

Risk of Parasitic Worm Infection from Eating Raw Fish in Hawai'i: A Physician's Survey

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Abstract

Public health concerns have been raised over the risk of parasitic helminth (roundworm, tapeworm and fluke) infections from eating raw fish, an increasing US consumer trend. Hawai'i consumers eat seafood at nearly 3 times the US national average rate, with a long tradition and high level of raw fish consumption. The local fish species commonly eaten raw in Hawai'i include tuna (bigeye, yellowfin, albacore and skipjack), marlin (blue and striped) and deepwater snappers (long-tailed red, pink and blue green). Forty-eight Hawai'i-based physicians (gastroenterologists, internists, general and family practitioners) were surveyed to count known cases of parasitic worm infection linked to raw fish consumption and to explore physicians' perceptions of risk associated with the consumption of fresh, never frozen local fish with an emphasis on raw tuna and skipjack. No single known case of helminth infection due to consumption of raw tuna or skipjack, or other local fish species caught in Hawai'i was reported. The majority of the physicians surveyed reported that they eat raw yellowfin and bigeye tuna, also eat raw skipjack and do not think that these fish present a significant health risk of helminthic parasites. The survey results support the conclusion that the risk of parasitic helminth infection from the consumption of Hawai'i-caught tuna, skipjack, marlin and deepwater snappers is negligible.

Introduction

Eating raw fish is extremely important in Hawai'i. It is estimated that Hawai'i consumers eat 18.6 kg of seafood per capita annually (much of it consumed raw), nearly 3 times the US national average.¹ The US Food and Drug Administration (FDA) has expressed concerns that fish-borne parasitic infections from the consumption of raw fish may be a significant and increasing problem in the United States.² If the risk of parasites associated with a species of fish is found to be significant (reasonably likely to occur) based on the best available science, FDA requires that processors freeze the fish to kill parasite larvae prior to serving raw.² The main helminthic parasites of concern are *Anisakis simplex* (anisakid roundworm which causes anisakiasis) and *Pseudoterranova decipiens* (anisakid roundworm which causes pseudoterranoviasis) and *Diphyllobothrium latum* (the broadfish tapeworm which causes diphyllobothriasis). Of special importance to Hawai'i consumers is the question of whether or not there is parasite risk from consuming locally-caught ocean fish. The most important fish species commonly eaten raw in Hawai'i include tuna (bigeye tuna *Thunnus obesus*; yellowfin tuna *Thunnus albacares*; albacore tuna *Thunnus alalunga*; skipjack tuna *Katsuwonus pelamis*), marlin (blue marlin *Makaira nigricans*; striped marlin *Tetrapturus audax*) and deepwater snappers (pink snapper *Pristipomoides filamentosis*; long-tail red snapper *Etelis coruscans*; blue green snapper *Aprion virescens*).

The American Gastroenterological Association (AGA) was commissioned by the FDA to survey its member gastroenterologists in coastal states³ to determine if cases of parasitism from raw fish consumption were occurring, but were under reported. The results of that survey indicate that cases of parasite infection from the consumption of raw fish are only a minute fraction of the AGA members' case-load. Only 1.7% (10) of the physicians who responded

(584) reported having diagnosed cases in the two year period prior to completing the survey. Fifteen cases were reported including 7 cases of anisakiasis, 1 case of diphyllobothriasis and 7 cases in which the parasite was unknown. Hawai'i-specific cases cannot be identified in this survey because coastal states were lumped into three regions. Nine of the 15 cases were reported from the Pacific region that included Alaska, Washington, Oregon, California and Hawai'i. The AGA survey does not contain specific information linking the consumption of any Hawai'i fish species of importance to the state's raw fish consumers to cases of fish-borne parasitic infections.

To address these information gaps, a group of Hawai'i physicians was surveyed for the total number of cases known to them of helminthic parasitic infection from raw fish consumption specific to Hawai'i. The survey contributes to the risk assessment of fish-borne parasites of public health significance by addressing the following questions.

1. Are Hawai'i physicians diagnosing fish-borne helminthic parasite infections (anisakiasis, pseudoterranoviasis and diphyllobothriasis)?
2. If yes, what types of worms have been identified?
3. If yes, what types of fish have been implicated?
4. Do Hawai'i physicians eat raw yellowfin tuna and bigeye tuna (*ahi*) and do they consider these fish a significant parasite risk to consumers?
5. Do Hawai'i physicians eat raw skipjack (*aku*) and do they consider this fish a significant parasite risk to consumers?

Methods

The State of Hawai'i, Department of Health, Epidemiology Branch was contacted in search of reported cases of fish-borne helminthic parasites in Hawai'i to complement information derived from the physician's survey. In contrast to the AGA survey, the Hawai'i survey was designed to capture specific information from Hawai'i physicians on total numbers of fish-borne parasitic infections diagnosed in the physician's experience (not previous two years only) and what species of parasites and fish hosts were identified. Background information on each physician was also collected, including the number of years in practice in Hawai'i, the approximate number of patients, whether the physicians had knowledge of cases in Hawai'i outside of their practice, and their personal raw fish consumption patterns.

Lists of Hawai'i-based AGA members and Hawai'i Medical Services Association physicians were obtained. Both were used to build a list of physicians eligible to participate in the survey. The objective was to target 100 physicians (gastroenterologists, internists, and general and family practitioners) practicing on the island of O'ahu, Hawai'i where the majority of the state population resides and the major portion of the local fresh fish landings in Hawai'i are made and consumed. Physicians (or their staff) were contacted by telephone to introduce the survey and solicit participation. Physi-

cians completed survey forms and returned them by facsimile or by mail. The identity of the physicians was kept confidential and their responses to survey questions were summarized.

Results

No cases of parasitism from eating raw skipjack, tuna or other local ocean fish have been reported in Hawai'i based on a review of epidemiological records from January 1991 to August 2008, according to Rebecca Kanenaka, Foodborne Disease Surveillance and Response Coordinator, Hawai'i Department of Health (personal communication, August 29, 2008). However, there is the possibility of cases being diagnosed but not reported by physicians because the Hawai'i Department of Health does not consider parasitic diseases reportable.

Of the 108 physicians that received the survey, a total of 48 completed surveys were returned achieving a 44.4% response rate. Forty-seven physicians were from the island of O'ahu and one was from the island of Moloka'i. The group of 48 physicians who responded to the survey represents about 21% of the approximately 226 physicians listed in the 2004 O'ahu telephone book that met the selection criteria for the survey. The 48 physicians reported a collective 673 years of practice in Hawai'i, with a mean of 14 years, a minimum of 1 year and maximum of 40 years. The group reported a mean number of patients of 2,760 and an estimated total of 132,500 patients.

Most of the physicians answering the survey (88%) did not know of cases of fish-borne helminthic parasitic infections outside of their practices. Only six physicians (12%) reported that they had knowledge of cases outside of their practices. Most of the physicians (85%) had never diagnosed cases. A total of 11 cases of fish-borne helminthic parasitic infections was reported by 6 physicians. Three of them had diagnosed multiple cases. Five of the physicians (1 gastroenterologist, 2 internists and 2 family practitioners) reported diagnosing a total of 6 cases of anisakiasis. Two physicians (1 gastroenterologist and 1 family practitioner) reported a total of 2 cases of pseudoterranoviasis and 3 family practitioners reported a total of 3 cases of diphyllbothriasis diagnosed in their practices.

The parasite and host fish species implicated in the 11 cases of fish-borne helminthic infections reported in the survey are presented in Table 1. *Anisakis simplex*, *Pseudoterranova decipiens* and *Diphyllbothrium latum* were the only 3 parasites identified. Pacific salmon and squid (not products of Hawai'i fisheries) were the only two seafoods (fish and shellfish) implicated in cases reported in Hawai'i.

The physicians were asked if they consume raw yellowfin and bigeye tuna to gain perspective on their personal dietary habits as an indicator of their level of concern about the potential risk of fish-borne parasites of public health significance. Most of the physicians responding to the survey (88%) reported that they eat raw yellowfin and bigeye tuna. Most of the physicians (90%) reported that they do not think the consumption of raw yellowfin or bigeye tuna poses a significant public health risk from parasites. Three physicians were undecided of the health risk, but 2 of them reported that they eat raw yellowfin and bigeye tuna, had never diagnosed cases and had no knowledge of cases outside of their practices. The other undecided physician reported that she/he did not eat raw tuna, had never diagnosed a case and had no knowledge of cases outside of

her/his practice. Only 2 physicians surveyed believed that eating raw yellowfin and bigeye tuna is a significant parasite risk.

All physicians were also asked if they consume raw skipjack. While fewer physicians reported that they eat raw skipjack than those that eat raw yellowfin or bigeye tuna, a majority of physicians (73%) reported that they eat raw skipjack. Most of the physicians (85%) reported that they do not think the consumption of raw skipjack poses a significant public health risk from parasites. Five physicians were undecided about the health risk. Four of these undecided physicians answered that they eat raw skipjack, had never diagnosed a case, and had no knowledge of cases outside of their practices. The fifth physician reported that she/he did not eat raw skipjack, had never diagnosed a case and had no knowledge of a case outside of her/his practice. Only 2 physicians surveyed thought that eating raw skipjack poses a significant parasite risk.

Follow up was conducted with the 2 Hawai'i physicians that considered raw yellowfin tuna, bigeye tuna and skipjack tuna to present a significant parasite hazard to better understand the scientific basis and rationale for their concerns. Neither physician provided an explanation or source of evidence. The physicians reported that they do not consume raw tuna or skipjack, only 1 had diagnosed a case of anisakiasis from an unknown source and neither had knowledge of cases outside of their practices. This indicates that they may have formulated their opinions on the safety of raw tuna and skipjack consumption on personal consumption patterns, culinary or cultural bias and not on scientific evidence or medical experience. The risk analysis of parasites in raw tuna, skipjack or other fish should be evidence-based.

Discussion

Hawai'i has a highly diverse population in terms of culture, ethnic backgrounds and culinary traditions. One commonality among many of the Pacific Island and Asian cultures is the long traditions of raw fish consumption. These include *sashimi* and *sushi* (Japanese), *poke* (Hawai'ian), *oka* (Samoan) and *poisson cru* (Tahitian). For these reasons, it is important to be aware of traditional or local knowledge and the scientific evidence needed to distinguish fish species that are safe to eat raw from those that are not.

Table 1.— The eleven (11) cases of fish-borne helminthic parasitic infections reported in the Hawai'i physicians' survey, and the species of parasites and host fish implicated.

Diagnosis	Parasite identification	Host fish implicated
Anisakiasis	<i>Anisakis simplex</i>	Pacific salmon
Anisakiasis	<i>Anisakis simplex</i>	Squid
Anisakiasis	Unknown	Pacific salmon
Anisakiasis	<i>Anisakis simplex</i>	Unknown
Anisakiasis	Unknown	Unknown
Anisakiasis	Unknown	Unknown
Pseudoterranoviasis	<i>Pseudoterranova decipiens</i>	Unknown
Pseudoterranoviasis	Unknown	Unknown
Diphyllbothriasis	Unknown	Pacific salmon
Diphyllbothriasis	<i>Diphyllbothrium latum</i>	Unknown
Diphyllbothriasis	Unknown	Unknown

The FDA Fish and Fishery Products Hazards and Controls guide² presents the current assessments of seafood-related public health hazards made by the FDA, based on what the agency considers to be the best available scientific information. The FDA does not associate parasite hazards with the consumption of raw yellowfin tuna or bigeye tuna and considers these fish to be safe to eat raw. The majority of the Hawai'i physicians surveyed shares this view. No single case of fish-borne helminthic parasitic infection has been reported in the United States or in Japan that was associated with the consumption of raw yellowfin tuna or bigeye tuna.⁴

Of special importance to Hawai'i consumers is the safety of raw skipjack tuna also known as *aku*. Nowhere else in the United States is a significant volume of fresh (never frozen) skipjack landed and consumed raw as *sashimi* or *poke* (a traditional Hawaiian raw fish preparation). In the 20-year period between 1987 and 2006, about 18.6 million kg of fresh skipjack were landed in Hawai'i.⁵ Most of the skipjack catch was landed on the island of O'ahu (90%) and the majority was consumed raw by local residents. Using conservative estimates, if the yield of edible muscle from skipjack is 42%, the majority (75%) of the skipjack is eaten raw, and a consumer portion is 100g, then over 52.8 million consumer portions of raw skipjack have been eaten on O'ahu since 1987 with no cases of parasitic infection reported by Hawai'i physicians to the Hawai'i Department of Health or discovered through this survey. The 2000 AGA survey did not find direct links between cases of fish-borne helminth infections and the consumption of skipjack or any of the major species of fish consumed in Hawai'i. Results from both surveys provide no evidence to conclude that there is a significant public health risk associated with the consumption of raw tuna, skipjack and the other fish caught in Hawai'i that are commonly eaten raw. High exposure has not resulted in cases and therefore there is no basis for an assumption of risk. Based on the traditional practice of eating raw skipjack and tuna in Pacific Island and Asian cultures, and the results of this survey of Hawai'i physicians, there does not appear to be any evidence of under reporting of cases of parasitism from the consumption of raw tuna, skipjack or other Hawai'i ocean fish species.

Cases of anisakiasis and diphyllobothriasis in Hawai'i are known to have involved *lomi lomi* salmon prepared with salted wild Alaska salmon that had not been properly frozen as is standard practice.⁶ Hawai'i consumers are at the greatest risk of fish-borne parasitic infections from the consumption of fresh (never frozen) raw Pacific salmon and raw squid. Raw wild-caught Pacific salmon may harbor harmful parasite larvae including roundworms (*Anisakis simplex*), tapeworms (*Diphyllobothrium latum*) and flukes (*Nanophyetus salmonicola*) each known to cause human parasitic infections. Wild Pacific salmon and squid are only potentially hazardous if eaten raw or undercooked without prior freezing that kills parasite larvae making them harmless. Farm-raised Atlantic salmon do not harbor harmful parasites^{2,7} because they are not exposed to wild forage species (intermediate hosts of parasites) and are fed formulated feeds, breaking the parasite life-cycle and resulting in salmon that are free of harmful parasite larvae. A potential concern is that because the practice of eating fresh, never frozen raw farm-raised Atlantic salmon has become so commonplace, that during the summer months when fresh wild-caught Pacific salmon is available in the market, consumers may expose themselves to parasite hazards if the wild salmon is eaten raw without prior freezing, as in *lomi lomi* salmon or *sashimi* or in undercooked preparations. Consumers should be

made aware of the potential for parasitic infections from raw never frozen wild Pacific salmon.

Conclusion

The new and important aspects of this study are findings that no cases of helminthic parasitic infection are known from consuming raw Hawai'i fish species of tuna (bigeye, yellowfin, albacore, skipjack), marlin (blue, striped) or deepwater snappers (long-tail red, pink, blue green snappers) among the approximately 132,500 Hawai'i residents served by the 48 gastroenterologists, internists, and general and family practitioners that responded to the survey. Although the survey relied on the physicians' recollection of their medical experience with some spanning several decades (maximum 40 years), it is likely that the rare case of anisakiasis or diphyllobothriasis would have been easily recalled.

The survey results support the conclusion that the risk of fish-borne helminthic infections is negligible from local ocean fish that are landed in Hawai'i and commonly consumed raw by its residents. There is no evidence at this time that Hawai'i consumers of fresh, never frozen raw bigeye tuna, yellowfin tuna, albacore tuna, skipjack tuna, blue marlin, striped marlin, long-tail red snapper, pink snapper and blue green snapper are exposed to a significant public health risk from fish-borne parasites. In the absence of cases and other scientific evidence of a significant health risk of parasites, control measures such as freezing requirements to kill parasite larvae in these Hawai'i fish species are not warranted.

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References

1. Pan, M.L. *Multilevel and Multiobjective Programming Model for Fisheries Management*. Ph.D. Dissertation, Dept. of Agricultural and Resource Economics, University of Hawai'i, Manoa, Honolulu, Hawai'i. 1998.
2. FDA. *Fish and Fishery Products Hazards Controls Guide 3rd ed.* Center for Food Safety and Applied Nutrition, Department of Health and Human Services. Bethesda, Food and Drug Administration, 2001.
3. American Gastroenterological Association. *Determination of the incidence of gastrointestinal parasitic infections from the consumption of raw seafood in the U.S.* Life Sciences Research Office, American Society of Nutritional Sciences, Bethesda, American Gastroenterological Association, 2000:9.
4. Kaneko JJ, Bartram PK. The Wholesomeness of Raw Tuna: Are parasites a public health hazard? Part 4 in A critical review of the newly proposed FDA HACCP System for the Seafood Industry: The Hawai'i Industry Perspective. Honolulu, Hawai'i Business and Economic Development, 1994:30-46.
5. WPRFMC (Western Pacific Regional Fishery Management Council. Pelagic Fisheries of the Western Pacific Region 2006 Annual Report. 2008. Available at: <http://www.wpcouncil.org/pelagic/Documents/AnnualReports/2006/2006%20Pelagics%20Annual%20Report.pdf>.
6. Deardorff TL, Kayes SG, Fukumura T. Human anisakiasis transmitted by marine food products. *Hawaii Med J* 1991;50(1):9-16.
7. Deardorff TL, Kent ML. Prevalence of larval *Anisakis simplex* in pen-reared and wild-caught salmon (Salmonidae) from Puget Sound, Washington. *J Wildl. Dis*; 1989; 25(3):416-419.