PUBLICATIONS

PUBLICATIONS IN MEDICAL AND SCIENTIFIC JOURNALS DESCRIBING DIET AND VISION STUDY FINDINGS

(Funded under the National Institutes of Health grant entitled: Carotenoids in Age-Related Eye Disease Study)

AGE-RELATED MACULAR DEGENERATION, OR "AMD"

Millen AR, Meyers KJ, Liu Z, Engelman CD, Wallace RB, Le Blanc ES, Tinker L, Iyengar SK, Robinson J, Sarto G, Mares JA. **Association between vitamin D status and age-related macular degeneration by genetic risk**. 2015. JAMA Ophthalmology. 2015 Oct 1;133(10):1171-9. PMCID4841267 http://www.ncbi.nlm.nih.gov/pubmed/26312598

This study found a lower likelihood of having age-related macular degeneration in women who had adequate levels of vitamin D in their blood 6 years earlier (when they entered the WHI), compared with the 30% of women who did not. The results suggested that the lowering of AMD risk in women having adequate levels of vitamin D was especially strong among women who had higher genetic risk for AMD.

Meyers KJ, Liu Z, Millen AE, Iyengar SK, Blodi BA, Johnson E, Snodderly M, Klein ML, Gehrs KM, Tinker L, Sarto GE, Robinson J, Wallace RB, Mares JA. **Joint associations of diet, lifestyle, and genes for age-related macular degeneration in the Carotenoids in Age-related Eye Disease Study.** Ophthalmology. 2015 Nov;122(11):2286-94. PMCID4714866. http://www.ncbi.nlm.nih.gov/pubmed/26354764

Women who reported the healthiest lifestyles, when they first participated in the WHI, had a three-fold lower odds of having age-related macular degeneration six years later (when they participated in the Diet and Vision Study). Having these lifestyles also lowered the estimated risk associated with having high–risk (complement factor H) gene variants. However, healthy lifestyles lowered risk **both** in women with and without high risk genetic variants. Women with healthiest lifestyles did not smoke, had overall diet scores in the highest 20%, and were physically active at least eight hours per week (including such things as walking, gardening and housework).

Mares JA, Voland R, Sondel SA, Millen AE, LaRowe T, Moeller SM, Klein ML, Blodi BA, Chappell R, Tinker C, Gehrs K, Sarto G, Johnson EJ, Snodderly M, Wallace RB. **Healthy lifestyles related to subsequent prevalence of age-related macular degeneration**. Arch Ophthalmol. 2011 Apr;129(4):470-80. http://pubmed.gov/21149749. PMCID3075357.

This paper described the finding that women in the Diet and Vision Study who had healthy lifestyles (diet scores in the highest 20%, non-smokers, and physical activity at least eight hours per week) had a lower risk of AMD. The risk lowering was marked (three-fold lower) in women who had all three healthy lifestyles, compared with those who smoked more than 7 pack-years in their lives, were not physically active, and had diet quality scores in the lowest 20%.

Millen AE, Voland R, Sondel S, Parekh N, Horst RL, Wallace RB, Hageman GS, Chapell R, Blodi BA, Klein ML, Gehrs KM, Sarto GE, Mares JA. **Vitamin D status and intermediate age-related macular degeneration in postmenopausal women.** Arch Ophthalmol. 2011;129(4):481-89. http://www.ncbi.nlm.nih.gov/pubmed/21482873. PMCID3075411.

This paper described the association between vitamin D in blood when women entered the WHI and risk of early AMD about six years later when participating in the Carotenoids in Age-Related Eye Disease Study (CAREDS). Risk of AMD was higher among women with lower levels of vitamin D, and in women who were younger than 75 years, when entering the WHI.

Parekh N, Voland RP, Moeller SM, Blodi BA, Ritenbaugh C, Chappell RJ, Wallace RB, Mares JA. (2009). **Association between dietary fat intake and age-related macular degeneration in the Carotenoids in Age-Related Eye Disease Study** (CAREDS): An Ancillary Study of the Women's Health Initiative. Arch Ophthalmol **127**(11): 1483-1493 (2009). http://Pubmed.gov/19901214.

This study examined the association of dietary fat, estimated from dietary questionnaires completed when women entered the WHI, to the odds of having AMD about six years later. High intake of polyunsaturated fats (largely from margarine, mayonnaise, salad dressing, vegetable oils) was associated with higher risk of AMD. High intake of polyunsaturated fats from these sources has been linked to higher inflammation in other studies. The study also found that AMD risk was ***lower*** in women who consumed more monounsaturated fats (as one could get from eating foods like olive oil and nuts).

Unexpectedly, intake of omega-3 fish oils was low in women's diets reported in 1998 or earlier and their intake was also associated with ***higher*** odds of having AMD, rather that lower odds, as reported in several other studies. This unexpected finding might be explained by the fact that, at this time, most women consumed fish as part of tuna salad, made with mayonnaise which was high in polyunsaturated fats.

The authors noted that high-fat diets also tended to be lower in healthful nutrients, which could lower inflammation and oxidative stress, both of which could affect AMD risk.

LaRowe TL, Mares JA, Snodderly DM, Klein ML, Wooten BR, Chappell R. **Macular pigment density and age-related maculopathy in the Carotenoids in Age-Related Eye Disease Study**, an ancillary study of the Women's Health Initiative. Ophthalmology, 115(5):876-883 (2008). http://Pubmed.gov/17868874

https://www.sciencedirect.com/science/article/pii/S0161642007006677?via%3Dihub

The scientific evidence to support the idea that lutein in the retina protected against AMD was mounting, but the relationship of levels of lutein in the diet were inconsistent in previous studies. Studies examining relationships of lutein ***in the retina*** were important, as it appeared that the amounts of dietary lutein and zeaxanthin that accumulated in the retina varied from person to person. Studying directly the relationships of the carotenoid plant pigments lutein and zeaxanthin in the center (macula) of the back of the eye (retina) to AMD were needed. The ability to make these macular pigment measurements with a non-invasive flicker test made this possible. However, studies of this type were few and conducted in small samples of 50 to 450 people. Almost 2,000 women participating in the Diet and Vision Study contributed to the first large study of relationships of macular pigment to AMD.

We found that when macular pigment and AMD were measured at the same point in time, protective associations were not observed. An exception was in women under 70 years with stable diets in whom we observed the hypothesized protective relationships. Among these women, the 20% with the highest macular pigment had a two-fold lower odds of having early signs of AMD. These findings suggested that it could be important to study these relationships over time to avoid conditions which could mask these protective relationships, as we are doing the second Diet and Vision Study.

Moeller SM, Parekh N, Tinker L, Ritenbaugh C, Blodi B, Wallace RB, Mares, JA. **Associations between intermediate age-related macular degeneration and lutein and zeaxanthin in the Carotenoids in Age-related Eye Disease Study** (CAREDS): an ancillary study of the Women's Health Initiative, Arch Ophthalmol 124: 1151-1162 (2006). http://Pubmed.gov/16908818.

This paper described the association between dietary intake of two carotenoid plant pigments (lutein and zeaxanthin) that accumulate in the eye, and risk of intermediate AMD. The authors found that women whose daily diets averaged more than about 3 mg of these pigments had a forty percent lower odds of having AMD, compared with those whose diets averaged less than 1 mg, if including women who were less than 75 years when they entered the WHI, and who had stable diets. Vegetables, especially green ones, are highest in these pigments. Women whose intake of green vegetables was in the highest third had a two-fold lower odds of having AMD, compared with those in the lowest third of intake.

CATARACT OF THE LENS AND LENS OPACITIES

Rao, P, Millen AE, Meyers KJ, Zhe L, Voland R, Sondel S, Tinker L, Wallace R, Blodi B, Binkley N, Sarto G, Robinson J, LeBlanc E, Mares JA. **The relationship between serum 25-hydroxyvitamin D levels and nuclear cataract in the Carotenoid Age-Related Eye Study** (CAREDS), an ancillary study of the Women's Health Initiative. Invest Ophthalmol Vis Sci. 2015 Jul 1; 56(8):4221-30. PMCID4495813. http://www.ncbi.nlm.nih.gov/pubmed/26132781

Diet and Vision study investigators were among the first to explore links between blood vitamin D and odds for having cataract. We examined whether women with higher levels of vitamin D in the blood at the time of entry into the WHI had a lower likelihood of having signs of central (nuclear) cataract or a cataract extraction six years later. We observed no association overall. However, women under 70 years of age at the time of entry into the WHI and who had serum vitamin levels in the highest 40%, had about 40% lower odds for having nuclear cataract or a cataract extraction, compared to women in the lowest 20%. More research is needed to better evaluate whether better vitamin D status lowers risk for cataract. Our longer (15 year) follow-up study is expected to provide even stronger evidence to determine whether vitamin D intake and blood levels are linked to slower development of cataract and risk of cataract surgery.

Freedman LA, Midthune D, Carroll RJ, Tasevska N, Schatzkin A, Mares J, Tinker L, Potischman N, Kipnis V. **Using regression calibration equations that combine self-reported intake and biomarker measures to obtain unbiased estimates and more powerful tests of dietary associations.** Am J Epidemiol. Dec 1 2011;174(11):1238-1245. http://www.ncbi.nlm.nih.gov/pubmed/22047826 PMCID3224252.

Statisticians and epidemiologists at the NIH collaborated with Diet and Vision Study investigators in a paper which demonstrated that using persons' lutein levels in both diet and blood together estimated a larger risk lowering than when using estimates in the diet alone.

Mares JA, Voland RP, Adler R, Tinker L, Millen AE, Moeller SM, Blodi B, Gehrs KM, Wallace RB, Chappell RJ, Neuhouser MJ, Sarto G. **Healthy diets and the subsequent prevalence of nuclear cataract in women**. Arch Ophthalmol. 2010 Jun;128(6):738-4. http://Pubmed.gov/20547952.

Women with the healthiest eating patterns (more fruits and vegetables and whole grains, less saturated fat and sodium) had a lower risk of the most common type of cataract in Americans.

Moeller, S, Voland, R, Tinker, L, Blodi, B, Klein, M, Gehrs, K., Johnson, E., Snodderly, M, Wallace, R, Chappell, R, Parekh, N, Ritenbaugh, C, Mares, JA. **Associations between age-related nuclear cataract and lutein and zeaxanthin in the diet and serum in the Carotenoids in Age-Related Eye Disease Study** (CAREDS), an Ancillary Study of the Women's Health Initiative. Arch Ophthalmol; 126(3):354-364 (2008). http://Pubmed.gov/18332316. PMCID2562026.

The prevalence of the most common type of cataract (central, or nuclear cataract) was lower in women who had higher intake or blood levels of the carotenoid plant pigments, lutein and zeaxanthin, six years earlier.

PLANT PIGMENTS, LUTEIN AND ZEAXANTHIN, IN OUR DIETS AND EYES

Meyers KJ, Mares JA, Igo RP, Truitt B, Liu Z, Millen AE, Klein M, Johnson EJ, Engelman CD, Karki CK, Blodi B, Gehrs K, Tinker L, Wallace R, Robinson J, LeBlanc ES, Sarto G, Bernstein PS, SanGiovanni JP, Iyengar SK. **Genetic evidence for role of carotenoids in age-related macular degeneration in the Carotenoids in Age-Related Eye Disease Study** (CAREDS). Invest Ophthalmol Vis Sci. 2014 Jan 29; 55(1):587-99. http://www.ncbi.nlm.nih.gov/pubmed/24346170.

We observed that women who had specific genetic variants for proteins that help us absorb carotenoids in our intestine, carry them in our blood, and take them into specific locations in the back of the eye (retina) have a lower risk for AMD. We reported these findings in 2013 (See publication below). These carotenoids can protect the retina from age-related damage and may lower risk of AMD. We created a 'risk score' to show that a combination of the most strongly associated genetic variants could lead to a 3-fold increase in odds of having of AMD. This evidence, from our genes, is powerful evidence for the importance of carotenoids, like lutein and zeaxanthin in protecting against this condition.

Meyers KJ, Johnson EJ, Bernstein PS, Iyengar SK, Engelman CD, Karki CK, Liu Z, Igo RP, Truitt B, Klein ML, Snodderly M, Blodi BA, Gehrs KM, Sarto GE, Wallace RB, Robinson J, LeBlanc ES, Hageman G, Tinker L, Mares JA. **Genetic determinants of macular pigment in women of the Carotenoids in Age-Related Eye Disease Stu**dy (CAREDS). Invest Ophthalmol Vis Sci. 2013 Mar 28; 54(3):2333-45. http://www.ncbi.nlm.nih.gov/pubmed/23404124.

Women participating in the Diet and vision Study, (Carotenoids in Age-Related Eye Disease Sub Study, CAREDS) provided blood samples from which genetic data were analyzed to conduct the largest study of genetic traits related to the accumulation of carotenoid pigments lutein and zeaxanthin in the macula of the retina (macular pigments). We found that 21 genetic variants in 11 different genes partially explained the more than 10-fold variation in the density of macular pigments across about 1,600 women. This provided a partial explanation for why people who eat the same amount of these carotenoids, have different levels of them in our eyes.

Mares, JA, LaRowe, TL, Snodderly, DM, Moeller, SM, Gruber, MJ, Klein, ML, Wooten, BR, Johnson, EJ, Chappell, R. **Predictors of optical density of lutein and zeaxanthin in retinas of older women in the Carotenoids in Age-Related Eye Disease Study**, an ancillary study of the Women's Health Initiative. Am J Clin Nutr ;84:1107-22 (2006). http://Pubmed.gov/17093164.

This Diet and Vision Study paper confirmed the observation of lower macular pigment density in people with more body fat, reported previously in smaller studies. We also found that women

with type 2 diabetes had lower levels of macular pigment at all levels of lutein and zeaxanthin intake. Moreover, we found clues about other diet attributes that may help us accumulate macular pigment. As expected, women who had higher levels of lutein and zeaxanthin in their diet and blood, tended to have higher levels in their retina. Other aspects of diet were also related to higher macular pigment after adjusting for lutein and zeaxanthin. This includes higher intakes of polyunsaturated fats, which other studies show increase the absorption of lutein. This also includes fiber (from fruits, vegetable, legumes and whole grains). We speculate these foods provide protective antioxidants that lessen the turnover of lutein, or promote the health of retinal tissue where these pigments reside. More recent studies implicate healthier gut microbes in people who eat high fiber diets, and this makes us wonder whether healthier microbes (which support lean waists and low inflammation) might also support healthier retinas and the ability to accumulate protective plant pigments.

Snodderly M, Mares JA, Wooten BR, Oxton LL, Gruber M, Ficek T. **Macular pigment measurement by heterochromatic flicker photometry in older subjects.** The Carotenoids and Age-Related Eye Disease Study (CAREDS). Invest Ophthalmol Vis Sci; 45(2):531-538 (2004). Http://Pubmed.gov/14744895.

This article describes the technology and standardized protocol used to measure levels of carotenoids (lutein and zeaxanthin) that accumulate in the eye, in the Carotenoids in Age-Related Eye Disease Study (CAREDS). The measurement technique is simple, non-invasive, is valid, and has a high level of reliability. (That is, you would get similar results if you repeated the test many times).

STUDIES OF GENETICS, DIET AND LIFESTYLES THAT INFLUENCE BLOOD LEVELS OF VITAMIN D

Engelman CD, Meyers KJ, Iyengar SK, Liu Z, Karki CK, Igo RP, Truitt B, Robinson J, Sarto GE, Wallace R, Blodi BA, Klein M, Tinker L, LeBlanc E, Jackson RD, Song Y, Manson JE, Mares JA, Millen AE. **Vitamin D intake and season modify the effects of GC and CYP2R1 genes on 25-hydroxyvitamin D concentrations**: J Nutr. 2013 Jan; 143(1):17-26. http://www.ncbi.nlm.nih.gov/pubmed/23190755. PMCID3521459.

The relationship of certain genetic factors to the levels of vitamin D in the blood, were determined from blood specimens in women participating in the Diet and Vision Study. Six of these genetic variants were associated with vitamin D levels, but the association was different depending on the season in which women had their levels measured (presumably because sun exposure is a major factor determining vitamin D levels). The authors concluded that certain individuals, depending on their genetic makeup, may need to take in greater amounts of vitamin D in order to maintain adequate levels in the blood.

Kluczynski MA, Lamonte MJ, Mares JA, Wactawski-Wende J, Wilder Smith A, Engelman CD, Andrews CA, Snetselaar LG, Sarto GE, Millen AE. **Duration of physical activity and serum 25-hydroxyvitamin D status of postmenopausal women**. Ann Epidemiol 21(6):440-449. June 2011. http://Pubmed.gov/21414803 PMCID3090482.

By examining the characteristics of Diet and Vision Study women that were related to higher levels of vitamin D in their blood, we were able to gain clues about which lifestyles may support healthy vitamin D status. We found that higher intake of vitamin D (from foods such as fish, milk, and fortified cereals, and from supplements) was associated with higher blood levels. Longer durations of recreational activity (such as walking, jogging, biking and golf) was associated with higher vitamin D. As expected, the association was strongest during the summer/fall seasons when the levels of UV light needed to make vitamin D in our skin would be higher. A longer duration of yardwork was also related to higher blood levels of vitamin D, but this was not significant after adjusting for vitamin D intake.

SELECTED RECENT ABSTRACTS

We present early findings at scientific meetings, giving us an opportunity to get input from other investigators in the field, as we prepare final papers to submit for publication. These give you an idea of soon to be published findings made possible by Diet and Vision Study participants after women who would like to contribute to the Second Diet and Vision Study have had a chance to do so, before study close-out in 2018.

Christensen K, Liu Z, Wallace R, Liu Y, Millen AE, Blodi BA, Klein ML, Mares, JA. **Macular pigment and prevalent inflammatory disease among older women in the Carotenoids in Age-Related Eye Disease Study (CAREDS), an ancillary study of the Women's Health Initiative**. Annual Meeting of the Association for Research in Vision and Ophthalmology, Honolulu, HI, April 28-May 3, 2018. Program #441. Poster Board #A0024.

Liu Z, Christensen K, Lawler TP, Wood K, Liu Y, Snodderly M, Millen AE, Tinker L, Mares JA. **Macular pigment and contrast sensitivity among older women in the second Carotenoids in Age-Related Eye Disease Study (CAREDS), an ancillary study of the Women's Health Initiative**. Annual Meeting of the Association for Research in Vision and Ophthalmology, Honolulu, HI, April 28-May 3, 2018. Program #509. Poster Board #A0235.

Lawler TP, Liu Z, Christensen K, Liu Y, Wallace R, Millen AE, Johnson E, Hall K, Gehrs K, Blodi B, Mares JA. **The relationship between lutein and zeaxanthin intake and change in macular pigment in the second Carotenoids in Age-Related Eye Disease Study (CAREDS 2).** Annual Meeting of the Association for Research in Vision and Ophthalmology, Honolulu, HI, April 28-May 3, 2018. Program #509. Poster Board #A0235.

Preliminary analyses in older women in the Second Diet and Vision Study indicate that higher macular pigment density was associated with better ability to see contrasts (such as needed when walking on steps). This was true both in women who had age-related eye diseases of AMD or glaucoma, and in women who had no eye disease. These results add to an increasing body of evidence suggesting that taking steps to increase macular pigment may improve vision.

Christensen K, Liu Z, Wallace R, Liu Y, Millen AE, Blodi BA, Klein ML, Mares, JA. . **Macular Pigment and Prevalent Inflammatory Disease Among Older Women in the Carotenoids in Age-Related Eye Disease Study (CAREDS), an ancillary study of the Women's Health Initiative**

Preliminary data in older women in the Second Diet and Vision Study suggest a trend towards lower odds of having an inflammatory disease or arthritis among 25% of women with the highest macular pigment density levels.

Mares J, Liu Z, Wallace R, Gangnon R, Hammond B, Johnson E, Tinker L, Engelman C, Sarto G, Snodderly MD, for the Carotenoids in Age-Related Eye Disease Study Investigators. **The relationship of macular pigment optical density (MPOD) to mortality in the second Carotenoids in Age-Related Eye Disease Study** (CAREDS 2), an ancillary study of the Women's Health Initiative (WHI). Annual Meeting of the Association for Research in Vision and Ophthalmology, Baltimore MD, May, 2017. http://iovs.arvojournals.org/article.aspx?articleid=2640437&resultClick=1

Women with the highest 40% of macular pigment density levels had about forty percent lower risk of death between the first Diet and Vision Study in 2001-2004 and 2016.

Liu Z, Ganaputra S, Johnson E, Hammond B, Wallace R, Tinker L, Snodderly MD, Sarto G, Blodi B, Mares J. **Relationships of macular pigment optical density (MPOD) to cataract extraction in the second Carotenoids in Age-Related Eye Disease Study** (CAREDS 2), an ancillary study of the Women's Health Initiative (WHI) Observational Study. Annual Meeting of the Association for Research in Vision and Ophthalmology, Baltimore MD, May 6-12, 2017. Program #572. Poster Board #B0259. http://iovs.arvojournals.org/article.aspx?articleid=2642493&resultClick=1

There was a protective trend for low risk of cataract extraction between first Diet and Vision Study in 2001-2004 and 2016, but it was not statistically significant.

Liu Z, Meyers K, Johnson E, Snodderly M, Tinker L, Wallace R, Sarto G, Mares J. **Exposure to lutein in infancy via breast milk and later life macular pigment optical density.** Annual Meeting of the Association for Research in Vision and Ophthalmology, Denver, CO, May 1-7, 2015. Program #192. Poster Board # C0047. http://iovs.arvojournals.org/article.aspx?articleid=2331661

Women in the diet and vision study who report being fed breastmilk in infancy had higher macular pigment density than women who did not. This contributes to an emerging body of evidence for the importance of breastfeeding, which is rich in the yellow lutein and zeaxanthin pigments that accumulate in the back of infants' eyes as they are gaining the ability to see acutely in early life, and in their brains, as well. It suggests that breastfeeding might have an impact of vision lifelong.

Meyers K, Liu Z, Wang S, Klein M, Wallace R, Tinker L, Blodi B, Johnson E, Iyengar S, Mares J. **Phenotypic and genotypic predictors of low retinal response to diets high in lutein**. Annual Meeting of the Association for Research in Vision and Ophthalmology, Denver, CO, May 1-7, 2015. Program #1083. Poster Board # C0096. http://iovs.arvojournals.org/article.aspx?articleid=2330765&resultClick=1

We used complex statistical methods to develop a model of genetic, diet and health attributes that best predict women who have low macular pigment density levels, despite reporting high intake in these lutein and zeaxanthin pigments in foods and supplements. These might represent women who have poor response to intake and might require even higher levels of these pigments, or diets which facilitate their accumulation to maintain high levels of these protect pigments in their eyes.

Selected Recent Book Chapters and Reviews of the Scientific Evidence from the Diet and Vision Study and Other Studies

Book chapters and reviews below detail how nutrition can improve eye health and lower risk for a variety of common age-related eye diseases. They are written for scientists, dieticians, eye doctors, and student of nutrition and ophthalmology worldwide. What we have learned from the Diet and Vision Study results have made major contributions to these publications.

Mares JA, Millen AE, Lawler, TP, Blomme, CK: **Diet and supplements in the prevention and treatment of eye diseases, In: Nutrition in the Prevention and Treatment of Disease**, Fourth Edition, Coulston, A, (ed) Elsevier, Inc., San Diego, CA, Chapter 19, pp 391-432, 2017.

This book chapter provides a detailed review of the role of the dietary carotenoids lutein and zeaxanthin (which accumulate in the eye and protect the retina from damage). It then provides a detailed account of the current evidence that suggests that many components of foods and supplements, and overall healthy diets could lower risk for AMD, cataracts, glaucoma and diabetic retinopathy.

Mares, JA **Lutein and Zeaxanthin Isomers in Eye Health and Disease.** Ann Rev Nutr. 2016: 36: 571-602. PMCID5611842. http://pubmed.gov/27431371.

This paper reviews the role of the dietary carotenoids lutein and zeaxanthin (which accumulate in the eye and protect the retina from damage) in eye health and disease. It includes information we learned in the Diet and Vision Study, (Carotenoids in Age-Related Eye Disease Study, CAREDS), as well as the most current information from many other studies around the world.

Evidence to date, indicates that lutein, zeaxanthin and meso-zeaxanthin accumulate in the eye during early life, when many structures of the eye are completing development. Breastmilk is an excellent source of these carotenoids. Since about 2012, some infant formulas also contain lutein and zeaxanthin.

The paper also reviews lutein and zeaxanthin levels in food and supplements. Some of the greatest contributors to American diets are leafy greens, corn tortillas, egg, and orange juice. However, it is not yet known exactly how much lutein and zeaxanthin need to be consumed to get the greatest eye health benefits.

Mares JA: Foods and supplements in the prevention and treatment of age-related macular degeneration. In: Albert and Jakobiec's Principles and Practice of Ophthalmology, Third Edition, Elsevier, Inc., 2008.

This book chapter reviews the role of nutrition in preventing and treating AMD, published to provide for eye doctors with the latest information needed to guide patient recommendations for eye health.

Three different streams of evidence are reviewed: results from animal or cell culture studies; results from observational studies of people with no investigator intervention; and results from clinical trials where investigators provided a nutritional intervention to some participants but not to others.

The evidence is summarized through **four simple nutritional recommendations**: eat an abundance of fruits and vegetables of varying colors; eat whole grains at most meals, as breads, cereals or pasta; eat a variety of protein sources daily (such as dairy, nuts, seeds, poultry, meat and eggs); eat moderate amounts of fat, reducing processed fats and omega-6 fats and increasing omega-3 fatty acids (such as those in nuts, olives, avocadoes, and fatty fish).

Whitehead, AJ, Mares, JA, Danis, RP, **Macular pigment: A review of current knowledge**. Arch Ophthalmol, 124: 1038-1054 (2006). http://Pubmed.gov/16832030.

This review summarizes what is known about dietary carotenoids that accumulate in the eye, where they are termed ‘macular pigment’. These carotenoid plant pigments are largely found in leafy greens, other fruits and vegetables, and eggs. They protect the retina from damage by filtering blue light, and by reducing oxidative stress. Many factors – including overall diet quality and genetic factors – affect individual ability to accumulate L and Z in the eye.