approximately 35%), dried apricots (boys approximately 20%, girls approximately 25%) and cordial (boys and girls approximately 20%). Major contributing foods to sulphite dietary exposure for teenagers aged 13-18 years were beef sausages (boys approximately 25%, girls approximately 30%), dried apricots (boys approximately 20%, girls approximately 10%), and cordial (boys and girls approximately 15%). Foods that were major contributors to dietary exposure to sulphites for adults (aged 19 years and over) were white wine (males approximately 25%, females approximately 40%), beef sausages (males approximately 25%, females approximately 15%) and dried apricots (males approximately 15%, females approximately 20%). The foods contributing to sulphites exposure for the population aged two years and over were white wine (males approximately 20%, females approximately 35%), beef sausages (males approximately 25%, females approximately 15%) and dried apricots (males approximately 15%, females approximately 20%).

Sulphites in minced meat

The *Food Standards Code* does not permit the addition of sulphites to minced meat. However, minced meat was included in the 21st ATDS as State and Territory health departments' compliance data has indicated that illegal addition of sulphites to minced meat may occur. Of the fifteen composite samples of minced meat analysed in this study, sulphites were detected in four samples, with concentrations ranging from <5-105 mg/kg. The contribution minced meat makes to the total dietary exposure to sulphites is approximately 1%, with the maximum being approximately 3% for females aged 13-18 years.

Whilst the contribution of minced meat to the total dietary exposure to sulphites may only be small, any additional sulphites in the diet from illegal uses should be eliminated in order to reduce the possible risk to health. Analytical results from the 21st ATDS are not suitable for enforcement purposes, however they may give an indication as to where further testing could be targeted and have therefore been provided to State and Territory health departments. State and Territory health departments, who are responsible for enforcement of food laws, conduct regular surveys of meat products to ensure compliance with food additive permissions contained in the *Food Standards Code*. The results of the present total diet study highlight the need for Australian food regulation enforcement agents to continue targeting enforcement and education activities at meat manufacturers in order to reduce illegal addition of sulphites to minced meat.

Sulphite sensitivity

A small section of the population, mainly people who suffer from asthma, react to sulphites with allergy-like symptoms. In sulphite-sensitive people sulphites can provoke asthma and other symptoms of allergic response such as skin rashes and irritations. Sensitivity to sulphites in food is dependent on how much a person is exposed to sulphur dioxide or sulphites from all sources in a short period of time (FSANZ, 2001, JECFA, 1998).

FSANZ has addressed the issue of sulphite-sensitivity by including provisions in the *Food Standards Code* that require the mandatory declaration of sulphites in the statement of ingredients when added to foods in concentrations of 10 mg/kg of food or more. This applies when sulphites are added as an ingredient, an ingredient of a compound ingredient, a food additive or component of a food additive, or a processing aid or component of a processing aid.

The dietary exposure assessment and risk characterisation of sulphites conducted as part of this study considers only the long-term health effects of dietary exposure by comparing estimated exposure with the ADI set by the JECFA. The 21st ATDS does identify foods containing sulphites but does not specifically address the issue of sulphite-sensitivity.

International estimates of dietary exposure to sulphites

Direct comparison of Australian estimated dietary exposure to sulphites to other national estimates of dietary exposure is not really achievable as each country employs different dietary modelling methods and makes different assumptions within the models. Methods of estimating food consumption range from relatively crude screening techniques such as using sales data and household economic surveys, to more refined methods such as using model diets and individual dietary records.   There are also differences in the collection and reporting of food chemical concentration data. If analytical data are unavailable, manufacturers use data or maximum permitted levels for food additives may be used. However, in the case of preservatives, these levels will be higher than that found in most foods as the preservative level decreases with time due to the chemical reactions occurring that allow the food to remain fit for consumption (ie the preservative action)

Table A11 of Appendix 5 provides a summary of international estimates of dietary exposure to sulphites, based on model diets or individual dietary records. However, drawing conclusions from the available international studies should be done with the utmost caution. In general terms, Australian estimated dietary exposure to sulphites is similar to international estimates of dietary exposure to sulphites. This suggests that a number of countries may be in the position of examining options relating to reducing dietary exposure to sulphites.

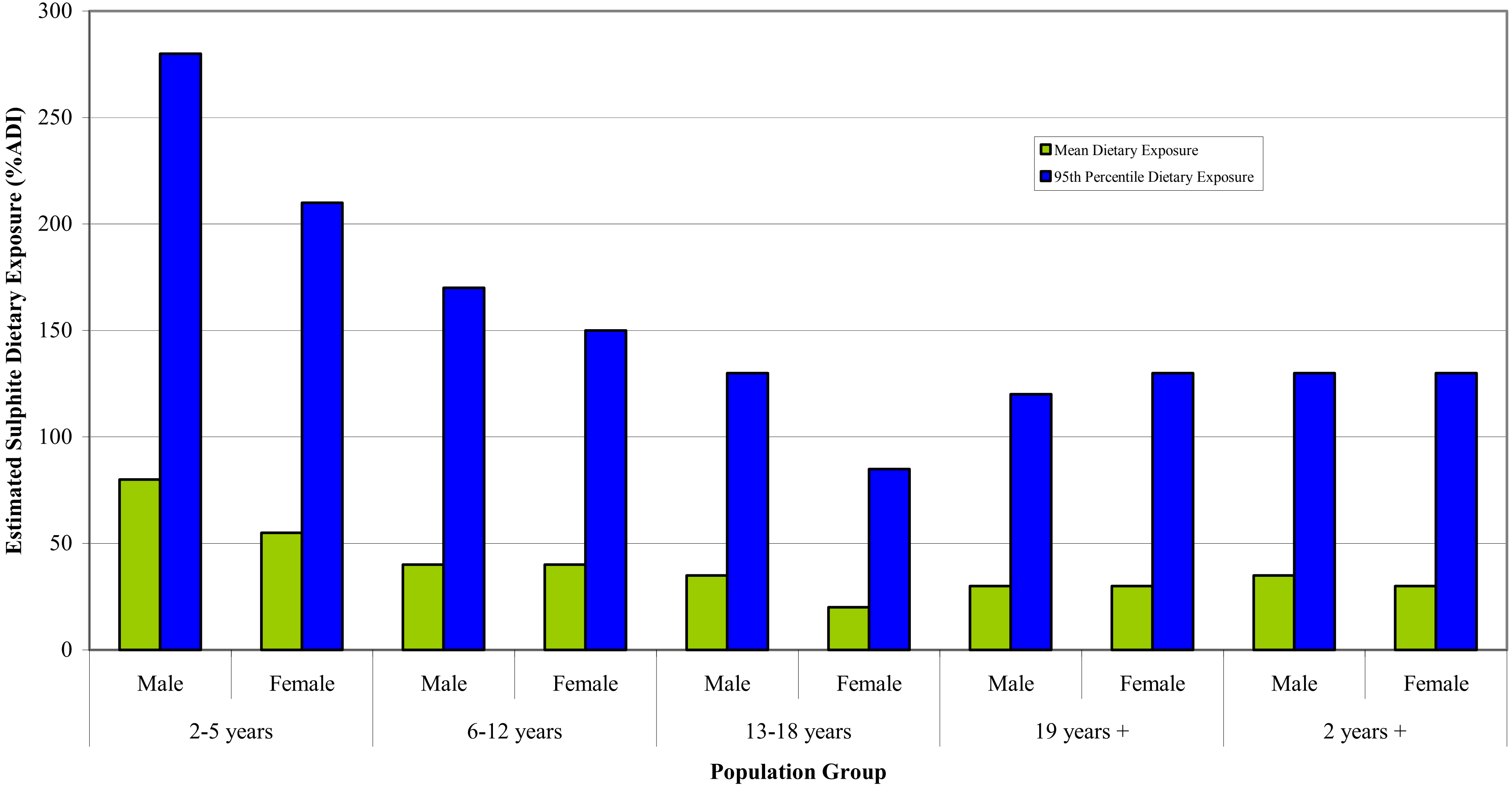


Figure 1: *Mean and 95th percentile upper bound estimated dietary exposure for consumers of sulphites as a percentage of the ADI (ADI=0.7 mg/kg bw)*

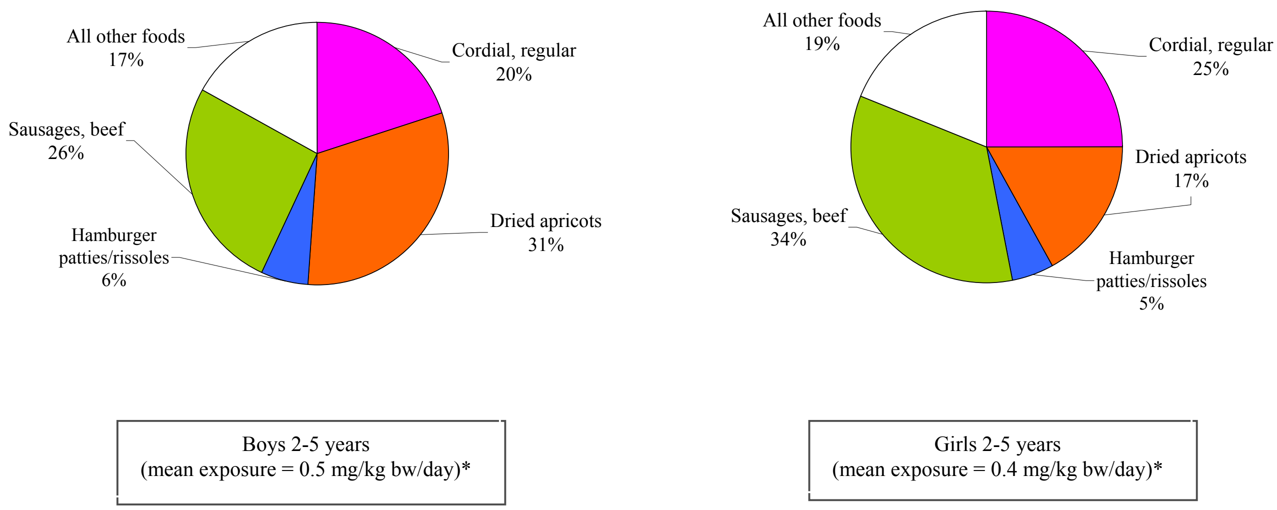


Figure 2: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for young children aged 2-5 years

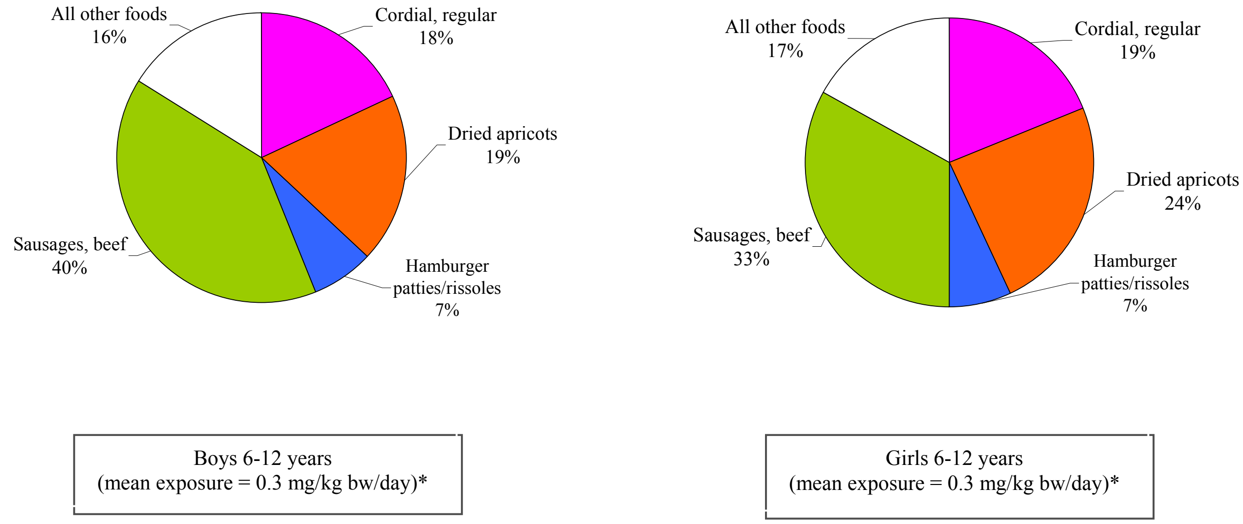


Figure 3: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for school children aged 6-12 years

* The percent contribution of each food group is based on total sulphite dietary exposure for all consumers in the population groups assessed.

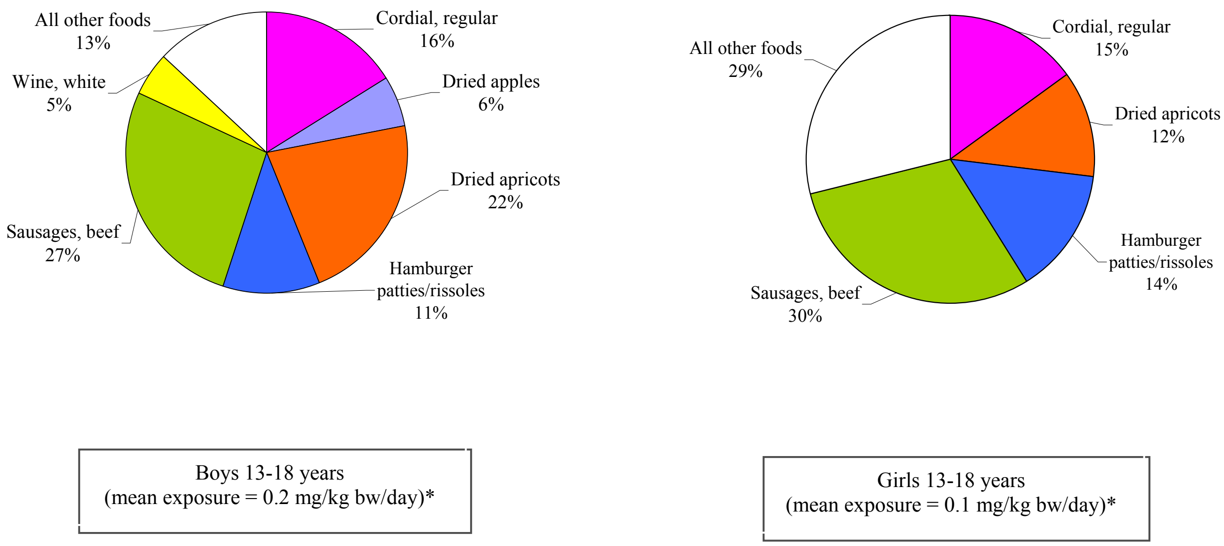


Figure 4: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for teenagers aged 13-18 years

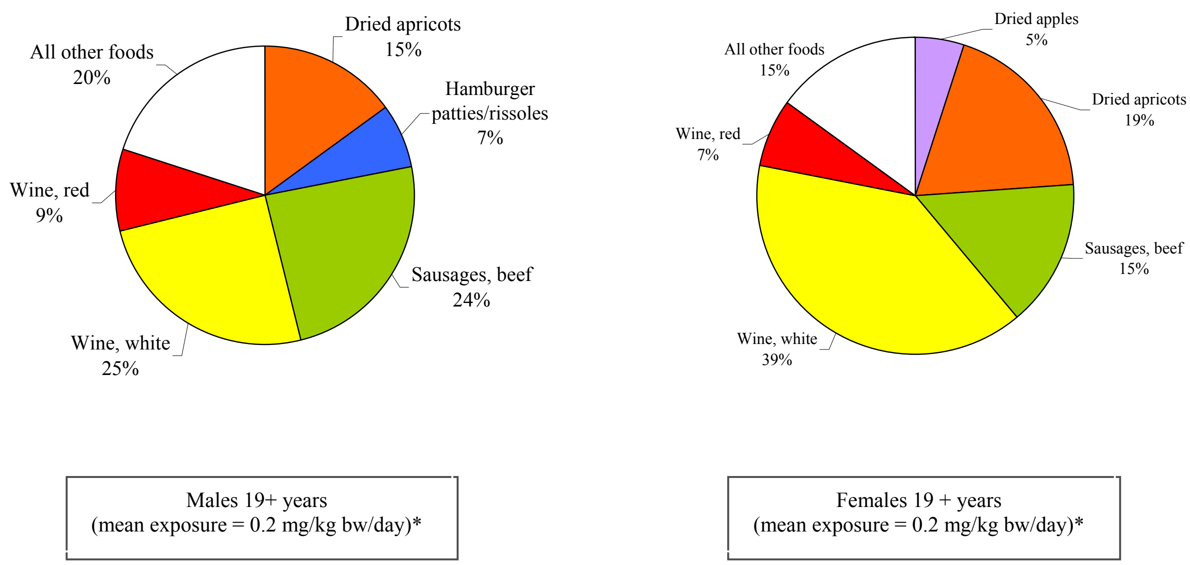


Figure 5: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for adults aged 19 years and over.

* The percent contribution of each food group is based on total sulphite dietary exposure for all consumers in the population groups assessed.

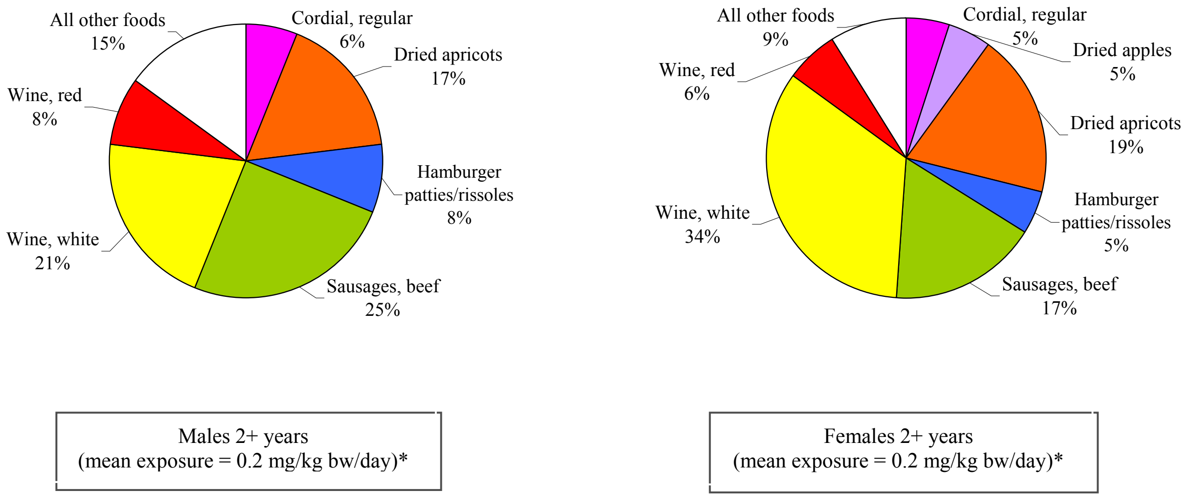


Figure 6: Percentage contribution of the major contributing foods to mean sulphite dietary exposure for the population aged two years and over.

* The percent contribution of each food group is based on total sulphite dietary exposure for all consumers in the population groups assessed.

Risk characterisation

The ADI of 0-0.7 mg/kg bodyweight established by JECFA for sulphites is based on studies conducted in rats and pigs, where exposure to sulphites was found to cause gastric lesions in both short- and long-term studies. The no-observed-effect level (NOEL) was 70 mg/kg bodyweight per day. There was little evidence of toxicity in other organs, even at higher dose levels. In establishing the ADI, a safety factor of 100 was applied to the NOEL to take into account species differences and individual human variation. JECFA also noted that the gastric effects arise from local irritation, and therefore the effects would be more dependent on concentration in the stomach than on daily dose. Therefore, adverse effects are more likely to occur following regular on-going consumption of meals with foods that have high concentrations of sulphites, such as dried apricots and dried apples.

The mean estimated dietary exposure to sulphites for all population groups was well below the ADI, indicating that for the majority of the population there is no public health and safety risk from the consumption of a balanced diet, which includes foods containing sulphites.

The 95th percentile estimated dietary exposure to sulphites, however, exceeded the ADI for most population groups assessed, ranging from approximately 80% of the ADI for girls aged 13-18 years to approximately 280% of the ADI for boys aged 2-5 years.

The 95th percentile estimated dietary exposure represents the consumption pattern of the more extreme consumer in each of the population groups. It is also based on conservative dietary modelling, which relies on the results of a 24-hour food recall survey and includes the assumption that people surveyed in the NNS eat the same foods every day. For commonly consumed foods, this may be a reasonable assumption, and in the case of sulphites, foods that significantly contribute to sulphite exposure, such as sausages and cordial, are commonly consumed foods[2].

The result of the total diet survey have highlighted a potential public health and safety concern for

[2] Commonly consumed foods are defined by FSANZ as those foods consumed one or more times per week by 25% or more of the population, based on 1995 NNS Food Frequency Questionnaire data.

above-average consumers of high sulphite-containing foods. The most sensitive adverse effect observed in animal studies is the appearance of gastric lesions caused by the presence of repeated high concentrations of sulphites in the stomach over a moderate to long timeframe. There is currently no evidence that such gastric lesions have occurred in humans, although clinical diagnosis of such an effect may be difficult. The 100-fold safety factor built into the ADI for sulphites provides a significant margin of safety, which serves to reduce the potential for adverse effects in humans. Nevertheless, exceeding the ADI by individuals at the 95th percentile estimated dietary exposure is a concern and effectively reduces the margin of safety provided by the ADI.

Recommendations

1. In order to better determine whether the ADI for sulphites is exceed by some population groups, the 95th percentile estimated dietary exposures for sulphites should be further refined where possible, using NNS food frequency questionnaire data or other available techniques, to adjust the 24-hour recall data to better predict the usual consumption patterns over time.
2. Risk management options should be considered in order to reduce the dietary exposure of the Australian population to sulphites, where necessary.

Benzoates

The dietary exposure assessment for benzoates carried out during the review of the Australian *Food Standards Code* and based on food additive permission levels and manufacturers' use data where available, indicated that dietary exposure may exceed the ADI for some population groups. However, it was concluded that in reality, given actual patterns of use, benzoate dietary exposure was unlikely to exceed the ADI and further monitoring was recommended.

Benzoates were evaluated by JECFA in 1996 (WHO, 1997), where the ADI for benzoic acid and its calcium, potassium and sodium salts, expressed as benzoic acid equivalents, of 0-5 mg/kg bw was maintained.

The 21st ATDS examined benzoates in a wide range of foods for which there were food additive permissions. The mean, maximum and minimum concentrations of benzoates found in the foods analysed are given in Table A12 of Appendix 6. The mean and 95th percentile estimated dietary exposures to benzoates are set out in detail in Table A13 of Appendix 6, and summarised in Figure 7.

Mean estimated dietary exposures for consumers of foods containing benzoates were below 50% of the ADI for all population groups assessed, ranging from approximately 7% of the ADI for females aged 19 years and above, to approximately 45% of the ADI for young boys aged 2-5 years. Mean estimated dietary exposure for the population aged two years and over, representing a lifetime of exposure, was approximately 15% of the ADI for males and approximately 10% of the ADI for females.

95th percentile estimated dietary exposures for benzoates exceeded the ADI for young boys and girls aged 2-5 years (approximately 140% and 120% respectively), and was equivalent to the ADI for schoolboys aged 6-12 years (approximately 100%). All other population groups were below the ADI for 95th percentile exposures, with the lowest 95th percentile exposure being for females aged 19 years and above (approximately 30%). 95th percentile estimated dietary exposure for the population aged two years and over, representing a lifetime of exposure, was approximately 60% of the ADI for males, and approximately 50% of the ADI for females.

Both mean and 95th percentile dietary exposures to benzoates were highest for children due to their higher food consumption relative to body weight and their lower body weights.

Major foods contributing to benzoate exposure for each age group assessed are summarised in Figures 8 through to 12 (full results provided in Table A 14 of Appendix 6). For young children aged 2-5 years, the major contributing foods to benzoate exposure were cordial (boys and girls approximately 40%), non-cola soft drinks (boys approximately 30%, girls approximately 25%) and orange juice (boys approximately 20%, girls approximately 30%). For all other age groups assessed non-cola soft drinks was the greatest contributor to benzoate dietary exposure, ranging from approximately 35% for school girls aged 6-12 years, to approximately 55% for male and female adults aged 19 years and over. Cordial and orange juice were also high contributors for all age groups assessed. For the population aged two years and over, representing a lifetime of exposure, the major contributing foods to benzoate dietary exposure were non-cola soft drinks (males and females approximately 50%), cordial (males approximately 25%, females approximately 20%) and orange juice (males approximately 15%, females approximately 20%).

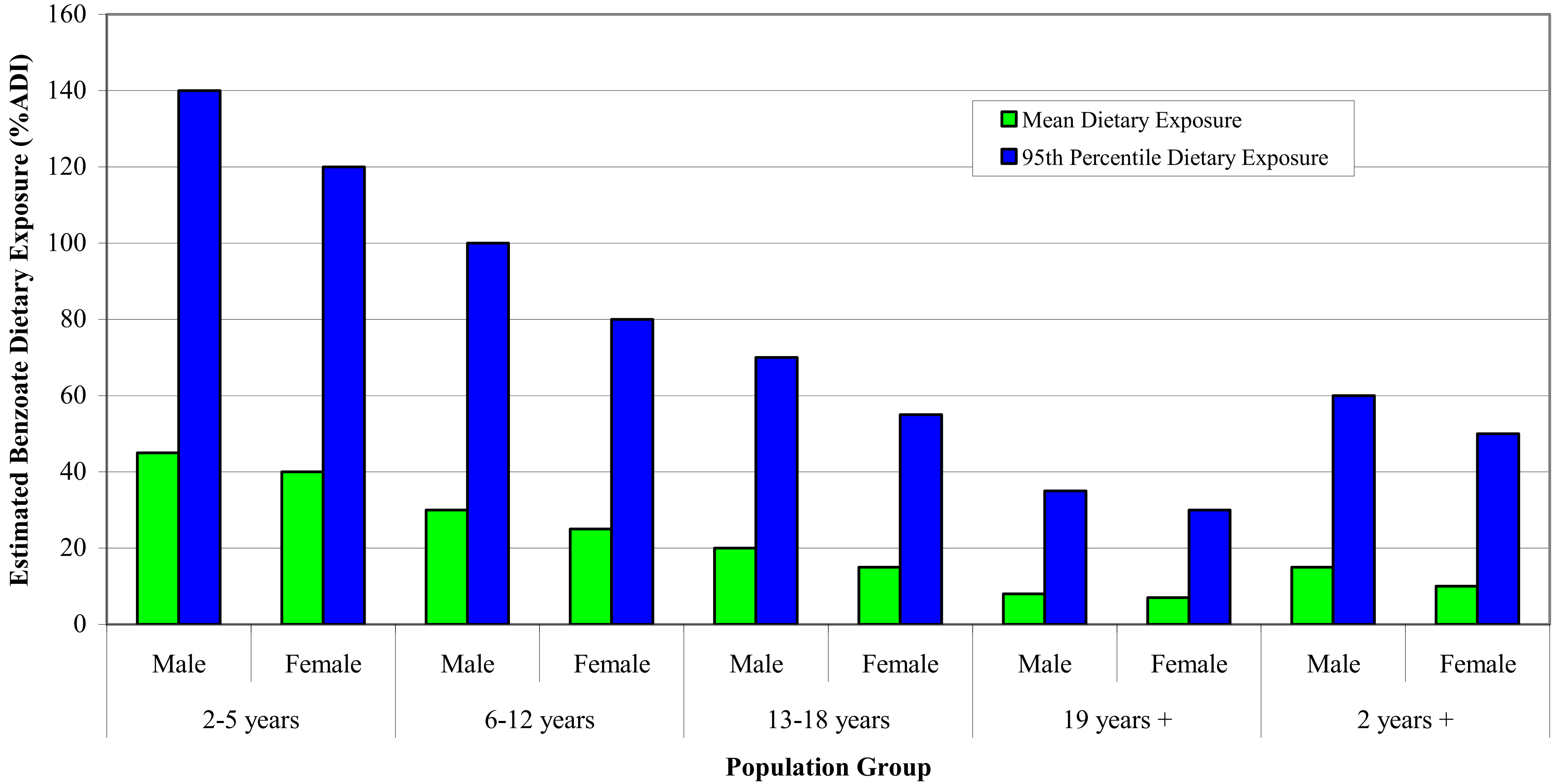
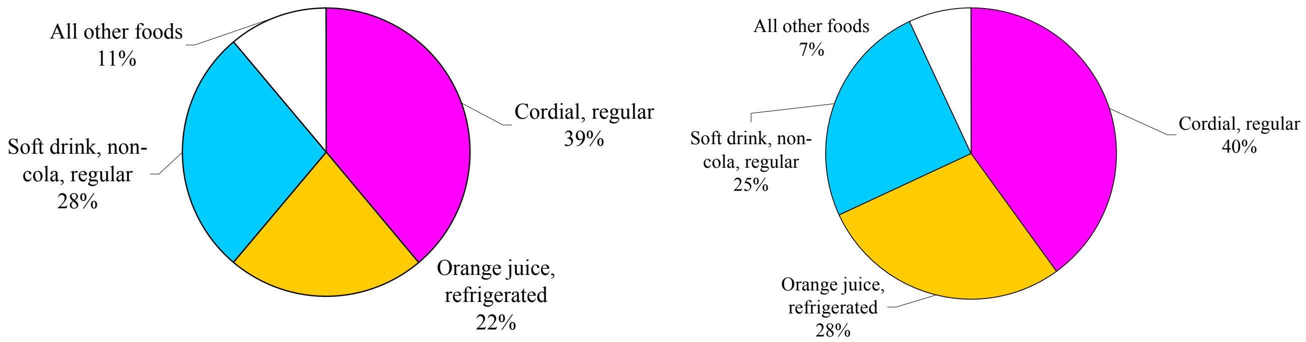


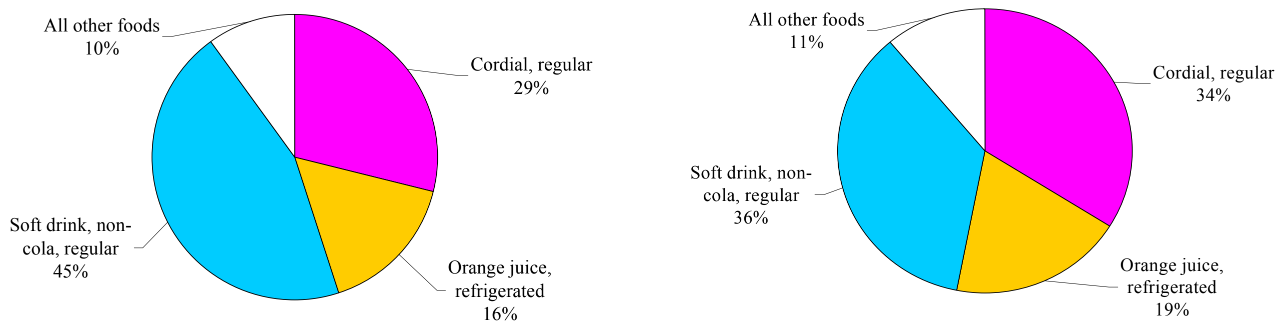
Figure 7: *Mean and 95th percentile upper bound estimated dietary exposure for consumers of benzoates as a percentage of the ADI (ADI=0-5 mg/kg bw)*



Boys 2-5 years
(mean exposure = 2.3 mg/kg bw/day)*

Girls 2-5 years
(mean exposure = 1.9 mg/kg bw/day)*

Figure 8: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for young children aged 2-5 years



Boys 6-12 years
(mean exposure = 1.6 mg/kg bw/day)*

Girls 6-12 years
(mean exposure = 1.3 mg/kg bw/day)*

Figure 9: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for school children aged 6-12 years

* The percent contribution of each food group is based on total benzoate dietary exposure for all consumers in the population groups assessed.

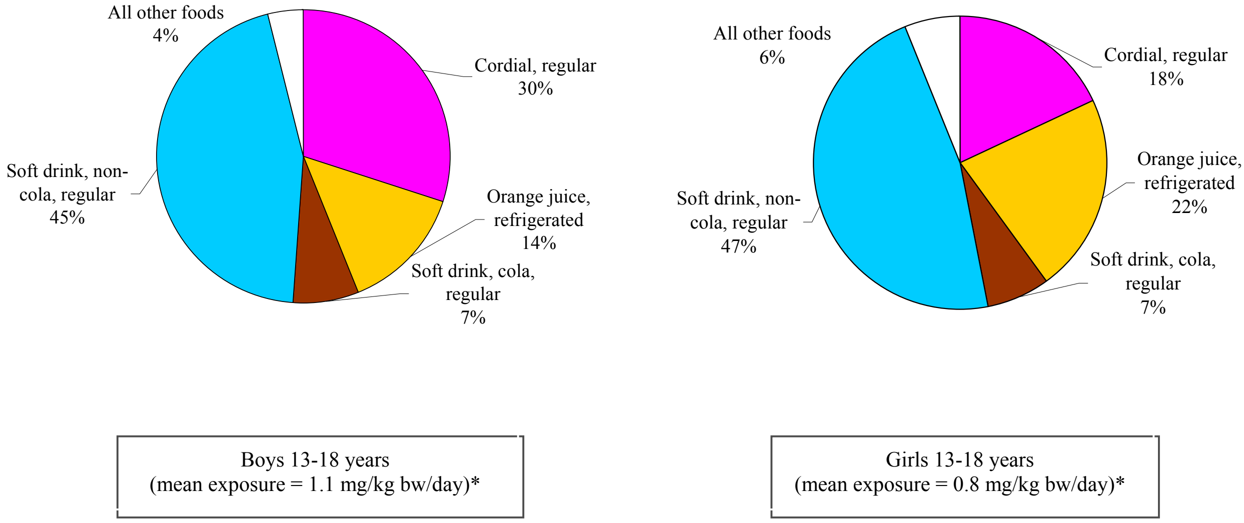


Figure 10: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for teenagers aged 13-18 years

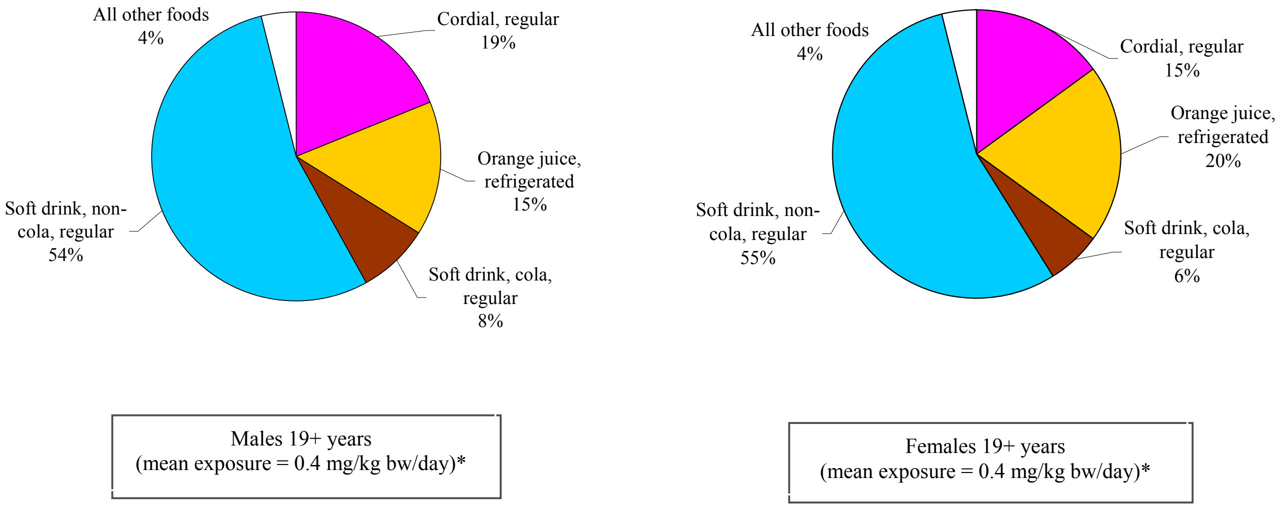


Figure 11: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for adults aged 19 years and over.

* The percent contribution of each food group is based on total benzoate dietary exposure for all consumers in the population groups assessed.

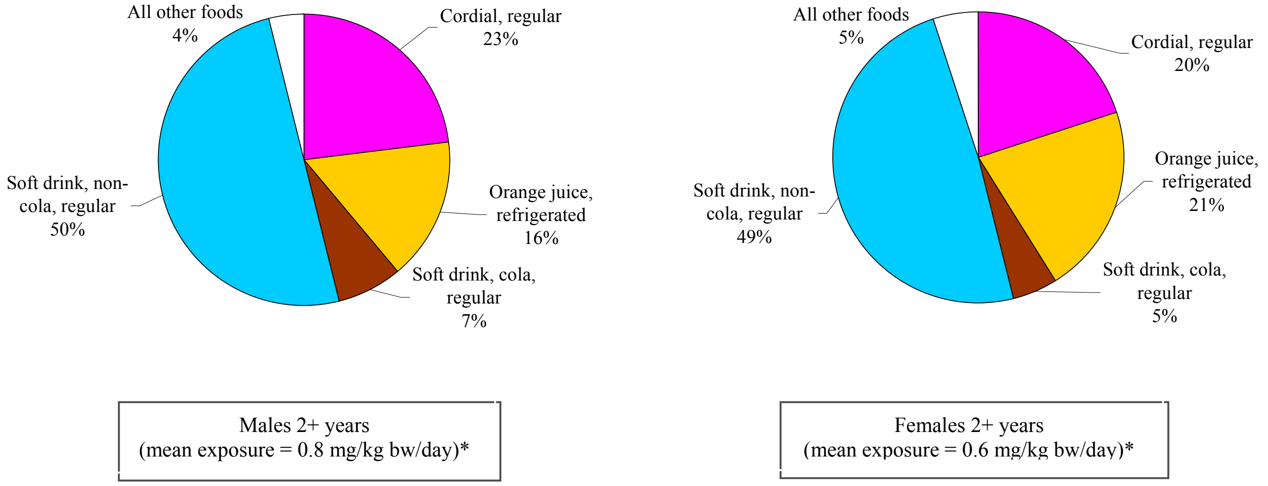


Figure 12: Percentage contribution of the major contributing foods to mean benzoate dietary exposure for the population aged two years and over.

* The percent contribution of each food group is based on total benzoate dietary exposure for all consumers in the population groups assessed.

Risk characterisation

The ADI of 0-5 mg/kg bodyweight established by JECFA for benzoic acid and its salts is based on a long-term exposure study in rats. The NOEL was established at the highest dose tested (500 mg/kg bodyweight per day) where no adverse effects were observed. Signs of toxicity were observed in more recent short-term studies at higher dose levels. In establishing the ADI, a safety factor of 100 was applied to the NOEL to take into account species differences and individual human variation.

The mean estimated dietary exposure to benzoates for all population groups was well below the ADI, indicating that for the majority of the population, there is no public health and safety risk from the consumption of a balanced diet which includes foods containing benzoates.

The 95th percentile estimated dietary exposure to benzoates, however, exceeded the ADI for boys (140%) and girls (120%) aged 2-5 years, and for boys aged 6-12 years, the 95th percentile estimated dietary exposure was at the ADI. For all other population groups, the 95th percentile estimated dietary exposures were below the ADI. The 95th percentile estimated dietary exposure for the population aged two years and over, representing a lifetime of exposure, was approximately 60% of the ADI for males, and approximately 50% of the ADI for females.

The 95th percentile estimated dietary exposure represents the consumption pattern of the more extreme consumer in each of the population groups. It is also based on conservative dietary modelling which relies on the results of a 24-hour diet recall survey and includes the assumption that people surveyed in the NNS eat the same foods every day of the year. For commonly consumed foods, this may be a reasonable assumption, and in the case of benzoates, foods that significantly contribute to benzoate exposure, such as cordials, fruit juices and soft drinks, could be consumed on a daily basis. In addition, consumption of these products is likely to have increased since the National Nutrition Survey was last undertaken in 1995 (Cook et al, 2001; FSANZ, 2003).

The result of the total diet survey have highlighted a potential public health and safety concern for above-average 2 to 5 year old consumers of high benzoate-containing foods. There is currently no evidence that adverse effects have occurred in individuals in this age group as a result of exposure to benzoates, although clinical evidence of such an effect would be difficult to obtain. The 100-fold safety factor built into the ADI for benzoates provides a significant margin of safety, which serves to reduce the likelihood of adverse effects in humans. Nevertheless, exceeding the ADI by individuals at the 95th percentile estimated dietary exposure is a concern and effectively reduces the margin of safety provided by the ADI.

Recommendations

3. In order to better determine whether the ADI for benzoates is exceeded by some population groups, the 95th percentile estimated dietary exposures for benzoates should be further refined, where possible, using NNS food frequency questionnaire data or other available techniques, to adjust the 24-hour recall data to better predict usual consumption patterns over time.
4. Risk management options should be considered to reduce the dietary exposure of some population groups to benzoates, where possible.

Sorbates

Sorbates were not identified as a cause for concern at the time of the review of the Australian *Food Standards Code*. However, they are often used in combination with benzoates and have similar, though more extensive, permissions. In addition, the analytical method for sorbates is similar to the method for benzoates and sorbate analysis can be conducted for little additional cost. Consequently, analysis of foods for sorbates was included in this ATDS.

Sorbates were evaluated by JECFA in 1973 (WHO, 1974), where a group ADI of 0-25 mg/kg bw for sorbic acid and its calcium, potassium and sodium salts, expressed as sorbic acid, was allocated.

The 21st ATDS examined sorbates in a wide range of foods for which there were food additive permissions. The mean, maximum and minimum concentrations of sorbates found in the foods analysed are given in Table A15 of Appendix 7. The mean and 95th percentile estimated dietary exposures to sorbates for the population groups assessed are set out in detail in Table A16 of Appendix 7, and summarised in Figure 13.

All mean and 95th percentile estimated dietary exposures to sorbates were less than or equal to 40% of the ADI. Mean estimated dietary exposures to sorbates ranged from approximately 2% of the ADI for males and females 19 years and above, to approximately 10% of the ADI for young boys and girls aged 2-5 years. Mean estimated dietary exposure to sorbates for the population aged two years and over, representing a lifetime of exposure, was approximately 3% of the ADI for both males and females.

The highest 95th percentile estimated exposure to sorbates was approximately 40% of the ADI for young boys aged 2-5 years. Males aged 19 years and older were estimated to have the lowest 95th percentile dietary exposure to sorbates, at approximately 7% of the ADI. For the population aged two years and older, representative of a lifetime of exposure to sorbates, estimated 95th percentile dietary exposure was approximately 15% of the ADI for males, and approximately 10% of the ADI for females.

Major foods contributing to sorbates dietary exposure for each age group assessed are summarised in Figures 14 through to 18 (full results provided in Table A17 of Appendix 7). The food that was the major contributor to dietary exposure to sorbates for all population groups was orange juice, ranging from approximately 45% for adult males aged 19 years and above, to approximately 65% for young boys and girls aged 2-5 years. Other foods that contributed more than 5% to total dietary exposure to sorbates, for one or more population groups assessed, were processed cheese, chocolate cake, meat and vegetable pasties and margarine style table spreads containing less than 80% fat.

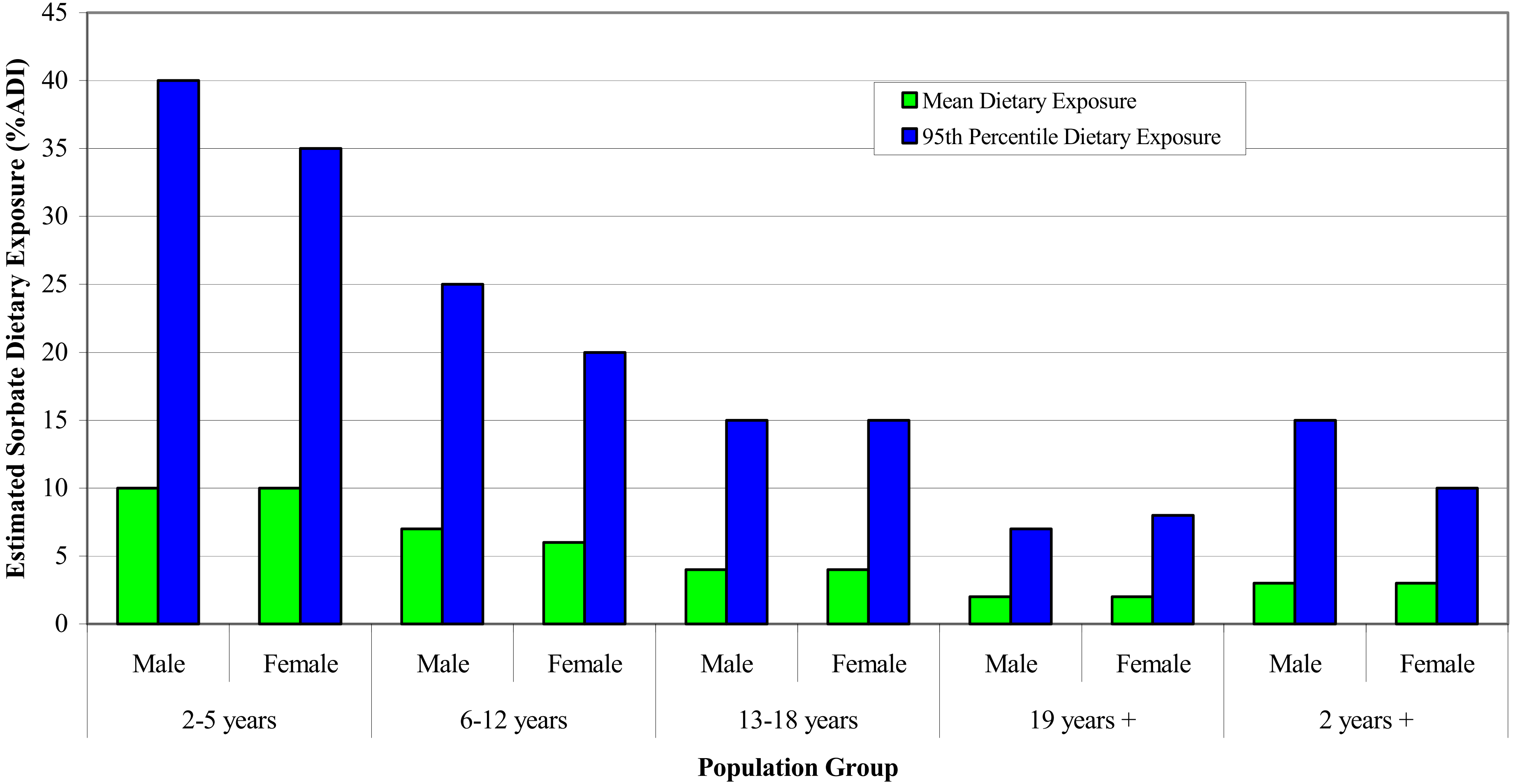
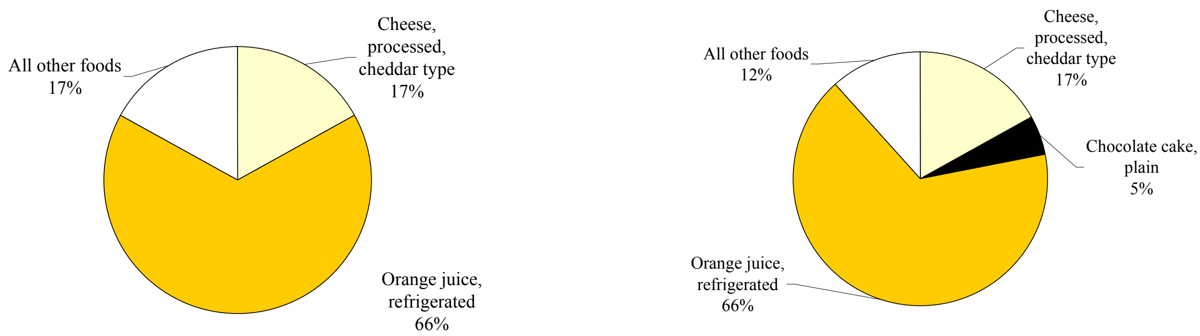


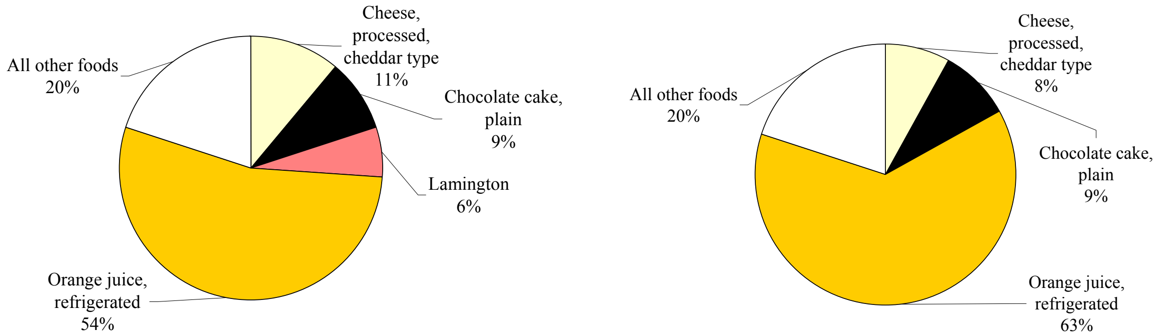
Figure 13: *Mean and 95th percentile upper bound estimated dietary exposure for consumers of sorbates as a percentage of the ADI (ADI = 0-25 mg/kg bw).*



Boys 2-5 years
(mean exposure = 3.2 mg/kg bw/day)*

Girls 2-5 years
(mean exposure = 3.3 mg/kg bw/day)*

Figure 14: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for young children aged 2-5 years



Boys 6-12 years
(mean exposure = 1.9 mg/kg bw/day)*

Girls 6-12 years
(mean exposure = 1.6 mg/kg bw/day)*

Figure 15: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for school children aged 6-12 years

* The percent contribution of each food group is based on total sorbate dietary expousre for all consumers in the population groups assessed.

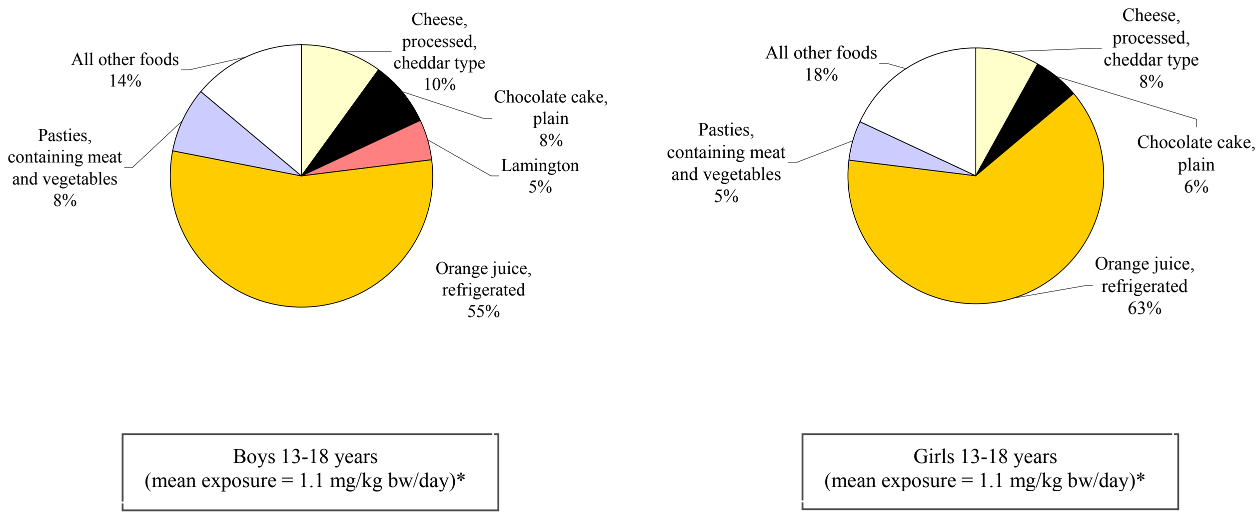


Figure 16: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for teenagers aged 13-18 years

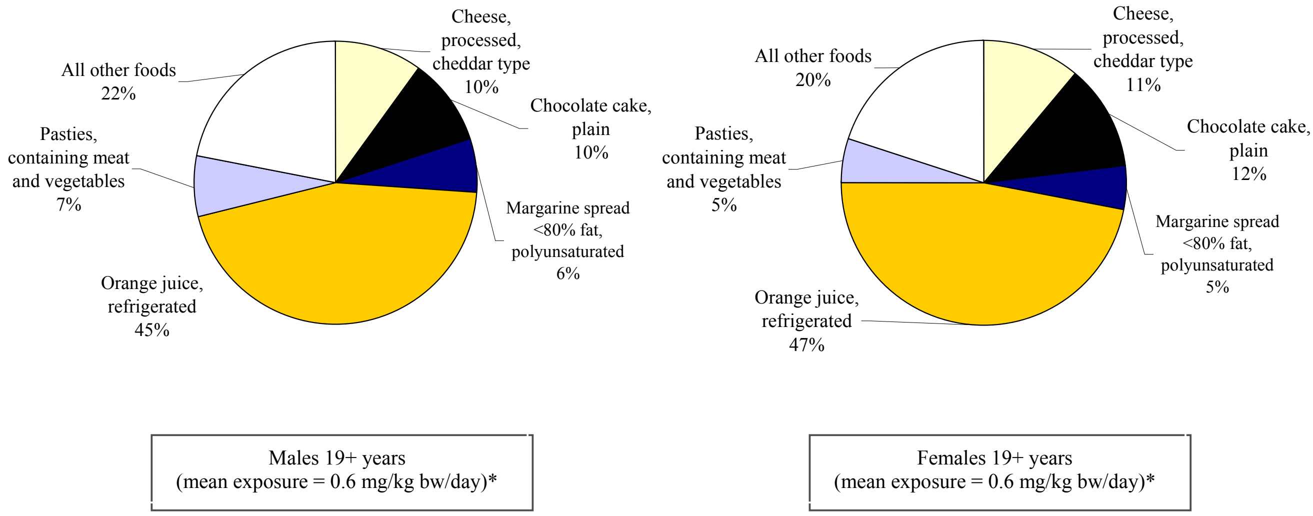
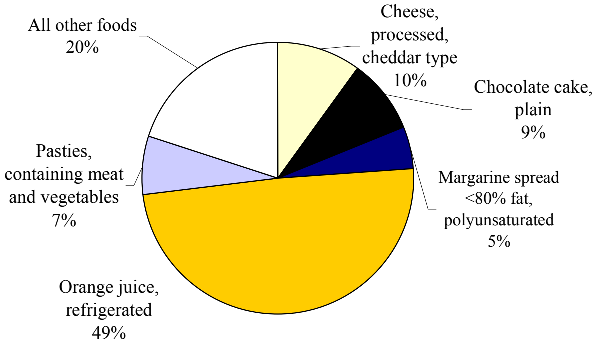
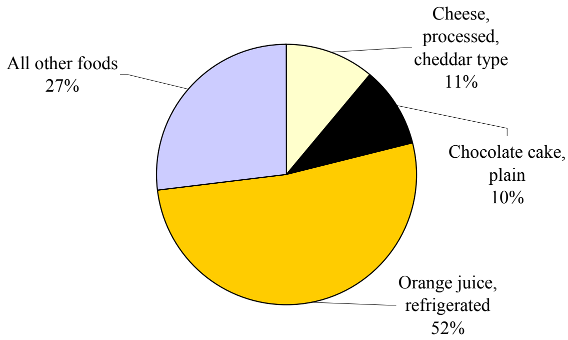


Figure 17: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for adults aged 19 years and over.

* The percent contribution of each food group is based on total sorbate dietary exposure for all consumers in the population groups assessed.



Males 2+ years
(mean exposure = 0.9 mg/kg bw/day)*



Females 2+ years
(mean exposure = 0.9 mg/kg bw/day)*

Figure 18: Percentage contribution of the major contributing foods to mean sorbate dietary exposure for the population aged two years and over.

* The percent contribution of each food group is based on total sorbate dietary exposure for all consumers in the population groups assessed.

Risk Characterisation

The ADI of 0-25 mg/kg bodyweight established by JECFA for sorbic acid and its calcium, potassium and sodium salts is based on long-term (lifetime) studies in rats. The NOEL was established at the highest dose tested (2500 mg/kg bodyweight per day) where no adverse effects were observed. In establishing the ADI, a safety factor of 100 was applied to the dose level to take into account species differences and individual human variation.

The mean and 95th percentile estimated dietary exposures were below 40% of the ADI for all population groups examined.

These results do not raise any public health and safety concerns associated with dietary exposure to sorbates at the current levels of use.

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Part D Appendices

Appendix 1: Definitions and glossary of terms

Acceptable Daily Intake (ADI)

The Acceptable Daily Intake (ADI) for humans is defined as an estimate of the amount of a chemical that can be ingested daily over a lifetime without appreciable risk to health (WHO 2001).

ADIs are set using information obtained from toxicological studies, including data from studies on various laboratory animals. From these studies, a No Observable Effect Level (NOEL) is established. The NOEL is the highest dose level that produces no observable toxic effect in the most sensitive test species and is expressed in milligrams per kilogram of body weight per day (mg/kg bw/day).

The ADI is derived by applying a safety factor to the NOEL. The safety factor takes into consideration the nature of the effect, differences between laboratory test animals and humans, and genetic variation in the human population. If any information on exposure in humans is available, usually from short to mid-term studies, this will be used to set the ADI. The unit for the ADI is milligrams per kilogram of body weight per day.

Limit of Detection (LOD)

The LOD is the lowest concentration of a chemical that can be qualitatively detected using a specified laboratory method and/or item of laboratory equipment (i.e. its presence can be detected but not quantified). For the purposes of this study, all analytical results reported as being less than the LOD were assumed to be zero.

Limit of Quantification (LOQ)

The LOQ is the lowest concentration of a chemical that can be detected and quantified, with an acceptable degree of certainty, using a specified laboratory method and/or item of laboratory equipment.

Limit of Reporting (LOR)

The LOR is the lowest concentration level that the laboratory reports analytical results. For the purposes of this report, the LOQ was chosen as the basis for the LOR (ie the LOR is equivalent to the LOQ).

Lower bound

An estimate of dietary exposure assuming analytical results reported as being less than the LOD equal zero, and analytical results reported as being between the LOD and the LOR equal zero.

Upper bound

An estimate of dietary exposure assuming analytical results reported as being less than the LOD equal zero, and analytical results reported as being between the LOD and the LOR equal the LOR.

Appendix 2: 21st ATDS food survey

Table A1: Foods sampled in the 21st ATDS

Beverages, alcoholic
- Alcoholic cider (N)
- Beer, regular alcohol (R)
- Wine, white (R)
- Wine, red (R)

Beverages, non-alcoholic
- Blackcurrant juice syrup (N)
- Cordial, regular (N)
- Orange juice, refrigerated (R)
- Soft drink, cola regular (N)
- Soft drink, non-cola regular (N)

Cereal and cereal products
- Bread, white (R)
- Chocolate cake, iced (cake only) (R)
- Fruit cake, uniced (R)
- Danish/pie, fruit (R)
- Lamingtons (R)
- Muesli bars, containing fruit (N)
- Noodles, egg fresh (N)
- Pasta, fresh (N)
- Pasties, meat & vegetable (R)
- Pikelets (N)
- Pizza, meat & vegetable topped (R)

Condiments
- Barbeque Sauce (N)
- Chutney, fruit (N)
- Dressing, oil & vinegar based (N)
- Soy sauce (N)

Dairy products
- Cheese, cheddar full fat (R)
- Cheese, cottage (N)
- Cheese, processed cheddar type (N)
- Dip, cream cheese based (R)

Fats and oils
- Margarine spread, polyunsaturated (N)

Fish, seafood and fish products
- Prawns, cooked fresh (R)
- Smoked cod (N)

Fruit
- Apples, dried (N)
- Apricots, dried (N)
- Fruit filled bars, cereal coated (N)
- Fruit fingers (N)
- Fruit salad, canned (N)
- Grapes, green seedless (R)
- Jam, low joule (N)
- Prunes (N)
- Sultanas (N)

Meat and meat products
- Frankfurts (R)
- Hamburgers, patties (including chicken) (R)
- Luncheon, Sausage (R)
- Mince, red meat (R)
- Salami (R)
- Sausages, beef(R)
- Strassburg (R)

Snack foods
- Potato chips (N)

Sugar/confectionery
- Chocolate cake, iced (icing only) (R)
- Ice confection, sold in liquid form (N)
- Ice cream topping (N)
- Lollies, soft jelly type (N)

Vegetables
- Coleslaw, with dressing (R)
- Instant vegetable soup, dry (N)
- Olives (N)
- Onion, pickled or cocktail (N)
- Potato chips, hot takeaway (R)
- Potato chips, frozen (N)
- Potato, salad (R)

1. N = National Food. Three retail samples make up each composite sample, 9 composite samples of each food.
2. R = Regional Food. Three retail samples make up each composite sample, 15 composite samples of each food.

Table A2: Food preparation instructions

FOOD	PREPARATION
Alcoholic cider	Mix together.
Barbeque sauce	Mix together.
Beer, regular alcohol	Mix together.
Blackcurrant juice syrup	Shake and invert containers to ensure thorough mixing. Prepare blackcurrant juice syrup as per label directions and then mix.
Bread, white	Chop and mix together.
Cheese, cheddar full fat	Chop into small cubes and mix together.
Cheese, cottage	Chop and mix together.
Cheese, processed cheddar type	Chop into small cubes and mix together.
Chocolate cake, iced – icing only	Mix together.
Chocolate cake, iced – cake only	Crumb and mix together.
Chutney, fruit	Mix together.
Coleslaw with dressing	Chop and mix together.
Cordial, regular	Shake and invert containers to ensure thorough mixing. Prepare cordial as per label directions and then mix together.
Dip, cream cheese based	Mix together.
Dressing, oil and vinegar-based	Shake and invert containers to ensure thorough mixing. Mix together.
Dried apples	Chop and mix together.
Dried, apricots	Chop and mix together.
Frankfurts	Separate into individual links. Prepare as per label and mix together.
Fruit cake, uniced	Crumb and mix together.
Fruit filled bars, cereal coated	Chop and mix together.
Fruit fingers/bars	Chop and mix together.
Fruit pie/danish	If the pie/danish is uncooked cook as per label. Chop and mix together.
Fruit salad, canned	Chop and mix together.

FOOD	PREPARATION
Grapes, green seedless	Remove stalks, chop grapes and mix together.
Hamburger patties/rissoles	Chop and mix together.
Hot potatoes chips, takeaway	Crush the chips. Mix the crushed potato chips thoroughly in a large bowl.
Ice confection sold in liquid form	Mix together.
Ice cream topping (syrup)	Mix together.
Instant vegetable soup, dry	Prepare instant soup as per label. Mix together.
Jam, low joule	Mix together.
Lamingtons	Crumb and mix together.
Lollies, soft jelly type	Chop and mix together.
Luncheon sausage	Chop and mix together.
Margarine spread, polyunsaturated	Mix thoroughly.
Mince, red meat	Mix together.
Muesli bars, containing fruit	Chop and mix together.
Noodles, egg fresh	Prepare noodles as per label. Chop and mix together.
Olives	Where necessary drain (discarding liquid) and remove seeds. Chop and mix together.
Onion, pickled or cocktail	Drain onions and discard liquid. Chop and mix together.
Orange juice, refrigerated	Shake and invert containers to ensure thorough mixing. Mix in a large stainless steel or glass bowl.
Pasta, fresh	Boil in unsalted water until cooked. Drain and chop.
Pasties, meat and vegetables	If uncooked prepare pasties as per label. Chop and mix together.
Pikelets	Chop and mix together.
Pizza, meat and vegetable topped	Chop and mix together.
Potato chips, frozen	Prepare as per label. Crush and mix together.
Potato crisps	Crush the crisps. Mix the crushed potato crisps thoroughly in a large bowl.
Potato salad	Chop and mix together.
Prawns	Remove shell and de-vein prawns. Chop and mix together.

FOOD	PREPARATION
Prunes	Chop and mix together.
Salami	Remove skin from salami. Chop and mix together.
Sausages, beef	Dry fry, cool, chop and mix together thoroughly.
Smoked cod	Prepare smoked cod as per label. Chop and mix together.
Soft drink, cola regular	Open, mix together, allow gas to escape.
Soft drink, non-cola regular	Open, mix together, allow gas to escape.
Soy sauce	Mix together.
Strassburg	Chop and mix together
Sultanas	Mix thoroughly.
Wine, red	Mix together.
Wine, white	Mix together.

Food preparation instructions

General Instructions

Boiling water

Except where other instructions are provided, ‘boiling water’ means that the food is to be boiled in ‘unsalted’ tap water.

Chop

Except where other instructions are provided, 'chop' means that the food is to be chopped with a stainless steel knife into pieces no larger than 1 cubic centimetre. In most cases, it should be possible to chop into pieces much smaller than this, which is desirable.

Mix

When the preparation instruction states 'mix' or 'mix thoroughly', then the following procedure is to be followed:

(1) For dry foods (such as bran) or semi-dry foods (such as cooked chopped meat):

- Form the food into a cone or pile;
- Flatten the cone slightly and separate into four equal segments;
- Pull the segments apart so that four separate piles are formed;
- Combine diagonally opposite piles and mix together thoroughly;
- This process should be repeated until thorough mixing of the group of purchases has been achieved.

(2) For foods containing juice such as canned fruit salad and grapes:

- If possible, the food being prepared should be chopped in a large glass or stainless steel bowl so that all the juice is collected;
- Mixing of the chopped pieces is then done in the bowl using gloved hands or stainless steel cutlery and should be mixed as thoroughly as possible;
- For the purposes of the ATDS, any juice must be regarded as an integral part of the food being prepared for analysis. A proportional amount of juice and seeds must therefore be included in the sample containers.

(3) For liquids such as cordial and soft drink:

- Liquids are to be measured into a large receptacle such as bowl or jug made of stainless steel or Pyrex. Plastic containers are to be avoided;
- The total volume added to the jug or bowl should be thoroughly stirred with a stainless steel utensil before being poured into the sample containers.

Cooking, Frying, Grilling

In the case of samples of meat, it is imperative that typical cooking behaviour be followed. For example, meat that is fried will exude fat. As the fried food is removed from the fry pan some fat will remain in the fry pan and some will remain on the cooked meat product. The fat remaining in the fry pan is to be discarded and only the fat on the cooked food is to be included for analysis.

Gloves

Gloves are to be worn whenever the food being prepared could come into contact with hands.

The gloves to be used are Ansell rubber gloves not containing lubricant. Gloves will be provided by the State or Territory health departments.

Equipment

- Stainless steel knives.
- Wooden cutting board (good quality, smooth, crack free).
- Stainless steel or teflon coated utensils (i.e. frypans, spatulas etc.).
- Glass/Pyrex equipment can also be used.
- For the purposes of mixing liquids, a large stainless steel or Pyrex receptacle such as a jug or bowl is to be used.
- Plastic bags for enclosing sample containers.

Washing of Equipment

The analytical laboratory or preparation facility is to determine the detergent to be used in the washing of food preparation equipment. The detergent chosen should not interfere with the analyses for sulphites, sorbates or benzoates.

Handling Purchases in the Food Preparation Facility:

Each purchase as provided by the purchasing officer should arrive in separate packaging. Unprocessed, raw foods such as mince and hamburger patties will be in separate packages labelled with the name of the food and the date of purchase. Manufactured, packaged foods will be labelled clearly with the date of purchase.

Purchases from each jurisdiction will be in lots of nine.

Keeping Samples Separate

Care must be taken to ensure no mixing of any kind between the three groups of samples. This means careful cleaning of utensils between the three preparation procedures.

To ensure accuracy and to keep food samples separate, the procedure for preparing one sample in readiness for analysis should be completed and all utensils cleaned thoroughly before the preparation of the next sample is started.

Table A3: 21st ATDS survey foods and corresponding NNS food

FOOD CATEGORY	ATDS FOODS ANALYSED	NNS FOODS REPRESENTED
Beverages, alcoholic	Alcoholic cider	Ciders
	Beer, regular alcohol	All “beers”
	Wine, red	All “red wines” and fortified wines
	Wine, white	All "white wines" and de-alcoholised and non-alcoholic wines
		Wine coolers
Beverages, non-alcoholic	Blackcurrant juice syrup	Blackcurrant cordials, except those made from dry base
	Cordial, regular	All cordials, except blackcurrant and those made from dry base
	Orange juice, refrigerated	All fruit and vegetable juices and fruit and vegetable juice products, except home squeezed juices and cordials
		Coconut milk and coconut cream
	Soft drink, cola regular	All cola soft-drinks and non-fruit flavoured drink bases
		Cola-spirit mixes; alcoholic cola
	Soft drink, non-cola regular	All non-cola soft-drinks, flavoured mineral waters and electrolyte drinks
		Alcoholic lemonade; ginger ale-spirit mixes
Cereal and cereal products	Bread, white	All “regular breads, and rolls”, “english-style muffins”, “crumpets”, “flat breads”, “buns and yeast-based products (uniced)”, “batter-based products”, “fancy breads”, “bread-based stuffings”, "tortilla, taco shells, and corn bread".
		Doughnuts, yeast type (excludes cake type)
	Chocolate cake, iced (cake only)	All uniced cakes and muffins, excluding dry mixes, muffins/cakes made from dry mixes, and home made muffins/cakes
		Cake-type desserts
		Cake type donuts
	Fruit cake, uniced	All commercial uniced fruit cakes, sultana cakes, and dried fruit containing cake-style desserts
	Lamingtons	Coconut biscuits & macaroons
		Lamingtons and lamington style sponges
		Coconut iced buns
		Coconut slices

FOOD CATEGORY	ATDS FOODS ANALYSED	NNS FOODS REPRESENTED
		Coconut
		Coconut filled chocolates/confectionery
	Muesli bars, containing fruit	All "breakfast cereal, breakfast bars" and all muesli bars except-chocolate chip
		Muesli slices, and fruit-containing slices, biscuits and scones
	Noodles, egg fresh	All "Noodles, Asian style", except dry and instant noodles
	Pasta, fresh	All "pasta and egg noodles", except filled pasta and corn pasta
	Pasties, meat & vegetable	Savoury pastry products - single crust, savoury pastry products - double crust except bacon-containing pies and quiches
		All "'Chicko-type' rolls, dim sims and spring rolls"
	Pikelets	Unfilled pancakes, crepes and pikelets, except home-made pancakes/ pikelets/ crepes and pancakes/ pikelets/ crepes made from dry mix
		Waffles
	Pizza, meat & vegetable topped	All "pizza"
Condiments	Barbeque sauce	Barbeque sauce
	Chutney, fruit	All chutneys
	Dressing, oil- and vinegar-based	Italian and French dressings and vinegar
	Soy sauce	All soy sauces
Dairy products	Cheese, cheddar, full fat	Ripened cheeses
	Cheese, cottage	Unripened cheeses
	Cheese, processed, cheddar type	Processed cheeses
	Dip, cream cheese based	All cheese-, cream- and yoghurt based dips (excluding home-made)
		Eggplant dip
		Guacamole
		Hummus
Fats and oils	Margarine spread, polyunsaturated, <80% fat	All "margarines" with <80% fat content
Fish, seafood and fish products	Prawns	All cooked and raw crustacea
	Smoked cod	All smoked fish
Fruit	Dried apples	Dried apples, bananas, pears, pineapple, fruit medley, and glace pineapple and ginger
	Dried apricots	All dried and glace "orange" coloured tree fruits, mixed peel

FOOD CATEGORY	ATDS FOODS ANALYSED	NNS FOODS REPRESENTED
	Fruit filled bars, cereal coated	Fruit filled biscuits and breakfast cereals, tartlet biscuits Fruit mince filled pies/slices
	Fruit fingers/bars	Fruit based bars except cereal/grain coated
		Infant fruit fingers
	Fruit pie/danish	Fruit containing pastries (pies, danish, strudels)
	Fruit salad, canned	All canned fruits, excluding infant fruit
		Apple and cranberry sauces
	Grapes, green, seedless	All fresh grapes
	Jam, low joule	All low joule jams and conserves
	Olives	All olives
	Prunes	All dried "darker" tree fruits, glace cherries
	Sultanas	All dried vine fruits, chocolate covered dried fruits, mixed dried fruit
Meat and meat products	Frankfurts (hot dog sausages)	All plain "Frankfurts, and saveloys"
	Hamburger patties/rissoles	All hamburger and meat patties
	Luncheon sausage	Meat pastes, except ham paste
		Chicken roll
		Luncheon meat
		Terrine
		All "Liver paste and pate"
		Black pudding
	Mince, red meat	All minced meats, including chicken
	Salami	All salamis, cabanossi
	Sausages, beef	All "sausages" and sausage patties
	Strassburg	Brawn
		Mortadella
		Strassburg
Snack foods	Potato crisps	All potato crisps and extruded snacks
Sugar/confectionery	Chocolate cake – icing only	All glace icings, "frostings and icings with added fat", except home made and those containing cream cheese or chocolate
	Ice confection sold in liquid form	All water ice confections in stick/bar form, excluding those containing beverage whitener
	Ice cream topping (syrup)	All "toppings"
	Lollies, soft jelly type	All lollies and other confectionery except compound yoghurts and carbohydrate modified confectionery
Vegetables	Coleslaw, with dressing	All coleslaw except homemade

FOOD CATEGORY	ATDS FOODS ANALYSED	NNS FOODS REPRESENTED
	Hot potato chips, takeaway	All commercially cooked fries, chips, wedges and hash browns
	Instant vegetable soup, dry	All soups made from dry mix
	Onion, pickled or cocktail	Pickled onion
	Potato chips, frozen	All fries, chips, wedges and hash browns, cooked from frozen
	Potato salad	All potato salads, except homemade

Appendix 3: Summary of analytical methods

Queensland Health Scientific Services (QHSS) provided sample coordination, preparation and analytical services for the 21st ATDS.

Sulphites

The method employed was based on the AOAC Modified Monier Williams Method 962.16 and involves the 'digestion' of a sample of food in a dilute solution of hydrochloric acid. The sulphite is converted to sulphur dioxide, which is carried in a stream of nitrogen into a solution of hydrogen peroxide contained in a U-tube where it is oxidised to sulphuric acid. The acid is then titrated against standard sodium hydroxide at the completion of the digestion. The sensitivity of the method is, in part, determined by the volume of the titrant and the initial weight of the sample.

Spiked quality control samples were prepared for liquid and solid foods (soft drink and minced meat respectively).

Method characteristics

Limit of detection: 2 mg/kg (based on a 50 g sample)

Limit of reporting: 5 mg/kg (based on a 50 g sample)

Table A4: *Sulphite statistical data on control samples used*

QC Sample	Spiked level of sulphite	Mean sulphite (repeatability)	Mean sulphite (reproducibility)
Mince	Approx 200 mg/kg	181.5 (SD: 4.5)	178 (SD 8.7)
Soft drink (1)	Approx 100 mg/kg	92.2 (SD: 2.9)	89 (SD: 7.5)
Soft drink (2)	Approx 100 mg/kg	92.2 (SD: 2.9)	91 (SD: 6.2)

Repeatability data

The repeatability data refer to the analytical results obtained under repeatability conditions, ie, replicate analysis undertaken by one analyst on the same day using the same instrumentation. This data is used to establish the homogeneity of the sample and its suitability as a control sample. It is assumed however, that the analyte and matrix is relatively stable over the period of use. The data is also used to set the initial control limits of the control chart.

Reproducibility data

The reproducibility data refer to the analytical results obtained under routine analytical conditions, ie, analysis undertaken by one or several analysts on different days possibly using some different equipment. Provided the analytes in combination with the matrix are stable, the mean value of each respective analyte obtained under repeatability and reproducibility conditions should not vary. The standard deviation of results obtained under repeatability conditions however, is normally observed to be less than that obtained under reproducibility conditions and may range from 1/3 to 2/3 depending on the method, matrix and analyte level.

Recovery efficiency

Various food samples were spiked to provide either 10 or 100 mg/kg of sulphite per 50 gram sample. The spiking level of 10 mg/kg was selected to be close to the LOR as it was expected that a significant number of samples would record very low or no reportable levels of sulphites in food. The higher spike was expected to be in the median range for sulphites in food. The higher anticipated recovery standard deviation reflects the precision of the method near the LOR.

Solid foods: mean: 91% (SD: 10.8)

Beverages: mean: 94% (SD: 9.0)

Benzoates and Sorbates

The method employed was based on the report on the Collaborative Trial: Determination of Preservatives in Foodstuffs (J. Assoc. Publ. Analysts, 1996, 32, 109-175). As it was anticipated that a significant number of the analytical samples would have no detectable or measurable levels of benzoate and sorbate, a screening method for all samples, based on an abbreviated form of the procedure, was used. All samples with detectable levels of benzoate and/or sorbate were re-analysed using the standard method.

Ten grams of prepared and macerated sample was extracted with 20 ml of 70% ethanol, centrifuged and filtered into a 100 ml volumetric flask. This process was repeated twice to ensure complete extraction. The screening method only employed one extraction, recovering only about 70% of the respective analytes. The sample extracts are made to volume and prepared for High Performance Liquid Chromatography (HPLC) analysis. Sample batches include a reagent blank, a QC, one or several duplicates and a spike. Batches normally comprised similar matrix samples.

Control samples included soft drink, with incurred levels of benzoate and sorbate, pikelet with incurred levels of sorbates, and cream cheese with higher levels of sorbates, representing high fat matrices.

Method characteristics

Limit of detection: 2 mg/kg each for sorbic and benzoic acid.

Limit of reporting: 5 mg/kg for sorbic acid; 10 mg/kg for benzoic acid.

Table A5: Benzoate and sorbates statistical data on control samples used

QC sample	Benzoic acid (repeatability)	Sorbic acid (repeatability)	Benzoic acid (reproducibility)	Sorbic acid (reproducibility)
Pikelet	-	634 (SD: 7)	-	663 (SD 23.6)
Cream cheese	-	1273 (SD: 10)	-	1265 (SD: 20.8)
Soft drink	155 (SD 0.6)	74 (SD: 0.4)	152 (SD: 5.5)	73 (SD: 2.0)

As noted for sulphites, the repeatability data refers to the results obtained for replicated analyses to establish homogeneity. The reproducibility data refer to the results of the control samples undertaken over the time of the study. The increase in the mean value of sorbic acid was due to a small and unexpected loss of moisture from the pikelet matrix during defrosting after storage at –18ºC.

Recovery efficiency

On order to cover the broad range of permitted levels of benzoates and sorbates in food, the laboratory undertook some preliminary trials on recpveries in the various food matrices with spiked levels ranging from 50 to 3000 mg/kg. In general, the recoveries observed were acceptable to very good ranging from 80 to 99%. In order to simplify the statistical evaluation, it was decided to use one representative spiking level for each analyte for the duration of the program.

Recoveries for benzoic acid spiked at 100 mg/kg and sorbic acid spiked at 80 mg/kg for various food matrices in the survey were as follows:

Benzoic acid:	mean:93% (SD: 4.6)

Sorbic acid:	mean: 91% (SD: 4.5)

Appendix 4: Mean food consumption and body weights

*Table A6: Mean consumption by consumers of each food sampled in the 21st ATDS, for each age-gender group in grams per day, derived from the 1995 NNS**

	Males (2-5y)	Females (2-5y)	Males (6-12y)	Females (6-12y)	Males (13-18y)	Females (13-18y)	Males (19+y)	Females (19+y)	Males (2+y)	Females (2+y)
Food	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**	**g/day**
Alcoholic cider	0	0	0	0	0	0	883	876	883	876
Bacon	16	12	28	29	44	26	39	31	39	30
Barbeque sauce	12	10	19	13	17	11	15	11	16	11
Beer, regular alcohol	52	17	0	20	1443	878	1223	755	1224	752
Blackcurrant juice syrup	452	183	316	433	271	760	585	299	508	329
Bread, white	88	79	120	104	152	114	146	103	141	102
Cheese, cheddar, full fat	20	21	32	25	37	30	37	28	36	28
Cheese, cottage	18	17	24	32	43	32	42	34	39	33
Cheese, processed, cheddar type	28	27	30	22	47	26	32	25	32	25
Chocolate cake - icing	7	9	12	10	15	14	13	11	13	11
Chocolate cake, plain	34	53	78	80	114	72	90	77	88	76
Chutney, fruit	2	13	6	19	17	9	19	14	18	14
Coleslaw, with dressing	49	50	115	86	140	120	107	87	109	88
Cordial, regular	464	387	428	411	744	427	578	418	553	412
Dip, cream cheese based	40	17	57	27	84	46	51	41	53	40
Dressing, oil and vinegar-based	5	3	6	6	6	5	8	8	8	8
Dried apples	6	2	6	6	7	3	5	6	5	6
Dried apricots	15	7	11	12	13	5	11	9	11	9
Frankfurts (hot dog sausages)	34	49	54	57	70	73	86	73	76	66
Fruit cake, uniced	70	121	127	75	74	93	87	76	88	77
Fruit filled bars, cereal coated	32	46	45	47	113	52	59	44	58	46
Fruit fingers/bars	26	25	27	23	54	35	45	42	33	29
Fruit pie/danish	107	25	122	141	161	175	166	139	162	141
Fruit salad, canned	98	124	72	123	91	69	127	85	120	89
Grapes, green, seedless	159	76	161	121	206	142	180	137	179	131
Ham	32	29	32	35	59	32	52	35	50	35
Hamburger patties/rissoles	55	47	73	60	106	86	109	76	103	74
Hot potato chips, takeaway	93	90	150	135	189	123	153	123	153	121
Ice confection sold in liquid form	101	74	111	99	170	112	137	110	121	98

Food	Males (2-5y) g/day	Females (2-5y) g/day	Males (6-12y) g/day	Females (6-12y) g/day	Males (13-18y) g/day	Females (13-18y) g/day	Males (19+y) g/day	Females (19+y) g/day	Males (2+y) g/day	Females (2+y) g/day
Ice cream topping	27	15	40	44	49	54	45	35	43	37
Instant vegetable soup, dry	215	313	241	219	523	234	311	279	314	275
Jam, low joule	10	10	10	40	0	3	15	10	14	11
Lamington	15	15	57	24	63	52	38	32	41	32
Lollies, soft jelly type	24	19	36	32	58	40	40	33	39	32
Luncheon sausage	51	28	54	33	53	33	59	33	57	32
Margarine, <80% fat, polyunsaturated	9	7	11	9	15	9	16	11	15	10
Mince, red meat	82	73	100	92	129	101	152	113	138	106
Muesli bars, containing fruit	34	33	36	33	37	52	61	55	52	50
Noodles, egg, fresh	0	63	194	156	128	219	183	127	179	129
Olives	9	17	19	15	16	13	24	19	23	19
Onion, pickled or cocktail	0	15	0	23	173	19	41	30	45	29
Orange juice, refrigerated	339	321	371	343	424	390	327	279	343	300
Pasta, fresh	123	109	165	150	280	199	248	167	231	163
Pasties, containing meat and vegetables	116	104	156	142	233	169	204	164	199	158
Pikelets, pancakes	138	61	160	37	112	69	89	72	104	68
Pizza, meat and vegetable containing	98	79	160	129	218	125	257	152	228	141
Potato chips, frozen	92	60	133	126	169	138	145	119	145	118
Potato crisps	34	32	31	34	44	38	46	37	40	36
Potato salad	24	39	312	90	146	0	162	96	161	94
Prawns	6	42	60	16	56	27	100	74	95	70
Prunes	40	24	23	7	16	22	41	35	40	34
Salami	24	6	20	25	35	48	40	32	38	30
Sausages, beef	67	63	99	85	131	82	133	97	124	91
Smoked cod	0	20	80	0	206	0	124	78	125	77
Soft drink, cola, regular	276	247	419	396	673	506	662	506	625	483
Soft drink, non-cola, regular	258	270	407	356	563	458	501	376	477	375
Soy sauce	3	2	6	11	10	7	11	9	10	9
Strassburg	36	60	55	23	132	120	87	57	80	56
Sultanas	13	19	16	14	17	9	17	11	17	12
Wine, red	4	1	7	4	348	343	278	220	277	220
Wine, white	3	0	0	2	555	232	386	335	387	334

*Mean food consumption amounts for different foods may be derived from different groups of respondents within each population group. Consequently, the mean consumption amounts cannot be added together to get total mean food/beverage consumption for each population group.

Table A7: Mean body weights in kilograms for each age-gender category examined in the 21st ATDS, derived from the 1995 NNS

Age group	Mean weight (kg)	Age group	Mean weight (kg)
Males (2-5 years)	18	Females (2-5 years)	17
Males (6-12 years)	33	Females (6-12 years)	35
Males (13-18 years)	65	Females (13-18 years)	59
Males (19+ years)	82	Females (19+ years)	68
Males (2+ years)	72	Females (2+ years)	62

Appendix 5: Sulphites in food – results

Table A8: Mean, minimum and maximum levels of sulphites in foods analysed in the 21st ATDS.

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Alcoholic cider	9	0	0	78	78	60	105
Barbeque sauce	9	0	3	5	7	<5	10
Beer, regular alcohol	15	6	5	2	3	nd	8
Blackcurrant juice syrup	9	6	3	0	2	nd	<5
Bread, white	15	15	0	0	0	nd	nd
Cheese, cheddar full fat	15	12	3	0	1	nd	<5
Cheese, cottage	9	9	0	0	0	nd	nd
Cheese, processed	9	6	2	1	2	nd	6
Chutney, fruit	9	0	0	7	7	6	12
Coleslaw, with dressing	15	0	3	6	7	<5	16
Cordial, regular	9	3	1	10	10	nd	30
Dip, cream cheese based	15	6	8	0	3	nd	6
Dressing, oil & vinegar based	9	0	5	4	7	nd	12
Dried Apples	9	0	0	1252	1252	990	1970
Dried Apricots	9	0	0	2097	2097	1760	3420
Frankfurts	15	2	0	55	55	nd	120
Fruit cake, uniced	15	0	13	1	6	<5	10
Fruit filled bars, cereal coated	9	0	3	15	16	<5	50
Fruit fingers	9	0	0	243	243	14	400
Fruit pie/Danish	14	9	3	1	2	nd	8
Fruit salad, canned	9	5	3	1	2	nd	6
Grapes, green seedless	15	13	2	0	1	nd	<5
Hamburgers, patties	15	0	0	129	129	30	265
Hot Potato chips, takeaway	15	14	0	1	1	nd	18
Ice confection, solid in liquid form	9	6	2	1	2	nd	6
Ice cream topping	9	2	6	1	4	nd	6
Instant vegetable soup, dry	9	8	1	0	1	nd	<5
Jam, low joule	9	7	1	1	1	nd	8
Lamingtons	15	7	4	2	3	nd	6
Lollies, soft jelly type	9	1	5	2	5	nd	10
Luncheon sausage	15	0	0	28	28	10	60
Mince, red meat	15	11	1	12	12	nd	105
Muesli bars, containing fruit	9	1	1	35	35	nd	160
Noodles, egg fresh	9	9	0	0	0	nd	nd
Olives	9	8	1	0	1	nd	<5

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Onion, pickled or cocktail	9	0	0	50	50	16	85
Orange juice	15	13	1	0	1	nd	6
Pasta, fresh	9	8	0	1	1	nd	10
Pasties, meat & vegetable	15	8	1	8	9	nd	35
Pizza, meat & vegetable topped	15	12	2	1	1	nd	10
Potato chips, frozen	9	4	3	1	3	nd	6
Potato crisps	9	4	5	0	3	nd	<5
Potato, salad	15	7	5	4	6	nd	25
Prawns	15	13	0	1	1	nd	10
Salami	15	10	4	2	3	nd	25
Sausages, beef	15	0	0	275	275	175	430
Soft drink, cola regular	9	0	9	0	5	nd	<5
Soft drink, non-cola regular	9	8	1	0	1	nd	<5
Soy sauce	9	0	2	10	11	<5	20
Strassburg	15	6	8	1	3	nd	12
Sultanas	9	3	4	74	76	nd	350
Table spread, polyunsaturated	9	9	0	0	0	nd	nd
Wine, red	15	0	0	55	55	25	85
Wine, white	15	0	0	123	123	90	150

Notes to table:

1. Results are derived from composite samples.
2. 'nd' not detected result less than the LOD (LOD = 2 mg/kg).
3. 'trace' means results were between the LOD and LOR (LOR = 5 mg/kg)
4. Two means are given in this table; the 'Lower Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of '0' (trace = 0), and the 'Upper Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of 5 mg/kg (i.e. the LOR) (trace = LOR).
5. 'Mean' results have been rounded to the nearest whole number.

Table A9: Sulphite mean and 95th percentile estimated dietary exposures for each age-gender group

Population group	No. of Respondents	No. of Consumers	Consumers* as a % of total respondents	Mean consumer exposure				95th percentile consumer exposure			
				Lower Bound		Upper Bound		Lower Bound		Upper Bound	
				mg/kg bw/day	% ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI
Males (2-5y)	380	369	97	0.5	75	0.5	80	2.0	280	1.9	280
Females (2-5y)	413	395	88	0.4	50	0.4	55	1.5	210	1.5	210
Males (6-12y)	664	643	97	0.3	40	0.3	40	1.2	170	1.2	170
Females (6-12y)	622	604	97	0.3	40	0.3	40	1.1	150	1.1	150
Males (13-18y)	491	476	97	0.2	35	0.3	35	0.9	130	0.9	130
Females (13-18y)	437	415	95	0.1	20	0.1	20	0.6	85	0.6	85
Males (19+y)	5,081	4,719	93	0.2	30	0.2	30	0.8	110	0.8	120
Females (19+y)	5,770	5,134	89	0.2	30	0.2	30	0.9	130	0.9	130
Males (2+y)	6,616	6,207	94	0.2	35	0.2	35	0.9	130	0.9	130
Females (2+y)	7,242	6,548	90	0.2	30	0.2	30	0.9	130	0.9	130

Notes to table:

1. ‘Lower bound’ assumes analytical results reported as being between the LOD and LOR are zero.
2. ‘Upper bound’ assumes analytical results reported as being between the LOD and LOR are the LOR.
3. ADI = 0.7 mg/kg bw/day.
4. Estimated dietary exposures are based on food consumption data from the 1995 NNS

Table A10: Percentage contribution of foods to total sulphites exposure for each age-gender group

	% Contribution									
	2-5 years		6-12 years		13-18 years		19 years +		2 years +	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Alcoholic cider	-	-	-	-	-	-	<1	2	<1	2
Barbeque sauce	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Beer, regular alcohol	<1	<1	-	<1	<1	<1	4	<1	3	<1
Blackcurrant juice syrup	-	-	-	-	-	-	-	-	-	-
Bread, white	-	-	-	-	-	-	-	-	-	-
Cheese, cheddar, full fat	-	-	-	-	-	-	-	-	-	-
Cheese, cottage	-	-	-	-	-	-	-	-	-	-
Cheese, processed, cheddar type	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chutney, fruit	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Coleslaw, with dressing	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cordial, regular	20	25	18	19	16	15	4	3	6	5
Dip, cream cheese based	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dressing, oil and vinegar-based	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dried apples	4	2	4	4	6	3	3	5	3	5
Dried apricots	31	17	19	24	22	12	15	19	17	19
Frankfurts (hot dog sausages)	<1	2	1	1	2	2	<1	<1	<1	<1
Fruit cake, uniced	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit filled bars, cereal coated	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit fingers/bars	4.3	3	1	2	<1	3	<1	<1	<1	<1
Fruit pie/danish	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit salad, canned	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Grapes, green, seedless	-	-	-	-	-	-	-	-	-	-
Hamburger patties/rissoles	6	5	7	7	11	14	7	4	8	5
Hot potato chips, takeaway	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ice confection sold in liquid form	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ice cream topping	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Instant vegetable soup, dry	-	-	-	-	-	-	-	-	-	-
Jam, low joule	<1	<1	<1	<1	-	<1	<1	<1	<1	<1
Lamington	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lollies, soft jelly type	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Luncheon sausage	<1	1	<1	<1	<1	<1	<1	<1	<1	<1

	% Contribution									
	2-5 years		6-12 years		13-18 years		19 years +		2 years +	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Margarine spread, polyunsaturated, <80% fat	-	-	-	-	-	-	-	-	-	-
Mince, red meat	1	1	1	1	<1	3	<1	<1	<1	<1
Muesli bars, containing fruit	1	1	1	<1	<1	1	<1	<1	<1	<1
Noodles, egg, fresh	-	-	-	-	-	-	-	-	-	-
Olives	-	-	-	-	-	-	-	-	-	-
Onion, pickled or cocktail	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Orange juice, refrigerated	<1	1	<1	<1	<1	1	<1	<1	<1	<1
Pasta, fresh	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pasties, containing meat and vegetables	<1	2	2	2	3	4	1	<1	2	1
Pizza, meat and vegetable containing	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potato chips, frozen	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potato crisps	-	-	-	-	-	-	-	-	-	-
Potato salad	<1	<1	<1	<1	<1	-	<1	<1	<1	<1
Prawns	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Salami	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sausages, beef	26	34	40	33	27	30	24	15	25	17
Soft drink, cola, regular	-	-	-	-	-	-	-	-	-	-
Soft drink, non-cola, regular	-	-	-	-	-	-	-	-	-	-
Soy sauce	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Strassburg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sultanas	2	4	2	2	1	1	1	1	1	1
Wine, red	<1	<1	<1	<1	2	3	9	7	8	6
Wine, white	<1	-	-	<1	5	4	25	39	21	34

Notes to table

1. '-' indicates that the food was not consumed or did not contain sulphites.
2. Percent contributions based on 'lower bound' values.
3. The sum of contributions for each population group may not equal 100% due to rounding.

Table A11: International estimates of dietary exposure to sulphites

Country	Year	Models and Assumptions	Population group	Mean dietary exposure (mg/kg bw/day)	High consumer dietary exposure (mg/kg bw/day)	Reference
Australia (this study)	2005	Individual dietary records, sulphite analytical data.	Population 2+ years	0.2	0.9 (95th percentile)	This study
United Kingdom	1995	Individual dietary records, sulphite analytical data plus maximum permitted levels.	Adults	0.35	1.0 (97.5th percentile)	UK FSA, 1995; DiNovi, 1999
Italy	2000	Model diets (realistic meals high in sulphite-containing foods), sulphite analytical data.	Children Adults	0.76 0.83		Leclercq et al, 2000
Japan	1994	Model diet, national nutrition intake survey, sulphite analytical data.		0.033		DiNovi, 1999
France	1993-94	Individual dietary records, EU maximum permitted sulphite levels, corrected for foods never containing sulphites and catering outside the home.	Population 5-75 years	0.59	1.6 (95th percentile)	DiNovi, 1999
United States	1982-88	Model diets, US maximum permitted sulphite levels.	Population 2 years and over	0.3	0.73 (90th percentile)	DiNovi, 1999
China	1992	Model diet, national household survey, 24-hour recall, maximum GSFA sulphite levels.		0.63	3.2 (percentile not specified)	DiNovi, 1999

GSFA – Codex draft General Standard for Food Additives (as at 1999)
Acceptable Daily Intake = 0.7 mg/kg bw/day

Appendix 6: Benzoates in foods – results

Table A12: Mean, minimum and maximum levels of benzoates in foods analysed in the 21st ATDS

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Alcoholic cider	9	9	0	0	0	nd	nd
Barbeque sauce	9	6	3	0	3	nd	<10
Blackcurrant juice syrup	9	0	0	94	94	75	130
Bread, white	15	15	0	0	0	nd	nd
Cheese, cheddar full fat	15	3	9	3	9	nd	25
Cheese, cottage	9	2	0	11	11	nd	20
Cheese, processed	9	0	3	9	12	<10	20
Chocolate cake	15	10	3	1	3	nd	10
Chocolate cake, icing	15	6	6	24	28	nd	205
Chutney, fruit	9	8	1	0	1	nd	<10
Coleslaw, with dressing	15	12	3	0	2	nd	<10
Cordial, regular	9	0	0	83	83	20	155
Dip, cream cheese based	15	2	9	3	9	nd	15
Dressing, oil & vinegar based	9	8	1	0	1	nd	<10
Fruit cake, uniced	15	1	0	23	23	nd	50
Fruit filled bars, cereal coated	9	9	0	0	0	nd	nd
Fruit fingers	9	9	0	0	0	nd	nd
Fruit pie/Danish	14	14	0	0	0	nd	nd
Ice confection, solid in liquid form	9	0	0	163	163	120	210
Ice cream topping	9	4	0	134	134	nd	445
Jam, low joule	9	1	7	1	9	nd	10
Lamingtons	15	10	1	41	41	nd	220
Muesli bars, containing fruit	9	6	3	0	3	nd	<10
Noodles, egg fresh	9	8	1	0	1	nd	<10
Olives	9	3	4	4	9	nd	20
Onion, pickled or cocktail	9	9	0	0	0	nd	nd
Orange juice	15	3	0	51	51	nd	155
Pasta, fresh	9	9	0	0	0	nd	nd
Pasties, meat & vegetable	15	9	6	0	4	nd	<10
Pikelets	9	9	0	0	0	nd	nd

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Pizza, meat & vegetable topped	15	11	4	0	2.7	nd	<10
Potato, salad	15	14	1	0	1	nd	<10
Prunes	9	2	5	3	9	nd	15
Salami	15	13	2	0	1	nd	<10
Smoked Cod	9	9	0	0	0	nd	nd
Soft drink, cola regular	9	8	0	17	17	nd	150
Soft drink, non-cola regular	9	0	0	220	220	145	350
Soy sauce	9	3	5	2	7	nd	15
Table spread, polyunsaturated	9	8	1	0	1	nd	<10
Wine, red	15	15	0	0	0	nd	nd
Wine, white	15	14	1	0	1	nd	<10

Notes to table:

1. Results are derived from composite samples.

2. 'nd' not detected result less than the LOD (LOD = 2 mg/kg).

3. 'Trace' means results were between the LOD and LOR (LOR = 10 mg/kg)

4. Two means are given in this table; the 'Lower Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of '0' (trace = 0), and the 'Upper Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of 10 mg/kg (i.e. the LOR) (trace = LOR).

5. 'Mean' results have been rounded to the nearest whole number.

Table A13: Benzoates mean and 95th percentile estimated dietary exposures for each age-gender group

Population group	No. of Respondents	No. of Consumers	Consumers* as a % of total respondents	Mean consumer exposure				95th percentile consumer exposure			
				Lower Bound		Upper Bound		Lower Bound		Upper Bound	
				mg/kg bw/day	% ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI
Males (2-5y)	380	362	95	2.3	45	2.3	45	7.2	140	7.2	140
Females (2-5y)	413	392	95	1.9	40	1.9	40	5.8	120	5.8	120
Males (6-12y)	664	626	94	1.6	30	1.6	30	5.1	100	5.0	100
Females (6-12y)	622	582	94	1.3	25	1.3	25	4.0	80	4.0	80
Males (13-18y)	491	461	94	1.1	20	1.1	20	3.6	75	3.5	70
Females (13-18y)	437	407	93	0.8	15	0.8	15	2.9	55	2.8	55
Males (19+y)	5,081	4,204	83	0.4	9	0.4	8	1.9	40	1.8	35
Females (19+y)	5,770	4,693	81	0.4	8	0.3	7	1.7	35	1.6	30
Males (2+y)	6,616	5,653	85	0.8	15	0.7	15	3.2	65	3.0	60
Females (2+y)	7,242	6,074	84	0.6	10	0.6	10	2.6	50	2.4	50

Notes to table:

1. ‘Lower bound’ assumes analytical results reported as being between the LOD and LOR are zero.
2. ‘Upper bound’ assumes analytical results reported as being between the LOD and LOR are the LOR.
3. ADI = 0-5 mg/kg bw/day.
4. Estimated dietary exposures are based on food consumption data from the 1995 NNS
5. For some population groups assessed, the lower bound estimated dietary exposure is higher than the upper bound estimated exposure. This is due to the dietary exposure estimates being derived from different populations of consumers, where a smaller number of consumers are included in the calculations at the lower bound in comparison to the upper bound.

Table A14: Percent contribution of foods to total benzoate exposure for each age-gender group

	%Contribution									
	2-5 years		**6-12 years**		**13-18 years**		**19 years +**		**2 years +**	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Alcoholic cider	-	-	-	-	-	-	-	-	-	-
Barbeque sauce	-	-	-	-	-	-	-	-	-	-
Blackcurrant juice syrup	4	2	<1	1	<1	2	1	<1	1	1
Bread, white	-	-	-	-	-	-	-	-	-	-
Cheese, cheddar, full fat	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cheese, cottage	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cheese, processed, cheddar type	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chocolate cake - icing	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chocolate cake, plain	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chutney, fruit	-	-	-	-	-	-	-	-	-	-
Coleslaw, with dressing	-	-	-	-	-	-	-	-	-	-
Cordial, regular	39	40	29	34	30	18	19	15	23	20
Dip, cream cheese based	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dressing, oil and vinegar-based	-	-	-	-	-	-	-	-	-	-
Fruit cake, uniced	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit filled bars, cereal coated	-	-	-	-	-	-	-	-	-	-
Fruit fingers/bars	-	-	-	-	-	-	-	-	-	-
Fruit pie/danish	-	-	-	-	-	-	-	-	-	-
Ice confection sold in liquid form	4	3	4	4	2	3	<1	<1	1	1
Ice cream topping	<1	<1	1	1	1	1	<1	<1	<1	<1
Jam, low joule	<1	<1	<1	<1	-	<1	<1	<1	<1	<1
Lamington	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Margarine spread, polyunsaturated, <80% fat	-	-	-	-	-	-	-	-	-	-
Muesli bars, containing fruit	-	-	-	-	-	-	-	-	-	-
Noodles, egg, fresh	-	-	-	-	-	-	-	-	-	-
Olives	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Onion, pickled or cocktail	-	-	-	-	-	-	-	-	-	-
Orange juice, refrigerated	22	28	16	19	14	22	15	20	16	21
Pasta, fresh	-	-	-	-	-	-	-	-	-	-

	%Contribution									
	2-5 years		**6-12 years**		**13-18 years**		**19 years +**		**2 years +**	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Pasties, containing meat and vegetables	-	-	-	-	-	-	-	-	-	-
Pikelets, pancakes	-	-	-	-	-	-	-	-	-	-
Pizza, meat and vegetable containing	-	-	-	-	-	-	-	-	-	-
Potato salad	-	-	-	-	-	-	-	-	-	-
Prunes	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Salami	-	-	-	-	-	-	-	-	-	-
Smoked cod	-	-	-	-	-	-	-	-	-	-
Soft drink, cola, regular	2	1	3	3	7	7	8	6	7	5
Soft drink, non-cola, regular	28	25	45	36	45	47	54	55	50	49
Soy sauce	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Wine, red	-	-	-	-	-	-	-	-	-	-
Wine, white	-	-	-	-	-	-	-	-	-	-

Notes to table

1. '-' indicates that the food was not consumed or did not contain benzoates.
2. Percent contributions based on 'lower bound' values.
3. The sum of contributions for each population group may not equal 100% due to rounding.

Appendix 7: Sorbates in foods – results

Table A15: Mean, minimum and maximum levels of sorbates in foods analysed in the 21st ATDS

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Alcoholic cider	9	9	0	0	0	nd	nd
Barbeque sauce	9	9	0	0	0	nd	nd
Blackcurrant juice syrup	9	5	0	16	16	nd	55
Bread, white	15	13	2	0	1	nd	<5
Cheese, cheddar full fat	15	15	0	0	0	nd	nd
Cheese, cottage	9	0	0	357	357	285	440
Cheese, processed	9	0	0	1506	1506	830	2260
Chocolate cake	15	0	0	714	714	15	2100
Chocolate cake, icing	15	0	0	706	706	10	1860
Chutney, fruit	9	7	0	6	6	nd	30
Coleslaw, with dressing	15	11	0	17	17	nd	100
Cordial, regular	9	8	1	0	1	nd	<5
Dip, cream cheese based	15	0	0	580	580	130	1400
Dressing, oil & vinegar based	9	8	0	22	22	nd	200
Fruit cake, uniced	15	0	0	651	651	290	980
Fruit filled bars, cereal coated	9	3	3	27	28	nd	125
Fruit fingers	9	6	1	7	7	nd	35
Fruit pie/Danish	14	6	1	21	21	nd	110
Ice confection, solid in liquid form	9	0	0	67	67	35	115
Ice cream topping	9	0	0	488	488	225	770
Jam, low joule	9	0	0	654	654	250	815
Lamingtons	15	0	0	835	835	345	1280
Muesli bars, containing fruit	9	6	3	0	2	nd	<5
Noodles, egg fresh	9	4	1	69	69	nd	355
Olives	9	0	0	98	98	15	250
Onion, pickled or cocktail	9	4	0	49	49	nd	170
Orange juice	15	0	0	191	191	50	310
Pasta, fresh	9	8	0	32	32	nd	285
Pasties, meat & vegetable	15	2	0	105	105	nd	330
Pikelets	9	2	0	366	366	nd	915

Food	No. of analyses	No. of 'nd' samples	No. of 'trace' samples	Mean (Trace=0)	Mean (Trace=LOR)	Minimum	Maximum
				mg/kg	mg/kg	mg/kg	mg/kg
Pizza, meat & vegetable topped	15	10	4	0	2	nd	5
Potato, salad	15	14	0	3	3	nd	50
Prunes	9	0	0	448	448	130	790
Salami	15	6	5	15	17	nd	100
Smoked Cod	9	8	1	0	1	nd	<5
Soft drink, cola regular	9	9	0	0	0	nd	nd
Soft drink, non-cola regular	9	8	1	0	1	nd	<5
Soy sauce	9	6	1	51	52	nd	230
Table spread, <80% fat, polyunsaturated	9	0	0	421	421	200	670
Wine, red	15	14	0	4	4	nd	65
Wine, white	15	13	0	4	4	nd	30

Notes to table:

1. Results are derived from composite samples.
2. 'nd' means result less than the LOD (LOD = 2 mg/kg).
3. 'Trace' means results were between the LOD and LOR (LOR = 5 mg/kg)
4. Two means are given in this table; the 'Lower Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of '0' (trace = 0), and the 'Upper Bound' derived assuming not detected results are assigned zero and results between the LOD and the LOR are assigned a value of 5 mg/kg (i.e. the LOR) (trace = LOR).
5. 'Mean' results have been rounded to the nearest whole number.

Table A16: Sorbates mean and 95th percentile estimated dietary exposures for each age-gender group

Population group	No. of Respondents	No. of Consumers	Consumers* as % of total respondents	Mean consumer exposure				95th percentile consumer exposure			
				Lower Bound		Upper Bound		Lower Bound		Upper Bound	
				mg/kg bw/day	% ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI	mg/kg bw/day	%ADI
Males (2-5y)	380	340	90	3.2	10	2.9	10	9.9	40	9.7	40
Females (2-5y)	413	374	91	3.3	15	3.1	10	9.8	40	9.3	35
Males (6-12y)	664	588	89	1.9	8	1.7	7	6.0	25	5.7	25
Females (6-12y)	622	549	88	1.6	6	1.5	6	5.0	20	4.9	20
Males (13-18y)	491	435	89	1.1	4	1.0	4	3.7	15	3.5	15
Females (13-18y)	437	397	91	1.1	4	1.0	4	3.3	15	3.2	15
Males (19+y)	5,081	4,363	86	0.6	2	0.5	2	1.9	8	1.8	7
Females (19+y)	5,770	5,651	98	0.6	2	0.5	2	2.2	9	2.0	8
Males (2+y)	6,616	5,726	87	0.9	4	0.8	3	3.4	15	3.2	15
Females (2+y)	7,242	6,221	86	0.9	4	0.8	3	3.3	15	3.1	10

Notes to table:

1. 'Lower bound' assumes analytical results reported as being between the LOD and LOR are zero.
2. 'Upper bound' assumes analytical results reported as being between the LOD and LOR are the LOR.
3. ADI = 0-25 mg/kg bw/day.
4. Estimated dietary exposures are based on food consumption data from the 1995 NNS
5. For some population groups assessed, the lower bound estimated dietary exposure is higher than the upper bound estimated exposure. This is due to the dietary exposure estimates being derived from different populations of consumers, where a smaller number of consumers are included in the calculations at the lower bound in comparison to the upper bound.

Table A17: Percentage contribution of foods to total sorbate exposure for each age-gender group

	%Contribution									
	2-5 years		6-12 years		13-18 years		19 years +		2 years +	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Alcoholic cider	-	-	-	-	-	-	-	-	-	-
Barbeque sauce	-	-	-	-	-	-	-	-	-	-
Blackcurrant juice syrup	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bread, white	-	-	-	-	-	-	-	-	-	-
Cheese, cheddar, full fat	-	-	-	-	-	-	-	-	-	-
Cheese, cottage	<1	<1	<1	<1	<1	<1	2	2	1	2
Cheese, processed, cheddar type	17	17	11	8	10	8	10	11	10	11
Chocolate cake - icing	<1	<1	2	1	1	1	2	1	1	1
Chocolate cake, plain	2	5	9	9	8	6	10	12	9	10
Chutney, fruit	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Coleslaw, with dressing	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cordial, regular	-	-	-	-	-	-	-	-	-	-
Dip, cream cheese based	<1	<1	<1	<1	<1	<1	1	1	1	1
Dressing, oil and vinegar-based	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit cake, uniced	<1	1	2	<1	1	2	4	4	3	3
Fruit filled bars, cereal coated	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit fingers/bars	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fruit pie/danish	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ice confection sold in liquid form	1	<1	2	1	<1	<1	<1	<1	<1	<1
Ice cream topping	2	1	4	4	4	4	2	2	3	2
Jam, low joule	<1	<1	<1	<1	-	<1	<1	<1	<1	<1
Lamington	1	<1	6	2	5	3	4	4	4	4
Margarine, <80% fat, polyunsaturated,	2	2	3	3	3	2	6	5	5	4
Muesli bars, containing fruit	-	-	-	-	-	-	-	-	-	-
Noodles, egg, fresh	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
Olives	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Onion, pickled or cocktail	-	<1	-	<1	<1	<1	<1	<1	<1	<1
Orange juice, refrigerated	66	66	54	63	55	63	45	47	49	52
Pasta, fresh	1	1	1	2	2	2	2	2	2	2
Pasties, containing meat and vegetables	2	3	4	4	8	5	7	5	7	4

	%Contribution									
	2-5 years		6-12 years		13-18 years		19 years +		2 years +	
Food	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Pikelets, pancakes	1	<1	1	<1	<1	<1	<1	<1	<1	<1
Pizza, meat and vegetable containing	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potato salad	<1	<1	<1	<1	<1	-	<1	<1	<1	<1
Prunes	<1	<1	<1	<1	<1	<1	1	2	<1	1
Salami	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Smoked cod	-	-	-	-	-	-	-	-	-	-
Soft drink, cola, regular	-	-	-	-	-	-	-	-	-	-
Soft drink, non-cola, regular	-	-	-	-	-	-	-	-	-	-
Soy sauce	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Wine, red	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Wine, white	<1	-	-	<1	<1	<1	<1	<1	<1	<1

Notes to table

1. ‘-‘ indicates that the food was not consumed or did not contain sorbates.
2. Percent contributions based on ‘lower bound’ values.
3. The sum of contributions for each population group may not equal 100% due to rounding.