

The egg consumption of the average household in Italy

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Summary

A survey was conducted over a one-year period by means of telephone interviews with 7 991 Italian households to establish the domestic consumption of eggs, the distribution by source of supply, seasonal variations and storage and preparation methods used. Eggs are mainly purchased from large retailers (53%), followed by small retailers (25.2%), direct purchase from producers (16%), and local or itinerant markets (5.8%). It was found that 69.9% of households buy packaged eggs; 92% of households store them in the refrigerator, although this percentage varies considerably, according to the type of presentation (packaged or loose) and the number of eggs bought. Italian households mainly eat eggs cooked (48.9%), followed by partly cooked (35.0%) and raw (16.1%).

Keywords

Consumption, Eating habits, Egg, Food safety, Italy, Nutrition, Salmonella.

Introduction

Eggs are frequently considered to be a cause of food poisoning which is attributed to chemical (21) and biological agents (8). They are considered to be a primary source of salmonellosis, especially the type caused by *Salmonella enterica* serotype Enteritidis, due to its ability to colonise the ovarian tissue of hens and to be present in eggs with intact shells (2, 4, 6, 8, 22, 27). Eggs therefore play a crucial role as a vehicle of human infection or food poisoning in a context in which international trade in poultry products is rapidly growing. The risk that consumers might contract this type of infection or food poisoning by eating

eggs depends on the quantity and dose-response ratio of the agent ingested (24). Quantity is associated with a variety of factors, mainly the prevalence of contaminated eggs and contamination levels, egg consumption and egg storage and preparation procedures. In regard to prevalence and contamination levels, the international literature provides much data on the principal pathogens involved. For example, in the case of *S. enterica* serotype Enteritidis, studies have been conducted on the prevalence of infection in laying units and the distribution of infected hens (5, 16, 26, 30). Studies of the prevalence of contaminated eggs on laying farms (9, 15) and at retail outlets (5, 7) are also available. The literature demonstrates that the contamination of eggs produced by small rural breeders is more frequent than that recorded in large industrial units (19); this suggests that the source of egg supply plays a crucial role in determining the risk to consumers. The influence of possible sources of supply on consumption and the influence determined by those sources in relation to seasonal variations are currently unknown.

Although a considerable amount of data is available on the nutritional aspects of eggs, correlated with the incidence of some human disorders (cardiovascular disease and tumours), no detailed or up-to-date information is available on average egg consumption in Italy. The available consumption data are generally collected using types of aggregation and units of measurement (purchase cost) which cannot then be used for risk analysis (13).

Moreover, only a few studies examine the microbiological aspects of egg storage and

preparation procedures which are relevant in the case of pathogens (3, 18).

The aim of our research was to obtain data on the average egg consumption in Italy, a breakdown of consumption on the basis of the various sources of supply, partly dependent on seasonal variations and on the related storage and preparation procedures.

Materials and methods

Characteristics of samples

A total of 7 991 interviews were conducted to estimate the purchase profile of shell eggs, with an expected value of 5%, precision of $\pm 1\%$, and a 95% confidence interval.

The interviews were conducted proportionally between five geographical areas, in accordance with the classification of the *Istituto nazionale di statistica* (National Statistics Institute or ISTAT) (14) (2 285, 1 464, 1 617, 1 766 and 859 in north-west, north-east, central, southern Italy and the islands, respectively); they were then stratified by municipality, taking into account the resident population (3 450, 1 387, 1 636 and 1 509 in municipalities with <20 000 inhabitants, 20 000-50 000 inhabitants, 50 000-250 000 inhabitants and >250 000 inhabitants, respectively). The service provided by the company responsible for compiling the Italian telephone directory and 'Yellow Pages' (SEAT, STET SpA Division, Italy) was used for randomised extraction of the sample.

The interviews were conducted over a one-year period in four cycles as follows:

- December, January, February
(2 006 interviews)
- March, April; May (2 017 interviews)
- June, July, August (1 990 interviews)
- September, October, November
(1 978 interviews).

The questionnaire used to conduct the interviews required the respondent's personal data relating to residence and characteristics of the household. The survey focused on obtaining information on purchases and consumption of eggs during the week preceding the interview, namely:

- quantity

- type of presentation (loose or packaged)
- place of purchase
- storage and preparation procedures.

The questionnaire enabled us to identify the number of respondent households who raised animals (poultry) and those who consumed eggs produced by their own hens (home-production). Finally, information was requested on the purchase of eggs directly from the producer (frequency of purchase and monthly quantities).

The sources of supply were classified on the same basis as that used by ISTAT for its surveys which involves a distinction between large retailers (supermarkets, hypermarkets, hard-discount stores, department stores and large specialist stores), small retailers (groceries, butcheries and specialist sales outlets with an area of under 400 square metres), local and itinerant markets and, finally, direct purchase from the producer.

Statistical analysis

The purchase data was only calculated for the households that purchased eggs during the week prior to the interview.

Home production and egg consumption data were only calculated for households who kept laying hens.

Annual per capita egg consumption was calculated for all the households interviewed and then broken down into purchase and home-production data.

In regard to egg purchases, the distribution of families on the basis of family size, number of eggs purchased in relation to family size, seasonal variations based on sources of supply, quantity of eggs that were home produced and consumed, type of presentation, storage temperature and storage temperature by number of eggs purchased, were evaluated using the χ^2 test (25).

In regard to egg purchases, the distribution of households in the different geographic areas and municipalities was analysed using the χ^2 test on the basis of family size, number of eggs purchased in relation to family size, seasonal variations and the related variations according to source of supply, direct purchase from

producers, relative frequency of purchase, type of presentation of eggs, families that raise poultry, quantity of eggs that were home-produced and consumed, egg storage temperatures and consumption habits.

In regard to the number of eggs purchased in Italy, univariate one-way analysis of variance (ANOVA) (20) was used to analyse the number of eggs purchased by source of supply, and univariate two-way ANOVA for the number of eggs purchased by season and source of supply.

For the various geographical areas and municipalities, the univariate two-way ANOVA was used to analyse the number of eggs purchased by area and municipality and by area or municipality and type of household; a distinction was made between households that produced eggs and those that did not. The number of eggs purchased from producers was analysed with univariate one-way ANOVA.

Regarding the number of eggs purchased in relation to the individual areas and types of municipality, univariate one-way ANOVA was used to analyse the number of eggs purchased by source of supply. Univariate two-way ANOVA was used for the number of eggs purchased by season and source of supply.

The Scheffé test (23) was used for the two-by-two comparison of one- and two-way univariate ANOVA.

A regression analysis was used to evaluate the trend of the number of eggs consumed by households in Italy as a whole, also on the basis of family size, a distinction being made between families that produced eggs and those that did not.

Finally, the correlation between the number of home-produced eggs and the number of eggs consumed was calculated for Italy and for each geographic area and municipality.

The significance level chosen was 95%.

Results

The sample examined correctly represented the Italian population for 1997 in terms of

distribution by geographic area, municipality and age groups; however, it underestimated the number of single-person families (12%) compared to the ISTAT 1991 census data (24.9%) (12).

Egg purchasing behaviour

Per capita purchases in general

In the week preceding the interview, 4 163 households (52.1%) purchased eggs, with an average number of 9.5 eggs per family bought weekly by households that bought eggs in the week preceding the interview. When a distinction was made between the households that did not produce eggs and those that did, the number of eggs purchased per family totalled 9.5 for the first group and 10.9 for the second (Table I).

In regard to the average number of eggs purchased weekly per family, a statistically significant difference was observed between the different areas ($F = 27.70$; $p = 0.0000$). In particular, households in southern Italy and the islands, where approximately 11 eggs were purchased, behaved similarly, but differed significantly from the rest of Italy (buying 2.7 eggs more than the north of Italy and 1.8 more than central Italy). The same trend was observed for the two types of households in southern Italy and the islands (11.0 and 10.9, respectively for the households that did not produce their own eggs, and 12.8 and 11.0 for those that did) (Table I).

Concerning the average number of eggs purchased per household, it was found that in municipalities with between 20 000 and 50 000 inhabitants, one more egg on average was purchased compared to municipalities with over 250 000 inhabitants; this difference was statistically significant ($F = 3.69$; $p = 0.0114$). The same trend was observed in households that did not produce their own eggs, whereas the families which did produce their own eggs consumed more eggs per week (12.8) in municipalities with over 250 000 inhabitants (Table I).

When the per capita values were considered, the average number of eggs purchased weekly by the households that bought eggs in the week preceding the interview was 3.4 (Table I).

Table I

Average number of eggs purchased and self-produced, broken down by household, per capita consumption and geographic area

Egg purchase/ consumption	Italy	Geographic area						Municipality (No. of inhabitants)		
		N-W	N-E	C	S	Isl	<20 000	20 000- 50 000	50 000- 250 000	>250 000
Eggs purchased per household										
All families interviewed	9.5	8.3	8.4	9.3	11.1	10.9	9.6	10.0	9.4	9.0
Families that do not produce their own eggs	9.5	8.3	8.4	9.3	11.0	10.9	9.6	10.0	9.4	9.0
Families that produce their own eggs	10.9	9.3	7.5	10.2	12.8	11.0	11.3	10.2	8.9	12.8
Eggs purchased per capita										
All families interviewed	3.4	3.2	3.4	3.5	3.5	3.6	3.4	3.5	3.4	3.5
Home-produced eggs per capita										
Produced	7.4	8.3	8.7	6.9	5.9	8.0	7.6	7.4	6.6	7.1
Consumed	3.4	3.6	3.7	3.2	3.2	3.2	3.4	3.2	3.4	3.9
Consumed/ produced (%)	45.9%	42.8%	42.0%	46.6%	53.8%	39.9%	44.3%	43.7%	50.8%	54.7%

NW north-west
NE north-east
C centre
S south
Isl islands

This value was the same in the households that did and did not produce their own eggs and no statistically significant difference was observed between the different areas ($F = 2.24$; $p = 0.0623$) or municipalities ($F = 0.11$; $p = 0.9535$) (Table I).

Purchases by source of supply per household

In regard to sources of supply, in the week preceding the interview, eggs were purchased from large retailers by 2 208 households (53%) and from small retailers by 1 047 households (25.1%). Eggs were purchased directly from the producer by 664 households (16%) and at local or itinerant markets by 244 households (5.9%) (Table II).

Statistically significant differences were recorded ($\chi^2 = 222.26$; $p = 0.0000$) between the different areas. In particular, the number of households that purchased eggs from large retailers in southern Italy and the islands was 10.9% and 13.3% lower than the national average, respectively. The number of households that bought eggs from small

retailers was 9.4% above the national average in southern Italy, while the number of households that bought eggs from producers was 11.3% above the national average on the islands.

Statistically significant differences ($\chi^2 = 131.82$; $p = 0.0000$) were observed between the different types of municipality. In particular, the number of households that purchased eggs from small retailers was 6.7% above the national average in municipalities with more than 250 000 inhabitants. The number of households that purchased eggs from producers was 5.9% above the national average in municipalities with less than 20 000 inhabitants and 7.5% below the national average in municipalities with over 250 000 inhabitants.

Purchases by season and source of supply per household

Seasonal patterns were observed, as follows: 1 316 households (32%) bought eggs in winter, 992 (24%) in spring, 946 (23%) in summer and 863 (21%) in autumn.

Table II
Behaviour of Italian households regarding egg purchases and storage and preparation methods

Household behaviour included in survey	Households		Distribution of households by geographic area (%)					Distribution of households by type of municipality (%)			
	No.	%	N-W	N-E	C	S	Isl	<20 000	20 000-50 000	50 000-250 000	>250 000
Source of supply											
Large retailers	2 208	53.0	63.7	60.6	53.3	42.1	39.7	50.5	57.0	57.2	50.2
Small retailers	1 047	25.1	19.7	22.0	23.5	34.5	26.1	23.7	21.9	23.5	31.8
Local/ itinerant market	244	5.9	4.8	2.8	9.8	5.5	6.9	3.9	5.5	5.7	9.5
Direct from producer	664	16.0	11.8	14.6	13.4	17.9	27.3	21.9	15.6	13.6	8.5
Total	4 163										
Frequency of purchase from producer											
Once a week	888	26.7	24.7	19.9	29.2	28.8	31.9	26.7	26.6	27.4	26.0
Once a fortnight	969	29.1	24.5	32.3	26.6	31.7	33.2	33.1	28.2	27.4	20.5
Once a month	735	22.1	23.2	22.0	23.2	21.4	19.5	21.4	22.6	22.0	23.6
Several times a year	735	22.1	27.6	25.8	21.0	18.1	15.4	18.8	22.6	23.2	29.9
Total	3 327										
Type of presentation											
Packaged	2 910	69.9	76.3	76.0	71.3	63.9	57.1	68.4	70.5	71.4	70.6
Loose	1 253	30.1	23.7	24.0	28.7	36.1	42.9	31.6	29.5	28.6	29.4
Total	4 163										
Storage temperature											
Refrigerated	3 829	92.0	94.6	92.1	92.5	89.4	90.1	89.6	93.0	92.7	94.4
Room temperature	334	8.0	5.4	7.9	7.5	10.6	9.9	10.4	7.0	7.3	5.6
Total	4 163										
Preparation procedure											
Cooked	21 816	49.0	47.6	50.1	51.1	49.3	45.8	49.3	48.8	48.6	48.6
Partly cooked	15 619	35.0	35.5	36.3	34.3	33.4	37.0	34.6	34.9	35.6	35.6
Raw	7 136	16.0	16.9	13.6	14.6	17.3	17.2	16.1	16.3	15.8	15.8
Total	44 571										

NW north-west
NE north-east
C centre
S south
Isl islands

The distribution of purchases by season and source of supply revealed that most purchases at large retailers were made during the autumn (54.5%); however, purchases from small retailers were mainly made in the summer (25.3%), with slightly lower values in

the other seasons; the trend of purchases from local or itinerant markets declined from autumn onwards (8.6%). Finally, purchases from producers peaked in spring (26.8%) and were lowest in autumn (13.4%) (Fig. 1). However, the difference in percentages

relating to sources of supply during the different seasons was not significant at a national level ($\chi^2 = 0.07$; $p = 1.0000$), by area ($0.09 < \chi^2 < 0.26$; $p = 1.0000$) or by municipality ($0.10 < \chi^2 < 0.13$; $p = 1.0000$).

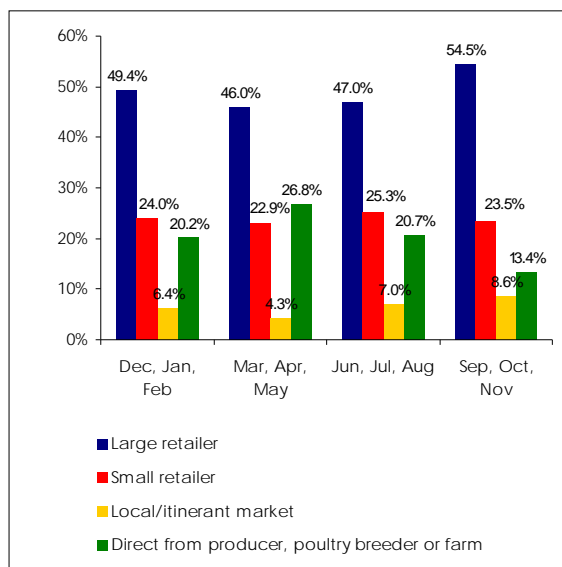


Figure 1
Distribution of purchases on the basis of quarter of purchase and source of supply

Characterisation of purchases from producers

In response to a specific question, 42.3% of the families interviewed said they bought eggs directly from a producer at least once a year.

The frequency of direct purchases from producers showed that 55.8% of families declared a frequency of less than 15 days (26.7% once a week, and 29.1% once a fortnight) (Table II).

Statistically significant differences ($\chi^2 = 64.58$; $p = 0.0000$) were recorded between the different areas. In particular, the percentage recorded was above the national average for weekly purchases on the islands (5.3% more) and for sporadic purchases in the north-west (5.5% higher); conversely, the percentage was below the national average for weekly purchases in north-east Italy (6.8% less) and for sporadic purchases on the islands (6.7% less) (Table II).

Statistically significant differences in the frequency of purchases from producers

($\chi^2 = 45.99$; $p = 0.0000$) were observed between the different types of municipality (Table II). In particular, the percentage of fortnightly purchases was 4% above the national average in municipalities with under 20 000 inhabitants, while the percentage of sporadic purchases was 7.8% above the national average in municipalities with over 250 000 inhabitants.

Purchases by type of presentation of eggs

The survey relating to the type of presentation of the eggs purchased revealed that 69.9% of households bought packaged eggs (Table II).

A statistically significant difference between the different areas was found in the percentages of households that purchased packaged or loose eggs ($\chi^2 = 94.11$; $p = 0.0000$) (Table II). In particular, the number of households that bought loose eggs was 6.4% below the national average in north-west Italy, but 6.0% and 12.8% above the national average in southern Italy and on the islands, respectively.

A statistically significant difference was found between municipalities of different sizes in the percentage of households that purchased packaged or loose eggs ($\chi^2 = 2.80$; $p = 0.4230$) (Table II).

Egg storage and preparation

Storage methods

The percentage of respondent households that kept eggs in the refrigerator totalled 92% (Table II).

The differences between areas were statistically significant ($\chi^2 = 23.33$; $p = 0.0001$). In particular, the number of households that stored eggs at room temperature was 2.6% below the national average in north-west Italy and 2.6% above the national average in southern Italy.

The difference in the percentages of families that stored eggs in the refrigerator or at room temperature was statistically significant in regard to the different size of municipality ($\chi^2 = 21.78$; $p = 0.0001$). In particular, the number of households that stored eggs at room temperature was 2.4% below the national average in municipalities with over

250 000 inhabitants and 2.4% above the national average in municipalities with less than 20 000 inhabitants.

Storage methods in relation to type of presentation of eggs

The majority (94.2%) of households that purchased packaged eggs stored them in the refrigerator. Of the households that bought loose eggs (30.1% of all families interviewed), 76.4% stored them in the refrigerator ($\chi^2 = 292.00$; $p < 0.0001$).

Preparation procedures

Different types of preparation were identified, based on the heat treatment to which the eggs were subjected, namely: raw, partly cooked and cooked (Table III). The households interviewed said they mainly used the product to make *frittata* (Italian-style omelette) and fried eggs (86.1% and 80.3%, respectively). Many households made soft-boiled eggs and used eggs to dress *pasta alla carbonara* (pasta with an egg, cheese and bacon sauce) (61.5% and 52.7%, respectively). The raw egg preparation eaten by the largest number of households was *tiramisú* (a dessert made with biscuits dipped in strong coffee or rum, layered with a whipped mixture of egg yolks, mascarpone cheese, and sugar, and topped with cocoa) (36.5%), followed by beaten eggs or *zabaglione* (a dessert made of egg yolks, sugar and sweet wine) (22.7%) and mayonnaise (18.1%). Eggs were eaten cooked (49%), partly cooked (35%) or raw (16%).

A similar trend was observed for all areas and types of municipality, with no statistically significant differences ($\chi^2 = 0.01$; $p = 1.0000$ and $\chi^2 = 4.71$; $p = 0.5815$ for the areas and municipalities, respectively).

Consumption data

Home-produced eggs

Home-produced eggs must be included in the egg consumption data. The survey demonstrates that 14.4% (1 147) of the households interviewed raised animals, with 97.5% (1 109 households) that raised hens or chickens (13.9% of the households interviewed). However, a statistically significant difference was found between the different areas ($\chi^2 = 35.11$, $p < 0.0001$). The highest percentage

(17.3%) was recorded in central Italy, the lowest (11.2%) in north-west Italy, and intermediate values in the other areas (13.7%, 15.3% and 11.9% for north-east and southern Italy and the islands, respectively). The difference between the various types of municipality was also statistically significant ($\chi^2 = 397.09$, $p < 0.0001$). A total of 21.9% of the households that raised poultry lived in municipalities with less than 20 000 inhabitants. This percentage declined as the size of the municipality increased (12.7%, 8.3% and 2.5% in municipalities with 20 000-50 000, 50 000-250 000 and over 250 000 inhabitants, respectively).

Consumption of home-produced eggs

The average weekly number of home-produced eggs was 7.4 per capita. The number of eggs that were home-produced weekly varied between the different areas. In particular, above average values were observed in northern Italy and on the islands (8.3 for the north-west, 8.7 for the north-east and 8 for the islands). Regarding the municipalities, the number of eggs that were home-produced each week was above the national average only in municipalities that had less than 20 000 inhabitants (7.6) (Table I).

The average number of home-produced eggs eaten weekly was 3.4 per capita. This value varied between the different areas, with values above the national average in the north-west and north-east (3.6 and 3.7 eggs, respectively), and the different municipalities, with values exceeding the national average only in those areas that had over 250 000 inhabitants (3.9 eggs) (Table I).

Egg consumption increased in proportion to home-production ($R = 0.28$; $p = 0.0000$). However, this correlation only applied to production of up to 30 eggs ($R = 0.58$; $p = 0.0000$ for ≤ 30 home-produced eggs and $R = -0.05$; $p = 0.0529$ for > 30 home-produced eggs).

A correlation was observed between the number of home-produced eggs and the number of eggs eaten in all areas apart from the islands ($R = 0.18$; $p = 0.0062$, $R = 0.34$; $p = 0.0000$, $R = 0.39$; $p = 0.0000$, $R = 0.33$; $p = 0.0000$ for the north-west, north-east, centre

Table III
Distribution of households in relation to food preparations requiring eggs

Ways in which eggs are consumed	Food preparation	No. of families	Percentage of total households interviewed
Cooked	<i>Frittata</i> ^(a)	6 881	86.1%
Cooked	Custard	3 389	42.4%
Cooked	Desserts	2 727	34.1%
Cooked	<i>Stracciatella</i> ^(b)	2 707	33.9%
Cooked	Hardboiled	1 928	24.1%
Cooked	Egg pasta	1 754	21.9%
Cooked	Meat	1 590	19.9%
Cooked	Stuffed	491	6.1%
Cooked	Egg-and-breadcrumbed/batter	165	2.1%
Cooked	Vegetables	104	1.3%
Cooked	Pancakes/omelettes	35	0.4%
Cooked	<i>Rustici</i> ^(c)	26	0.3%
Cooked	Dressings	14	0.2%
Cooked	Fish	5	0.1%
Raw	<i>Tiramisu</i> ^(d)	2 913	36.5%
Raw	Beaten eggs/ <i>zabaglione</i> ^(e)	1 815	22.7%
Raw	Mayonnaise	1 447	18.1%
Raw	Raw eggs/eggnog	950	11.9%
Raw	Ice-cream	10	0.1%
Raw	Tartare	1	0.0%
Partly cooked	Fried eggs	6 418	80.3%
Partly cooked	Soft-boiled eggs	4 917	61.5%
Partly cooked	<i>Carbonara</i> ^(f)	4 210	52.7%
Partly cooked	Scrambled	46	0.6%
Partly cooked	Poached	28	0.4%

a) Italian-style fried omelettes

b) scrambled eggs with grated parmesan cheese and cooked in a meat broth

c) savory cakes and pastries made with vegetables, cheese, salami and other pork products

d) a dessert made with biscuits dipped in strong coffee or rum, layered with a whipped mixture of egg yolks, mascarpone cheese, and sugar, and topped with cocoa

e) a dessert made of egg yolks, sugar and sweet wine

f) egg, cheese and bacon sauce

and south, respectively). A correlation was also found between the number of home-produced eggs and the number of eggs eaten for all types of municipality (in increasing order of population: $0.25 < R < 0.58$; $0.0000 < p < 0.0005$).

Per capita consumption

The average number of eggs purchased per week per person and calculated for all households interviewed, was 2 eggs. On the assumption that the eggs bought per person per week are all consumed in the same period, the total weekly per capita consumption, namely the sum of the number of eggs

purchased (2 eggs) and the number of home-produced eggs consumed per capita per week (0.2), was 2.2.

The total annual per capita consumption was calculated at 114 eggs.

Discussion

Using a family-based survey provided a good estimate of average egg consumption by the population as a whole, with the advantage of flexible data management, as observed by other authors (17).

Purchase of eggs

Quantity of eggs purchased

The survey on the quantity of eggs purchased by households in the different areas and municipalities revealed that the highest egg consumption was in southern Italy and on the islands, and in medium/small municipalities (with 20 000-50 000 inhabitants); this is probably due to the eating habits of the different areas (there is a stronger tradition of eating home-made pasta and other dishes in the south and rural areas). Other authors (18) have also observed higher egg consumption in rural areas. However, a different situation was observed in a survey conducted in Italy (28), where higher (but not significant) egg consumption was observed in southern Italy and greater consumption of home-made pasta in the north than the centre or south. These differences can be attributed to the different period of time considered and the different survey methodologies.

Distribution of purchases by source of supply

The distribution of food purchases by distribution channel in Italy in 2004 demonstrated a preference for purchases from large retailers which accounted for over three-quarters of the market after its growth during the five-year period 2000-2004 (11).

In this survey, the total volume of egg purchases attributable to large retailers was 53%. This difference may be due, in part, to the period during which the studies were conducted. The 2005 survey conducted by the *Istituto di servizi per il mercato agricolo alimentare* (Institute of Services for Agro-Food Markets or ISMEA) was conducted after our study and the structure of the distribution market changed considerably in the meantime, with a consequent reduction in purchases through traditional channels in favour of large retailers. Moreover, the figure corresponds to purchases of all types of food, not just eggs. No data exist which describe in detail the sources of supply of eggs which seem to have some unusual aspects in view of the results obtained. They include the considerable proportion of purchases from producers (16%) and from local or itinerant markets (5.9%).

The large proportion of purchases made directly from producers is further confirmed by the high percentage of households which confirmed that they used this distribution channel at least a once a year (42.3%); this preference may be due to the fact that the product is considered by Italian families to be more genuine than those offered by traditional distribution channels (small retailers) or modern channels (large retailers). This preference was particularly evident on the islands and in small municipalities (less than 20 000 inhabitants), probably due to different purchasing practices in the various areas, partly as a result of the larger number of local family-run egg-laying farms.

Distribution of purchases by season and source of supply

The interviews were divided into four cycles to examine seasonal variations in egg purchases in relation to sources of supply, especially in regard to local markets and producers. The results demonstrated that seasonal differences and changes in the source of supply were only significant for the number of eggs purchased in municipalities that had less than 20 000 inhabitants. In this case, the larger purchases from local or itinerant markets in the spring, and from producers in the summer, are probably correlated to seasonal patterns of egg laying on rural laying farms, which are numerous in small municipalities, and different purchasing practices in households during the warm weather. In all the other cases, purchases proved to be independent of seasonal laying patterns on rural laying farms.

Distribution of purchases by type of presentation of eggs

This survey demonstrated that purchases of packaged eggs (69.9%) accounted for a much greater percentage of the total than loosely sold eggs; the different behaviour of consumers in the various areas surveyed, with a greater tendency to buy loose eggs in southern Italy and on the islands, may be due to the larger number of purchases made directly from producers.

A survey performed in Italy in 2000 found, in relation to the type of presentation, that Italian households bought packaged eggs in

quantities not much greater (57.16%) than loose eggs (42.84%) (ISMEA, unpublished findings). This percentage proved highly variable between the different areas; however, they were obtained by grouping the regions differently from the present survey (Sardinia was aggregated with central Italy and Sicily with the south). In particular, a general prevalence of purchase of packaged eggs was observed (67.85% in the north-west, 73.24% in the north-east and 66.35% in the centre and Sardinia), with the exception of the south and Sicily, where more loose eggs were bought (65.3%).

The difference between the percentages found by ISMEA and by our survey may be due to the different stratification of the sample analysed. ISMEA stratified the sample on the basis of geographic sizes (representative of distribution concentration and urbanisation levels) that were different from those used in this survey, and demographic/behavioural characteristics, balancing the same sample with additional elements (regions, number of members of each household, age group of household member who bought the eggs and of other members of the family, presence of children in the household, and socio-economic levels). ISMEA also used a different data collection methodology (home-scanning technology) (10).

Consumption of home-produced eggs

The differences observed between the various areas and municipalities confirmed that differences were also noted in regard to the distribution of family-run laying farms and egg-buying habits.

The data obtained demonstrated the importance of family-run poultry farms across the country, especially in central Italy and in small municipalities. The distribution of this type of farm is not very well documented because compulsory registration with Local Health Agencies was only introduced recently. Poor control of this source of supply is important for public health purposes on account of the fact that half of the home-produced eggs were consumed by the producing household, while the remainder was destined for non-traditional sales channels.

The fact that as home production of eggs increases, egg consumption by the household also increases (for production of up to 30 eggs) and the number of families that consumes its entire production decreases; this indicates that family-run laying farms can be divided into small farms, mainly designed for the household's personal consumption, and large farms, destined for both the household's use and for sale.

Annual per capita egg consumption

The annual per capita consumption of 114 eggs calculated in this survey was lower than the figure reported in the literature. It is estimated that the per capita consumption of shell eggs purchased by Italian households in 1999 totalled 143 (29).

The difference observed can be explained by the different destinations of the shell eggs purchased because the data reported by the *Unione Nazionale dell'Avicoltura* (National Aviculture Union or UNA) also included purchases destined for small processing units, hospitals and clinics, which were not included in his survey.

In a survey conducted in Finland, the average number of eggs consumed per capita per annum was estimated at 128 (18). The difference between this figure and that obtained in our study may be due to different eating habits between the two countries.

The higher consumption among families that produce their own eggs confirmed, yet again, the importance of family-run laying farms throughout Italy as a source of supply of eggs for Italian families.

Egg storage and preparation methods

Storage methods

In private homes, eggs are stored for long periods of time. The storage temperature of eggs, and consequently their inner temperature, is crucial in microbiological terms, because it influences the replication of many microbial agents. In the case of *S. enterica* serotype Enteritidis in particular, the storage temperature can modulate the occurrence of some biological events, such as the replication of micro-organisms in the albumen (the

primary site of contamination in most cases) and deterioration of the vitelline membrane, leading to the availability of some nutrients in which albumen is deficient (8). Storage at an uncontrolled temperature can therefore lead to a rapid increase in bacterial count, nullifying the effect of cooking, the efficacy of which is proportional to the bacteria count in the raw eggs.

It emerged that 92% of households interviewed in Italy stored eggs in the refrigerator, with a decreasing trend as the number of eggs purchased increased. A similar situation was found in Finland (18), where 77% of respondents stored eggs at a temperature of between 2°C and 5°C, 16% between 10°C and 14°C, and 7% at room temperature. It is clear from the data obtained that nearly all households (94.2%) comply with the regulations requiring packaged eggs to be stored in the refrigerator. Very different behaviour emerged with regard to loose eggs, which were only refrigerated by 76.4% of the households interviewed.

This research also showed a greater trend towards storage at room temperature in the south and in municipalities that had less than 20 000 inhabitants. This trend was partly linked to the purchase of greater quantities of eggs and was partly attributable to larger volumes purchased from producers whose eggs were considered to be more genuine, and not to need refrigeration. This situation may attribute a greater degree of risk to loose eggs in view of the frequent absence of laying and 'use-by' dates.

Preparation methods

According to the risk analysis for *S. enterica* serotype Enteritidis in shell eggs (8), cooking is an important method to control that pathogen because it reduces the number of bacteria by up to 8 decimal reductions. An evaluation of the type of heat treatment to which eggs are subjected therefore constitutes an important factor when assessing the risk to consumers.

The proportion of eggs consumed raw or slightly cooked in this survey (51%) was

similar (50%) to that found in a telephone survey conducted in the United States between 1995 and 1996 (1). The difference in consumption of raw or slightly cooked eggs on the basis of type of area, observed in the United States between residents in rural areas (56%) and towns (50%), was not significant in this survey.

The data on consumption of cooked eggs (49% of the families interviewed) showed a different situation from that seen in Finland (84% of the families interviewed) (18). This difference was due to the intensive health safety campaign designed to prevent human salmonellosis which has led the Finnish public to pay greater attention to egg preparation methods. A health education campaign has been conducted in Italian schools over the past few years to provide information on the correct methods of handling and preparing foods, including eggs. The high percentage of families that still practice 'risky' behaviour (eggs that are merely whisked, or 'fresh' eggs given to children) is probably due to ingrained eating habits and the belief that the act of cooking eggs reduces their nutritional content.

Conclusions

Food consumption estimates are an invaluable means of evaluating the exposure of consumers to risks associated with foodstuffs. The data obtained from this survey supplement the insufficient information so far obtained on the consumption of shell eggs by the average Italian household. The survey demonstrates some interesting differences between geographic areas and municipalities of different sizes, due to different habits relating to egg supply, storage and preparation.

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