Table 2. Interactions between nutrients and Hg: foods and macronutrients.[a]

Nutrient/nutrition factor	Proposed type of interaction	Ref.
Protective effects		
Cysteine	Stimulates de novo synthesis of CoASH, which then exerts protective effect	(*68*)
Cystine	Decreases Hg deposition in kidney	(*69–71*)
Fish protein	Decreases toxicity symptoms of MeHg, presumably due to its Se content	(*70,72*)
Garlic	Promotes Hg excretion due to -SH and -SS- radicals that promote formation of Hg–sulfur compounds	(*73*)
Glutathione	Forms low molecular weight conjugate with Hg that can be extracted into kidneys and catabolized	(*74*)
γ-Linolenic acid	Allows the bypass of blocked linoleic acid production that occurs due to MeHg displacement of Zn ions from rate-determining enzymes	(*75*)
Neutral amino acids (e.g., leucine)	Inhibit uptake of Hg in brain because of competition for the neutral amino acid transport carrier with Hg–Cys complex; leucine has a greater affinity for the carrier	(*76*)
Phospholipids	Prevent toxic effect of MeHg	(*77*)
Wheat bran	Decreased the retention of orally administered MeHg in mice due to modification of metabolic activity of gut microflora	(*78*)
Enhanced toxicity		
Alcohol	Causes additive effect with MeHg on kidney pathology; may inhibit reoxidation of Hg vapor; may stimulate absorption of metals from the intestinal mucosa	(*80,81*)
Chewing gum	Increases Hg release from dental amalgams through mechanical action	(*40*)
Cysteine	Increases brain uptake of MeHg and Hg^{2+} in kidney by forming Cys–Hg complexes	(*76,81,82*)
Cystine	Increases brain MeHg	(*69–71*)
Glutamate	Interrupts transport by forming Hg–sulfide bridges between Cys and residues in protein; interactions result in neurotoxicity	(*83*)
Linoleic acid	May compete with Hg for the vitamin E antioxidant system and thus exacerbate the lethal effects of MeHg	(*84*)
Milk	Increases MeHg absorption from the intestinal tract; decreases fecal excretion; increases initial absorption due to binding of Hg to fatty acid from milk triglycerides	(*85,86*)
Protein	Low protein diet increases uptake of Hg in the brain because of involvement of neutral amino acid carrier; low protein diet may decrease urinary excretion of Hg; higher protein levels increase the susceptibility of the liver to Hg	(*69,87–89*)
Thiamine-related factors: high carbohydrate diet; intake of tea, raw fish; alcoholism	Clinical manifestation of thiamine deficiency may intensify clinical symptoms of Hg toxicity	(*30,90*)
Other effects		
Amino acids	Altered Hg uptake in kidney; renal uptake of Hg partially involves amino acid transport mechanisms acting on Hg–amino acid complexes	(*91,92*)
Cellulose	Alters metabolism of MeHg by intestinal flora	(*78*)
Glucose	Competes with Hg in use of the facilitated D-glucose transport system	(*93*)
Glutamine and glycylglycine	Serve as messengers in functional alterations in uptake of MeHg that occur through signaling pathways	(*94*)
Methionine	Increases brain MeHg; acts competively to inhibit Cys–Hg transport across the blood–brain barrier; Hg inhibits methionine synthase in brain because it is a sulfhydryl enzyme	(*69,82,95*)
Phytate	No effect on absorption of Hg	(*96*)
Seleno-L-methionine	Minimal effect on Hg distribution in offspring	(*97,98*)
Small aliphatic dicarboxylic acids (e.g., succinate)	Mechanism of Hg^{2+} uptake in the proximal tubule involves the activity of the organic anion transporter; affects renal uptake of Hg	(*99,100*)
Thiol compounds	Increase brain, liver, and kidney MeHg; decrease plasma MeHg; alter chelation and excretion of Hg	(*101–103*)
Effects of Hg		
Albumin	Hg alters free albumin availability; albumin shows preferential interaction with hydrophobic domains of the mercurial ligand; mercaptoalbumin forms stable complex with MeHg in serum	(*69,104*)
Carbohydrate	Hg acts through the endocrine system creating hormone/enzyme imbalance in carbohydrate metabolism; induces anaerobic stress that causes switch to glycolysis	(*93,105–107*)
Linoleic acid	May compete with Hg for the vitamin E antioxidant system and thus exacerbate the lethal effects of MeHg; Hg may catalyze lipid peroxidation of linoleic acid	(*84*)
Lipids	Inhibition of carnitine acetyltransferase occurs when Hg binds to enzyme sulfhydryl groups; Hg reacts with double bonds of fatty acid residues in phospholipids (major component of biomembranes)	(*108,109*)
Lipids	Inhibitory effect on hepatic fatty acid synthetase activity is mediated through interaction of Hg with sulfhydryl groups of the enzymes; Hg promotes oxidation of lipids; fat composition of diet affects toxicokinetics of Hg	(*110,111*)
Sugars	Hg inhibition of sugar absorption is ascribed to impairment of the sugar–Na phlorizin-sensitive cotransport; interacts with ligands of the transport proteins in the luminal membrane of enterocytes	(*112,113*)
Ubiquinol	MeHgCl induces alterations in electron transport in the ubiquinol–cytochrome *c* oxidoreductase region	(*114*)

Abbreviations: SH-, thiol; -SS-, oxidized thiol. [a]Table contains references to both inorganic and organic forms of Hg.