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Nitrite and nitrate content in meat products and estimated intake in Denmark from 1998 to 2006

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Food Types:	Meat, Processed foods

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Table I. Food groups in the Danish Dietary Survey and most abundant foods analysed for nitrite.

Table II. Sodium nitrite mgkg^{-1} . Mean for samples with content > detection limit (n=number of samples), (*min-max*).

Table III. Sodium nitrate mgkg^{-1} . Mean content in all samples and mean for samples with content > detection limit (n=number of samples), (*min-max*).

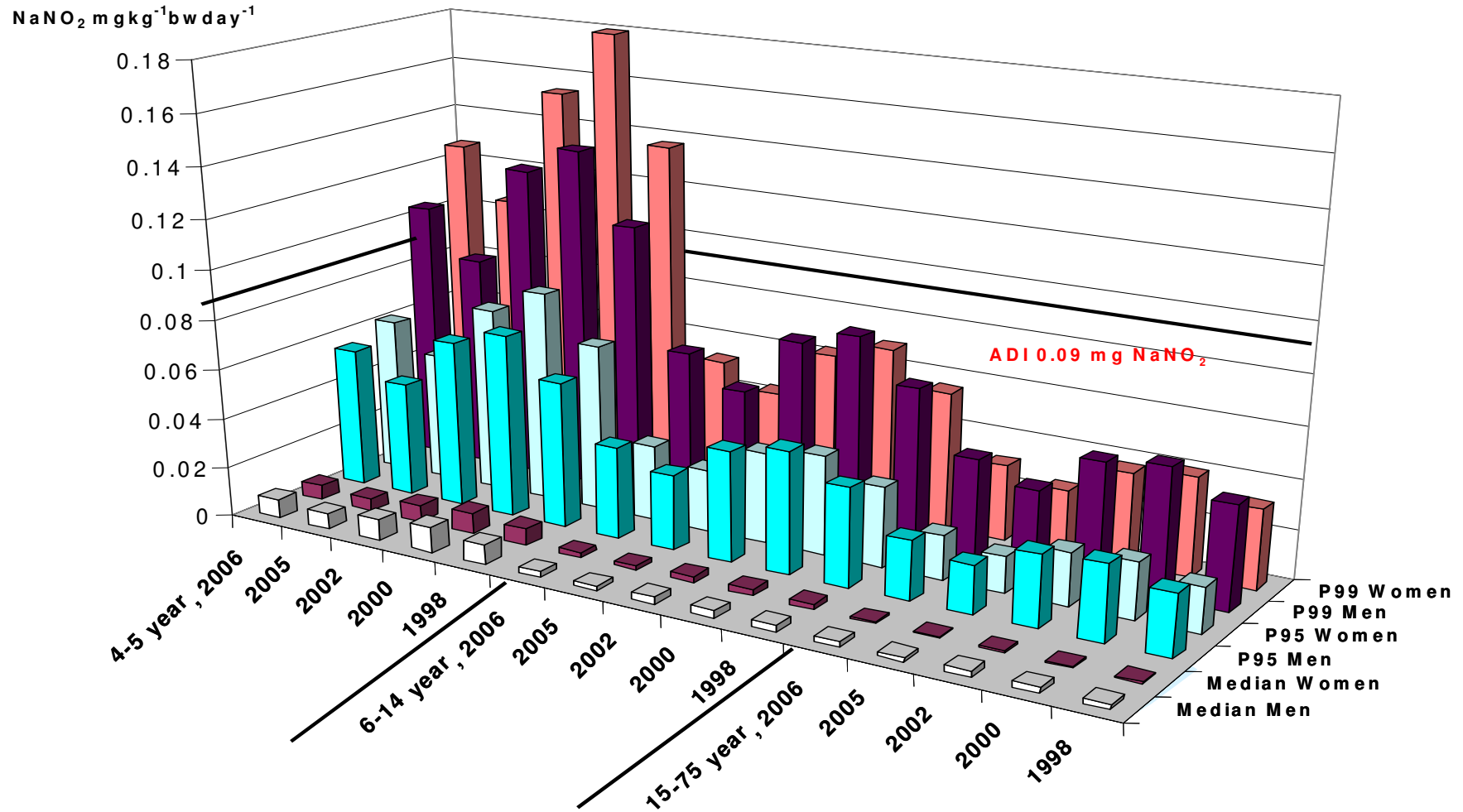
Table IV. Mean intake of sodium nitrate from cured meat mgday^{-1} based on samples with content of nitrate (high intake calculation).

Table V. Food intake and high intake of NaNO_2 in 2006. Age group 4-5 years.

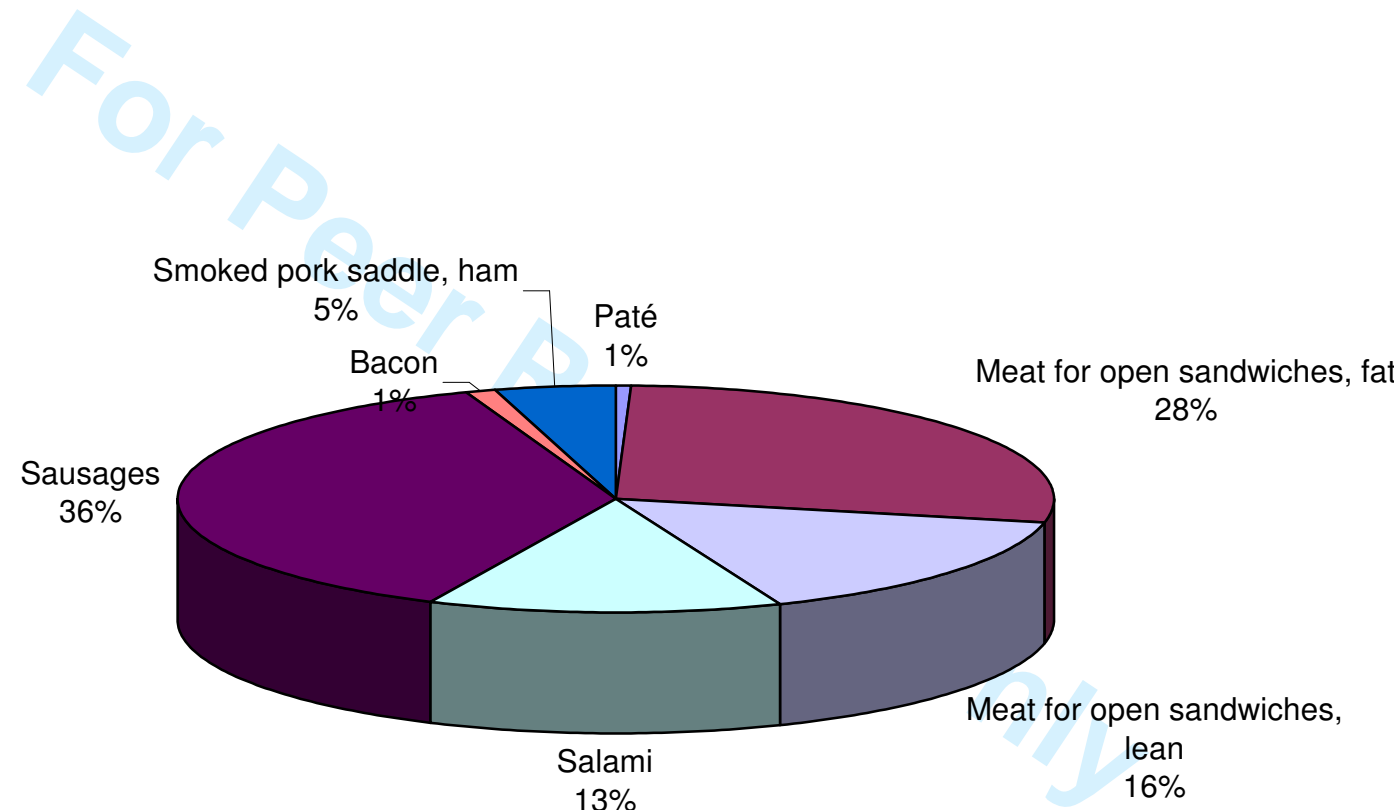
Figure 1. Intake of NaNO_2 $\text{mgkg}^{-1}\text{bwday}^{-1}$.

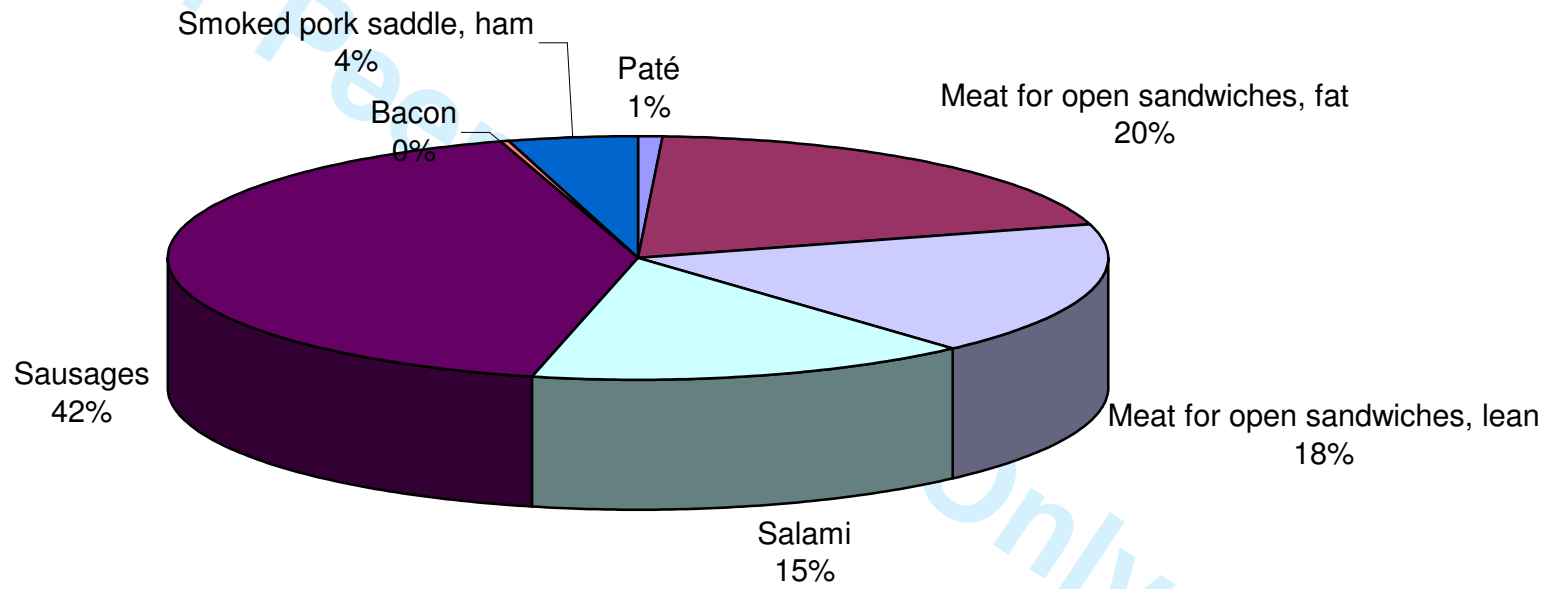
Figure 2. Distribution of mean nitrite intake. Boys 4-5 years.

Figure 3. Distribution of mean nitrite intake. Girls 4-5 years.



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Nitrite and nitrate content in meat products and estimated intake in Denmark from 1998 to 2006

Abstract

The content of nitrite and nitrate in cured meat products has been monitored in Denmark seven times in the period from 1995 to 2006. The maximum permitted added amounts of sodium nitrite in Denmark (60 mg kg^{-1} for most products up to 150 mg kg^{-1} for special products) was not exceeded, except for a few samples in 2002. The intake, mean and intake distribution, of sodium nitrite was calculated from 1998 to 2006 with data from the Danish dietary survey conducted in 2000-2002 on Danes from 4 to 75 years of age. The amounts used by industry were relatively stable through the whole period with levels varying between 6 and $20 \text{ mg sodium nitrite kg}^{-1}$ with sausages, meat used for open sandwiches and salami type of sausages as the greatest contributors. The mean intake of sodium nitrate was around 1 mg day^{-1} , which is very low compared to the total intake of 61 mg day^{-1} . The mean intake of sodium nitrite was in $\text{mg kg}^{-1} \text{ bw day}^{-1}$ for men and women was 0.017 and 0.014, 0.009 and 0.008 and 0.007 and 0.003 in the age groups 4-5 years, 6-14 years and 15-75 years, respectively, which was much lower than the ADI value of $0.09 \text{ mg kg}^{-1} \text{ bw day}^{-1}$. The 99 percentile for the group of 4 year olds was 0.107 and 0.123 $\text{mg kg}^{-1} \text{ bw day}^{-1}$ for boys and girls, respectively, and the 95 percentile 0.057 and 0.073 $\text{mg kg}^{-1} \text{ bw day}^{-1}$ for boys and girls, respectively, highest for the girls. With less than 100 boys and girls in the age group 4-5 years only a small number of individuals were responsible for the high intake. The conversion of nitrate to nitrite in the saliva and the degradation of nitrite during production and storage must also be considered when evaluating the intake of nitrite.

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4 **Keywords:-** Estimated intake, sodium nitrite, sodium nitrate, Denmark, cured meat,
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6 children.
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10 11 **Introduction**

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13 Nitrite, used as a food additive for its antimicrobial properties in cured meat products and
14 its desirable effects on colour, flavour and texture, is considered a considerable health risk
15 with high exposure caused by its ability to form carcinogenic nitrosoamines in foods and in
16 the organism (SCF 1995). The ADI value is fixed at 0.06 mg nitrite (nitrite ion) or 0.09 mg
17 sodium nitrite $\text{kg}^{-1}\text{bw day}^{-1}$. For nitrate the ADI value is fixed at 3.7 mg nitrate (nitrate ion)
18 or 5 mg sodium nitrate $\text{kg}^{-1}\text{bw day}^{-1}$.
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30 EU controls as specified in Directive 95/2/EC (EU 1995) are based on fixed residual
31 amounts between 50 and 175 mg kg^{-1} of sodium nitrite (in bacon) and an indicative usage
32 amount of 150 mg kg^{-1} . In Denmark stricter rules have been employed based on
33 permissible added amounts from 60 mg to 150 mg kg^{-1} of sodium nitrite (the higher
34 amount only for semi-preserved products and special cured hams) (Positivlisten 2005),
35 and we succeeded in continuing with these rules after winning a case against the
36 Commission at the European Court of Justice in 2003 (Opinion, EFSA 2003). In Denmark
37 nitrate is only allowed added to bacon of the Wiltshire type and special types of ham in an
38 amount of 300 mg kg^{-1} , while in 95/2/EC a residual amount of 250 mg kg^{-1} in salted meat
39 products is specified.
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56 In Estonia an average estimated intake in 2003-04 of 105% of the ADI value of 0.06 mg
57 nitrite $\text{kg}^{-1}\text{bw day}^{-1}$ for the 1 to 6 year age group was found (Reinik et al 2005). In New
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4 Zealand the average intake has just recently been estimated to 13% of the ADI with
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6 maximum intake 7 times this value, and the authors concluded that with the endogenous
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8 conversion of nitrate to nitrite, between 10% and 50% of all people will exceed the ADI
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10 (Thomson et al. 2007), both investigations indicating a high intake of nitrite with many
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12 children having intakes over the ADI value. In Denmark as a part of the Danish Veterinary
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14 and Food Administration programme for monitoring of food additives the content of nitrate
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16 and nitrite in meat products has been investigated seven times between 1995 and 2006.
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18 The primary objective has been to check that the additives are used legally and within the
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20 maximum permitted levels, but the analyses are also utilized to assess the intake of food
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22 additives. A rough average estimate of the intake of nitrite and nitrate has been carried out
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24 earlier giving a value of 0.5 mg nitrite day⁻¹, which even for small children is well below the
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26 ADI value, and 61 mg nitrate day⁻¹. Cured meat was the most important source for nitrite
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28 with an additional 30% contribution from fruit and vegetables, while for nitrate fruit and
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30 vegetables and water were the only important sources with only 1 mg day⁻¹ coming from
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32 meat (Petersen and Stolze 1999). However, an intake distribution could not be calculated.
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34 With the new dietary survey carried out by the National Food Institute from 2000 and
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36 onwards (Lyhne et al, 2005) and the data from the monitoring programme it is possible to
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38 estimate the intake and intake distribution. The results of the development of the use of
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40 nitrite and nitrate in cured meat in Denmark and the intake estimation for nitrite and nitrate
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42 are presented in this paper.
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Materials and methods

Monitoring programme

The Danish food monitoring programme for food additives started in 1995 with the purpose of partly supervising the actual occurrence and use of food additives, partly controlling whether the maximum permitted levels were exceeded and whether illegal applications and/or declaration errors occurred in contravention of EU rules. Since the beginning meat and meat products have been analysed in seven different years from 1995 to 2006. Samples have been drawn all over the country from producers, importers and wholesalers with production both Danish produced and imported. The most abundant meat products in the food groups from the dietary survey are shown in table I and the total number of samples are shown in table II. The samples were sent to the laboratory and stored in a refrigerator at 4°C. If analysis could not be performed within two days after receipt, the samples in unopened condition were frozen in polyethylene bags at -18°C until analysis could be started.

Chemical analysis

Nitrite and nitrate were extracted from the samples by mixing 5 min with hot water (70°C). Protein was precipitated with addition of Carrez solution I and II and the suspension was filtrated. The filtrate was injected in a FIA system, where sulphanilamide and N-(1-naphtyl)-ethylenediammoniumchloride were added to the carrier stream to react with nitrite to form a violet azo colour which was measured spectrophotometrically at 540 nm. For nitrate, after injection, the carrier stream went through a Cd-column where nitrate was reduced to nitrite which subsequently reacted to form the azo colour. A calibration curve was prepared every day with nitrite and nitrate on 5 concentration levels for quantitative calculation. All

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4 chemicals were analytical grade and the water was de-ionised. The laboratory was
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6 accredited to perform the analysis after ISO 17025. In every series of samples was
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8 included blind samples of reagents and water, a duplicate divided between two series, a
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10 reference material of freeze dried dill and a recovery experiment for both nitrate and nitrite
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12 with the data plotted in control charts. Depending on sample type and concentration level
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14 an average recovery of 100% for nitrate and 95% for nitrite was found and relative
15
16 standard deviations between 2 and 4% for nitrite and between 2 and 5% for nitrate.
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18 Detection limit for NaNO_2 was 3 mgkg^{-1} and for NaNO_3 5 mgkg^{-1} . The results showed that
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20 the analytical method had been under control at all times with no values exceeding the
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22 control limits for double determinations or for recoveries.
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30 *Dietary survey*

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32 The survey was conducted in 2000-2002 on a random sample of Danes aged from 4 to 75
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34 years drawn from the Central Population Register (Lyhne et al, 2005). Dietary data was
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36 based on recording on 7 consecutive days. The questionnaire was designed to cover the
37
38 whole diet and included 5 cuts of meat used on bread (e.g. different types of meat, salami
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40 and liver paste), 3 types of pork meat (lean, medium and high fat) and sausages. A
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42 combination of food quantification methods (household measures and estimation from
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44 photographs of different portion sizes) were used to obtain the best estimate of amounts
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46 consumed.
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54 *Estimated intake calculation*

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56 The between 160 and 320 samples of meat analysed in the later years were aggregated
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58 into eight different types of meat for which intake data was present: Liver paste; paté; fatty
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4 meat intended to be used in sandwiches; lean meat intended to be used for sandwiches;
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6 salami; sausages for dinner; medium fat and fat pork meat for dinner.
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11 For each person the registered average daily intake of the eight food groups or the part of
12 the food group with content of nitrite (see table I) was multiplied with the content of nitrite,
13 and a calculation of basic statistic parameters of the intake distribution was carried out in
14 the form of mean, standard error of mean and percentiles with the persons divided in age
15 groups 4-5 year, 6-14 year, 15-75 year, males, females and the total population.
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25 For the content of nitrite two scenarios were used: One with the analytical determined
26 mean value used for all the samples with a detectable nitrite content called "high intake",
27 and another with the analytical determined values for all the samples in each category
28 called "average intake", which will be lower than "high intake", since many of the meat
29 samples were produced without the use of nitrite salts. The variability in the content of
30 nitrite within each meat category was not used in the estimated intake calculation.
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42 Results

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47 [Insert Table I about here]
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49 In table I is shown the eight food groups where data were collected in the dietary survey
50 and the most abundant foods analysed for nitrite. It was estimated based on knowledge of
51 dietary habits in Denmark and sales statistics that 5% of liver paste was eaten as paté,
52 that 7-10% of fat pork meat was eaten as bacon, which was also used in fat meat for open
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sandwiches, and that 30% of medium fat pork meat was eaten as smoked pork saddle and ham, which were also used in lean meat for open sandwiches.

[Insert Table II about here]

In table II is shown the mean sodium nitrite content found in samples with content over the detection limit. The mean value of all the samples is typically about 20% lower than the mean value of samples with content over the detection limit (data not shown). In very few samples the maximum permitted level of nitrite was exceeded and that was back in 2002 and earlier. A few declaration errors were found every year mainly due to declaration of nitrite, which could not be found in the sample, probably because the nitrite was used up during production and storage. No nitrite was used in liver paste, where it is not allowed. However, in paté nitrite was generally used. In the group meat for open sandwiches, fat and medium fat nitrite was found in more than half of the samples. However, the results show that it was also possible to produce meat products in these groups without using nitrite. Products like bacon and sausage of the saveloy type often contained nitrite, while smoked saddle and loin fillet were often without added nitrite. Salami was mainly without nitrite, while the other sausage types in this group often contained nitrite. Also sausages usually contained nitrite. The average level of nitrite seemed fairly stable over the years although with some variation and with a low level in 2005. However, in 2006 the level of nitrite increased again.

[Insert Table III about here]

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4 In table III is shown the average nitrate content in samples with content over the detection
5 limit but only for the years 2005 and 2006. The nitrate content was generally low but higher
6 than a possible natural content, which meant that added nitrate was found in many meat
7 products, where it was not allowed to add nitrate. However, in many cases it could not be
8 excluded that the nitrate followed an ingredient, where addition was legal.
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18 [Insert Table IV about here]
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23 In table IV is shown the average sodium nitrate intake in the age groups 4-5 year, 6-14
24 year and 15-75 year with the contribution from the different food groups for the years 2005
25 and 2006 based on the average of the samples with nitrate content, that is, a high intake
26 calculation. It appears that the average intake of nitrate from meat was more or less the
27 same in all age groups and both years about 1 mg day^{-1} , although a little higher in 2006
28 than 2005, which was very low compared to the intake from vegetables, fruits and water.
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40 Fifty percent of the samples did not comply with regulations either through mislabelling or
41 addition of nitrate, where it is not permitted. No improvement has been seen with this
42 situation, which has persisted for a number of years despite follow-up with producers and
43 importers. This necessitates a continuation of the monitoring programme for nitrite and
44 nitrate in meat products.
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54 [Insert Table V]
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4 A detailed intake distribution of sodium nitrite in 2006 is shown in table V for the age group
5 4-5 year. The mean for samples with content over the detection limit (high intake
6 calculation) was taken from table II. For bacon in the food group fat pork meat was used
7 the content for fat meat for open sandwiches, and for smoked pork saddle and ham in the
8 food group medium fat pork meat was used the content for lean meat for open
9 sandwiches. An overview of the calculations for all the years from 1998 to 2006 and all the
10 age groups appears in figure 1.
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23 [Insert figure 1 about here]
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28 Only for 4-5 year olds the intake was rather high and even with the 99 percentile (P99)
29 exceeding the ADI value. However, with the number of participants below 100 it is a single
30 individual, who determined P99, and apparently there was always at least one person with
31 unusual food consumption. 4-5 year old girls had higher P99 and P95 than boys because
32 of a higher intake of sausages, but in the other age groups men had a higher intake of
33 nitrite than women because of a higher food intake.
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44 [Insert figure 2 and 3 about here]
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49 From figure 2 and 3 the significant sources for nitrite intake are demonstrated. Sausages,
50 fat and lean meat for open sandwiches (the famous Danish "smorrebrod") and salami type
51 of sausage were the main sources in that order. The 4-5 year old girls had a higher
52 consumption of sausage than the 4-5 year old boys. On the other hand boys eat more fat
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4 meat for open sandwiches than the girls. The distribution was more or less the same for all
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6 percentiles as for the mean intake.
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10 11 **Discussion**

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13 Data for nitrite intake in table V and figure 1 are only shown for “the high intake” calculation
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15 based on the consideration that people do not eat an average diet, but they have probably
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17 considerable brand loyalty and will eat the same sausage or ham as they always eat. This
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19 may be with or without nitrite, but “the high intake” calculation will be a more realistic
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21 representation of what people can be exposed to.
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28 The intake of nitrate of about 1 mg per day in 2005 and 2006 (see table IV) was very low
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30 compared to the intake from vegetables, fruit and water with an average intake in Denmark
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32 of about 61 mg nitrate day⁻¹ (Petersen and Stoltze 1999). It can be concluded that the
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34 intake of cured meat is not important for the nitrate intake, and therefore intake
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36 calculations presented in this article have only been carried out in detail for 2005 and
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40 2006.
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44 Considering the development in the content of nitrite from 1998 to 2006, with too few
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46 samples to include 1995 and 1997 in the evaluation, there was apparently a decreasing
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48 tendency towards 2005. However, in 2006 a small increase in the nitrite content was seen
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50 again. Thus, it seems the variation was more or less accidental. The Danish authorities
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52 have been very interested in the development in the use of nitrite after the decision in 2003
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54 about the more strict Danish rules for the use of nitrite could be uphold (Opinion, EFSA
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56 2003). However, no clear development can be seen after 2003 compared to before 2003,
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so the decision seems not to have influenced the use of nitrite in Danish cured meat products. This is not a surprise, since the maximum permitted level did not change.

The total intake of sodium nitrite with cured meat varied from a mean value around 0.3 mg day⁻¹ to P99 of 2-3 mg day⁻¹, and no clear connection between age and intake can be seen, except that 15-75 year old men seem to have a higher total intake than the other age groups (see table V and figure 1). This means that the young 4-5 year old children had a P99 for nitrite intake 20 to 35% over the ADI value and also P95 was high for both boys and girls. However, these values were based on very few children with less than a hundred boys and girls in the 4-5 year groups.

Compared to Reinik (Reinik et al. 2005), where the mean intake in Estonia for 1-6 year old children in 2004 was about 50% of the ADI value based on all children and all days, the intake in Denmark is much lower with mean intake 16-19% of the ADI value. In Estonia the maximum permitted value for residual sodium nitrite was 100 mgkg⁻¹ in contrast to the Danish system with maximum permitted added levels, mostly only 60 mgkg⁻¹. In New Zealand (Thomson et al. 2007) a mean sodium nitrite intake for adults of 13% of the ADI value was recently found based on the content in both meat and vegetables compared to a mean intake in Denmark of only 5% of the ADI value for adults. Only in broccoli was found a nitrite content over the detection limit, but for other vegetables the intake was calculated with a level of half the detection limit, i.e. 2.5 mgkg⁻¹. In the Danish investigation from the nineties (Petersen and Stoltze 1999) an intake of 0.097 mgday⁻¹ sodium nitrite from vegetables was found, which amounts to about 30% of the intake found with cured meat in

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4 this investigation, but no attempt has been made here to correct the intake with these old
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6 data from 1996 for nitrite content in vegetables.
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11 Another aspect to consider is the fact that there is no direct relationship between the in-
12 going and the residual amount of nitrite, but the degradation of nitrite added to meat is
13 influenced by several factors like pH-value, storage temperature, heat treatment of the
14 meat and the presence of reducing substances. Especially added ascorbate will increase
15 the rate of degradation of nitrite. (Opinion, EFSA 2003). Thus, ideally addition of nitrite
16 should be controlled through recipe control of maximum permitted added levels, instead of
17 analytical control of maximum permitted added levels, as it has been done in this
18 investigation, or maximum residual amounts after directive No 95/2/EC, as it has been
19 done in many other investigations.
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35 Endogenous conversion of nitrate in saliva to nitrite is reported to be between 5% and 20%
36 of the nitrate (SCF 1995). With a mean intake of 60 mg nitrate day⁻¹ this amounts to 3 mg
37 nitrite day⁻¹, which is higher than even the P99 intake value for nitrite with cured meat. The
38 4-5 year old will get 0.15 mgkg⁻¹bwday⁻¹ sodium nitrite, which is about 50% over the ADI
39 value of 0.09 mg, and the 6-14 year old will get 0.08 mgkg⁻¹bwday⁻¹, which together with
40 the intake from cured meat also will exceed the ADI value for more than 10% of the group.
41 Only for the adults, who will get 0.04 mgkg⁻¹bwday⁻¹, will the conversion of nitrate to nitrite
42 not lead to transgression of the ADI value. If the calculation is carried out with the P95 for
43 nitrate intake of 113 mgday⁻¹ (Petersen and Stoltze 1999) and/or a conversion of 20% of
44 nitrate to nitrite, much higher intakes of nitrite will be obtained. However, it is known that
45 higher contents of nitrite will also increase the content of nitrosamines in meat products,
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4 but whether such a relation exists for endogenous formation of nitrosamines from
5 precursors is presently not known. So far no epidemiological studies have shown a
6 correlation between increased nitrate or nitrite intake and increased cancer risk and may
7 even show positive health effects due to the positive effects of high intake of fruit and
8 vegetables (SCF 1995).
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18 With these uncertainty factors taken into account, which point to an underestimation of the
19 nitrite intake based on residual amounts, the advice remains to keep the level of nitrate
20 and nitrite in food as low as the minimal required to achieve the necessary preservative
21 effect.
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30 **Conclusion**

31
32 Monitoring the added amounts of nitrate and nitrite to cured meat from 1998 to 2006
33 showed a relatively stable use of nitrite as a food additive with a slight decrease in 2005
34 but increase again in 2006. The levels varied in the different food groups from 6 to 20 mg
35 kg^{-1} of sodium nitrite for sausages, fat and lean meat for open sandwiches, and salami
36 type of sausages with the highest content. With the Danish Dietary Survey from 2000 to
37 2002 the mean intake and intake distribution have been calculated in three age groups 4-5
38 year, 6-14 year and 15-75 year for both men and women. This gave mean intakes well
39 below the ADI value for sodium nitrite of $0.09 \text{ mg kg}^{-1} \text{ bw day}^{-1}$. However, P99 for the group
40 of 4-5 year olds exceeded the ADI value with about 30% and P95 was more than 60% of
41 the ADI value, but with groups of boys and girls below a hundred very few persons with a
42 special eating pattern were responsible for the high intakes. With a conversion of nitrate in
43 the saliva to nitrite of at least 5% of the intake of nitrate, which in Denmark is about 60 mg
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4 day⁻¹, the nitrite from conversion will by far exceed the intake of nitrite from cured meat
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6 and also in many cases exceed the ADI value. The significance of conversion of nitrate to
7
8 nitrite in relation to the existing ADI for nitrite of 0.06 mg kg⁻¹bw day⁻¹ needs evaluation.
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12 13 14 **Acknowledgements**

15
16 Dietician Karin Hess Ygil, National Food Institute for incorporating data from sales
17
18 statistics into the calculations.
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Food group	Food intake gday ⁻¹					High intake of NaNO ₂ mgday ⁻¹				
	Mean	P50	P90	P95	P99	Mean	P50	P90	P95	P99
Boys, n=82, Average weight 21.3 kg										
1. Liver paste	7.2	5.2	15.0	19.1	59.4	0	0	0	0	0
1. 5% paté	0.4	0.3	0.8	1.0	3.0	0.002	0.002	0.005	0.006	0.020
2. Meat for open sandwiches, fat	5.1	2.1	12.9	15.6	24.6	0.095	0.040	0.243	0.294	0.464
3. Meat for open sandwiches, lean	3.5	1.5	10.3	12.9	27.9	0.055	0.022	0.158	0.198	0.429
4. Salami	4.1	3.3	11.6	12.9	17.9	0.045	0.036	0.126	0.140	0.195
5. Sausages	11.2	5.0	30.0	40.0	78.6	0.130	0.058	0.348	0.464	0.911
6. Pork meat, fat	3.1	0	11.6	15.7	43.3	0	0	0	0	0
6. 7% bacon	0.2	0	0.8	1.1	3.0	0.004	0	0.015	0.021	0.057
7. Pork meat, middle fat	3.4	0	11.6	15.7	34.6	0	0	0	0	0
7. 30% smoked pork saddle and ham	1.0	0	3.5	4.7	10.4	0.016	0	0.053	0.073	0.160
8. Pork meat, lean	1.1	0	4.3	11.6	14.4	0	0	0	0	0
<i>Total intake of NaNO₂ mgday⁻¹</i>						<i>0.347</i>	<i>0.158</i>	<i>0.949</i>	<i>1.196</i>	<i>2.236</i>
<i>Intake of NaNO₂ mgkg⁻¹bwday⁻¹</i>						<i>0.016</i>	<i>0.007</i>	<i>0.045</i>	<i>0.056</i>	<i>0.105</i>
Girls, n=77, Average weight 20.3 kg										
1. Liver paste	7.0	6.4	15.0	22.9	46.7	0	0	0	0	0
1. 5% paté	0.4	0.3	0.8	1.1	2.3	0.002	0.002	0.005	0.008	0.015
2. Meat for open sandwiches, fat	3.1	1.1	7.7	12.9	28.0	0.058	0.020	0.146	0.243	0.592
3. Meat for open sandwiches, lean	3.4	1.3	9.4	12.9	14.9	0.053	0.020	0.145	0.198	0.229
4. Salami	4.2	2.6	10.9	15.0	28.0	0.046	0.028	0.118	0.164	0.305
5. Sausages	10.6	4.3	37.1	48.6	117.1	0.123	0.050	0.431	0.563	1.359
6. Pork meat, fat	1.0	0	0	11.4	23.1	0	0	0	0	0
6. 7% bacon	0.1	0	0	0.8	1.6	0.001	0	0	0.015	0.031
7. Pork meat, middle fat	2.8	0	11.6	15.7	23.1	0	0	0	0	0
7. 30% smoked pork saddle and ham	0.8	0	3.5	4.7	6.9	0.013	0	0.053	0.073	0.107
8. Pork meat, lean	0.2	0	0	0	7.1	0	0	0	0	0
<i>Total intake of NaNO₂ mgday⁻¹</i>						<i>0.295</i>	<i>0.119</i>	<i>0.899</i>	<i>1.263</i>	<i>2.575</i>
<i>Intake of NaNO₂ mgkg⁻¹bwday⁻¹</i>						<i>0.015</i>	<i>0.006</i>	<i>0.044</i>	<i>0.062</i>	<i>0.127</i>

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Food group	Foods analysed for nitrite
1. Liver paste	Liver paste and pâté (5% of the food group)
2. Meat for open sandwiches, fat	Pork loin, spiced pork flank, meat balls, pork sausage saveloy type, bacon
3. Meat for open sandwiches, lean	Ham, roast beef, smoked pork saddle, salted veal eye of round, smoked pork loin fillet
4. Salami	Salami, liver sausage, tea sausage, hunters sausage
5. Sausages	Frankfurter, Danish pork sausage, cocktail sausage
6. Pork meat, fat	Only bacon (7% or 10% of the food group)
7. Pork meat, medium fat	Only smoked pork saddle and ham (30% of the food group)
8. Pork meat, lean	Not analysed

Food group	Sodium nitrite mg kg ⁻¹						
	1995	1997	1998	2000	2002	2005	2006
1. Liver paste	4 (n=1)	0 (n=1)	0 (n=7)	0 (n=8)	0 (n=20)	0 (n=15)	0 (n=7)
2. Paté	7.6 (n=8) (3-14)	6.7 (n=3) (4-11)	5.8 (n=7) (4.2-8.8)	4.1 (n=3) (3.7-4.7)	4.7 (n=7) (1.3-8.6)	6.0 (n=5) (5.5-6.6)	6.6 (n=4) (3.5-8.6)
3. Meat for open sandwiches, fat	23.7 (n=12) (4-49)	23.0 (n=4) (3-41)	12.6 (n=25) (4.2-33)	18.0 (n=61) (3-120)	21.3 (n=60) (3.2-94)	13.6 (n=52) (3.1-42)	18.9 (n=26) (4.3-61)
4. Meat for open sandwiches, lean	24.3 (n=16) (4-105)	14.5 (n=8) (3-55)	16.0 (n=28) (3.3-77)	14.9 (n=59) (3-160)	18.6 (n=86) (3-78)	12.0 (n=49) (3-53)	15.4 (n=33) (3.5-68)
5. Salami	9.0 (n=9) (4-21)	13.2 (n=5) (4-27)	16.7 (n=17) (3-47)	17.9 (n=17) (3.7-42)	10.2 (n=33) (3-84)	8.5 (n=18) (3.2-32)	10.9 (n=8) (3.1-35)
6. Sausages	7 (n=3) (5-10)	8 (n=1)	13.5 (n=11) (3.6-38)	19.4 (n=26) (3.3-45)	15.2 (n=17) (5.3-39)	10.6 (n=17) (3.3-27)	11.6 (n=10) (7.6-19)

Food group	Sodium nitrate mgkg ⁻¹			
	2005		2006	
	All samples	With content	All samples	With content
1. Liver paste	2.9 (n=14)	13.6 (n=3) (7.7-25)	7.1 (n=7)	25 (n=2) (9-41)
2. Paté	33.7 (n=6)	33.7 (n=6) (13-67)	35.2 (n=5)	35.2 (n=5) (26-43)
3. Meat for open sandwiches, fat	24.1 (n=64)	24.1 (n=64) (5.3-170)	35.2 (n=42)	38.9 (n=38) (6.8-230)
4. Meat for open sandwiches, lean	19.0 (n=76)	21.5 (n=67) (5.9-190)	23.4 (n=53)	27.6 (n=45) (5.6-200)
5. Salami	30.5 (n=64)	39.9 (n=49) (7.2-68)	31.5 (n=42)	50.9 (n=26) (5.6-120)
6. Sausages	33.2 (n=21)	33.2 (n=21) (5.7-76)	30.3 (n=12)	30.3 (n=12) (12-57)

Food group	4-5 year old			6-14 year old			15-75 year old		
	Food intake gday ⁻¹	NaNO ₃ intake mgday ⁻¹		Food intake gday ⁻¹	NaNO ₃ intake mgday ⁻¹		Food intake gday ⁻¹	NaNO ₃ intake mgday ⁻¹	
		2005	2006		2005	2006		2005	2006
1. Liver paste	6.73	0.091	0.168	5.26	0.072	0.132	5.12	0.070	0.128
2. Paté	0.35	0.012	0.012	0.28	0.009	0.010	0.27	0.009	0.010
3. Meat for open sandwiches, fat	4.1	0.099	0.159	3.37	0.081	0.131	4.71	0.114	0.183
4. Meat for open sandwiches, lean	3.48	0.075	0.096	4.87	0.105	0.134	6.2	0.133	0.171
5. Salami	4.16	0.166	0.212	3.17	0.126	0.161	2.6	0.104	0.132
6. Sausages	10.91	0.362	0.331	11.42	0.379	0.346	9.75	0.324	0.295
7. Pork meat, fat	0.14	0.003	0.005	0.21	0.005	0.008	0.49	0.012	0.019
8. Pork meat, middle fat	0.93	0.020	0.026	1.07	0.023	0.030	1.83	0.039	0.051
Total NaNO₃ intake mgday⁻¹		<i>0.829</i>	<i>1.010</i>		<i>0.801</i>	<i>0.952</i>		<i>0.804</i>	<i>0.989</i>