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Reliability and validity of a culturally appropriate food frequency questionnaire to measure the omega-3 fatty acid intakes of Midwestern African American women of childbearing age

Narissa Scales

University of Nebraska-Lincoln, narissa_s@yahoo.com

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Frequency Questionnaire to Measure Omega-3 Fatty Acid Intakes
in Midwestern African American Women of Childbearing Age

By

Narissa E. Scales

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Reliability and Validity of a Culturally Appropriate Food Frequency Questionnaire to Measure Omega-3 Fatty Acid Intakes in Midwestern African American Women of Childbearing Age

Narissa Scales, Ph.D.

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Adviser: Julie A. Albrecht

Omega-3 fatty acid intakes may play an important role in maternal health outcomes and infant brain and neural development. Research has shown that pregnant African American women have intakes below recommended levels for optimal health. The aim of this study was to determine the reliability and validity of a culturally specific food frequency questionnaire (FFQ) to measure total omega-3 fatty acid, alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) intake of Midwestern African American women (n=49) of childbearing age and examine associations of maternal health issues from previous pregnancies. The omega-3 FFQ questionnaire was developed by 24 hour recall interviews, analyzed for content validity and pilot tested. The final culturally appropriate 187 item FFQ was then completed by women three times, via interview by an RD, along with three non-consecutive 24 hour recalls, in a two week period. Maternal health issues were assessed by demographic questionnaire. The reliability and validity of the FFQ was assessed by Cronbach's coefficient alpha and Pearson correlation coefficients, respectively. Mean daily consumption of total omega-3 fatty acid, ALA, EPA, DHA and DPA, as estimated by the three administrations of the FFQ, were 2.68 ± 1.37 g/day, 2.45 ± 1.30 g/day, 0.07 ± 0.07

g/day, 0.12 ± 0.11 g/day and 0.03 ± 0.02 g/day, respectively. The Cronbach's coefficient alpha, for reliability of the FFQ, was 0.89 for total omega-3, 0.89 for ALA, 0.89 for EPA, 0.88 for DHA and 0.83 for DPA. The Pearson correlation coefficients as measured for validity between the FFQ and the recalls, were 0.44, 0.44, 0.59 and 0.60 for total n-3 fatty acid, ALA, EPA and DHA (P<.01), respectively. African American women with past history of low birth weight, preterm labor, premature rupture of membranes and post-partum depression had a significant difference (p<.05) in omega-3 fatty acid intakes when compared to those without prior history. In conclusion, this culturally appropriate FFQ seems to be reliable and valid in measuring omega-3 fatty acid intake in Midwestern African American women. This tool may be used to assess other populations of African American women's intake of omega-3 fatty acids.

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Introduction

Dietary intake of omega-3 fatty acids may play an important role in positive maternal and infant health outcomes.[1] Alpha-linolenic acid (ALA), an essential omega-3 fatty acid, must be obtained from the diet and is needed for optimal health.[2,3] The Adequate Intake (AI) for ALA is 1.4g/d and 1.1g/d for pregnant and non-pregnant females, between the ages of 14-50.[4] Food sources of ALA are vegetable oils, such as soybean, canola and flaxseed, as well as, nuts and seeds.[5] Once acquired from the diet, ALA can be further metabolized to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are both needed by the body, especially during pregnancy.[1-3,6] EPA and DHA are reported to possibly decrease the risk of maternal health issues, including preterm birth and low birth weight,[7-10] preeclampsia[11,12] and postpartum depression.[13,14] DHA seems to be important for growth and development, evidenced by it comprising 97% and 93% of all omega-3 fatty acids found in brain and retinal tissue, respectively.[15,16] Researchers have found that conversion of ALA to EPA and DHA is inefficient and varies, with estimates of 0.2%-21%[3] and <1%[6] of dietary ALA converted to EPA and DHA, respectively. Increasing ALA intake has been found to have little effect on increasing blood levels of DHA[2,17,18]; however, DHA from food sources is well absorbed and readily incorporated into human plasma and blood cell lipids.[6,19] There is not an AI for EPA and DHA, but The International Society for the Study of Fatty Acids and Lipids (ISSFAL) recommends 500 mg of EPA and DHA per day for cardiovascular health and that pregnant and lactating women should attempt to achieve an average of 200mg DHA per day.[20,21] Non-pregnant,

pregnant and lactating mothers should obtain EPA and DHA from food sources including eggs, poultry and cold water fish, i.e. salmon, tuna and shellfish.[6]

According to the National Health and Nutrition Examination Survey 2009-2010, women of child-bearing age are not meeting their needs for EPA and DHA.[22]These same results have been observed in several populations of American pregnant and lactating women,[23-27] suggesting that women from the United States are potentially not meeting the recommendations for omega-3 fatty acids, according to experts and government agencies. Research on omega-3 fatty acid intakes of African American women of childbearing age is very limited. In comparison to Caucasians, researchers have reported African Americans suffer increased rates of preterm birth which may be partially explained by an imbalance of omega-3 and omega-6 fatty acid intakes found more often in African Americans when compared to Caucasions.[28]

Food frequency questionnaires are often used to assess nutrient intakes because they are often self-administered, inexpensive to process and tend to alleviate changes in diet when being completed.[29] FFQs should be culturally and population specific and can be created or adapted to fit the population or purpose needed for the specific study by adding foods commonly eaten by the study population.[30-32]This dietary assessment method has been developed and/or validated to measure omega-3 fatty acids in several diverse pregnant populations, including Mexican,[33]Finnish,[34] Dutch,[35] and Canadians.[36] FFQs that measure n-3 fatty acids have been validated in African American pregnant populations,[36,37]but to date there has not been an omega-3 fatty acid FFQ specifically created to measure African American female intakes.

Therefore, the purpose of this research was to develop a valid, culturally appropriate food frequency questionnaire to measure omega-3 fatty acid intakes in non-pregnant and pregnant Midwestern African American females and assess possible associations between intakes and maternal/infant health outcomes.

The primary objectives were as follows:

1.   To measure the reliability and validity of a culturally appropriate food frequency questionnaire (and adjust accordingly) to estimate total omega-3 fatty acid, ALA, EPA, DPA and DHA intakes of low income Midwestern African American women of childbearing age.

2.   To examine the association of health outcomes from prior pregnancies with the omega-3 fatty acid intake of low income Midwestern African American women of childbearing age.

Review of Literature

I. Polyunsaturated fatty acids

In terms of human health and nutrition, as well as occurrence in the food supply, the most important families of polyunsaturated fatty acids (PUFAs), fatty acids that contain more than one double bond, are the omega 3 and omega 6 fatty acids.[2] The terms omega-3 and omega-6 refer to the placement of the first double bond 3 or 6 carbon atoms away from the methyl carbon, respectively.[2,39] Through de novo fatty acid synthesis, the body has the ability to produce other PUFAs, but due to the inability of mammals to add double bonds after the 10th carbon on the methyl terminal end of a fatty acid chain, the omega-3 fatty acid ALA (18:3n-3) and the omega-6 fatty acid linoleic acid (18:2n-6) (LA) cannot by synthesized by humans. LA and ALA are "essential fatty acids", meaning they have to be obtained from the diet and they are both substrates to other fatty acids that are needed for physiological functions in the body.[2,3]

LA is the parent to a metabolically important omega-6 fatty acid, arachidonic acid, 20:4n-6 (AA).[2,3,40] AA is a major component of phospholipids found in the cell membranes of brain tissue, retinal tissue and platelets, as well as, a substrate for signaling molecules called eicosanoids.[2,3,39.40] A cell's response to outside stimuli is the production of eicosanoids which are involved in a variety of processes, including muscle contraction, immune response, inflammation, stimulation/inhibition of platelet aggregation and cell adhesion.[2,3,39] Eicosanoids derived from AA promote inflammation, stimulation/inhibition of platelet aggregation, as well as cell growth and proliferation.[2,3]

ALA is the parent to the omega-3 fatty acid, DHA via EPA and DPA. Both EPA and DHA play important roles in human health. EPA is a substrate for eicosanoids that

promote vasodilation and inhibition of inflammation and platelet aggregation, and is released from membrane phospholipids to compete with AA for enzymatic metabolism thus creating a less inflammatory environment.[3] Researchers suggests an imbalance of eicosanoid production could have deleterious effects on health, so both AA and EPA derived eicosanoids seem to be important.[2] DHA is found in high concentrations in the brain cells, retinal cells, sperm and cardiomyocytes and is the substrate for docosanoids, signaling molecules similar to eicosanoids, which are anti-inflammatory and protective of neural tissue.[2] EPA and DHA are also important in maternal and infant outcomes.[1] Researchers have reported a possible impact of increased EPA and DHA intakes leading to decreased risk of maternal health, including preeclampsia,[11,12] postpartum depression[13,14] and preterm labor.[7-10] These effects have also been seen in infant health outcomes, including decreased risk of low birth weight and proper neural and retinal development.[15,16]

Research suggest that the efficiency of the conversion of ALA to longer chain polyunsaturated fatty acids (EPA, DPA and DHA) is low and depends on intake of ALA and LA in the diet.[41-43] Western diets are estimated to have a ratio of omega-6 to omega-3 fatty acids of about 10:1 to 20-25:1, which leads to a deficiency in the conversion of ALA to longer chain polyunsaturated fatty acids (LCPUFAs).[3] Harnack and others found that maximum conversion of ALA to EPA and DHA, 17% and 0.7%, respectively, was seen with a mixture of LA/ALA at a ratio of 1:1.[42] The same results were reported in piglets with a ratio of 4:1 to 2:1 for LA/ALA.[43] As illustrated in figure 1, omega-6 and omega-3 fatty acid metabolism share a common set of enzymes, so a diet rich in LA

would competitively inhibit ALA metabolism to LCPUFAs.[41,44] This situation is further compounded by the observation that increased ALA intake increases the level of ALA, EPA and DPA but has little or no impact on DHA levels.[2,17,18,41] Even conversion of ALA to EPA is limited and variable with estimates between 0.2% to 21%.[3] Intake of preformed DHA seems to be the most efficient way to increase blood and tissue DHA.[19,45] In a meta-regression analysis of 12 studies, researchers found that plasma phospholipid DHA is highly sensitive to dietary DHA and increases in a dose-dependent manner up to two grams of DHA intake per day.[19] Both preformed EPA and DHA are well absorbed and readily incorporated into human plasma and blood cell lipids, which has led to the theory that the best way to increase an omega-3 fatty acid in plasma or tissues is to supplement with that specific fatty acid.[6,19]

II. Dietary sources and intake recommendations of omega-6 and omega-3 fatty acids

Food sources of LA include vegetable oils (corn, safflower, sunflower and soybean) and animal meats.[46] The AI for LA is 11 grams (g) and 12 g/d for women between the ages of 14-18 and 19-50, respectively and 13 g/d for pregnant women.[4] According to NHANES 2009-2010, females between the ages of 16-49 eat an average of 13.65 g/d of LA, which meets the Adequate Intake. AA is found in animal sources like meat, egg and dairy products.[22] Experts from the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) determined that for healthy adults with habitual intake of LA greater than 2.5% of energy, AA is not essential, so this PUFA does not have an AI.[47]

Figure 1. Omega-6 and omega-3 metabolic pathways. Adapted from reference Ratnayake et al.[2]
[a.]Desaturase enzyme adds a double between two carbons.
[b.] Elongase adds two carbons to the fatty acid chain at a time

The major food source of ALA is vegetable oils, with soybeans, nuts and seeds

also being rich sources. Flaxseed oil is not commonly used as a food oil but is rich in

ALA.[5,48] The AI for non-pregnant and pregnant females, between the ages of 14-50, is

1.1 g/d and 1.4 g/d, respectively and an Acceptable Macronutrient Distribution Range of

.6-1.2 percent of energy for ages $\geq$16 with up to 10% coming from EPA and DHA.[4] The

International Society for the Study of Fatty Acids and Lipids (ISSFAL) recommends ALA be .7% of energy for maintenance of a healthy cardiovascular system, with no specific recommendations for pregnant women possibly because intake of ALA has less of an impact on fetal brain DHA deposition than intake of preformed DHA.[20]

The major food source of EPA and DHA is fish. Fatty fish like halibut, mackerel, herring and salmon are especially rich sources.[6] There is not an AI for EPA and DHA, but the ISSFAL recommends a minimum of 500 mg of EPA + DHA intake per day for cardiovascular health [20] and an average of 200 mg DHA per day for pregnant and lactating women.[21] Since preformed EPA and DHA have the greatest impact on health outcomes, pregnant and lactating mothers should obtain these LCPUFAs from food sources including eggs, poultry and cold water fish, i.e. salmon, tuna and shellfish.[6,21] The U.S. Food and Drug Administration recommends that women of childbearing age, pregnant or lactating eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury, which should meet the recommendations for DHA[21,49]. Food sources of omega-3 fatty acids are found in Table 1.

III. Omega-3 fatty acids and maternal outcomes

Consumption of omega-3 fatty acids during pregnancy may have a beneficial impact on several maternal health outcomes, including gestation duration, birth weight, blood pressure and depression, but results are inconclusive and still being investigated.[50]

Table 1. Food sources of ALA, EPA, DPA and DHA[a]

Foods	Serving	ALA	EPA	DPA	DHA
				Omega-3 fatty acid content of foods (g)	
Flaxseed oil	1 tbsp	7.258	0	0	0
Canola oil	1 tbsp	1.279	0	0	0
Soybean oil	1 tbsp	0.923	0	0	0
Flaxseed, ground	1 tbsp	1.597	0	0	0
Walnuts, black	1 oz	0.569	0	0	0
Tuna, light, packed in water	3 oz, raw	0	0.400	.008	0.190
Salmon, Chinook	3 oz, raw	.076	.857	.256	.802
Crab, Dungeness	3 oz, raw	Not reported	.359	.016	.143
Trout, rainbow	3 oz, raw	.101	.142	.090	.357
Large egg	1 egg	.018	0	.004	.029

[a.]Adapted from the USDA National Nutrient Database for Standard Reference [51]

Preterm birth and low birth weight

Duration of gestation less than 37 weeks and a birth weight of less than 2500 g or 5 pounds 5 ounces are considered preterm birth (PTB) and low birth weight (LBW), respectively.[28,52] Both PTB and LBW are a leading causes of mortality for infants, with African Americans having 2.3 times the infant mortality rate of non-Hispanic whites.[28,53] Intake of omega-3 fatty acids, especially EPA, may influence increased gestation and higher birth weights. Researchers theorize that increased levels of AA, the consequence of a linoleic rich diet, leads to the formation of eicosanoids, specifically PGE2 and PGF2α, involved in contractions and preterm labor.[7,16] EPA and DHA play a protective role by competitively inhibiting AA production, leading to lower circulating amounts of these eicosanoids. Furthermore, EPA, is the precursor to eicosanoids, specifically PGE3 and PGI3, that relax the uterine wall.[16]

In 2000, Olsen and others examined the preventative and therapeutic effects of omega-3 fatty acid intake on several maternal health outcomes. In a total of six mutually

exclusive multicenter trials, women were randomly assigned to receive fish oil (rich in omega-3 fatty acids) or olive oil (deficient in omega-3 fatty acids) capsules. The prophylactic trials consisted of women who were currently greater than 16 weeks pregnant, with no complications, but had previous experience with (1) preterm delivery or (2) intrauterine growth retardation or (3) preeclampsia or (4) women with current twin pregnancies. These women received a total of four oil capsules per day. The two therapeutic trials enrolled women with (5) threatening preeclampsia or (6) suspected intrauterine growth retardation, and they were given nine oil capsules per day. Among women who had previously experienced preterm delivery, the reoccurrence was reduced from 33.3% to21.3% (OR 0.54, 95% CI 0.30-0.98), in the fish oil group, in comparison to the olive oil group. The preterm delivery trial also reported a significant difference in pregnancy duration (P=.01) and mean birth weight (g) (P=.02), between the fish oil and olive oil groups. In the fish oil group, when combining all trials, there was a delay in spontaneous delivery (P=.002) when compared to the olive oil group. No effect was seen on pregnancy induced hypertension, intrauterine growth retardation or prematurity in twins.[8]

In 2002, Olsen and others looked at pregnant women's consumption of fish and its' impact on birth weight, preterm delivery and intrauterine growth retardation. At 16 weeks gestation, Danish women (n=8729) filled out a self-administered questionnaire. The subjects were placed in six frequency categories based on their consumption of fish servings per 28 days. Women consumed an estimated average of 15.8 g of fish and 0.182 g of long chain n-3 fatty acids a day. Out of 8707 subjects, low birth occurred in 2.7%,

preterm delivery occurred in 3.4% and intrauterine growth retardation occurred in 6.6%.

The results showed that as fish consumption increased, low birth weight (P<.001),

preterm birth (P=.001) and intrauterine growth retardation (P=.001) all tended to

decrease. The author noted that these associations were mainly apparent at the lower end

of fish intakes.

Olafsdottir et al. also looked at the effects of fish and cod liver oil consumption on

birth weight in an observational study. Healthy, low risk pregnant Icelandic women

(n=436) filled out a semi-quantitative food frequency questionnaire, two different times

during their pregnancy. Higher birth weight was positively correlated with liquid cod

liver oil intake in early pregnancy (r=0.107, P=0.026), but not with concentrated cod liver

oil capsules or fish consumption.[10]

Preeclampsia

Preeclampsia is when a pregnant woman develops high blood pressure (Blood

pressure $\geq$ 140/90 mm Hg over time) and protein in the urine, after 20 weeks of

pregnancy.[54] Affecting at least 5-8% of all pregnancies, preeclampsia is one of the

leading causes of maternal death.[55,56] A possible cause may be Thromboxane A_2, an AA

derived eicosanoid which promotes vasoconstriction.[11,16,57] As mentioned previously, a

balance of AA and EPA derived eicosanoids seems to be important to health.[2]

Researchers have found that erythrocyte AA is higher in preeclamptic women when

compared to normotensive women.[11] While, omega-3 fatty acids tended to be lower in

placental tissues of women with preeclampsia, possibly leading to an environment where

production of AA derived eicosanoids is favored.[58,59]

A small case control study looked at the relationship between dietary intake of marine omega-3 fatty acids and risk of preeclampsia. Researchers measured the erythrocyte content of PUFAs in preeclamptic (case) and normotensive (control) pregnant women. Women who had the lowest intake of omega-3 fatty acids and the lowest omega-3/omega-6 ratio value, had a 7.6 times (95% CI=1.4-4.06), and 7.3 times (OR =7.2; 95% CI=1.1-46.5) higher risk of preeclampsia, respectively, when compared to those with the highest intakes and the highest ratio values. With just a 15% decrease in the omega-3/omega-6 ratio, there was a 46% reduction in preeclampsia (OR=0.54; 95% CI = 0.41-0.72). These results were adjusted for parity and pre-pregnancy body mass index (BMI).[11]

Olafsdottir et al. found opposite results, with women who took cod liver oil being 4.7 times as likely to develop hypertensive disorders during pregnancy (95% CI 1.8-12.6). When the omega-3 LCPUFA was divided into different levels of intake, risk of hypertensive disorders was greater in the lowest and highest intake levels. Researchers theorize that intake of omega-3 fatty acid may have a positive impact on hypertensive disorders and gestational hypertension at certain levels but may become detrimental in high doses.[60]

Postpartum depression

According to the American Psychological Association, an estimated 9-16% of postpartum women will suffer from postpartum depression, and prevalence increases to 41% if the mom has experienced postpartum depression during a previous pregnancy.[61] Postpartum depression is characterized as a nonpsychotic depressive illness of mild-to

moderate severity occurring in a mother during the first postnatal year, which is a time of major change and increased responsibilities in the care of a newborn infant.[61,62] Research has shown that postpartum depression is associated with dysfunctional mother-infant attachment, with mothers being hostile, critical and less responsive to their children, leading to possible cognitive and emotional impairments in the child, that can persist in adolescence.[62,63] Researchers theorize that DHA deficiency, caused by increased and preferential transfer of DHA from the mother to the fetus, during the 3rd trimester, as well as low DHA intakes, may be related to maternal depressive symptoms.[64,65] Postpartum depression has also been associated with increased levels of pro-inflammatory eicosanoids, whose creation is competitively inhibited by omega-3 fatty acid derived anti-inflammatory eicosanoids. So a DHA deficient pregnant woman may be at increased risk.[65]

In a cross-national ecological analysis, Hibbeln et al. looked at 14,532 subjects, over 23 countries in 41 studies. Prevalence data that used the Edinburgh Postpartum Depression Scale (EDPS) was compared to the DHA, EPA and AA content in mother's breast milk for 16, 12 and 15 countries, respectively. The data was also compared to seafood consumption rates found in published reports from 23 countries. Results suggests that lower concentrations of DHA in mother's breast milk and lower national rates of seafood consumption were associated with higher rates of postpartum depression.[14]

Researchers studied the impact of omega-3 fatty acid intake as a treatment for postpartum depression. Postpartum women's pre-treatment scores of the EDPS and another baseline mood rating scale, the Hamilton Rating Scale for Depression (HRSD),

were compared to post-treatment scores. Participants were randomly assigned to different daily dosage amounts for eight weeks. Across groups, all dose levels combined, scores on the EDPS (t=8.47, d.f.=15, P<0.05) and HRSD (t=6.76, d.f.=15, P<0.05) decreased 51.5% and 48.8%, respectively, when comparing pre to post-test scores. Authors noted that interpretation of these results is limited by sample size (n=16) and lack of a placebo-control group.[13]

IV. Omega-3 fatty acids and infant outcomes

In mammals, DHA is the principle omega-3 fatty acid in the brain, comprising 97% of all omega-3 fatty acids and 10-20% of total fatty acid composition.[15,16] Researchers state DHA is involved in neurotransmission, regulates ion-channel activity, gene expression and promotes fluidity and flexibility of neural and endothelial membranes in the central nervous system (CNS).[66,67] DHA also comprises approximately 93% of all omega-3 fatty acids of the outer segment of retinal rods and cones.[68] These properties are thought to be associated with DHA's role in proper neural and retinal function. Feeding animals a DHA deficient diet lead to decreased neuron size and dendritic aborization, in rats, and decreased levels of visual acuity at 4-12 weeks of age, in rhesus monkeys, when compared to those animals fed a diet rich in DHA.[69,70]

The fetus is dependent on the mother's intake, as well as, the placenta's transfer ability and metabolism for its' LCPUFA needs.[67] Higher amounts of DHA and lower amounts of ALA have been found in fetal circulation, with the opposite found in maternal circulation, which may be due to the placental ability to preferentially transfer DHA, over other LCPUFAs, to the fetus.[71-73] Along with placental transfer and metabolism, the

mother's intake is important. Donahue et al. found that maternal intake of DHA and EPA correlated with the amount of these PUFAs found in maternal erythrocytes (r=0.18, P<0.0001) and umbilical cord plasma (r=0.21, P<0.001).[24] Similar results, a correlation between maternal DHA intake and erythrocyte phospholipid DHA (β=0.30, 95% CI: 0.007-0.60, P=0.045), were found in a sample of healthy pregnant Mexican women.[33] During the third trimester and early weeks of life, the fetus needs approximately 50 to 70 mg/kg/day of DHA which, research has reported, is selectively incorporated into brain and retinal phospholipids 10 times faster than any other LCPUFA.[16,67]

Researchers used the Avon Longitudinal Study of Parents and Children (ALSPAC) to assess the impact of different levels of maternal seafood consumption during and after pregnancy on a child's development. At 32 weeks gestation, pregnant women filled out food frequency questionnaires to determine seafood intake, as well as, questionnaires, mailed at different times during pregnancy and after the child's birth to obtain socio-demographic information and information on behavioral and developmental outcomes. Seafood consumption was analyzed in grams, so a mom who had seafood three times a week, typically had an intake of 347 grams. Seventy-seven percent of these pregnant women had ≥340g of seafood each week. Intakes less than 340g during pregnancy was associated with increased risk for their children being in the lowest quartile for verbal intelligence quotient (no seafood consumption, OR 1.48, 95% CI 1.16-1.90; some, 1.09, 0.92-1.29; overall trend, p=0.004), when compared with mothers eating >340g per week.[74]

Several studies have reported similar results. At age four children's "Mental Processing Scores," which serves as a measure of intelligence in the Kaufman Assessment Battery for Children, were significantly correlated with mother's intake of cod liver oil (rich in omega-3 fatty acids) during pregnancy, when compared to those who took corn oil (deficient in omega-3 fatty acids) (P=.049), and with plasma phospholipid concentrations of DHA (r=0.28, P=0.02), at four weeks of age.[75] Infants at 18 months of age, who drank formula supplemented with DHA+AA, had higher Mental Development Index (MDI) scores (t=2.51, P,0.05), when compared to those who drank formula with no omega-3 or omega-6 fatty acids. The MDI is the scale, in the Bayley Scales of Infant Development, 2nd edition, that assesses memory, problem solving, discrimination, classification, language and social skills. At four months of age, plasma DHA correlated with infant scores at 18 months (r=0.32, P=0.016).[76] Child's hand and eye coordination scores have also been found to increase with supplementation of fish oil during pregnancy and positively correlate with cord blood erythrocyte levels of EPA (r=0.331, p=0.007) and DHA (r=0.308, p=0.009).[77]

A study determining the relationship between DHA and visual and neural development in healthy, term exclusively breast fed infants was completed by Innis and others. Red blood cell phosphatidylethanolamine DHA content, measured at 2 months of age, significantly correlated with visual acuity at 2 months (r=0.32, P=0.01) and 12 months of age (r=0.30, P=0.03).[78] A similar positive association between red blood cell DHA content and visual acuity was found in 4 month [79]and 1 year old[80] infants. Innis et al. also found that infants of mothers' supplemented with DHA had higher visual acuities

than those who ate their usual diet (OR=3.37, β=0.60, and SE=1.93), which may suggest that some of the pregnant women were "DHA deficient."[81]

V. Omega-3 fatty acid intake of pregnant women in the United States

Several studies have shown that pregnant and lactating women's omega-3 fatty acid intake is very important to their pregnancy outcomes as well as their fetus or infant's development, but little research has been done on the omega-3 fatty acid intakes of pregnant women in the United States. In the US, women of childbearing age are not meeting the recommended amounts of EPA and DHA intake, according to the NHANES 2009-2010.[22] The Continuing Survey of Individuals 1994-1996, 1998 (CSFII) showed that pregnant and lactating women in the United States were getting approximately 50mg of DHA/day.[82] Nochera et al. found that pregnant and lactating women in the Midwest were eating an average of 1.18 grams/month of EPA+DHA, which is 13% of the advisable intake of 9 grams/month, 300 mg/day or 2 servings (up to 12 oz) of fish per week.[25] Information on African American pregnant women's omega-3 fatty acid intake is limited, as evidenced by the studies presented in Table 2. Stark et al. reported omega-3 fatty acid intakes for an African American population.[37] The intakes of pregnant and lactating women shown in Table 2, along with the intakes mentioned above, seem to provide evidence that pregnant and non-pregnant women are not meeting their needs for EPA and DHA intake.

VI. Dietary Assessment in Pregnant Women

Maternal dietary intake has to meet the needs of the mother as well as provide adequate nutrient stores for the growth and development of the fetus and lactation after the baby is

born.[83,84] Common health issues that occur during pregnancy, including nausea, heartburn, constipation, emesis and changes in sense of taste and smell may lead to food preferences, aversions and general changes in food habits. [85]Maternal concerns about the health of the fetus, weight gain and parenting may lead to increased nutrition awareness, leading to possible changes in dietary intake.[85] In a sample of 278 Belgian women, Verbeke et al. found that significantly more pregnant women, when compared to non-pregnant women, indicated not eating foods with a heightened safety risk, mainly from potential microbiological contamination.[86] In a cohort of pregnant women, Oken et al. observed that total fish consumption decreased approximately 1.4 servings per month (95% CI 0.7,2.0), after a national advisory recommending that pregnant women limit certain fish due to possible mercury contamination. These women were surveyed before and after the advisory to assess changes in intake.[87] Changes in food habits, whether they occur due to pregnancy related health issues like nausea or due to maternal concerns about the health of the fetus, make dietary assessment during pregnancy complicated but important due to the total dependence of the fetus on maternal food and nutrient intake for proper development.[67,85]

Table 2. Omega-3 fatty acid intakes of pregnant and lactating women in the United States[a,b]

	% of AA[c]	Location	Method	Grams/day Total n-3	ALA	EPA	DHA	EPA+DHA
Lewis et al., 1995[23]								
Midwest pregnant women (n=30)	3	Nebraska	24 hour recall 2-d food record	1.060 $\pm$ 0.300	0.989$\pm$0.301	0.023 $\pm$ 0.060	0.048 $\pm$ 0.081	
Donahue et al., 2009[24]								
Women, mid-pregnancy (n=1,666)	12.4	Massachusetts	FFQ Dietary questionnaire	1.17$\pm$0.43	0.99$\pm$0.40	0.06$\pm$0.08	0.11$\pm$0.09	0.16$\pm$ 0.17
Women, month before delivery (n=1,928)	NR[d]					0.04$\pm$0.06	0.08$\pm$0.09	0.12$\pm$0.14
Nochera et al., 2011[25]								
Pregnant women (n=48)								2.37$\pm$0.56[f]
	26.5[e]	Michigan	N-3 FFQ					
Lactating women (n=19)								2.04$\pm$0.42[f]
Loosemore et al., 2004[26]								
Healthy pregnant women (n=31)	6			1.46$\pm$.71	1.34$\pm$.66	0.016$\pm$0.021	0.068$\pm$0.099	
Pregnant women with Gestational Diabetes mellitus (GDM) (n=14)	14	Connecticut	24 hour recall	1.57$\pm$.89	1.52$\pm$.88	0.012$\pm$0.009	0.034$\pm$0.019	
Wijendran et al., 1999[27]								
Healthy pregnant women (n=15)	13			1.20$\pm$0.34	1.13$\pm$0.31	0.020$\pm$0.021	0.038$\pm$0.033	
Pregnant women with GDM (n=15)	13	Connecticut	24 hour recall	1.46$\pm$0.81	1.30$\pm$0.80	0.051$\pm$0.017	0.087$\pm$0.110	
Stark et al., 2005[37]								
24 weeks Gestation (n=157)				1.80$\pm$0.42	1.68$\pm$0.41	0.038$\pm$0.061	0.081$\pm$0.094	
Women at delivery (n=157)	100	Michigan	FFQ	1.63$\pm$0.34	1.55$\pm$0.32	0.026$\pm$0.042	0.059$\pm$0.059	
3 months postpartum (n=157)				1.46$\pm$0.38	1.36$\pm$0.35	0.028$\pm$0.042	0.093$\pm$0.107	

[a]Grams per day
[b]Mean $\pm$ standard deviation
[c]Percent of study participants who are African American
[d]Not Reported

[e]n=68
[f]Grams per month

VII. **Dietary assessment methods**

According to Gibson, methods used to measure individual's food intake can be placed

into two groups. Recalls or records, also referred to as "quantitative daily consumption

methods," are designed to measure the quantity of an individual's food intake over a

period of one day. Estimation of "usual" intake can also be achieved with these same

methods by increasing the number of days measured. Diet histories and food frequency

questionnaires make up the other group of dietary assessment methods. These methods

provide retrospective information on "usual" food intake patterns for a longer, less

defined time period.[29]

All dietary assessment methods have inherent error and are random or

systematic.[29,32] Random errors are accidents like skipping questions and may occur across

all subjects and all days. These types of errors can be minimized by increasing the

administrations of the dietary method. Systematic errors refer to under- or over-reporting

intakes or respondent bias like social desirability and approval biases. These errors may

only be associated with some respondents (e.g. elder or obese), specific interviewers or

certain foods (e.g. alcohol).[29]

Twenty-four hour recall method

In a 24-hr recall, subjects are asked, generally by a "trained" interviewer, to recall

and report their intake, including all food and beverages, consumed in the previous 24

hours or preceding day.[29,31] Currently, self-administered electronic recalls are available.[31]

Due to large within-person variations in dietary intake, research suggests that usual intake

cannot be sufficiently determined by a single recall, so multiple recalls are required.[29,30]

Also, recalls should be done in such a way that all days of the week are represented,

which takes into account any effects that different days have on food or nutrient intakes.[29] Experts suggest a successful interview should be done by someone educated in foods and nutrition, ideally a dietitian or someone trained in how to use a standardized recall form and knowledgeable about foods in the marketplace, regional and ethnic foods, as well as, preparation techniques.[31] Standardized, nonjudgmental, open-ended probing questions should be used to help the respondent remember foods and specific details, like food preparation techniques.[31,32] Whenever possible, the interview should happen in the respondent's home, placing the respondent at ease and in familiar surroundings to help improve participation and memory of foods eaten.[29,31,32]

There are advantages and disadvantages to this dietary assessment method. Recall advantages include that subjects are not required to be literate because the interviewer administers the tool and records the answers. Because the recall requires food consumption from the previous day, subjects are generally able to remember most of their dietary intake. When compared to food records: 24-hour recalls are more representative of the population secondary to low subject burden; the trained interviewer is able to gain details so that the food can be accurately researched later; and recalls have less potential to effect dietary behavior since they occur after the food has been consumed. The main disadvantage of 24-hour dietary recalls is that subjects may not accurately report their food intake, related to knowledge, memory or the interview situation.[31] According to Gibson, a successful 24-hour recall depends on several factors: the subject's memory, the subject's ability to accurately report portion size estimates, the subject's motivation and the interviewer's persistence.[31]

A new 24-hour dietary recall instrument is the United States Department of Agriculture's (USDA) 5-step Multiple Pass Method, which is used in the U.S. National Health and Nutrition Examination Survey (NHANES). The first step is a "Quick List," this is where the interviewer collects a list of foods and beverages consumed the previous day. "Forgotten Foods," the second step, is where the interviewer probes for foods forgotten on the quick list. The third step, "Time and Occasion," involves the collection of time and eating occasion for each food. The fourth step, "Detail Cycle," involves the collection of a detailed description, amount and additions for each food. This step is a review for the 24 hour day. The fifth and final step, "Final Probe" is the last probe for any other foods consumed.[88] Research indicates that this method assessed mean intake within 10% of mean actual intake for normal, overweight and obese women .[90]

Dietary (food) records

The two categories of food records are estimated food records and weighed food records. In both types of food records, subjects record all foods and beverages (ideally at time of consumption) and amounts consumed over a specified time period. Since all foods and beverages are described in detail, including brand name, their method of preparation and cooking, respondents should be trained, in advance, to do a food record. Common household measuring cups and spoons, scales, food models or pictures can be used to measure or estimate amounts consumed.[29,31] In weighed food records, the subjects also weigh all foods and beverages consumed. Once the recording period ends, a trained interviewer should review the record with the respondent, to ensure an adequate description of foods and preparation methods.[31,32] According to Gibson, the number of days for food records depends on the objective of the study. One day is adequate to

describe intake in a group, as long as all days of the week are equally represented.[29] Other researchers suggest that if multiple days are recorded, then typically no more than seven days are included, and anything more than four days may lead to an increase in respondent fatigue .[31]

Recording foods when consumed, not relying on memory, is a characteristic of food records that increases the potential for providing more accurate portion sizes, lessening the problem of omission and providing greater food detail.[31] On the other hand, subjects may delay recording intake for several hours, therefore increasing their reliance on memory, change their eating habits or decrease the amounts consumed to simplify the measuring or weighing process or to impress the investigator.[29,31,32] Food records have higher respondent burden than 24-hr recalls and require subjects to be highly motivated, trained and literate, which may limit the use of this dietary assessment technique in some populations.[29-31] Weighed food records result in increased reproducibility, when compared to estimated food records, secondary to the food being weighed.[29]

Dietary history

The dietary history, introduced by Burke in 1947[90], tries to estimate the individual's usual food intake, which includes characteristics of the foods, and meal patterns over a long period of time. Burke's dietary history included three components.[29,31] The first component consisted of an interview obtaining a usual pattern of eating, including detailed food descriptions, frequency of consumption and usual portion sizes expressed in common household measures. The second component consisted of a questionnaire that assessed the consumption frequency of certain foods.[29]

The third component was a three day food record. Both the second and third component

are treated as crosschecks or to check the internal consistency of the first component.[29-31]

A strength of the dietary history method is the combination of assessing meal

patterns and food details when compared to other dietary assessment methods that just

look at intake for a short period of time or only frequency of consumption.[22] Time

periods for this type of dietary assessment varies and a maximum time has not been

established. Shorter time frames, one month or less, leads to increased reproducibility and

validity when compared to longer periods. Diet histories that last longer than a year may

be unrealistic.[21] A disadvantage is that subjects have to make many judgments about their

usual food intake and amounts consumed which prompts the suggestion that data

collected from dietary histories should be considered relative rather than absolute.[22]

Interviews can last from one to two hours which can be labor intensive and require a lot

of cooperation from the respondent.[29,30]

Food frequency questionnaire

The food frequency questionnaire (FFQ) attempts to assess subject's "usual"

frequency of food consumption over a specified period of time.[29,91] The simplest FFQ

consists of a list of foods which ask for frequency of use and sometimes include portion

sizes. Specific groups of foods, particular foods or foods that are eaten on special events

or seasons can be included in the food list, but other characteristics of foods eaten, like

preparation methods, are not included.[29,31] Nutrient intake estimates are derived by

adding the products of the reported frequency weight of each food by the amount of

nutrient in a specified serving of that food, to produce an estimated daily intake of

nutrients. For example, an assigned frequency weight of one is given to "once a day," 2.5 to "2-3 times per day" or .43 for 2-4 times per week.[29,31]

The Block Food Frequency Questionnaires,[92-95] the Harvard University Food Frequency Questionnaires or Willett Questionnaires [95-98] and the National Cancer Institute's Diet History Questionnaires,[96] the Fred Hutchinson Cancer Research Center Food Frequency Questionnaires[99,100] are commonly used FFQs to assess dietary intake. Experts suggest that an FFQ should be culturally and population specific.[30,31] FFQs can be created or adapted to fit the population or purpose needed for the specific study.[31] Willet suggests if an FFQ has been created for a different population, then what is being studied, the addition of some population specific foods to the existing questionnaire, may be desirable.[32]

When developing or adapting an existing FFQ, researchers advise to define the purpose of the dietary method. [101,102] For example, determining the population of interest is important.[101,102] When creating an FFQ for a specific population subgroup, Subar advises seeking out recent population specific data that can be used to determine the foods, portion sizes and nutrient database to include.[103] The objective of the FFQ may be to measure either the total daily diet, specific food groups or only specific nutrients. Willet suggests that a more "comprehensive assessment" of the diet is desirable, for example, the end of the study may bring important questions about the diet that were not apparent at the beginning, and a restricted food list may not include a food that, in retrospect, is important. But if the purpose is to focus on a few nutrients or the list is highly restricted, it may be best to select a list of foods identified by other investigators as important predictors of those nutrients, if the cultural background of the study population

is similar.[32] The objective of the FFQ may be to rank individuals or to provide a measure

of estimated intakes. [32,101] FFQs meant to measure estimated intakes have to collect more

comprehensive information, but researchers have to be careful to not create an

excessively long questionnaire, which could lead to respondent fatigue and boredom.

Defining the purpose of the FFQ assists in the development of the food list.[32,101,104]

Several approaches can be used to compile the food list, which is important to the

success of the questionnaire.[102] Foods that are rich in the nutrient or nutrients of interest

can be identified and compiled from food composition tables, but this strategy may lead

to the inclusion of foods, that even though they contain substantial amounts of the

nutrient of interest, they are not eaten enough to be important.[32] According to Willett, for

a food item to be informative, it must: be eaten reasonably often by an appreciable

amount of individuals, contain a substantial amount of the nutrient of interest and be

discriminating, meaning intake varies from person to person.[32] Another approach is to

start with a long list and remove the foods most infrequently eaten, which can be

accomplished by pilot testing the questionnaire. The problem with this approach is foods

with high between-person variation, which is more informative than those foods that are

of similar average use, may be deleted. Or after pilot testing the food list, which may

originate from sources including food composition tables, national survey data, or a

Registered Dietitian, foods with low predictive values are discarded, then stepwise

regression analysis can be used to further determine the foods that are most predictive of

the nutrient of interest.[32,101] Another option is the use of diet records or 24 hour recalls to

collect data from the population of interest to determine the foods and portion sizes to

appear on the food list.[103] For example, Jensen et al. created an FFQ to assess the calcium

intake of Asian, Hispanic and White youth, the foods for the FFQ were selected from food composition tables, existing dietary questionnaires and epidemiological data on food consumption patterns of the population measured.[104] Twenty-four hour recall data was used to construct a food list for a quantitative food frequency questionnaire (QFFQ) for low-income inner city African Americans. For every food item, the place where the food was obtained, amount consumed, additions such as butter, gravy, skin on chicken, etc. and methods of cooking was recorded. Healthy foods, like baked chips, low fat milk and high-fiber low calorie cereals, that will be highlighted in a nutritional intervention in this population to decrease the risk of chronic disease, were added as well.[105] Buchowski et al. created a FFQ for use with 40-79 year old men and women living in the southeastern region of the United States. The food list consisted of foods, in the NHANES-III database, that were frequently eaten by African Americans and/or whites in the NHANES-III sample, foods that differentiated between the eating behaviors of the aforementioned racial groups and those that contributed meaningfully to intake of cancer-related nutrients, including total energy, saturated fat, fiber, vitamin A, vitamin E and vitamin C.[106]

Frequency and portion size are the next issues to consider once the food list is compiled.[102] Research suggests that frequency options should be anywhere from 1 to 12, but if every food is given the same options, then five choices would be too few and result in loss of information.[32,102] Cade et al. suggests that is important to have frequency categories that reflect intake of most foods (e.g. number of times per week); however, for foods that are eaten infrequently but may contain a substantial amount of the food component of interest, it is important to include a less frequent option (e.g. less than once

a month).[102] Another option is the use of an open-ended format, where respondents have the option of answering in terms of frequency per day, week or month. In theory, this may enhance some precision in reporting but, Subar, found that multiple choice frequency options increased clarity and reduced errors when compared to open-ended formats.[32,107]

Several options are also available when reporting portion sizes on FFQs. Researchers can collect no portion information, specify a portion size as part of the food line item or include discrete questions, for portion sizes, for each food.[101] The collection of no portion information is considered a "simple" or "non-quantitative" food frequency questionnaire, which may be useful if the estimated intake of the total diet is not required, the population of interest is homogenous or if it is unlikely that the respondent can answer the portion questions.[102] Average portion sizes, specific to the population being studied, can be obtained from existing data, including national survey data, to help calculate gram weights and nutrient intakes.[101,102] A FFQ which collects portion information as part of the food line item is called a "semi-quantitative" food frequency questionnaire. Portion information provides clarity and answering is relatively easy for foods that come in standard units, like one egg, a slice of bread or cookies; however, portion size information for foods without a standard or natural unit, such as meat, rice and pasta can be cognitively difficult. If the respondent's normal intake is twice the given "typical" portion amount, they will then be required to double the amount. The third option is a "quantitative" food frequency questionnaire, which offers discrete portion sizes or additional items for each food to describe the portion size.[32,102] For example, the Block FFQ provides pictures of each food item in amounts corresponding to the portion

size choices (e.g. ¼ cup, ½ cup and 1 cup) given. Respondents who are able to conceptualize the portion size clearly and relate it to their own eating habits seem to provide the most useful portion size information.[32] This would seem to be best accomplished by a "quantitative" FFQ, because they offer the clearest information about portion sizes.[101]

The FFQ dietary assessment method has several strengths. Administration and processing is inexpensive because most FFQ are created to be self-administered and take approximately 30 to 60 minutes to complete based on the subject. Because the FFQ ask information about diet from a prior time period, respondents are able to avoid changes in diet.[29] A disadvantage is the amount of measurement error that can occur, which comes from the inability to list all possible foods, errors in frequency and serving size estimates.[29,30] FFQs may not provide estimation of absolute nutrient intake, due to lack of specificity and detail, when compared to 24 hour recalls and diet records.[30] Due to the error inherent in the FFQ approach, FFQ data is not considered appropriate to use to estimate quantitative parameters such as, the mean and variance of a population's absolute intake. Rather, nutrient intake as measured by an FFQ should be considered an "approximation," and is typically used to rank individuals according to food or nutrient intake or to assess the association between dietary intake and disease risk.[31]

VII. Reliability and validity of food frequency questionnaires

Reliability refers "to the consistency of questionnaire measurements on more than one administration to the same persons at different times"; validity refers to "the degree to which the questionnaire actually measures the aspect of diet that it was designed to

measure."[32,108]. Reliability and validity should be measured with any new FFQ or a previously tested FFQ that will be used with a different population.[32]

Reliability

When a dietary assessment method, in this case the FFQ, is administered repeatedly, generally two times, in the same situation and provides similar results, it is considered reliable.[29] This is also called a "test-retest" design.[90] Researchers suggest four to eight weeks time between administrations of the questionnaire, because subjects may remember their previous responses if the interval is too short.[32,108] Changes in food habits or effects of seasons can also influence reliability measurements. An example of this would be decreases in reliability that has been assessed over long intervals, such as several years, should be due to true changes in food habits.[29,32] Reliability is considered a function of both the uncertainty resulting from true variation in daily nutrient intakes due to both among and within individuals and random measurement errors.[29]

Experts vary on their interpretation of reliability studies. Willet et al. suggests that a low degree of reliability indicates that the questionnaire does not provide a valid measure of long term intake[109]; however, Gibson[29] suggests that lack of agreement between two nutrient intake results may not reflect poor reliability in the method, but the nutrient intake may have changed in the interval between the two administrations of the method. Researchers do agree that a high degree of reliability does not necessarily mean the FFQ is reliable. For example, FFQs tend to have higher reliability than others because of its design to assess usual food intake over a long period of time, resulting in insensitivity to daily variations in intake.[29] Or a high correlation between administrations

could be the result of correlated error (i.e. systematic within-person error), for example, a questionnaire that is missing important sources of a nutrient may have high reliability but does not provide a true measure of intake for that nutrient.[109] In the literature, typical correlation coefficients between repeat administrations of FFQs range from 0.5-0.8, for various nutrients.[29,108,109]

Reliability can be assessed statistically by several methods. A review done by Cade, et al. found that the most frequently method used is correlational analysis,[102] but other methods are used, including: ANOVA, paired test on the mean or median intake, and the Bland-Altman method.[29,102]

Correlation analysis refers to the use of: intraclass correlation coefficients, which are usually used to calculate agreement on an individual basis; Pearson correlation coefficients, which are used for normally distributed data; and/or Spearman's rank nonparametric correlation coefficients for non-normal distributions.[29] As mentioned previously in this review of literature, Jensen et al. created an FFQ to measure calcium intakes of Asian, Hispanic and White youth. After administration of two FFQs, four weeks apart, the test-retest reliability correlation coefficient was 0.68.[104] Researchers adapted the 1998 Block FFQ to measure micro- and macronutrients in a population-based sample (n=166) of Canadian women aged 25 to 74 years of age. The first and second FFQ were completed an average of 56 days apart, with reliability correlation coefficients (Pearson's r) ranging from 0.57 (percentage of energy from protein) to 0.90 (percentage of energy from alcohol) for macronutrients and 0.65 (iron) to 0.88 (vitamin C) for micronutrients.[110] Willet et al. administered two semi-quantitative FFQ to 173 women, a

year apart. Intraclass correlation coefficients ranged from 0.49 (total vitamin A) to 0.79 (sucrose).[98]

Cronbach's Alpha is also a statistical method used to measure reliability, specifically internal consistency reliability. Cronbach's alpha assesses the variability between the individual nutrient intakes relative to the total variability of intakes, as measured by the administrations of the FFQ. A high coefficient alpha means the FFQ is able to differentiate between respondents' nutrient intake, meaning there is higher between-person variation in nutrient intakes than within-person variation, and is reliable.[111] Ritter-Gooder, et al. validated an FFQ, to measure omega-3 fatty acid intakes, in women (n=17) and men (n=11) at an outpatient cardiac clinic. Test-retest reliability for the two administrations of the FFQ two weeks apart, indicated a coefficient alpha of 0.83. Researchers concluded that the FFQ was reliable to measure omega-3 fatty acid intakes in the study population.[112] A multicultural FFQ was developed and validated to measure nutrient intakes in young women in the Southeastern United States. The dietary instrument was validated in two sample populations, college women (n=95) and low-income postpartum women (n=50). The Cronbach's alpha for internal consistency reliability was an average of 0.75 for the food groups represented in the FFQ, for college women and 0.73 for low-income women.[113]

In conclusion, even though a reliability study does not necessarily tell whether the instrument is producing the correct or same answer, there are definite benefits such as, they are: relatively easy to do and can uncover problems in instrument design, respondent instructions or quality control, which can aid in improvement of the questionnaire.[108] Experts suggest the reliability of an FFQ depends on many variables, including:

- time frame of the method[29]

- population group under study[29]

- nutrient of interest[29]

- technique used to measure the foods and quantities consumed[29]

- between- and within- subject variances[29]

- variability of portion sizes or frequency choices[108]

- adequacy of the instructions given to the respondent[108]

- poor quality control techniques, like inadequate attention to recoding or double keying leading to simple coding or typing errors[108]

Validity

Validity can be absolute or relative. Since absolute validity, which compares food intake during and either before or after the study period, is time consuming and fraught with practical difficulties, it is generally determined in dietary studies that have a limited number of subjects or only cover a relatively short time period.[29] Relative validity, which can be assessed on dietary methods covering short- and long-term time frames, is defined as the comparison of the "test" method with another method, on the same subjects, termed the 'reference' method or "gold standard."[29,32,108] Researchers list several factors to consider when designing a validity study, including:

• Selection of subjects

When designing a validation study, the study should occur in a sample that is representative of the population under study. For example, the Diet and Physical Activity Sub-Study (DPASS), a sub-study within the Jackson Heart Study (a longitudinal cohort

study to investigate risk factors associated with coronary vascular disease in African

American populations in Jackson, MS), was conducted to examine the validity of The

Delta NIRI Jackson Heart FFQ and Delta NIRI Jackson Heart Study FFQ, which were

originally developed to measure nutrient intake in African American and White adults

living in the lower Mississippi Delta. A representative subset of African American

participants (n=499) were chosen from the original cohort (N=5,302) to participant in the

validation study.[114]

- Sample size for validation study

Sample size is often determined based on the statistical methods used for

reliability and validity of the questionnaire.[108] For example, if using correlation

coefficients, 100 to 200 participants should be adequate as long as a sufficient number of

days of dietary intake, typically 14 to 28, are obtained to reasonably describe an

individual's diet.[32,102]

- Selection of "reference" method

Since all dietary methods have inherent errors, the goal is to choose two methods

which have errors that are independent or uncorrelated with each other to avoid high

estimates of validity.[32,102] The most practical reference methods, to validate an FFQ, are

diet records or 24 hour recalls, but these are both considered to have errors that correlate

with errors in the FFQ.[30] Diet records are considered, by some researchers, to have fewer

correlated errors, because they are open-ended, do not depend on memory, portion sizes

are measured during recording and errors related to interpretation are more at the level of

the coder than the subject.[11] Thompson et al. states that neither recalls or records are good

reference methods because neither represent the time period of interest[30]; but Willet et al.[109] suggest that food records should be collected so that they cover the interval of time corresponding to the questionnaire. Even though errors inherent in 24 hour recalls may be similar to those found in FFQs, when subjects are illiterate or less motivated, recalls are the most reasonable option.[109]

• Sequence of the test and reference method administrations

In general, it is suggested that the test instrument is given prior to the reference method, because administration should mimic what would actually happen in the proposed study and the process of collecting one method could influence collection of the other method by possibly drawing attention to one's diet.[29,102,109] Willet et al. suggests that the test method be completed before and after the reference method, especially with diet records; therefore providing a conservative estimate (administering an FFQ before the detailed assessment dietary intake seems to result in artificially low correlations) and an optimistic estimate (administrating an FFQ after a detailed assessment of intake may sensitize the subject to their food intake and artificially improve accuracy in completing the FFQ) of the true correlation between the FFQs and the reference method.[29,109]

• Time frame

The time frame of the method in relation to the FFQ needs to be considered when conducting a validation study. On average, "true" intake is usually measured over a long period of time, so the reference method reflects this longer time frame.[109] Cade et al. provided the example of an FFQ that assesses intake over a period of one year that could be administered twice, a year apart, and compared to diet records that are collected in intervals during that year.[102]

There are several statistical methods used to measure validity. Correlation analysis, which was discussed earlier in this review of literature, is considered the most commonly used method to measure the strength of the relationship at the individual level, between intakes from the test and the reference dietary method. Gibson recommends that if the data are not normally distributed, it should be transformed to increase normality, before the correlation coefficients be computed. Other statistical methods include, the paired t-test or Wilcoxin signed rank test, regression analysis and Bland-Altman method.[29]

IX. Reliability and validity of FFQs measuring omega-3 fatty acid and fish intakes

Lora et al. validated a FFQ in first-generation Midwestern Latinas (n=162) to measure intakes of omega 3 fatty acids. From a FFQ that was previously validated in a cardiac population, the culturally specific dietary instrument was developed by interviewing and obtaining 24 hour recall data from five first-generation Latinas, to help describe the major food contributors of omega-3 fatty acids, as well as obtain recipes and portion size information for culturally specific dishes. The FFQ was then pilot tested in a convenience representative sample of 10 Latinas. The resulting n-3 FFQ, which contained 183 food items and 26 prepared dishes (15 culturally-specific dishes), was administered twice, one month apart, and to test validity, three nonconsecutive 24 recalls were done within the corresponding month. Test-retest reliability coefficients for the two administrations of the FFQ were 0.71, 0.65, 0.74, 0.54 for total omega-3 fatty acids, ALA, EPA and DHA (P<.01), respectively. The Pearson correlation coefficients for the

means of the 2 FFQs and the 24 hour recalls were 0.32, 0.34, 0.28 and 0.24 for total

omega-3 fatty acids, ALA, EPA and DHA, respectively. After running a paired t-test, the

means of the FFQs and 24 hour recalls were not significantly different for total omega-3

fatty acids and ALA (P>.05) indicating that there was no detectable bias and the FFQ was

valid for measuring these nutrients.[115]

A FFQ to measure EPA and DHA intake in Canadian adults was assessed for

relative validity in 78 Canadian men and women. Patterson et al. adapted an existing

Australian FFQ previously assessed for validity and reproducibility by adding whole

foods, functional foods and nutraceuticals containing EPA and/or DHA from the

Canadian Nutrient File (a source of nutrition information for foods commonly eaten in

Canada), internet searches and visits to local grocery chains and specialty food stores. For

validity, the Canadian FFQ was compared to 3-day food records, typically returned

within two weeks of FFQ administration, and whole blood biomarker measurements of

EPA and DHA. After intakes were log_e transformed, the food record and blood biomarker

measurements of EPA and DHA were moderately correlated with the FFQ for EPA,

DHA and EPA+DHA with Pearson correlation coefficients of 0.31, 0.49, 0.38 and 0.31,

0.42, 0.43, respectively. Using Wilcoxin signed rank test, no significant difference was

found between intakes measured by the FFQ and food records (P=0.93). Overall,

researchers concluded that the Canadian FFQ was an adequate tool for ranking and

estimating habitual EPA and DHA intakes of Canadian adults.[116]

A brief 21-item FFQ, to measure ALA, EPA and DHA, was validated against

plasma PUFA levels, in a sample of adults with (n=34) and without (n=27) Major

Depressive Order living in New York City. The FFQ was developed using the National

Cancer Institute's Diet History Questionnaire as a model and included specific seafood and fish available in the metropolitan New York area, as well as, foods rich in ALA. Blood samples were obtained on the same day that the FFQ was administered. Using Spearman's rho for nonparametric data, correlation coefficients between the FFQ and plasma values were r=0.50 (p<0.0001) for DHA, r=0.38 (p=0.002) for EPA and r=0.22 (p=0.086) for ALA. Since ALA intake as estimated by the FFQ and plasma levels were not correlated, so Sublette et al. concluded that the FFQ was valid to measure EPA and DHA intake in healthy and depressed patients.[117]

X. Reliability and validity of FFQs measuring omega-3 fatty acid intake in pregnant populations

FFQs to measure omega-3 fatty acid intakes, in pregnant women are limited, and due to the importance of omega-3 fatty acids in maternal and infant health outcomes, increased knowledge on intakes and appropriate dietary assessment methods to measure these intakes seems warranted.

As part of a larger study, pregnant women filled out a FFQ meant to measure intakes over the past year and provided blood samples. An FFQ, previously validated in Mexican women, was adapted by adding extra food sources of omega-3 fatty acids, and tested for validity in pregnant Mexican women (n=35).FFQ intake of ALA, DHA and EPA were validated against erythrocyte cell membrane phospholipid content of the three PUFAs. Pearson correlation coefficients were 0.32, 0.35 and 0.36 (P< 0.05) for ALA, DHA and EPA, respectively. In a linear regression model, erythrocyte DHA and AA were significantly related to their dietary intakes (β=0.30, 95% CI: 0.007-0.60, P=0.045 for DHA; β=0.49, 95% CI: 0.010-0.98 for AA) and the relation between erythrocyte ALA

and dietary ALA intake reached significance, after adjustment (β=0.44, 95% CI: 0.026-0.825). Parra et al. concluded these pregnant Mexican women's omega-3 fatty acid intakes correlated reasonably well with their erythrocyte cell membrane phospholipid status; however, it should be considered that the faster turnover of PUFAs from fat storage, intrinsic to pregnancy, may modify the profile of erythrocyte PUFAs resulting in lower correlations with dietary intake.[33]

Fawzi et al. calibrated an existing semi-quantitative FFQ to measure several nutrients, including long chain omega-3 fatty acids and ALA, in African American (n=72) and Caucasian (n=132) pregnant women. For calibration purposes, researchers pooled aliquots of individuals in the same decile of dietary intake for a particular nutrient, analyzed the samples then compared them to the biomarkers across categories of nutrient intakes. After combining two sets of deciles together, eight pooled specimens for each nutrient were prepared and separate pools were created for African Americans and Caucasians. Percentage of long-chain omega-3 fatty acids in red blood cell measurements increased 48% and 68% from the bottom to the top deciles of intake for African Americans and Caucasians, respectively. Increases of 1.72% and 4.79% per gram of intake were noted for erythrocyte concentrations of long chain n-3 fatty acids (p=0.09 for African American women and p=0.0001 for Caucasian women). There was no difference found for ALA between erythrocyte concentrations and deciles of intakes. This FFQ was considered valid to measure long chain omega-3 fatty acids but not ALA.[38]

Another FFQ was validated in a sample of 923 pregnant women. Fish intakes were compared to erythrocyte and plasma concentrations of omega-3 fatty acids. Researchers used a multivariable linear regression analyses with robust variances to

assess associations between various fish intake or erythrocyte fatty acid content with plasma lipid concentrations. As frequency (less than once a week, once a week, twice a week and more than twice a week) of maternal self-reported fish consumption increased, so did mean erythrocyte omega-3 fatty acid (EPA, DHA, long chain omega-3 fatty acids) increased (all trend p-values were <0.001), with strong linear increases in mean erythrocyte EPA and DHA for each higher category of intake.[11]

XI. Reliability and validity of FFQs measuring omega-3 fatty acid intake in pregnant African American populations

To date, there have not been any FFQs created specifically to measure omega-3 fatty acid intakes in African American pregnant women. As mentioned earlier, Fawzi et al. calibrated an FFQ in a sample of 72 African American pregnant women with an FFQ that was previously validated in a low-income multicultural population, including African Americans.[38] But currently, no FFQ has been adapted by the addition of omega-3 fatty acid rich foods that are specific to African American culture and eaten commonly by this race of people. Since food and nutrient intakes vary among ethnic groups, dietary practices may help to provide an explanation for the diversity of disease and problematic outcomes.[118] For example, African Americans suffer disproportionately from many health issues, when compared to other races, including preterm birth, which is possibly associated with lower omega-3 fatty acid intakes.[28] Stark et al. administered an FFQ and determined fatty acid compositions of plasma and erythrocyte total lipid abstracts at 24 weeks gestation, at delivery and three months postpartum of 152 African American pregnant women.[37] Omega-3 lipid intakes are listed in Table 2. Researchers concluded

that the low intake amounts and blood levels of DHA may not support optimal fetal DHA accretion and subsequent neural development, in this population.[37]

Low fish or DHA intakes in African American women may be attributable to a variety of issues. James conducted six focus groups to explore the impact of culture and community on nutrition attitudes, food choices and dietary intake in a population of African American men and women in northern Florida. She found that barriers to healthy eating, included poor taste of healthy foods, the expense of healthy foods and lack of information. To this population, eating healthfully was perceived as giving up part of ones' cultural heritage and trying to conform to the dominant culture.[119]

When specifically focusing on fish and DHA intakes, fish intakes vary by region of the United States. Mahaffey et al. looked at blood mercury (BHg) distributions within U.S. Census regions and within coastal and noncoastal areas among women of childbearing age, their association with fish consumption and changes from 1999 through 2004. Intakes and BHg concentrations were obtained from NHANES 1999-2004 data. Elevated BHg occurred more commonly in women in coastal regions and the lowest exposures were reported in the Midwest. Results suggest women living in coastal areas consume more fish and shellfish when compared to those living in non-coastal areas.[120]

In conclusion, omega-3 fatty acid intakes of pregnant and non-pregnant women have been found to be below recommended levels. FFQs to measure these intakes are limited but this is especially seen in African American cultures who suffer from health disparities. Experts suggest that development and validation of culturally appropriate dietary measures are important to identify the role diet plays in the etiology of diseases.[118]

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Study I:

Reliability and Validity of a Culturally Appropriate Food Frequency Questionnaire to Measure Omega-3 Fatty Acid Intakes in Midwestern African American Women, of Childbearing Age.

Abstract

Background: Omega-3 fatty acid intakes may play an important role in maternal health outcomes and infant brain and neural development. Research has shown that pregnant African American women have intakes below recommended levels for optimal health.

Objective: The aim of this pilot study was to determine the reliability and validity of a culturally specific FFQ to measure total omega-3 (n-3) fatty acid, ALA, EPA and DHA intake of Midwestern African American women (n=49) of child-bearing age and examine associations between these intakes with maternal health issues from previous pregnancies.

Methods: The omega-3 FFQ questionnaire was developed by 24 hour recall interviews, analyzed for content validity and pilot tested. The final culturally appropriate 187 item FFQ was then completed by women three times, via interview by an RD, along with three non-consecutive 24 hour food recalls, during a two week period. Maternal health issues were assessed by demographic questionnaire. The reliability and validity of the FFQ was assessed by Cronbach's coefficient alpha and Pearson correlation coefficients, respectively.

Results: Mean daily consumption of total omega-3 fatty acid, ALA, EPA, DHA and DPA as estimated by the 3 administrations of the FFQ, were 2.68 ± 1.37 g/day, 2.45 ± 1.30 g/day, 0.07 ± 0.07 g/day, 0.12 ± 0.11 g/day and 0.03 ± 0.02 g/day, respectively. The Cronbach's coefficient alphas, for reliability of the FFQ, were 0.89 for total omega-3, 0.89 for ALA, 0.89 for EPA, 0.88 for DHA and 0.83 for DPA. Pearson correlation coefficients as measured for validity between the FFQ and the recalls, were 0.44, 0.44, 0.59 and 0.60 for total n-3 fatty acid, ALA, EPA and DHA ($P<.01$), respectively. African

American women with past history of low birth weight, preterm labor, premature rupture of membranes and post-partum depression had a significant difference in omega-3 fatty acid intakes when compared to those without prior history.

Conclusions: In conclusion, this culturally appropriate FFQ seems to be reliable and valid in measuring omega-3 fatty acid intake in Midwestern African American women. This tool may be used to assess other populations of African American women's intake of omega-3 fatty acids.

Introduction

Omega-fatty acids, alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may have an impact on the occurrence of preterm birth, low birth weight, preeclampsia and postpartum depression. Research indicates that avoidance of seafood rich in omega-3 fatty acids, may lead to increased risk of preterm labor[1] and intake of cod liver oil (an oil rich in omega-3 fatty acids) has been associated with longer gestation and higher birth weights.[2] A moderate increase in consumption of omega-3 fatty acids has also been associated with a risk reduction in the occurrence of preeclampsia.[3] Omega-3 fatty acids, especially DHA, are found abundantly in retinal and neural tissues and studies have reported that restricting these fatty acids in developing animals results in reduced brain DHA and deficits in behavioral tasks of learning.[4] During the last three months of gestation and the first few months after birth, the brain is at its highest rate of growth, which suggests that a third trimester fetus and a newborn may suffer developmentally without adequate amounts of omega-3 fatty acids.[5] Therefore, omega-3 fatty acid intake in pregnant women may have a role in positive maternal and infant health outcomes.

ALA can be found in soybean, canola, and flaxseed oils and some nuts[4,6] and can be further metabolized to DHA through the intermediate fatty acids, EPA and DPA.[7] Researchers suggest that this is a slow process, with humans including newborns, converting less than 1% ALA to DHA. However, DHA from food sources is well absorbed and readily incorporated into human plasma and blood cell lipids.[4,8] Women of childbearing age should obtain DHA from food sources including eggs, poultry and cold water fish, i.e. salmon, tuna and shellfish.[6] The U.S. Food and Drug Administration

recommends that women of childbearing age, pregnant or lactating should eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury, which would meet EPA and DHA needs.[9,10] Several studies have reported that omega-3 fatty acid intake during pregnancy and lactation is very important to pregnancy outcomes, and fetus or infant development, but little research has been done on the intakes of pregnant women in the United States, especially African American women. According to the Continuing Survey of Individuals 1994-1996, 1998 (CSFII), pregnant and lactating women in the United States are consuming approximately 50 mg of DHA/day.[11] Low income pregnant women in the Midwest were found to consume 980 mg/day, 23 mg/day and 48 mg/day of ALA, EPA and DHA, respectively.[12] The International Society for the Study of Fatty Acids and Lipids (ISSFAL) recommends 500 mg of EPA and DHA per day for cardiovascular health[13] and that pregnant and lactating women should attempt to achieve an average of 200 mg DHA per day.[10] These results suggest that women from the United States are potentially not meeting the recommendations for omega-3 fatty acids, according to experts and government agencies.

Food frequency questionnaires (FFQ) are often used to assess nutrient intakes because they can be self-administered, inexpensive to process and tend to avoid changes in diet.[14] FFQs should be culturally and population specific and can be created or adapted to fit the population or purpose needed for the specific study by adding foods commonly eaten by the study population.[15,16] Newly developed FFQs should be measured for validity and reliability in the population of interest.[16] Ritter-Gooder et al. validated an omega-3 fatty acid FFQ with three 24 hour recalls in cardiac patients. The validity coefficient was 0.42 and test-retest reliability was 0.83.[17] Lora et al. did a similar

reliability and validity study in first-generation Latinas. Correlations for two administrations of the omega-3 FFQ were 0.71 for total omega-3 fatty, 0.65 for ALA, 0.74 for EPA, and 0.54 for DHA and the FFQ was considered valid for total omega-3 and ALA.[18] Currently, no FFQs exist that are specifically created to measure omega-3 fatty acid intakes in African American women.

Therefore, the purpose of this study was to validate and determine the reliability of a culturally specific FFQ to measure omega-3 fatty acid intakes in Midwestern African American women of childbearing age and to examine associations between health outcomes from prior pregnancies with their current omega-3 fatty acid intakes.

Methods

Subjects and Study Design

African American women of childbearing age, 16 to 49 years old, were recruited from the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), emergency pregnancy centers, schools and churches that have a high African American population, in Lincoln and Omaha, Nebraska. A total of 49 subjects were recruited, 11 non-pregnant and 38 pregnant women. Pregnant subjects were recruited between 8 and 37 weeks gestation. A registered dietitian completed one-on-one interviews with each participant, three times, one week apart, to obtain sociodemographic information and dietary intakes. Interviews were conducted at WIC sites, in the participant's home, library or grocery store and mall food courts. Participants received a $20 Wal-Mart gift certificate as compensation for their participation. The study was approved by the Institutional Review Board at the University of Nebraska-Lincoln.

Dietary Intake Methods

Two dietary assessment methods were used: three food frequency questionnaires, a week apart, and three, non-consecutive 24 hour dietary recalls, within a two week period.

Food Frequency Questionnaire

A food frequency questionnaire that was previously validated in a Caucasian cardiac population[17] and a first-generation Latina population[18] was adapted to be used in this African American female population. To identify omega-3 rich culturally appropriate foods and dishes that are commonly eaten by African Americans, interviews were conducted with a convenience sample of five African American women. These women

filled out a 24 hour recall and answered the following questions: *Are the foods listed on the 24 hour recall a part of your daily diet? What foods do you eat during special events or holidays? What foods do you eat that make you unique to your peers, co-workers, friends, etc.? What foods do you eat that may be considered soul food?* Subjects also answered questions about the types of fats and oils used to cook their foods, as well as fish, seafood and other meats that they eat.[18] A $5 Wal-Mart gift card was provided for compensation for participation. Common foods and dietary intakes of African Americans were also obtained from research literature .[19]

The resulting FFQ contained 209 food items and culturally specific dishes which were analyzed for total omega-3 fatty acid, ALA, EPA, DPA and DHA content in grams per medium serving and contained $\geq$10 mg of omega-3 fatty acid/medium serving. A medium serving size of each food was equivalent to one serving as described by the US Department of Agriculture (USDA) MyPyramid daily recommendation guidelines[21] and the USDA Nutrient Database for Standard Reference,[21] where a small serving size equals 0.5 times and the large equals 1.5 times the medium serving size, respectively. Serving size estimates for the culturally specific dishes were based on amounts commonly eaten by the study population. Foods were grouped in the following sections: meats, seafood, eggs, dairy, vegetables, fruit, breads and cereals, condiments and snacks, oils, nuts and seeds, beans, and prepared dishes. This FFQ was analyzed for content validity by three nutrition experts and then pilot tested with the first 10 African American pregnant women, involved in the study (n=49). These women were asked questions adapted from Lora et al.,[18] which assesses the level of difficulty of the instructions given, whether or not the FFQ was understandable and any reasons to not answer questions. After each

section of the FFQ, each pilot study participant was asked: *Are there any foods that are not on the FFQ, which are part of your daily diet?*[18] Recipes and serving sizes were also checked for accuracy.

After changes were made, the final culturally appropriate FFQ contained 187 food items, culturally specific dishes (i.e. featherbones, black eyed peas with ham hocks or neck bones, salmon croquettes) and food items commonly eaten by African Americans (i.e. fried catfish). All foods contained $\geq$ 10 mg omega-3 fatty acid/medium serving. A large serving size was considered two times the medium serving size due to reported amounts consumed during the pilot study. Frequency amounts were as follows (frequency weights): once a month (0.03), 2-3 times per month (0.08), 1-2 times a week (0.2), 3-4 times a week (0.5), 5-6 times a week (0.8), one time daily (1) and two or more times daily (2).[16] Food models, bowls, drinking cups and measuring cups were used to illustrate portion sizes for foods on the FFQ. To measure reliability, this FFQ was given three times, in a two week period, one week apart, to 40 African American women of childbearing age (four women completed two FFQs and five completed one FFQ).

24 hour recalls

The 24 hour recall was used as the reference method in this validation study. For the three days of recalls (n=42), a registered dietitian did one-on-one interviews with the participants in a requested place, including: their home, their WIC clinic, library or local food courts. Recalls were done on non-consecutive days so that they represented all days of the week, including weekend days.

Sociodemographic questionnaire

During the first appointment, participants filled out a demographic questionnaire, which was adapted from the Behavioral Risk Factor Surveillance System 2010 Questionnaire.[22] The questionnaire obtained information on marital status, income, education level, employment status, whether participants were pregnant, weeks of gestation and number of prior pregnancies. The questionnaire also contained questions adapted from the 2008 Maternal and Infant Health Assessment which asks information about health outcomes during previous pregnancies.[23]

Dietary Intake Analysis

Dietary intakes measured by both recalls and FFQs were analyzed using the Nutrition Data System for Research software version NDSR 2009, developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN.[24] On the FFQ, estimated intakes of omega-3 fatty acids were calculated by multiplying the amount of the omega-3 fatty acids in each food by the frequency weight of the selected frequency (as described above) by the selected serving size: small (0.5), medium (1) and large (2). Estimated omega-3 fatty acid intakes from the FFQ, were calculated using a template created in Microsoft Excel 2010 (Microsoft Corp, Seattle, WA).

Statistical Analysis

Data were analyzed using Statistical Analysis System (SAS) (version 9.2, 2008, SAS Institute, Inc., Cary, NC). Descriptive statistics were determined for individual total omega-3 fatty acid, ALA, EPA DPA and DHA intake from both the 24 hour recalls and FFQs and the sociodemographic information. These statistics included the means, frequencies and standard deviations. Cronbach's coefficient alpha was used to assess internal consistency reliability between individual nutrient intakes, from the three FFQ

administrations, and food groups. Since individual intake varies, a reliable FFQ will discern between individual dietary intakes or higher between-person variation. A high Cronbach's coefficient alpha represents low within-person variation relative to among person variation; therefore, signifying a reliable dietary instrument. Validity was measured by Pearson correlation coefficients, which were calculated to assess relationships between mean intakes of the 24 hour recalls and mean intakes of the FFQs. Statistical significance for validity correlation coefficients was set at $p<0.05$. The nutrient intakes were skewed and not normally distributed, so all data was log transformed $(x+1)$ to better approximate the normality of the distribution before Cronbach's alpha and Pearson correlation coefficients were computed. Analysis of variance and covariance was used to evaluate the effects of demographic and pregnancy related health variables on omega-3 fatty acid intakes.

Results

Sociodemographic factors of the study population are found in Table 1. In the present study, out of 49 African American women, 38 were pregnant and an average of 26.7 years old. More than a third (39%), had one to three years of college, 45% had an income of less than 10,000 dollars a year and 73% were either unemployed or full-time employed. Almost half of the participants (49%) had never been married.

Mean Intakes

Mean intakes for both the three administrations of the FFQ and the 24 hour recalls are represented in Table 2. Mean intakes, estimated by the FFQs, for total omega-3, ALA, EPA, DPA and DHA were 2.68 g/d, 2.45g/d, 0.07 g/d, 0.03g/d and 0.12g/d

respectively. When compared to recalls, the FFQ overestimated total omega-3, ALA, EPA, DPA and DHA intakes by approximately 145%, 142%, 140%, 150% and 170%, respectively. The mean intakes of total omega-3 ALA, EPA, DHA and DPA by food groups are represented in Table 3. Oils, prepared dishes and vegetables provided the most total omega-3 and ALA intakes, while seafood and meat provided the most EPA and DHA intakes. Seafood, meat and prepared dishes provided the most DPA intake. Oils, prepared dishes and vegetables provided more than 50% of the total omega-3 fatty acid for the study population (Table 4). Approximately, 50% of EPA and DHA, which represented 7% of the total omega-3 fatty acids consumed by these African American women, were provided by tilapia, fresh or frozen salmon, crab legs and fried catfish (Table 5).

Reliability

The culturally appropriate FFQ for Midwestern African American women was administered three times to 40 women to assess reliability (four women only completed two FFQs and five only completed one FFQ). Cronbach's coefficient alpha for the test administrations of the FFQ was 0.89, 0.89, 0.89, 0.83 and 0.88 for total omega-3, ALA, EPA, DPA and DHA, respectively (Table 6). Alpha correlation coefficients for food groups are represented in Table 7. The lowest to highest coefficient alpha for each nutrient is as follows: 0.17 (breads) to 0.86 (oils) for total omega-3, 0.15 (seafood) to 0.86 (oils/nuts and seeds) for ALA, 0.62 (meats) to 0.88 (dairy) for EPA, 0.17 (Seafood) to 0.69 (breads, cereals) for DPA and 0.62 (meats) to 0.86 (breads, cereals) for DHA.

Validity

To assess validity, the FFQs or "test" method was compared to a "reference" method, which was three 24 hour recalls. Pearson correlation coefficients between the two dietary assessment methods were 0.44 ($p<0.01$) for total omega-3, 0.44 ($p<0.01$) for ALA, 0.59 ($p<0.001$) for EPA and 0.60 ($p<0.001$) for DHA. Validity coefficients for DPA were not statistically significant. These values are reported in Table 2.

Maternal characteristics and health outcomes

The 38 pregnant women, had an average gestation of 25 weeks. EPA and DHA intakes were significantly different ($p<.05$) between the pregnant and non-pregnant women, with non-pregnant women having higher intakes (Table8). Approximately 70% of the African American women had prior pregnancies. Figure 1 provides the maternal health questions and any significant difference in intakes of those who had these health conditions, compared to those who did not. The ten women, who had babies born at less than 5 pounds 8 ounces, ate significantly more ($p<0.05$) total omega-3 and DHA than those women who did not. Of the women who reported a previous diagnosis of post-partum depression, approximately 24% of those who had previous pregnancies, had significantly higher intakes ($p<0.05$) of total omega-3 and ALA, which was also found in the seven women who reported premature rupture of membranes. Total omega-3 and EPA intakes were higher ($p<0.05$) in those women who reported past history of preterm or early labor.

Demographics and mean intakes

The average body mass index (BMI) for these subjects was 30.4, which is considered overweight by the Centers for Disease Control (CDC).[25] BMI information is reported in Table 9. More than half of these women were overweight or obese according

to their BMI, which is based on reported pre-pregnancy or current weights for the pregnant and non-pregnant participants, respectively. When comparing omega-3 intakes for those women who were obese (BMI >30) and non-obese, no significant difference in intakes was found (data not shown).

Analysis of covariance was used to evaluate the effects of age (quantitative variable) and education and income (both categorical variables) on omega-3 fatty acid intakes. No significant differences were found with age and income. EPA and DHA intakes were significantly different ($p < 0.05$) between education levels (Table 10). Those women who were college graduates had higher EPA and DHA intakes than those women with less education.

Discussion

The following study assessed the reliability and validity of a culturally appropriate questionnaire created to measure omega-3 fatty acid intakes in Midwestern African American women of childbearing age. As assessed by the administrations of the FFQ, women in the current study met the AI for ALA, which is 1.1 g/d and 1.4 g/d for non-pregnant and pregnant women, respectively.[26] Similar results have been found in other diverse populations of women, including African American, [27] French-Canadian[28] and Mexican women.[29] ALA contributed approximately 90% of total omega-3 fatty acid intakes of the African American women, in the present study. Intake of ALA is essential due to the body's inability to synthesize this fatty acid and it can be further metabolized to the longer chain polyunsaturated fatty acids (LCPUFAs) EPA and DHA, which are needed for optimal health.[30,31] But due to the inefficiency of conversion of EPA and DHA from ALA, experts suggest obtaining these omega-3 fatty acids in preformed options, like

foods or supplements.[31-33] For cardiovascular health, the International Society for the Study of Fatty Acids and Lipids (ISSFAL) recommends an intake of 500 mg of EPA+DHA daily.[13] Women in the present study ate approximately 190 mg of EPA and DHA per day, which does not meet the recommendation set by The ISSFAL.[13]

Furthermore, the 38 pregnant women in the present study, with mean DHA intakes of 100 mg/d only met approximately 50% of the ISSFAL recommendation of 200 mg per day of DHA for pregnant and lactating women.[10] Stark et al. found that African American pregnant women, at 24 weeks gestation, ate approximately 81 mg/d of DHA.[27] African American women involved in Project Viva, an observational cohort study of factors in pregnancy, including gestational diet and its' impact on pregnancy outcomes and offspring health, ate approximately 70 mg/d of EPA+DHA per day.[35] In a predominantly, Caucasian sample of pregnant women, DHA intakes were 48 mg/d, as assessed by 24 hour recalls.[12] Higher DHA intakes have been found in other diverse populations of pregnant women, including 140 mg/day in pregnant Mexicans[29],140 mg/d in pregnant Dutch women[35] and 160 mg/day in pregnant Canadians.[36] Interestingly, EPA and DHA intakes of pregnant African American women were significantly different than intakes of non-pregnant women, in the present study, with pregnant women consuming fewer LCPUFAs. Similarly, Stark et al.[27] found that African American women three months postpartum had a higher mean intake of DHA than women at 24 weeks gestation. In contrast, Nochera et al.[37] found that pregnant women (2.37 g/mo) consumed more EPA+DHA when compared to lactating women (2.04 g/mo). EPA and DHA are found predominantly in cold water fish, i.e. salmon, tuna and shellfish, eggs, and poultry.[4,9] In

the present study, women consumed approximately 50% of their EPA and DHA from tilapia, fresh/frozen salmon, crab and fried catfish.

Several factors may play a role in fish consumption. After conducting focus groups with low-income African American women, non-Hispanic white women, Spanish and non-Spanish speaking Latinas, Troxel et al. found that cost, lack of knowledge in food preparation and dislike of foods that are rich in DHA were some of the reported barriers for choosing foods rich in this omega-3 fatty acid.[38] Living in a non-coastal community may impact fish consumption; for example, NHANES 1999-2004 data found that the lowest mercury exposures from fish consumption were found in the the non-coastal Midwest.[39] Cultural food traditions, which seem to play a large role in African American food choices, may also impact fish and other DHA rich food consumption [37,40]

Sociodemographic factors were associated with omega-3 fatty acid intake. In Project Viva, higher education was related with higher fish intake .[34] In the current study, EPA and DHA intake was significantly different across education levels (some high school, high school graduate, college 1-3 years and college graduate). Those who reported graduating from college had the highest intakes of EPA and DHA. Education was positively correlated with EPA+DHA intakes in a first-generation Latina population[41] and with fish consumption in a Swedish[42] and European[43] male and female population. Researchers suggest education is the most used, reliable and valid indicator of socioeconomic status (SES)[44] Living a healthy lifestyle, recognizing the importance of preventative health measures and making behavioral choices that bring about lifetime health benefits may all be influenced by the level of education and knowledge that a person acquires.[43] When using occupation as the SES, Wardle et al. found that those of

lower SES were less likely to think about "things to do to keep healthy, " the future, and had stronger beliefs in the influence of "chance" on health. [45]African American college graduates, in the present study, may have had more knowledge of the health benefits of EPA and DHA, as well as, which foods are rich in these nutrients or due to educational level, and/or increased ability to purchase EPA+DHA rich foods.[43] Intakes, however, were not significantly different across income levels, in the present study.

Obesity is also a determinant of health and more than a third of the study population was obese, with an average BMI of 30.4. In the current study, omega-3 fatty acid intakes between obese and non-obese women were not significantly different. This differs from what Donahue et al.[34] found in a large cohort of pregnant women. Women who were obese prior to pregnancy had significantly higher total omega-3 fatty acid intakes than women who had normal pre-pregnancy weights. In a large cohort of Canadian pregnant women, a higher percentage of obese women ate fish more than once a week when compared to underweight, normal weight and overweight women .[46]

The omega-3 fatty acid FFQ was administered to 40 of the AA women three times (four women only completed two FFQs and five only completed one FFQ) to assess reliability. The Cronbach's coefficient alphas for total n-3, ALA, EPA, DPA and DHA were 0.89, 0.89, 0.89, 0.83 and 0.88, respectively. The closer the coefficient alpha is to 1.00 indicates the ability of the FFQ to distinguish intakes between participants. The current FFQ is considered reliable with high between-person variation, which is to be expected because subjects differ from each other in their usual daily food intake [33] The coefficient alphas in the current study, may suggest that the current FFQ was able to distinguish between subject's omega-3 fatty acid intakes and participants were able to

provide the same information between all three administrations of the FFQ, though there is a risk that participants remember responses with shorter intervals between questionnaire administrations.[16] The current study provided a week between each administration of the FFQ. These results are similar to the results of the reliability study done by Ritter-Gooder et al., with a coefficient alpha of 0.83 measured between two administrations of an omega-3 fatty acid food frequency questionnaire used with Caucasian cardiac patients.[17] In the current study reliability was assessed for each food group with the use of Cronbach's coefficient alpha. Oils, nuts and seeds, eggs and seafood had the highest coefficient alphas for total omega-3 and breads and cereals had the lowest. Similar results were found in ALA, except the lowest coefficient alpha for ALA was seafood. Seafood and eggs had the highest coefficient alphas for EPA and DHA, with a high reliability also found in dairy for EPA, which seemed to be based on ice cream intakes. Those food groups with the highest coefficient alpha seem to be the most prevalent in these women's diets. Those with low coefficient alphas may reflect actual changes in intakes or they are eaten inconsistently by the study population.

During one-on-one interviews, over a two week period, subjects provided three non-consecutive 24 hour recalls, including one weekend day. Validity of the FFQ was measured by computing Pearson correlation coefficients, with log transformed data, between the omega 3 fatty acid mean intakes from 24 hour recalls and FFQs. The correlation coefficients were 0.44 for total n-3, 0.44 for ALA, 0.59 for EPA, 0.25 for DPA and 0.60 for DHA. All correlations were statistically significant at $p < 0.05$ except for DPA. The correlation coefficients calculated between the two dietary methods, in the present study, are similar to those computed in other omega-3 fatty acid FFQ validation

studies. Lora et al.[18] validated an omega-3 FFQ to measure intakes in a sample of first-generation Latinas against 24-hour recalls. Pearson correlation coefficients were 0.32 for total n-3, 0.34 for ALA, 0.28 for EPA and 0.24 for DHA. The FFQ was found to only be valid for total n-3 and ALA.[18] In another study omega-3 fatty acid FFQ was validated against three 24 hour recalls, with a Pearson correlation coefficient of 0.42 between the two dietary methods.[17] In a sample of pregnant Finnish women, an FFQ to assess dietary intakes during pregnancy was validated against two 5-day food records. After attenuation and adjustment for energy, the Pearson correlation coefficient for total omega-3 fatty acid intake, between the two methods, was 0.39.[47] A semi-quantitative FFQ was validated in a multicultural pregnant population with maternal erythrocyte and cord plasma EPA + DHA concentrations, at mid and late pregnancy. At mid-pregnancy, the Spearman correlations were 0.38 and 0.36 between the FFQ and the two biomarkers: maternal erythrocyte and cord blood plasma, respectively. The Spearman correlations between the FFQ and biomarkers were 0.18 and 0.21, in late pregnancy .[34]

All dietary methods have inherent errors so when developing a validation study, the goal is to find a reference method that has error which does not correlate with the error found in the test method.[16,48] Biochemical indicators of dietary intakes are advantageous over other dietary methods as the "reference" method in a validation study, because measurement errors should not be correlated with errors found in any dietary assessment methods.[16] They do, however, have their own sources of error, i.e. individual variations in absorption and metabolism of nutrients or technical error associated with laboratory measurement. The next choice seems to be food records. When compared to 24 hour recalls, food records are the preferred test method, due to less correlated error

between them and FFQs.[14,16] But since, food records require subjects to be motivated and literate, a 24 hour recall is sometimes the best option.[16] In the current study, the all of the omega-3 fatty acid intakes measured by the FFQ were at least 142% higher than the intakes measured by the 24 hour recalls. Other studies have reported subjects underreporting energy intakes with the use of 24 hour recalls. Thirty-five weight stable women, with a mean age of 30 years, completed four multiple pass 24hour recalls, in-person and on the phone. When comparing the recall intakes against doubly labeled water measurements of total energy expenditure (TEE), subjects underreported their intakes by an average of 16%.[49] A similar result of underreporting was found when men and women completed three 24- hour recalls using the USDA Automated Multiple Pass Method, a computer-assisted version of the USDA 5-step method. When the recall data was compared to the TEE, measured by doubly labeled water, subjects underreported intakes by 11% [50] Poslusna et al.[51] stated that underreporting is associated higher BMI, being a women, lower socioeconomic status and lower education level. In the present study, 40% of women were considered obese, based on reported pre-pregnancy or current body weight. Almost half of the subjects have not been to college and approximately, 18% did not graduate high school. These characteristics of the current population, may have contributed to the underreporting of intakes, measured by recalls, when compared to the FFQs.

Preterm birth, low birth weight, preeclampsia and postpartum depression are all health issues which may be influenced by maternal omega-3 fatty acid intakes. African American infants have approximately 2.3 times the mortality rate of non-Hispanic white infants and some of this can be explained by preterm birth and low birth weight .[52,53]

Preterm birth is defined as a baby born at less than 37 weeks gestation.[52] Researchers, after a structured literature review, found that an imbalance of omega-3 and omega-6 fatty acids may have an impact on preterm birth occurrence in African American women.[52] In the current study, 39% of women with previous pregnancies reported having a preterm baby, but there was not a significant difference in omega-3 fatty acid intakes, when compared to women who did not have a preterm baby. African American women who reported history of preterm labor (18%) ate significantly more foods containing total omega-3 fatty acids and EPA, furthermore, those who reported history of premature rupture of membranes (21%) ate significantly more foods containing total omega-3 and ALA. Intakes of EPA and DHA may play a protective role in decreasing the occurrence of preterm birth and preterm labor, because of the eicosanoids derived from these LCPUFAs may relax the uterine wall and competitively inhibit those eicosanoids that lead to rupture of membranes and contractions.[54] Dhobale et al. found that placental DHA levels were lower in preterm deliveries when compared to term deliveries ,[55] and placental DHA is dependent on metabolism of maternal DHA intakes.[56] In the current study, EPA and DHA intakes were below recommended levels. If this is any indication of previous intakes, then these African American women are not meeting their needs which may lead to reoccurrence of this maternal health outcome. Klebanoff et al. found that moderate fish intake (up to three meals per week) before 22 weeks gestation was associated with a reduction in repeat preterm labor .[57] In addition, fish oil supplementation in Danish pregnant women decreased the risk of preterm birth occurrence from 33% to 21% .[58]

History of low birth weight, a birth weight below 5 pounds 8 ounces, was reported by 30% of the African American women with previous pregnancies, in the current study. African American infants are three times more likely to die from complications of low birth weight than non-Hispanic white infants.[53] Researchers have found that pregnant women who took EPA and DHA rich cod liver oil gave birth to larger babies, when compared to mothers who took olive oil (a poor source of EPA and DHA) .[58] Interestingly, in the current study, participants who had a history a of low birth weight infants ate significantly more foods containing DHA than those moms who did not have a low birth weight baby. Their mean intakes were 196 mg of DHA, which meets 98% of the guidelines set by ISSFAL for pregnant women, compared to 96 mg of DHA intake of those participants who have not had low birth weight babies.

Preeclampsia, defined as high blood pressure (blood pressure > 140/90 mm Hg over time) and protein in the urine, after 20 weeks of pregnancy,[59] was reported by 27% of AA women, with previous pregnancies, in the current study. No significant difference was found between these women's intakes and participants who did not have history of preeclampsia. EPA derived eicosanoids are thought to have a beneficial effect on decreasing the occurrence of preeclampsia .[54] In placental tissues of preeclamptic women, EPA and DHA decreased, when compared to normotensive women, in a sample of pregnant Indian[60] and American women.[61] Williams et al. found that pregnant women with the lowest total omega-3 fatty acid erythrocyte levels were 7.6 times more likely to have preeclampsia than those with the highest erythrocyte levels.[3] Currently women, in the present study, had mean DHA intakes of 110 mg, which is not meeting their needs and may put them at risk for reoccurrence of preeclampsia.

Twenty-four percent of women, in the current study, who had previous pregnancies, reported a diagnosis of postpartum depression. Postpartum depression is characterized as a nonpsychotic depressive illness of mild-to moderate severity occurring in a mother during the first postnatal year, which is a time of major change and increased responsibilities in the care of a newborn infant .[62,63] A possible factor in postpartum depression is inflammation, which may be inhibited by intake of EPA and DHA secondary to their anti-inflammatory nature. Also, researchers have reported that populations which have higher intakes of omega-3 fatty acids, have lower rates of depression [64] and bipolar disorder .[65] Limited research supports the role of EPA and DHA in the prevention of depression. Hibbeln et al. found that lower amounts of DHA in breast milk and lower amounts of seafood intakes were associated with higher amounts of postpartum depression.[66] Another study found that a 1% higher plasma DHA status was associated with a 59% reduction in the likelihood of reporting depressive symptoms postpartum .[67] In the current study, those participants who had a prior diagnosis of postpartum depression (3.73 g/d vs. 2.19 g/d) consumed significantly more foods containing total omega-3 fatty acids and ALA but their EPA and DHA intakes were not significantly different. Researchers suggest that high ALA intakes can inhibit further conversion of ALA to DHA [68] In rats, linoleic acid was held at a constant level and ALA was increased from 0.1 to 2.8% of energy. While dietary intake of both ALA and EPA content in both plasma and liver follow a linear pattern, DHA status follows a curvilinear pattern with ALA intake. DHA status increases up to a dietary level of ALA approximately 1% of energy and then plateaus and eventually declines .[69] The Acceptable Macronutrient Distribution Range for ALA is 0.6 to 1.1% of energy.[26] Similar results

were reported in piglets at a dietary level of ALA at 2% of energy and any intake above this level inhibited DHA conversion .[70] Chan et al. found that EPA increased in a dose-dependent manner with low (0.8% of energy), intermediate (6.6%) and high (13.4%) intakes of ALA, but DHA did not change in a population of normolipidemic Canadian men.[71] African American women, who had a prior diagnosis of postpartum depression, ALA intakes were 339% higher than the Adequate Intake for women between the ages of 14-50 years.[26] If current intakes reflect past intakes, then the high amount of ALA consumed by these women may have inhibited further conversion of ALA to DHA and with current low intakes of DHA, at approximately 127 mg/d, this could have possibly increased their risk for postpartum depression.

Conclusions

Currently, this is the first food frequency questionnaire developed to specifically measure Midwestern African American omega-3 fatty acid intakes. The omega-3 fatty acid FFQ had acceptable reliability and validity to measure nutrients studied in this population. In the current study, intakes exceeded the recommended amounts for ALA but did not meet the recommended amounts for EPA and DHA, including those who were pregnant. African Americans suffer disproportionately from several diseases, including preterm birth and low birth weight, which may be associated with low omega-3 intakes in this population. Omega-3 fatty acid rich foods may be too expensive, not appetizing to these women or considered going against the cultural norm, leading to lower intakes. Further research is needed to find out factors that influence these intakes. Assessment of low income African American women's knowledge of omega-3 rich foods and their role in health is warranted, as well as, what would be the best way to provide

educational information to this population. Nutrition educators can then tailor educational materials to the targeted audience and possibly increase access to information about the importance of these nutrients.

Table 1. Demographic characteristics of Midwestern African American women
of childbearing age (n=49).

Characteristic	Mean + SD	n(%)
Age (y)[a]	26.7±6.3	
Pregnant		38(78)
Weeks of gestation (range)	24.6+8.9 (8-37)	
Education		
Some High school		10(18.4)
High school graduate/GED		14(28.6)
1-3 years of college		19(38.8)
College Graduate		6(12.2)
Marital Status		
Married		10(20.4)
Divorced		4(8.2)
Separated		2(4.1)
Never Married		24(49)
Member of an unmarried couple		9(18.4)
Annual Household Income		
>$10,000		22(44.9)
$10,000 - $20,000		7(14.3)
$21,000 - $35,000		13(26.5)
$36,000 – $50,000		1(2)
Not sure/did not answer		6(12.2)
Employment		
Full time employed		18(36.7)
Part time employed		3(6.1)
Unemployed/Homemaker		18(36.7)
Student		4(8.2)

[a] Mean ± SD

Table 2. Mean intakes (±SD) of total omega-3 (Total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and docosapentaenoic acid estimated by the three FFQs and three 24 hour recalls with correlations between the two methods.

	FFQs (g/d)	24-h recalls (g/d)	Pearson Correlation[a]
Total n-3	2.68±1.37	1.85±0.86	0.44[b]
ALA	2.45±1.30	1.72+0.81	0.44[b]
EPA	0.07±0.07	0.05±0.08	0.59[c]
DPA	0.03±0.02	0.02±0.02	0.25
DHA	0.12±0.11	0.07±0.09	0.60[c]

[a] Calculated based on log-transformed values.
[b] $p<.01$
[c] $p<.00$

Table 3. Mean intakes of total omega-3 (total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), and docosahexaenoic acid (DHA) by food groups as estimated by the three FFQs.

Food Groups	Total n-3	ALA	EPA[a]	DPA[a]	DHA[a]
			g/d		
Meat	0.22±0.18	0.18±0.15	0.005±0.005	0.01±0.01	0.02±0.02
Seafood	0.21±0.22	0.05±0.08	0.07±0.07	0.02±0.03	0.09±0.09
Eggs	0.09±0.08	0.07±0.07	0.002±0.002	-	0.01±0.01
Dairy	0.25±0.17	0.25±0.17	0.001±0.001	-	-
Vegetables	0.35±0.25	0.35±0.25	-	-	-
Fruit	0.05±0.05	0.05±0.05	-	-	-
Bread, cereals	0.19±0.22	0.19±0.22	0.001±0.002	0.00005±0.0001	.0001±.0001
Condiments, snacks	0.17±0.11	0.17±0.11	-	-	-
Oil	0.73±0.70	0.73±0.11	-	-	-
Nuts	0.04±0.14	0.04±0.14	0.0001±0.00002	-	-
Beans	0.005±0.007	0.005±0.007	-	-	-
Prepared Dishes	0.42±0.27	0.43±0.31	0.003±0.006	0.01±0.01	0.002±0.003

[a] Blanks signify that the food group contains below detectable amounts of the fatty acid

Table 4. Rank order listing of food groups that provided total omega-3 fatty acid intakes consumed by African American women, as measured by three FFQs.

Rank order	Food group	% of total omega-3 intake
1.	Oils	26.9
2.	Prepared Dishes	15.5
3.	Vegetable	12.9
4.	Dairy	9.1
5.	Meat	8.1
6.	Seafood	7.8
7.	Bread, cereals	6.9
8.	Condiments, snacks	6.4
9.	Eggs	3.2
10.	Fruit	1.7
11.	Nuts and Seeds	1.4
12.	Beans	0.2

Table 5. Rank order listing of foods that provided approximately 90% of eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA) in the study population, as assessed by the means of the FFQs.

Rank order	Food	% each food provided to EPA+DHA intake
1.	Tilapia	21.8
2.	Salmon, frozen/fresh	12.0
3.	Crab	7.5
4.	Fried Catfish	7.4
5.	Tuna, canned in water	5.9
6.	Fried/scrambled egg, in butter	5.4
7.	Shrimp	5.2
8.	Fried shrimp	4.3
9.	Sardines	3.8
10.	Salmon, canned	3.6
11.	Fried wings	2.9
12.	Salmon croquettes	2.6
13.	Chicken breast	1.9
14.	Boiled eggs	1.7
15.	Fried chicken legs	1.5
16.	Chicken wing	1.2
17.	Chicken leg	1.1

Table 6. Cronbach's coefficient alphas[a] of total omega-3 (Total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DHA), and docosahexaenoic acid (DPA) from the three FFQs.

Nutrient	Coefficient
Total n-3	0.89
ALA	0.89
EPA	0.89
DPA	0.83
DHA	0.88

[a] Calculated based on log-transformed values.

Table 7. Cronbach's coefficient alphas of food groups by total omega-3 (total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), docosahexaenoic acid (DHA) between the three FFQs.

Food Groups	Total n-3	ALA	EPA[a]	DPA[a]	DHA[a]
Meats	0.77	0.79	0.62	0.62	0.62
Seafood	0.82	0.15	0.83	0.17	0.82
Eggs	0.83	0.82	0.82	-	0.82
Dairy	0.80	0.80	0.88	-	-
Vegetables	0.68	0.68	-	-	-
Fruits	0.79	0.79	-	-	-
Breads, cereals	0.17	0.16	0.68	0.69	0.86
Condiments, snacks	0.59	0.58	-	-	-
Oils	0.86	0.86	-	-	-
Nuts and seeds	0.85	0.86	0.70	-	-
Beans	0.79	0.80	-	-	-

[a] Blanks signify that the food group contains below detectable amounts of the fatty acid

Table 8. Mean intakes ($\pm$SD) of total omega-3 (Total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid, docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) of pregnant and non-pregnant African American women.

	N	Total n-3	ALA	EPA[a]	DPA	DHA[a]
				g/d		
Pregnant	38	2.70$\pm$1.46	2.50$\pm$1.38	0.06$\pm$0.06	0.02$\pm$0.02	0.10$\pm$0.09
Non-pregnant	11	2.58$\pm$1.09	2.24$\pm$1.00	0.12$\pm$0.09	0.04$\pm$0.02	0.19$\pm$0.13

[a]Intakes are significantly different at $p>.05$

Table 9. Midwestern African American women's body mass index (BMI)
(n=49).

Characteristic	Mean(+SD)	n(%)
BMI[a]	30.4 $\pm$ 8.5	
Body mass index category:		
18.5-24.9[b]		14(28.6)
25-29.9[c]		15(30.6)
>30[d]		20(40.8)

[a] Based on pre-pregnancy weight (n=37)
[b] Normal weight
[c] Overweight
[d] Obese

Figure 1. Previous pregnancy maternal health issues of African American women as assessed by questions adapted from the 2008 Maternal and Infant Health Assessment[30](n=33)[a].

	n(%)
Did you ever:	
have a baby that weighed less than 5 pounds, 8 ounces (2 ½ kilos) at birth?	10(30)[b]
have a baby that was born prematurely (before you reached 37 weeks of pregnancy)?	13(39)
have labor pains more than 3 weeks before your baby was due (preterm/early labor)?	6(18)[c]
have your water break more than 3 weeks before you baby was due (premature rupture of membranes)?	7(21)[d]
have pregnancy induced high blood pressure (preeclampsia, eclampsia or toxemia)?	9(27)
After any of your pregnancies:	
Did you ever have 2 weeks or longer when you felt sad, empty or depressed for most of the day?	13(39)
Has a doctor, nurse or midwife referred you to a counselor who helps people who are feeling sad, empty or depressed?	7(21)
Have you ever been diagnosed with post-partum depression?	8(24)[d]

[a] Two women, who had previous pregnancies, did not provide answers to the maternal health questions.
[b] Intakes for total omega-3 and DHA were significantly different (p<.05) between women who had previous maternal health issues and those who did not.
[c] Intakes for total omega-3 and EPA were significantly different (p<.05) between women who had previous maternal health issues and those who did not.
[d] Intakes for total omega-3 and ALA were significantly different (p<.05) between women who had previous maternal health issues and those who did not.
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Table 10. Mean intakes ($\pm$ SD) of Total omega-3 (total n-3), alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA) of African American women by education level, from the three FFQs.

Education level	n	Total n-3	ALA	EPA[a]	DPA	DHA[a]
				g/d		
Some high school	9	3.77$\pm$1.93	3.52$\pm$1.87	0.08$\pm$0.07	0.03$\pm$0.03	0.13$\pm$0.13
High school graduate	14	2.05$\pm$0.76	1.94$\pm$0.70	0.03$\pm$0.03	0.02$\pm$0.01	0.06$\pm$0.03
College 1-3 years	20	2.61$\pm$1.20	2.37$\pm$1.12	0.08$\pm$0.06	0.03$\pm$0.02	0.13$\pm$0.09
College graduate	6	2.71$\pm$1.27	2.23$\pm$1.21	0.17$\pm$0.11	0.05$\pm$0.02	0.25$\pm$1.27

[a]Intakes are significantly different at $p<.05$

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APPENDIX A

Institutional Review Board Letters

Nebraska
Lincoln

INFORMED CONSENT FORM

IRB# 20110311493 EX
Date Approved: 03/04/2011
Valid Until: 01/01/2013

Dear Participant:

You are invited to participate in this research study because you are an African American woman. We want to learn more about the foods that you eat. The following information is provided in order to help you make an informed decision whether or not to participate. Participation in this study is voluntary and does not pose any risk to you. All information is kept strictly confidential.

Identification of Project:
Validity and reliability of a culturally appropriate Food Frequency Questionnaire to measure omega-3 fatty acid food intake in African American Pregnant women-**Phase 1/24** hour recall and preliminary interviews

Omega-3 fatty acid foods are important for maternal and infant health. For the mom, they can protect against high blood pressure during pregnancy and post partum depression. For the infant, they can protect against pre-term birth and promote a higher birth weight. We are conducting this study to know how much and how often you are eating foods that contain Omega-3 fatty acids.

Purpose of the Research:
This research project aims develop a culturally competent Food Frequency Questionnaire to measure Omega-3 fatty acid intake in pregnant African American Pregnant Women. To participate in Phase 1 of this study, you must be an African American woman.

Procedures:
Participation in this study will require approximately 25 minutes of your time. You will be asked to fill out a 24 hour dietary recall, where a trained interviewer will ask you to recall and report your intake, including all food and beverages, consumed in the previous 24 hours or preceding day. You will also be asked some questions about foods that are a part of your daily diet, foods that you eat on special holidays, foods that you eat that are considered soul food and foods that you eat which make you unique to your others. You will also be asked to list the type of fats and/or oils you use to cook with and types of fish, seafood or other meats that you eat daily. You will not be required to write anything down. This study will take place at the Charles Drew WIC clinic.

Risks and/or Discomforts:
There are no known risk or discomforts associated with this research. You may experience very slight discomfort in answering some of the questions. You are free to not answer a question, or to discontinue the process at any time.

_____
Research Participant

Benefits:
This study may not provide direct benefit to you. However, the information obtained during this study will help assess Omega 3 fatty acid intake of African American pregnant women. Omega 3 fatty acid intake may impact maternal and infant health.

Confidentiality:
Any information obtained during this study that could identify you will be kept strictly confidential. You will receive ID numbers that will be used throughout the study. Your name will not appear on the information collected. The data and identifying information will be stored in a locked cabinet in the main researcher's office and will only be seen by the researchers then destroyed five years after the research project is complete. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your identity will be kept strictly confidential.

Compensation:
You will receive a $10 dollar gift certificate from Wal-Mart for participating in this study.

Opportunity to Ask Questions:
You may ask questions concerning this research and have those questions answered before agreeing to participate in or during the study. If you need more information or have questions about this research, please contact the principal investigator, Narissa Scales, office phone, (402) 472-3836 or by email at narissa_s@yahoo.com. If you have any additional questions concerning your rights as a research participant, or to report any concerns, you may contact the University of Nebraska-Lincoln Institutional Review Board (UNL IRB), telephone (402) 472-6965.

Freedom to Withdrawal:
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigator, the University of Nebraska-Lincoln or WIC. Your decision will not result in any loss of benefits to which you are otherwise entitled.

DOCUMENTATION OF INFORMED CONSENT

YOU ARE VOLUNTARILY MAKING A DECISION WHETHER OR NOT TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE CERTIFIES THAT YOU HAVE DECIDED TO PARTICPATE HAVING READ AND UNDERSTOOD THE INFORMATION PRESENTED. YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

Signature of Participant:

_____   _____
Signature of Research Participant   **Date**

IN MY JUDGEMENT, THE PARTICIPANT IS VOLUNTARILY AND KNOWINGLY GIVING INFORMED CONSENT TO PARTICPATE IN THIS RESEARCH STUDY.

_____   _____
Signature of Investigator   **Date**

Name and phone number of investigator(s)
    Narissa Scales, Principal Investigator   **Office: (402) 472-3836**
    Kaye Stanek Krogstrand PhD., Secondary Investigator Office: (402) 472- 5285

Nebraska
UNIVERSITY OF
Lincoln

COLLEGE OF EDUCATION AND HUMAN SCIENCES
Department of Nutrition and Health Sciences

INFORMED CONSENT FORM

IRB# 20110311493 EX
Date Approved: 03/04/2011
Valid Until: 01/01/2013

Dear Participant:

You are invited to participate in this research study because you are an African American pregnant woman. We want to learn more about the foods that you eat. The following information is provided in order to help you make an informed decision whether or not to participate. Participation in this study is voluntary and does not pose any risk to you. All information is kept strictly confidential.

Identification of Project:
Validity and reliability of a culturally appropriate Food Frequency Questionnaire to measure omega-3 fatty acid food intake in African American Pregnant women-**Phase 2**/24 hour recalls and food frequency questionnaires.

Omega-3 fatty acid foods are important for maternal and infant health. For the mom, they can protect against high blood pressure during pregnancy and post partum depression. For the infant, they can protect against pre-term birth and promote a higher birth weight. We are conducting this study to know how much and how often you are eating foods that contain Omega-3 fatty acids.

Purpose of the Research:
This research project aims to test a culturally competent Food Frequency Questionnaire to measure Omega-3 fatty acid intake in pregnant African American women. To participate in Phase 2 of this study, you must be an African American woman and in your second or third trimester of pregnancy.

Procedures:
For this study, you will be asked to fill out a demographic questionnaire and two dietary assessments. The demographic questionnaire ask you general questions such as your age, education level, ethnic background and questions about any previous pregnancies. You will be asked to fill out a 24 hour dietary recall, where a trained interviewer will ask you to recall and report your intake, including all food and beverages, consumed in the previous 24 hours or preceding day. You will need to complete 3 dietary recalls, one week apart each. To complete the 24 hour food recall, you will need to provide short answers and participation will take approximately 10-15 minutes. The next dietary assessment is a food frequency questionnaire, where you will report types and amounts of foods that you eat. You will complete two questionnaires, two weeks apart. Participation in the questionnaire will require approximately 15 to 20 minutes to complete.

_____
Research Participant

Participants will be required to 1) read and sign the consent form, 2) fill out a demographic questionnaire, 3) fill out three 24 hour recalls, one week apart each, and 4) fill out two food frequency questionnaires, two weeks apart. This study will take place at either one of the following locations: Charles Drew WIC, Douglas County WIC or University of Nebraska Medical Center WIC.

Risks and/or Discomforts:
There are no known risks or discomforts associated with this research. You may experience very slight discomfort in answering some of the questions. You are free to not answer a question, or to discontinue the process at any time.

Benefits:
This study may not provide a direct benefit to you. However, the information obtained during this study will help assess Omega 3 fatty acid intake of African American pregnant women. Omega 3 fatty acid intake may impact maternal and infant health.

Confidentiality:
Any information obtained during this study that could identify you will be kept strictly confidential. You will receive ID numbers that will be used throughout the study. Your name will not appear on the information collected. The data and identifying information will be stored in a locked cabinet in the main researcher's office and will only be seen by the researchers then destroyed five years after the research project is complete. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your identity will be kept strictly confidential.

Compensation:
You will receive a $20 dollar gift certificate from Wal-Mart at the completion of this study for participating.

Opportunity to Ask Questions:
You may ask questions concerning this research and have those questions answered before agreeing to participate in or during the study. If you need more information or have questions about this research, please contact the principal investigator, Narissa Scales, office phone, (402) 472-3836 or by email at narissa_s@yahoo.com. If you have any additional questions concerning your rights as a research participant, or to report any concerns, you may contact the University of Nebraska-Lincoln Institutional Review Board (UNL IRB), telephone (402) 472-6965.

Freedom to Withdrawal:
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigator, the University of Nebraska-Lincoln or WIC. Your decision will not result in any loss of benefits to which you are otherwise entitled.
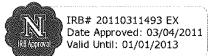
DOCUMENTATION OF INFORMED CONSENT

IRB# 20110311493 EX
Date Approved: 03/04/2011
Valid Until: 01/01/2013

YOU ARE VOLUNTARILY MAKING A DECISION WHETHER OR NOT TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE CERTIFIES THAT YOU HAVE DECIDED TO PARTICPATE HAVING READ AND UNDERSTOOD THE INFORMATION PRESENTED. YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

Signature of Participant:

_____   _____
Signature of Research Participant   **Date**

IN MY JUDGEMENT, THE PARTICIPANT IS VOLUNTARILY AND KNOWINGLY GIVING INFORMED CONSENT TO PARTICPATE IN THIS RESEARCH STUDY.

_____   _____
Signature of Investigator   **Date**

Name and phone number of investigator(s)
Narissa Scales, Principal Investigator   Office: (402) 472-3836
Kaye Stanek Krogstrand PhD., Secondary Investigator Office: (402) 472- 5285

UNIVERSITY OF **Nebraska** Lincoln

INFORMED CONSENT FORM

Dear Participant:
You are invited to participate in this research study because you are an African American woman of childbearing age, within the ages of 16 to 44. We want to learn more about the foods that you eat. The following information is provided in order to help you make an informed decision whether or not to participate. Participation in this study is voluntary and does not pose any risk to you. All information is kept strictly confidential.

Identification of Project:
Validity and reliability of a culturally appropriate Food Frequency Questionnaire to measure omega-3 fatty acid food intake in African American women, of childbearing age-**Phase 2**/demographic questionnaire, 24 hour recalls and food frequency questionnaires.

Research has shown that omega-3 fatty acid foods are important for women's health. They may boost heart health by lowering the risk of blood clotting. They can protect against high blood pressure during pregnancy and postpartum depression. We are conducting this study to know how much and how often you are eating foods that contain Omega-3 fatty acid

Purpose of the Research:
This research project aims to test a culturally competent Food Frequency Questionnaire to measure Omega-3 fatty acid intake in African American women. To participate in Phase 2 of this study, you must be an African American woman, of childbearing age, within the ages of 16-44.

Procedures:
For this study, you will be asked to fill out a demographic questionnaire and two dietary assessments. The demographic questionnaire asks you general questions such as your age, education level, ethnic background and questions about any previous pregnancies. You will be asked to fill out a 24 hour dietary recall, where a trained interviewer will ask you to recall and report your intake, including all food and beverages, consumed in the previous 24 hours or preceding day. You will need to complete 3 dietary recalls, one week apart each. To complete the 24 hour food recall, you will need to provide short answers and participation will take approximately 10-15 minutes. The next dietary assessment is a food frequency questionnaire, where you will report types and amounts of foods that you eat. You will complete two questionnaires, two weeks apart. Participation in the questionnaire will require approximately 30 minutes to complete.

Participants will be required to 1) read and sign the consent form, 2) fill out a demographic questionnaire, 3) fill out three 24 hour recalls, one week apart each, and 4) fill out two food frequency questionnaires, two weeks apart. This study will take place at either one of the following locations: Charles Drew WIC, Douglas County WIC, University of Nebraska Medical Center WIC or Immanuel Hospital WIC.

Risks and/or Discomforts:
There are no known risks or discomforts associated with this research. You may experience very slight discomfort in answering some of the questions. You are free to not answer a question, or to discontinue the process at any time.

Benefits:
This study may not provide a direct benefit to you. However, the information obtained during this study will help assess Omega 3 fatty acid intake of African American women.

Confidentiality:
Any information obtained during this study that could identify you will be kept strictly confidential. You will receive ID numbers that will be used throughout the study. Your name will not appear on the information collected. The data and identifying information will be stored in a locked cabinet in the main researcher's office and will only be seen by the researchers then destroyed five years after the research project is complete. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your identity will be kept strictly confidential.

Compensation:
You will receive a $20 dollar gift certificate from Walmart at the completion of this study for participating.

Opportunity to Ask Questions:
You may ask questions concerning this research and have those questions answered before agreeing to participate in or during the study. If you need more information or have questions about this research, please contact the principal investigator, Narissa Scales, cell phone, (402) 213-8729 or by email at narissa_s@yahoo.com. If you have any additional questions concerning your rights as a research participant, you may contact the University of Nebraska-Lincoln Institutional Review Board (UNL IRB), telephone (402) 472-6965.

Freedom to Withdrawal:
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigator, the University of Nebraska-Lincoln or WIC. Your decision will not result in any loss of benefits to which you are otherwise entitled.

DOCUMENTATION OF INFORMED CONSENT

YOU ARE VOLUNTARILY MAKING A DECISION WHETHER OR NOT TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE CERTIFIES THAT YOU HAVE DECIDED TO PARTICPATE HAVING READ AND UNDERSTOOD THE INFORMATION PRESENTED. YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

Signature of Participant:

_____   _____
Signature of Research Participant   **Date**

IN MY JUDGEMENT, THE PARTICIPANT IS VOLUNTARILY AND KNOWINGLY GIVING INFORMED CONSENT TO PARTICPATE IN THIS RESEARCH STUDY.

_____   _____
Signature of Investigator   **Date**

Name and phone number of investigator(s)

Narissa Scales, Principal Investigator   **Office: (402) 213-8729**

Julie Albrecht, PhD., Secondary Investigator Office: (402) 472-8884

APPENDIX B

Letter to Manager of Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

Kathy Blanke
WIC Manager
1819 Farnam
Room 403
Omaha, NE 68183
402-444-1770

Dear Kathy Blanke,

My name is Narissa Scales. I am a PhD student in the department of Nutrition and Health Sciences at the University of Nebraska Lincoln. I have also worked as a CPA at the Charles Drew Health Center WIC office.

I would like to request your permission to recruit and survey African American pregnant women at several of the WIC offices in the Omaha Metro area. These offices include: Charles Drew Health Center, University of Nebraska Medical Center, 120th and Dodge, 42nd and Center. My research aims to assess the intake of omega-3 fatty acids in African American pregnant women. The participants will be asked to complete two food frequency questionnaires and three 24 hour diet recalls. To accomplish that, I will meet with the participant twice and call the participant once in a two week period. During the first meeting, I will interview the participant about the foods that she ate the previous day and in the last month. During the second meeting, I will conduct an interview similar to the one in the first meeting. Participants will fill out a demographic questionnaire and a pregnancy health assessment during the first interview. Participation in this research study does not post any risk to the participants or anyone else.

I am also asking your permission to contact the Coordinator's of the above mentioned WIC clinics directly.

If you agree to grant me permission to carry out this study at the above mentioned WIC clinics, please let me know so by signing the attached letter of consent. The letter of consent needs to be printed on your letter head for use in our university's Institutional Review Board (IRB) process.

Thank you,
Sincerely

Narissa Scales, M.S., R.D., L.M.N.T.   Dr. Kaye Stanek-Krogstrand
(Principal Investigator)   (Secondary Investigator)
Graduate Student   Professor
Department of Nutrition & Health Sciences   Department of Nutrition & Health
University of Nebraska-Lincoln   Sciences
Lincoln, NE 68588-0806   University of Nebraska-Lincoln
Email: narissa_s@yahoo.com   Lincoln, NE 68588-0806

APPENDIX C

Letter of Consent from WIC Manager

Douglas/Sarpy County WIC
Room 403, Civic Center
1819 Farnam
Omaha, NE 68183-0401
(402) 444-1770

November 10, 2010

Narissa Scales, M.S., R.D., L.M.N.T.
Graduate Student
Department of Nutrition and Health Sciences
University of Nebraska-Lincoln
Lincoln, NE 68588-0806

Dear Narissa;

Thank you for meeting with me today to discuss your research project that would involve WIC participants. WIC is always open to research that will benefit our clients. Your project, to determine the intake of omega -3 fatty acids in African Amerian pregnant women, is research that will benefit WIC participants in the long run to have healthier pregnancies and healthier babies.

I will be glad to work with you and allow you to go into the following WIC clinics to conduct your research. The clinics are Charles Drew WIC, University of Nebraska WIC, Immanuel WIC and Douglas County WIC. The supervisor of these clinics and me will work closely with you to ensure that all the WIC participants will have to opportunity to refuse or accept the survey offer.

If you have any other questions please let me know. I am looking forward to working with you on this project.

Sincerely,

Kathy Blake, MS, RD
WIC Manager

APPENDIX D

Flier Used for Recruitment of Participants

YOU ARE INVITED TO PARTICIPATE IN A
NUTRITION RESEARCH STUDY

EARN A $20 WAL-MART GIFT CERTIFICATE!

We want to learn more about how you eat.

Eligibility:
1. African American women
2. 16-44 years of age

Estimated Time:
1. 3 meetings over a 2 week period
2. Approx. 45 minutes/meeting

****If interested, Contact Narissa Scales at (402) 213-8729****

APPENDIX E

Preliminary Interview Questions

Preliminary Interview

1. Are the foods listed here (on the 24 hr recall) a part of your daily diet? Yes or No

    What are other foods that are part of your daily diet?

    _____   _____

    _____   _____

    _____   _____

    _____   _____

    _____   _____

    _____   _____

2. What foods do you eat during special events or holidays?

    _____   _____

    _____   _____

    _____   _____

    _____   _____

    _____   _____

    _____   _____

3. What foods do you eat that may be considered soul food?

    _____   _____

    _____   _____

    _____   _____

    _____   _____

    _____   _____

4. What foods do you eat that make you unique to your peers, co-workers, friends, etc.?

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

5. What types of fats and oils do you cook with?

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

6. What fish, seafood and other meats do you typically eat?

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

APPENDIX F

Pilot Test Questionnaire

Pilot test Questions-Omega 3 FFQ

1. Were the instructions easy to understand?

   _____

2. Did you know how to mark your answer?

   _____

3. Do you think or feel there were too many options to mark your answer?

   _____

4. How hard was it to answer the questions?

   _____

5. I saw that you hesitated to answer some questions, what did you think at that
   moment?

   _____

   _____

6. Did you find the questionnaire interesting?

   _____

7. Was there a time you wanted to stop answering the questions? Why?

   _____

8. Did any question offend you?

   _____

APPENDIX G

Sociodemographic Questionnaire

ID#_____

DEMOGRAPHIC QUESTIONNAIRE

We need to describe who was in the study. Your answers will be kept private. We will only report information about the entire group.

1. Age _____ (years)

2. Are you
   ___Married
   ___Divorced
   ___Widowed
   ___Separated
   ___Never married
   ___A member of an unmarried couple

3. What is the <u>highest</u> grade or year of school you completed?

   ___Never attended school or only attended kindergarten
   ___Grades 1 through 8 (elementary school)
   ___Grades 9 through 11 (some high school)
   ___Grades 12 or GED (high school graduate)
   ___College 1 year to 3 years (some college or technical school)
   ___College 4 years or more (college graduate)
   ___Refuse to answer

4. Are you
   ___Full time employed
   ___Part time employed
   ___Unemployed
   ___Homemaker
   ___Student

5. Is your annual household income from all sources? _____

a. Less than $10,000	f. Between $35,000 and $50,000
b. Between $10,000 and $15,000	g. Between $50,000 and $75,000
c. Between $15, 000 and $20,000	h. 75,000 or more
d. Between $20,000 and $25,000	i. Do not know/she is not sure
e. Between $25,000 and $35,000	j. Refuse to answer

6. What is your current height and weight?

    Height: _____feet   _____inches

    Weight: _____pounds (please estimate if not known)

7. Are you currently pregnant?

    ___Yes   ___No

8. If yes, how far along are you?

    _____ (in weeks)

9. What was your weight before you became pregnant?

    Weight: _____pounds (please estimate if not known)

10. Have you been pregnant before?

    ___Yes   ___No

    If yes, how many pregnancies have you had? _____

11. Did you ever have a baby that weighed less than 5 pounds, 8 ounces ($2\frac{1}{2}$ kilos) at birth?

    ___Yes   ___No

12. Did you ever have a baby that was born prematurely (before you reached 37 weeks of
    pregnancy)?

    ___Yes   ___No

13. Did you have any of these health problems during pregnancy?

    _____a. Labor pains more than 3 weeks before your baby was due (preterm/early labor)

    _____b. Water broke more than 3 weeks before your baby was due (premature rupture of membranes)

_____c. Pregnancy induced high blood pressure (pre-eclampsia, eclampsia or toxemia)

14. After any of your pregnancies, did you ever have <u>2 weeks</u> or longer when you felt sad, empty, or depressed for most of the day?

_____Yes   ___No

15. After any of your pregnancies, has a doctor, nurse or midwife referred you to a counselor who helps people who are feeling sad, empty, or depressed?

___Yes   ___No

16. Have you ever been diagnosed with post-partum depression?

___ Yes   ___ No

17. Do you currently take a multivitamin or any other supplement?

        ___Yes   ___No

If yes, what kind?

_____

APPENDIX G

Twenty-four Hour Recall

24-Hour Food Recall (Entry)

Do you take a vitamin supplement or other nutritional supplement?_____What kind?_____

List all foods and beverages you ate/drank in the last 24 hours.

- For Meal Type, please write: Morning, Noon, Afternoon, Evening or Late Evening
- List all ingredients in mixed dishes (ex: pizza, thin crust with sausage, pepperoni, mushroom)
- Include as much detail as possible regarding amount, type and preparation of food
- Use the following abbreviations: TBSP=tablespoon; tsp=teaspoon, c=cup;oz=ounce;lb=pound; sl=slice

Meal Type	Amount Eaten	Food Item & Detailed Description

Appendix I

Food Frequency Questionnaire

Food Frequency Questionnaire

Date _____   Code _____

This form asks about your usual dietary intake over the past month. It will require approximately 15 to 20 minutes of your time to complete. Please use the following instructions:

1. Read each food item. If you have not eaten this food in the past month, mark "none" and move onto the next food item.
2. Indicate whether you think your usual serving size is small (S), medium (M), or large (L) by marking the correct serving size box. The dietary interviewers will show you food models and pictures for visual reference of servings.

    Note: A small (S) serving is equal to half (1/2) the usual serving
              A medium (M) is equal to the medium servings listed on the form
              A large (L) is equal to one and a half (1 ½) times as much or more of the medium serving

3. Think over the past month. How often do you usually eat each of the following items? Again, mark the box under the correct heading. Answer each question as best as you can; estimate if you are not sure.

Meats		Never	S	M	L	Month Once a month	2-3 times a month	1-2 times a week	Week 3-4 times a week	5-6 times a week	Daily 1 time	2 or more
Turkey	3 ounces											
Ground beef	3 ounces											
Beef Roast	3 ounces											
Beef steak	3 ounces											
Chicken leg	2 medium											
Fried chicken leg	2 medium											
Chicken wing	2 medium											
Fried chicken wing	2 medium											
Chicken thigh	2 medium											
Fried chicken thigh	2 medium											
Chicken breast, no skin	4 ounces											
Fried chicken breast	4 ounces											
Ham	3 ounces											
Deli Ham	1 ounce											
Deli Turkey	1 ounce											
Salami	1 ounce											
Ground turkey	3 ounces											
Pork Roast	3 ounces											
Pork Steak	3 ounces											
Bacon	2 strip											
Breakfast pork sausage link	2 link											
Breakfast pork sausage patty	2 small											
Italian Sausage	1 link											
Bratwurst	1 link											
Pork or combination hotdogs/franks	2 hot dog											
Beef hotdogs/franks	2 hot dog											
Pork ribs	2 medium rib											
Pork chops	3 ounces											

Seafood		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Tuna canned in oil	3 ounces											
Tuna canned in water	3 ounces											
Sardines canned in oil	3 ounces											
Salmon, canned	3 ounces											
Fresh or Frozen salmon	3 ounces											
Tilapia	3 ounces											
Fried Catfish	3 ounces											
Fish Sticks	3 sticks											
Breaded fish filets	3 ounces											
Shrimp	1/2 cup											
Fried shrimp	½ cup											
Crab legs	4 crab legs											

Eggs		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Egg boiled	1 large											
Fried egg, oil	1 large											
Fried egg, butter	1 large											

Dairy		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Vitamin D whole milk	1 cup											
2% milk	1 cup											
1% milk	1 cup											
Evaporated milk (PET milk)	¼ cup											
Sweetened condensed milk	¼ cup											
Buttermilk	1 cup											

Dairy		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Cheddar cheese, shredded	1 ounce											
Cheddar cheese, slice	1 slice											
Swiss cheese, slice	1 slice											
American cheese regular, slice	1 slice											
Monterrey Jack cheese, shredded	1 ounce											
Mexican blend cheeses, shredded	1 ounce											
Mozarella cheese, shredded	1 ounce											
Parmesan cheese	1 ounce											
Cream cheese, regular	1 tbsp											
Cottage cheese	½ cup											
Yogurt, original or regular	6 ounces											
Ice cream, regular	½ cup											
Pudding	½ cup											
Butter	1 tsp											

Vegetables		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Potato, boiled, no skin	1 medium											
Baked potato	1 medium											
Mashed potatoes	½ cup											
French fries	1 small serving											
Hash Browns	½ cup											
Broccoli, raw	½ cup											
Broccoli, fresh cooked	½ cup											
Broccoli, frozen cooked	½ cup											
Green peas, frozen cooked	½ cup											
Green peas, canned cooked	½ cup											
Spinach, fresh	½ cup											
Spinach, fresh cooked	½ cup											
Spinach, frozen cooked	½ cup											
Spinach, canned cooked	½ cup											
Cauliflower, raw	½ cup											
Cauliflower, cooked	½ cup											
Carrots, frozen cooked	½ cup											
Carrots, canned cooked	½ cup											
Corn on the cob	½ cup											
Corn, canned cooked	½ cup											
Corn, frozen cooked	½ cup											
Cabbage, cooked	½ cup											
Green beans, canned	½ cup											
Bell peppers, chopped	½ cup											
Iceberg lettuce	½ cup											
Green olives	1 ounce											
Black olives	1 ounce											
Spaghetti sauce	½ cup											
Avocado	½ of med											

Fruit (serving size)

Fruit		Never	S	M	L	Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
						Month		**Week**			**Daily**	
Banana	1 medium											
Strawberries	½ cup											
Apple	1 medium											
Cranberry Juice	1 medium											
Apple juice ready to drink	1 cup											
Orange	1 medium											
Orange juice	1 cup											
Red/Green grapes	½ cup											
Grape juice	¾ cup											
Blueberries, frozen	½ cup											
Blueberries, fresh	½ cup											
Pineapple	½ cup											
Kiwi fruit	1 medium											
Cantaloupe/muskmelon	½ cup											
Honeydew Melon	½ cup											
Fruit Cocktail	½ cup											

Breads, cereals (serving size)

Breads, cereals		Never	S	M	L	Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
						Month		**Week**			**Daily**	
Whole wheat bread	1 slice											
White bread	1 slice											
Hot dog bun	1 bun											
Hamburger bun	1 bun											
Baking powder or buttermilk, biscuit	1 medium biscuit											
Refrigerated biscuit, canned dough	1 medium biscuit											
Cornbread, made with Jiffy mix	1 medium square											
Oatmeal, instant	1 pack											
Oatmeal, regular	½ cup											

Breads, cereals		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Life cereal	½ cup											
Cheerios	½ cup											
Raisin Bran	½ cup											
White rice	½ cup											
Pasta or Noodles	½ cup											
Ramen Noodles	1 pack											
Waffle, Frozen	1 waffle											
Pancake from mix	2 medium pancakes											
Bagel	1 (4 oz.) bagel											
Donut	1 medium											
Garlic bread	1 slice											
Cake with frosting, different flavors	1 medium square											

Condiments, snacks		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Miracle Whip, regular	1 tbsp											
Miracle Whip, light	1 tbsp											
Mayonnaise, regular	1 tbsp											
Mayonnaise, light	1 tbsp											
Popcorn natural/butter	1 bag											
Lay's classic potato chips, different flavors	17 chips											
Doritos	17 chips											
Cheetos	17 chips											
Tortilla Chips	17 chips											
Ritz Crackers	5 crackers											
Club Crackers	5 crackers											
Saltines	5 crackers											

Oils		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Margarine	1 tbsp											
Canola oil	1 tbsp											
Vegetable oil	1 tbsp											
Olive oil	1 tbsp											
Ranch dressing	1 tbsp											
Italian salad dressing	1 tbsp											
Dorothy Lynch	1 tbsp											
French Dressing	1 tbsp											

Nuts and seeds		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
English Walnuts	1 ounce											
Pecans	1 ounce											
Cashews	1 ounce											
Sesame seeds	1 ounce											
Brazil nuts	1 ounce											
Pistachios	1 ounce											
Peanuts	1 ounce											

Beans		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Refried beans	½ cup											
Peanut butter	1 tbsp											

Prepared Dishes		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Double Cheeseburger	1 burger											
Single Cheeseburger	1 burger											
Chicken sandwich, breaded	1 sdwich											
Chicken sandwich, grilled	1 sdwich											
Chicken nuggets	4 nuggets											
Greens (collard, mustard, kale, turnip) with ham hocks or neck bones	1 cup											
Pinto beans with ham hocks/neck bones	½ cup											

Prepared Dishes		Never	S	M	L	Month		Week			Daily	
						Once a month	2-3 times a month	1-2 times a week	3-4 times a week	5-6 times a week	1 time	2 or more
Black eyed peas with ham hocks/neck bones	½ cup											
Navy (Red) beans with ham hocks	½ cup											
Macaroni and cheese, velveeta	¾ cup											
Cornbread dressing/stuffing	½ cup											
Salmon patties/croquettes	1 patty											
Yams or Sweet potatoes	½ cup											
Smothered pork chops	1 chop											
Potato salad	½ cup											
Featherbones (riblets)	3 ounces											
Chitterlings	½ cup											
Tacos	2 tacos											
Enchiladas	2 ench.											
Pizza, pepperoni	2 med slices											
Pizza, supreme	2 med slices											
Pizza, hamburger	2 med slices											
Pizza, sausage	2 med slices											
Peach cobbler	1 medium square											
Cream cheese pound cake	1 slice											
Lemon pound cake	1 slice											
Cheesecake	1/8 of 9' pie											