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Review

Dietary and lifestyle guidelines for the prevention of Alzheimer's disease

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ABSTRACT

Risk of developing Alzheimer's disease is increased by older age, genetic factors, and several medical risk factors. Studies have also suggested that dietary and lifestyle factors may influence risk, raising the possibility that preventive strategies may be effective. This body of research is incomplete. However, because the most scientifically supported lifestyle factors for Alzheimer's disease are known factors for cardiovascular diseases and diabetes, it is reasonable to provide preliminary guidance to help individuals who wish to reduce their risk. At the International Conference on Nutrition and the Brain, Washington, DC, July 19–20, 2013, speakers were asked to comment on possible guidelines for Alzheimer's disease prevention, with an aim of developing a set of practical, albeit preliminary, steps to be recommended to members of the public. From this discussion, 7 guidelines emerged related to healthful diet and exercise habits.

1. Introduction

Alzheimer's disease affected an estimated 4.7 million Americans in 2010, and its prevalence is expected to nearly triple in coming decades (Hebert et al., 2013). Several factors contribute to the risk of developing late-onset Alzheimer's disease, including older age, genetic factors (especially the presence of the APOEε4 allele), family history, a history of head trauma, midlife hypertension, obesity, diabetes, and hypercholesterolemia (Bendlin et al., 2010).

In addition, recent prospective studies have shown that certain dietary and lifestyle factors, including saturated fat intake, vitamin E intake, and physical exercise, among others, are associated with Alzheimer's risk, suggesting that prevention strategies may be applicable for these factors. In each of these areas, scientific evidence is less than complete. Nonetheless, individuals at risk for

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Alzheimer's disease make decisions about dietary and lifestyle on a daily basis and need to act on the best evidence available to them, even when scientific consensus may not have been achieved.

In toxicology, the "precautionary principle" is invoked in situations in which there is a substantial basis for concern regarding the health consequences of an exposure and for which available data preclude a comprehensive evaluation of risk (European Commission, 2000). A similar approach can be applied to nutritional and other lifestyle-related exposures, particularly for conditions, such as cancer or Alzheimer's disease, for which there may be a long latency period between exposure and disease manifestation and for which randomized controlled trials are impractical or are, for whatever reason, not rapidly forthcoming. Some have argued that the level of evidence required for making dietary recommendations for disease prevention may be different from that required for establishing the efficacy of medical treatments, such as pharmaceuticals (Blumberg et al., 2010).

At the International Conference on Nutrition and the Brain, Washington, DC, July 19–20, 2013, evidence regarding the influence of dietary factors, physical and mental exercise, and sleep on aspects of cognition was reviewed, and conference speakers were asked to comment on possible dietary and lifestyle guidelines for Alzheimer's disease prevention, with an aim of developing a set of practical steps to be recommended to members of the public.

2. Methods

The following principles were applied to the development of guidelines:

1. Guidelines were to be based on substantial, although not necessarily conclusive, evidence of benefit.
2. Implementation of guidelines should present no reasonable risk of harm.
3. The guidelines were to be considered to be subject to modification as scientific evidence evolves.

3. Results

Seven guidelines emerged and are as follows:

1. Minimize your intake of saturated fats and trans fats. Saturated fat is found primarily in dairy products, meats, and certain oils (coconut and palm oils). Trans fats are found in many snack pastries and fried foods and are listed on labels as "partially hydrogenated oils."
2. Vegetables, legumes (beans, peas, and lentils), fruits, and whole grains should replace meats and dairy products as primary staples of the diet.
3. Vitamin E should come from foods, rather than supplements. Healthful food sources of vitamin E include seeds, nuts, green leafy vegetables, and whole grains. The recommended dietary allowance (RDA) for vitamin E is 15 mg per day.
4. A reliable source of vitamin B12, such as fortified foods or a supplement providing at least the recommended daily allowance (2.4 μg per day for adults), should be part of your daily diet. Have your blood levels of vitamin B12 checked regularly as many factors, including age, may impair absorption.
5. If using multiple vitamins, choose those without iron and copper and consume iron supplements only when directed by your physician.
6. Although aluminum's role in Alzheimer's disease remains a matter of investigation, those who desire to minimize their exposure can avoid the use of cookware, antacids, baking powder, or other products that contain aluminum.
7. Include aerobic exercise in your routine, equivalent to 40 minutes of brisk walking 3 times per week.

4. Discussion

The rationale for each of these guidelines is briefly discussed as follows.

1. Minimize your intake of saturated fats and trans fats.

As reviewed elsewhere in this supplement, several (although not all) prospective studies have indicated an association between intake of saturated or trans fats and incident Alzheimer's disease (Barnard et al., 2014; Morris, 2014). Saturated fat is found especially in dairy products and meats; trans fats are found in many snack foods.

In the Chicago Health and Aging Project, individuals in the upper quintile of saturated fat intake had twice the risk of developing Alzheimer's disease during a 4-year study period, compared with participants in the lowest quintile (Morris et al., 2003). In the Washington Heights-Inwood Columbia Aging Project in New York and the Cardiovascular Risk Factors, Aging, and Dementia study in Finland, Alzheimer's disease risk was positively, but nonsignificantly, associated with saturated fat intake (Laitinen et al., 2006; Luchsinger et al., 2002). A number of well-controlled studies of cognitive decline have found that high saturated fat intake increases the rate of decline in cognitive abilities with age (Beydoun et al., 2007; Devore et al., 2009; Eskelinen et al., 2008; Heude et al., 2003; Morris et al., 2006b; Okereke et al., 2012).

Increased saturated fat intake is associated with risk of cardiovascular disease and type 2 diabetes (Mahendran et al., 2013; Mann, 2002), which, in turn, are associated with increased risk of Alzheimer's disease (Ohara et al., 2011; Puglielli et al., 2003). A large study of Kaiser Permanente patients showed that participants with total plasma cholesterol levels $\geq$240 mg/dL in midlife had a 57% higher risk of Alzheimer's disease 3 decades later, compared with participants with cholesterol levels $<$200 mg/dL (Solomon et al., 2009).

Additional evidence of mechanistic associations between saturated or trans fat intake and Alzheimer's risk comes from the fact that the APOEε4 allele, which is strongly linked to Alzheimer's risk, produces a protein that plays a key role in cholesterol transport (Puglielli et al., 2003) and from the observation that high-fat foods and/or the increases in blood cholesterol concentrations they may cause may contribute to beta-amyloid production or aggregation in brain tissues (Puglielli et al., 2001).

2. Vegetables, legumes (beans, peas, and lentils), fruits, and whole grains should replace meats and dairy products as primary staples of the diet.

Vegetables, berries, and whole grains provide healthful micronutrients important to the brain and have little or no saturated fat or trans fats. In both the Chicago Health and Aging Project and the Nurses' Health Study cohorts, high vegetable intakes were associated with reduced cognitive decline (Kang et al., 2005; Morris et al., 2006a). Legumes and fruits merit emphasis, not because of an association with reduced Alzheimer's disease risk, but because, like grains and vegetables, they provide macronutrient nutrition that is essentially free of saturated and trans fats

and are part of a dietary pattern associated with reduced risk of cardiovascular disease, weight problems, and type 2 diabetes (Fraser, 2009; Tonstad et al., 2009), which, in turn, have critical influences on brain health.

Many plant-based foods are rich in several B-vitamins. Folate and vitamin B6 are noteworthy in that, along with vitamin B12, they act as cofactors for the methylation of homocysteine; elevated homocysteine levels are associated with higher risk of cognitive impairment in some studies (Morris, 2012; Smith et al., 2010; Vogel et al., 2009). Nonetheless, the efficacy of B-vitamins is not yet settled; in an Oxford University study of older individuals with elevated homocysteine levels and mild cognitive impairment, supplementation with these 3 vitamins maintained memory performance and reduced the rate of brain atrophy (de Jager et al., 2012; Douaud et al., 2013; Smith, 2010).

Healthful sources of folate include leafy green vegetables, such as broccoli, kale, and spinach, beans, peas, citrus fruits, and cantaloupe. The RDA for folate acid in adults is 400 μg per day. Vitamin B6 is found in green vegetables in addition to beans, whole grains, bananas, nuts, and sweet potatoes. The RDA for adults up to age 50 is 1.3 mg per day. For adults >50 years older, the RDA is 1.5 mg for women and 1.7 mg for men.

3. Vitamin E should come from foods, rather than supplements. Healthful food sources of vitamin E include seeds, nuts, green leafy vegetables, and whole grains. The RDA for vitamin E is 15 mg per day.

In the Chicago Health and Aging Project, higher intakes of vitamin E from food sources were associated with reduced Alzheimer's disease incidence (Morris et al., 2005). Similarly, in the Rotterdam study, high vitamin E intake was associated reduced dementia incidence (Devore et al., 2010).

Vitamin E occurs naturally in the form of tocopherols and tocotrienols and is found in many foods, including mangoes, papayas, avocadoes, tomatoes, red bell peppers, and spinach, and particularly in high quantities in nuts, seeds, and oils. The RDA for adults is 15 mg. A small handful of typical nuts or seeds contains ~5 mg of vitamin E.

Vitamin E from supplements has not been shown to reduce Alzheimer's disease risk. Many common supplements provide only α-tocopherol, and most do not replicate the range of vitamin E forms found in foods. A high intake of α-tocopherol has been shown to reduce serum concentrations of γ- and δ-tocopherols (Huang and Appel, 2003).

4. A Reliable source of vitamin B12, such as fortified foods or a supplement providing at least the recommended dietary allowance (2.4 μg per day for adults) should be part of your daily diet. Have your blood levels of vitamin B12 checked regularly as many factors, including age, may impair absorption.

Vitamin B12 is essential for the health of the brain and nervous system and for blood cell formation. The RDA for adults is 2.4 μg. It is found in supplements and fortified foods, such as some breakfast cereals or plant milks. Vitamin B12 is also found in meats and dairy products, although absorption from these sources is limited in many individuals, particularly those older than 50 years, those with reduced stomach acid production, those taking certain medications (e.g., metformin and acid blockers), and individuals who have had gastrointestinal surgery (e.g., bariatric surgery) or who have Crohn disease or celiac disease.

The US Government recommends that vitamin B12 from supplements or fortified foods be consumed by all individuals older than 50 years. Individuals on plant-based diets or with absorption problems should take vitamin B12 supplements regardless of age. However, dietary sources and even vitamin B12 supplements may not be sufficient to sustain adequate blood levels. Some individuals require vitamin B12 injections. Every middle-aged or older adult should have his or her vitamin B12 status checked on a regular basis.

5. If using multiple vitamins, choose those without iron and copper and consume iron supplements only when directed by your physician.

Iron is essential for formation of hemoglobin and certain other proteins, and copper plays an essential role in enzyme functions among many other aspects of health. However, some studies have suggested that excessive iron and copper intake may contribute to cognitive problems for some individuals (Brewer, 2009; Squitti et al., 2014; Stankiewicz and Brass, 2009). In recent meta-analyses (Schrag et al., 2013; Squitti et al., 2013; Ventriglia et al., 2012), circulating non-protein-bound copper was associated Alzheimer's disease risk.

Other aspects of the diet may play a modulating role in the relationship between metals and cognitive effects. In the Chicago Health and Aging Project, individuals with a high intake of saturated fat along with a high copper intake were found to have cognitive decline equivalent to 19 additional years of aging (Morris et al., 2006b).

Most common multivitamins contain both iron and copper, sometimes exceeding the RDA (Physicians Committee for Responsible Medicine, 2013). However, most individuals in the United States meet the recommended intake of these minerals from everyday foods and do not require supplementation. The RDA for iron for women older than 50 years and for men at any age is 8 mg daily. For women of age 19–50 years, the RDA is 18 mg. The RDA for copper for men and women is 0.9 mg per day. For individuals who use multiple vitamins, it is prudent to favor products that deliver vitamins only, unless specifically directed by one's personal physician. Some authorities also suggest specific clinical testing (e.g., to measure levels of non-ceruloplasmin copper) before initiating diet changes (Squitti et al., 2014).

6. Although aluminum's role in Alzheimer's disease remains a matter of investigation, those who desire to minimize their exposure can avoid the use of cookware, antacids, baking powder, or other products that contain aluminum.

Aluminum's role in Alzheimer's disease remains controversial. Some researchers have called for caution, citing aluminum's known neurotoxic potential when entering the body in more than modest amounts (Kawahara and Kato-Negishi, 2011) and the fact that aluminum has been demonstrated in the brains of individuals with Alzheimer's disease (Crapper et al., 1973, 1976). Studies in the United Kingdom and France found increased Alzheimer's prevalence in areas where tap water contained higher aluminum concentrations (Martyn et al., 1989; Rondeau et al., 2009). However, because of the limited number of relevant studies, most experts regard current evidence as insufficient to indict aluminum as a contributor to Alzheimer's disease risk.

Because aluminum plays no role in human biology, it may be prudent to avoid aluminum exposure to the extent possible, although its role in cognitive disorders remains under investigation. Aluminum is found in some brands of baking powder, antacids, certain food products, and antiperspirants.

7. Include aerobic exercise in your routine, equivalent to 40 minutes of brisk walking 3 times per week.

Observational studies have shown that individuals who exercise regularly are at reduced risk for Alzheimer's disease (Erickson et al., 2012). Adults who exercised in midlife were found to be less likely to develop dementia after age 65, compared with their sedentary peers (DeFina et al., 2013). In controlled trials, aerobic exercise—such as brisk walking for 40 minutes 3 times per week—reduces brain atrophy and improves memory and other cognitive functions (Hotting and Roder, 2013).

In addition to the foregoing guidelines, other steps merit further investigation for possible inclusion in future iterations of prevention guidelines. These could include recommendations as follows:

1. Maintain a sleep routine that will provide an appropriate amount of sleep each night, approximately 7–8 hours for most individuals. It is important to evaluate and treat any underlying sleep disorders, such as obstructive sleep apnea. Sleep disturbances have been associated with cognitive impairment in older adults (Blackwell, 2011; Lim et al., 2013; Tworoger et al., 2006; Yaffe et al., 2011).
2. Engage in regular mental activity that promotes new learning, for example, 30 minutes per day, 4–5 times per week. Several studies have suggested that individuals who are more mentally active have reduced risk for cognitive deficits later in life (Curlik and Shors, 2013; Hotting and Roder, 2013; Robertson, 2013; Stern, 2012; Tucker and Stern, 2011).

5. Conclusions

Although current scientific evidence is incomplete, substantial evidence suggests that, a combination of healthful diet steps and regular physical exercise may reduce the risk of developing Alzheimer's disease. These lifestyle changes present additional benefits, particularly for body weight, cardiovascular health, and diabetes risk, and essentially no risk of harm. As investigations into Alzheimer's disease bear additional fruit, these guidelines should be modified accordingly.

Disclosure statement

Dr NDB writes books and articles, gives lectures related to nutrition and health, and has received royalties and honoraria from these sources. He and SML are affiliated with the Physicians Committee for Responsible Medicine, which promotes the use of low-fat, plant-based diets and discourages the use of animal-derived, fatty, and sugary foods. Dr AIB is a shareholder in Cogstate Ltd, Prana Biotechnology Ltd, and Mesoblast Pty Ltd. Dr CAdeJ has received honoraria from the Institute of Life Sciences Europe to contribute to manuscripts for publication and traveling expenses for meetings while on their nutrition and cognition expert group and task force and from the Chinese Nutrition Society for a conference presentation. Dr SK writes books and gives lectures regarding cognitive exercise and cognitive reserve and has received royalties and honoraria from these sources. All authors other than Dr NDB and Ms SML received honoraria from the Physicians Committee for Responsible Medicine for oral presentations at the International Conference on Nutrition and the Brain. Drs AC, JC, KIE, GF, SK, BL, MCM, and RS reported no other dualities of interest.

References

Barnard, N.D., Bunner, A.E., Agarwal, U., 2014. Saturated and trans fats and dementia: a systematic review. Neurobiol. Aging in press.

Bendlin, B.B., Carlsson, C.M., Gleason, C.E., Johnson, S.C., Sodhi, A., Gallagher, C.L., Puglielli, L., Engelman, C.D., Ries, M.L., Xu, G., Wharton, W., Asthana, S., 2010. Midlife predictors of Alzheimer's disease. Maturitas 65, 131–137.

Beydoun, M.A., Kaufman, J.S., Satia, J.A., Rosamond, W., Folsom, A.R., 2007. Plasma n-3 fatty acids and the risk of cognitive decline in older adults: the Atherosclerosis Risk in Communities Study. Am. J. Clin. Nutr. 85, 1103–1111.

Blackwell, T., Yaffe, K., Ancoli-Israel, S., Redline, S., Ensrud, K.E., Stefanick, M.L., Laffan, A., Stone, K.L., 2011. Association of sleep characteristics and cognition in older community-dwelling men: the MrOS sleep study. Sleep 34, 1347–1356.

Blumberg, J., Heaney, R.P., Huncharek, M., Scholl, T., Stampfer, M., Vieth, R., Weaver, C.M., Zeisel, S.H., 2010. Evidence-based criteria in the nutritional context. Nutr. Rev. 68, 478–484.

Brewer, G.J., 2009. The risks of copper toxicity contributing to cognitive decline in the aging population and Alzheimer's disease. J. Am. Coll. Nutr. 28, 238–242.

Crapper, D.R., Kishnan, S.S., Dalton, A.J., 1973. Brain aluminum distribution in Alzheimer's disease and experimental neurofibrillary degeneration. Science 180, 511–513.

Crapper, D.R., Krishnan, S.S., Quittkat, S., 1976. Aluminum, neurofibrillary degeneration and Alzheimer's disease. Brain 99, 67–80.

Curlik II, D.M., Shors, T.J., 2013. Training your brain: do mental and physical (MAP) training enhance cognition through the process of neurogenesis in the hippocampus? Neuropharmacology 64, 506–514.

DeFina, L.F., Willis, B.L., Radford, N.B., Gao, A., Leonard, D., Haskell, W.L., Weiner, M.F., Berry, J.D., 2013. The association between midlife cardiorespiratory fitness levels and later-life dementia. A cohort study. Ann. Intern. Med. 158, 162–168.

de Jager, C.A., Oulhaj, A., Jacoby, R., Refsum, H., Smith, A.D., 2012. Cognitive and clinical outcomes of lowering homocysteine-lowering B-vitamin treatment in mild cognitive impairment: a randomized controlled trial. Int. J. Geriatr. Psychiatry 27, 592–600.

Devore, E.E., Stampfer, M.J., Breteler, M.M.B., Rosner, B., Kang, J.H., Okereke, O., Hu, F.B., Grodstein, F., 2009. Dietary fat intake and cognitive decline in women with type 2 diabetes. Diabetes Care 32, 635–640.

Devore, E.E., Goldstein, F., van Rooij, F.J., Hofman, A., Stampfer, M.F., Witteman, J.C., Breteler, M.M., 2010. Dietary antioxidants and long-term risk of dementia. Arch. Neurol. 67, 819–825.

Douaud, G., Refsum, H., de Jager, C.A., Jacoby, R., Nichols, T.E., Smith, S.M., Smith, A.D., 2013. Preventing Alzheimer' s disease-related gray matter atrophy by B-vitamin treatment. Proc. Natl. Acad. Sci. U.S.A. 110, 9523.

Erickson, K.I., Weinstein, A.M., Lopez, O.L., 2012. Physical activity, brain plasticity, and Alzheimer's disease. Arch. Med. Res. 43, 615–621.

Eskelinen, M.H., Ngandu, T., Helkala, E.L., Tuomilehto, J., Nissinen, A., Soininen, H., Kivipelto, M., 2008. Fat intake at midlife and cognitive impairment later in life: a population-based CAIDE study. Int. J. Geriatr. Psychiatry 23, 741–747.

European Commission, 2000. Communication from the Commission on the Precautionary Principle. EUR-Lex. Available at: http://eur-lex.europa.eu/legal-content/EN/NOT/?uri=CELEX:52000DC0001&qid=1401297623692. Accessed September 7, 2013.

Fraser, G.E., 2009. Vegetarian diets: what do we know of their effects on common chronic diseases? Am. J. Clin. Nutr. 89 (Suppl), 1607S–1612S.

Hebert, L.E., Weuve, J., Scherr, P.A., Evans, D.A., 2013. Alzheimer disease in the United States (2010-2050) estimated using the 2010 census. Neurology 80, 1778–1783.

Heude, B., Ducimetière, P., Berr, C., 2003. Cognitive decline and fatty acid composition of erythrocyte membranes—the EVA Study. Am. J. Clin. Nutr. 77, 803–808.

Hotting, K., Roder, B., 2013. Beneficial effects of physical exercise on neuroplasticity and cognition. Neurosci. Biobehav. Rev. 9, 2243–2257.

Huang, H.Y., Appel, L.J., 2003. Supplementation of diets with α-tocopherol reduces serum concentrations of γ- and δ-tocopherol in humans. J. Nutr. 133, 3137–3140.

Kang, J.H., Ascherio, A., Grodstein, F., 2005. Fruit and vegetable consumption and cognitive decline in aging women. Ann. Neurol. 57, 713–720.

Kawahara, M., Kato-Negishi, M., 2011. Link between aluminum and the pathogenesis of Alzheimer's disease: the integration of aluminum and amyloid cascade hypotheses. Int. J. Alzheimer's Dis. 3, 276393.

Laitinen, M.H., Ngandu, T., Rovio, S., Helkala, E.L., Uusitalo, U., Viitanen, M., Nissinen, A., Tuomilehto, J., Soininen, H., Kivipelto, M., 2006. Fat intake at midlife and risk of dementia and Alzheimer's disease: a population-based study. Dement. Geriatr. Cogn. Disord. 22, 99–107.

Lim, A.S., Kowgier, M., Yu, L., Buchman, A.S., Bennett, D.A., 2013. Sleep fragmentation and the risk of incident Alzheimer's disease and cognitive decline in older adults. Sleep 36, 1027–1032.

Luchsinger, J.A., Tang, M.X., Shea, S., Mayeux, R., 2002. Caloric intake and the risk of Alzheimer's disease. Arch. Neurol. 59, 1258–1263.

Mahendran, Y., Cederberg, H., Vangipurapu, J., Kangas, A.J., Soininen, P., Kuusisto, J., Uusitupa, M., Ala-Korpela, M., Laakso, M., 2013. Glycerol and fatty acids in serum predict the development of hyperglycemia and type 2 diabetes in Finnish men. Diabetes Care. 36, 3732–3738.

Mann, J.I., 2002. Diet and risk of coronary heart disease and type 2 diabetes. Lancet 360, 783–789.

Martyn, C.N., Osmond, C., Edwardson, J.A., Barker, D.J.P., Harris, E.C., Lacey, R.F., 1989. Geographical relation between Alzheimer's disease and aluminum in drinking water. Lancet 333, 61–62.

Morris, M.C., Tangney, C.C., 2014. Dietary fat composition and dementia risk. Neurobiol. Aging in press.

Morris, M.C., Evans, D.A., Bienias, J.L., Tangney, C.C., Bennett, D.A., Aggarwal, N., Schneider, J., Wilson, R.S., 2003. Dietary fats and the risk of incident Alzheimer's disease. Arch. Neurol. 60, 194–200.

Morris, M.C., Evans, D.A., Tangney, C.C., Bienias, J.L., Wilson, R.S., Aggarwal, N.T., Scherr, P.A., 2005. Relation of the tocopherol forms to incident Alzheimer disease and cognitive change. Am. J. Clin. Nutr. 81, 508–514.

Morris, M.C., Evans, D.A., Tangney, C.C., Bienias, J.L., Wilson, R.S., 2006a. Associations of vegetable and fruit consumption with age-related cognitive change. Neurology 67, 1370–1376.

Morris, M.C., Evans, D.A., Tangney, C.C., Bienias, J.L., Schneider, J.A., Wilson, R.S., Scherr, P.A., 2006b. Dietary copper and high saturated and trans fat intakes associated with cognitive decline. Arch. Neurol. 63, 1085–1088.

Morris, M.S., 2012. The role of B vitamins in preventing and treating cognitive impairment and decline. Adv. Nutr. 3, 801–812.

Ohara, T., Doi, Y., Ninomiya, T., Hirakawa, Y., Hata, J., Iwaki, T., Kanba, S., Kiyohara, Y., 2011. Glucose tolerance status and risk of dementia in the community: the Hisayama Study. Neurology 77, 1126–1134.

Okereke, O.I., Rosner, B.A., Kim, D.H., Kang, J.H., Cook, N.R., Manson, J.E., Buring, J.E., Willett, W.C., Grodstein, F., 2012. Dietary fat types and 4-year cognitive change in community-dwelling older women. Ann. Neurol. 72, 124–134.

Physicians Committee for Responsible Medicine. Metals of Concern in Common Multivitamins. Available at: http://www.pcrm.org/health/reports/metals-of-concern-in-common-multivitamins. Accessed September 7, 2013.

Puglielli, L., Konopka, G., Pack-Chung, E., Ingano, L.A., Berezovska, O., Hyman, B.T., Chang, T.Y., Tanzi, R.E., Kovacs, D.M., 2001. Acyl-coenzyme A: cholesterol acyltransferase modulates the generation of the amyloid beta-peptide. Nat. Cell Biol. 3, 905–912.

Puglielli, L., Tanzi, R.E., Kovacs, D.M., 2003. Alzheimer's disease: the cholesterol connection. Nat. Neurosci. 6, 345–351.

Robertson, I.H., 2013. A noradrenergic theory of cognitive reserve: implications for Alzheimer's disease. Neurobiol. Aging 34, 298–308.

Rondeau, V., Jacqmin-Gadda, H., Commenges, D., Helmer, C., Dartigues, J.-F., 2009. Aluminum and silica in drinking water and the risk of Alzheimer's disease or cognitive decline: findings from 15-year follow up of the PAQUID cohort. Am. J. Epidemiol. 169, 489–496.

Schrag, M., Mueller, C., Zabel, M., Crofton, A., Kirsch, W.M., Ghribi, O., Squitti, R., Perry, G., 2013. Oxidative stress in blood in Alzheimer's disease and mild cognitive impairment: a meta-analysis. Neurobiol. Dis. 59, 100–110.

Smith, A.D., Smith, S.M., de Jager, C.A., Whitbread, P., Johnston, C., Agacinski, G., Oulhaj, A., Bradley, K.M., Jacoby, R., Refsum, H., 2010. Homocysteine-lowering by B vitamins slows the rate of accelerated brain atrophy in mild cognitive impairment: a randomized controlled trial. PLoS One 5, e12244.

Solomon, A., Kivipelto, M., Wolozin, B., Zhou, J., Whitmer, R.A., 2009. Midlife serum cholesterol and increased risk of Alzheimer's and vascular dementia three decades later. Dement. Geriatr. Cogn. Disord. 28, 75–80.

Squitti, R., Simonelli, I., Ventriglia, M., Siotto, M., Pasqualetti, P., Rembach, A., Doecke, J., Bush, A.I., 2013. Meta-analysis of serum non-ceruloplasmin copper in Alzheimer's disease. J. Alzheimers Dis. 38, 809–822.

Squitti, R., Siotto, M., Polimanti, R., 2014. Low-copper diet as preventive strategy to decrease the risk for copper phenotype in Alzheimer's disease. Neurobiol. Aging in press.

Stankiewicz, J.M., Brass, S.D., 2009. Role of iron in neurotoxicity: a cause for concern in the elderly? Curr. Opin. Clin. Nutr. Metab. Care 12, 22–29.

Stern, Y., 2012. Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol. 11, 1006–1012.

Tonstad, S., Butler, T., Yan, R., Fraser, G.E., 2009. Type of vegetarian diet, body weight and prevalence of type 2 diabetes. Diabetes Care 32, 791–796.

Tucker, A.M., Stern, Y., 2011. Cognitive reserve in aging. Curr. Alzheimer Res. 8, 354–360.

Tworoger, S.S., Lee, S., Schernhammer, E.S., Grodstein, F., 2006. The association of self-reported sleep duration, difficulty sleeping, and snoring with cognitive function in older women. Alzheimer Dis. Assoc. Disord. 20, 41–48.

Ventriglia, M., Bucossi, S., Panetta, V., Squitti, R., 2012. Copper in Alzheimer's disease: a meta-analysis of serum, plasma, and cerebrospinal fluid studies. J. Alzheimers Dis. 30, 981–984.

Vogel, T., Dali-Youcef, N., Kaltenbach, G., Andrès, E., 2009. Homocysteine, vitamin B12, folate and cognitive functions: a systematic and critical review of the literature. Int. J. Clin. Pract. 63, 1061–1067.

Yaffe, K., Laffan, A.M., Harrison, S.L., Redline, S., Spira, A.P., Ensrud, K.E., Ancoli-Israel, S., Stone, K.L., 2011. Sleep-disordered breathing, hypoxia, and risk of mild cognitive impairment and dementia in older women. J. Am. Med. Assoc. 306, 613–619.