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Environmental Research 92 (2003) 254–261

Environmental
Research

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Fish, shellfish, and meat meals of the public in Singapore

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Received 14 May 2002; received in revised form 15 November 2002; accepted 2 January 2003

Abstract

Understanding different patterns of fish consumption is an important component of the assessment of risk from contaminants in fish. While there have been extensive studies of fish consumption in Western cultures, less attention has been devoted to the role of fish and meat in the diets of people in other cultures. A survey of 212 people living in Singapore was conducted to examine the relative importance of fish, shellfish, and other meat in their diets and to ascertain whether there were differences as a function of age, income, education or gender. As expected, fish and shellfish played an important role in their daily diets. On average, people ate fish in about 10 meals a week, chicken for eight meals, and shrimp and pork for about six meals each. While nearly 8% never ate fish, 18% ate fish at all 21 meals a week and over 20% ate shellfish for all 21 meals. Income explained about 14% of the variation in the number of fish meals consumed, and age explained about 8% of the variation in number of chicken meals per week. There were no gender differences in the number of meals of each type. People less than 26 years old ate significantly more pork, chicken, and other meat meals and fewer shellfish meals than older people. People with higher incomes ate significantly more fish meals than those with lower incomes. Chinese individuals ate significantly more meals of pork, chicken, and other meat than other ethnic groups, and they ate only 26% of their meals at home, while others ate 33% of their meals at home. The data indicate a great deal of variation in the number of meals of fish, shellfish, and other meats eaten by the people interviewed, making dietary and risk assessments challenging.

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Keywords: Diet; Fish; Shellfish; Human health; Consumption; Age differences

1. Introduction

For many cultures, particularly in eastern Asia, fish and fish consumption are an integral part of daily life. Eating fish and shellfish in these regions is often taken for granted, and many meals may have small amounts of fish or shellfish as part of rice dishes or as side dishes. Although fish provides a healthy and nutritious source of protein (Egeland and Middaugh, 1997), the levels of contaminants in fish and shellfish have led to health concerns, particularly for high-risk populations, such as pregnant women and children. (EPA, 1998; NRC, 1991, 2000). There is a positive relationship between contaminant levels in fish, fish consumption by pregnant women, and deficits in neurobehavioral development in children (Jacobson and Jacobson, 1996; Jacobson et al.,

1989, 1990; Weihe et al., 1996). Mercury is particularly problematic in coastal fish and shellfish which are exposed to anthropogenic as well as natural sources, leading to health advisories in the United States, Canada, and elsewhere (ATSDR, 1996a, b, 1999). Recently, the US Food and Drug Administration issued a consumption advisory based on mercury that suggested that pregnant women and women of childbearing age who may become pregnant should avoid eating four marine species (or species groups): shark, Swordfish, King Mackerel, and Tilefish (FDA, 2001). Some of these fish or their close relatives are integral parts of the diet of people living in the Orient.

Understanding consumption patterns is key to determining whether people are at risk from eating fish and to monitoring changes in diet for nutritional reasons. Most of the information on fish in diets comes from North America and Europe, but the contrasts between Western and Asian diets have often been noted.

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In this study, we examine the meal patterns of people living in Singapore with respect to fish, shellfish, pork, chicken, and other meats. The diet for many people living in coastal areas of Asia contains a high proportion of foods from the sea, yet few data are available on the relationship between fish, shellfish, and meats. A diet high in fish and shellfish is potentially problematic from a contamination viewpoint (ATSDR, 1999). Further, mercury levels in the hair of healthy Singapore residents is high (average 6.1 ppm; Foo et al., 1988) compared to that of healthy Americans (98% less than 1 ppm; ATSDR, 1999; Stern et al., 2001). In addition, the levels have remained high for people in Singapore and other Southeast Asia islanders (Foo and Tan, 1998).

Further, with changing mores and increases in Western foods in these cultures, we were interested in documenting the current use of fish and shellfish and in examining whether there were age-related differences in the frequency of consuming different types of fish, shellfish, and meat. We hypothesized that as the world culture becomes more homogenized, food consumption patterns likewise might become more similar among countries. If this were occurring, one might expect younger people to have consumption patterns different from those of older people, who might be expected to be more conservative in switching dietary patterns. Changes in diets in Singapore have been noted but most information is about food groups (such as fruits, vegetables, fish; Kiang, 1998) rather than within food groups. There are no age-specific data, although a study done of Asian diets in the United States reported that young Asians had more fat in their diet (Wu-Tso et al., 1995).

Thus, our objectives were to (1) document meal patterns with respect to fish, shellfish, and meat, (2) estimate the number of meals comprising different kinds of fish, shellfish, and meat, and (3) examine whether there were differences as a function of ethnicity, age, income, education, or gender.

The question of how much fish to consume (and what species) is complicated because of the positive health and social benefits of eating fish (Toth and Brown, 1997). Fish provide omega-3 acids, which reduce cholesterol levels (Anderson and Wiener, 1995; Horn, 1992; Hunter et al., 1988; Kimbrough, 1991). For most people in the Orient, fish may be their main source of protein, while for others it may be the healthiest source. Consumption of other shellfish and other meat is also of interest in assessing the relative contributions of each to the diet.

There are numerous studies of fish consumption, but relatively few that examine fish, shellfish, and other types of meat at the same time (but see Burger et al., 2001), and fewer still look at diet patterns in the Orient. Fish consumption studies are common in the United States and Canada because of the exposure of recrea-

tional and subsistence fishermen (Burger et al., 1999a, b; Ebert, 1996; Ebert et al., 1993; Reinert et al., 1996). This study provides data from Singapore that can be used as a baseline for future studies examining dietary patterns and changes.

2. Methods

Interviews were conducted in Singapore from May until early September 2000 in and around parks, shopping malls, and other places where people were sitting and standing about. In-person interviews were selected because they would greatly increase the likelihood of reaching urban people of different ages and ensure a high response rate. This is a convenience sample, and every attempt was made to interview people in order, without selection, except to alternate people under and over 25 years of age. This age was selected arbitrarily to ensure that we could examine differences between younger and older adults. Nonetheless, there could be biases in the sample.

The survey instrument was one modified from a standard instrument used in several other studies (Burger et al., 1999a, b). Interviews were conducted on all days of the week and at all times of day. At the beginning of the interview, subjects were told it was a study being conducted by Rutgers University as part of a longer term project to understand dietary patterns. Interviews took approximately 20–25 min to complete. The refusal rate was very low; only six individuals said that they did not want to be interviewed because they were in a hurry or had small children to attend to. The low refusal rate may have been due to interest in the interviewer (J.F.), who was young and obviously not from Singapore, and an intrinsic politeness to foreigners.

The survey form was divided into questions about meal patterns (number of meals per week of different fish, shellfish, and meat types; percentage of meals/week eaten raw or cooked; percentage of fish eaten whole or as fillets), health-related questions (health rating, whether subjects smoked or drank), and demographics (age, gender, ethnicity, education, income). The survey form had 50 questions on it; questions were mainly specific (What is your age, how many meals a week do you eat of chicken?), but one involved a rating (Rate your health on a scale of 1–5.), and one was open ended (What is the most important environmental issue in Singapore?). Information on age, ethnicity, and income were asked last because of the sensitive nature of the information. (Subjects are usually more willing to provide such information after they have talked to an interviewer for 15 min.)

We did not survey the same people on different days to examine for reliability among days. We did have

some of the same questions repeated on different parts of the survey, and they yielded similar results, indicating internal consistency. For example, early in the survey, 8% of the subjects reported eating no fish, and toward the end, on a question about the number of meals of fish per week, 8% said zero.

For analysis, the data were divided by age classes (25 and under, over 25 years), educational level (high school or less, at least some college), and income (under versus over \$40,000). These categories were chosen to ensure sufficient sample size in each category for statistical analysis. Although 212 people were interviewed, not all people gave their ethnicity, income, or schooling, thus on some tables the total sample size is slightly less. The numbers of meals of different types were compared using Kruskal–Wallis nonparametric analysis of variance yielding a χ^2 statistic to determine whether there were differences among variables as a function of gender, age, and education (SAS, 1999; PROC NPARIWAY with Wilcoxon option).

Multiple regression procedures were used to determine if ethnicity, income, gender, age, or education (or interactions between variables) contributed to the variations in the number of meals of fish, other seafood, or chicken (PROC GLM, SAS, 1999). This procedure adds the variable that contributes the most to the R^2 , then adds the next variable that increases the R^2 the most, continuing until all significant variables are added. Thus variables that vary colinearly are entered only if they add independently to explaining the variation. However, there were no significant interactions between any of the variables.

In the text we report the data as what people “ate”, but it should be borne in mind that this means “reportedly eaten.”

3. Results

3.1. Demographics

Of the 212 people interviewed, half were men. Of those who self-reported ethnicity, 64% were Chinese, compared to the 77% Chinese population of Singapore overall (United Nations, 2002). The others in our sample were Indian (14%), Malaysian (15%), and others (4%). The mean age was 28 ± 0.9 (range 13–66), the mean level of education was 12 (± 0.3) years (range of 8–24 years), and the mean income was \$ 42,140 ($\pm \$2670$) (range of \$1300–\$176,000), compared to the Singapore mean of \$30,550 (United Nations, 2002).

3.2. Meal patterns

In descending order, people reported eating fish, chicken, shrimp, pork, other meat, and fish eggs at

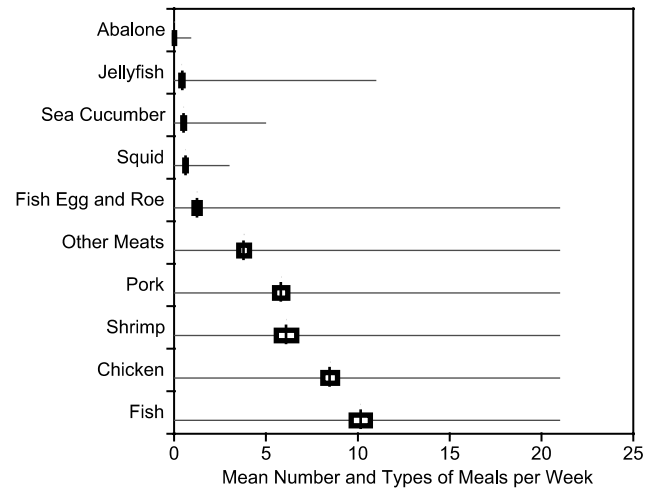


Fig. 1. Mean (\pm SE) numbers and types of fish and meat meals eaten per week by people interviewed in Singapore.

different rates (Fig. 1). Overall, the mean number of fish meals reportedly eaten per week by the whole population was just over 10 (Fig. 1). For fish, 40% were eaten whole; 20% of whole fish were eaten raw, and 18% of fillets were eaten raw. There was, however, a great deal of variation in the number of meals people ate of different fish, other seafood, and chicken (Fig. 2). About 8% of the people never ate fish, and almost 20% ate fish at every meal. Similarly, nearly 13% never ate other seafood, and 22% ate seafood at every meal (21/week, Fig. 2). This means that some people ate fish and seafood at breakfast. Unlike American meals, however, fish and shellfish were often eaten in very small quantities as side dishes or in rice dishes.

When individuals were examined for overall patterns, only 3.5% never ate meat (of any types), and only 6.3% never ate seafood (fish or other seafood, Fig. 3). However, some people reported eating meat during 56 meals/week and seafood during 51 meals/week. We interpret this as meaning that they often ate two or three different meats or seafood at each meal.

Only 13% of the variation in the number of fish meals per week was explained by a single factor (income: $F = 2.71$, $P < 0.05$). Other factors, such as age, education, or gender, did not enter the models as a significant factor. Only age explained the variation (22%) in the number of chicken meals eaten per week ($F = 4.85$, $P < 0.003$).

There were age differences in the number of seafood, pork, chicken, and other meat meals eaten, confirming our original hypothesis (Table 1). Young people ate more pork, chicken, and other meats, and fewer other seafood meals, than did older people. It appears that younger people are adding more other meats to their diet than are older people (Fig. 4).

People with higher incomes ate significantly more fish meals per week than did people with lower incomes (Table 1). People with more education ate fewer chicken

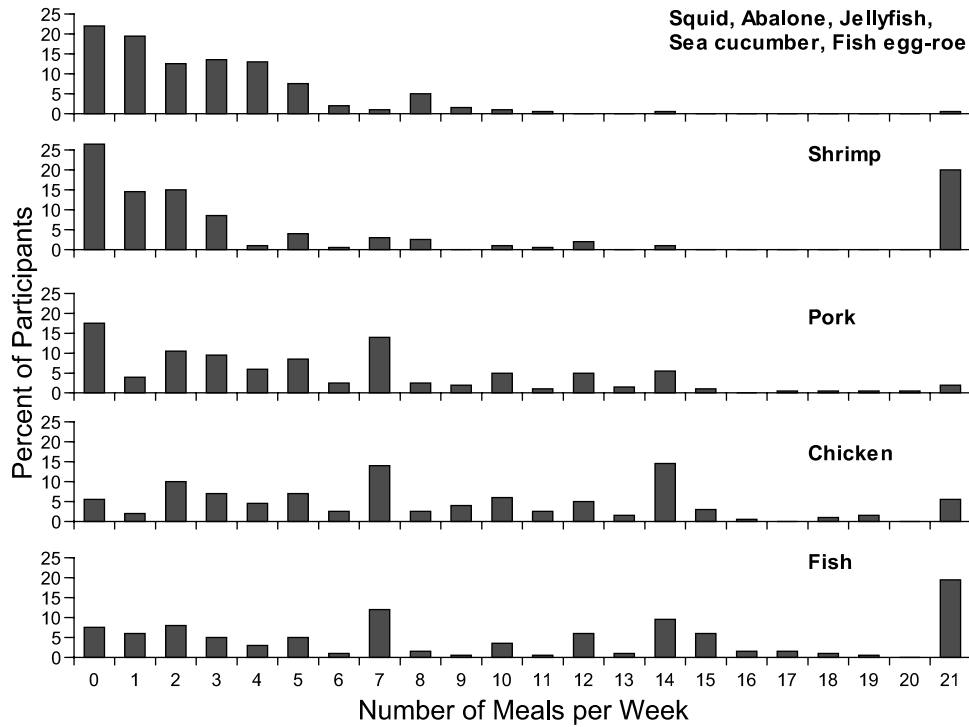


Fig. 2. Numbers of meals subjects interviewed in Singapore ate of different fish, other seafood, and chicken. Given are the percentages of people consuming each item.

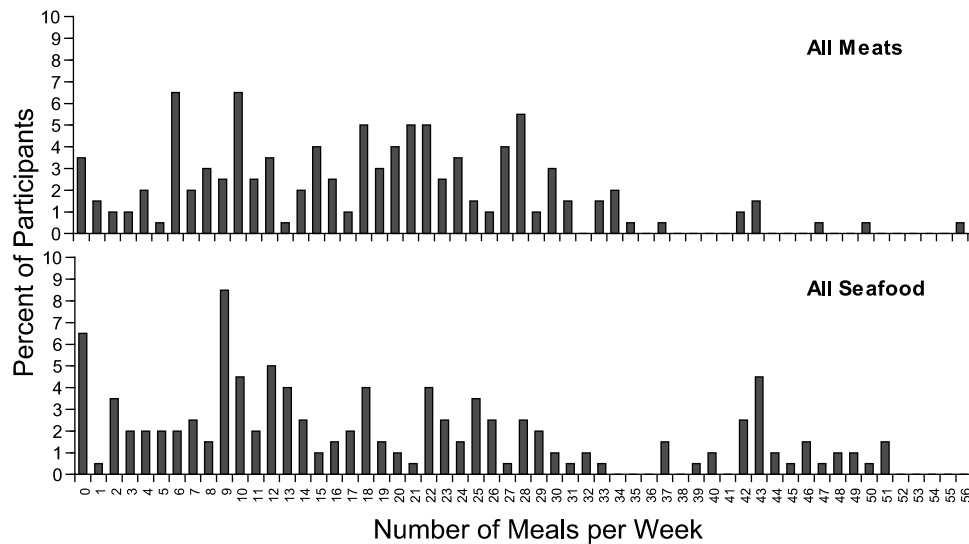


Fig. 3. Relative importance (percentages of meals) of fish, shellfish, and meats in the diets of people in Singapore. People eat more than one type of meat or seafood per meal.

and fewer other meat meals than those with a high school degree or less. There were no significant differences in the number of meals of any fish, shellfish, or meat as a function of gender (Table 1).

There were significant differences in the meal patterns of Chinese compared to others (mainly Indian and Malaysian, Table 2). People who identified themselves

as Chinese ate significantly more meals of pork, chicken, and other meat than others. Chinese people ate only 26% of their meals at home, while others ate 33% of their meals at home (Wilcoxon $\chi^2 = 3.84$, $P < 0.05$). There were no ethnic differences in the percentage of meals eaten in fast-food restaurants (about 19%) compared to eating in other restaurants (52%).

Table 1
Effects of age, income, education, and gender on the numbers of fish and meat meals of people in Singapore (2000)

Effect of age	25 and under	Over 25	Wilcoxon χ^2 (P)
Sample	101	99	
Fish per week	10.13±0.73	10.18±0.73	0.02 (NS)
All other seafood	7.80±0.88	10.11±0.93	5.06 (0.02)
Pork	6.78±0.57	4.85±0.43	4.95 (0.03)
Chicken	9.68±0.56	7.29±0.55	9.70 (0.002)
Other meats	5.06±0.48	2.54±0.28	15.46 (0.0001)
Effect of income	Under \$40,000	\$40,000 and over	Wilcoxon χ^2 (P)
Sample	44	58	
Fish per week	9.23±0.95	11.74±0.93	3.95 (0.05)
All other seafood	10.45±1.17	10.31±1.37	0.25 (NS)
Pork	6.25±0.66	5.47±0.52	0.18 (NS)
Chicken	7.57±0.55	7.17±0.84	1.49 (NS)
Other meats	3.13±0.37	2.48±0.40	2.91 (0.09)
Effect of education	HS degree or less	Some college/BA/BS	Wilcoxon χ^2 (P)
Sample	111	89	
Fish per week	10.37±0.72	9.89±0.74	0.05 (NS)
All other seafood	8.29±0.79	9.75±1.06	0.70 (NS)
Pork	5.86±0.53	5.79±0.48	0.39 (NS)
Chicken	9.03±0.50	7.84±0.64	3.85 (0.05)
Other meats	4.53±0.45	2.91±0.33	5.02 (0.03)
Effect of gender	Males	Females	Wilcoxon χ^2 (P)
Sample	100	100	
Fish per week	9.56±0.73	10.75±0.72	1.48 (NS)
All other seafood	8.06±0.86	9.82±0.96	2.63 (NS)
Pork	5.62±0.50	6.03±0.53	0.28 (NS)
Chicken	8.18±0.56	8.82±0.58	0.59 (NS)
Other meats	3.89±0.43	3.73±0.40	0.06 (NS)
Effect of ethnicity	Chinese	All others	Wilcoxon χ^2 (P)
Sample	129	71	
Fish per week	10.28±0.64	9.93±0.88	0.22±(NS)
All other seafood	2.71±0.23	3.04±0.43	0.24±(NS)
Pork	6.43±0.45	4.72±0.59	7.29±(0.007)
Chicken	9.30±0.51	7.04±0.62	7.96±(0.005)
Other meats	3.29±0.31	4.76±0.60	4.07±(0.04)
Eat at home	5.54±0.44	6.94±0.68	3.75±(0.05)
Eat in restaurants	14.50±0.54	12.68±0.76	4.88±(0.03)
Eat fast-food	3.00±0.25	4.14±0.45	5.35±(0.02)

Shown are mean (\pm SE) meals/week. NS, not significant; HS, high school; BA, bachelor of arts degree; BS, bachelor of science degree.

4. Discussion

Several conclusions can be reached from the survey and data: (1) the choice of foods to place on the questionnaire is critical, (2) the meaning of “meal” differs between people surveyed in Singapore and those surveyed in the United States (or Europe), (3) some subjects interviewed in Singapore eat fish and shellfish at every meal, (4) the young people who were surveyed eat more pork, chicken, and other meat than do the older people, and (5) people in Singapore believe pollution is their greatest environmental problem. Each of these will be discussed below.

4.1. Methodological considerations

The choice of food items to place on the questionnaire was derived from experience in Singapore, from information from people living there, and from Food and Agriculture Organization web sites. Beef and lamb were combined into other meats. Moreover, we also asked people to report other fish, shellfish, and meat items, and no other protein items that were normally eaten were mentioned.

While dietary studies are sometimes criticized because of recall bias and reliability over time, [Smith \(1993\)](#) reported that subjects have excellent recall about the

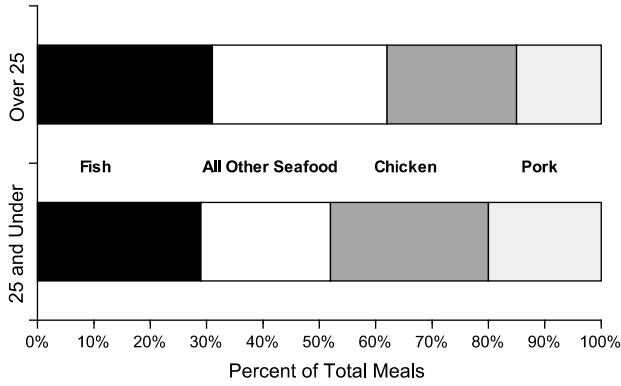


Fig. 4. Percentages of total meals in which fish, all other seafood, chicken and pork are eaten as a function of age. Younger people eat more chicken and pork than fish and other seafood.

Table 2
Effects of ethnicity on the number of meals of people living in Singapore

Effect of ethnicity	Chinese	All others	Wilcoxon χ^2 (P)
Sample	129	71	
Fish per week	10.28 ± 0.64	9.93 ± 0.88	0.22 (NS)
All other seafood	2.71 ± 0.23	3.04 ± 0.43	0.24 (NS)
Pork	6.43 ± 0.45	4.72 ± 0.59	7.29 (0.007)
Chicken	9.30 ± 0.51	7.04 ± 0.62	7.96 (0.005)
Other meats	3.29 ± 0.31	4.76 ± 0.60	4.07 (0.04)
Eat at home	5.54 ± 0.44	6.94 ± 0.68	3.75 (0.05)
Eat in restaurants	14.50 ± 0.54	12.68 ± 0.76	4.88 (0.03)
Eat fast-food	3.00 ± 0.25	4.14 ± 0.45	5.35 (0.02)

Shown are mean (±SE) meals/week. NS = not significant.

frequency of consumption. Thus, in this study we used the number of meals per week as our consumption variable and did not include portion size. In short-term studies of dietary intake, recall reliability is fairly high (Jarvinen et al., 1993). However, we did not put a time limit on our question and suggest that in the future it might be useful to ask the number of meals in the past week or past two weeks. Nonetheless, Nomura et al. (1976) reported that foods which are eaten regularly are reliably recalled. In the present study, fish, pork, chicken, shrimp, and other meats were eaten quite regularly; in some cases, they were eaten at every meal (which people would clearly recall easily).

Another problem is that although there was internal consistency for individuals, as we had the same question in different places in the questionnaire, we did not survey the same people on different days. It would be useful to survey a subset of respondents a week or two later to examine survey reliability, but this is difficult in a convenience survey where people are NOT identified individually (required by our protocol approval).

There are other potential biases in the study: (1) there could be seasonal differences in diet; (2) enrollment was in public places; (3) the dietary recall was for a week,

while a longer time period may have provided information on foods eaten at different times of the year; and (4) we asked about meals, where if a food was eaten at a meal it counted, regardless of whether it was the only meat (fish) item at that meal. Researchers should consider the meaning of meal. For most studies of consumption, those done in North America and Europe, a meal is a serving of one meat or fish type only and people normally do not mix and match fish, poultry, and other meats. This study indicates that the usual method of asking the number of meat or fish meals per week is problematic for people in Singapore because they mix several fish, shellfish, and meats in the same meal and obviously eat less of each. Future studies should include an indication of the size of each meal, perhaps concentrating on meals eaten in the last day or two. Nonetheless, the data from Singapore can be used to show the frequency of consuming meat or fish (nearly every meal), the relative types eaten, and the differences as a function of age.

4.2. Overall consumption patterns

The mean number of fish meals eaten per week was just over 10, indicating that, on average, people ate fish every day and twice a day on some days. When the total number of fish, shellfish, and meat meals were considered, people ate these sources of protein every day. Nonetheless, some people did not eat fish, other seafood, or chicken. However, when the total number of fish, shellfish, and meat meals was considered overall, only 3.5% ate no meats and 6.3% ate no fish or shellfish. In contrast, Americans usually eat only one main meat at a meal (Burger, 2000; Burger and Gochfeld, 2002; Burger et al., 2002), although in the United States many stews and soups use two or more, people eating in restaurants may include more (as the main entree or in appetizers), and people eating in Chinese restaurants often eat more types of fish and meat at one meal. For example, in the state of South Carolina, people reported eating all types of meat and fish on average 31 times a month (Burger, 2000), much less than reported in this survey. The people interviewed in Singapore ate different meats and fish up to 55 times per week (refer to Fig. 3). People are clearly eating more than one meat or fish type for most of these meals. While this pattern also occurs in the United States (Burger and Gochfeld, 2002), the overlap is less.

In comparison with people in the United States, the people of Singapore ate fish, shellfish, and meat at more individual meals (Burger, 2000). People from the United States often eat meat, fish, or shellfish only once a day and not usually at all three meals. Only with information on meal size, however, can consumption patterns be contrasted because Americans may well eat larger portions per meal. Kromhout et al. (1989) compared

food consumed (in grams/day) by people from many countries and found that the ratio of meat to fish in people from Japan (1:12 and 1:26) was much lower than in people from Europe (range of 1:0.8–1:0.06) or the United States (1:0.1). Thus, traditionally people from the Orient eat much more fish (Toshima, 1989). But in this Singapore study, the ratio of meat meals to fish meals was 1:2, perhaps suggesting an increase in meat in the diet.

The lack of a gender difference in the percentage of people consuming fish, shellfish, shrimp, pork, and chicken is not surprising, since presumably these meats and fish are cooked at home for the whole family. However, since interviewees ate most meals away from home, men and women could have had different preferences and patterns. Since the population interviewed was not fishers, a lack of gender difference may simply reflect that when people eat together, they eat the same things (Burger and Gochfeld, 2002). In a similar study, Burger (2000) found that commercial fish and meat, and those meals eaten in restaurants, did not show a gender difference, although men ate more wild-caught game than did women. That study was aimed at examining difference in wild-caught fish and game by people who fished and hunted, while the present study did not target fishers but the general public instead. Further, the general public in Singapore rely heavily on marine foods, such as fish and shellfish, and obtain these from fresh seafood markets as well as from local supermarkets.

That people with higher incomes ate more meals of fish may relate to age differences (see below). That is, older people might be expected to have higher incomes than people under 25 years of age, and they ate more fish and less chicken and pork than younger people. Further, some fish, such as tuna and shark, are more expensive than chicken and pork.

4.3. Age-related differences

One of the initial objectives of the study, in addition to providing baseline data on types of fish, shellfish, and meats consumed, was to determine whether there were age-related differences that might reflect an increasingly Western habit in younger people. In this sample, young people ate more pork, chicken, and other meats and less other seafood than did older people, suggesting that younger people are adding more other meats to their diet than are older people. In a similar study of people in South Carolina, older people also ate less chicken than younger people (Burger et al., 2001).

To some extent, the age-related differences reflect changes in diet over time, where younger people change diets earlier than older people. As they age, they maintain the patterns of their younger years, resulting in a change in the diet of the population overall. This

confirms what has been found in the US population; there has been a change in diet over time to more high-fat foods (Popkin et al., 1989). Fish is clearly a prominent feature of the average diet in Singapore, where annual consumption has varied from 36.9 kg (1986), to 41.9 kg (1992), to 27.8 kg (1996), the last year for which data are available (Kiang, 1998).

4.4. Conclusions

Overall this study indicates that fish, shellfish, and meats are generally eaten at more than one meal a day and that many people eat more than one fish or meat type at each meal. Fish is still the most common form of protein consumed, but chicken, shrimp, and pork are also very common. Surprisingly, some people did not eat any fish, while others ate fish at every meal. Variation in the frequency of consumption of fish, shellfish, and meat characterized this population. People ate a great deal of fish and shellfish, despite the fact that they listed water pollution as a major environmental problem in Singapore (Burger, unpublished data). The potential for exposure to mercury, Polychlorinated biphenyls, and other contaminants in fish remains high in the subjects interviewed. The high fish consumption may account for the high levels of mercury in the hair of healthy Singapore residents (Foo et al., 1988) compared to those in the hair of healthy Americans (ATSDR, 1999; Stern et al., 2001).

Acknowledgments

We thank C. Jeitner for computer assistance and C. Chess, C. Powers, B.D. Goldstein, B. Friedlander, K.K. Pflugh, and A. Upton for comments on the research and on the manuscript. This research was partly funded by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) through the US Department of Energy (AI# DE-FC01-95EW55084, DE-FG 26-00NT 40938), NIESH (ESO 5022), and the Environmental and Occupational Health Sciences Institute. The results, conclusions, and interpretations reported herein are the sole responsibility of the authors and should not in any way be interpreted as representing the views of the funding agencies.

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