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Fish Consumption Patterns of Populations in Vicinities of Lake Kastoria and Lake Pamvotis, Greece

Eugene G. Maurakis,[1,2,3] **David V. Grimes,**[4]
and **Dimitra Bobori** [5]

[1]Science Museum of Virginia, 2500 W. Broad St., Richmond, VA 24542
[2]School of Continuing Studies, University of Richmond, VA 23173
[3]School of Environmental Science and Policy, George Mason University, Fairfax, VA 22030,
[4]Virginia Department of Environmental Quality
4949 A Cox road, Glen Allen, VA 23060
[5]Department of Biology, Aristotle University, Thessaloniki, Greece 54006.

ABSTRACT

Objectives are to establish fish consumption patterns of populations in vicinities of two lakes (Kastoria and Pamvotis) in Greece for use in the assessment of risks associated with consumption of fishes in these agri-chemically impaired lakes. Parameters measured were demographics (i.e., gender, age, weight, education level, occupation, residency), freshwater fish eating frequency, species and sizes of fishes consumed, and fish consumption habits [i.e., quantity, parts, and preparation method). All annual mean site-specific consumption rates of the four gender-age class sub-populations surveyed in vicinity of Lake Kastoria (avg. range= 0.103-0.29 kg/day) exceed those of Greece (0.066 kg/day), EU (0.068 kg/day), Spain (0.104 kg/day), Portugal (0.159 kg/day), and the USEPA default value (0.054 kg/day) with two exceptions. Female consumption rates (0.087-0.103 kg/day) of *Perca fluviatilis* were below annual consumption rates of Spain and Portugal. Similarly, annual mean site-specific consumption rates of *Anguilla anguilla* and *Cyprinus carpio* by male (0.199-0.210 kg/day) and female adults (0.096-0.157 kg/day) in vicinity of Lake Pamvotis exceeded those of Greece, EU, Spain, Portugal, and the USEPA default value. Survey results indicate better-educated Greeks to be higher consumers of fish; however, market availability appears to be a stronger determinant of food choice in comparison to health education. All populations in vicinities of both lakes preferred to eat fried fishes with one exception: grilled *C. carpio* from Lake Pamvotis was preferred by female and male adults.

Keywords: fish consumption, risk assessment, chronic daily intake, Greece

INTRODUCTION

Bioconcentration of environmental contaminants is receiving increased attention from Europe's general public, for-profit and non-profit institutions, regulatory agencies of countries in the European Community (EC), and the European Environmental Agency (EEA)(Hill, 1999; Millstone et al., 2000; Tait, 2001; Tait and Quin, 1998; WHO, 1989; UNEP, 1999). Increased concern stems from increased public and governmental awareness of their impacts on human health, tourism, and other economic issues that effect gross domestic markets (Braxton and Frewer, 1998; Hites et al., 2004; Miles and Frewer, 1998; World Bank, 1994). Public demand for healthful foods is causing considerable shifts in commodity markets (Millstone et al., 2000; Tait, 2001; Kafka and Alvensleben, 1997; World Bank, 1992), and demands for clean water has now become a dominant issue in the tourism industry (UNEP, 1999; World Bank, 1994).

In Greece, fish consumption has been increasing since 1995, concurrent with public awareness that seafood is healthy and can substitute for meat consumption (USDA. 2003). Per capita consumption of fisheries products in Greece is 24 kg (USDA. 2003). With the increased use and exploitation of localized fisheries comes an incremental increase in exposure to local pollution problems (Szucs and Grasselli, 2004; World Bank, 1992). The problem may be particularly acute in highly localized fisheries such as those in lakes, rivers, and natural water dependent aquaculture facilities as they tend to be located in, or impacted by, high yield agriculture areas (Stickney, 1979; Landau, 1992; Stevenson, 2004). Such is the case in Lake Kastoria, Lake Pamvotis, and Lake Vistonis in Greece. For example, we identified 10 pesticides (Atonik, Cobex, Efmathrin=Efmetren/Permethrin, Fusilade, Primextra, Ridomil, Sencor, Targa, Thimet, and Thiodan=Endosulfan)) that were routinely applied prophylatically to agricultural fields draining into Lake Vistonis in 1993, where acute toxicity had been reported to decimate the population of *Cyprinus carpio* in an aquaculture facility operated by monks (Alpanezos, pers. comm.). Consumption of freshwater fishes from Lake Pamvotis has diminished in recent years because of increased public awareness of the pollution state of the lake (Filos, pers. comm., 2002). Whereas studies in the variability of fish consumption within 10 European countries, nutrient content of foods in Greece, policy analysis on food safety in Europe, and the association of cooking methods to cancer have been conducted (Boulous et al., 1996; Millstone et al., 2000; Rohrmann et al., 2002; Welch et al., 2002), there appear to be no published data on human consumption patterns of freshwater fisheries products for use in calculating risks associated with consumption of freshwater fishes in Greece.

Our objective is to establish fish consumption patterns of populations in vicinities of two lakes (Kastoria and Pamvotis) in Greece for use in assessing risks associated with consumption of fishes in these two agri-chemically impaired lakes.

STUDY AREA

Lake Kastoria (~28 km^2; karst basin=304 km^2; avg. depth=4 m; max. depth=8.5 m), a eutrophic lake with large concentrations of phytoplankton and mats of submerged aquatic vegetation (Aliakmon River drainage), is located in Kastoria (Macedonia Prefecture) in northwestern Greece (Skoulikidis et al., 1998). The lake, which receives runoff from agricultural operations (e.g., corn, apple orchards, livestock) and a furrier industry, has dropped ~ 1.5 m in the last 5 years, primarily through water withdrawal for agricultural operations (Filos, pers. comm.). Mean physical and nutrient concentrations in the lake are pH (8.2), total phosphorus (39 μg/l), P-PO_4 (31.3 μg/l: max=62.5), N-NO_2 (5.8 μg/l; max=19.0), N (15.8 μg/l; max=1011); N-NO_3 (22.4 μg/l), and N-NH_4 (288 μg/l)(Hadjibiros et al., 1998). Mean heavy metal concentrations for Pb (31.1 ppb), Zn (32.8-81.2 ppb), Cu (6.6-19.4 ppb), Cd (0.7 ppb), Hg (0.25 ppb) and As (11.1 ppb) have been recorded from Lake Kastoria (Hadjibiros et al., 1998). Main sources of cadmium, copper, lead, and zinc are fertilizer and pesticide residues (Hadjibiros et al., 1998).

Lake Pamvotis (22 km^2; basin=330 km^2; avg. depth=5.5 m; max. depth=11 m) is an eutrophic lake beside the city of Ioannina (Epiros Prefecture) in western Greece (Skoulikidis et al., 1998). Mean physical and nutrient concentrations in the lake are pH (8.4), total phosphorus (38 μg/l), P-PO_4 (31.7 μg/l: max=91), N-NO_2 (2.2 μg/l; max=65.3), N (24.1 μg/l; max=926); N-NO_3 (27.3 μg/l), and N-NH_4 (62.8 μg/l) (Hadjibiros et al., 1998). Mean heavy metal concentrations for Zn (33.1 ppb), Cu (5.2 ppb), Cd (1.6 ppb), and As (1.9 ppb) have been reported from Lake Pamvotis (Hadjibiros et al., 1998). Eutrophication is primarily a result of domestic wastewater inputs (Hadjibiros et al., 1998).

MATERIALS AND METHODS

Fish consumption patterns were determined through the use of personal interviews with 90 people selected at random in Kastoria Greece for Lake Kastoria; and 135 people in Ioannina, Greece for Lake Pamvotis. Fish consumption survey interviews, modeled after guidelines and recommendations in USEPA (1998), were conducted in Greek for Lake Kastoria on June 5, 6, 10, and 17, 2002; and in Ioannina for Lake Pamvotis, Greece on June 6, 7, 8, 9, 11, 28, 29, 30 and July 1, 2002. Variables recorded included: demographics [i.e., gender, age, weight (kg), education (0=none, 1=elementary, 2=middle school, 3=1st-2nd years of high school, 4=3rd and 4th years of high school, 5=graduate school), occupation (0=unemployed/retired; 1=student; 2=housewife; 3=agricultural worker/fisherman; 4=blue collar; 5=professional), residency (1=yes, 2=no), domicile distance from lake (m)] and eating statistics [i.e., general marine and freshwater fish eating frequency (days/year); specific freshwater species and sizes (kg) eaten (*Perca fluviatilis*, *Rutilus rutilus* for Lake Kastoria, and *Anguilla anguilla*, *Cyprinus carpio*, *Silurus aristotelis* for Lake Pamvotis), specific eating frequency (days/year) per freshwater species from each lake, and fish consumption habits [i.e., quantity (kg), parts (frequency consumption of muscle, skin, bones, head, intestine), and preparation method (fry, grill, boil, head boil, soup frequency). Selection of fish species was based on freshwater fish eating preference, species availability per lake, and ecological feeding type: food chain position (predator, prey); feeding type (i.e., carnivore, herbivore, omnivore), and feeding position (e.g. bottom) as follows: herbivorous bottom feeder=*R. rutilus* and *C. carpio*; carnivorous bottom feeder= *S. aristotelis*; carnivorous pelagic feeder: *P. fluviatilis*; and carnivorous bottom feeder= *A. anguilla*.

Four gender-age class groups (male adult ≥ 18 yo; female adult ≥ 18 yo; male youth <18 yo; female youth <18 yo) conform to those specified in USEPA (1998). Percentages and other proportional measurements were converted into arcsin equivalents to normalize variance prior to statistical tests. Spearman's correlation analysis (SAS, 2002) was used to identify significant correlations among variables per lake and species. Option NOMISS was employed to eliminate observations with missing values as pairwise correlation matrices may not be nonnegative definite, and the pattern of missing values may bias results (SAS, 2002). Analysis of variance followed by Duncan's multiple range test (SAS, 2002) was used to test differences in each variable among gender-age class groups by lake and species in order to distinguish group specific consumption patterns from overall consumption patterns.

RESULTS

Lake Kastoria demographics- Mean ages and weights of male (47.3 y; 85.9 kg) and female (48.5 y; 63.5 kg) adults were significantly greater than those of female (12 yo; 37.4 kg) and male (10.4 y; 38.6 kg) youth (Table 1). Mean grade level (1.75) of male youth was significantly lower than those of male and female adults (range=2.7-2.8; Table 1). Occupation level of male adults (3.8) was significantly greater than those of female adults (2.8) and male and female children (Table 1). Mean eating days (126.2) of marine and freshwater fishes by male adults were significantly greater than those (range=76.9-105.8 days) of other interview groups, and negatively correlated with weight (coefficient=-0.3175; p=0.0336; Table 1).

Lake Kastoria Consumption Patterns by Species Consumed:

Perca fluviatilis: Annual mean consumption of *P. fluviatilis* ranged from 0.087 kg/day in female adults to 0.273 kg/day in male adults and (Table 2), and did not vary significantly among gender-age groups (F=1.70; p=0.1889). Mean fish size (range=0.32-0.50 kg) and number of days (range= 57.5-73.9) of eating *P. fluviatilis* did not vary significantly among all gender-age groups (Table 3). However, quantity ($\bar{x}$=0.93 kg) of *P. fluviatilis* consumed per meal by male adults was significantly greater than those (range $\bar{x}$=0.34-0.45 kg) consumed by other gender-age groups (Table 3).

Interviewee weight was significantly positively correlated with age ($p<0.0001$), education (p=0.0037), occupation ($p<0.0001$) quantity of *P. fluviatilis* consumed (p=0.004), and eating skin (p=0.0072) and bones (p=0.0218) of the species. Frequency of eating skin was correlated with quantity of *P. fluviatilis* consumed (p=0.0204). *Perca fluviatilis* consumption days were correlated positively with frequency of eating skin (p=0.0163) and negatively with eating heads (p=0.0099). Boiling heads of *P. fluviatilis* was correlated with frequency of eating bones (p=0.0136) and soup ($p<0.0001$).Fish size and frequency of eating fried *P. fluviatilis* were negatively correlated (coefficient=-0.4906), whereas fish size and frequency of eating grilled *P. fluviatilis* were positively correlated (coefficient=0.3580; p=0.0376) indicating that smaller fish were fried and larger ones grilled. Mean percents (65-67) of consumption of fried *P. fluviatilis* were significantly greater than those of grilled ($\bar{x}$ range=27-35) and boiled ($\bar{x}$ range=0-3) in female and male adults (Table 4).

Mean skin eating frequencies (range=82-90 %) in female and male adults were significantly greater than those ($\bar{x}$ range=0-33 %) in female and male youth (Table 3). Mean frequencies of eating heads (60 %) and bones (40 %) by male adults were significantly greater than those ($\bar{x}$ range=0-1 %) in female and male youth (Table 3). Mean percents (range 33-55) of consumption of fried *P. fluviatilis* were significantly greater than those of other preparation methods except by female youth (Table 3). All *P. fluviatilis* were gutted prior to consumption, regardless of preparation method.

Rutilus rutilus: Annual mean consumption of *R. rutilus* ranged from 0.185 kg/day in female adults to 0.297 kg/day in male children (Table 2), and did not vary significantly among gender-age groups (F=1.68; p=0.1970). Mean quantity ($\bar{x}$=0.93 kg) of *R. rutilus* consumed per meal by male adults was significantly greater than those ($\bar{x}$ range=030-0.48 kg) consumed by other gender-age groups (Table 5). Mean fish size (range=0.10-0.12 kg) and number of days (range= 77.0-96.7) of eating *R. rutilus* did not vary significantly among all gender-age groups (Table 5).

Interviewee weight (correlation=0.5340; p=0.0028) and occupation (correlation=0.4178; p=0.0269) were significantly correlated with quantity of *R. rutilus* consumed. Age was significantly correlated with eating skin (correlation=0.36984; p=0.0483) and bones (correlation=0.4550; p=0.0131) of *R. rutilus*. Eating skin was significantly correlated with occupation (correlation=0.3908; p=0.0398), and eating heads (correlation=0.4761, p=0.0090) and bones (correlation=0.3864; p=0.0384), negatively correlated with grilling *R. rutilus* (correlation=-0.3864; p=0.0384), and

number of days per year consuming *R. rutilus* (correlation=-0.5811; p=0.0009).

Frequencies of eating skin, heads, and bones (fried or grilled) did not vary significantly among gender-age groups (Table 5). Percent frequencies ($\bar{x}$ range=67-80 %) of eating fried *R. rutilus* by all gender-age groups was significantly greater than eating the species either grilled ($\bar{x}$ range=20-33 %) or boiled (0 %)(Table 5). All *R. rutilus* were gutted prior to consumption, regardless of preparation method, and none was boiled to make soup.

Lake Pamvotis demographics (based on 135 interviews): Mean ages and weights of male (43.2 y; 81.9 kg) and female (44.6 y; 68.6 kg) adults were significantly greater than those of female (10.1 y; 40.6 kg) and male (11.3 y; 44.4 kg) youth (Table 1). Mean educational levels of female (3.8) and male (3.5) adults were significantly greater than those of male (1.4) and female (1.2) youth (Table 1). Occupation levels of female (3.7) and male (3.0) adults were significantly greater than those of female (1.1) and male youth (0.96)(Table 1). Mean distance (1270.8 m) between homes and lakes of male youth were significantly greater than those of adult females (640.2) and males (640.0; F=2.81; $p<0.042$). Mean eating days ($\bar{x}$ range=40.5-60.9) of marine and freshwater fishes did not vary significantly among all gender-age groups (F=7.86; $p<0.0001$).

Anguilla anguilla: Annual mean consumption of *A. anguilla* ranged from 0.010 kg/day in female children to 0.199 kg/day in male adults (Table 6), and did not vary significantly among gender-age groups (F=1.31; p=0.3193). Mean number of consumption days (55) for *A. anguilla* by male adults was significantly greater than those ($\bar{x}$ range=1-6.5) for female and male youth (Table 6).

Age (correlation=0.5360; p=0.0001), weight (correlation=0.3828; p=0.0087), and frequency of eating fried fish (correlation=0.5647; $p<0.0001$) were correlated with frequency of eating *A. anguilla*. Frequency of eating soup made from *A. anguilla* was significantly correlated with boiling heads (correlation=1.0; $p<0.0001$) eating bones (correlation=1.0; $p<0.0001$), eating heads (correlation=1.0; $p<0.0001$).

Quantity, fish size, frequency of eating skin, heads, bones by any preparation method (i.e., fried, grilled, or boiled) of *A. anguilla* did not vary significantly among gender-age groups (Table 6). Consumption of fried *A. anguilla* (63 %) was significantly greater than other preparation methods (grilled, 37 %; boiled, 0 %) in female adults (Table 7). Correspondingly, male adults ate fried (48 %) and grilled (48 %) *A. anguilla* significantly more than boiled (4 %) *A. anguilla* (Table 7). All *A. anguilla* were gutted prior to consumption, regardless of preparation method.

Cyprinus carpio: Annual mean consumption of *C. carpio* ranged from 0.056 kg/day in female children to 0.210 kg/day in male adults (Table 1), and did not vary significantly among gender-age groups (F=1.17; p=0.33427). Mean quantity (0.86 kg) of *C. carpio* consumed per meal by male adults was significantly greater than those ($\bar{x}$ range=0.21-0.25 kg) consumed by female and male youth (Table 8).

Interviewee weight was significantly correlated with age (correlation=0.4768, p=0.0011), education level (correlation=0.4768, p=0.0011), occupation (correlation=0.0.5868, 0.0011), and quantity of *C. carpio* consumed (correlation=0.7959, $p<0.0001$). Occupation was correlated with eating grilled *C. carpio* (correlation=0.4041; p=0.0406) and negatively correlated with eating fried *C. carpio* (correlation=-6645; p=0.0002). Interviewees consuming a greater quantity of *C. carpio* were more likely to boil *C. carpio* (correlation=0.6040; p=0.0009), heads of *C. carpio* (correlation=0.6040; p=0.0009) and eat soup (correlation=0.6018; p=0.0009).

Eating skins of *C. carpio* was correlated with frequencies of eating heads (correlation=0.9117; p<0.0001), boiling *C. carpio* (correlation=0.5449; p=0.0033), boiling heads (correlation=0.5449; p= 0.0033), and eating soup made from boiled flesh and heads of *C. carpio* (correlation=0.5328; p=0.0042). Eating heads of *C. carpio* was correlated with boiling flesh of *C. carpio* (correlation=0.5976; p=0.0010), heads of *C. carpio* (correlation=0.5976; p=0.0010), and eating soup (correlation=0.5844; p=0.0014). Likewise, eating bones of *C. carpio* was correlated with boiling flesh (correlation=0.5547; p=0.0027), boiling heads (correlation=0.5547; p=0.0027); and frequency of eating soup made from *C. carpio* (correlation=0.7167; p<0.0001). Grilling *C. carpio* was inversely correlated with frying the species (correlation=-0.5437; p=0.0034). Grilling was correlated with number of consumption days for *C. carpio* (correlation=0.4710; p=0.0132).

Percentages of eating grilled *C. carpio* in female adults (78) and male adults (63) were significantly greater than those for fried (18-28 %) and boiled (4-9 %) in female and male adults (Table 7). Fried *C. carpio* (70 %) consumed by female youth was significantly greater than that consumed boiled (0 %)(Table 7).

Silurus aristotelis: Annual mean consumption of *S. aristotelis* ranged from 0.02 kg/day in male adults to 0.042 kg/day in female adults (Table 1), and did not vary significantly among gender-age groups (F=0.30; p=0.8217).

Interviewee age was significantly correlated with quantity of *S. aristotelis* consumed (correlation=0.5546; p=0.0258)(Table 9). Eating skin was significantly correlated with eating heads (correlation=0.5092; p=0.0440), grilling (correlation=0.8783;p<0.0001), and number of consumption days (correlation=0.7398; p<0.0001) for *S. aristotelis*. Consumers living closer to Lake Pamvotis ate *S. aristotelis* on fewer days than those living further away (correlation=-0.3357; p=0.0278).

Mean numbers of consumption days (7.5-11.9 days), quantity (0.27-0.50 kg) and fish size (0.61-1.1 kg) of *S. aristotelis*, parts eaten [skin (38-100 %), head (0-40 %), bones (0-12 %)], and preparation methods [fry (88-100 %), grill (50-100 %)] did not vary significantly among gender-age groups (Table 9). Consumption of fried ($\bar{x}$ range=69-70 %) *S. aristotelis* by female and male adults was significantly greater than that for grilled ($\bar{x}$ range=30-31 %) or boiled (0) *S. aristotelis* (Table 7). There was no difference in the percent of fried (50) and grilled (50) *S. aristotelis* consumed by female or male youth (Table 7). All *S. aristotelis* were gutted prior to consumption, regardless of preparation method, and none was boiled to make soup.

DISCUSSION

This is the first published study to generate site-specific consumption rates of freshwater fishes in Greece that can be applied as chronic daily intake values (CDI) in determining carcinogenic and non-carcinogenic human health risks associated with the consumption of fish tissues. All annual mean site-specific consumption rates of gender-age populations in vicinity of Lake Kastoria (avg. range= 0.103-0.29 kg/day) exceed those of Greece (0.066 kg/day; USDA, 2003 and Welch et al., 2002), EU (0.068 kg/day; Leatherhead Food RA, 2001), Spain (0.104 kg/day; Szucs and Grasselli, 2004), Portugal (0.159 kg/day; Szucs and Grasselli, 2004), and the USEPA default value (0.054 kg/day; USEPA, 1991) with two exceptions. Female consumption rates (0.087-0.103 kg/day) of *P. fluviatilis* were below annual consumption rates of Spain and Portugal (Table 2). Similarly, annual mean site-specific consumption rates of *A. anguilla* and *C. carpio* by male (0.199-0.210 kg/day) and female adults (0.096-0.157 kg/day) in vicinity of Lake Pamvotis exceeded those Greece, EU, Spain, Portugal, and

the USEPA default value (USEPA, 1991) (Table 2). Many of our site-specific consumption rates for the two lakes rival those of Native Americans in Alaska whose annual mean consumption rate is 0.324 kg/day, six times greater the USEPA default value (TERA, 1999). As there are such high consumption rates for these two different inland populations, and as exposure varies considerably under different circumstances, we concur with the WHO (1999) which strongly encourages responsible authorities in countries to characterize risk on the basis of local measured or predicted site-specific exposure scenarios and not default values such as those available for USEPA models. To date, no default values have been issued by the EEA. Application of site-specific consumption rates as the CDI in risk assessment investigations is warranted as current consumption rates (0.0.66 and 0.068 kg/day) listed for Greece (USDA, 2003 and Welch et al., 2002), and the EU (Leatherhead Food RA, 2001) would underestimate effects of chronic pesticide and other contaminant exposures to local populations utilizing freshwater fishes as a protein source. For example, the EEA (2004) indicates that pesticides are the most common cause of acute and sub-chronic poisonings because of the amounts of pesticides used in comparison with other chemicals, their high toxicity, and inappropriate storage. EEA (2004) did not comment on long-term exposures to pesticides, but indicated that scientific evidence and information concerning actual exposures to chemical substances and their possible health effects is lacking in most European countries, and that the lack of data for health impact assessment poses a big problem. Further, no association between exceedances of EU standards or (WHO) guidelines for pesticides and the incidence of morbidity or mortality has been established, possibly because of the safety margin built into EU standards/WHO guidelines is considerable, and because of the scarcity of appropriate studies (EEA, 2004).

Average consumption of fishes has increased from 0.039 kg/day (Trichopoulou and Lagiou, 1998) to 0.066 kg/day in Greece from 1980-2003 (USDA, 2003 and Welch et al., 2002). The Greek Ministry of Health and Welfare (2003) states that fish and seafood can physiologically substitute meat and eggs, but culinary, practical, and economic constraints dictate a recommendation of about one serving of fish (0.060 kg) per day. Trichopoulou and Lagiou (1998) indicate that fish and seafood availability in Greece decreases with proximity to urban areas, and can be attributed to the immediate availability of sea products in rural costal areas and islands. Our high consumption rates of fishes from both of these inland lakes, where fishes are plentiful and readily available, are consistent with the statement by Trichopoulou and Lagiou (1998) who reported that one would expect better educated Greeks to be higher consumers of fish; however, market availability appears to be a stronger determinant of food choice in comparison to health education in this case: better educated Greeks are usually residing in the urban and not the rural areas.

Consumption frequencies of fish from Pamvotis Lake were lower than those from Kastoria Lake. This is consistent with the report of Filos (pers. comm., 2002) who indicated consumption of freshwater fishes from Pamvotis Lake had decreased in recent years as public awareness of the lake's pollution had increased. The significantly lower educational levels of adults in Kastoria coupled with fewer pollution reports for Lake Kastoria (Filos, pers. comm., 2002) are probably related to higher consumption rates at this lake.

A study of consumer perceptions of food-related hazards (including pesticide residue health risks) in 16 European countries and the USA conducted by Kafka and

Alvensleben (1997) indicated the index of concern (112) for Greece was greater than the European mean (100), USA (109), and all other European countries (range=63 in Spain-103 in Norway) except Germany (143) and Austria (136). This may reflect the recent and increased frequency of reports about pesticides and environmental and human health concerns available in Greece (Braxton and Frewer, 1998; Miles and Frewer, 1998; EEA, 2003). For example, pesticides have been identified as important freshwater pollutants in Greece (Albanis, 1992; Albanis et al., 1994). Greece authorized the use of nine of the 12 hazardous pesticides on the EEA's Water Framework Directive Priority List, but does not monitor any of them (EEA, 2003), despite documented exceedances (0.2-0.6 mg/kg; limit of detection=0.05 mg/kg) of maximum residue limit (MRL) in grapes tested from Greece (Brown, 2004); presence of organochlorine pesticide residues in human breast milk associated with food consumption patterns of mothers (Schinas et al., 2000); higher than normal concentrations of pesticides in mousaka, bean soup, infant food, and feta cheese (Boulous et al., 1996); and mammogram abnormalities and malignant changes in tumors of female greenhouse workers in Crete (Dolapsakis et al., 2001).

Data on food cooking methods in the EEA and Greece are scarce, even though there is epidemiologic evidence that consumption of fried, grilled or barbecued meat and fish that are well-done or browned may be associated with an increased cancer risk (Rohrmann et al., 2002). All populations in vicinities of both lakes preferred to eat fried fishes with one exception: grilled *C. carpio* from Lake Pamvotis was preferred by female and male adults (Tables 4 and 7). Preference for fried fish may reflect the transition from traditional Mediterranean and Cretan diets (Simopoulos, 2001) to a more western style diet in Greece, a phenomenon described for younger dwellers in urban areas of the country by Costacou et al. (2003). This is in contrast to the report by Rohrmann et al. (2002) who found that frying was more often noted in northern Europe, and roasting and stir-frying were more often used in the south.

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TABLE 1. Comparison of demographic characteristics of adult and youth males and females surveyed in vicinities of Lake Kastoria and Lake Pamvotis, Greece from June-July, 2002.

Age (yr) F=54.1; p<0.0001	Pamvotis ♀ Child 10.1	Kastoria ♂ Child 10.4	Pamvotis ♂ Child 11.3	Kastoria ♀ Child 12.0	Pamvotis ♂ Adult 43.2	Pamvotis ♀ Adult 44.6	Kastoria ♂ Adult 47.3	Kastoria ♀ Adult 48.5
Weight (kg) F=51.1; p<0.0001	Kastoria ♀ Child 37.4	Kastoria ♂ Child 38.6	Pamvotis ♀ Child 40.6	Pamvotis ♂ Child 44.4	Kastoria ♀ Adult 63.5	Pamvotis ♀ Adult 68.6	Pamvotis ♂ Adult 81.9	Kastoria ♂ Adult 85.9
Education[a] F=17.5; p<0.0001	Pamvotis ♀ Child 1.2	Pamvotis ♂ Child 1.4	Kastoria ♂ Child 1.8	Kastoria ♀ Child 2.0	Kastoria ♀ Adult 2.7	Kastoria ♂ Adult 2.8	Pamvotis ♂ Adult 3.5	Pamvotis ♀ Adult 3.8
Occupation[b] F=29.8; p<0.0001	Pamvotis ♂ Child 1.0	Kastoria ♀ Child 1.0	Kastoria ♂ Child 1.0	Pamvotis ♀ Child 1.1	Kastoria ♀ Adult 2.8	Pamvotis ♂ Adult 3.0	Pamvotis ♀ Adult 3.7	Kastoria ♂ Adult 3.8
Quantity consumed (kg/meal) F=8.45; p<0.0001	Pamvotis ♀ Child 0.24	Pamvotis ♂ Child 0.27	Kastoria ♀ Child 0.32	Kastoria ♂ Child 0.43	Kastoria ♀ Adult 0.45	Pamvotis ♀ Adult 0.46	Pamvotis ♂ Adult 0.72	Kastoria ♂ Adult 0.93
Days of eating fish F=7.86; p<0.0001	Pamvotis ♂ Adult 40.5	Pamvotis ♀ Child 43.4	Pamvotis ♂ Child 47.2	Pamvotis ♀ Adult 60.9	Kastoria ♀ Adult 76.9	Kastoria ♂ Adult 80	Kastoria ♀ Child 105.9	Kastoria ♂ Child 126.2

TABLE 2. Consumption rates (kg) of *Perca fluviatilis*, *Rutilus rutilus*, *Anguilla anguilla*, *Cyprinus carpio*, and *Silurus aristotelis* by populations in vicinity of Lake Kastoria and Lake Pamvotis, Greece in 2002, and fish consumption rates of other selected populations.

		kg/day		
Lake Kastoria	♂ adult	♀ adult	♂ child	♀ child
P. fluviatilis	0.273	0.087	0.172	0.103
R. rutilus	0.244	0.185	0.297	0.219
Lake Pamvotis				
A. anguilla	0.199	0.096	0.027	0.010
C. carpio	0.210	0.157	0.079	0.056
S. aristotelis	0.023	0.042	0.035	0.035
		kg/day		
USEPA default[1]		0.054		
EU[2]		0.068		
Greece[3]			0.066	
Portugal[4]		0.159		
Spain[4]			0.104	
USA Subsistence fishermen		0.086		
USA MN Native Americans		0.390		

1 – USEPA, 1991a
2 – Leatherhead Food RA, 2001
3 – USDA, 2003
4 – Szucs and Grasselli, 2004

TABLE 3. Results of Duncan's Multiple Range Test of population consumption parameters for *Perca fluviatilis*. Underscored means do not differ (p=0.05).

Species eating frequency	Female youth	Male youth	Male adult	Female adult
Mean %	50	67	83	84
F=1.32; p=0.2814				
No. days eating species	Female youth	Female adult	Male adult	Male youth
Mean days	57.5	62	71.8	73.9
F=0.14; p=0.9382				
Quantity consumed/meal	Female youth	Male youth	Female adult	Male adult
Mean (kg)	0.34	0.41	0.45	0.93
F=4.92; p=0.0067				
Fish size	Male youth	Female adult	Female youth	Male adult
Mean (kg)	0.32	0.43	0.5	0.5
F=0.59; p=0.6265				
% skin consumption	Female youth	Male youth	Female adult	Male adult
Mean %	0	33	82	90
F=7.7; p=0.0006				
Eating heads	Female youth	Male youth	Female adult	Male adult
Mean %	0	10	36	60
F=2.75; p=0.0598				
Eating bones	Male youth	Female youth	Female adult	Male adult
Mean %	0	0	10	40
F=2.89; p=0.0519				
Eating fried fish	Female youth	Male youth	Male adult	Female adult
Mean %	50	78	90	91
F=1.32; p=2859				
Eating grilled fish	Female adult	Male youth	Male adult	Female youth
Mean %	55	56	60	75
F=0.17; p=0.9173				
Eating boiled fish	Female youth	Male youth	Male adult	Female adult
Mean %	0	0	0	10
F=0.68; p=0.5733				
Soup eating frequency	Female youth	Male youth	Male adult	Female adult
Mean %	0	0	0	20
F=0.68; p=0.5733				

TABLE 4. Percent fried, grilled, and boiled *Perca fluviatilis* and *Rutilus rutilus* consumed by female and male adults and youth in vicinity of Lake Kastoria, Greece, June, 2002. Underscored means do not differ significantly (p=0.05).

Perca fluviatilis			
Female adult	Boil	Grill	Fry
Mean	3.0	30.0	67.0
F=13.91; p=<0.0001			
Female youth	Boil	Fry	Grill
Mean	0	37	63
F=2.60; p=0.1288			
Male adult	Boil	Grill	Fry
Mean	0	35	65
F=13.00; p<0.0001			
Male youth	Boil	Grill	Fry
Mean	0	33	67
F=7.62; p=0.0027			
Rutilus rutilus			
Female adult	Boil	Grill	Fry
Mean	0	20	80
F=39.07; p<0.0001			
Female youth	Boil	Grill	Fry
Mean	0	25	75
F=10.53; p=0.0044			
Male adult	Boil	Grill	Fry
Mean	0	33	67
F=12.04; p=0.0002			
Male youth	Boil	Grill	Fry
Mean	0	33	67
F=15.07; p=0.0003			

TABLE 5. Results of Duncan's Multiple Range Test of population consumption parameters for *Rutilus rutilus*. Underscored means do not differ (p=0.05).

Parameter				
Species eating frequency	Male youth	Female adult	Female youth	Male adult
Mean %	67	91	100	100
F=2.01; p=0.1339				
No. days eating species	Female adult	Male adult	Male youth	Female youth
Mean days	77	81.1	88	96.7
F=0.10; p=0.9594				
Quantity consumed/meal	Female youth	Female adult	Male youth	Male adult
Mean (kg)	0.3	0.45	0.48	0.93
F=6.15; p=0.0028				
Fish size	Male youth	Female adult	Female youth	Male adult
Mean (kg)	0.1	0.1	0.1	0.12
F=1.64; p=0.2050				
% skin consumption	Male youth	Female youth	Male adult	Female adult
Mean %	67	75	89	100
F=1.33; p=0.2855				
Eating heads	Female youth	Male youth	Male adult	Female adult
Mean %	25	50	67	70
F=0.90; p=0.4559				
Eating bones	Male youth	Female youth	Female adult	Male adult
Mean %	17	25	60	67
F=1.75; p=0.1821				
Eating fried fish	Female youth	Male youth	Male adult	Female adult
Mean %	89	100	100	100
F=0.72; p=0.5504				
Eating grilled fish	Female adult	Female youth	Male adult	Male youth
Mean %	40	50	56	67
F=0.34; p=0.7948				

TABLE 6. Results of Duncan's Multiple Range Test of population consumption parameters for *Anguilla anguilla*. Underscored means do not differ (p=0.05).

Parameter				
Species eating frequency	Female youth	Male youth	Female adult	Male adult
Mean %	8	25	31	62
F=3.13; p=0.0356				
No. days eating species	Female youth	Male youth	Female adult	Male adult
Total days	0.9	6.4	35.4	55
F=2.88; p=0.0473				
Quantity consumed/meal	Female adult	Male youth	Female youth	Male adult
Mean (kg)	0.28	0.3	0.35	0.78
F=3.02; p=0.0754				
Fish size	Female youth	Female adult	Male youth	Male adult
Mean (kg)	0.3	1.1	1.3	1.43
F=0.40; p=0.7562				
% skin consumption	Male youth	Female youth	Male adult	Female adult
Mean %	0	0	50	50
F=0.73; p=0.5535				
Eating heads	Female youth	Male youth	Female adult	Male adult
Mean %	0	0	25	38
F=0.43; p=0.7352				
Eating bones	Male youth	Female youth	Female adult	Male adult
Mean %	0	0	0	17
F=0.24; p=0.8636				
Eating fried fish	Female youth	Male youth	Male adult	Female adult
Mean %	0	50	88	100
F=2.73; p=0.0944				
Eating grilled fish	Male youth	Female adult	Male adult	Female youth
Mean %	50	75	88	100
F=0.47; p=0.7063				
Eating boiled fish	Female youth	Male youth	Female adult	Male adult
Mean %	0	0	0	12
F=0.24; p=0.8636				
Soup eating frequency	Female youth	Male youth	Female adult	Male adult
Mean %	0	0	0	38
F=0.24; p=0.8636				

TABLE 7. Percent fried, grilled, and boiled *Anguilla anguilla*, *Cyprinus carpio*, and *Silurus aristotelis* consumed by female and male adults and youth in vicinity of Lake Pamvotis, Greece, June, 2002. Underscored means do not differ significantly (p=0.05).

Anguilla anguilla				
Female adult	Boil	Grill	Fry	
Mean	0	37	63	
F=9.65; p=0.0059				
Male Adult	Boil	Grill	Fry	
Mean	4	48	48	
F=9.41; p=0.0012				
Cyprinus carpio				
Female adult	Boil	Fry	Grill	
Mean	4	18	78	
F=9.56; p=0.0059				
Female youth	Boil	Grill	Fry	
Mean	0	30	70	
F=4.63; p=0.0323				
Male adult	Boil	Fry	Grill	
Mean	9	28	63	
F=6.07; p=0.0067				
Male youth	Boil	Grill	Fry	
Mean	0	50	50	
F=1.50; p=0.2953				
Silurus aristotelis				
Female adult	Boil	Grill	Fry	
Mean	0	30	70	
F=12.38; p=0.0012				
Female youth	Boil	Grill	Fry	
Mean	0	50	50	
F=99.99; p<0.0001				
Male adult		Boil	Grill	Fry
Mean	0	31	69	
F=10.30; p=0.0008				
Male youth	Boil	Grill	Fry	
Mean	0	50	50	
F=99.99; p<0.0001				

TABLE 8. Results of Duncan's Multiple Range Test of population consumption parameters for *Cyprinus carpio*. Underscored means do not differ (p=0.05).

Species eating frequency	Male youth	Female youth	Male adult	Female adult
Mean %	38	42	69	77
F=1.82; p=0.1580				
No. days eating species	Male youth	Female youth	Male adult	Female adult
Total days	47	47.4	50.3	84
F=0.62; p=0.6035				
Quantity consumed/meal	Female youth	Male youth	Female adult	Male adult
Mean (kg)	0.21	0.25	0.52	0.86
F=7.17; p=0.0014				
Fish size	Male youth	Female adult	Female youth	Male adult
Mean (kg)	4	5.6	5.9	7.6
F=1.32; p=0.2929				
% skin consumption	Female youth	Female adult	Male youth	Male adult
Mean %	20	20	33	44
F=0.49; p=0.6900				
Eating heads	Male youth	Female adult	Female youth	Male adult
Mean %	0	20	20	44
F=0.93; p=0.4403				
Eating bones	Male youth	Female youth	Female adult	Male adult
Mean %	0	0	0	10
F=0.64; p=0.5977				
Eating fried fish	Female adult	Male adult	Female youth	Male youth
Mean %	30	33	40	67
F=0.42; p=0.7379				
Eating grilled fish	Male youth	Female youth	Male adult	Female adult
Mean %	67	80	89	90
F=0.36; p=0.7841				
Eating boiled fish	Female youth	Male youth	Female adult	Male adult
Mean %	0	0	10	22
F=0.66; p=0.5855				
Soup eating frequency	Female youth	Male youth	Female adult	Male adult
Mean %	0	0	20	56
F=0.76; p=0.5302				

TABLE 9. Results of Duncan's Multiple Range Test of population consumption parameters for *Silurus aristotelis*. Underscored means do not differ (p=0.05).

Species eating frequency	Female youth	Male youth	Female adult	Male adult
Mean %	17	25	42	47
F=0.77; p=0.5183				
No. days eating species	Male adult	Female youth	Female adult	Male youth
Total days	7.5	7.9	10.3	11.9
F=0.15; p=0.9285				
Quantity consumed/meal	Female youth	Male youth	Male adult	Female adult
Mean (kg)	0.27	0.27	0.5	0.5
F=0.53; p=0.6693				
Fish size	Male adult	Female adult	Male youth	Female youth
Mean (kg)	0.61	0.62	1.1	1.1
F=1.62; p=0.2374				
% skin consumption	Male adult	Female adult	Male youth	Female youth
Mean %	38	60	100	100
F=1.12; p=0.3789				
Eating heads	Male youth	Female youth	Male adult	Female adult
Mean %	0	0	25	40
F=0.44; p=0.7256				
Eating bones	Male youth	Female adult	Female youth	Male adult
Mean %	0	0	0	12
F=0.29; p=0.8348				
Eating fried fish	Male adult	Male youth	Female youth	Female adult
Mean %	88	100	100	100
F=0.29; p=0.8348				
Eating grilled fish	Male adult	Female adult	Male youth	Female youth
Mean %	50	60	100	100
F=0.69; p=0.5768				