VITAMIN B12 DEFICIENCY AND SUPPLEMENTATION IN OLDER AMERICANS NUTRITION PROGRAMS IN NORTHEAST GEORGIA

by

EVELYN TERESA BUTLER DOLCE

(Under the Direction of Mary Ann Johnson)

ABSTRACT

The objective of this study was to examine the correlates of vitamin B12 deficiency and elevated homocysteine (tHcy) in Older Americans Nutrition Programs in northeast Georgia and to examine the effects of crystalline B12 in B12 deficient elders and in B12 adequate elders. An intervention trial was performed in which vitamin B12 deficient participants received 1,000 µg/d vitamin B12 and B12 adequate participants were randomized to receive 0, 25, or 100 µg/d vitamin B12. Participants included 149 men and women receiving congregate meals through Older Americans Nutrition Programs in northeast Georgia. Vitamin B12 supplementation improved biochemical indices but did not consistently effect clinical outcomes. In conclusion, high dose oral B12 improves biochemical status in B12 deficient older adults and low dose oral B12 improves biochemical status in B12 adequate older adults. Clinical manifestations such as depression and poor orientation-memory-concentration were not consistently affected by B12 supplementation in this study.

INDEX WORDS: Vitamin B12, Elderly, Micronutritient deficiency, Micronutrient supplementation

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CHAPTER 1

INTRODUCTION

Vitamin B12 deficiency is common among older adults. Many estimate that around 15% of adults age 65 and older are vitamin B12 deficient (Stabler et al., 1997; Chui et al., 2001; Rajan et al., 2002a). Estimations of the prevalence of vitamin B12 deficiency range from 3% to 40.5% (Baik & Russell, 1999). Participants in Older Americans Nutrition Programs at senior centers in northeast Georgia are at high risk for micronutrient deficiencies and for poor general nutrition (Accettura, 2000). Possible consequences of vitamin B12 deficiency in older adults include elevated homocysteine (tHcy), poor cognition, depression, and macrocytic anemia (NAS, 1998; Baik & Russell, 1999).

In a previous study (Johnson et al., 2003), 23% of a convenience sample of 103 participants in Older Americans Nutrition Programs in Georgia were vitamin B12 deficient with serum vitamin B12 < 258 pmol/L and methylmalonic acid (MMA) > 271 nmol/L and MMA > methylcitric acid. The objective of the present study was to examine the demographic, biochemical, dietary, and health correlates of vitamin B12 deficiency and elevated homocysteine (tHcy) in Older Americans Nutrition Programs in northeast Georgia and to examine the effects of crystalline vitamin B12 in vitamin B12 deficient elders and in vitamin B12 adequate elders. An intervention trial was performed in which vitamin B12 deficient participants received 1,000 µg/d vitamin B12 and vitamin B12 adequate participants were randomized to receive 0, 25, or 100 µg/d vitamin B12. It was found that high dose oral vitamin B12 improved biochemical status in vitamin B12 deficient older adults and low dose oral vitamin B12 improved biochemical status in vitamin B12 adequate older adults. Clinical manifestations such as depression and poor

orientation-memory-concentration were not consistently affected by vitamin B12 supplementation in this study.

Chapter 2 in this thesis is a review of literature pertaining to vitamin B12 and older adults. The literature review explores the estimated prevalence, possible clinical manifestations, demographic, biochemical, and dietary correlates, diagnosis, and treatment of vitamin B12 deficiency.

Chapter 3 is a manuscript that will be submitted to the American Journal of Clinical Nutrition for publication. The manuscript details the methods used and the results obtained in the vitamin B12 intervention trial and includes a discussion of these results. All data tables are included as part of the manuscript in Chapter 3. Chapter 4 offers a summary of the major findings of the intervention trial.

CHAPTER 2

LITERATURE REVIEW

Vitamin B12 deficiency is common among older adults. Many estimate that around 15% of adults age 65 and older are vitamin B12 deficient (Stabler et al., 1997; Chui et al., 2001; Rajan et al., 2002a). Estimations of the prevalence of vitamin B12 deficiency range from 3% to 40.5% (Baik & Russell, 1999). Participants in Older Americans Nutrition Programs at senior centers in northeast Georgia are at high risk for micronutrient deficiencies and for poor general nutrition (Accettura, 2000). Johnson et al. (2003) found that 23% percent of a group of 103 participants receiving Older Americans Nutrition services in Georgia were vitamin B12 deficient. Possible consequences of vitamin B12 deficiency in older adults include elevated homocysteine (tHcy), poor cognition, depression, and macrocytic anemia (NAS, 1998; Baik & Russell, 1999).

Clinical signs associated with vitamin B12 deficiency

Vitamin B12 is a coenzyme required for methionine synthase to convert homocysteine to methionine (Weir & Scott, 1999). S-adenosyl-methionine (SAM) and S-adenosyl-homocysteine (SAH) are intermediates in the homocysteine-methionine cycle (Figure 1.1). Accumulation of tHcy due to dietary deficiencies results in decreased levels of SAM and increased levels of SAH (James et al., 2002; Mason, 2003). These metabolic disturbances result in inhibition of various methyltransferase reactions that are critical to nervous system function (James et al., 2002), liver function, and stabilization of proteins and DNA (Miller, 2003).

Hankey and Eikelboom (1999) estimate that 67% of cases of elevated tHcy can be accounted for by a lack of folate, vitamin B12, and to a lesser degree, vitamin B6. Vitamin B12 may play a more prominent role than folate in elevated tHcy in older adults, especially since the introduction of mandatory folate fortification in the U.S. (Stabler et al., 1996; Quinlivan et al., 2002). Cross-sectional, case-control, and prospective cohort studies demonstrate a dose-dependent, positive relationship between tHcy levels and vascular disease (Hankey & Eikelboom, 1999). A meta-analysis by Boushey et al. (1995) concluded that there is evidence for a causal relationship between elevated tHcy and coronary artery disease.

Clinical vitamin B12 deficiency is associated with neurological symptoms in 75 to 90% of cases (NAS, 1998). Interference in methylation reactions that depend on vitamin B12 and/or vascular damage from elevated tHcy may lead to nervous system impairment in a deficiency state (Calvaresi & Bryan, 2001). Difficulty with memory and concentration may result. Goodwin et al. (1983) demonstrated that older adults whose plasma vitamin B12 levels were in the lowest 10% scored significantly worse than those whose plasma levels were above this level on the Wechsler Memory Test and on the Halstead-Reitan Categories Test, which tests abstract thinking ability. In a group of 28 patients with dementia, 29% of the patients with primary degenerative dementia had low serum vitamin B12 (Karnaze & Carmel, 1987). Van Asselt et al. (2001) demonstrated that vitamin B12 supplementation improved performance on the Verbal Word Learning Test, Verbal Fluency, and Similarities test as well as electroencephalograph (EEG) readings in 16 community-dwelling adults age 64-89 with low plasma vitamin B12 levels ($\leq$ 150 pmol/L). In 88 older adults with low serum vitamin B12 and varying degrees of cognitive dysfunction, vitamin B12 treatment improved performance on cognitive tests in patients with mild cognitive impairment but not in patients with dementia (Eastly et al., 1999).

Patients with neuropathy secondary to vitamin B12 deficiency are at high risk and require attention for two reasons. First, these patients are unlikely to show hematological signs that might alert physicians to the need for vitamin B12 treatment. Anemia seems to have an inverse relationship with neuropathy in deficient patients (Healton et al., 1991). Second, there may be a limited time frame in which neurological damage can be reversed with vitamin B12 treatment. Healton et al. (1991) found that response to vitamin B12 treatment was significantly improved in those who had experienced neurological symptoms for six months or less compared to those with symptoms for more than 12 months ($p < 0.001$).

Mood changes, including depression, are a possible neurological symptom of vitamin B12 deficiency (NAS, 1998). In a group of 700 disabled women with a mean age of 77 years, depression was two times more likely in those who were vitamin B12 deficient than those who were vitamin B12 adequate (Penninx et al., 2000). No relationship between folate status and depression was found in this group. Tiemeier et al. (2002) concluded that 694 community-dwelling older adults who were vitamin B12 deficient had an almost 70% greater risk for depressive disorders than control participants. More studies examining the link between poor vitamin B12 status and depression are needed.

Macrocytic anemia is the traditional clinical sign of vitamin B12 deficiency but is not a specific or sensitive indicator. Anemia is absent in many cases of deficiency (Baik & Russell, 1999). Elevated mean cell volume (MCV) is only 17 – 30 % sensitive in marking vitamin B12 deficiency (Chui et al., 2001). Both Mischoulon et al. (2000) and Bates et al. (2003) found no relationship between vitamin B12 deficiency and macrocytosis or hematocrit and concluded that anemia is not useful in predicting vitamin B12 deficiency. Because folate fortification was implemented in 1998, macrocytosis may have become even less prevalent in vitamin B12

deficiency. Macrocytic anemia may be reversed with folate supplementation even when vitamin B12 is inadequate. Folate does not, however, prevent the neuropathy associated with vitamin B12 deficiency (Snow, 1999). Clinicians clearly cannot rely on hematological abnormalities alone to diagnose vitamin B12 deficiency.

Demographic, physical, and dietary correlates of vitamin B12 status

Meat, poultry, fish, and dairy products are the only natural dietary sources of vitamin B12 for humans. Vitamin B12 is bound to protein in these foods. Healthy older adults are able to absorb about 50% of vitamin B12 from animal foods, although this amount varies with the source (NAS, 1998). In 2999 participants of the Framingham Offspring Study, vitamin B12 status was associated with milk consumption but not with other animal foods (Tucker et al., 2000). Johnson et al. (2003) found that out of 103 older adults receiving Older Americans Nutrition services in Georgia, vitamin B12 deficient participants were significantly less likely to consume meat, poultry, fish, and dairy foods every day. Howard et al. (1998), however, did not show that vitamin B12 deficiency was related to poor dietary intake in 95 older adults. Inconsistency in the link between intake of animal foods and vitamin B12 status may be at least partially explained by the role that gastric function plays in vitamin B12 absorption.

It is widely understood that the incidence of vitamin B12 deficiency increases greatly with age (NAS, 1998). The relationship between aging and poor vitamin B12 status is likely due to the decline in gastric function that is common among older adults. Malabsorption of protein-bound vitamin B12 secondary to Type B chronic atrophic gastritis occurs in up to 30% of older adults and explains a significant number of cases of vitamin B12 deficiency (NAS, 1998; Baik & Russell, 1999). Type B atrophic gastritis is associated *Helicobacter pylori* (*H. pylori*) infection (Baik & Russell, 1999). Atrophic gastritis may result in insufficient gastric acidity and

overgrowth of bacteria, which impairs the stomach's ability to separate vitamin B12 from the protein in the foods. Andrés et al. (2003) suggest that food-bound vitamin B12 malabsorption is the primary cause of vitamin B12 deficiency. In addition to the large percentage of older adults affected by atrophic gastritis, 1 to 2 % suffer from pernicious anemia, which is defined by a lack of intrinsic factor due to severe gastric atrophy (Baik & Russell, 1999). Intrinsic factor is necessary for active uptake of vitamin B12 in the ileum. Atrophic gastritis and pernicious anemia together explained about 50% of vitamin B12 deficiency in 95 people age 60 and older (Howard et al., 1998).

Synthetic vitamin B12 is not bound to protein so individuals with protein-bound vitamin B12 malabsorption are able to absorb synthetic vitamin B12 from supplements and fortified foods (NAS, 1998). Older adults with low or no intake of supplements and foods fortified with vitamin B12 may thus be at higher risk for developing deficiency. In 242 healthy, community-dwelling adults with a mean age of 73, the group that did not take supplemental vitamin B12 had lower serum vitamin B12 (254 vs. 351 pg/mL, $p < 0.001$) and higher serum methylmalonic acid (MMA) (188 vs. 173 nmol/L, $p = 0.042$) than those that did consume supplemental vitamin B12 (Garcia et al., 2002). Fifty-six percent of participants with normal vitamin B12 status took vitamin B12 supplements compared to only 34% of participants with poor vitamin B12 status in a study of 173 adults older than 60 years (Howard et al., 1998). In a study by Kwan et al. (2002), both Hispanics and non-Hispanic whites that took vitamin B12 supplements had significantly higher serum vitamin B12 ($p < 0.001$) than those who did not. This study also found that consuming fortified cereal at least 4 times per week was protective against low serum vitamin B12 in the Hispanic group. In 2999 participants age 26 - 83 from the Framingham Offspring Study, both vitamin B12 supplements and fortified cereals were protective against low serum

vitamin B12 (Tucker et al., 2000). Campbell et al. (2003) found that intakes of crystalline vitamin B12 were significantly higher in participants with plasma vitamin B12 > 221 pmol/L compared to participants with plasma vitamin B12 < 148 pmol/L ($p < 0.01$), and that fortified cereals were not a primary source of crystalline vitamin B12 in this group of Latino older adults. Studies have focused more on supplement use than fortified food intake. More research is needed to clarify the role of fortified foods in maintaining vitamin B12 adequacy.

Vitamin B12 deficient individuals are more likely to be Caucasian than African-American. In 581 adults age 60 and older, Caucasians were more likely than African-Americans to have serum vitamin B12 levels < 140 pmol/L (14.8% vs. 9.3%, $p \leq 0.005$) (Carmel et al., 1999). Caucasian women had higher mean serum MMA than African-American women (284 nmol/L vs. 218 nmol/L, $p = 0.0001$) in a group of 550 Caucasian and 212 African-American women (Stabler et al., 1999). It is possible that vitamin B12 metabolism and/or dietary patterns differ by ethnicity.

Demographic, physical, and dietary correlates of tHcy

In NHANES III, the prevalence of elevated tHcy increased with age and male gender (Jacques et al., 1999). Age-related changes in renal function, renal dysfunction, and elevated creatinine are all associated with higher tHcy (Jacques et al., 1999). In our previous study, determinants of elevated tHcy were vitamin B12 deficiency (defined as serum vitamin B12 < 258 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid), elevated creatinine, and low red blood cell folate (Johnson et al., 2003).

Diagnosis of vitamin B12 deficiency

Methods for diagnosing vitamin B12 deficiency have changed over time. A clear standard for diagnosis has yet to be determined. As stated above, anemia is not an a reliable

indicator. Since the improvement of methods for determining serum vitamin B12, use of serum vitamin B12 as an indicator of adequacy predominates. A conservative cutoff for vitamin B12 deficiency is serum vitamin B12 < 148 pmol/L and a more liberal cutoff is serum vitamin B12 < 258 pmol/L (Penninx, 2000). Nevertheless, serum vitamin B12 above these cutoff points does not always represent tissue adequacy (NAS, 1998). A significant number of those with functional metabolite levels suggestive of deficiency also have a serum vitamin B12 level within the range that is considered normal (Stabler et al., 1997).

Serum MMA is a specific and effective marker of vitamin B12 deficiency (Stabler et al., 1996; Weir & Scott, 1999; Morris et al., 2002). MMA accumulates when vitamin B12 is not available to act as a coenzyme for L-methylmalonyl CoA mutase. MMA appears to be a better marker for vitamin B12 deficiency than serum vitamin B12 or tHcy (Stabler et al., 1996). The use of MMA in determining vitamin B12 deficiency has two limitations. First, MMA may be elevated due to renal insufficiency. If serum MMA is greater than serum 2-methyl citric acid, it has been suggested that renal insufficiency can be ruled out as a cause of elevated MMA in an individual (Stabler et al., 1997). Second, MMA has a degree of measurement variability that must be taken into account. A combination of serum vitamin B12 (< 258 pmol/L), serum MMA (> 271 nmol/L) with MMA > 2-methyl citric acid has been used in various studies to define vitamin B12 deficiency (Penninx et al., 2000; Rajan et al., 2002b; Johnson et al., 2003). More studies using serum MMA as an indicator of vitamin B12 status are needed.

Treatment of vitamin B12 deficiency

The medical community has traditionally treated vitamin B12 deficiency parenterally with intramuscular injections of vitamin B12. Oral supplements present an alternative to injections. Those with protein-bound vitamin B12 malabsorption can absorb the synthetic

vitamin B12 found in supplements and patients with pernicious anemia can absorb 1 to 2 % of synthetic vitamin B12 in oral supplements (Baik & Russell, 1999). Compliance and efficacy of high-dose oral supplements are comparable to intramuscular injections and supplements involve less discomfort and lower costs (Kuzminski et al., 1998; Lederle, 1991; van Walraven et al., 2001).

Intervention trials with vitamin B12

Table 1 lists studies that have evaluated the effects of vitamin B12 supplementation, mostly in samples of older adults with low serum vitamin B12. Interventions of vitamin B12 supplementation for 3 months or longer in vitamin B12 deficient participants have consistently reported that vitamin B12 supplementation significantly increases serum vitamin B12 and significantly decreases serum MMA and tHcy (Kuzminski et al., 1998; Bjorkegren & Svardsudd, 1999; Hvas et al., 2001; van Asselt et al., 2001). Seven of the studies in Table 1 were especially well designed and involved at least 29 participants. Each of these 7 studies will be discussed in detail below.

Andrés et al. (2003) examined the efficacy of oral vitamin B12 for treating deficiency related to food-bound vitamin B12 malabsorption in 30 patients with a mean age of 72. All participants were determined to be vitamin B12 deficient based on serum vitamin B12 < 200 pg/mL on two occasions or serum vitamin B12 < 200 pg/mL with tHcy > 13.0 μmol/L. Participants were assigned to receive oral vitamin B12 in the amount of 250 μg/d (n = 6), 500 μg/d (n = 8) or 1,000 μg/d (n = 16) for 1 month. Serum vitamin B12 increased significantly in each group and 87% normalized serum vitamin B12 levels after 1 month (normal serum vitamin B12 defined as > 200 pg/mL). For the whole sample, one month of oral vitamin B12 significantly improved hemoglobin, MCV, and reticulocyte count. Andrés et al. (2003)

concluded that oral vitamin B12 is useful in treating vitamin B12 deficiency that is secondary to food-bound vitamin B12 malabsorption.

Abyad (2002) studied the effects of vitamin B12 supplementation on cognition in 56 demented patients with low serum vitamin B12 (< 300 pg/mL) and a mean age of 82 years. Participants received intramuscular injections of 1 mg vitamin B12 for a minimum of 6 months. Outcomes measured included the Folstein Minimental Status Examination (MMSE), clock drawing tests, and caregiver interviews. Forty of the 56 patients improved their mental status scores and the extent of improvement was correlated with duration of dementia symptoms. Those who had been symptomatic for less than 12 months had significantly better improvements in cognitive performance than those who had been symptomatic for greater than 12 months. Healton et al. (1991) previously suggested the possibility of a limited window for improvement of cognitive dysfunction in vitamin B12 deficient patients.

Hvas et al. (2001) evaluated the biochemical and clinical effects of vitamin B12 supplementation in 140 patients with serum MMA between 400 and 2,000 nmol/L. Participants received intramuscular injections of 1,000 μg vitamin B12 weekly for 18 months. Although patients had significant improvements in serum vitamin B12, serum MMA, and tHcy, there was no significant change in anemia or neurologic symptoms.

Björkegren and Svärdsudd (1999) conducted a population based intervention trial among 61 adults aged 70 or older with serum vitamin B12 < 300 pmol/L and either MMA ≥ 370 nmol/L or tHcy ≥ 15.0 μmol/L. Participants received 1,000 μg oral vitamin B12 daily for 6 months. Serum vitamin B12 was significantly increased and serum MMA and tHcy were significantly decreased after 6 months of supplementation. In this sample, tHcy remained relatively high (19.5 μmol/L) and 41 out of 56 persons with tHcy ≥ 15.0 μmol/L before treatment did not

normalize tHcy levels after 6 months of supplementation. This study was conducted in a Swedish population that would not have had the benefits of mandatory folate fortification. Björkegren and Svärdsudd (1999) concluded that there was evidence of deficiency of both vitamin B12 and folate in this sample, which would explain why tHcy did not decrease to normal when only vitamin B12 was given.

Kuzminski et al. (1998) compared the efficacy of oral vitamin B12 supplementation to intramuscular vitamin B12 supplementation in 33 adults with a mean age of 72 and serum vitamin B12 < 160 pg/mL. Fifteen participants received 1,000 μg vitamin B12 intramuscularly on days 1, 3, 7, 10, 14, 21, 30, 60, and 90 and 18 participants received 2,000 μg oral vitamin B12 daily for 4 months. Both groups had significant improvements in serum vitamin B12, MMA, and tHcy levels, although the improvements in serum vitamin B12 and MMA in the oral vitamin B12 group was significantly greater than in the intramuscular group. In addition to correction of serum metabolite levels, patients in each group showed comparable improvements in neurological symptoms such as mental status, gait, and vibration sense. This study demonstrates that oral vitamin B12 is as effective and possibly more effective than intramuscular vitamin B12 supplementation.

Lindgren et al. (1997) examined the effects of vitamin B12 supplementation in 61 patients with a mean age of 51 who had serum vitamin B12 < 200 pmol/L. Patients received 1,000 μg vitamin B12 intramuscularly 5 times in 2 weeks. Biopsy specimens were also taken from the gastric and duodenal mucosa and Schilling tests were performed to identify the presence of a physiological basis for malabsorption of vitamin B12. Vitamin B12 supplementation resulted in a significant reduction in serum MMA and tHcy in all groups, regardless of the presence or absence of gastrointestinal pathology.

Pennypacker et al. (1992) studied 29 geriatric outpatients with serum vitamin B12 ≤ 300 pg/mL. Participants were given 1,000 μg vitamin B12 intramuscularly on a weekly basis for 8 weeks, then monthly for 6 months. Vitamin B12 supplementation resulted in a significant reduction in serum MMA and tHcy levels and correction of metabolite abnormalities in almost all patients.

Together, these studies show that intramuscular, as well as oral, vitamin B12 supplementation in vitamin B12 deficient people is generally associated with marked improvements in serum vitamin B12, MMA, and tHcy. However, improvements in cognition and other clinical signs of vitamin B12 deficiency are variable.

Vitamin B12 supplementation in vitamin B12 adequate populations

Most studies have focused on treating deficient participants and have not looked at the effects of supplementation in populations with adequate vitamin B12 status. Garcia et al. (2002) concluded that low-dose vitamin B12 supplements between 2 and 25 μg/d significantly decreased the risk for deficiency based on higher serum vitamin B12 and lower serum MMA in a group of healthy older adults. Intervention studies are needed to assess the effects of vitamin B12 supplementation in healthy older adults.

Proposed Study

In a previous study (Johnson et al., 2003), it was observed that 23% of a convenience sample of 103 participants in Older Americans Nutrition Programs in northeast Georgia were vitamin B12 deficient with serum vitamin B12 < 258 pmol/L and methylmalonic acid (MMA) > 271 nmol/L and MMA > methylcitric acid. Elevated tHcy was related more to vitamin B12 status than to folate status in these older adults. Vitamin B12 deficient participants were almost 3 times more likely to have impaired orientation, memory, and concentration. Oral vitamin B12

(2.5 mg/d) combined with a multivitamin supplement effectively lowered the mean MMA and tHcy to the normal range in this group of folate replete older adults. Some of the limitations of this previous study were that crystalline vitamin B12 intake was not estimated and the intervention included other micronutrients (e.g. folate, 400 µg/d; vitamin B6, 2 mg) along with vitamin B12, making it difficult to determine the effects of vitamin B12 alone.

The purpose of the present study was to confirm the high prevalence, risk factors, and health consequences of vitamin B12 deficiency and elevated tHcy in elders in northeast Georgia Older Americans Nutrition Programs and to determine the intake of crystalline vitamin B12 from supplements and fortified foods, the relationship of crystalline vitamin B12 to vitamin B12 status, the effects of high dose crystalline vitamin B12 (1,000 µg/d) on vitamin B12 status in vitamin B12 deficient elders, and the effects of 0, 25, and 100 µg/d vitamin B12 in vitamin B12 adequate elders. It was hypothesized that 1) the prevalence of vitamin B12 deficiency as estimated by serum vitamin B12 and serum MMA would be about 20% and that vitamin B12 deficiency would be associated with elevated serum tHcy, anemia, depression and poor orientation-memory-concentration, 2) vitamin B12 deficient participants would be older, more likely to be Caucasian, have low intakes of animal products, low use of fortified cereals, low use of vitamin B12 supplements and/or poor gastric function as estimated by serum pepsinogen I, 3) participants with elevated serum tHcy would be more likely to be older, male, vitamin B12 deficient, have lower serum folate, low intakes of animal products, low use of fortified cereals, and have poor renal function as estimated by serum creatinine, 4) 1,000 µg/d of vitamin B12 would correct elevated serum MMA and tHcy and increase serum vitamin B12 in participants with elevated MMA within 3 months, and 5) vitamin B12 supplementation of 25 and 100 µg/d

would lower serum MMA and tHcy and increase serum vitamin B12 in vitamin B12 adequate participants.

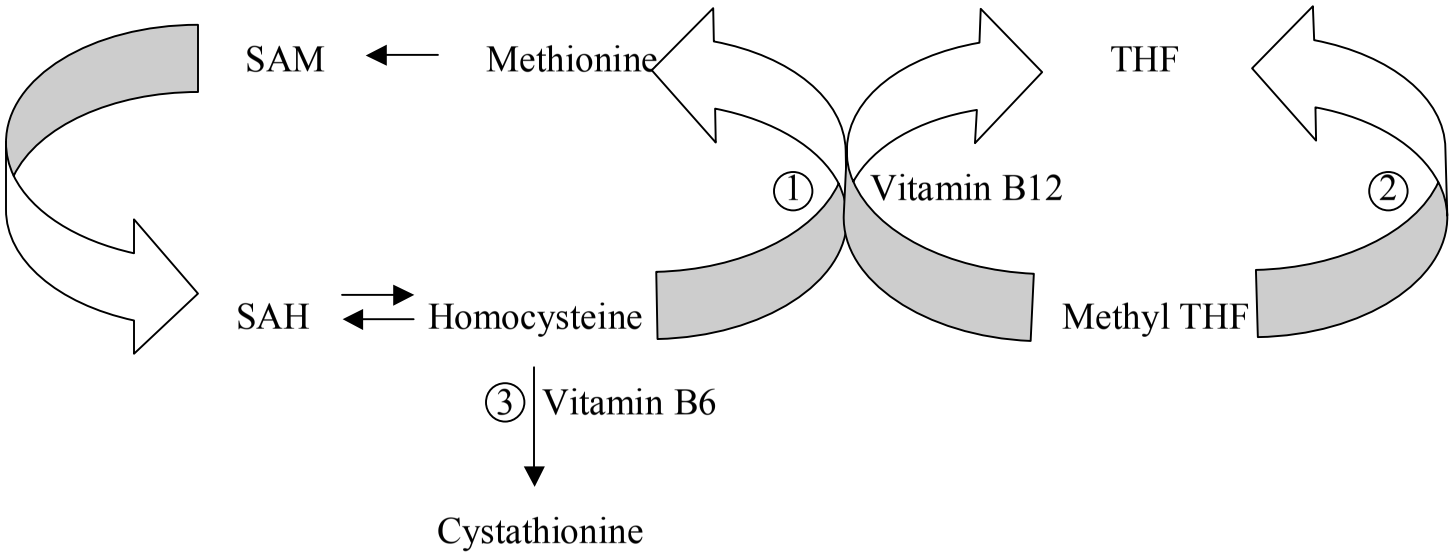

Figure 1.1 The homocysteine-methionine cycle

1. Methionine synthase
2. Methylenetetrahydrofolate reductase
3. Cystathionine β-synthase

Table 1.1 Vitamin B12 intervention trials

Authors/ year/ country	Age, y	n	Study population	Treatment criteria (tHcy* and MMA in µmol/L)	Treatment given	Duration	Serum B12, pmol/L pre→post	MMA**, µmol/L pre→post	THcy, µmol/L pre→post
Andrés et al., 2003 France	72 mean	16 8 6	B12 deficient Patients	B12 < 200 pg/mL on 2 samples or B12 < 200 pg/mL with tHcy > 13.0	Oral B12 1 mg/d Oral B12 500 µg/d Oral B12 250 µg/d	1 month	128→310 133→262 139→242	n/a	n/a
Abyad et al., 2002 Lebanon	82 mean	56	Nursing home residents + outpatients	B12 < 300 pg/mL + dementia	IM# B12 1 mg/d x 1 week + 1 mg/wk x 1 month + 1 mg/ month	3 months	160→n/a	n/a	n/a
Seal et al., 2002 Australia	81 mean	10 10	Geriatric Patients	B12 100 - 150 pmol/L	Oral B12 10 µg/d Oral B12 50 µg/d	4 weeks	140→196 163→248	n/a	28.4→25.5 20.8→17.6
Rajan et al., 2002 U.S.	79 mean	23	Patients	B12 ≤ 221 pmol/L + MMA > 271 nmol/L	Oral B12 25 µg/d x 6 wks + 100 µg/d x 6 wks + 1 mg/d x 6 wks	18 weeks	n/a	n/a	n/a
Andrés et al., 2001 France	78 mean	10	Patients	B12 < 160 pg/mL + tHcy > 13.0	Oral B12 3 to 5 mg/ week	3 months	76→142	n/a	n/a
Hvas et al., 2001 Denmark	75 mean	140	Patients	MMA 0.40 - 2.0	IM B12 1 mg/ week	18 months	278→934	0.54→0.21	13.5→10.4

Authors/ year/ country	Age, y	n	Study population	Treatment criteria (tHcy and MMA in µmol/L)	Treatment given	Duration	Serum B12, pmol/L pre→post	MMA, µmol/L pre→post	THcy, µmol/L pre→post
van Asselt et al., 2001 The Netherlands	71 mean	16	Healthy volunteers	B12 ≤ 150 pmol/L	IM B12 1mg/ week x 4 wks + IM B12 1mg / month x 4 months	5 months	110→640	0.34→0.17	15.3→12.4
Björkegren and Svärdsudd, 1999 Sweden	≥ 70	61	Population sample	B12 < 300 pmol/L + (MMA ≥ 0.37 or tHcy ≥ 15.0)	Oral B12 1 mg/d	6 months	208→849	0.27→0.20	22.2→19.5
Kuzminski et al., 1998 U.S.	72 mean	18 15	Outpatients	B12 < 160 pg/mL	Oral B12 2 mg/d IM B12 1 mg days 1,3,7,10,14,21,30,60, and 90	4 months	93→1005 95→325	3.85→0.17 3.63→0.27	37.2→10.6 40.0→12.2
Nilsson et al., 1997 Sweden (cont on next page)	79 mean	11 10 12	Psycho-geriatric patients	B12 < 150 pmol/L and tHcy > 19.9 B12 < 150 pmol/L and tHcy < 19.9 B12 > 150 pmol/L and tHcy > 19.9	IM B12 1 mg every other day IM B12 1 mg every other day IM B12 1 mg every other day	7 – 10 days	n/a	0.57→0.22 0.27→0.15 0.33→0.21	30.6→19.6 16.2→10.8 25.2→15.7

Authors/ year/ country	Age, y	n	Study population	Treatment criteria (tHcy and MMA in µmol/L)	Treatment given	Duration	Serum B12, pmol/L pre→post	MMA, µmol/L pre→post	THcy, µmol/L pre→post
Nilsson et al., 1997 Sweden (cont)	79 mean	5	Psycho-geriatric patients	B12 > 150 pmol/L and tHcy < 19.9	IM B12 1 mg every other day	7 – 10 days	n/a	0.27→0.19	12.2→11.2
Lindgren et al., 1997 Sweden	51 mean	61	Patients	Clinical signs + B12 < 200pmol/L	IM B12 1 mg	2 weeks (given 5 times)	n/a	0.31→0.17	10.0→7.0
Rasmussen et al., 1996 Denmark	50 mean	235	Volunteers		Oral B12 1 mg bid	1 week	n/a	0.15→0.15	9.2→8.8
Ubbink et al., 1994 South Africa	38 mean	17 17	Patients	tHcy > 16.3 µmol/L	Oral B12 0.4 mg/d Placebo	6 weeks	218→379 217→211	n/a n/a	30.5→26.0 30.6→30.7
Pennypacker et al., 1992 U.S.	65-99	29	Outpatients, geriatric clinic	B12 ≤ 300 pg/mL	IM B12 1 mg weekly for 8 weeks + monthly for 6 months	8 months	n/a	1→0.2	30→15
Lindenbaum et al., 1990 U.S.	5-91	12	Pernicious Anemia Patients	B12 < 200 pmol/L + clinical signs	IM B12 1 mg	2 to 6 months	n/a	3→0.2	40→15
Brattström et al., 1988 Sweden	62 mean	20	Volunteers	B12 < 110 pmol/L	IM B12 1 mg/d	14 days	71→929	n/a	23.8→12.2
Lindenbaum et al., 1988 U.S.	17-88	31	Patients	B12 < 175 pmol/L + clinical signs	IM B12 1 mg	4 months	n/a	10→0.5	120→30

*tHcy - homocysteine in µmol/L

** MMA - methylmalonic acid in µmol/L
[#] IM - intramuscular vitamin B12 injection

CHAPTER 3

VITAMIN B12 DEFICIENCY AND SUPPLEMENTATION IN OLDER AMERICANS NUTRITION PROGRAMS IN NORTHEAST GEORGIA[1]

[1]Dolce, E.B., Johnson, M.A., Hawthorne, N.A., Miller, L.S., Lewis, M., Janke, M., Davey, A., Stabler, S.P. To be submitted to The American Journal of Clinical Nutrition.

Abstract

Objective: To examine the prevalence, risk factors, and health consequences of vitamin B12 deficiency and elevated homocysteine (tHcy) in Older Americans Nutrition Programs in northeast Georgia and to determine the intake of crystalline vitamin B12 from supplements and fortified foods, the relationship of crystalline vitamin B12 to vitamin B12 status, the effects of high dose crystalline vitamin B12 (1,000 μg/d) on vitamin B12 status in vitamin B12 deficient elders, and the effects of 25 and 100 μg/d vitamin B12 in vitamin B12 adequate elders.

Design: An intervention trial was performed in which vitamin B12 deficient participants received 1,000 μg/d vitamin B12 for 9 months and vitamin B12 adequate participants were randomized to receive 0 μg/d for 9 months or 25 or 100 μg/d vitamin B12 for 3 months.

Participants: 149 men and women receiving congregate meals through Older Americans Nutrition Programs in northeast Georgia.

Results: 1,000 μg/d vitamin B12 significantly increased serum vitamin B12 and decreased methylmalonic acid (MMA) and tHcy in vitamin B12 deficient participants, while 25 and 100 μg/d vitamin B12 significantly decreased MMA, but did not increase serum vitamin B12, in vitamin B12 adequate participants. 100 μg/d vitamin B12 significantly decreased tHcy in vitamin B12 adequate participants. In vitamin B12 deficient individuals, supplementation did not affect depression and did not consistently affect anemia or orientation-memory-concentration.

Conclusion: High dose oral vitamin B12 improves biochemical status in vitamin B12 deficient older adults and low dose oral vitamin B12 improves biochemical status in vitamin B12

adequate older adults. Clinical manifestations such as depression and poor orientation-memory-concentration were not consistently affected by vitamin B12 supplementation in this study.

Introduction

Vitamin B12 deficiency is common among older adults. Estimates on prevalence of vitamin B12 deficiency range from 3 to 40.5% (Baik & Russell, 1999), and many estimate that around 15% of adults age 65 and older are vitamin B12 deficient (Stabler et al., 1997; Chui et al., 2001; Rajan et al., 2002a). Possible consequences of vitamin B12 deficiency in older adults include elevated homocysteine (tHcy), depression, macrocytic anemia, and poor cognition (NAS, 1998; Baik & Russell, 1999).

Baik and Russell (1999) estimate that 67% of cases of elevated tHcy can be accounted for by a lack of folate, vitamin B12, and to a lesser degree, vitamin B6. Vitamin B12 may play a more prominent role than folate in elevated tHcy in older adults, especially since the introduction of mandatory folate fortification in the U.S. (Stabler et al., 1996; Quinlivan et al., 2002). Cross-sectional, case-control, and prospective cohort studies demonstrate a dose-dependent, positive relationship between tHcy levels and vascular disease (Hankey & Eikelboom, 1999). A meta-analysis by Boushey et al. (1995) concluded that there is evidence for a causal relationship between elevated tHcy and coronary artery disease. S-adenosyl-methionine (SAM) and S-adenosyl-homocysteine (SAH) are intermediates in the homocysteine-methionine cycle. Accumulation of tHcy due to dietary deficiencies results in decreased levels of SAM and increased levels of SAH (James et al., 2002; Mason, 2003). These metabolic disturbances result in inhibition of various methyltransferase reactions critical to nervous system function (James et al., 2002), stabilization of proteins and DNA, and liver function (Miller, 2003).

Clinical vitamin B12 deficiency is associated with neurological symptoms in 75 to 90% of cases (NAS, 1998). Electrophysiological changes indicative of neuropathology are evident in roughly half of patients who have metabolic signs of deficiency but who lack clinical evidence of deficiency (Carmel, 2000). Older adults with lower serum vitamin B12 levels may be more likely to suffer from dementia (Karnaze & Carmel, 1987), and more likely to score poorly on tests of memory and abstract thinking ability (Goodwin, et al., 1983). Van Asselt et al. (2001) demonstrated that supplementation with vitamin B12 improves performance on some tests of cognitive function in older adults.

Mood changes, including depression, are a possible neurological symptom of vitamin B12 deficiency (NAS, 1998). In a group of 700 women with a mean age of 77 years, depression was two times more likely in those who were vitamin B12 deficient than those who were vitamin B12 adequate (Penninx et al., 2000). No relationship between folate status and depression was found in this group. Tiemeier et al. (2002) concluded that community-dwelling older adults who were vitamin B12 deficient had an almost 70% greater risk for depressive disorders than control participants.

Malabsorption of protein-bound vitamin B12 secondary to Type B chronic atrophic gastritis occurs in up to 30% of older adults and explains a significant number of cases of vitamin B12 deficiency (NAS, 1998; Baik & Russell, 1999). Type B atrophic gastritis is associated *Helicobacter pylori* (*H. pylori*) infection (Baik & Russell, 1999). Atrophic gastritis and pernicious anemia together explained about 50% of vitamin B12 deficiency in 95 people age 60 and older (Howard et al., 1998). Crystalline vitamin B12 is not bound to protein so it is thought that individuals with protein-bound vitamin B12 malabsorption are able to absorb crystalline vitamin B12 from supplements and fortified foods (NAS, 1998), however, this notion

has not been studied extensively (Carmel, 2000). Older adults with low or no intake of supplements and foods fortified with vitamin B12 may thus be at higher risk for developing deficiency. In 2999 participants age 26 - 83 from the Framingham Offspring Study, both vitamin B12 supplements and fortified cereals were protective against low serum vitamin B12 (Tucker et al., 2000). Compliance and efficacy of high-dose oral supplements for treatment of vitamin B12 deficiency are comparable to intramuscular injections (Berlin et al., 1978; Lederle, 1991; van Walraven et al., 2001). A daily oral dose of 1,000 μg/d can effectively replace intramuscular injections for the treatment of vitamin B12 deficiency (Kuzminski et al., 1998; Baik & Russell, 1999).

In a previous study (Johnson et al., 2003), we observed that 23% of a convenience sample of 103 participants in Older Americans Nutrition Programs in northeast Georgia were vitamin B12 deficient with serum vitamin B12 < 258 pmol/L and methylmalonic acid (MMA) > 271 nmol/L and MMA > methylcitric acid. Elevated tHcy was related more to vitamin B12 status than to folate status in these older adults. Vitamin B12 deficient participants were almost 3 times more likely to have impaired orientation, memory, and concentration. Oral vitamin B12 (2.5 mg/d) combined with a multivitamin supplement effectively lowered the mean MMA and tHcy to the normal range in this group of folate replete older adults. Some of the limitations of this previous study were that crystalline vitamin B12 intake was not estimated and the intervention included other micronutrients (e.g. folate, 400 μg/d; vitamin B6, 2 mg) along with vitamin B12, making it difficult to determine the effects of vitamin B12 alone.

The purpose of the present study was to confirm the high prevalence, risk factors, and health consequences of vitamin B12 deficiency and elevated tHcy in elders in northeast Georgia Older Americans Nutrition Programs and to determine the intake of crystalline vitamin B12 from

supplements and fortified foods, the relationship of crystalline vitamin B12 to vitamin B12 status, the effects of high dose crystalline vitamin B12 (1,000 μg/d) on vitamin B12 status in vitamin B12 deficient elders, and the effects of 25 and 100 μg/d vitamin B12 in vitamin B12 adequate elders. We hypothesized that 1) the prevalence of vitamin B12 deficiency as estimated by serum vitamin B12 and serum MMA would be about 20% and that vitamin B12 deficiency would be associated with elevated serum tHcy, anemia, depression and poor orientation-memory-concentration, 2) vitamin B12 deficient participants would be older, more likely to be Caucasian, have low intakes of animal products, low use of fortified cereals, low use of vitamin B12 supplements and/or poor gastric function as estimated by serum pepsinogen I, 3) participants with elevated serum tHcy would be more likely to be older, male, vitamin B12 deficient, have lower serum folate, low intakes of animal products, low use of fortified cereals, and have poor renal function as estimated by serum creatinine, 4) 1,000 μg/d of vitamin B12 would correct elevated serum MMA and tHcy and increase serum vitamin B12 in participants with elevated MMA within 3 months, and 5) vitamin B12 supplementation of 25 and 100 μg/d would lower serum MMA and tHcy and increase serum vitamin B12 in vitamin B12 adequate participants. For the purpose of this study and to be consistent with our previous study, vitamin B12 deficiency was defined as serum vitamin B12 < 258 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid; elevated MMA was defined as MMA > 271 nmol/L; elevated tHcy was defined as tHcy > 13.9 μmol/L. Our rationale for this definition of vitamin B12 deficiency is based on reports that these criteria for deficiency are associated with depression (Penninx et al., 2000; Johnson et al., 2003) and poor orientation-memory-concentration (Johnson et al., 2003).

Participants and Methods

Participants

Institutional Review Boards on Human Subjects of the Georgia Department of Human Resources, the University of Georgia, the University of Colorado, and the Athens Community Council on Aging approved all questionnaires and procedures used in this study. Participants were recruited from the Older Americans Act Nutrition Program at six senior centers in northeast Georgia. A letter describing the study was sent to senior center directors in Clarke, Barrow, Morgan, Jackson, Franklin, and Newton counties. The directors and other employees of the centers recruited clients of the centers for the study. We obtained written informed consent from each participant. Because this was a population-based study, we did not wish to exclude participants taking nutritional supplements including those supplements containing vitamin vitamin B12. The only exclusion criterion was medical treatment for vitamin B12 deficiency. At baseline, 149 participants were enrolled in the study. All assessments were performed at the senior centers.

Methods

The methods are similar to those used in a previous study (Johnson et al., 2003). Participants were not asked to fast before blood collection due to their advanced age and possible frailty. Complete blood counts including hemoglobin and mean cell volume (MCV) (automated cell counts), sedimentation rate, and serum creatinine concentrations were conducted by a local clinical laboratory (SmithKline-Beecham Clinical Laboratories, Atlanta). The normal MCV was defined as 80-100 fL. Anemia was defined as hemoglobin < 120 g/L for women and < 130 g/L for men. Blood samples for the serum folate and vitamin B12 analyses were frozen at -70^{o} C in cryogenic vials with minimal air space (Nalgene Brand Products, Rochester, NY) until they were

analyzed. Analyses for serum vitamin B12 and serum folate were performed at the Centers for Disease Control and Prevention (Atlanta) with a radioassay (Quantaphase II Vitamin B12/Folate Radioassay; Bio-Rad, Richmond, CA) (Gunter et al., 1996). Serum MMA, tHcy, serum 2-methylcitric acid, and cystathionine were analyzed by capillary gas chromatography-mass spectrometry (Stabler et al., 1986). The previously determined normal ranges were 73-271 nmol/L for MMA (Allen et al., 1993), 5.4-13.9 μmol/L for tHcy (Stabler et al., 1999), 44-342 nmol/L for cystathionine (Stabler et al., 1999), and 60-228 nmol/L for 2-methylcitric acid (Allen et al., 1993). Serum pepsinogen I was measured with the use of a kit (SORIN/Bio-medica kit P2560; INCSTAR Corporation, Stillwater, MN). Folate deficiency was diagnosed if serum folate was < 6.8 nmol/L (Wright et al., 1998). No participants were folate deficient. For assignment to supplement group at baseline, vitamin B12 deficiency was defined as MMA > 271 nmol/L. For some of the data analyses, vitamin B12 deficiency was defined as serum vitamin B12 < 258 pmol/L, serum MMA > 271 nmol/L, and MMA concentration greater than that of the accompanying 2-methylcitric acid (Allen et al., 1993; Stabler et al., 1999). Serum pepsinogen I was used as an indirect index of atrophic gastritis (Samloff et al., 1982). Participants were considered to have mild atrophic gastritis if their pepsinogen I concentrations were between 10 and 60 μg/L and to have severe atrophic gastritis if their pepsinogen I was < 10 μg/L (Samloff et al., 1982).

Questionnaires were administered at baseline to collect information on diet, health, depression, orientation-memory-concentration, and clinical signs of vitamin B12 deficiency. An interviewer read questions to the participant and then marked the participant's response.

The dietary component of the questionnaires focused on obtaining information on the amount of vitamin B12 consumed both from vitamin B12 rich foods and from synthetic sources

such as supplements and fortified foods. Participants were asked how often they consumed milk, yogurt, cheese, meat, poultry, fish, and liver. They were asked whether they consumed breakfast cereals, breakfast or energy bars, and liquid meal replacements fortified with vitamins B12, B6, and folic acid. Interviewers probed for brand names and frequency of consumption so that an estimate could be made of the amount consumed per week of B vitamins from fortified foods. Data on B vitamin content of fortified foods was obtained from Bowes and Church's Food Values of Portions Commonly Used (Pennington, 1997) and was updated by checking food labels in local grocery stores. Analyses were based on information obtained from food labels. Supplement use was based on self-report. Interviewers probed for brand names and amounts taken. Selected questions from the Mini-Nutritional Assessment (MNA, Guigoz et al., 1996) were used. Anthropometric measurements were included in this assessment.

A self-reported history of health problems and current medications was obtained. This assessment included a question about stomach surgery, which may affect vitamin B12 status. In addition, participants brought their medications to the senior centers and interviewers made a list of the name, dosage, and length of use of each medication. Self-rated health was measured with three questions.

The 15-item Geriatric Depression Scale (GDS) was used to determine possible depression. This questionnaire has been validated for use in an older adult population (Sheikh & Yesavage, 1986).

For purposes of this paper, a brief cognitive measurement tool was administered to all participants at each time point. The Orientation-Memory-Concentration Test has been validated in studies of older adults and been shown to be sensitive to brain pathology (Katzman et al., 1983). This instrument has six questions on the date and time, phrases to be repeated, counting

backwards, and saying the months of the year in reverse order. A score of $\leq$ 8 indicated normal or minimal impairment, 9 to 19 indicated moderate impairment, and $\geq$ 20 indicated severe impairment. This tool has been used previously in the context of cognitive impairment in vitamin B12 deficiency (Johnson et al., 2003).

Detailed assessments of cognition by Dr. L. Stephen Miller and assessments of auditory function by Dr. Albert DeChicchis will be summarized in separate reports.

Supplementation

Supplements were designed to appear identical (Sunstar Pharmaceutical, Inc., Elgin, IL). The 25 µg, 100 µg, and 1000 µg tablets contained cyanocobalamin, the chemical form of vitamin B12 that is commonly used in supplements in the U.S. (NAS, 1998). Dr. Joan Fischer kept a coded list of the assignment of supplements.

Time 1 (baseline) assessments were performed in the six senior centers January through April of 2001. After baseline testing, the participants were assigned to either the vitamin B12 adequate group (MMA < 271 nmol/L, n = 103) or the vitamin B12 deficient group (MMA $\geq$ 271 nmol/L, n = 46). We wanted participants to begin supplementation as soon after the initial assessments as possible because assignment to supplementation group was based on these assessments. MMA was used for these initial assignments because the results of the MMA were available from Dr. Stabler within two weeks. To ensure treatment efficacy, deficient participants were made aware of their deficiency state by the phlebotomist (JE) and the research coordinator (NH). Other researchers and staff did not have access to information about the vitamin B12 status of the participants. In addition, the physicians of the deficient participants were notified in writing by the phlebotomist and research coordinator. None of the deficient participants elected to receive medical treatment in place of study participation. Those in the deficient group

received tablets containing 1,000 µg vitamin B12 and were instructed to take one tablet daily. The intervention in the vitamin B12 deficient group was neither randomized nor blinded.

A randomized, double blind, placebo-controlled design was used for the vitamin B12 adequate group. Those in the vitamin B12 adequate group were randomized to receive either 0 µg (placebo), 25 µg, or 100 µg tablets and were instructed to take one tablet daily.

After approximately 3 months of supplementation, 132 participants completed time 2 testing between May and August of 2001. Time 2 testing involved the same methods for blood draw, questionnaires, and cognitive screening as time 1. Percent compliance was calculated using pill counts.

Dr. Stephen Miller (co-PI) suggested that cognitive improvements with vitamin B12 treatment might take up to 9 months to become apparent. Therefore, the adequate-placebo group and the vitamin B12 deficient group continued supplementation after time 2 testing.

The adequate-placebo group (0 µg/d) and the vitamin B12 deficient group (1000 µg/d) were tested again from December 2001 through March 2002, approximately 9 months after supplementation was initiated at baseline. Sixty-one participants were tested at time 3. Testing involved the same methods for blood draw, questionnaires, and cognitive screening. Again, percent compliance was calculated using pill counts.

Statistics

Statistical analysis was performed using Statistical Analysis System (SAS, Version 8.2, Cary, NC). A p-value of < 0.05 was considered significant. Data were log transformed to approximate normal distributions where necessary. For Time 1, cross-sectional analyses including *t* tests for continuous variables and chi-square analyses for dichotomous variables were used to examine differences between the deficient and non-deficient groups (Tables 1-3).

Multiple stepwise regression analyses were used to evaluate the independent effects of factors on MMA, serum vitamin B12, vitamin B12 deficiency, and tHcy. For Time 1 and Time 2 comparisons in the adequate groups receiving 0, 25, or 100 μg/d, paired *t* tests, chi-square analyses, and the Wilcoxon two-sample test were used to compare within treatment groups. The treatment intervention was analyzed using repeated measures ANOVA with Helmert orthogonal contrasts (Tables 4-5). Mixed models were used with participant ID as the random effects variable. Difference scores were calculated for selected variables to examine changes in these variables from Time 1 to Time 2 as well as Time 2 to Time 3 (Table 4-6). Difference scores were compared between treatment groups by ANOVA (Table 4).

Results

At Time 1 (Table 1), participants (n = 149) had a mean (± SD) age of 76.3 ± 7.6, and were primarily female (81%) and Caucasian (70%). Mean serum vitamin B12 was 364 ± 161 pmol/L (499 ± 222 pg/mL), serum MMA was 273 ± 213 nmol/L, tHcy was 10.7 ± 4.2 μmol/L, hemoglobin was 13.2 ± 1.4 g/dL, MCV was 90.5 ± 5.3 (fl), 21% met the criteria for anemia, serum pepsinogen was 99.0 ± 71.0 ng/mL, and creatinine was 1.09 ± 0.48 mg/dL with 12% meeting the criteria for elevated creatinine (≥ 1.4 mg/dL). The RDA for vitamin B12 is 2.4 μg/d with adults aged > 50 years advised to consume the majority as cystalline vitamin B12 (NAS, 1998); 44% of this sample consumed ≥ 2.4 μg/d as crystalline vitamin B12 from supplements or fortified foods. Forty percent reported using multivitamin or multivitamin-mineral supplements.

Prevalence of vitamin B12 deficiency

Table 1 summarizes the demographic, biochemical, dietary, and health related characteristics of the non-deficient and deficient groups. At Time 1, 18 (12%) of the 149 participants met the deficiency criteria of serum vitamin B12 < 258 pmol/L and MMA > 271

nmol/L and MMA > methylcitric acid. Compared to the adequate group, the deficient group had significantly lower serum vitamin B12, serum folate, multivitamin mineral use, and intake of crystalline vitamin B12, as well as higher serum MMA, tHcy, SAM, SAH, and methylcitric acid ($p < 0.05$). There were no differences in demographic characteristics, prevalence of anemia, MCV, SAM/SAH ratio, renal function, intake of animal products, orientation-memory-concentration, or depression.

Stepwise logistic regression analysis was performed to determine the major predictors of vitamin B12 deficiency (serum vitamin B12 < 258 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid). Potential predictors were serum creatinine (< 1.4 mg/dL compared with ≥ 1.4 mg/dL), age (< 80 y compared with ≥ 80 y), gender, race (Caucasian or African-American), serum pepsinogen I (< 60 compared with ≥ 60 ng/mL), crystalline vitamin B12 intake (< 6 compared with ≥ 6 μg/d), and animal product intake (< 2 vs. ≥ 2 servings/day). For all stepwise regression analyses performed, the criterion for entry into the model was a significance value of 0.10 and the criterion for inclusion into the model was significance value of 0.05. Predictors of vitamin B12 deficiency were intake of less than 6 μg/d crystalline vitamin B12 [$p = 0.03$; odds ratio (OR): 6.3; 95% CI: 1.6, 24.4], Caucasian race ($p = 0.02$; OR: 6.5; 95% CI: 1.3, 31.9), and low serum pepsinogen ($p = 0.03$; OR: 3.4; 95% CI: 1.1, 10.3).

Stepwise logistic regression analysis was also performed to determine the major predictors of low serum vitamin B12 (< 258 pmol/L). Potential predictors were MMA (≤ 271 compared with > 271 nmol/L), serum creatinine (< 1.4 mg/dL compared with ≥ 1.4 mg/dL), age (< 80 y compared with ≥ 80 y), gender, race (Caucasian or African-American), serum pepsinogen I (< 60 compared with ≥ 60 ng/ml), crystalline vitamin B12 intake (< 2.4 compared with ≥ 2.4 μg/d and < 6 compared with ≥ 6 μg/d), and animal product intake (< 2 vs. ≥ 2

servings/day). The predictors of low serum vitamin B12 were elevated MMA [p = 0.01; odds ratio (OR): 2.7; 95% CI: 1.2, 6.1] and low serum pepsinogen (p = 0.03; OR: 2.5; 95% CI: 1.1, 5.6). When crystalline vitamin B12 intake < 6 μg/d was substituted for intake < 2.4 μg/d, this variable still did not enter into this model.

Prevalence of elevated MMA

Table 2 summarizes the demographic, biochemical, dietary, and health related characteristics of the participants with normal MMA and participants with elevated MMA. At Time 1, 45 (30%) of the 149 participants had elevated MMA (> 271 nmol/L). Compared to participants with normal MMA, the participants with elevated MMA had significantly lower serum vitamin B12, hemoglobin, multivitamin mineral use, and intake of crystalline vitamin B12 and higher MMA, tHcy, SAM, SAH, cystathionine, methylcitric acid, and creatinine and were more likely to be older, Caucasian, and to have poor orientation-memory-concentration scores ($p < 0.05$). There were no differences in gender, folate, serum pepsinogen, MCV, SAM/SAH ratio, intake of animal products, or depression.

Stepwise logistic regression analysis was performed to determine the major predictors of elevated serum MMA (> 271 nmol/L). Potential predictors were serum vitamin B12 (< 258 pmol/L compared with ≥ 258 pmol/L), serum creatinine (< 1.4 mg/dL compared with ≥ 1.4 mg/dL), age (< 80 y compared with ≥ 80 y), gender, race (Caucasian or African-American), serum pepsinogen I (< 60 compared with ≥ 60 ng/mL), crystalline vitamin B12 intake (< 2.4 compared with ≥ 2.4 μg/d and < 6 compared with ≥ 6 μg/d), and animal product intake (< 2 vs. ≥ 2 servings/day). The predictors of elevated MMA were elevated creatinine (p = 0.002; OR: 6.5; 95% CI: 1.9, 22.0), age 80 y or older (p = 0.002; OR: 5.7; 95% CI: 2.3, 14.2), low serum vitamin B12 (p = 0.003; OR: 3.1; 95% CI: 1.2, 8.0), Caucasian race (p = 0.01; OR: 5.5; 95% CI: 1.8,

16.6), and crystalline vitamin B12 intake < 2.4 μg/d (p = 0.006; OR: 3.6; 95% CI: 1.4, 9.1). Crystalline vitamin B12 intake < 6 μg/d when substituted for intake < 2.4 μg/d was also predictive of elevated MMA (p = 0.003; OR: 4.1; 95% CI: 1.6, 10.6).

Prevalence of elevated homocysteine

Table 3 summarizes the demographic, biochemical, dietary, and health related characteristics of the participants with normal tHcy and participants with elevated tHcy. At time 1, 20 (13%) of the 149 participants had elevated tHcy (> 13.9 μmol/L). Compared to the participants with normal tHcy, participants with elevated tHcy had lower hemoglobin, serum folate, and crystalline vitamin B12 intake, and higher serum MMA, SAM, SAH, pepsinogen, and creatinine ($p < 0.05$). Participants with elevated tHcy were also more likely to be older and male ($p < 0.05$).

Stepwise logistic regression analysis was performed to determine the major predictors of elevated tHcy (> 13.9 μmol/L). Potential predictors were vitamin B12 deficiency (serum vitamin B12 < 258 pmol/L, MMA > 271 nmol/L, MMA > methylcitric acid), serum vitamin B12 (< 258 pmol/L compared with ≥ 258 pmol/L), serum MMA (≤ 271 compared with > 271 nmol/L), serum creatinine (< 1.4 mg/dL compared with ≥ 1.4 mg/dL), age (< 80 y compared with ≥ 80 y), gender, race (Caucasian or African-American), serum pepsinogen I (< 60 compared with ≥ 60 ng/mL), serum folate in the lowest 25th percentile (≤ 11.6 compared with > 11.6 nmol/L), crystalline vitamin B12 intake (< 2.4 compared with ≥ 2.4 μg/d and < 6 compared with ≥ 6 μg/d), and animal product intake (< 2 vs. ≥ 2 servings/day). The predictors of elevated tHcy were elevated creatinine (p = 0.0001; OR: 19.9; 95% CI: 4.5, 88.4), elevated MMA (p = 0.0002; OR: 17.3; 95% CI: 3.9, 76.6) and serum folate in the lowest percentile (p < 0.01; OR: 8.5; 95% CI: 1.9, 38.1).

Effects of vitamin B12 supplementation in non-deficient participants

Participants with MMA ≤ 271 nmol/L were randomized at time 1 to receive 0, 25, or 100 µg/d vitamin B12 for 3 months (Table 4). At time 2, 34 participants in the adequate-placebo group (0 µg/d), 26 participants in the 25-µg/d group, and 31 participants in the 100-µg/d group completed testing. Compliance monitoring by pill count showed that the adequate-placebo group had an average compliance of 93%, the 25-µg/d group had an average compliance of 89%, and the 100-µg/d group had an average compliance of 101%.

Contrasts indicated that serum MMA increased in the adequate-placebo group and decreased in the 25 and 100 µg/d groups to the same degree and that MMA in the 25 and 100 µg/d groups was significantly lower than in the adequate-placebo group at time 2 ($p < 0.01$). According to the contrasts, there was no apparent advantage of 100 µg/d over 25 µg/d in this case. There was, however, an apparent advantage of 100 µg/d ($p < 0.01$) over 25 µg/d ($p = 0.09$) compared to the adequate-placebo group in lowering tHcy levels.

Effects of 1,000 µg/d vitamin B12 in participants with elevated MMA

High dose (1,000 µg/d) oral vitamin B12 was offered to the 45 participants who had elevated MMA (>271 nmol/L) (Table 5). Thirty-nine of these participants completed the intervention trial through time 2 testing. The interaction term indicated that compared to the adequate-placebo group, the 1,000-µg/d group had significantly lower serum MMA, tHcy, and methylcitric acid and significantly higher serum vitamin B12 at time 2 testing.

Compliance monitoring by pill count showed that the 1,000-µg/d group had an average compliance of 91% at time 2 ($n = 25$ due to missing data and exclusion of extremely high compliance values). If the pill count revealed that more pills were missing than could be accounted for by number of days the participant had the pills, then the calculated compliance was

over 100% for that participant. Extremely high compliance values were not considered valid because they could indicate that pills were thrown out or given away instead of taken. Therefore, compliance values > 108% were excluded.

Thirty-three participants in the 1,000-µg/d group went on to complete time 3 testing after 9 months of supplementation (Table 6). Compliance in the treatment group was 74% (n = 31) from time 2 to time 3 testing. Changes over time were evaluated by ANOVA and contrasts. Compared to the normal MMA group, the elevated MMA group maintained lower intake of crystalline vitamin B12, lower hemoglobin, higher (worse) orientation-memory-concentration score, and higher cystathionine throughout the 9-month intervention. The contrasts indicated that within the 1,000-µg/d group, serum vitamin B12 increased further between time 2 and time 3; serum MMA remained higher than the adequate-placebo group at each of the 3 time points and tended to increase in both the adequate-placebo and the 1,000-µg/d groups between time 2 and time 3; and both tHcy and methylcitric acid were decreased to adequate-placebo group levels at both time 2 and time 3. Supplementation with 1,000 µg/d did not significantly change MCV, SAM, SAH, SAM/SAH ratio, orientation-memory-concentration score, or GDS score over the 9-month intervention. There was no significant change in SAM, SAH, or SAM/SAH ratio regardless of creatinine level (when examined separately in those with serum creatinine < 1.3 or ≥ 1.3 mg/dL).

Discussion

Crystalline vitamin B12 was strongly related to serum MMA and tHcy in this sample of older adults receiving congregate meals. In the intervention, low dose vitamin B12 lowered both MMA and tHcy in the normal MMA group, despite apparently adequate vitamin B12 status in these participants. Moreover, in the normal MMA group, a vitamin B12 supplement of 100

µg/d, but not 25 µg/d, significantly decreased tHcy. In the elevated MMA group, 1000 µg/d vitamin B12 lowered tHcy to levels observed in the vitamin B12-adequate groups and this decrease was sustained over time during the 9-month intervention. Despite the marked improvement in MMA, tHcy, and serum vitamin B12 in the 1000-µg/d group, there were no improvements in cognition, depression, or anemia.

Prevalence of Deficiency

The prevalence of vitamin B12 deficiency was lower in this study of congregate meal participants (12%) than our previous study (23%; Johnson et al., 2003). Some participants in the previous study received home delivered meals (47%) and these participants may have had poorer nutritional status than congregate meal participants. In addition, our ongoing nutrition education efforts in these congregate meal sites may have increased the percentage of people taking multivitamin supplements over time. Forty percent in the current study took multivitamins compared with 31% in the previous study (Johnson et al., 2003). Other factors, such as age, gender, ethnicity, serum pepsinogen, and serum creatinine were similar between the two studies.

Clinical signs associated with deficiency

Associations with vitamin B12 deficiency in this study depended on how deficiency was defined. As noted previously, vitamin B12 deficiency was defined based on elevated serum MMA (MMA > 271 nmol/L) for assigning supplements. We analyzed the data using this definition as well as a definition of deficiency that included serum vitamin B12 level (serum vitamin B12 < 258 pmol/L, serum MMA > 271 nmol/L, and MMA concentration greater than that of the accompanying 2-methylcitric acid). No matter how deficiency was defined, it was always associated with elevated homocysteine, was never associated with depression, and was not consistently associated with either anemia or orientation-memory-concentration. In our

previous study, vitamin B12 deficient participants had higher mean tHcy (17.6 ± 7.2 vs. 10.8 ± 3.6, $p = 0.001$) were more likely to be anemic (38% vs. 18%, $p = 0.05$), and were more likely to show impairment on the orientation-memory-concentration test (58% vs. 20%, $p < 0.001$) than non-deficient participants were (Johnson et al., 2003). Our previous study found no relationship between vitamin B12 deficiency and depression (Johnson et al., 2003). Fava et al. (1997) also found no relationship between serum vitamin B12 and depression in 213 patients with major depressive disorders. Other studies, however, have shown that vitamin B12 deficient patients are significantly more likely than non-deficient patients to suffer from depression (Penninx et al., 2000; Tiemeier et al., 2002). Both Mischoulon et al. (2000) and Bates et al. (2003) found no relationship between vitamin B12 deficiency and macrocytosis or hematocrit and concluded that anemia is not useful in predicting vitamin B12 deficiency.

Demographic, physical, and dietary correlates of vitamin B12 status

Although older age and Caucasian race predisposed participants to elevated serum MMA, these characteristics were not associated with vitamin B12 deficiency when defined by serum vitamin B12, MMA, and methyl-citric acid. Moreover, intake of at least the RDA (2.4 μg/d) of vitamin B12 as crystalline vitamin B12 was protective against elevated MMA but not against vitamin B12 deficiency based on the 3 biochemical criteria. These differences may reflect the fact that serum MMA is more closely related than serum vitamin B12 to the functional status of vitamin B12. Unlike our previous study, vitamin B12 deficiency was not associated with a likelihood of lower serum pepsinogen or lower intake of animal products. Low intake of crystalline vitamin B12 from supplements and fortified foods is clearly associated with vitamin B12 deficiency in the current study.

Crystalline vitamin B12 intake and vitamin B12 status

Perhaps the relatively high intake of crystalline vitamin B12 in the present study overcame the adverse effects of poor gastric function and/or low intake of animal foods. Campbell et al. (2003) studied a group of Latino older adults in which the vitamin B12 deficient participants had a mean intake of 5.0 μg/d vitamin B12 from crystalline sources while the vitamin B12 adequate participants had a mean intake of 9.4 μg/d from crystalline sources and concluded that the 6 μg vitamin B12 found commonly in multivitamins may not be sufficient in populations with a high prevalence of protein-bound vitamin B12 malabsorption secondary to atrophic gastritis. Other cross-sectional studies have shown that regular intake of vitamin B12-containing supplements is associated with higher serum vitamin B12 (Campbell et al., 2003; Kwan et al., 2002; neither study reported MMA or tHcy) and higher serum vitamin B12, lower MMA, and lower tHcy (Koehler et al., 1996; Garcia et al., 2002). Participants in the current study who consumed $\geq$ 2.4 μg/d crystalline vitamin B12 were far more likely to consume this amount from supplements than from fortified foods. Similarly, Campbell et al. (2003) found that in a Latino population, fortified cereals were not a primary source of crystalline vitamin B12. Figure 1 shows the prevalence of vitamin B12 deficiency by level of crystalline vitamin B12 consumed.

Demographic, physical, and dietary correlates of tHcy

As predicted, elevated tHcy was associated with older age, male gender, vitamin B12 deficiency, lower serum folate, lower intakes of crystalline vitamin B12, and elevated creatinine. Similarly, in our previous study, determinants of elevated tHcy were vitamin B12 deficiency, elevated creatinine, and low red blood cell folate (Johnson et al., 2003). NHANES III also found that the prevalence of elevated tHcy increased with age and male gender (Jacques et al., 1999).

Despite the significantly lower intake of crystalline vitamin B12 of participants with tHcy > 13.9 μmol/L compared to participants with tHcy ≤ 13.9 (4.1 ± 11.4 compared to 14.5 ± 58.3 μg/d, $p < 0.01$), intake of crystalline vitamin B12 was not predictive of tHcy in our logistic regression model.

Effects of supplementation of 25 and 100 μg/d in vitamin B12 adequate participants

In vitamin B12 adequate participants, both 25 and 100 μg/d vitamin B12 significantly reduced serum MMA and there was no apparent advantage of 100 μg/d in this case. There was, however, an apparent advantage of 100 μg/d over 25 μg/d in lowering tHcy in adequate participants. To our knowledge, this is the only study to report the effects of vitamin B12 supplementation on serum MMA and tHcy in participants with apparently adequate vitamin B12 status. Further studies are needed to determine if these high intakes of vitamin B12 may have beneficial effects associated with tHcy lowering such as decreased risk of cardiovascular disease (Chait et al., 1999) or neurological dysfunction (Miller, 2003).

Effects of 1,000 μg/d in vitamin B12 deficient participants

In vitamin B12 deficient participants, 1,000 μg/d did not have a consistent effect on anemia. This study lends support to the idea that elevated MCV and anemia are not reliable indices of vitamin B12 deficiency. In fact, during the intervention, MCV was lower in the vitamin B12 deficient group compared to the vitamin B12 adequate-placebo groups. Hvas et al. (2001) reported no significant change in hemoglobin or MCV after 18 months of intramuscular vitamin B12 in 140 older adults with vitamin B12 deficiency at baseline. Other studies in vitamin B12 deficient people reported significant decreases in MCV with oral vitamin B12

supplementation (Kuzminski et al., 1998) and decreases in MCV along with increases in hemoglobin with oral vitamin B12 (Andrés et al., 2001; Andrés et al., 2003).

This small study showed no effect of high dose oral vitamin B12 on orientation-memory-concentration or depression in vitamin B12 deficient older adults. Some studies have shown improvements in cognitive performance with vitamin B12 supplementation (van Asselt et al., 2001; Abyad, 2002), and other studies have failed to show any effects of vitamin B12 supplementation on cognitive performance (Hvas et al., 2001). Although the orientation-memory-concentration test can be used to distinguish between mild, moderate, and severe cognitive impairment (Katzman et al., 1983), this tool tests only limited aspects of cognition, it is not widely used, and it may have poor sensitivity to change. Detailed assessment of vitamin B12 status and cognitive processes was performed using a web-based neurocognitive testing battery and will be discussed in other publications (Lewis, 2004). There is a lack of research on the effects of vitamin B12 supplementation on depression in vitamin B12 deficient participants, although large cross-sectional studies show a relationship between vitamin B12 status and depression [Penninx et al., 2000 (n = 700); Tiemeier et al., 2002 (n = 694)].

Vitamin B12 supplementation of 1,000 µg/d significantly increased serum vitamin B12 and significantly decreased serum MMA and tHcy in vitamin B12 deficient participants. Supplementation reduced tHcy to below 13.9 µmol/L in 10 of the 13 participants with elevated tHcy at time 1. Interventions of vitamin B12 supplementation for 3 months or longer in vitamin B12 deficient participants have consistently reported that vitamin B12 supplementation significantly increases serum vitamin B12 and significantly decreases serum MMA and tHcy (Kuzminski et al., 1998; Bjorkegren & Svardsudd, 1999; Hvas et al., 2001; van Asselt et al., 2001). The final mean MMA (293 nmol/L) and tHcy (8.9 µmol/L) in those given 1,000 µg/d

vitamin B12 tended to be higher and slightly lower, respectively than in similar intervention trials (Kuzminski et al., 1998; Bjorkegren & Svardsudd, 1999; Hvas et al., 2001; van Asselt et al., 2001).

Twelve (31%) of the 39 participants in the 1,000-µg/d group at time 2 were considered to be non-responders [defined as continued low serum vitamin B12 (< 258 pmol/L) OR elevated MMA (> 271 nmol/L) at time 2 in the 1,000-µg/d group]. Several factors may account for non-response. There was a high rate of missing or invalid compliance data among non-responders. Five of the 12 had missing compliance data at time 2 and an additional 4 of the 12 had compliance data > 108% indicating that pills may have been discarded instead of taken. Low serum pepsinogen was predictive of vitamin B12 deficiency (serum vitamin B12 < 258 pmol/L, MMA > 271 nmol/L, MMA > methylcitric acid), thus poor gastric function could account for non-response in some participants. Poor renal function could also account for non-response in some participants, as elevated creatinine (≥ 1.4 mg/dL) was predictive of elevated MMA in stepwise logistic regression. Although non-responders had a significantly higher serum creatinine than responders (1.31 compared to 1.11 mg/dL, $p < 0.05$), they were not significantly different in terms of age, gender, race, serum vitamin B12, MMA, and tHcy levels, or orientation-memory-concentration score.

This study showed a strong relationship of crystalline vitamin B12 intake to vitamin B12 status. Higher intakes of crystalline vitamin B12 were associated with lower serum MMA levels, with benefits continuing to accrue with ≥ 12 µg/day. This is the first study to show benefits of 100 µg/day vitamin B12 in vitamin B12 adequate adults in lowering tHcy. In vitamin B12 deficient adults, 1,000 µg/day vitamin B12 improved biochemical but not clinical signs of vitamin B12 deficiency, such as depression, poor orientation-memory-concentration, or anemia.

Therefore, prevention of vitamin B12 deficiency is important, as some effects of vitamin B12 deficiency may be irreversible. Considering that vitamin B12 supplementation is safe and has no apparent toxic effects, and considering the potential benefits vitamin B12 has for the growing number of older adults in the U.S., a national policy of vitamin B12 fortification should be considered, as suggested by others (SoRelle, 2002; Ray et al., 2003).

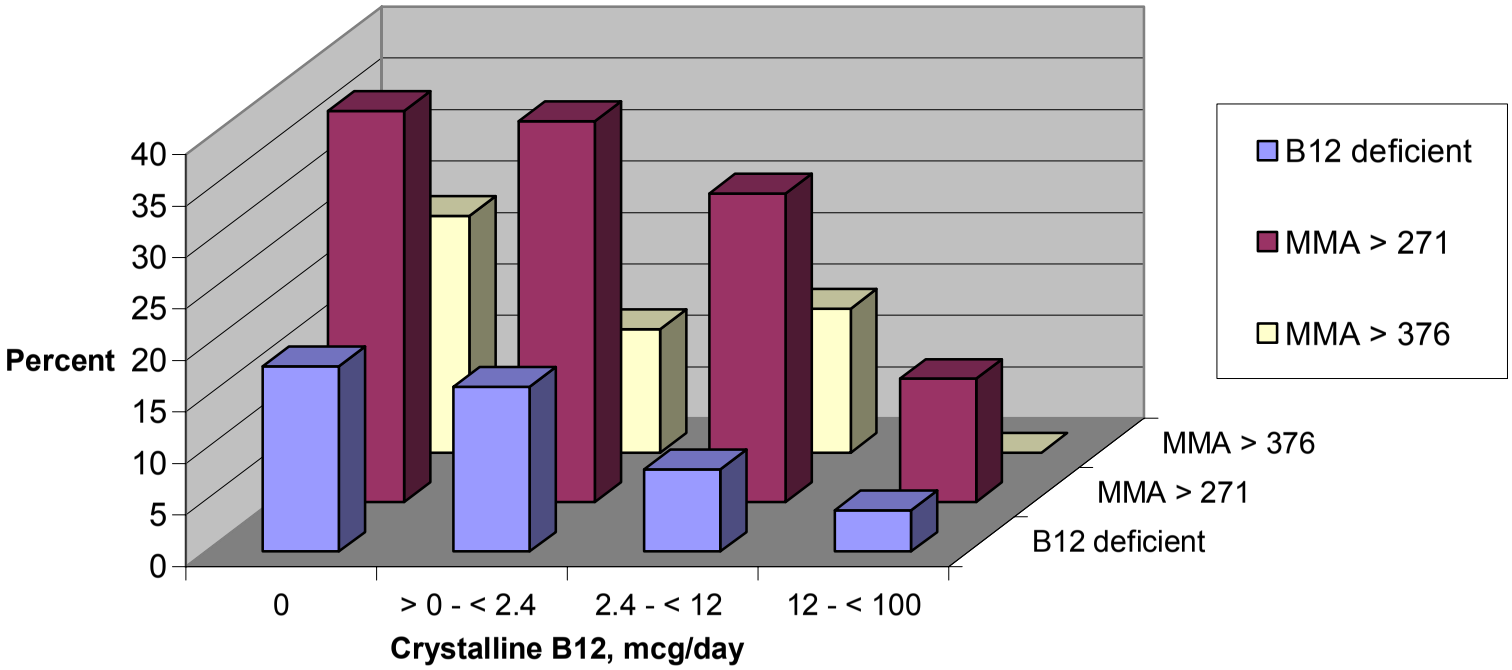

Figure 3.1 Prevalence of deficiency by level of Crystalline B12 intake

Table 1. Vitamin B12 deficiency and its relationship with demographic, biochemical, dietary, and health factors at Time 1

	Total group	Non-deficient	B12 deficient**	p
(N)	**(149)**	**(131)**	**(18)**	
Age (yr)	76.3 ± 7.6 (58-97)	76.2 ± 7.8	77.4 ± 6.6	0.26[b]
Gender N (%)				
Male	28 (19)	24 (18)	4 (22)	0.69[#]
Female	121 (81)	107 (82)	14 (78)	
Ethnicity N (%)				
Caucasian	105 (70)	89 (68)	16 (89)	0.07[#]
African-American	44 (30)	42 (32)	2 (11)	
Serum B12 (pmol/L)	364 ± 161 (74 – 993)	391 ± 150	163 ± 59	<0.001[†]
MMA (nmol/L)	273 ± 213 (85 - 1972)	227 ± 79	607 ± 463	<0.001[†]
Homocysteine (μmol/L)	10.7 ± 4.2 (5.1 - 39.5)	10.2 ± 3.8	14.4 ± 5.4	<0.001[†]
S-adenosyl-homocysteine (nmol/L)	34.8 ± 21.5	33.8 ± 21.3	41.7 ± 22.5	0.05[†]
S-adenosyl-methionine (nmol/L) (n = 148)	118 ± 61.0	116 ± 62.9	129 ± 44.9	0.05[†]
SAM/SAH (n = 148)	4.03 ± 2.0	4.07 ± 2.03	3.7 ± 1.8	0.22[†]

Cystathionine (nmol/L)	261 ± 131 (89 - 968)	253 ± 129	291 ± 113	0.06[†]
Methylcitric acid (nmol/L)	190 ± 71 (58 - 482)	183 ± 64	231 ± 68	<0.001[†]
Anemic [a] N (%) n = 148	31 (21)	25 (19)	6 (33)	0.17[#]
Hemoglobin (g/dL)	13.2 ± 1.4 (9.2 - 17.3)	13.3 ± 1.4	12.7 ± 1.4	0.07[b]
Creatinine (mg/dL)	1.09 ± 0.48 (0.60 - 4.60)	1.09 ± 0.50	1.09 ± 0.32	0.33[†]
N, (%) ≥ 1.4 mg/dL creatinine	18 (12)	16 (12)	2 (11)	0.88[#]
MCV (fl)	90.5 ± 5.3 (68 - 107)	90.6 ± 4.9	90.4 ± 7.8	0.48[†]
Serum folate (nmol/L)	46.3 ± 27.7 (8.8 – 163.3)	48.6 ± 28.5	29.3 ± 11.2	0.01[†]
Serum pepsinogen (ng/mL)	99.0 ± 71.0	101.7 ± 72.5	78.3 ± 55.5	0.10[†]
N, (%) low pep (≤ 50ng/mL)	34 (23)	28 (21)	6 (33)	0.26[#]
Multivitamin use N (%)	59 (40)	56 (43)	3 (17)	0.05[#]
Synthetic B12 intake (µg/d)	13.1 ± 54.5	14.4 ± 57.8	3.9 ± 11.7	0.01[†]
N, (%) ≥ 2.4 µg/d synthetic B12	66 (44)	62 (47)	4 (22)	0.05[#]
N, (%) ≥ 6 µg/d synthetic B12	63 (42)	60 (46)	3 (17)	0.02[#]
N, (%) ≥ 12 µg/d synthetic B12	29 (19)	28 (21)	1 (6)	0.11[#]
N, (%) ≥ 25 µg/d synthetic B12	24 (16)	23 (18)	1 (6)	0.19[#]

Meat, fish, poultry (N, % ≥ 1/d) n = 146	79 (54)	69 (54)	10 (56)	0.90[#]
Milk, yogurt, cheese (N, % ≥ 1/d) n = 147	86 (59)	76 (59)	10 (56)	0.79[#]
Animal foods (N, % ≥ 2/d) n = 146	53 (36)	47 (37)	6 (33)	0.78[#]
Impaired cognition[‡] N (%)	40 (27)	35 (27)	5 (28)	0.92[#]
Geriatric Depression Score > 5, N (%)	11 (7)	10 (8)	1 (6)	0.75[#]
Geriatric Depression Score ≥ 10, N (%) n = 148	4 (3)	3 (2)	1 (6)	0.43[#]

** Vitamin B12 deficiency defined as serum vitamin B12 <350 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid
[†] Wilcoxon 1-sided z-score
[#] Chi-square statistic
[a] Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
[b] t-test (pooled) statistic
[‡] Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test

Table 2. Elevated methylmalonic acid (MMA) and its relationship with demographic, biochemical, dietary, and health factors at Time 1

	Total group	Normal MMA	Elevated MMA*	p
(N)	**(149)**	**(104)**	**(45)**	
Age (yr)	76.3 ± 7.6 (58 - 97)	75.0 ± 7.7	79.3 ± 6.5	0.001[b]
Gender N (%)				
Male	28 (19)	17 (16)	11 (24)	0.25[#]
Female	121 (81)	86 (84)	35 (76)	
Ethnicity N (%)				
Caucasian	105 (70)	67 (64)	38 (84)	0.01[#]
African-American	44 (30)	37 (36)	7 (16)	
Serum B12 (pmol/L)	364 ± 161 (74 - 993)	386 ± 153	312 ± 166	0.01[†]
MMA (nmol/L)	273 ± 213 (85 - 1972)	196 ± 45	450 ± 320	<0.001[†]
Homocysteine (μmol/L)	10.7 ± 4.2 (5.1 - 39.5)	9.3 ± 2.3	13.8 ± 5.8	<0.001[†]
S-adenosyl-homocysteine (nmol/L)	34.8 ± 21.5	29 ± 13.2	48.3 ± 29.8	<0.001[†]
S-adenosyl-methionine (nmol/L) (n = 148)	118 ± 61.0	103 ± 43.0 (n = 103)	152 ± 80.4	<0.001[†]
SAM/SAH (n = 148)	4.03 ± 2.0	4.2 ± 2.13	3.63 ± 1.6	0.10[†]
Cystathionine (nmol/L)	261 ± 131 (89 - 968)	224 ± 88	337 ± 166	<0.001[†]

Methylcitric acid (nmol/L)	190 ± 70 (58 - 482)	165 ± 43	242 ± 80	<0.001[†]
Anemic N (%) n = 148	31 (21)	14 (14)	17 (38)	<0.001[#]
Hemoglobin (g/dL) n = 148	13.2 ± 1.4 (9.2 - 17.3)	13.4 ± 1.3	12.8 ± 1.4	0.01[b]
Creatinine (mg/dL) n = 148	1.09 ± 0.48 (0.6 - 4.6)	0.98 ± 0.23	1.34 ± 0.75	<0.001[†]
N, % ≥ 1.4 mg/dL creatinine n = 148	18 (12)	7 (7)	11 (24)	0.01[#]
MCV (fl) n = 148	90.5 ± 5.3 (68 - 107)	90.8 ± 4.5	90.0 ± 6.7	0.48[†]
Serum folate (nmol/L)	46.3 ± 27.7 (8.8 – 163.3)	47.2 ± 25.4	44.1 ± 32.6	0.11[†]
Serum pepsinogen (ng/mL) n = 147	99.0 ± 71.0 (8.6 - 549.9)	94.5 ± 59.1	109.4 ± 93.1	0.24[†]
N, (%) low pep (≤ 50 ng/mL)	34 (23)	24 (23)	10 (22)	0.91[#]
Multivitamin use N (%)	59 (40)	48 (46)	11 (24)	0.01[#]
Synthetic B12 intake (µg/d)	13.1 ± 54.5	17.1 ± 64.6	4.1 ± 8.9	0.02[†]
N, % ≥ 2.4 µg/d synthetic B12	66 (44)	52 (50)	14 (31)	0.05[#]
N, % ≥ 6 µg/d synthetic B12	63 (42)	51 (49)	12 (27)	0.01[#]
N, % ≥ 12 µg/d synthetic B12	29 (19)	26 (25)	3 (7)	0.01[#]
N, % ≥ 25 µg/d synthetic B12	24 (16)	22 (21)	2 (4)	0.01[#]
Meat, fish, poultry (N, % ≥ 1/d) n=146	79 (54)	57 (55)	22 (51)	0.64[#]

Milk, yogurt, cheese (N, % ≥ 1/d) n=147	86 (59)	58 (56)	28 (65)	0.30[#]
Animal foods (N, % ≥ 2/d) n = 146	53 (36)	38 (37)	15 (35)	0.82[#]
Impaired cognition [‡] N (%)	40 (27)	23 (22)	17 (38)	0.05[#]
Geriatric Depression Score > 5, N (%)	11 (7)	9 (9)	2 (4)	0.37[#]
Geriatric Depression Score ≥ 10, N (%)	4 (3)	3 (3)	1 (3)	0.83[#]

* Elevated MMA defined as >271 nmol/L
[†] Wilcoxon 1-sided z-score
[#] Chi-square statistic
[a] Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
[b] t-test (pooled) statistic
[‡] Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test

Table 3. Homocysteine (HC) and its relationship with demographic, biochemical, dietary, and health factors at Time 1

	Total group	Normal HC	Elevated HC*	p
(N)	**(149)**	**(129)**	**(20)**	
Age (yr)	76.3 ± 7.6 (58-97)	75.7 ± 7.5	80.1 ± 7.2	0.01[b]
Gender N (%)				
Male	28 (19)	21 (16)	7 (35)	0.05[#]
Female	121 (81)	108 (84)	13 (65)	
Ethnicity N (%)				
Caucasian	105 (70)	91 (71)	14 (70)	0.96[#]
African-American	44 (30)	38 (29)	6 (30)	
Serum B12 (pmol/L)	364 ± 161 (74 - 993)	369 ± 162	330 ± 147	0.28[†]
MMA (nmol/L)	273 ± 213 (85 - 1972)	242 ± 173	472 ± 324	<0.001[†]
B12 deficient** N (%)	18 (12)	12 (9.3)	6 (30)	0.01[#]
Homocysteine (µmol/L)	10.7 ± 4.2 (5.1 - 39.5)	9.5 ± 2.1	18.3 ± 6.1	<0.001[†]
S-adenosyl-homocysteine (nmol/L)	34.8 ± 21.5	30.7 ± 14.1	61.7 ± 37.3	<0.001[†]
S-adenosyl-methionine (nmol/L) (n = 148)	118 ± 61.0	108 ± 43.8 (n = 128)	181 ± 106	<0.001[†]
SAM/SAH (n = 148)	4.03 ± 2.0	4.12 ± 2.03	3.43 ± 1.68	0.08[†]

Cystathionine (nmol/L)	261 ± 131 (89 - 968)	234 ± 93	411 ± 199	<0.001[†]
Methylcitric acid (nmol/L)	190 ± 71 (58 - 482)	173 ± 48	288 ± 84	<0.001[†]
Anemic N (%) n = 148	31 (21)	21 (16)	10 (50)	<0.001[#]
Hemoglobin (g/dL) n = 148	13.2 ± 1.4 (9.2 - 17.3)	13.3 ± 1.3	12.6 ± 1.6	0.05[b]
Creatinine (mg/dL) n = 148	1.09 ± 0.48 (0.60 - 4.60)	0.98 ± 0.23	1.7 ± 0.97	<0.001[†]
N, % ≥ 1.4 mg/dL creatinine	18 (12)	7 (5)	11 (55)	<0.001[#]
MCV (fl) n = 148	90.5 ± 5.3 (68 - 107)	90.7 ± 5.0	89.6 ± 7.1	0.43[†]
Serum folate (nmol/L)	46.3 ± 27.7 (8.8 – 163.3)	48.0 ± 28.1	35.0 ± 22.3	0.02[†]
Serum pepsinogen (ng/mL) n = 147	99.0 ± 71.0 (8.6 - 549.9)	92.1 ± 56.1	143 ± 125	0.02[†]
N, (%) low pep (≤ 50ng/mL)	34 (23)	30 (23)	4 (20)	0.75[#]
Multivitamin use, N (%)	59 (40)	54 (42)	5 (25)	0.15[#]
Synthetic B12 intake (µg/d)	13.1 ± 54.5	14.5 ± 58.3	4.1 ± 11.4	0.01[†]
N, % ≥ 2.4 µg/d synthetic B12	66 (44)	62 (48)	4 (20)	0.02[#]
N, % ≥ 6 µg/d synthetic B12	63 (42)	59 (46)	4 (20)	0.03[#]
N, % ≥ 12 µg/d synthetic B12	29 (19)	27 (21)	2 (10)	0.25[#]
N, % ≥ 25 µg/d synthetic B12	24 (16)	23 (18)	1 (5)	0.15[#]

Meat, fish, poultry (N, % ≥ 1/d) n = 146	79 (54)	68 (53)	11 (61)	0.52[#]
Milk, yogurt, cheese (N, % ≥ 1/d) n = 147	86 (59)	74 (57)	12 (67)	0.45[#]
Animal foods (N, % ≥ 2/d) n = 146	53 (36)	45 (35)	8 (44)	0.44[#]
Impaired cognition [‡] N (%)	40 (27)	33 (26)	7 (35)	0.38[#]
Geriatric Depression Score > 5, N (%)	11 (7)	9 (7)	2 (10)	0.70[#]
Geriatric Depression Score ≥ 10, N (%) n = 148	4 (3)	2 (2)	2 (10)	0.05[#]

* Elevated HC defined as serum HC > 13.9 μM
[†] Wilcoxon 1-sided z-score
[#] Chi-square statistic
** B12 deficiency defined as serum B12 <350 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid
[a] Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
[b] t-test (pooled) statistic
[‡] Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test

Table 4. Effects of 0, 25, & 100 µg/d B12 in adequate participants from Time 1 to Time 2

	Placebo			25 µg/d			100 µg/d			B12int	Time	Inter-action
	Time 1	Time 2	Δ	Time 1	Time 2	Δ	Time 1	Time 2	Δ	p-values		
n	34	34		26	26		31	31				
Age	73			75			77					
Gender (% M/F)	9/91			23/77			19/81					
Race (% W/B)	68/32			65/35			68/32					
Compliance (%)	92.5 ± 15.3			89.4 ± 35.7			101 ± 33.0					
Serum B12 (pmol/L)	383 ± 138	393 ± 181	10.7[a] ± 122	426 ± 196	440 ± 182	13.9[a] ± 228	367 ± 123	427 ± 147	60.2[a] ± 89.3	0.46	0.08	0.36
MMA (nmol/L)	190 ± 53.2	213 ± 78.1	22.9[a] ± 55.5	197 ± 36.6	186 ± 51.1	-10.4[b] ± 41.1	197 ± 36.4	188 ± 52.8	-9.8[b] ± 44.9	0.69	0.86	0.01
Homocysteine (µmol/L)	9.05 ± 1.9	9.31 ± 2.5	0.26[a] ± 1.17	9.65 ± 2.9	9.31 ± 2.6	-0.34[ab] ± 1.3	9.03 ± 2.05	8.23 ± 2.25	-0.80[b] ± 1.6	0.35	0.05	0.01
S-adenosyl-homocysteine (nmol/L)	25.2 ± 9.3	27.8 ± 15.4	2.56 ± 15.6	33.2 ± 14.5	28.4 ± 11.8	- 4.73 ± 13.3	28.2 ± 15.4	28.7 ± 13.8	0.45 ± 10.6	0.01	0.63	0.52
S-adenosyl-methionine (nmol/L)	102 ± 47.9	123 ± 49.1 (n = 28)	18.4 ± 57.3 (n = 28)	118 ± 55.7	129 ± 36.1 (n = 22)	8.9 ± 64.5 (n=22)	94.3 ± 27.1 (n = 30)	113 ± 36.3 (n = 22)	18.3 ± 43.4 (n = 22)	0.05	0.12	0.86
SAM/SAH	4.55 ± 2.21	5.63 ± 4.95 (n = 28)	0.72 ± 5.17 (n = 28)	4.14 ± 2.32	5.22 ± 2.16 (n = 22)	0.81 ± 3.22 (n=22)	4.27 ± 2.13 (n = 30)	5.27 ± 3.31 (n = 22)	0.41 ± 3.69 (n = 22)	0.77	0.07	0.99
Cystathionine (nmol/L)	203 ± 73.0	247 ± 192	44.1[a] ± 170	241 ± 104	241 ± 97.8	-0.08[a] ± 105	232 ± 88.2	200 ± 65.6	-32.7[a] ± 63.3	0.61	0.77	0.05
Methylcitric acid (nmol/L)	160 ± 41.6	181 ± 81.1	21.2[a] ± 65.2	179 ± 48.8	182 ± 62.8	3.2[a] ± 45.1	167 ± 37.3	167 ± 64.3	0.23[a] ± 54.4	0.58	0.17	0.28

	Placebo			25 µg/d			100 µg/d			B12int	Time	Inter-action
	Time 1	Time 2	Δ	Time 1	Time 2	Δ	Time 1	Time 2	Δ	p-values		
n	34	34		26	26		31	31				
Anemic[†] N, (%) **	4 (12)	7 (21)	43%	5 (19)	9 (35)	46%	3 (10)	4 (13)	23%			
Hemoglobin (g/dL)	13.8 ± 1.4	13.4 ± 1.2	-0.36[ab] ± 0.85	13.1 ± 1.4	12.3 ± 1.7	-0.72[a] ± 1.2	13.6 ± 1.0	13.3 ± 0.91	-0.2[b] ± 0.54	0.01	<0.001	0.10
Creatinine (mg/dL)	0.93 ± 0.22	n/a	n/a	1.04 ± 2.3	n/a	n/a	0.99 ± 0.28	n/a	n/a			
N, (%) ≥ 1.4 mg/dL creatinine	2 (6)	n/a	n/a	2 (8)	n/a	n/a	3 (10)	n/a	n/a	0.86		
MCV	91.0 ± 3.9	91.2 ± 4.4	0.48[a] ± 1.8	90.8 ± 4.5	90.0 ± 6.1	-0.85[b] ± 3.3	89.8 ± 4.6	90.3 ± 5.3	0.48[a] ± 1.7	0.72	0.90	0.06
Serum folate (nmol/L)	50.3 ± 28.1	52.4 ± 30.8	2.1 ± 24.9	45.8 ± 26.0	51.7 ± 27.4	5.9[a] ± 20.9	46.8 ± 23.9	55.3 ± 31.0	8.5[a] ± 19.2	0.92	0.02	0.50
Serum pep	83.3 ± 53.0	n/a	n/a	110 ± 57.8	n/a	n/a	97.8 ± 68.1	n/a	n/a			
MVI use, N (%)**	18 (53)	22 (65)	18%	12 (46)	8 (31)	- 48%	11 (35)	16 (52)	45%			
Intake of synthetic B12 (µg/d)	8.3 ± 11.3	9.4 ± 11.8	1.1[a] ± 6.2	39.4 ± 124	11.8 ± 39.4	-27.6[b] ± 90.5	10.8 ± 25.9	17.3 ± 42.8	6.4[a] ± 18.8	0.40	0.20	0.05
N, % ≥ 2.4 µg/d **	19 (56)	19 (56)	-	13 (50)	8 (38)	- 38%	13 (42)	13 (42)	-			
OMC score	5.4 ± 5.5	4.2 ± 4.7	- 1.2[ab] ± 4.5	4.1 ± 5.2	4.3 ± 6.0	0.23[a] ± 3.4	5.2 ± 5.2	3.2 ± 5.1	- 1.9[b] ± 3.1	0.87	0.02	0.10
Impaired cognition[#], N (%) **	6 (18)	3 (9)	-100%	3 (12)	6 (23)	48%	7 (23)	4 (13)	- 77%			
GDS[‡]	2.0 ± 2.7	1.9 ± 2.5	- 0.12[ab] ± 1.8	2.2 ± 2.1	1.3 ± 1.6	- 0.8[a] ± 1.6	2.0 ± 2.4	2.1 ± 2.9	0.06[b] ± 2.1	0.89	0.15	0.19
GDS > 5, N (%) **	2 (6)	2 (6)	0 %	1 (4)	1 (4)	0 %	4 (13)	4 (13)	0 %			
GDS > 10, N (%)**	2 (6)	1 (3)	- 100%	0 (0)	0 (0)	0 %	0 (0)	2 (6)	-			

* B12 deficiency as defined as serum B12 <350 pmol/L and MMA > 271 nmol/L and MMA > methylcitric acid
† Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
** Based on chi-square statistic, no significant differences from Time 1 to Time 2 within groups for these variables
# Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test
‡ GDS is Geriatric Depression Score

Table 5. Effects of 1,000 µg/d B12 (Times 1 and 2) in participants with elevated MMA compared to placebo

	B12 adequate - placebo			B12 deficient* – given 1,000 µg/d			B12int	Time	Inter-action
	Time 1	Time 2	Δ	Time 1	Time 2	Δ	p-values		
n	34	34		39	39				
Age	73			79					
Gender (% M/F)	9/91			26/74					
Race (% W/B)	68/32			87/13					
Compliance (%)	n/a	93 (n=29)	n/a	n/a	91 (n=25)	n/a			
Serum B12 (pmol/L)	383 ± 138	393 ± 181	10.7 ± 122	297 ± 167	801 ± 569	509 ± 516	0.01	<0.001	<0.001
MMA (nmol/L)	190 ± 53.2	213 ± 78.1	22.9 ± 55.5	468 ± 340	271 ± 207	-197 ± 287	<0.001	<0.001	<0.001
Homocysteine (µmol/L)	9.1 ± 1.9	9.3 ± 2.5	0.26 ± 1.2	13.0 ± 4.3	9.9 ± 3.7	- 3.1 ± 3.2	0.01	<0.001	<0.001
Cystathionine (nmol/L)	203 ± 73.0	247 ± 192	44.1 ± 170	319 ± 135	322 ± 159	0.93 ± 116	0.01	0.17	0.22
Methylcitric acid (nmol/L)	160 ± 41.6	181 ± 81.1	21.2 ± 65.2	233 ± 73.0	195 ± 60.7	- 38.3 ± 62.0	0.01	0.25	<0.001
Anemic† N, (%) **	4 (12) (n = 33)	7 (21)	75%	12 (31)	16 (41)	32%			
Hemoglobin (g/dL)	13.8 ± 1.4 (n = 33)	13.4 ± 1.2	- 0.36 ± 0.85 (n = 33)	13.0 ± 1.3	12.8 ± 1.4	-0.25 ± 0.58	0.02	<0.001	0.52

	B12 Adequate - Placebo			B12 Deficient* – Given 1,000 µg/d			B12-int	Time	Inter-action
	Time 1	Time 2	Δ	Time 1	Time 2	Δ	p-values		
n	34	34		39	39				
Creatinine (mg/dL)	0.93 ± 0.22 (n = 33)	n/a	n/a	1.17 ± 0.29	n/a	n/a			
N, (%) ≥ 1.4 mg/dL creatinine	2 (6) (n = 33)	n/a	n/a	7 (18)	n/a	n/a			
MCV (fl)	91.0 ± 3.9 (n = 33)	91.2 ± 4.4	0.48 ± 1.77 (n = 33)	90.4 ± 6.5	90.5 ± 6.6	0.10 ± 1.96	0.66	0.20	0.41
Serum folate (nmol/L)	50.3 ± 28.1	52.4 ± 30.8	2.1 ± 24.9	40.1 ± 28.0	52.8 ± 48.0	12.7 ± 43.2	0.50	0.08	0.21
Serum pep (ng/mL)	83.3 ± 53.0 (n = 33)	n/a	n/a	95.0 ± 52.7 (n = 38)	n/a	n/a			
MVI use, N (%) **	18 (53)	22 (65)	22%	10 (26)	8 (21)	- 20%			
Intake of synthetic B12 (µg/d)	8.3 ± 11.3	9.4 ± 11.8	1.1 ± 6.2	3.7 ± 9.4	4.0 ± 9.8	0.3 ± 4.8	0.05	0.29	0.54
N, % ≥ 2.4 µg/d synthetic B12 **	19 (56)	20 (59)	5%	11 (28)	9 (23)	- 18%			
OMC score	5.4 ± 5.5	4.2 ± 4.7	-1.2 ± 4.5	7.6 ± 7.7	6.8 ± 7.8	-0.8 ± 4.2	0.10	0.06	0.67
Impaired cognition[#], N (%) **	6 (18)	3 (9)	- 100%	13 (33)	12 (31)	- 6%			
GDS score	2.0 ± 2.7	1.9 ± 2.5	-0.12 ± 1.8	2.1 ± 2.3	1.8 ± 2.2	-0.23 ± 1.4	0.99	0.35	0.76
GDS[‡] > 5, N (%) **	2 (6)	2 (6)	0%	2 (5)	2 (5)	0%			
GDS[‡] ≥ 10, N (%)	2 (6)	1 (3)	- 100%	1 (3)	1 (3)	0%			

* Based on serum MMA > 271 nmol/L
† Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
** Based on chi-square statistic, no significant differences from Time 1 to Time 2 within groups for these variables
# Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test
‡ GDS is Geriatric Depression Scale

Table 6. Effects of 1,000 µg/d B12 (Times 1, 2, and 3) in participants with elevated MMA compared to placebo

	B12 adequate - placebo					B12 deficient* – given 1,000 µg/d					p-values		
	Time 1	Time 2	Δ	Time 3	Δ	Time 1	Time 2	Δ	Time 3	Δ	B12int	Time	Inter-action
n	26	26		26		33	33		33				
Age	73					79							
Gender (% M/F)	8/92					27/73							
Race (% W/B)	65/35					88/12							
Compliance (%)	n/a	93 (n=23)	n/a	80%		n/a	91 (n=25)	n/a	74.2 (n=31)				
Serum B12 (pmol/L)	352[a] ± 131	361[a] ± 179	9.0 ± 134	329[a] ± 137	- 32.4 ± 175	300[b] ± 175	835[c] ± 593	535 ± 544	971[d] ± 641	136 ± 311	<0.001	<0.001	<0.001
MMA (nmol/L)	192[a] ± 56.0	206[b] ± 69.5	14.6 ± 41.3	244[c] ± 92.1	38.0 ± 65.0	445[d] ± 304	241[e] ± 79.1	- 203 ± 310	293[f] ± 93.7	52.0 ± 67.7	<0.001	<0.001	<0.001
Homocysteine (µmol/L)	8.9[a] ± 1.8	9.1[a] ± 2.3	0.17 ± 1.1	9.3[a] ± 2.4	0.25 ± 1.9	12.6[b] ± 3.8	9.4[a] ± 3.1	- 3.2 ± 3.4	8.9[a] ± 2.3	- 0.56 ± 2.2	< 0.01	<0.001	<0.001
S-adenosyl-homocysteine (nmol/L)	24.7 ± 9.5	23.5 ± 6.9	- 1.15 ± 11.0	23.0 ± 9.4	-0.5 ± 10.6	39.8 ± 18.2	34.6 ± 18.5	- 4.58 ± 15.0 (n = 31)	34.5 ± 15.3	- 0.19 ± 15.8 (n = 31)	< 0.001	0.30	0.71
S-adenosyl-methionine (nmol/L)	102 ± 52.3	113 ± 26.3	6.95 ± 47.8 (n = 20)	109 ± 31.9	1.0 ± 18.4 (n = 20)	133 ± 55.8	156 ± 60.8	13.3 ± 52.7 (n = 25)	133 ± 40.3	- 20.0 ± 48.4 (n = 25)	< 0.001	0.14	0.62
SAM/SAH	4.64 ± 2.30	6.32 ± 5.71 (n = 20)	1.14 ± 5.90 (n = 20)	5.47 ± 2.69	- 0.32 ± 6.17 (n = 20)	3.86 ± 1.77	5.36 ± 2.58 (n = 23)	1.10 ± 3.49 (n = 23)	4.44 ± 1.84	- 0.83 ± 2.86 (n = 23)	0.07	0.05	0.97
Cystathionine (nmol/L)	197[a] ± 72.2	214[a] ± 83.6	16.7 ± 126	221[a] ± 83.1	7.0 ± 134	311[b] ± 139	317[b] ± 169	5.8 ± 118	301[b] ± 129	-16.2 ± 222	<0.001	0.89	0.74
Methylcitric acid (nmol/L)	163[a] ± 43.8	170[a] ± 49.2	7.7 ± 48.7	163[a] ± 46.4	- 7.2 ± 49.9	219[b] ± 66.7	188[a] ± 60.1	-31.8 ± 63.8	175[a] ± 51.1	-12.6 ± 86.6	<0.001	0.05	0.05
Anemic[†] N, (%)**	1 (4) (n=25)	3 (12)	200%	5 (19)	58%	10 (30)	14 (42)	40%	12 (36)	- 14%			
Hemoglobin (g/dL)	13.8 ± 1.3 (n=25)	13.5 ± 1.1	- 0.28 ± 0.51 (n=25)	13.5 ± 1.4	- 0.02 ± 0.53	13.1 ± 1.3	12.7 ± 1.4	- 0.32 ± 0.56	12.8 ± 1.7	0.02 ± 0.67	<0.001	0.38	0.99

	B12 Adequate - Placebo					B12 Deficient* – Given 1,000 µg/d					p-values		
	Time 1	Time 2	Δ	Time 3	Δ	Time 1	Time 2	Δ	Time 3	Δ			
n	26	26		26		33	33		33				
Creatinine (mg/dL)	0.91 ± 0.19 (n=25)	n/a	n/a	n/a	n/a	1.1 ± 0.3	n/a	n/a	n/a	n/a			
N, (%) ≥ 1.4 mg/dL creatinine	1 (4) (n=25)					6 (18)							
MCV (fl)	91.3 ± 3.4 (n=25)	91.4 ± 3.8	0.44 ± 1.9 (n=25)	90.8 ± 4.1	-0.58 ± 1.9	89.5 ± 6.5	89.8 ± 6.7	0.30 ± 1.8	88.8 ± 7.4	-1.0 ± 1.8	0.05	0.73	0.98
Serum folate (nmol/L)	48.75 ± 29.8	52.6 ± 32.0	3.9 ± 26.7	39.4 ± 23.1	-13.23	40.1 ± 29.4	50.3 ± 43.1	10.2 ± 41.3	37.2 ± 21.6	-13.1 ± 30.7	0.35	0.07	0.81
Serum pep (ng/mL)	88.5 ± 54.8 (n=25)	n/a	n/a	n/a	n/a	95.2 ± 53.1	n/a	n/a	n/a	n/a			
MVI use, N (%) [a]	14 (54)	16 (62)	15%	8 (31)	- 100%	8 (24)	8 (24)	-	7 (21)	- 13%			
Intake of synthetic B12 (µg/d)	9.1 ± 12.0	10.3 ± 12.3	1.1 ± 3.9	6.8 ± 12.3	-3.4 ± 7.4	4.7 ± 10.2	5.8 ± 10.6	1.1 ± 5.5	4.0 ± 7.7	-1.8 ± 11.5	0.02	0.45	0.90
N, % ≥ 2.4 µg/d synthetic B12 **	15 (58)	15 (58)	-	8 (42)	- 28%	10 (30)	9 (28)	- 7%	5 (18)	- 36%			
OMC Score	4.8 ± 4.4	3.7 ± 3.7	-1.2 ± 4.0	3.2 ± 3.8	-0.42 ± 3.6	8.0 ± 7.9	6.8 ± 8.0	-1.2 ± 4.2	6.1 ± 8.1	-0.70 ± 4.3	< 0.01	0.35	0.99
Impaired cognition[#], N (%) **	3 (12)	2 (8)	- 33%	3 (12)	50%	11 (33)	10 (30)	- 9%	8 (24)	- 20%			
GDS score	1.6 ± 2.4	1.4 ± 1.8	-0.23 ± 1.3	1.2 ± 1.9	-0.23	1.9 ± 1.9	1.8 ± 2.1	-0.12 ± 1.4	1.5 ± 1.4	-0.30 ± 1.8	0.29	0.46	0.99
GDS[‡] > 5, N (%) **	1 (4)	1 (4)	-	1 (4)	-	1 (3)	1 (3)	-	0				
GDS[‡] ≥ 10, N (%) **	1 (4)	0		0		0	1 (3)		0				

* Based on serum MMA > 271 nmol/L
† Anemic defined as hemoglobin ≤ 12 g/dL for females, ≤ 13 g/dL for males
** Based on chi-square statistic, no significant differences from Time 1 to Time 2 or from Time 2 to Time 3 within groups for these variables
[a] Based on chi-square statistic, MVI use changed significantly from Time 2 to Time 3 in the placebo group
Impaired cognition defined as ≥ 9 on Orientation Memory Concentration test
‡ GDS is Geriatric Depression Scale

CHAPTER 4

CONCLUSION

The purpose of this thesis was to: 1) confirm the high prevalence, risk factors, and health consequences of vitamin B12 deficiency and elevated tHcy in elders in northeast Georgia Older Americans Nutrition Programs, 2) to determine the intake of crystalline vitamin B12 from supplements and fortified foods and the relationship of crystalline vitamin B12 to vitamin B12 status, and 3) to study the effects of high dose crystalline vitamin B12 (1,000 µg/d) on vitamin B12 status in vitamin B12 deficient elders and the effects of 25 and 100 µg/d vitamin B12 in vitamin B12 adequate elders.

Major Findings

Crystalline vitamin B12 was strongly related to serum MMA and tHcy in this sample of older adults receiving congregate meals. In the intervention, low dose vitamin B12 lowered both MMA and tHcy in the normal MMA group, despite apparently adequate vitamin B12 status in these participants. Moreover, in the normal MMA group, a vitamin B12 supplement of 100 µg/d, but not 25 µg/d, significantly decreased tHcy. In the elevated MMA group, 1000 µg/d vitamin B12 lowered tHcy to levels observed in the vitamin B12-adequate groups and this decrease was sustained over time during the intervention. Despite the marked improvement in MMA, tHcy, and serum vitamin B12 in the 1000-µg/d group, there were no improvements in cognition, depression, or anemia.

Implications

The clear association of crystalline vitamin B12 intake with vitamin B12 status in these older adults receiving Older Americans Nutrition services suggests that crystalline vitamin B12 intake in the form of supplements or fortified foods should be encouraged and perhaps made

available to these older adults. Considering that vitamin B12 supplementation is safe and has no apparent toxic effects, and considering the potential benefits vitamin B12 has for the growing number of older adults in the U.S., a national policy of vitamin B12 fortification should be considered as suggested by others (SoRelle, 2002; Ray et al., 2003). Although federal food programs often prohibit the use of funds for nutritional supplements, funds can be used for fortified foods. The purchase of foods fortified with vitamin B12 should be encouraged in Older Americans Nutrition Programs and perhaps the policy against supplements in these programs should be revisited.

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APPENDIX

Text for B12 contrasts

A series of Repeated Measures ANOVAs were conducted to determine between and within group differences. Each variable was measured at 3 different time points, and there was a control (adequate B12) and treatment (receiving 1000mg B12) group.

Homocysteine
For Homocysteine, the authors predicted that the values would remain constant over the three time points for the control group. The initial value for the treatment group would be different; however, at the second and third time point, the hypothesis was that the individuals' values would return to the same level as those in the control group. (ex: AAA, BAA). When a Repeated Measures ANOVA with Helmert orthogonal contrasts was conducted, support the authors' hypothesis was found. There were no within group differences for the Adequate group, $F_{(2,50)} = 1.45$, $p = .244$. The Helmert contrasts for the treatment group were significant for Time 1 vs Time 2 and 3 ($F_{(1,33)} = 35.337$, $p < .0001$), but not for Time 2 vs. Time 3 ($F_{(1,33)} = 1.42$, $p = .24$), confirming that the values at Time 2 and 3 are similar and that they are significantly different from the initial values of Homocysteine at Time 1. Next, we tested the equivalence of the values at Time 2 and 3 for the control and treatment groups. These values at these time points for the groups were not found to be significantly different from each other, $F_{(1,58)} = 0.14$, $p = .882$. To ensure that the values of the control and treatment group were significantly different at Time 1, a t-test was conducted. Significant differences between the initial values of these groups were found ($t_{(55.6)} = 5.11$, $p < .0001$).

Methylcitric acid
For methylcitric acid, the authors predicted that the values would remain constant over the three time points for the control group. The initial value for the treatment group would be different; however, at the second and third time point, the hypothesis was that the individuals' values would return to the same level as those in the control group. (ex: AAA, BAA). When a Repeated Measures ANOVA with Helmert orthogonal contrasts was conducted, support the authors' hypothesis was found. There were no within group differences for the Adequate group, $F_{(2,50)} = 0.75$, $p = .476$. The Helmert contrasts for the treatment group were significant for Time 1 vs Time 2 and 3 ($F_{(1,33)} = 15.37$, $p < .0001$), but not for Time 2 vs. Time 3 ($F_{(1,33)} = 1.05$, $p = .314$), confirming that the values at Time 2 and 3 are similar and that they are significantly different from the initial values of Homocysteine at Time 1. Next, we tested the equivalence of the values at Time 2 and 3 for the control and treatment groups. These values at these time points for the groups were not found to be significantly different from each other, $F_{(1,58)} = 2.06$, $p = .157$. To ensure that the values of the control and treatment group were significantly different at Time 1, a t-test was conducted. Significant differences between the initial values of these groups were found ($t_{(55.6)} = 6.19$, $p < .0001$).

MMA
The authors predicted that the values for MMA would be different at each time point and for each group, ex (ABC, DEF). The log was taken for each MMA value and used in the analyses. For both the adequate B12 (control) and treatment (1000mg B12) groups, Repeated Measures ANOVAs with Helmert orthogonal contrasts were conducted. The results showed that Time 1 for the control group was significantly different from Time 2 and Time 3 ($F_{(1,25)} = 21.97$, $p <$

.0001), and that there was a significant difference between Time 2 and Time 3 in the control ($F_{(1,25)} = 10.82$, $p = .003$). Similar results were found when Repeated Measures ANOVAs were conducted within the treatment group, Time 1 vs Time 2 and Time 3 ($F_{(1,33)} = 6.88$, $p < .0001$), and Time 2 versus Time 3 ($F_{(1,33)} = 1.27$, $p < .0001$). Overall, there was a significant interaction between time and treatment for MMA ($F_{(2,66)} = 27.60$, $p < .0001$).

Serum B12

For Serum B12, the authors predicted that the values would remain constant over the three time points for the control group. All three values for the treatment group were hypothesized to be different. (ex: AAA, BCD). When a Repeated Measures ANOVA with Helmert orthogonal contrasts was conducted, support the authors' hypothesis was found. There were no within group differences for the Adequate group, $F_{(2,50)} = 1.13$, $p = .332$. The Helmert contrasts for the treatment group were significant for Time 1 vs Time 2 and 3 ($F_{(1,33)} = 39.86$, $p <. 0001$), as well as between Time 2 and Time 3 ($F_{(1,33)} = 5.50$, $p= .025$), confirming that the Serum B12 values at Time 1, Time 2, and Time 3 are all significantly different from each other. Significance was also found in the overall model for a time by treatment interaction, $F_{(2,66)} = 33.10$, $p < .0001$.

Cystathionine

The authors' hypothesis for the cystathionine values was that the control group and the treatment group remain constant over the three time points. However, the values for each of these groups were predicted to be significantly different from each other. These results were confirmed in the analyses. Repeated Measures ANOVAs were conducted to determine between and within group differences. No significant differences were found within the adequate group over time ($F_{(2,50)} = 1.07$, $p = .350$), nor within the treatment group ($F_{(2,66)} = 0.15$, $p = .864$).

FORM B

NUTRITION, HEARING, AND MEMORY STUDY
CONSENT FORM

I,_____agree to participate in the research titled "NUTRITION, HEARING, AND MEMORY" conducted by Drs. Mary Ann Johnson, Albert DeChicchis, and L. Stephen Miller in the Departments of Foods and Nutrition, Communication Sciences and Disorders, and Psychology at the University of Georgia.

I understand that I do not have to take part if I do not want to. I can stop taking part without giving any reason, and without penalty. I can ask to have all of the information about me returned to me, removed from the research records, or destroyed. My decision to participate will not effect the services that I receive at the Senior Center.

The reason for this study is to learn more about nutrition and health, and to determine if taking a vitamin B-12 supplement will help me hear better and improve my memory. If I volunteer to take part in this study, I will be asked to do the following things:

1) **Answer questions about my food, nutrition, and health.**
2) **Have my hearing tested.**
3) **Have my memory and thinking tested with a computer based test.**
4) **A medical technologist will take 4 7-10 ml tubes of blood to measure my blood sugar, cholesterol, vitamins and minerals. My blood sample will be destroyed within 10 years.**
5) **Have my blood pressure taken.**
6) **I will take a vitamin B-12 supplement (up to 1,000 mcg/day) or a placebo (a pill without vitamin B-12) for 4 months to see if it helps me hear and think better.**
7) **After 4 months, all of the questions and tests related to health, food, nutrition, hearing, and memory, and the blood tests will be repeated.**
8) **If my tests show that I have depression, I will be notified and referred for treatment.**
9) **Someone from the study may call me to clarify my information.**

If I am found to have vitamin B-12 deficiency, my physician and I will be notified. I will given vitamin B-12 (1,000 mcg/day as a tablet) as part of this study. If my doctor treats me with vitamin B-12 (pill or shots) I can still continue in this study, and will not need to take the vitamin B-12 supplement provided by this study.

I will receive $25 after completing all the test the first time, and another $25 after taking vitamin B-12 (or the placebo) for 4 months and repeating the tests a second time.

My blood will not be tested for HIV-AIDS. I understand that these questions and blood tests are not for diagnostic purposes. If I have questions about my test results I should see a physician. The benefits for me are that the study may help me understand and improve my health.

No risk is expected but I may experience some discomfort or stress when my hearing is tested (because of the ear plugs), when my blood is drawn or when the researchers ask me questions about my health, memory and nutrition. The risks of drawing blood from my arm include the unlikely possibilities of a small bruise or localized infection, bleeding, and fainting. These risks will be reduced in the following ways: my blood will be drawn only by a qualified and experienced person who will follow standard sterile techniques, who will observe me after the needle is withdrawn, and who will apply pressure to the blood draw-site. In the event that I have any health problems associated with the blood draws, my insurance or I will be responsible for any related medical expenses.

No information about me, or provided by me during the research, will be shared with others without my written permission, except if it is necessary to protect my welfare (for example, if I need physician care) or if required by law. I will be assigned an identifying number and this number will be used on all of forms I fill out.

If I have any further questions about the study, now or during the course of the project I can call Mrs. Nikki Hawthorne 706-542-4838 or Dr. Mary Ann Johnson 706-542-2292.

I give my permission for you to release my blood analysis information to my health care providers.
Circle one: YES / NO. Initial _____.

I give my permission for you to release my hearing results to my health care providers.
Circle one: YES / NO. Initial _____.

I give my permission for you to release my memory test results to my primary physician.
Circle one: YES / NO. Initial _____.

I will allow the staff to take my picture, videotape or record me while participating in the study. I can verbally refuse at anytime and my wishes will be upheld. My pictures will only be used to promote this nutrition, hearing, and memory study.
Circle one: YES / NO. Initial _____.
I understand that I am agreeing by my signature on this form to take part in this project and understand that I will receive a signed copy of this consent form for my records.

_____
__
Project Coordinator Date Signature of Participant Date

_____
__
Phone Number Address

Questions or problems regarding your rights as a participant should be addressed to Ms. Julia Alexander; Institutional Review Board; Office of V.P. for Research; The University of Georgia; 604A Graduate Studies Research Center; Athens, GA 30602-7411; Telephone 706-542-6514.

revised 00/13/12

UGA project number:H1998-10501-4
DHR project number: 000904

FORM D

NUTRITION, HEARING, AND MEMORY STUDY
CONSENT FORM

I,_____agree to participate in a continuation to the research titled "NUTRITION, HEARING, AND MEMORY" conducted by Drs. Mary Ann Johnson, Albert DeChicchis, and L. Stephen Miller in the Departments of Foods and Nutrition, Communication Sciences and Disorders, and Psychology at the University of Georgia.

I understand that I do not have to take part if I do not want to. I can stop taking part without giving any reason, and without penalty. I can ask to have all of the information about me returned to me, removed from the research records, or destroyed. My decision to participate will not effect the services that I receive at the Senior Center.

The reason for this continuation to this study is to learn more about nutrition and health, and to determine if taking a vitamin B-12 supplement will help improve my memory. If I volunteer to take part in this study, I will be asked to do the following things:

10) **Answer questions about my food, nutrition, and health.**
11) **Have my memory and thinking tested with a computer based test.**
12) **A medical technologist will take 2 7-10 ml tubes of blood to measure my vitamin B-12 status. My blood sample will be destroyed within 10 years.**
13) **Have my blood pressure taken.**
14) **I will take a vitamin B-12 supplement (up to 1,000 mcg/day) or a placebo (a pill without vitamin B-12) for 6 months to see if it helps me think better.**
15) **If my tests show that I have depression, I will be notified and referred for treatment.**
16) **Someone from the study may call me to clarify my information.**

I will receive $25 after completing all of the testing.
My blood will not be tested for HIV-AIDS. I understand that these questions and blood tests are not for diagnostic purposes. If I have questions about my

test results I should see a physician. The benefits for me are that the study may help me understand and improve my health.

No risk is expected but I may experience some discomfort or stress when my blood is drawn or when the researchers ask me questions about my health, memory and nutrition. The risks of drawing blood from my arm include the unlikely possibilities of a small bruise or localized infection, bleeding, and fainting. These risks will be reduced in the following ways: my blood will be drawn only by a qualified and experienced person who will follow standard sterile techniques, who will observe me after the needle is withdrawn, and who will apply pressure to the blood draw-site. In the event that I have any health problems associated with the blood draws, my insurance or I will be responsible for any related medical expenses.

No information about me, or provided by me during the research, will be shared with others without my written permission, except if it is necessary to protect my welfare (for example, if I need physician care) or if required by law. I will be assigned an identifying number and this number will be used on all forms I fill out.

If I have any further questions about the study, now or during the course of the project I can call Mrs. Nikki Hawthorne 706-542-4838 or Dr. Mary Ann Johnson 706-542-2292.

I give my permission for you to release my blood analysis information to my health care providers.
Circle one: YES / NO. Initial _____.

I give my permission for you to release my memory test results to my primary physician.
Circle one: YES / NO. Initial _____.

I will allow the staff to take my picture, videotape or record me while participating in the study. I can verbally refuse at anytime and my wishes will be upheld. My pictures will only be used to promote this nutrition, hearing, and memory study.
Circle one: YES / NO. Initial _____.
I understand that I am agreeing by my signature on this form to take part in this project and understand that I will receive a signed copy of this consent form for my records.

_____

Project Coordinator Date Signature of Participant Date

_____

Phone Number Address

Questions or problems regarding your rights as a participant should be addressed to Dr. Chris Joseph; Institutional Review Board; Office of V.P. for Research; The University of Georgia; 604A Graduate Studies Research Center; Athens, GA 30602-7411; Telephone 706-542-6514.

UGA project number:H1998-10501-4
DHR project number: 000904

5/16/01

Department of Foods and Nutrition
University of Georgia
390 Dawson Hall
Athens, GA 30602

Date: _____

Dear _____:

We are so pleased that you are participating in our study "Vitamin B-12 Deficiency in Elderly Nutrition Programs." We look forward to seeing you again in four months to repeat the hearing tests, memory tests, blood tests, and nutrition questions. As a service to our participants we are sending you a copy of your blood work and nutritional status report. These tests are not for diagnostic purposes. If you have any questions about your results, you should call your physician. Your physician will also receive a copy of your blood work, hearing tests, and memory tests.

If you have any questions, please contact me at 706-542-4838.

Sincerely,

Nikki Hawthorne, MS, RD, LD.
Research Coordinator

Enc.

Department of Foods and Nutrition
University of Georgia
390 Dawson Hall
Athens, GA 30602

Date: _____

Dear _____:

We are so pleased that you are participating in our study "Vitamin B-12 Deficiency in Elderly Nutrition Programs." We look forward to seeing you again in four months to repeat the hearing tests, memory tests, blood tests, and nutrition questions. As a service to our participants, we are sending you a copy of your blood work and nutritional status report.

These tests are not for diagnostic purposes. However, the methylmalonic acid test of your blood indicates that you might be deficient in vitamin B-12. As part of this study, we are giving you a daily supplement of vitamin B-12 (1 milligram) which should improve your vitamin B-12 status if taken daily. Your physician will also receive a copy of your blood work, hearing tests, and memory tests. Your physician may decide to give you vitamin B-12 which will not in any way interfere with this study. If you have any questions about your results, please call your physician and please follow your physicians' advice.

If you have any questions, please contact me at 706-542-4838.

Sincerely,

Nikki Hawthorne, MS, RD, LD.
Research Coordinator
Enc.

Department of Foods and Nutrition
University of Georgia
390 Dawson Hall
Athens, GA 30602

Date: _____

Dear Physician:

Your patient, _____, has recently enrolled in the research study titled "Vitamin B-12 Deficiency in Elderly Nutrition Programs" with the Department of Foods and Nutrition at the University of Georgia. As a service to our participants, we are providing their physicians with copies of blood work, nutrition status report, hearing tests, and memory tests. Any critical values have been reported previously to your office. We do not provide a diagnosis based on the results of their blood work. However, based on the serum methylmalonic acid, it is possible that this patient is vitamin B-12 deficient (> 271 nmol/L indicates possible vitamin B-12 deficiency). Your patient's serum methylmalonic acid is _____nmol/L. These analyses were performed by Dr. Sally P. Stabler, MD, Co-Director of Hematology, University of Colorado Health Sciences Center, Denver, CO. As part of this research study, we have given your patient an oral supplement of vitamin B-12 (1 mg) to be taken daily. Oral vitamin B-12 has been shown to reverse vitamin B-12 deficiency (see enclosure). Your follow-up and treatment of possible vitamin B-12 deficiency in this patient is welcome and will not in any way interfere with this ongoing study.

If you have any questions, please contact me at 706-542-2292.

Sincerely,

Mary Ann Johnson, Ph.D.
Professor of Foods and Nutrition
& Faculty of Gerontology

Enc.

Department of Foods and Nutrition
University of Georgia
390 Dawson Hall
Athens, GA 30602

Date: _____

Dear Physician:

Your patient, _____, has recently enrolled in the research study titled "Vitamin B-12 Deficiency in Elderly Nutrition Programs" with the Department of Foods and Nutrition at the University of Georgia. As a service to our participants, we are providing their physicians with copies of blood work, nutrition status report, hearing tests, and memory tests. Any critical values have been previously reported to your office. We do not provide a diagnosis based on the results of their blood work.

If you have any questions, please contact me at 706-542-2292.

Sincerely,

Mary Ann Johnson, Ph.D.
Professor of Foods and Nutrition
& Faculty of Gerontology

Enc.

Department of Foods and Nutrition
University of Georgia
390 Dawson Hall
Athens, GA 30602-3622

June 2, 2001

Dear _____:

We would like to congratulate and thank you for participating in our study "Vitamin B-12 Deficiency in Elderly Nutrition Programs." More than 220 people had their ears examined and 150 people enrolled in the study and are taking a supplement.

As a service to our participants we are sending you a copy of your nutritional status report and two copies of your blood work. The extra copy can be given to your physician. These tests are not for diagnostic purposes. If you have any questions about your results, you should contact your physician.

Please continue to take your vitamins. We plan to continue the study. It is possible you might qualify and be given more supplements, so please continue to take your remaining vitamins.

We will let you know what supplement you were taking and issue the results of the study in the year 2002. Again, we thank you for participating and look forward to seeing you at the senior center soon. If you have any questions please feel free to contact us at 706-542-4838.

Sincerely,

Nikki Hawthorne, MS, RD, LD.

Enc.

October 23, 2001

Dear Physician:

Your patient, _____, has enrolled in the research study titled "Vitamin B-12 Deficiency in Elderly Nutrition Programs" with the Department of Foods and Nutrition at the University of Georgia. As a service to our participants, we are providing their physicians with copies of blood work. Any critical values have been previously reported to your office. We do not provide a diagnosis based on the results of their blood work. We gave your patient vitamin B-12 supplements (1000mcg) for 3 months, but their methylmalonic acid is still indicating a vitamin B-12 deficiency
(> 271 nmol/L indicates possible vitamin B-12 deficiency). Your patient's methylmalonic acid is _____nmol/L. These analyses were performed by Dr. Sally P. Stabler, MD, Hematologist at the University of Colorado. We are encouraging them to continue taking the supplements however, your treatment of possible vitamin B-12 deficiency in this patient is welcome and will not in any way interfere with this ongoing study.

If you have any questions, please feel free to contact me at 706-542-2292.

Sincerely,

Mary Ann Johnson, Ph.D.
Professor of Foods and Nutrition
& Faculty of Gerontology

Enc.

NUTRITION, HEARING, AND MEMORY AMONG SENIOR CENTERS IN NORTHEAST GEORGIA

2001

Vitamin B-12 Study Checklist
ID:_____

Questionnaire	PRE TEST		POST TEST		Flagged-Explain
	Date Completed	**Initials**	**Date Completed**	**Initials**	
Consent Form					
Blood Drawn					
General Information					
Sun Exposure					
Blood Pressure (Gave Blood Pressure Form to participant)					
Orientation/Memory Test					
Nutritional Screening Initiative					
MNA					
Nutrition Questions					
Illnesses					
Medications					
Supplements: Explained & Date Started					
Supplements: Stopped					
Nutritional Status Report - Sent to Individual					
Hearing History Questionnaire (HHQ)			**(E) ONLY**		
Hearing Handicap Inventory for adults (HHIA)					

Noise Exposure History					
Hearing Evaluation					
Cognition/computer -prompted test					
Geriatric Depression Scale					

7
Flagged Notes:

_____
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Revised 00/09/13

GENERAL INFORMATION **ID: _____**
(1-3)

_ _ _ _ _ _ (10-15) **1. Today's date: ___ / ____ / ____** ***Month/Day/Year***

__ (16) **2. This information was obtained from:**
0 _____ Client
1 _____ Senior center staff person
2 _____ Family member of client
3 _____ Caregiver for client
4 _____ Other: _____

__ __ . __ (17-20) **3. How long has the client been using the services of the senior center?**
___ ___.___ years *Code as years (xx.x years)*

_ _ _ _ _ _ _ _ (21-28) **4. Date of birth: ___ / ____ / ____** ***Month/Day/Year***

__ __ __ (29-31) **5. Current age: _____** years *Example: age 75 is 075*

__ (32) **6. Gender:** _____ Male (0) _____ Female (1)

__ (33) **7. Ethnicity:** _____ Caucasian (0) _____ Black (1) _____ Hispanic (2)
_____ Asian (3) _____ Other (4)

__ __ (34-35) **8. Years completed in school?** _____ Years

__ (36) **9. Do you take a multiple-vitamin/mineral supplement?** _____ No (0) ____ Yes (1)

__ (37) **10. Do you take any other nutritional supplements that contain vitamins or minerals?**

_____ No (0) _____ Yes (1)

*** Health Care Provider _____**

Address_____

_____

Phone_____

*** Care giver/ Next of Kin**

(1) _____ Phone_____

Address_____

__ __ **38-39** **11. How many hours ago did you last eat?** _____ (code number of hours ago).

__ **40** **12. Fasting status (coded by medical technologist).**

0 Not fasted, food in the last 4 hours
1 Fasted, food not eaten in the past 4 hours

__ **41** **13. How would you rate your overall health at the present time -- excellent, good, fair, or poor?**

3 Excellent
2 Good
1 Fair
0 Poor
9 Not answered

__ **42** **14. Is your health now better, about the same, or worse than it was five years ago?**

2 Better
1 About the same
0 Worse
9 Not answered

__ **43** **15. How much do your health troubles stand in the way of your doing things you want to -- not at all, a little (some), or a great deal?**

2 Not at all
1 A little (some)
0 A great deal
9 Not answered

__ __ **44-45** **16. County of residence** **00-12**

00= Madison	03= Jackson	06= Greene	09= Elbert	12=Franklin
01= Morgan	04= Newton	07= Clark	10= Oconee	
02= Walton	05= Barrow	08= Oglethorpe	11= Jasper	

__ **18. Did you participate in our vitamin supplement study during spring and summer 1999?**

46 ***(ASK ONLY IN GREENE AND MORGAN COUNTY)***

1= YES
0= NO

SUN EXPOSURE

__
47

19. How many minutes of sun exposure do you get each week?

__ (0) < 9 minutes/week
__ (1) 10-30 minutes/week
__ (2) 30-59 minutes/week
__ (3) 60-89 minutes/week
__ (4) 90-119 minutes/week
__ (5) 120 (2 hours) or more minutes/week
__ (8) do not know
__ (9) missing

__
48

20. How often do you use sunscreen when you go outside?

__ (0) Rarely/Never
__ (1) Sometimes
__ (2) Always
__ (8) Not applicable; does not go outside
__ (9) Missing

__
49

21. If you use sunscreen, what level do you use?

__ (0) Don't know
__ (1) SPF 4 or less
__ (2) SPF 6 or 8
__ (3) SPF 10
__ (4) SPF 15
__ (5) SPF 30 and up
__ (8) Doesn't use
__ (9) Missing

BLOOD PRESSURE

(NOTE: RECORD RESULTS ON "BLOOD PRESSURE FORM" AND GIVE TO PARTICIPANT)

__ __ __
50-52

22. Blood Pressure

Systolic (mmHg)

__ (0) < 120 Optimal
__ (1) < 130 Normal
__ (2) 130-139 High-normal
__ (3) 140-159 Mild Hypertension (Stage 1)
__ (4) 160-179 Moderate Hypertension (Stage 2)
__ (5) > 180 Severe Hypertension (Stage 3)
__ (999) Missing

Diastolic (mmHg)

__ __ __
53-55

__ (0) < 80 Optimal

__ (1) < 85 Normal
__ (2) 85-95 High-normal
__ (3) 90-99 Mild Hypertension (Stage 1)
__ (4) 100-109 Moderate Hypertension (Stage 2)
__ (5) > 110 Severe Hypertension (Stage 3)

ORIENTATION-MEMORY-CONCENTRATION TEST

Read all questions to the participant. Tell them that some of the questions may be easy and some may be hard -- just do the best you can.

	Response	# of Errors	Max. Errors	Weight Factor	Total
1) What is the year now?			**1**	**4**	
2) What month is it now?			**1**	**3**	
Please repeat this phrase after me: **JOHN BROWN, 42 MARKET STREET, CHICAGO** *No score for this -- it is a memory phrase for Item # 6. Allow the person up to three trials for learning (repeating) the phrase. If the subject has not learned the phrase after three trials, record the value of "0" as the total score for Item #6, and proceed to Item #3.*					
3) Without looking at your watch or a clock, tell me about what time is it? *Note: score is correct if within one hour of actual time.*			**1**	**3**	
4) Count backwards from 20 to 1. *20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1*			**2**	**2**	
5) Say the months of the year in reverse order. *DEC, NOV, OCT, SEPT, AUG, JULY, JUNE, MAY, APR, MAR, FEB, JAN*			**2**	**2**	
6) Please repeat the name and address I asked you to remember. *Count the number of items (5) in memory phrase recalled incorrectly. An answer of either Market or Market Street is acceptable.* John / Brown / 42 / Market Street / Chicago			**5**	**2**	

(10-11) **TOTAL SCORE**					

Interpretation of corrected scores:

≤ 8	Normal or minimal impairment
9-19	Moderate impairment
≥ 20	Severe impairment

Source: Katzman, R., Brown, T., Fuld, P., Peck, A., Schechter, R., Schimmel, H. Validation of a short orientation-memory-concentration test of cognitive impairment. *American Journal of Psychiatry* 140: 734-739, 1983.

NUTRITIONAL HEALTH: Nutritional Screening Initiative Questionnaire

ID: _____

No=0
Yes=

____ (10) NH1. I have an illness or condition that made me change the kind and/or amount of food I eat.....Yes / No (2)

____ (11) NH2. I eat fewer than 2 meals per day.....Yes / No (3)

____ (12) NH3. I eat few fruits or vegetables, or milk products.....Yes / No (2)

____ (13) NH4. I have 3 or more drinks of beer, liquor or wine almost every day.....Yes / No (2)

____ (14) NH5. I have tooth or mouth problems that make it hard for me to eat .....Yes / No (2)

____ (15) NH6. I don't' always have enough money to buy the food I need.....Yes / No (4)

____ (16) NH7. I eat alone most of the time.....Yes / No (1)

____ (17) NH8. I take 3 or more different prescribed or over-the-counter drugs a day....Yes / No (1)

____ (18) NH9. Without wanting to, I have lost or gained 10 pounds in the last 6 months.....Yes / No (2)

____ (19) NH10. I am not always physically able to shop, cook, and/or feed myself.....Yes/No (2)

Your Nutritional Score is: _____. If it's: (20-21)

0-2 **Good.** Recheck your nutritional score in 6 months.

3-5 **You are at moderate nutritional risk.** See what can be done to improve your eating habits and lifestyle. Your office on aging, senior nutrition program, senior citizens center or health department can help. Recheck your nutritional score in 3 months.

6 or more. **You are at high nutritional risk.** Bring this checklist the next time you see your doctor, dietitian or other qualified health or social service professional. Talk with them about any problems you may have. Ask for help to improve

MINI-NUTRITIONAL ASSESSMENT

ID# _____
(1-3)

Name: First name: Sex: Date:
Age:

04 *** enter decimal points*
(4-5)

TSF. Triceps skin fold (mm): __ __.__
(6-9)

Kneeht. Knee Height (cm): __ __.__
(10-13)

I. ANTHROPOMETRIC ASSESSMENT

____ MNA1. BMI (weight/(height)^2 in kg/m^2); weight = _____ lbs. / 2.205 = __ __ __ . __kg
(14) *0 = BMI < 19* height = _____ in. * .0254 = __ __ __ . __ meters
1 = 19 ≤ BMI < 21 BMI = __ __ . __
2 = 21 ≤ BMI < 23
3 = BMI ≥ 23

_____ MNA2. Mid arm circumference (MAC in cm.): __ __ . __ cm.
(29) *0.0 = MAC < 21*
0.5 = 21 ≤ MAC ≤ 22
1.0 = MAC > 22

_____ MNA3. Calf circumference (CC in cm.): __ __ . __cm.
(34) *0 = CC < 31*
1 = CC ≥ 31

_____ MNA4. Weight loss during last 3 months: _____ lbs. / 2.205 = __ __ __ . __ kg (40-44)kg
(39) *0 = weight loss > 3 kg*
1 = does not know
2 = weight loss between 1 and 3 kg
3 = no weight loss

_____ MNA12A. How many servings of milk, yogurt, or cheese does the individual consume?
(45)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

_____ MNA12D. How many servings of meat, fish, or poultry does the individual consume?
(46)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day

NUTRITION QUESTIONS

1. Have you ever received home delivered meals?

47 0 = Yes
1 = No

__ __ **2. If you receive home delivered meals, for how long have you been receiving them?** ___

48-49 ___ ***years***
Code as whole years (xx years)

50 **3. How many times a week do you eat at the senior center?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

4. How many servings of green vegetables do you eat?

51

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

5. How many servings of orange or yellow vegetable do you eat?

52

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

6. How many servings of citrus fruit or citrus juice do you eat (e.g., orange, grapefruit)?

53

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

__
54 **7. How many servings of other non-citrus fruit or juice do you consume?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

__
55 **8. How many servings of liver (eg., beef, chicken,pork) do you consume?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

FOODS FORTIFIED WITH B-VITAMINS

We would like to know if you eat any of the following foods that may be fortified with B-vitamins

				Code daily intake of vit. B12 from each source.	**Code daily intake of folate from each source.**	**Code daily intake of vit. B6 from each source.**
8. Breakfast cereals, such as, Just Right w/ fruits & nuts, Product 19, Nutri-Grain, Total, Special K	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast cereal?**			
9. Breakfast or energy bars, such as, Nutri-Grain, power bar,	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast bars?**			
10. Liquid meal replacements, such as, carnation, ensure plus	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually drink?**	**If yes, how often do you drink ensure, or boost etc.?**			
Other	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat this food?**			
Other	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat this food and in what quantity?**			

Complete the following questionnaire to find out your risk for developing osteoporosis.

Question	Yes	No
1. Are you a postmenopausal women?		
2. If you are a postmenopausal woman, did you have an early (before 50 years old) menopause or surgically induced menopause?		
3. If you are a postmenopausal women, are you taking Hormone Replacement Therapy such as Raloxifene, Draloxifene, Premarin, Prempo?		
4. Do you have a small, thin frame?		
5. Has anyone in your family (father, mother, sister, brother) ever had a fracture or broken bone after age 50?		
6. Have you had a fall within the past 1 year?		
7. Have you had a fracture or broken bone after age 50?		
8. Do you eat at least 2 servings of dairy products such as milk, yogurt, or cheese everyday?		
9. Do you eat salmon at least twice a week?		
10. Do you eat calcium-rich green vegetables such as mustard, turnip, or collard greens everyday?		
11. Do you drink calcium-fortified juice everyday?		
12. Do you eat calcium-fortified cereals (such as Total, Kellogg's K) everyday?		
13. Do you take a calcium and vitamin D supplement everyday?		
14. Have you been taking excessive thyroid medication or high or prolonged doses of cortisone-like drugs for asthma, arthritis, or cancer?		
15. Do you currently or did you ever smoke cigarettes, pipes, cigars or chew tobacco on a daily basis?		
16. Do you exercise at least 30 minutes everyday?		

(NOTE: COPY THIS INFORMATION FROM PREVIOUS QUESTIONS)

17. Age : _____ years old
18. Gender : Male Female (please circle)
19. Ethnicity : White Black Hispanic Asian Others (please circle)
20. County : _____
21. Height : _____ feet _____ inches OR _____ cm
22. Weight : _____ pounds OR _____ kg

Is height and weight measured or self-reported?

MEDICATIONS AND ILLNESSES
NAME/ID: _____

Obtain information from reliable source. This information was provided by: client, caretaker, other___?

	YES (1)	NO (0)	DON'T KNOW	Space
Total number of PRESCRIPTION medications				10-11
Total number of NON -PRESCRIPTION medications, not counting vitamins and minerals				12-13
Multiple vitamin mineral supplement? 0 = no, 1 = yes				14
Number of other nutritional supplements?				15
Total number of illnesses - fill in when finished below.				16-17
1) Anemia in the past year				18
2) Alzheimer's: Kind_____; Dx date_____				19
3) Other dementias: Kind_____; Dx date _____				20
4) Cancer: Kind_____; Dx date_____; Status_____				21
5) Circulatory problems in the past year				22
6) Congestive heart failure in the past year				23
7) Constipation in the past year				24
8) Diabetes: Kind_____; Dx date _____				25
9) Diarrhea in the past year				26
10) Glaucoma in the past year				27
11) Hearing problems in the past year				28
12) Heart disease in the past year				29
13) Hypertension in the past year				30
14) Legally blind in the past year				31
15) Liver disease in the past year				32
16) Mental illness: Kind_____; Dx date_____				33
17) Osteoporosis in the past year				34
18) Hip fracture in the past year				35
19) Have you every had a pace maker				36
20) Parkinson's disease: Dx date_____				37
21) Renal disease in the past year				38
22) Respiratory disease in the past year				39
23) Seizures: 1st date_____; last date_____				40
24) Skin rashes, bed sores in the past year				41
25) Stroke: Number_____; Dates_____				42
26) Thyroid problems: Kind_____; Dx date_____				43
27) Visual disturbances in the past year				44
28) Cataracts in the past year				45
29) Have you used any type of tobacco in the past year				46
30) Have you every had stomach surgery				47
31) Emergency room visit in the past year				48
32) Other				49
33) Arthritis in the past year				50
34) Pneumonia in the past year				51

MEDICATIONS *(NOTE: ASK EVERY MEDICATION QUESTION THEN RECORD MEDS ON THE NEXT FORM)*			
1)	Are you currently taking aspirin?	1 = Yes 0 = No	10
2)	Are you currently taking ibuprofen such as Advil, Motrin, Nuprin?	1 = Yes 0 = No	11
3)	Are you currently taking Aleve?	1 = Yes 0 = No	12
4)	Are you currently taking Acetaminophen such as Tylenol or similar medication?	1 = Yes 0 = No	13
5)	Are you currently taking antacids or medications for heartburn or indigestion such as maalox, mylanta, alka aid (alka-seltzer) gaviscon, propulsid, zantac, pepcid, axid, cyotec, tums, tagamet, proton pump inhibitors such as prevacid, prevapac,prilosec, or other medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	14
6)	Are you currently taking laxatives such as milk of magnesia, fiber tablets, metamucil or other laxative medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	15
7)	Are you currently taking a cough suppressant such as humibid, robitussin, entrex or other medication?	1 = Yes 0 = No	16
8)	Are you currently taking allergy, sinus, or cold medication such as chlorpheniramine, relief, allerfed, seldane, sudafed, sine aid, Tylenol allergy sinus, contac, tylenol cold formulas, methypred dose, claritin, phenylprop, guaif, bromfed, tavist-d, actifed, benadryl, equate allergy sinus or other medication?	1 = Yes 0 = No	17
9)	Are you currently using nasal spray for allergy or sinus, such as aerobid, flonase, beconase, Nasalcrom or other medication?	1 = Yes 0 = No	18
10)	Are you currently taking a non-steroidal anti-inflammatory drug (NSAID) such as voltaren, diclofenac, naprosyn, naproxyn, sulindac, lodine, relafen, daypro, oruvail or similar medication?	1 = Yes 0 = No	19
11)	Are you currently taking a pain medication such as ultram, darvocet-N-100, fiorinal or similar medication?	1 = Yes 0 = No	20
12)	Are you currently taking an arthritis medication such as prednisone, rheumatrex methotrexate, orasone, deltasone or other medication?	1 = Yes 0 = No	21
13)	Are you currently taking antibiotics such as zithromax, amoxicillin or other antibiotic medication?	1 = Yes 0 = No	22
14)	Are you currently taking a sleeping aid such as Tylenol PM or other medication?	1 = Yes 0 = No	23

	MEDICATIONS		
15)	Are you currently taking migraine medication such as mepergan fortis, imitrex, ercaf, Forbal-S or other migraine medication?	1 = Yes 0 = No	24
	# 16 and #18 - important for cognitive tests - so probe carefully		
16)	Are you currently taking anti-anxiety medication such as Alprazolam (xanax), Buspirone (Buspar), Chlordiaxepoxide (Librium), Clonazepam (klonopin), Clorazepate (tranxene), Diazepam (Valium), Hydroxyzine (Vistaril), Lorazepam (Ativan), Oxazepam (Serax), Propanolol (Inderal) or other anti-anxiety medication? **Circle all that apply**	1 = Yes 0 = No	25
17)	Are you currently taking anti-depressant medication such as Amitriptyline (Elavil), Citalopram (Celexa), Clomipramine (Anafranil), Desipramine (Norpramin), Doxepin (Sinequan), Fluoxetine (Prozac), Fluvoxamine (Luvox), Imipramine (Tofranil), Maprotiline (Ludiomil), Nortriptyline (Pamelor), Paroxetine (Paxil), Sertraline (zoloft), Trazadone (Desyrel), Venlafaxine (Effexor) or other anti-depressant medication? **Circle all that apply**	1 = Yes 0 = No	26
	#41 & 42 - important for cognitive tests - so probe carefully		
41)	Are you currently taking any drugs to help or enhance your thinking such as Chlorpromazine (Thorazine), Thioridazine (Mellaril), Fluphenazine (Prolixin), Trifluoperazine (Stelazine), Haloperidol (Haldol), Thiothixene (Navane), Loxapine (Loxitane), Molindone (Moban), Clozapine (Clozaril), Risperidone (Risperdal), Quetiapine (Seroquel), Olanzapine (Zyprexa) or other neuroleptic medications? **Circle all that apply**	1 = Yes 0 = No	27
42)	Are you currently taking any drugs to help or enhance your memory such as Tacrine (Cognex) or Donepezil hydrochloride (Aricept)? **Circle all that apply**	1 = Yes 0 = No	28
43)	List any other medications currently taken:	1 = Yes 0 = No	29
45)	Are you currently receiving Vitamin B-12 injections/shots? Last Vitamin B-12 shot (date) : _____ How often? _____(*example: once a year, twice a year, every other month, once a month) 762* ***(NOTE: IF YES, THEY NEED TO HAVE HAD A SHOT 6 MONTHS AGO OR LATER AND AGREE NOT TO RECEIVE A SHOT FOR THE NEXT FOUR MONTHS TO PARTICIPATE IN THIS STUDY)***	1 = Yes 0 = No	30
	Total number of prescription medications *(total of prescription meds)*		31-32
	Total number of non-prescription medications *(total of nonprescription meds)*		33-34

RESIDENT MEDICATION RECORDS:
Include prescription, non-prescription, and vitamins/minerals

ID _____

Medication	Dosage	Schedule	Route of Administration	*How Long have you been taking medication	DOCUMENTATION (Check all that apply)		
					Bottle only	Cardex Record	Signature Administration Record

	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	***TOTAL***
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	
Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	

Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						
	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	***TOTAL***
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	

Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						

HEARING HANDICAP INVENTORY FOR ADULTS (HHIA)

Date: _____ ID: _____

The purpose of these questions is to identify any problems your hearing loss may be causing you. Please do not skip any questions. Even if you feel you do not have a hearing loss, please answer all of the questions. For each question, circle one response: No, Sometimes, or Yes.

		0	2	4	Line Space Line # 4-5
S1	Does a hearing problem cause you to use the phone less often than you would like?	No	Sometimes	Yes	10
E2*	Does a hearing problem cause you to feel embarrassed when meeting new people?	No	Sometimes	Yes	11
S3	Does a hearing problem cause you to avoid groups of people?	No	Sometimes	Yes	12
E4	Does a hearing problem make you irritable?	No	Sometimes	Yes	13
E5*	Does a hearing problem cause you to feel frustrated when talking to members of your family?	No	Sometimes	Yes	14
S6	Does a hearing problem cause you difficulty when attending a party?	No	Sometimes	Yes	15

S7	Does a hearing problem cause you difficulty hearing/understanding coworkers, clients, or customers?	No	Sometimes	Yes	16
E8*	Do you feel handicapped by a hearing problem?	No	Sometimes	Yes	17
S9*	Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbors?	No	Sometimes	Yes	18
E10	Does a hearing problem cause you to feel frustrated when talking to coworkers, clients, or customers?	No	Sometimes	Yes	19
S11*	Does a hearing problem cause you difficulty in the movies or theater?	No	Sometimes	Yes	20
E12	Does a hearing problem cause you to be nervous?	No	Sometimes	Yes	21
S13	Does a hearing problem cause you to visit friends, relatives, or neighbors less often than you would like?	No	Sometimes	Yes	22
E14*	Does a hearing problem cause you to have arguments with family members?	No	Sometimes	Yes	23
S15	Does a hearing problem cause you difficulty when listening to the TV or radio?	No	Sometimes	Yes	24
E16	Does a hearing problem cause you to go shopping less often than you would like?	No	Sometimes	Yes	25
E17	Does any problem or difficulty with your hearing upset you at all?	No	Sometimes	Yes	26

E18	Does a hearing problem cause you to want to be by yourself?	No	Sometimes	Yes	27
S19	Does a hearing problem cause you to talk to family members less often than you would like?	No	Sometimes	Yes	28
E20*	Do you feel that any difficulty with your hearing limits or hampers your personal or social life?	No	Sometimes	Yes	29
S 21	Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?	No	Sometimes	Yes	30
E 22	Does a hearing problem cause you to feel depressed?	No	Sometimes	Yes	31
S 23	Does a hearing problem cause you to listen to TV or radio less often than you would like?	No	Sometimes	Yes	32
E 24	Does a hearing problem cause you to feel uncomfortable when talking to friends?	No	Sometimes	Yes	33
E 25	Does a hearing problem cause you to feel left out when you are with a group of people?	No	Sometimes	Yes	34
E 26	Does a hearing problem cause you to feel "stupid" or "dumb"?	No	Sometimes	Yes	35
S 27	Do you have difficulty hearing when someone speaks in a whisper?	No	Sometimes	Yes	36
S 28	Does a hearing problem cause you to attend religious services less often than you would like?	No	Sometimes	Yes	37

* Items comprising the HHIA-S.

From: Newman, C.W., Weinstein, B.E., Jacobson, G.P., and Hug, G.A. Test-retest reliability of the Hearing Handicap Inventory for Adults, Hearing and Hearing, 12(5): 355-

NOISE EXPOSURE HISTORY

We need to know about noise exposure in your past, even as a child. An example of a loud noise is a noise that makes it hard to talk or hear another person, or makes your ears ring after exposure.

NOISE AT YOUR WORK **1. Have you had any of these jobs?**			**Date Started**	**Date Ended**	**How often did you use hearing protection?** **Never**	**Sometimes**	**Always**
A. Cannery	No	Yes	19_____	_____	1	2	3
B. Construction	No	Yes	19_____	_____	1	2	3
C. Factory: _____ *(type of factory)*	No	Yes	19_____	_____	1	2	3
D. Farming	No	Yes	19_____	_____	1	2	3
E. Logging, Lumber industry	No	Yes	19_____	_____	1	2	3
F. Loud music (performing)	No	Yes	19_____	_____	1	2	3
G. Mining	No	Yes	19_____	_____	1	2	3
H. Police, Fire, Dept.	No	Yes	19_____	_____	1	2	3
I. Printing	No	Yes	19_____	_____	1	2	3
J. Transportation *(truck, boat, plane...)*	No	Yes	19_____	_____	1	2	3
K. Any other types of noisy jobs Describe_____	No	Yes	19_____	_____	1	2	3

NOISE DURING MILITARY SERVICE **2. Were you exposed to noise during military service (including basic training and reserves)?**			**Date Started**	**Date Ended**	**How often did you use hearing protection?** **Never**	**Sometimes**	**Always**
A. Artillery	No	Yes	19_____	_____	1	2	3
B. Explosion	No	Yes	19_____	_____	1	2	3
C. Planes, helicopters	No	Yes	19_____	_____	1	2	3
D. Small arms	No	Yes	19_____	_____	1	2	3
E. Tanks, other heavy equipment	No	Yes	19_____	_____	1	2	3
F. Other types of noise: Describe_____	No	Yes	19_____	_____	1	2	3

NOISE DURING RECREATION **3. Have you been exposed to noise during recreational or leisure-time activities?**			**Date Started**	**Date Ended**	**How often did you use hearing protection?** **Never**	**Sometimes**	**Always**
A. Gunfire	No	Yes	19_____	_____	1	2	3
B. Loud Engines *(boat, auto, plane, motorcycle, skimobile)*	No	Yes	19_____	_____	1	2	3
C. Loud Music	No	Yes	19_____	_____	1	2	3
D. Power Tools	No	Yes	19_____	_____	1	2	3
E. Other types of noise: Describe_____	No	Yes	19_____	_____	1	2	3

Have you ever undergone any accidental exposure to sudden intense noise?

No 1

Yes 2 Type of noise_____

Your age then_____

Which ear or side?

LEFT ear 1 BOTH ears 3

Right ear 2 Not sure 4

Adapted fom Meikle, Griest & Press (1986)

Geriatric Depression Scale (GDS) Short form

Choose the best answer for how you felt over the past week. Please answer the following questions "YES" or "NO there are no right or wrong answers, only what best applies to you.

		1 0	Space
1)	Are you basically satisfied with your life?	Yes *NO	10
2)	Have you dropped many of your activities and interests?	*YES No	11
3)	Do you feel that your life is empty?	*YES No	12
4)	Do you often get bored?	*YES No	13
5)	Are you in good spirits most of the time?	Yes *NO	14
6)	Are you afraid that something bad is going to happen to you?	*YES No	15
7)	Do you feel happy most of the time?	Yes *NO	16
8)	Do you often feel helpless?	*YES No	17
9)	Do you prefer to stay at home, rather than going out and doing new things?	*YES No	18
10)	Do you feel you have more problems with memory than most people?	*YES No	19
11)	Do you think it is wonderful to be alive now?	Yes *NO	20
12)	Do you feel pretty worthless the way you are now?	*YES No	21
13)	Do you feel full of energy?	Yes *NO	22
14)	Do you feel that your situation is hopeless?	*YES No	22
15)	Do you think that most people are better off than you are?	*YES No	23

*** = 1 point. If * score is 10 or greater, or if (Nos. 1,5,7,11,13) were answered with * then the participant may be depressed. Proceed with referral plan.**

In the last few weeks have you found things to be easily disturbing or annoying (e.g., have other people, objects or situations been getting on your nerves or causing you frustration?)

1 2 3 4 5 6 7

Not at all all of the time

In the last few weeks have you felt restless or experienced difficulty with activities such as sleeping, following instructions, keeping your mind on what you are doing?

1 2 3 4 5 6 7

Not at all all of the time

NUTRITION AND DEPRESSION STATUS REPORT

NAME: _____
COUNTY: _____

NUTRITION SCREENING INITIATIVE - 10 ITEM QUESTIONNAIRE:

This questionnaire screens for nutritional problems.

_____	0-2	Good
_____	3-5	Moderate nutritional risk
_____	6 or more.	High nutritional risk; recommend nutrition consult

BODY MASS INDEX (KG/M2) - INDEX OF WEIGHT FOR HEIGHT:

This is an index of underweight, normal weight, overweight and obesity.

_____ Greater than 30 Obese; recommend nutrition consult

_____ 25-29 Overweight; At risk for nutrition problems; recommend nutrition consult

_____ 21-24.9 Normal Range

_____ Less than 19.9; At risk for nutrition problems; recommend nutrition consult

WEIGHT LOSS (> 3 KG or 7 POUNDS IN PREVIOUS 3 MONTHS): _____

Unintentional weight loss is an indicator of low food intake or illness. However, some people need to lose weight if they are overweight and their weight is contributing to health problems.

_____ No weight loss Good

_____ Weight loss > 7 lb At risk for nutrition problems; recommend nutrition consult

PLEASE FEEL FREE TO CONTACT NIKKI HAWTHORNETO MAKE AN APPOINTMENT FOR A NUTRITIONAL CONSULT: 706-542-4838

GERIATRIC DEPRESSION SCALE- 15 ITEM QUESTIONNAIRE:_____

This questionnaire measures depression.

_____ 9 or less; probably not depressed

_____ 10 or more; at risk for depression - contact senior center director

POST TEST

GENERAL INFORMATION **ID: _____** (1-3)

_ _ _ _ _ _ (10-15) **1. Today's date: ___ / ____ / ____** ***Month/Day/Year***

__ (16) **2. This information was obtained from:**

0 _____ Client
1 _____ Senior center staff person
2 _____ Family member of client
3 _____ Caregiver for client
4 _____ Other: _____

__ __ . __ (17-20) **3. How long has the client been using the services of the senior center?**

___ ___.___ years *Code as years (xx.x years)*

_ _ _ _ _ _ _ _ (21-28) **4. Date of birth: ___ / ____ / ____** ***Month/Day/Year***

__ __ __ (29-31) **5. Current age: _____** years *Example: age 75 is 075*

__ (32) **6. Gender:** _____ Male (0) _____ Female (1)

__ (33) **7. Ethnicity:** _____ Caucasian (0) _____ Black (1) _____ Hispanic (2) _____ Asian (3) _____ Other (4)

__ __ (34-35) **8. Years completed in school?** _____ Years

__ (36) **9. Do you take a multiple-vitamin/mineral supplement?** _____ No (0) ____ Yes (1)

__ (37) **10. Do you take any other nutritional supplements that contain vitamins or minerals?**

_____ No (0) _____ Yes (1)

*** Health Care Provider** _____

Address_____

_____

Phone_____

*** Care giver/ Next of Kin**

(1) _____ **Phone**_____

Address_____

_____

(2) _____ **Phone**_____

Address_____

__ __ **38-39** **11. How many hours ago did you last eat?** _____ (code number of hours ago).

__ **40** **12. Fasting status (coded by medical technologist).**

0 Not fasted, food in the last 4 hours
1 Fasted, food not eaten in the past 4 hours

__ **13. How would you rate your overall health at the present time -- excellent, good, fair,**
41 **or poor?**

3 Excellent
2 Good
1 Fair
0 Poor
9 Not answered

__ **14. Is your health now better, about the same, or worse than it was five years ago?**
42

2 Better
1 About the same
0 Worse
9 Not answered

__ **15. How much do your health troubles stand in the way of your doing things you want**
43 **to -- not at all, a little (some), or a great deal?**

2 Not at all
1 A little (some)
0 A great deal
9 Not answered

__ __ **16. County of residence** **00-12**
44-45

00= Madison **03= Jackson** **06= Greene** 09= Elbert **12=Franklin**
01= Morgan **04= Newton** **07= Clark** 10= Oconee
02= Walton **05= Barrow** 08= Oglethorpe 11= Jasper

__ **18. Did you participate in our vitamin supplement study during spring and summer 1999?**
46 ***(ASK ONLY IN GREENE AND MORGAN COUNTY)***

1= YES
0= NO

BLOOD PRESSURE

(NOTE: RECORD RESULTS ON "BLOOD PRESSURE FORM" AND GIVE TO PARTICIPANT)

__ __ __ **22. Blood Pressure**
50-52 **Systolic (mmHg)**
__ (0) < 120 Optimal
__ (1) < 130 Normal

__ (2) 130-139 High-normal
__ (3) 140-159 Mild Hypertension (Stage 1)
__ (4) 160-179 Moderate Hypertension (Stage 2)
__ (5) > 180 Severe Hypertension (Stage 3)
__ (999) Missing

Diastolic (mmHg)

53-55

__ (0) < 80 Optimal
__ (1) < 85 Normal
__ (2) 85-95 High-normal
__ (3) 90-99 Mild Hypertension (Stage 1)
__ (4) 100-109 Moderate Hypertension (Stage 2)
__ (5) > 110 Severe Hypertension (Stage 3)
__ (999) Missing

ORIENTATION-MEMORY-CONCENTRATION TEST

Read all questions to the participant. Tell them that some of the questions may be easy and some may be hard -- just do the best you can.

	Response	# of Errors	Max. Errors	Weight Factor	Total
1) What is the year now?			**1**	**4**	
2) What month is it now?			**1**	**3**	
Please repeat this phrase after me: **JOHN BROWN, 42 MARKET STREET, CHICAGO** *No score for this -- it is a memory phrase for Item # 6. Allow the person up to three trials for learning (repeating) the phrase. If the subject has not learned the phrase after three trials, record the value of "0" as the total score for Item #6, and proceed to Item #3.*					
3) Without looking at your watch or a clock, tell me about what time is it? *Note: score is correct if within one hour of actual time.*			**1**	**3**	
4) Count backwards from 20 to 1. *20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1*			**2**	**2**	
5) Say the months of the year in reverse order. *DEC, NOV, OCT, SEPT, AUG, JULY, JUNE, MAY, APR, MAR, FEB, JAN*			**2**	**2**	
6) Please repeat the name and address I asked you to remember. *Count the number of items (5) in memory phrase recalled incorrectly. An answer of either Market or Market Street is acceptable.* John / Brown / 42 / Market Street / Chicago			**5**	**2**	
(10-11) **TOTAL SCORE**					

Interpretation of corrected scores:

≤ 8	Normal or minimal impairment
9-19	Moderate impairment
≥ 20	Severe impairment

Source: Katzman, R., Brown, T., Fuld, P., Peck, A., Schechter, R., Schimmel, H. Validation of a short orientation-memory-concentration test of cognitive impairment. *American Journal of Psychiatry* 140: 734-739, 1983.

MINI-NUTRITIONAL ASSESSMENT

ID# _____
(1-3)

Name: First name: Sex: Date:
Age:

04 ** *enter decimal points*
(4-5)

TSF. Triceps skin fold (mm): __ __.__
(6-9)

Kneeht. Knee Height (cm): __ __.__
(10-13)

I. ANTHROPOMETRIC ASSESSMENT

____ MNA1. BMI (weight/(height)^2 in kg/m^2); weight = _____ lbs. / 2.205 = __ __ __ . __kg
(14) *0 = BMI < 19* height = _____ in. * .0254 = __ __ __ . __ meters
1 = 19 ≤ BMI < 21 BMI = __ __ . __
2 = 21 ≤ BMI < 23
3 = BMI ≥ 23

_____ MNA2. Mid arm circumference (MAC in cm.): __ __ . __ cm.
(29) *0.0 = MAC < 21*
0.5 = 21 ≤ MAC ≤ 22
1.0 = MAC > 22

_____ MNA3. Calf circumference (CC in cm.): __ __ . __cm.
(34) *0 = CC < 31*
1 = CC ≥ 31

_____ MNA4. Weight loss during last 3 months: _____ lbs. / 2.205 = __ __ __ . __ kg (40-44)kg
(39) *0 = weight loss > 3 kg*
1 = does not know
2 = weight loss between 1 and 3 kg
3 = no weight loss

_____ MNA12A. How many servings of milk, yogurt, or cheese does the individual consume?
(45)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

_____ MNA12D. How many servings of meat, fish, or poultry does the individual consume?
(46)

0 ____ Less than one per week
3 ____ 3 per week
6 ____ 6 per week

1 ____ 1 per week
2 ____ 2 per week
4 ____ 4 per week
5 ____ 5 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

NUTRITION QUESTIONS

1. Have you ever received home delivered meals?

47 0 = Yes
1 = No

__ __ **2. If you receive home delivered meals, for how long have you been receiving them?** ___

48-49 ___ ***years***
Code as whole years (xx years)

50 **3. How many times a week do you eat at the senior center?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

4. How many servings of green vegetables do you eat?

51

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

5. How many servings of orange or yellow vegetable do you eat?

52

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

6. How many servings of citrus fruit or citrus juice do you eat (e.g., orange, grapefruit)?

53

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

__
54 **7. How many servings of other non-citrus fruit or juice do you consume?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

__
55 **8. How many servings of liver (eg., beef, chicken,pork) do you consume?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

FOODS FORTIFIED WITH B-VITAMINS

We would like to know if you eat any of the following foods that may be fortified with B-vitamins

				Code daily intake of vit. B12 from each source.	**Code daily intake of folate from each source.**	**Code daily intake of vit. B6 from each source.**
8. Breakfast cereals, such as, Just Right w/ fruits & nuts, Product 19, Nutri-Grain, Total, Special K	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast cereal?**			
9. Breakfast or energy bars, such as, Nutri-Grain, power bar,	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast bars?**			
10. Liquid meal replacements, such as, carnation, ensure plus	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually drink?**	**If yes, how often do you drink ensure, or boost etc.?**			
Other	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat this food?**			

MEDICATIONS AND ILLNESSES

NAME/ID: _____

Obtain information from reliable source. This information was provided by: client, caretaker, other___?

	YES (1)	NO (0)	DON'T KNOW	Space
Total number of PRESCRIPTION medications				10-11
Total number of NON -PRESCRIPTION medications, not counting vitamins and minerals				12-13
Multiple vitamin mineral supplement? 0 = no, 1 = yes				14
Number of other nutritional supplements?				15
Total number of illnesses - fill in when finished below.				16-17
1) Anemia in the past year				18
2) Alzheimer's: Kind_____; Dx date_____				19
3) Other dementias: Kind_____; Dx date _____				20
4) Cancer: Kind_____; Dx date_____; Status_____				21
5) Circulatory problems in the past year				22
6) Congestive heart failure in the past year				23
7) Constipation in the past year				24
8) Diabetes: Kind_____; Dx date _____				25
9) Diarrhea in the past year				26
10) Glaucoma in the past year				27
11) Hearing problems in the past year				28
12) Heart disease in the past year				29
13) Hypertension in the past year				30
14) Legally blind in the past year				31
15) Liver disease in the past year				32
16) Mental illness: Kind_____; Dx date_____				33
17) Osteoporosis in the past year				34
18) Hip fracture in the past year				35
19) Have you every had a pace maker				36
20) Parkinson's disease: Dx date_____				37
21) Renal disease in the past year				38
22) Respiratory disease in the past year				39
23) Seizures: 1st date_____; last date_____				40
24) Skin rashes, bed sores in the past year				41
25) Stroke: Number_____; Dates_____				42
26) Thyroid problems: Kind_____; Dx date_____				43
27) Visual disturbances in the past year				44
28) Cataracts in the past year				45
29) Have you used any type of tobacco in the past year				46
30) Have you every had stomach surgery				47
31) Emergency room visit in the past year				48
32) Other				49
33) Arthritis in the past year				50
34) Pneumonia in the past year				51
35) Dizziness in the past year				52

MEDICATIONS *(NOTE: ASK EVERY MEDICATION QUESTION THEN RECORD MEDS ON THE NEXT FORM)*			
1)	Are you currently taking aspirin?	1 = Yes 0 = No	10
2)	Are you currently taking ibuprofen such as Advil, Motrin, Nuprin?	1 = Yes 0 = No	11
3)	Are you currently taking Aleve?	1 = Yes 0 = No	12
4)	Are you currently taking Acetaminophen such as Tylenol or similar medication?	1 = Yes 0 = No	13
5)	Are you currently taking antacids or medications for heartburn or indigestion such as maalox, mylanta, alka aid (alka-seltzer) gaviscon, propulsid, zantac, pepcid, axid, cyotec, tums, tagamet, proton pump inhibitors such as prevacid, prevapac,prilosec, or other medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	14
6)	Are you currently taking laxatives such as milk of magnesia, fiber tablets, metamucil or other laxative medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	15
7)	Are you currently taking a cough suppressant such as humibid, robitussin, entrex or other medication?	1 = Yes 0 = No	16
8)	Are you currently taking allergy, sinus, or cold medication such as chlorpheniramine, relief, allerfed, seldane, sudafed, sine aid, Tylenol allergy sinus, contac, tylenol cold formulas, methypred dose, claritin, phenylprop, guaif, bromfed, tavist-d, actifed, benadryl, equate allergy sinus or other medication?	1 = Yes 0 = No	17
9)	Are you currently using nasal spray for allergy or sinus, such as aerobid, flonase, beconase, Nasalcrom or other medication?	1 = Yes 0 = No	18
10)	Are you currently taking a non-steroidal anti-inflammatory drug (NSAID) such as voltaren, diclofenac, naprosyn, naproxyn, sulindac, lodine, relafen, daypro, oruvail or similar medication?	1 = Yes 0 = No	19
11)	Are you currently taking a pain medication such as ultram, darvocet-N-100, fiorinal or similar medication?	1 = Yes 0 = No	20
12)	Are you currently taking an arthritis medication such as prednisone, rheumatrex methotrexate, orasone, deltasone or other medication?	1 = Yes 0 = No	21
13)	Are you currently taking antibiotics such as zithromax, amoxicillin or other antibiotic medication?	1 = Yes 0 = No	22
14)	Are you currently taking a sleeping aid such as Tylenol PM or other medication?	1 = Yes 0 = No	23

	MEDICATIONS		
15)	Are you currently taking migraine medication such as mepergan fortis, imitrex, ercaf, Forbal-S or other migraine medication?	1 = Yes 0 = No	24
	# 16 and #18 - important for cognitive tests - so probe carefully		
16)	Are you currently taking anti-anxiety medication such as Alprazolam (xanax), Buspirone (Buspar), Chlordiaxepoxide (Librium), Clonazepam (klonopin), Clorazepate (tranxene), Diazepam (Valium), Hydroxyzine (Vistaril), Lorazepam (Ativan), Oxazepam (Serax), Propanolol (Inderal) or other anti-anxiety medication? **Circle all that apply**	1 = Yes 0 = No	25
17)	Are you currently taking anti-depressant medication such as Amitriptyline (Elavil), Citalopram (Celexa), Clomipramine (Anafranil), Desipramine (Norpramin), Doxepin (Sinequan), Fluoxetine (Prozac), Fluvoxamine (Luvox), Imipramine (Tofranil), Maprotiline (Ludiomil), Nortriptyline (Pamelor), Paroxetine (Paxil), Sertraline (zoloft), Trazadone (Desyrel), Venlafaxine (Effexor) or other anti-depressant medication? **Circle all that apply**	1 = Yes 0 = No	26
	#41 & 42 - important for cognitive tests - so probe carefully		
41)	Are you currently taking any drugs to help or enhance your thinking such as Chlorpromazine (Thorazine), Thioridazine (Mellaril), Fluphenazine (Prolixin), Trifluoperazine (Stelazine), Haloperidol (Haldol), Thiothixene (Navane), Loxapine (Loxitane), Molindone (Moban), Clozapine (Clozaril), Risperidone (Risperdal), Quetiapine (Seroquel), Olanzapine (Zyprexa) or other neuroleptic medications? **Circle all that apply**	1 = Yes 0 = No	27
42)	Are you currently taking any drugs to help or enhance your memory such as Tacrine (Cognex) or Donepezil hydrochloride (Aricept)? **Circle all that apply**	1 = Yes 0 = No	28
43)	List any other medications currently taken:	1 = Yes 0 = No	29
45)	Are you currently receiving Vitamin B-12 injections/shots? Last Vitamin B-12 shot (date) : _____ How often? _____(*example: once a year, twice a year, every other month, once a month) 762* ***(NOTE: IF YES, THEY NEED TO HAVE HAD A SHOT 6 MONTHS AGO OR LATER AND AGREE NOT TO RECEIVE A SHOT FOR THE NEXT FOUR MONTHS TO PARTICIPATE IN THIS STUDY)***	1 = Yes 0 = No	30
	Total number of prescription medications *(total of prescription meds)*		31-32
	Total number of non-prescription medications *(total of nonprescription meds)*		33-34

RESIDENT MEDICATION RECORDS:
Include prescription, non-prescription, and vitamins/minerals

ID _____

Medication	Dosage	Schedule	Route of Administration	*How Long have you been taking medication	DOCUMENTATION (Check all that apply)		
					Bottle only	Cardex Record	Signature Administration Record

	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	*TOTAL*
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	
Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	

Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						
	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	***TOTAL***
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	

Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						

POST TEST

Hearing History Questionnaire (HHQ)

E. Tinnitus

Do you have ringing or noises (tinnitus) in your ears? YES NO

If yes, about how long have you been aware of having tinnitus?

(1) _____ Less than a year
(2) _____ 1 to 2 years
(3) _____ 3 to 5 years
(4) _____ 6 to 10 years
(5) _____ 11 to 20 years
(6) _____ 20 or more years

Which one of the statements below best describes your current tinnitus?

(1) _____ Tinnitus usually lasts a few minutes at most
(2) _____ Tinnitus usually lasts up to several hours
(3) _____ Tinnitus usually lasts up to several days
(4) _____ Tinnitus is always there

If your tinnitus is not present all of the time, how much of the time does it seem to be present?

(1) _____ Less than half the time (2) _____ Half the time or more

Does your tinnitus interfere with your...

(1) SLEEP YES NO
(2) HEARING YES NO
(3) DAY TO DAY LIVING YES NO

III. ADDITIONAL COMMENTS

_____

_____

_____

HEARING HANDICAP INVENTORY FOR ADULTS (HHIA)

Date: _____ ID: _____

The purpose of these questions is to identify any problems your hearing loss may be causing you. Please do not skip any questions. Even if you feel you do not have a hearing loss, please answer all of the questions. For each question, circle one response: No, Sometimes, or Yes.

		0	2	4	Line Space Line # 4-5
S1	Does a hearing problem cause you to use the phone less often than you would like?	No	Sometimes	Yes	10
E2*	Does a hearing problem cause you to feel embarrassed when meeting new people?	No	Sometimes	Yes	11
S3	Does a hearing problem cause you to avoid groups of people?	No	Sometimes	Yes	12
E4	Does a hearing problem make you irritable?	No	Sometimes	Yes	13
E5*	Does a hearing problem cause you to feel frustrated when talking to members of your family?	No	Sometimes	Yes	14
S6	Does a hearing problem cause you difficulty when attending a party?	No	Sometimes	Yes	15
S7	Does a hearing problem cause you difficulty hearing/understanding coworkers, clients, or customers?	No	Sometimes	Yes	16
E8*	Do you feel handicapped by a hearing problem?	No	Sometimes	Yes	17
S9*	Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbors?	No	Sometimes	Yes	18
E10	Does a hearing problem cause you to feel frustrated when talking to coworkers, clients, or customers?	No	Sometimes	Yes	19
S11*	Does a hearing problem cause you difficulty in the movies or theater?	No	Sometimes	Yes	20
E12	Does a hearing problem cause you to be nervous?	No	Sometimes	Yes	21
S13	Does a hearing problem cause you to visit friends, relatives, or neighbors less often than you would like?	No	Sometimes	Yes	22
E14*	Does a hearing problem cause you to have arguments with family members?	No	Sometimes	Yes	23
S15	Does a hearing problem cause you difficulty when listening to the TV or radio?	No	Sometimes	Yes	24
E16	Does a hearing problem cause you to go shopping less often than you would like?	No	Sometimes	Yes	25
E17	Does any problem or difficulty with your hearing upset you at all?	No	Sometimes	Yes	26

E18	Does a hearing problem cause you to want to be by yourself?	No	Sometimes	Yes	27
S19	Does a hearing problem cause you to talk to family members less often than you would like?	No	Sometimes	Yes	28
E20*	Do you feel that any difficulty with your hearing limits or hampers your personal or social life?	No	Sometimes	Yes	29
S 21	Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?	No	Sometimes	Yes	30
E 22	Does a hearing problem cause you to feel depressed?	No	Sometimes	Yes	31
S 23	Does a hearing problem cause you to listen to TV or radio less often than you would like?	No	Sometimes	Yes	32
E 24	Does a hearing problem cause you to feel uncomfortable when talking to friends?	No	Sometimes	Yes	33
E 25	Does a hearing problem cause you to feel left out when you are with a group of people?	No	Sometimes	Yes	34
E 26	Does a hearing problem cause you to feel "stupid" or "dumb"?	No	Sometimes	Yes	35
S 27	Do you have difficulty hearing when someone speaks in a whisper?	No	Sometimes	Yes	36
S 28	Does a hearing problem cause you to attend religious services less often than you would like?	No	Sometimes	Yes	37

* Items comprising the HHIA-S.

From: Newman, C.W., Weinstein, B.E., Jacobson, G.P., and Hug, G.A. Test-retest reliability of the Hearing Handicap Inventory for Adults, Hearing and Hearing, 12(5): 355-

Geriatric Depression Scale (GDS) Short form

Choose the best answer for how you felt over the past week. Please answer the following questions "YES" or "NO there are no right or wrong answers, only what best applies to you.

		1 0	Space
1)	Are you basically satisfied with your life?	Yes *NO	10
2)	Have you dropped many of your activities and interests?	*YES No	11
3)	Do you feel that your life is empty?	*YES No	12
4)	Do you often get bored?	*YES No	13
5)	Are you in good spirits most of the time?	Yes *NO	14
6)	Are you afraid that something bad is going to happen to you?	*YES No	15
7)	Do you feel happy most of the time?	Yes *NO	16
8)	Do you often feel helpless?	*YES No	17
9)	Do you prefer to stay at home, rather than going out and doing new things?	*YES No	18
10)	Do you feel you have more problems with memory than most people?	*YES No	19
11)	Do you think it is wonderful to be alive now?	Yes *NO	20
12)	Do you feel pretty worthless the way you are now?	*YES No	21
13)	Do you feel full of energy?	Yes *NO	22
14)	Do you feel that your situation is hopeless?	*YES No	22
15)	Do you think that most people are better off than you are?	*YES No	23

*** = 1 point. If * score is 10 or greater, or if (Nos. 1,5,7,11,13) were answered with * then the participant may be depressed. Proceed with referral plan.**

In the last few weeks have you found things to be easily disturbing or annoying (e.g., have other people, objects or situations been getting on your nerves or causing you frustration?)

1 2 3 4 5 6 7

Not at all all of the time

In the last few weeks have you felt restless or experienced difficulty with activities such as sleeping, following instructions, keeping your mind on what you are doing?

1 2 3 4 5 6 7

Not at all all of the time

NUTRITION AND DEPRESSION STATUS REPORT

NAME: _____
COUNTY: _____
DATE:_____

NUTRITION SCREENING INITIATIVE - 10 ITEM QUESTIONNAIRE:

This questionnaire screens for nutritional problems.

_____	0-2	Good
_____	3-5	Moderate nutritional risk
_____	6 or more.	High nutritional risk; recommend nutrition consult

BODY MASS INDEX (KG/M2) - INDEX OF WEIGHT FOR HEIGHT:

This is an index of underweight, normal weight, overweight and obesity.

_____ Greater than 30 Obese; recommend nutrition consult

_____ 25-29 Overweight; At risk for nutrition problems; recommend nutrition consult

_____ 21-24.9 Normal Range

_____ Less than 19.9; At risk for nutrition problems; recommend nutrition consult

WEIGHT LOSS (> 3 KG or 7 POUNDS IN PREVIOUS 3 MONTHS): _____

Unintentional weight loss is an indicator of low food intake or illness. However, some people need to lose weight if they are overweight and their weight is contributing to health problems.

_____ No weight loss Good

_____ Weight loss > 7 lb At risk for nutrition problems; recommend nutrition consult

PLEASE FEEL FREE TO CONTACT NIKKI HAWTHORNETO MAKE AN APPOINTMENT FOR A NUTRITIONAL CONSULT: 706-542-4838

GERIATRIC DEPRESSION SCALE- 15 ITEM QUESTIONNAIRE:_____

This questionnaire measures depression.

_____ 9 or less; probably not depressed
_____ 10 or more; at risk for depression - contact senior center director

TIME 3

Questionnaire	TIME 3		Flagged-Explain
	Date Completed	**Initials**	
Consent Form			
Blood Drawn			
General Information			
Sun Exposure			
Blood Pressure (Gave Blood Pressure Form to participant)			
Orientation/Memory Test			
MNA/Nutrition Questions			
Illnesses			
Medications			
Cognition/computer-prompted test			
Geriatric Depression Scale			

Flagged Notes:

_____

_____

_____

_____

_____

_____

_____

TIME 3

GENERAL INFORMATION **ID: _____** (1-3)

_ _ _ _ _ _ **(10-15)** **1. Today's date: ___ / ____ / ____** ***Month/Day/Year***

__ __ **16-17** **2. How many hours ago did you last eat?** _____ (code number of hours ago).

__ **18** **3. Fasting status (coded by medical technologist).**

0 Not fasted, food in the last 4 hours
1 Fasted, food not eaten in the past 4 hours

__ **19** **4. How would you rate your overall health at the present time -- excellent, good, fair, or poor?**

3 Excellent
2 Good
1 Fair
0 Poor
9 Not answered

__ **20** **5. Is your health now better, about the same, or worse than it was five years ago?**

2 Better
1 About the same
0 Worse
9 Not answered

__ **21** **6. How much do your health troubles stand in the way of your doing things you want to -- not at all, a little (some), or a great deal?**

2 Not at all
1 A little (some)
0 A great deal
9 Not answered

__ **22** **7. If you use sunscreen, what level do you use?**

__ (0) Don't know
__ (1) SPF 4 or less

__ (2) SPF 6 or 8
__ (3) SPF 10
__ (4) SPF 15
__ (5) SPF 30 and up
__ (8) Doesn't use

BLOOD PRESSURE

(NOTE: RECORD RESULTS ON "BLOOD PRESSURE FORM" AND GIVE TO PARTICIPANT)

__ __ __
23-25 **8. Blood Pressure**

Systolic (mmHg)

__ (0) < 120 Optimal
__ (1) < 130 Normal
__ (2) 130-139 High-normal
__ (3) 140-159 Mild Hypertension (Stage 1)
__ (4) 160-179 Moderate Hypertension (Stage 2)
__ (5) > 180 Severe Hypertension (Stage 3)
__ (999) Missing

Diastolic (mmHg)

__ __ __
26-28

__ (0) < 80 Optimal
__ (1) < 85 Normal
__ (2) 85-95 High-normal
__ (3) 90-99 Mild Hypertension (Stage 1)
__ (4) 100-109 Moderate Hypertension (Stage 2)
__ (5) > 110 Severe Hypertension (Stage 3)
__ (999) Missing

ORIENTATION-MEMORY-CONCENTRATION TEST

Read all questions to the participant. Tell them that some of the questions may be easy and some may be hard -- just do the best you can.

	Response	# of Errors	Max. Errors	Weight Factor	Total
1) What is the year now?			**1**	**4**	
2) What month is it now?			**1**	**3**	
Please repeat this phrase after me: **JOHN BROWN, 42 MARKET STREET, CHICAGO** *No score for this -- it is a memory phrase for Item # 6. Allow the person up to three trials for learning (repeating) the phrase. If the subject has not learned the phrase after three trials, record the value of "0" as the total score for Item #6, and proceed to Item #3.*					
3) Without looking at your watch or a clock, tell me about what time is it? *Note: score is correct if within one hour of actual time.*			**1**	**3**	
4) Count backwards from 20 to 1. *20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1*			**2**	**2**	
5) Say the months of the year in reverse order. *DEC, NOV, OCT, SEPT, AUG, JULY, JUNE, MAY, APR, MAR, FEB, JAN*			**2**	**2**	
6) Please repeat the name and address I asked you to remember. *Count the number of items (5) in memory phrase recalled incorrectly. An answer of either Market or Market Street is acceptable.* John / Brown / 42 / Market Street / Chicago			**5**	**2**	
(10-11) **TOTAL SCORE**					

Interpretation of corrected scores:

≤ 8	Normal or minimal impairment
9-19	Moderate impairment
≥ 20	Severe impairment

Source: Katzman, R., Brown, T., Fuld, P., Peck, A., Schechter, R., Schimmel, H. Validation of a short orientation-memory-concentration test of cognitive impairment. *American Journal of Psychiatry* 140: 734-739, 1983.

MINI-NUTRITIONAL ASSESSMENT

ID# _____
(1-3)

Name: First name: Sex: Date:
Age:

04 *** enter decimal points*
(4-5)

_____ MNA12A. How many servings of milk, yogurt, or cheese does the individual consume?
(6)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

_____ MNA12D. How many servings of meat, fish, or poultry does the individual consume?
(7)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

__
(8) **3. How many times a week do you eat at the senior center?**

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day
9 ____ Missing/don't know

8. How many servings of liver (eg., beef, chicken,pork) do you consume?
__
(9)

0 ____ Less than one per week
1 ____ 1 per week
2 ____ 2 per week
3 ____ 3 per week
4 ____ 4 per week
5 ____ 5 per week
6 ____ 6 per week
7 ____ At least one per day
8 ____ 2 or more per day

FOODS FORTIFIED WITH B-VITAMINS

We would like to know if you eat any of the following foods that may be fortified with B-vitamins

				Code daily intake of vit. B12 from each source.	**Code daily intake of folate from each source.**	**Code daily intake of vit. B6 from each source.**
8. Breakfast cereals, such as, Just Right w/ fruits & nuts, Product 19, Nutri-Grain, Total, Special K	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast cereal?**			
9. Breakfast or energy bars, such as, Nutri-Grain, power bar,	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat breakfast bars?**			
10. Liquid meal replacements, such as, carnation, ensure plus	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually drink?**	**If yes, how often do you drink ensure, or boost etc.?**			
Other	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat this food?**			
Other	**0 = No 1 = Yes**	**If yes, what BRAND(s) do you usually eat?**	**If yes, how often do you eat this food and in what quantity?**			

MEDICATIONS AND ILLNESSES - IN THE PAST YEAR

IN THE PAST YEAR	YES (1)	NO (0)	DON'T KNOW	Space
Total number of PRESCRIPTION medications				10-11
Total number of NON -PRESCRIPTION medications, not counting vitamins and minerals				12-13
Multiple vitamin mineral supplement? 0 = no, 1 = yes				14
Number of other nutritional supplements?				15
Total number of illnesses - fill in when finished below.				16-17
1) Anemia				18
2) Alzheimer's: Kind_____; Dx date_____				19
3) Other dementias: Kind_____; Dx date _____				20
4) Cancer: Kind_____; Dx date_____; Status_____				21
5) Circulatory problems				22
6) Congestive heart failure				23
7) Constipation				24
8) Diabetes: Kind_____; Dx date _____				25
9) Diarrhea				26
10) Glaucoma				27
11) Hearing problems				28
12) Heart disease				29
13) Hypertension				30
14) Legally blind				31
15) Liver disease				32
16) Mental illness: Kind_____; Dx date_____				33
17) Osteoporosis				34
18) Hip fracture				35
19) Pace maker				36
20) Parkinson's disease: Dx date_____				37
21) Renal disease				38
22) Respiratory disease				39
23) Seizures: 1st date_____; last date_____				40
24) Skin rashes, bed sores				41
25) Stroke: Number_____; Dates_____				42
26) Thyroid problems: Kind_____; Dx date_____				43
27) Visual disturbances				44
28) Cataracts				45
29) Smoking: cigarettes, pipes, cigars, OR chewing tobacco				46
30) Stomach Surgery				47
31) Emergency room visit in the past year?				48
32) Other?				49
33) Arthritis				50
34) Pneumonia				51
35) Dizziness				52
36) Gout				53

MEDICATIONS *(NOTE: ASK EVERY MEDICATION QUESTION THEN RECORD MEDS ON THE NEXT FORM)*			
1)	Are you currently taking aspirin?	1 = Yes 0 = No	10
2)	Are you currently taking ibuprofen such as Advil, Motrin, Nuprin?	1 = Yes 0 = No	11
3)	Are you currently taking Aleve?	1 = Yes 0 = No	12
4)	Are you currently taking Acetaminophen such as Tylenol or similar medication?	1 = Yes 0 = No	13
5)	Are you currently taking antacids or medications for heartburn or indigestion such as maalox, mylanta, alka aid (alka-seltzer) gaviscon, propulsid, zantac, pepcid, axid, cyotec, tums, tagamet, proton pump inhibitors such as prevacid, prevapac,prilosec, or other medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	14
6)	Are you currently taking laxatives such as milk of magnesia, fiber tablets, metamucil or other laxative medication? **CIRCLE ALL THAT APPLY**	1 = Yes 0 = No	15
7)	Are you currently taking a cough suppressant such as humibid, robitussin, entrex or other medication?	1 = Yes 0 = No	16
8)	Are you currently taking allergy, sinus, or cold medication such as chlorpheniramine, relief, allerfed, seldane, sudafed, sine aid, Tylenol allergy sinus, contac, tylenol cold formulas, methypred dose, claritin, phenylprop, guaif, bromfed, tavist-d, actifed, benadryl, equate allergy sinus or other medication?	1 = Yes 0 = No	17
9)	Are you currently using nasal spray for allergy or sinus, such as aerobid, flonase, beconase, Nasalcrom or other medication?	1 = Yes 0 = No	18
10)	Are you currently taking a non-steroidal anti-inflammatory drug (NSAID) such as voltaren, diclofenac, naprosyn, naproxyn, sulindac, lodine, relafen, daypro, oruvail or similar medication?	1 = Yes 0 = No	19
11)	Are you currently taking a pain medication such as ultram, darvocet-N-100, fiorinal or similar medication?	1 = Yes 0 = No	20
12)	Are you currently taking an arthritis medication such as prednisone, rheumatrex methotrexate, orasone, deltasone or other medication?	1 = Yes 0 = No	21
13)	Are you currently taking antibiotics such as zithromax, amoxicillin or other antibiotic medication?	1 = Yes 0 = No	22
14)	Are you currently taking a sleeping aid such as Tylenol PM or other medication?	1 = Yes 0 = No	23

	MEDICATIONS		
15)	Are you currently taking migraine medication such as mepergan fortis, imitrex, ercaf, Forbal-S or other migraine medication?	1 = Yes 0 = No	24
	# 16 and #18 - important for cognitive tests - so probe carefully		
16)	Are you currently taking anti-anxiety medication such as Alprazolam (xanax), Buspirone (Buspar), Chlordiaxepoxide (Librium), Clonazepam (klonopin), Clorazepate (tranxene), Diazepam (Valium), Hydroxyzine (Vistaril), Lorazepam (Ativan), Oxazepam (Serax), Propanolol (Inderal) or other anti-anxiety medication? **Circle all that apply**	1 = Yes 0 = No	25
17)	Are you currently taking anti-depressant medication such as Amitriptyline (Elavil), Citalopram (Celexa), Clomipramine (Anafranil), Desipramine (Norpramin), Doxepin (Sinequan), Fluoxetine (Prozac), Fluvoxamine (Luvox), Imipramine (Tofranil), Maprotiline (Ludiomil), Nortriptyline (Pamelor), Paroxetine (Paxil), Sertraline (zoloft), Trazadone (Desyrel), Venlafaxine (Effexor) or other anti-depressant medication? **Circle all that apply**	1 = Yes 0 = No	26
18)	Are you currently taking diverticulitis medication such as levsin or other medication?	1 = Yes 0 = No	27
19)	Are you currently taking colitis medication such as dicyclomine or other medication?	1 = Yes 0 = No	28
20)	Are you currently taking any medications for gout (such as allopurinol), an ulcer (such as prilosec or prevacid), or any other GI medications?	1 = Yes 0 = No	29
21)	Are you currently taking high cholesterol medication such as questran, lopid, mevacor, niacin or other medication?	1 = Yes 0 = No	30
22)	Are you currently taking a diuretic such as hydrochloro-thiazide, lasix, furosemide, triamterene/HCTZ, aldactone or other medication?	1 = Yes 0 = No	31
23)	Are you currently taking hypokalemia medication such as potassium chloride or potassium gluconate or other medication?	1 = Yes 0 = No	32
24)	Are you currently taking high blood pressure medication such as hydrochlorothiazide, regroton, triamterene, maxzide, zestril, norvasc, verapamil, vasotec, prinivil, zestoretic, aldactone (aldosterone), lopressor, capoten, captopril, minipril or other medication?	1 = Yes 0 = No	33
25)	Are you currently taking heart or cardiac medication such as lanoxin or other medication?	1 = Yes 0 = No	34
26)	Are you currently taking an anticoagulant such as coumadin, dipyridamole or other medication?	1 = Yes 0 = No	35
27)	Are you currently taking urinary tract medication such as nitrofurantoin, macrobid, macrodantin or other medication?	1 = Yes 0 = No	36

28)	Are you currently taking incontinence medication such as oxybutynin, ditropan, detrol or other medication?	1 = Yes 0 = No	37
29)	Are you currently taking asthma medication such as theophylline, singulair or other medication?	1 = Yes 0 = No	38
	MEDICATIONS		
30)	Are you currently using a topical medication such as aclovate, cleocin-t, metrogel, elocon lotion or other topical medication?	1 = Yes 0 = No	39
31)	Are you currently using eye medication such as timoptic, Beta-optic or other medication?	1 = Yes 0 = No	40
32)	Are you currently taking weight loss medication such as profast hs, phentermine, meridia or other medication?	1 = Yes 0 = No	41
33)	Are you currently taking any medications for Parkinson's disease such as seligiline, carbidopa or other medicaiton?	1 = Yes 0 = No	42
34)	Are you currently taking any medication for dizziness or vertigo such as meclizine, antivert or other medication?	1 = Yes 0 = No	43
35)	Are you currently taking any anticonvulsant medication such as clonidine or other medication?	1 = Yes 0 = No	44
36)	Are you currently taking any estrogen/hormone therapy such as premarin, prempro or other medication?	1 = Yes 0 = No	45
37)	Are you currently taking any thyroid hormones such as synthroid or other medication?	1 = Yes 0 = No	46
38)	Are you currently taking chemotherapy or tamoxifen?	1 = Yes 0 = No	47
39)	Are you currently taking any bone-altering drugs such as bisphosphonates (Fosomax) or calcitonin?	1 = Yes 0 = No	48
40)	Are you currently taking any diabetes medications such as glucotrol, insulin, glucophage, precose, diabinese, or other medications?	1 = Yes 0 = No	49

	#41 & 42 - important for cognitive tests - so probe carefully		
41)	Are you currently taking any drugs to help or enhance your thinking such as Chlorpromazine (Thorazine), Thioridazine (Mellaril), Fluphenazine (Prolixin), Trifluoperazine (Stelazine), Haloperidol (Haldol), Thiothixene (Navane), Loxapine (Loxitane), Molindone (Moban), Clozapine (Clozaril), Risperidone (Risperdal), Quetiapine (Seroquel), Olanzapine (Zyprexa) or other neuroleptic medications? **Circle all that apply**	1 = Yes 0 = No	50
42)	Are you currently taking any drugs to help or enhance your memory such as Tacrine (Cognex) or Donepezil hydrochloride (Aricept)? **Circle all that apply**	1 = Yes 0 = No	51
43)	List any other medications currently taken:	1 = Yes 0 = No	52
44)	Prostate medication (flomax, proscar) - 715, 717	1 = Yes 0 = No	53
45)	Are you currently receiving Vitamin B-12 injections/shots? Last Vitamin B-12 shot (date) : _____ How often? _____(*example: once a year, twice a year, every other month, once a month) 762* ***(NOTE: IF YES, THEY NEED TO HAVE HAD A SHOT 6 MONTHS AGO OR LATER AND AGREE NOT TO RECEIVE A SHOT FOR THE NEXT FOUR MONTHS TO PARTICIPATE IN THIS STUDY)***	1 = Yes 0 = No	54
	Total number of prescription medications *(total of prescription meds)*		55-56
	Total number of non-prescription medications *(total of nonprescription meds)*		57-58

RESIDENT MEDICATION RECORDS:
Include prescription, non-prescription, and vitamins/minerals

ID _____

Medication	Dosage	Schedule	Route of Administration	*How Long have you been taking medication	DOCUMENTATION (Check all that apply)		
					Bottle only	Cardex Record	Signature Administration Record

	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	_____ *SUPP # __*	*TOTAL*
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	
Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	

Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						
	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	_____ ***SUPP # __***	***TOTAL***
	__ # pills per D, W, M **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	**__ # pills per D, W, M** **WRITE IN AMOUNT /PILL & CIRCLE UNIT**	
For how long?	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	**_____mo/yrs**	
Vitamin A	IU RE	IU RE	IU RE	IU RE	IU RE	
Vitamin C	mg	mg	mg	mg	mg	
Vitamin D	IU mg	IU mg	IU mg	IU mg	IU mg	
Vitamin E	IU mg	IU mg	IU mg	IU mg	IU mg	
Thiamin (B1)	mg	mg	mg	mg	mg	
Riboflavin (B2)	mg	mg	mg	mg	mg	
Niacin or Niacinamide or Vit. B3	mg	mg	mg	mg	mg	
Pyridoxine or Vitamin B6	mg	mg	mg	mg	mg	
Folic acid or Folate	mcg mg	mcg mg	mcg mg	mcg mg	mcg mg	
Vitamin B-12	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Biotin	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Pantothenic Acid	mg	mg	mg	mg	mg	
Vitamin K	mcg	mcg	mcg	mcg	mcg	
Calcium	mg	mg	mg	mg	mg	
Iron	mg	mg	mg	mg	mg	
Phosphorus	mg	mg	mg	mg	mg	
Iodine	mcg	mcg	mcg	mcg	mcg	
Magnesium	mg	mg	mg	mg	mg	
Zinc	mg	mg	mg	mg	mg	
Copper	mg	mg	mg	mg	mg	
Potassium	mg	mg	mg	mg	mg	
Manganese	mg	mg	mg	mg	mg	

Chromium	mcg	mcg	mcg	mcg	mcg	
Molybdenum	mcg	mcg	mcg	mcg	mcg	
Chloride	mg	mg	mg	mg	mg	
Nickel	mcg	mcg	mcg	mcg	mcg	
Silicon	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Vanadium	mcg	mcg	mcg	mcg	mcg	
Boron	mg mcg	mg mcg	mg mcg	mg mcg	mg mcg	
Fluoride	mg	mg	mg	mg	mg	
Selenium	mcg	mcg	mcg	mcg	mcg	
Other						

Geriatric Depression Scale (GDS) Short form

Choose the best answer for how you felt over the past week. Please answer the following questions "YES" or "NO there are no right or wrong answers, only what best applies to you.

		1 0	Space
1)	Are you basically satisfied with your life?	Yes *NO	10
2)	Have you dropped many of your activities and interests?	*YES No	11
3)	Do you feel that your life is empty?	*YES No	12
4)	Do you often get bored?	*YES No	13
5)	Are you in good spirits most of the time?	Yes *NO	14
6)	Are you afraid that something bad is going to happen to you?	*YES No	15
7)	Do you feel happy most of the time?	Yes *NO	16
8)	Do you often feel helpless?	*YES No	17
9)	Do you prefer to stay at home, rather than going out and doing new things?	*YES No	18
10)	Do you feel you have more problems with memory than most people?	*YES No	19
11)	Do you think it is wonderful to be alive now?	Yes *NO	20
12)	Do you feel pretty worthless the way you are now?	*YES No	21
13)	Do you feel full of energy?	Yes *NO	22
14)	Do you feel that your situation is hopeless?	*YES No	22
15)	Do you think that most people are better off than you are?	*YES No	23

*** = 1 point. If * score is 10 or greater, or if (Nos. 1,5,7,11,13) were answered with * then the participant may be depressed. Proceed with referral plan.**

In the last few weeks have you found things to be easily disturbing or annoying (e.g., have other people, objects or situations been getting on your nerves or causing you frustration?)

1 2 3 4 5 6 7

Not at all all of the time

In the last few weeks have you felt restless or experienced difficulty with activities such as sleeping, following instructions, keeping your mind on what you are doing?

1 2 3 4 5 6 7

Not at all all of the time