6-2003

Long-term Almond Supplementation: Effects on Diet, Eating Patterns, and Satiety in Free-Living Healthy Individuals

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LONG-TERM ALMOND SUPPLEMENTATION: EFFECTS ON DIET, EATING PATTERNS, AND SATIETY IN FREE-LIVING HEALTHY INDIVIDUALS

by

Karen Jaceldo-Siegl

A Dissertation in Partial Fulfillment of the

Requirements for the

Degree of Doctor of Public Health

in Nutrition

June 2003

Each person whose signature appears below certifies that this dissertation, in his/her opinion is adequate in scope and quality as a dissertation for the degree Doctor of Public Health.

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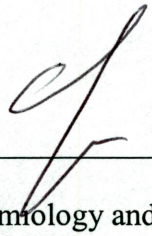

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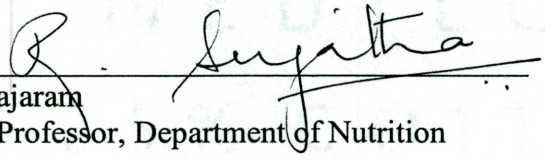

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ABSTRACT OF THE DISSERTATION

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by

Karen Jaceldo-Siegl

Doctor of Public Health in Nutrition

Loma Linda University, Loma Linda California, 2003

Joan Sabaté, Chairman

Because of the growing evidence of the cardio protective effect of nuts, examining the potential of nuts as a healthy food choice for the larger population should be considered. The purpose of this 12-month crossover study was to evaluate the impact on diet, eating patterns, and satiety of supplementing a self-selected diet (with little or no nuts) with ~52 g of almonds in free-living healthy males (43) and females (38) between the ages 25 and 70 years. The first six months constituted the control period where subjects followed their habitual diet (HD). During the intervention (second 6 months), subjects were asked to incorporate almonds into their HD without dietary advice by free feeding daily on the nuts (AD). Subjects incorporated the almonds into the HD as a single portion, and consumed the nuts during snacks and at breakfast. Almond supplementation resulted in an increased intake of monounsaturated- and polyunsaturated fats, fiber, magnesium, and plant protein, and a reduced intake of saturated fats, animal protein, cholesterol, and sodium.

With the exception of saturated and polyunsaturated fats, the aforementioned nutrients met the dietary recommendations to prevent CVD and chronic diseases. Total energy, protein, fat, dietary fatty acids, and fiber were partially displaced, whereas the total food weight and carbohydrate content were completely displaced from the AD. Chronic almond consumption induced a displacement pattern that led to a reduction in the intake of grains, dairy products, fats, sweets, and vegetables, and prevented breakfast skipping among lean males. These findings are important, as they may have contributed to improved energy intake regulation in this population. There was no evidence that almonds lowered or raised subsequent energy intake at lunch or dinner; however, almonds nearly prolonged pre-meal duration at dinner. Other properties of almonds, such as total fat, fatty acids, or fiber content, may impact satiety response in this population. Findings from this study indicate that in promoting regular consumption of high fat, high energy foods such as almonds, a comprehensive dietary assessment should record changes in the nutrient profile, eating patterns, and displacement of other foods, as long-term almond supplementation significantly impacts food consumption and eating patterns in free-living healthy individuals.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 3 – METHODS

CHAPTER 4 – FIRST PUBLISHABLE PAPER

CHAPTER 5 – SECOND PUBLISHABLE PAPER

CHAPTER 6 – OTHER FINDINGS

ACKNOWLEDGMENTS

The research reported in this dissertation could not have been accomplished without the support and assistance of many people. I would like to express my gratitude for the assistance I received from my committee members, Drs. Joan Sabaté, Gary E Fraser, and Sujatha Rajaram. I am especially thankful to Dr. Sabaté for providing the conceptual and theoretical direction, Dr. Fraser for the methodological and statistical guidance, and Dr. Rajaram for the editorial comments, which this project required. I am also grateful to Hanni Bennett for her assistance in administrative matters and in collecting the data.

I owe tremendous gratitude to my family and friends. My husband, Bernard Siegl, and my parents, Teodorico and Carmen Jaceldo, gave me the encouragement, love, and support that I needed to overcome the difficulties of this project. I also would like to thank Eugene Jaceldo, Joanne Jaceldo, René Jaceldo, Caesar Jaceldo, Ted Jaceldo, and Raymundo Jaceldo for their words of encouragement and expressions of pride in this work. This dissertation belongs to all of us.

LIST OF ABBREVIATIONS

AD	Almond supplemented diet
BMI	Body mass index
BMR	Basal metabolic rate
C	Control
CD	Control diet
CHD	Coronary heart disease
CVD	Cardiovascular disease
D	Difference
DRI	Dietary Reference Intake
EDTA	Sodium ethylenediaminetetraacetic acid
FFQ	Food frequency questionnaire
HD	Habitual diet
HDL	High-density lipoprotein
I	Intervention
ID	Intervention diet
LDL	Low-density lipoprotein
MFA	Monounsaturated fatty acid
MUFA	Monounsaturated fatty acid
PFA	Polyunsaturated fatty acid
PUFA	Polyunsaturated fatty acid
SAS	Statistical Analysis System

SD	Standard deviation
SFA	Saturated fatty acid

CHAPTER 1

INTRODUCTION

A. Statement of the Problem

The established association between habitual dietary patterns and health status has prompted organizations such as the National Research Council, as well as other authorities to issue dietary recommendations or guidelines for the public to promote healthful eating and prevent disease. Foods and food groups such as grains, fruits, vegetables, dairy products and meats have been incorporated into these recommendations to help the public make healthful choices. Because of the growing evidence of the cardio protective effect of nuts, examining the potential of nuts as a healthy food choice for the larger population should be considered.

Epidemiologic and metabolic studies have shown that regular nut consumption may protect against risk of heart disease and diabetes. The focus of nut research to date has been on the beneficial effect of nut consumption on plasma lipoproteins, plasma fatty acids, blood pressure, and the favorable or neutral effects on body weight. The literature lacks investigations that examine the effect of long-term nut consumption on the habitual diets of free-living healthy individuals.

B. Purpose of the Study

The purpose of this study was to evaluate the long-term effect of almond supplementation on dietary and eating patterns, as well as satiety in free-living healthy individuals.

C. Hypotheses

This study tested the following hypotheses: (1) the nutrient composition of habitual diets change with long-term almond supplementation; (2) food intake, snacking, and meal-skipping patterns change with long-term almond supplementation; (3) almond consumption reduces the caloric intake and delays timing/starting of a subsequent meal.

D. Research Questions

This study addressed the following research questions: (1) does long-term almond supplementation improve the nutrient profile of the habitual diets of free-living healthy individuals; (2) what nutrient displacement pattern is associated with long-term almond supplementation; (3) what changes in eating patterns are associated with long-term almond supplementation; (4) does almond consumption reduce the caloric intake of a subsequent meal; (5) does almond consumption delay the intake of a subsequent meal.

CHAPTER 2

REVIEW OF THE LITERATURE

A. Current Dietary Recommendations

The association between habitual dietary patterns and health status is well recognized (Appel et al., 1997; Fung et al., 2001; Lauber & Sheard, 2001). Scientific knowledge on the role of diet in health has prompted organizations such as the Food and Nutrition Board, World Health Organization, as well as other authorities, to issue dietary recommendations or guidelines for the public to promote healthful eating and prevent disease (Anonymous, 1990; Committee on Diet and Health, Board, & Council, 1989; Haddad, 2001; Lauber & Sheard, 2001). These guidelines are primarily nutrient based. Recognizing that people choose and eat foods rather than nutrients, nutrition policies also provide food-based recommendations to help the public make healthful choices. Food groups such as grains, fruits, vegetables, dairy products and meats have been incorporated into some of the recommendations (Anonymous, 1990; Lauber & Sheard, 2001). Because of the growing evidence of the cardio protective effect of nuts, examining the potential of nuts as a healthy food choice needs consideration.

B. Health Benefits of Nuts

The high fat and high calorie profile of nuts have contributed to the previously widespread message that regular nut consumption impacts health negatively. Many health professionals as well as the public have in the past avoided them for these reasons. Nutrition research, however, refutes these common stereotypes. Nuts contain several bioactive compounds that probably confer cardiovascular benefits, such as

unsaturated fatty acids (Feldman, 2002; Sabate & Fraser, 1993; Sabate, Radak, & Brown, 2001), copper (Klevay, 1992), arginine-rich amino acids (Kritchevsky, Tepper, Czarnecki, & Klurfeld, 1982), dietary fiber, magnesium (Durlach & Rayssiguier, 1993), tocopherols (National Research Council, 1989), phytosterols (Ostlund, 2002), and other phytochemicals (Farquhar, 1996). The composition of nuts is shown in Tables 1-2.

1. Evidence From Epidemiology

Frequent consumption of nuts has been shown to protect against risk of coronary heart disease (CHD) in five large epidemiologic studies to date: The Adventist Health Study (Fraser, Sabaté, Beeson, & Strahan, 1992), The Iowa Women's Health Study (Kushi et al., 1996; Prineas, Kushi, Folsom, Bostick, & Wu, 1993), The Nurses' Health Study (Hu et al., 1998), The Cholesterol and Recurrent Events Study (Brown, Rosner, Willett, & Sacks, 1999), and The Physicians' Health Study (Albert, Gaziano, Willett, & Manson, 2002). Few authors (Fraser, 1999; Hu & Stampfer, 1999; Kris-Etherton, Zhao, Binkoski, Coval, & Etherton, 2001; Sabate & Fraser, 1993) have reviewed findings from these studies. A recent report showed that higher nut and peanut butter consumption lowered risk of type 2 diabetes in women (Jiang et al., 2002). Sabaté (1999) reviewed epidemiologic evidence that nut consumption reduces risk of ischemic heart disease and increases longevity.

2. Evidence From Human Nutrition Studies

Several studies in well-controlled environments and studies with free-living normal, hyperlipidemic and overweight subjects have shown that regular nut

consumption has favorable effects on plasma lipid profiles, as well as favorable or neutral effects on body weight.

a. Effects on Plasma Lipoproteins. Twenty human studies to date examined the effect of nut-containing diets on lipoprotein content in plasma. Reductions in total cholesterol and low-density-lipoprotein (LDL) cholesterol were reported with diets containing almonds (Abbey, Noakes, Belling, & Nestel, 1994; Hyson, Schneeman, & Davis, 2002; Jenkins et al., 2002; Lovejoy, Most, Lefevre, Greenway, & Rood, 2002; Sabate, Haddad, Tanzman, Jambazian, & Rajaram, 2003; Spiller et al., 1998; Spiller et al., 1992), walnuts (Abbey et al., 1994; Almario, Vonghavaravat, Wong, & Kasim-Karakas, 2001; Chisholm et al., 1998; Iwamoto et al., 2002; Munoz et al., 2001; Sabate et al., 1993; Zambon et al., 2000), pecans (Morgan & Clayshulte, 2000; Rajaram, Burke, Connell, Myint, & Sabate, 2001), macadamia nuts (Colquhoun, Humphries, Moores, & Somerset, 1996; Curb, Wergowske, Dobbs, Abbott, & Huang, 2000), peanuts (O'Byrne, Knauft, & Shireman, 1997), pistachio nuts (Edwards, Kwaw, Matud, & Kurtz, 1999), and hazelnuts (Durak et al., 1999). Improvements in plasma lipoproteins also were observed in another study that used a mixture of nuts as part of a mixed diet (Jenkins et al., 1997). Of these, five were controlled feeding trials (Curb et al., 2000; Iwamoto et al., 2002; Rajaram et al., 2001; Sabate et al., 1993; Sabate, Rajaram, Jambazian, Tanzman, & Haddad, 2001), and the rest were conducted using free-living conditions. Few authors have reviewed the findings from these studies (Feldman, 2002; Kris-Etherton et al., 1999; Kris-Etherton et al., 2001; Sabate & Hook, 1996; Sabate, Radak et al., 2001).

b. Effects on Body Weight. Only three nut studies to date have examined body weight as the primary outcome. One study found that incorporating almonds in the diet each day for six months did not lead to significant changes in body weight (Fraser, Bennett, Jaceldo, & Sabate, 2002). Another study investigated the effects of peanuts on body weight by asking subjects to incorporate the nuts in the diet with no dietary advice (free feeding) for 8 weeks, add the nuts to their customary diet for 3 weeks (addition), and replace an equal amount of other fats in the diet for an additional 8 weeks (substitution) (Alper & Mattes, 2002). The investigators found that body weight gain significantly was lower than predicted during free feeding and addition, and body weight was maintained during substitution. The third study, which was a randomized, prospective 18-month trial for weight loss, found that a mixed diet containing a combination of nuts offered improvements in weight loss (McManus, Antinoro, & Sacks, 2001).

c. Potential Mechanisms. Several mechanisms for the cardioprotective effects of nuts have been proposed, but only few have been examined. The fatty acid profile of nuts was found to contribute partially to the total reduction in CHD risk (Kris-Etherton et al., 2001) in an epidemiologic study. This effect may be due in part to the high monounsaturated fatty acid content of nuts, which was shown to reduce LDL oxidation (Hargrove, Etherton, Pearson, Harrison, & Kris-Etherton, 2001; Hyson et al., 2002; Jenkins et al., 2002), and serum apolipoprotein B and/or lipoprotein (a) (Jenkins et al., 2002; Rajaram et al., 2001; Zambon et al., 2000) in human subjects. In a novel study, polyphenol extracts from walnuts were found to inhibit in vitro human

plasma and LDL oxidation (Anderson et al., 2001). Nuts may contain an array of bioactive compounds also found in other plant foods, such as phytosterols, flavonoids, tocotrienols, bioflavonoids, ellagic acid, and luteolin, which are thought to regulate a variety of mechanisms that offer beneficial effects (Kris-Etherton et al., 2001). Studies that elucidate these mechanisms are very limited.

C. Effect of Nut Consumption on Dietary Patterns

To date, the primary outcome of interest in most nut studies have been lipids, and more recently body weight. Since dietary patterns were not the main focus of these studies, most reports that described subsequent dietary changes, which occurred after consuming a diet containing nuts, limited the characterization of the diet to macronutrients and fiber. Jenkins et al (1997), however, assessed the changes in energy, macronutrient, mineral and vitamin intake following a four-week dietary intervention on serum lipids, and only one study assessed changes in food intake following an 18-month dietary intervention for weight loss (McManus et al., 2001).

This section will review studies that described dietary patterns. Studies, which compared (by *t-test*) and reported intake of energy, fat, carbohydrate, protein, and fiber during the control and intervention diets are shown in Table 3. Three feeding studies examined the effect of substituting nuts for other fats (Chisholm et al., 1998; Jenkins et al., 1997; O'Byrne et al., 1997), one study added the nuts to a foundation diet (Spiller et al., 1998), one used free-feeding with nuts (Almario et al., 2001), and one study studied the effects of addition, substitution and free-feeding with nuts on the same subjects (Alper & Mattes, 2002). In the studies that used substitution, Jenkins *et*

al (1997) and O'Byrne *et al* (1997) reported decreases in energy and fat intake, increases in carbohydrate and fiber, and either a decrease or increase in protein intake during the nut-containing diets compared to the control diets. In the studies by Chisholm *et al* (1998) and Alper *et al* (2002), intake of energy and fat, and protein increased, carbohydrate decreased, and fiber intake either increased or did not change. The direction of change in the intake of energy, fat, and carbohydrate in studies that used addition and free-feeding with nuts was similar to those found by Chisholm *et al* (1998) and Alper *et al* (2002). The magnitude of change in these studies differed due to the study design and the amount of nuts used by the investigators.

It is important to note that although most of these feeding studies were conducted in free-living conditions, investigators carefully provided dietary instructions to all the study participants on how to incorporate the nuts into their respective diets. These feeding studies not only introduced nuts into the diet as the primary variable, but also imposed a prescribed reference diet that departed from the individual's habitual diet. This method of intervention prevents the ability to examine subsequent dietary changes that occur naturally after introducing a single item to an individual's habitual diet. The only studies that gave no dietary advice were those that used free-feeding with nuts, in which the control was the subjects' habitual diet.

D. Approaches to a Comprehensive Assessment of Diets

Research on nuts following conventional investigations typically characterizes diet in terms of nutrients, which appears to be the preferred method throughout the nutrition literature. Foods (not nutrients) are what individuals eat. Since the effect of

diet on health is believed to occur mainly through the addition of foods rather than nutrients, the assessment of diet in terms of foods or food groups is necessary. Certain strengths and weaknesses are associated with each technique. Since nutrients can be directly related to our fundamental knowledge of biology, the quantitation of diet in terms of nutrient composition is advantageous. Food or food group representation is useful when examining relationships with risk of disease, especially when a hypothesis relating to a defined nutrient has not been formulated (Willett, 1998). The latter becomes particularly important in light of the fact that foods are not only sources of the currently known nutrients, but also are potential carriers of chemical substances that remain to be identified (Mertz, 1984). Thus, examining diets at the level of individual foods, food groups, and nutrients is important.

Recently, there has been great interest in finding alternative approaches to examining the relationship between diet and disease risk. Dietary pattern analysis, which examines the effects of the overall diet rather than individual nutrients or foods (Hu, 2002), has been used to examine the relationship between dietary patterns (e.g. Western diet) and disease risk (Fung et al., 2001; Tseng & DeVellis, 2001). Alternatively, dietary quality indices have been developed to examine whether adherence to current dietary guidelines lowers disease risk (Kant, Schatzkin, Graubard, & Schairer, 2000).

Assessing diets by nutrients and/or foods have been valuable; however, free-living people eat meals that combine a variety of foods with complex combinations of nutrients, which may produce interactive or synergistic responses. The fact that the

timing of, the reasons for, and the manner in which meals are eaten vary within and between individuals (Longnecker, Harper, & Kim, 1997) further complicates dietary assessment.

Eating patterns have been examined primarily in observational and correlational studies. To date, studies investigating the effect of an intervention on eating patterns are very limited. Eating patterns can include the frequency of eating episodes in a day, the timing and duration of traditional meals (breakfast, lunch, and dinner) and snacks throughout the day, or the contribution of meal size, energy, and nutrients to each eating episode. Some of these variables have been found to play a role in energy intake (McCrory, Suen, & Roberts, 2002), blood glucose levels (Westerterp-Plantenga, Kovacs, & Melanson, 2002), and in some instances, impact body fatness (Wahlqvist, Kouris-Blazos, & Wattanapenpaiboon, 1999), and body weight (Drummond, Crombie, Cursiter, & Kirk, 1998; Pearcey & de Castro, 2002) in certain populations. These results, however, have not been consistent in free-living individuals. In spite of these findings, eating pattern analysis has been relegated to a minor role in the assessment of the overall diet.

E. The Role of Selected Nutrients on Energy Intake, Satiation and Satiety

Numerous studies have examined the role of dietary fat, protein and carbohydrate on energy intake regulation (Burton-Freeman, Gietzen, & Schneeman, 997; de Graaf et al., 1997; Foltin et al., 1992; Green, Wales, Lawton, & Blundell, 2000; Hill, Leathwood, & Blundell, 1987; Kamphuis, Westerterp-Plantenga, & Saris, 2001; Lawton, Delargy, Brockman, Smith, & Blundell, 2000; Lawton, Delargy, Smith,

Hamilton, & Blundell, 1998; Rolls & Hammer, 1995). In general, these studies suggest that specific nutrients regulate energy intake through their effects on satiation and satiety. Satiation is the satisfaction experienced during the course of eating, which results in the termination of eating. Possible indicators of satiation are the duration of a meal and/or the size of the meal. Satiety, on the other hand, is a condition achieved whereby further eating is inhibited, which results as a consequence of having eaten. Satiety may be measured by the duration of time between meals/eating episodes and/or the amount of food consumed at the subsequent meal (Burton-Freeman, 2000).

Some evidence support the notion that the ordering of macronutrients in its effects on satiety (from greatest to smallest) is protein > carbohydrate > fat (Prentice & Poppitt, 1996). Other findings suggest their effects are equivalent (de Graaf, Hulshof, Weststrate, & Jas, 1992; Green et al., 2000; Rolls et al., 1991). Still others have shown that oleic acid is less satiating than linoleic acid (Kamphuis et al., 2001; Lawton et al., 2000).

Recently, there has been a growing interest in examining the effect of dietary fiber on energy regulation. Dietary fibers enhance satiation through their ability to add bulk and weight to the diet, and potentially displace other nutrients. The textural qualities of dietary fibers also may reduce energy by increasing the work effort necessary for mastication (Burton-Freeman, 2000). Dietary fibers also can enhance satiety through its capability to form viscous colloidal dispersions when hydrated, and potentially prolong gastric emptying, small bowel transient time, and the digestion and absorption of fat and carbohydrate (Schneeman & Tietyen, 1994). A number of

investigators have demonstrated greater satiety and satiation with dietary fibers (Burley, Paul, & Blundell, 1993; Howarth, Saltzman, & Roberts, 2001). More recent studies have shown partial suppression of total energy intake with consumption of peanuts (Alper & Mattes, 2002; Kirkmeyer & Mattes, 2000) and almonds (Fraser et al., 2002).

F. Summary

Because of the growing evidence of the beneficial effects of regular nut consumption on cardiovascular health and body weight, it is very likely that nuts will be encouraged as a healthy food choice. Examining nut consumption in intervention studies should include questions about its effects on the intake of nutrients and other foods, and eating patterns.

Table 1. Composition of Nuts (per 100 g edible portion)[1]

	Almonds	Brazil	Hazelnuts	Macadamia	Peanuts	Pistachio	Walnuts
Water (g)	5.25	3.34	5.31	1.36	6.50	3.97	4.07
Energy (kcal)	578	656	628	718	567	557	654
Protein (g)	21.26	14.34	14.95	7.91	25.80	20.61	15.23
Total Fat (g)	50.64	66.22	60.75	75.77	49.24	44.44	65.21
Carbohydrate (g)	19.74	12.80	16.70	13.82	16.14	27.97	13.71
Total Fiber (g)	11.8	5.4	9.7	8.6	8.5	10.3	6.7
Calcium (mg)	248	176	114	85	92	107	98
Magnesium (mg)	275	225	163	130	168	121	158
Copper (mg)	1.110	1.770	1.725	0.756	1.144	1.300	1.586
Vitamin E (mg)	26.179	7.60	15.188	0.537	9.130	4.584	2.916
α-Tocopherol (mg)	25.87		15.03	0.54	8.33	2.30	0.70

Table 1. Composition of Nuts (per 100 g edible portion) (Continued)

	Almonds	Brazil	Hazelnuts	Macadamia	Peanuts	Pistachio	Walnuts
β-Tocopherol (mg)	0.43		0.33	0		0	0.15
γ-Tocopherol (mg)	0.89		0	0		22.60	20.83
δ-Tocopherol (mg)	0.25		0	0		0.80	1.89
Lysine (g)	0.601	0.541	0.420	0.018	0.926	1.151	0.424
Arginine (g)	2.466	2.390	2.211	1.402	3.085	2.028	2.278
Phytosterols (mg)	120		96	116	220	214	72
Stigmasterol (mg)	4		1	0		5	1
Campesterol (mg)	5		6	8		10	7
β-Sistosterol (mg)	111		89	108		198	64

[1]US Department of Agriculture & Agricultural Research Service, 2002.

Table 2. Fatty Acid Composition of Nuts (per 100 g edible portion)[1]

	Almonds	Brazil	Hazelnuts	Macadamia	Peanuts	Pistachio	Walnuts
Total SFA	3.881	16.154	4.464	12.061	6.834	5.440	6.126
4:0	0	0	0	0	0	0	0
6:0	0	0	0	0	0	0	0
8:0	0	0	0	0	0	0	0
10:0	0	0	0	0	0	0	0
12:0	0	0	0	0.076	0	0	0
14:0	0	0.620	0	0.659	0.025	0	0
16:0	3.198	9.519	3.097	6.036	5.154	4.889	4.404
18:0	0.683	5.679	1.265	2.329	1.100	0.466	1.659
20:0	0		0.102	1.940		0.043	0.063
22:0	0		0	0.616		0.043	0

Table 2. Fatty Acid Composition of Nuts (per 100 g edible portion) (Continued)

	Almonds	Brazil	Hazelnuts	Macadamia	Peanuts	Pistachio	Walnuts
24:0	0		0	0.281		0	0
Total MFA	32.155	23.016	45.652	58.877	24.429	23.319	8.933
14:1	0		0	0		0	0
16:1	0.234	0.324	0.116	12.981	0.009	0.463	0
18:1	31.921	22.382	45.405	43.755	23.756	22.686	8.799
20:1	0	0.062	0.131	1.890	0.661	0.170	0.134
22:1	0	0	0	0.233	0	0	0
Total PFA	12.214	24.129	7.920	1.502	15.559	13.455	47.174
18:2	12.214	23.807	7.833	1.296	15.555	13.201	38.093
18:3	0	0.062	0.087	0.206	0.003	0.254	9.080
20:5	0	0	0	0	0	0	0

Table 2. Fatty Acid Composition of Nuts (per 100 g edible portion) (Continued)

	Almonds	Brazil	Hazelnuts	Macadamia	Peanuts	Pistachio	Walnuts
22:5	0	0	0	0	0	0	0
22:6	0	0	0	0	0	0	0
Phytosterols (mg)	120		96	116	220	214	72
Stigmasterol (mg)	4		1	0		5	1
Campesterol (mg)	5		6	8		10	7
β-Sistosterol (mg)	111		89	108		198	64

[1]US Department of Agriculture & Agricultural Research Service, 2002.

Table 3. Effects of Nuts on Diet

Study and subjects	Design		Treatment	Duration	Energy (kcal)			Fat (% of energy)			Carbohydrate (% of energy)			Protein (% of energy)			Fiber (g)		
					CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]
Studies using addition with nuts (ADD)																			
Spiller *et al*, 1998	Dietary advice,	C	Background +	4 wks	1852	1917	65	33	35	2	48	45	-3	15	17	2	18	26	8
33 females	randomized,		butter (28 g)																
12 males	controlled,		cheese (85 g)																
	parallel arm	I	Background +	4 wks	1668	1703	35	34	39	5	47	44	-3	17	16	-1	15	25	10
			almonds (100 g)																
			Background +	4 wks	2013	2183	170	28	35	7	52	47	-5	8	17	9	22	29	7
			olive oil (48 g)																
Studies using substitution with nuts for other fats (SUB)																			
Chisholm *et al*, 1998	Dietary advice,	C	Low-fat diet	4 wks	2171	2255	84	30	38	8	46	40	-6	19	17	2	30	30	0
21 males	randomized,	I	Walnut diet	4 wks															
	Crossover		walnuts (78 g)																
Jenkins *et al*, 1997	Dietary advice,	C	Habitual diet	2 wks	2327	2300	-27	29	25	-4	54	62	8	14	12	-2	29	64	35
3 females	randomized,	I	Vegetable diet	2 wks															
7 males	Crossover		nut mixture (100 g)																
O'Byrne *et al*, 1997	Dietary advice,	C	Low-fat diet	6 mos	1687	1446	-241	23	17	-6	60	63	3	19	22	3	14	17	3
36 females	parallel arm	I	Low-fat diet +	6 mos	1848	1654	-194	34	26	-8	50	55	5	15	20	5	11	22	11
			peanuts (35-68 g)																

Table 3. Effects of Nuts on Diet (Continued)

Study and subjects	Design		Treatment	Duration	Energy (kcal)			Fat (% of energy)			Carbohydrate (% of energy)			Protein (% of energy)			Fiber (g)		
					CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]	CD	ID	D[1]
Studies using free-feeding with nuts (FF)																			
Almario *et al*, 2001	Crossover																		
13 females	No dietary advice	C	Habitual diet	4 wks	1936	2333	397	31	37	6	51	47	-4	17	15	-2	19	21	2
5 males		I	Habitual diet + walnuts (48 g)	6 wks															
	Dietary advice	C	Low-fat diet	6 wks	1590	1951	361	20	34	14	61	50	-11	19	16	-3	19	21	2
		I	Low-fat diet + walnuts (48 g)	6 wks															
Studies using addition, substitution, and free-feeding with nuts																			
Alper *et al*, 2002	Crossover																		
7 females	No dietary advice	C	Habitual diet	3 wks															
8 males	No dietary advice	FF	Habitual diet + peanuts (89 g)	8 wks	2290	2460	170	31	39	8	56	48	-8	14	15	1	18	26	8
	Dietary advice	ADD	Prescribed diet + peanuts (89 g)	3 wks	2290	2510	220	31	39	8	56	47	-9	14	17	3	18	29	11
	Dietary advice	SUB	Prescribed diet + peanuts (89 g)	8 wks	2290	2300	10	31	35	4	56	51	-5	14	17	3	18	28	10

Note: C = Control, I = Intervention, CD = Control diet, ID = Intervention diet, wks = weeks, mos = months.

[1]The difference (D = ID – CD) was calculated based on the means of CD and ID reported in the published studies.

CHAPTER 3

METHODS

A. Subjects

Three hundred men and women who responded to newspaper, radio, and campus advertisements initially were screened by telephone for age, allergies to nuts, body mass index (BMI), consumption of nuts, smoking status, and weight gain/loss status (Appendix A). A second telephone screen established medical status, drug and alcohol use, and physical activity (Appendix B). Finally, a third screening process involved a face-to-face interview (Appendix C) with two investigators, and questionnaires regarding dietary (Appendix D) and exercise habits (Appendix E). Subjects were enrolled if they met the following inclusion criteria: age 25 and 70 years, did not smoke, had no known allergies to nuts, ate nuts less than twice a week or ate less than 57 g (~2 oz) of nuts weekly, did not have more than 9 kg weight change in the last six months, had BMI below the 95th percentile according to national distributions for age, gender and race (Must, Dallal, & Dietz, 1991; US Department), did not follow a very heavy exercise program, had no concurrent medical conditions that might affect body weight, drank no more than two glasses of alcoholic beverage per day, was not pregnant, or did not consume a very atypical diet. One hundred men and women enrolled; 81 completed the study. Five withdrew because of inconvenience; 3 women became pregnant, 2 moved out of the area, 3 were unable to comply with the repeated telephone 24-hour recalls, 4 had gastrointestinal reactions to almonds, 1 died of causes unrelated to nut consumption, and 1 was dropped because of

a physician-recommended weight loss. The dropouts included 13 women (Mean BMI = 24.32 kg/m2, SD = 4.05) and 6 men (Mean BMI = 27.97 kg/m2, SD = 4.43), with average age 40.4 years. Baseline characteristics of subjects who completed the study are shown in Table 1.

B. Study Design

A multiple crossover design was used. Subjects were randomly allocated to four groups based on stratification by age, sex, and BMI. Subjects were entered into the study in staggered 3-month intervals, each period representing a particular season of the year to offset any seasonal effects on diet and body weight. The first group started in April, the second in July, the third in October, and the fourth in January (Figure 1). In each quarter, equal numbers of subjects, with similar attributes (age, sex, BMI), were enrolled to the habitual (control) and almond supplemented diets (intervention).

In each group, subjects were followed for 12 months. The first six months comprised the control phase, where all subjects followed their usual, self-selected diet (habitual diet). Throughout the habitual diet period (HD), subjects attended four clinics (0, 2, 4, and 6 months). Body weight and waist/hip circumferences were assessed at the beginning of the study, and subsequently every two months; height was taken at 0 months. Blood samples were collected to assess levels of magnesium, leptin, total cholesterol, low density lipoprotein cholesterol (LDL), and high density lipoprotein (HDL) cholesterol, and nitric oxide in plasma, and fatty acid content of erythrocyte membranes at four and six months. Resting, fasting energy expenditure

was obtained from each subject to measure basal metabolic rate (BMR). This was performed once during the habitual diet at an early morning clinic using the Sensormedics 4400 metabolic unit (Sensormedics, 1983-90). Subjects also completed dietary and exercise questionnaires at each clinic, and a change in health status questionnaire at the end of the habitual diet period. Although there was no intervention during the habitual diet period, subjects' diets were assessed by 24-hour dietary recall, food diary, and food frequency questionnaire (described below).

The intervention phase occurred in the second six months of the study for all subjects. There were three clinics during this period--at 8, 10, and 12 months. The collection of anthropometric, resting, fasting energy expenditure, dietary data and changes in health status was repeated as was done during the habitual diet period; however, height was measured at 10 months, and blood samples were obtained at 8 and 12 months. At the end of the intervention period, subjects also completed three psychological scales. The Eating Attitudes Test provided an index of symptoms of anorexia nervosa (Garner & Garfinkel, 1979). The Three Factor Eating Questionnaire identified restrained and unrestrained eaters (Stunkard & Messick, 1985), and the Mood Assessment Scale assessed depression. A list of all the data obtained is summarized in Table 2.

During the intervention phase, subjects were required to add almonds to their habitual diets, thus this period will be referred to as the almond supplemented diet (AD). The almond supplement was equivalent to fifteen percent of each subject's mean energy intake during the habitual diet. Subjects were assigned to one of three

weight levels of nuts. Individuals whose energy intake was in the lowest tertile received 1.5 oz, middle tertile 2 oz, and the highest 2.5 oz. Subjects had a choice of either the dry roasted or raw nuts, or both. Participants were asked to eat the almonds daily with no restrictions on how and when to eat them. No dietary advice was given, except to suggest simply that the almonds may be eaten with meals or as snacks, or added to desserts or salads. Thus subjects ate the almonds as they thought best.

Each two months each subject was provided a large packaged supply of almonds free of charge, distributed at clinic visits. The nuts were packaged for weekly consumption, thus a week's supply contained seven small packets, each labeled with the amount of almonds (in grams) and the day of the week. This type of packaging allowed subjects to carry the smaller packets conveniently in purses, or pockets, and store the weekly packages in travel bags as necessary during vacations. The labels also helped subjects to remember if the nuts were eaten for a particular day. In addition, each was provided a large package of almonds for family members or friends to ensure that the labeled packages would not be consumed other than by the subject.

Throughout the study, the research staff made frequent telephone calls (apart from the 24-hour diet recalls) to subjects to remind them of clinic appointments or to verify information. The staff also participated in discussions with participants during clinic visits, acknowledged special occasions, and provided assistance with transportation to and from the clinics, when necessary. These helped establish a relationship of trust with the study participants. This was particularly valuable during the intervention phase as it was important that the investigators knew if the almonds

were not eaten for any reason at all, and that there would be no repercussion for doing so. When subjects reported missing a day, they were advised to double up their almond intake the following day. If they reported not eating the nuts for several days due to illness, they were advised to resume eating the nuts gradually.

C. Dietary Assessment

1. Twenty-Four Hour Dietary Recalls

At the beginning of the study, a registered dietitian explained how the telephone diet recalls would be conducted. Actual samples of foods, cups, glasses, bowls and spoons, as well as the Food Portion Visual ™, were presented to assist subjects in estimating portion sizes. Seven random order telephone 24-hour recalls (5 weekdays and each weekend day), one every three to four weeks, were obtained for each diet period, thus a total of 14 diet recalls were collected for the duration of the study. All recalls were unannounced and tape-recorded. Registered dietitians or graduate students in nutrition obtained the recalls using Nutrition Data System version 2.8 ("Nutrition Data System Software," 1993). A second dietitian later reviewed a random sample of the recordings and edited the recalls as needed. Data from dietary recalls were used to examine the effect of almond supplementation on nutrient and food intake patterns.

2. Food Diaries

During the 2nd clinic visit of the habitual diet period, subjects were given a 1-day (practice) food diary to record their food intakes (Appendix F). The diary was a booklet containing detailed instructions and photographs of different

servings of foods. For each eating episode, subjects were asked to define whether the eating episode was a meal (breakfast, lunch, dinner) or a snack, to record in detail every item that they ate or drank, the time they ate it, the amount they ate, and how the food was prepared. The diary also included a series of 19-point appetitive rating scales. Subjects were asked the following questions: 1) How hungry do you feel right now? 2) How strongly is your desire to eat right now? 3) How full do you feel right now? 4) How thirsty do you feel right now? 5) How pleasant was the meal you just consumed? 6) How much food do you think you could eat right now? Self-ratings were obtained either before and/or after each eating episode for hunger from *Not at all* (1) to *Extremely* (19) hungry, desire to eat from *Not at all* (1) to *Extremely* (19) strong, fullness from *Not at all* (1) to *Extremely* (19) full, thirst from *Not at all* (1) to *Extremely* (19) thirsty, pleasantness from *Not at all* (1) to *Extremely* (19) pleasant, and amount you could eat from *A large amount* (1) to *Nothing at all* (19).

After completion of the 1-day practice diary, research staff reviewed the diary, and subjects were instructed if any recording errors were noted. For each diet period, two food diaries (one Sunday, and one Wednesday) were obtained. Diaries were collected at months 4 and 6 during the HD, and at months 8 and 12 during the AD. Blank food diaries were mailed to each subject a week prior to the clinic visit, and subjects were instructed to complete the diary on the day preceding the clinic. After the completed diaries were submitted, the investigator reviewed the diaries and contacted the subjects by phone when data from the diaries were missing or needed clarification. Food diary data were entered and coded by the investigator using

Nutrition Data System software package version 2.8 ("Nutrition Data System Software," 1993). Data from food diaries were used to examine the effects of the intervention on eating patterns and satiety.

3. Food Frequency Questionnaire

At the end of each diet period (6 and 12 months) each subject submitted a diet questionnaire (Appendix G) during clinic, which assessed eating patterns and food choices over the previous six months. Section A of the questionnaire asked about the timing, location and duration of each meal, and the types of snack foods eaten. Section B was a food frequency questionnaire (FFQ) with a list of 187 items, and section C assessed the intake of vitamins, minerals and other dietary supplements. The questionnaires were mailed a week prior to the clinic visit to avoid fatigue and to minimize the number of activities during clinic visits.

D. Anthropometric Measurements

Body weight while fasting was measured using the Scale-Tronix electronic scale (Abbey et al., 1994) calibrated at the beginning of each morning clinic using a standard 122.9-pound weight. Subjects were instructed to have fasted 12 hours and drunk no more than one cup of liquid prior to the morning of the clinic. Subjects were weighed in light clothing and without shoes. Waist and hip circumferences were taken while the subject was standing and breathing quietly, and unclothed, although close fitting slip and underwear were allowed (Appendix H). Girdle or pantyhose was not worn during this measurement. Waist was measured one-inch above the navel, and

the hips at the largest point between the waist and thighs. All measurements were made by trained research staff, and recorded to the nearest quarter inch.

E. Laboratory Procedures

Blood was drawn at 4, 6, 8, and 12 months. At each of these clinics, 4.5-ml of blood was drawn into a vacutainer tube containing sodium ethylenediaminetetraacetic acid (EDTA) from each subject after a 12-hour fast. Plasma was analyzed for triglycerides, total cholesterol, LDL cholesterol, and HDL cholesterol, magnesium, nitric oxide, and leptin. Total lipid was analyzed from erythrocyte membranes. Since almonds are rich in oleic acid, the oleic acid content of erythrocyte membranes was measured as an indicator of compliance. Lipids were extracted from plasma using chloroform: methanol (2:1 v/v) (Folch, Lees, & Sloane-Stanley, 1957). Individual lipid classes were separated by preparative thin-layer chromatography (Watkins et al., 2001). Fatty acid methyl esters were separated and quantified by capillary gas chromatography using a gas chromatograph (Hewlett-Packard model 6890, Wilmington, DE) equipped with a 30 m DB-225MS capillary column (J&W Scientific, Folsom, CA) and a flame-ionization detector (Watkins et al., 2001).

F. Assessment of Physical Activity

All subjects completed a short 4-item physical activity questionnaire at 0, 2, 4, 6, 8, 10 and 12 months, which assessed changes in the level of physical activity over the last twelve months (Appendix I).

G. Assessment of Basal Metabolic Rate

BMR was measured once during each diet period. Subjects were instructed to fast and not to engage in any exercise immediately before the BMR test.

H. Change in Health Status

At the end of each diet period (6 and 12 months) subjects informed us about changes in their health status by responding to questions about cigarette smoking, recent diagnosis of any medical conditions, prescription drugs, or pregnancy (Appendix J).

I. Statistical Analyses

1. Estimation of Nutrient Displacement

Let i be a nutrient. H_i is the intake of a nutrient during the habitual diet; S_i is the amount of that nutrient contained in the almond supplement; and A_i is the intake of that nutrient during the almond supplemented diet. Since the almond supplement methodologically was added to the habitual diet, the expected intake of that nutrient in the supplemented diet is $H_i + S_i$. Displacement of that nutrient (D_i) was estimated by subtracting the observed intake of that nutrient in the supplemented diet, A_i, from the expected intake of that nutrient; thus, $D_i = (H_i + S_i) - A_i$. Percent displacement was calculated by $D_i/S*100_i$. Dietary recall data was used for this analysis.

2. Changes in Nutrient Profile

The arithmetic mean of the seven diet recalls from each diet period was calculated, and paired t test was used to compare results from the habitual and almond

supplemented diets. Statistical significance was defined by $\alpha = 0.05$ (2-sided). Paired *t* test was carried out using Statistical Analysis System for Windows version 8 ("SAS for Windows Software Package," 1999). Data from dietary recalls was used for this analysis.

3. Displacement of Food Groups

Complex food items were broken down into individual components. Individual foods/components were then aggregated into separate categories using a modified food group scheme (See Chapter 5, Table 1). The daily temporal distribution of the amount and energy of selected food groups consumed during breakfast, lunch, dinner, snacks, and in the overall diet was calculated by taking the arithmetic mean of the seven diet recalls from each diet period. To determine which food groups were displaced, changes (from the habitual to the almond supplemented diet) in the consumption of foods during breakfast, lunch dinner, snacks, and in the overall diet were calculated. Displacement occurs when there is a change in the contribution of food groups to daily intake. Stepwise regression was used to determine which of the selected food groups consumed during snacks were predictors of change in energy intake. Dietary recall data was used to examine displacement of food groups. Analyses were carried out using Statistical Analysis System for Windows statistical software package version 8.("SAS for Windows Software Package," 1999)

4. Changes in Eating Patterns

Data from food diaries was used in the analyses. Two males each had a missing diary; therefore, data from only 79 subjects were included in the analyses of

eating patterns. Subjects defined each eating episode as meals (breakfast, lunch, or dinner) or snacks (eating episodes outside those defined as meals), thereby eliminating investigator bias on predefined meals and snacks.

a. Meal Skipping Patterns Meal skipping patterns were examined by calculating the average daily frequency of each meal (breakfast, lunch, and dinner) during each diet period. Subjects who had a mean daily value of 0.5 for a particular meal were considered meal skippers for that meal. McNemars Test for paired data was performed to compare the frequency of meal skippers between the habitual and almond supplemented diet periods.

b. Incorporation of Almonds in the Diet Descriptive analysis and chi-square tests were performed to describe how subjects incorporated almonds into their habitual diets. All statistical methods to examine eating patterns were carried out using Statistical Analysis System for Windows software package version 8.("SAS for Windows Software Package," 1999)

5. Effect on the Caloric Intake of a Subsequent Meal

Restricted maximum likelihood estimation for the general linear models was performed to examine the effect of several predictive variables on two separate endpoints defined below.

Table 1. Model Variables for Effect on the Caloric Intake of a Subsequent Meal

Variable type	Variable name
Categorical fixed effects	Gender, and diet period
Random effects	Subject ID nested within the intervention diet
Covariates	Time since last meal, BMI, age, caloric intake at last meal, cumulative nut calories up to but not including this meal, cumulative non-nut calories up to but not including this meal, and proportion of nut calories over total number of calories consumed at a given meal
Endpoints	Calories consumed at lunch, calories consumed at dinner

6. Effect on the Time Delay of a Subsequent Meal

Restricted maximum likelihood estimation for the general linear models was performed to examine the effect of several predictive variables on two separate endpoints defined below. All general linear models were carried out using Statistical Analysis System for Windows version 8 ("SAS for Windows Software Package," 1999).

Table 2. Model Variables for Effect on the Time Delay of a Subsequent Meal

Variable type	Variable name
Categorical fixed effects	Gender and diet period
Random effects	Subject ID nested within the intervention diet
Covariates	BMI, age, caloric intake at last meal, proportion of nut calories over total number of calories consumed at a given meal
Endpoints	Time since last meal/snack before lunch and time since last meal/snack before dinner

J. Ethical Approval

Approval of the design and ethical conduct of this study was obtained from the Institutional Review Board of The Loma Linda University Human Subjects Committee before the study began. Each subject signed a consent form prior to enrollment in the study. Subjects who completed the study received $100, and their nutrient analysis and lipid profile reports.

Table 3. Baseline Characteristics of Subjects Completing the Study

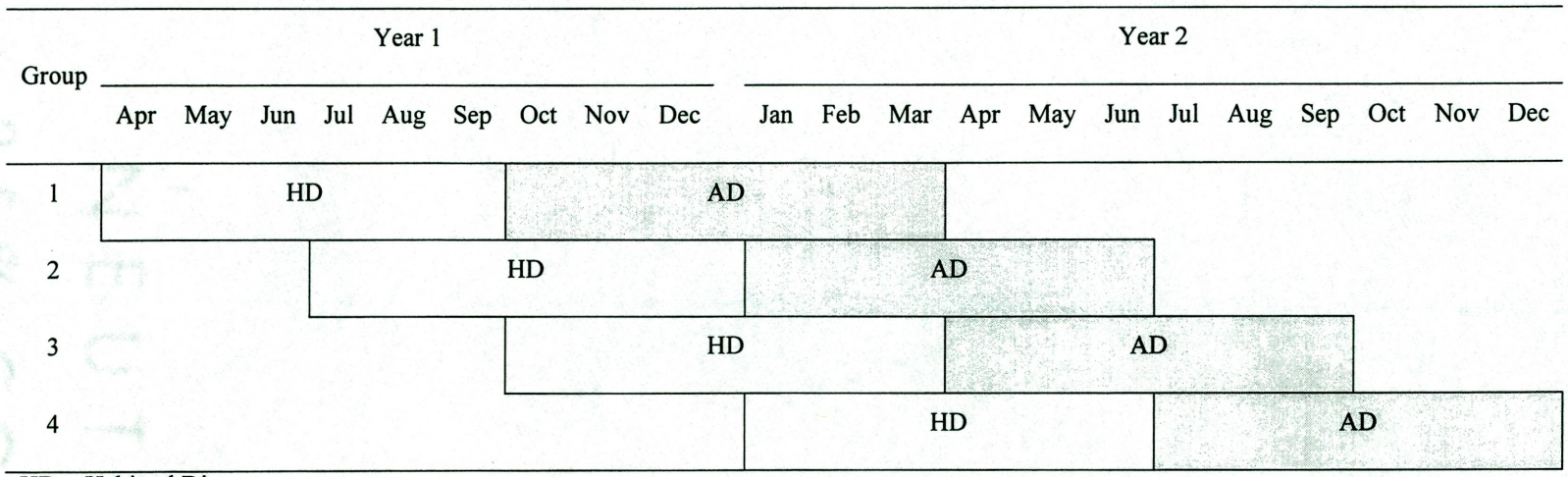
	Group				All
	1	2	3	4	
Males					
Number of subjects	11	11	11	10	43
Age (Years)*	49.8 (14.5)	47.7 (12.4)	52.0 (13.4)	47.0 (15.4)	49.2 (13.6)
BMI (kg/m2) *	27.1 (2.80)	25.4 (3.47)	26.8 (2.44)	27.5 (5.16)	26.7 (3.56)
Females					
Number of subjects	10	9	8	11	38
Age (Years)*	48.9 (13.4)	51.8 (11.7)	51.0 (15.3)	48.5 (14.9)	49.9 (13.4)

Table 3. Baseline Characteristics of Subjects Completing the Study (Continued)

	Group				All
	1	2	3	4	
BMI (kg/m2) *	25.9 (5.79)	28.1 (6.50)	25.3 (6.76)	24.8 (3.16)	25.9 (5.54)

Modified from Fraser *et al* (2002).
*Standard error in parentheses.

Figure 1. Study Design.



HD = Habitual Diet
AD = Almond Supplemented Diet

Table 4. Almond Study Time Table														
	Habitual diet								Almond supplemented diet					
Month	0	1	2	3	4	5	6		7	8	9	10	11	12
24-hour telephone diet recall	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Height	X											X		
Weight	X		X		X		X			X		X		X
Waist/hip	X		X		X		X			X		X		X
Exercise questionnaire	X		X		X		X			X		X		X
Diet pattern questionnaire	X		X		X		X			X		X		X
Food diary			Train X		X		X			X				X
Satiety scales			Train X		X		X			X				X
Blood draw					X		X			X				X
Stored serum					X		X			X				X
Serum magnesium analysis					X		X			X				X

Table 4. Almond Study Time Table (Continued)

	Habitual diet								Almond supplemented diet					
Month	0	1	2	3	4	5	6		7	8	9	10	11	12
Serum lipid profile analysis					X		X			X				X
RBC fatty acid analysis					X		X			X				X
Serum leptin analysis					X		X			X				X
Nitric oxide analysis					X		X			X				X
BMR	—	—	—	—	—	—	—		—	—	—	—	—	—
Eating patterns questionnaire							X							X
Food frequency questionnaire							X							X
Changes in health status questionnaire							X							X
Eating attitudes test														X
Three factor eating questionnaire														X
Mood assessment scale														X

CHAPTER 4

FIRST PUBLISHABLE PAPER

Long-Term Almond Supplementation Improves the Habitual Diets of Free-Living Healthy Individuals

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Short title: Long-term almond supplementation improves habitual diets

Key words: Almonds, Habitual diets, Nutrient intake, Nutrient displacement

Submitted to *British Journal of Nutrition* on January 13, 2003.

Abstract

Epidemiologic and metabolic studies have shown that regular nut consumption may protect against risk of heart disease and diabetes. None have investigated the effect of adding nuts to a self-selected habitual diet (containing little or no nuts) on dietary patterns. This study evaluated the impact of long-term almond supplementation in healthy men (43) and women (38) between the ages 25 and 70 years on nutrient profile and nutrient displacement. All subjects were followed for one year. During the first 6 months, subjects followed their habitual diets; in the second 6 months, subjects added almonds to their diets. Diets were assessed by 7 random 24-hour telephone diet recalls during each diet period. On average, the almond supplement was 52 g/d (~50 nuts) containing 1318 kilojoules. When subjects shifted from habitual to the almond supplemented diet, the intake of MUFA, PUFA, fiber, vegetable protein, magnesium, and potassium to sodium ratio significantly increased by 52%, 23%, 13%, 20%, 26%, and 17% respectively; the intake of saturated fats, animal protein, sodium, and cholesterol significantly decreased by 2%, 9%, 11%, and 11%, respectively. These nutrients exceeded the dietary recommendations to prevent cardiovascular and other chronic diseases. Displacement estimates for energy, fat, protein, dietary fatty acids, fiber, magnesium, and potassium ranged from 16% - 75%; total food weight, carbohydrate, and selenium, over 250%. A daily supplement of almonds can induce favorable nutrient modifications to an individual's habitual diet for chronic disease prevention.

Abbreviations

BMI Body Mass Index

CVD Cardiovascular Disease

DRI Dietary Reference Intake

g/d grams per day

kcal kilocalories

kg kilograms

kJ kilojoules

mcg/d micrograms per day

mg/d milligrams per day

MUFA Monounsaturated Fatty Acid

oz ounces

PUFA Polyunsaturated Fatty Acid

SFA Saturated Fatty Acid

The association between habitual dietary patterns and health status is well recognized (Appel *et al.*, 1997; Fung *et al.*, 2001; Lauber & Sheard, 2001). Scientific knowledge on the role of diet in health has prompted organizations such as the World Health Organization, European nutrition councils, the Food and Nutrition Board, as well as other authorities to issue dietary recommendations or guidelines for the public to promote healthful eating and prevent disease (Committee on Diet and Health *et al.*, 1989; Anonymous, 1990; Norum *et al.*, 1997; Serra-Majem *et al.*, 1997; Haddad, 2001). Some guidelines provide information about the consumption of foods and types of foods that can help the public make healthful choices. Food groups such as grains, fruits, vegetables, dairy products and meats have been incorporated into these recommendations. Because of the growing evidence of the cardio protective effect of nuts, examining the potential of nuts as a healthy food choice would be timely.

Findings from large epidemiologic investigations (Fraser *et al.*, 1992; Prineas *et al.*, 1993; Hu *et al.*, 1998; Albert *et al.*, 2002; Jiang *et al.*, 2002) and several metabolic studies (Kris-Etherton *et al.*, 1999) have shown that regular nut consumption may protect against risks of heart disease and diabetes. Specifically, the focus of nut research to date has been on the beneficial effect of nut consumption on plasma lipoproteins, plasma fatty acids, blood pressure (Kris-Etherton *et al.*, 1999; Curb *et al.*, 2000; Almario *et al.*, 2001; Rajaram *et al.*, 2001), and more recently, body weight (McManus *et al.*, 2001). In a previous publication, we reported the neutral effects of almond supplementation on body weight (Fraser *et al.*, 2002). The aforementioned studies, with the exception of those that evaluated body weight, have

been short-term feeding studies that used rigorous dietary intervention, which not only introduced nuts into the diet as the primary variable, but also imposed a prescribed reference diet that departed from an individual's habitual diet.

In this study, the effect of a daily supplement of nuts on the overall habitual diets of healthy individuals was examined. The impact of almond supplementation on nutrient profile and nutrient displacement of almond supplemented habitual diets will be reported and discussed in this paper.

Methods

Subjects

Subjects were recruited by newspaper, radio, and bulletin board announcements. Men and women between the ages of 25 and 70 years, who met the inclusion criterion, were enrolled. Individuals successfully enrolled in the study were below the 95th percentile of their age-sex body mass index (BMI) distribution (Must *et al.*, 1991), did not have more than 9 kg weight change during the last six months, ate nuts less than twice a week or ate less than 57 g (~2 oz) of nuts weekly, did not smoke, had no allergy or aversion to nuts, did not follow a rigorous exercise program, had no concurrent medical conditions that might affect body weight, drank no more than two glasses of alcoholic beverage per day, were not pregnant, or did not consume a very atypical diet.

Design

Details of the randomization strategy used to enroll subjects into this study was previously reported (Fraser *et al.*, 2002). Briefly, subjects were randomly allocated to

four groups stratified by age, sex, and BMI. Subjects were entered into the study in staggered 3-month intervals, each period representing a particular season of the year to offset any seasonal effects on diet. In each quarter, equal numbers of subjects, with similar attributes, were enrolled.

All subjects were followed for 12 months. The first six months comprised the control diet period, where all subjects followed their habitual diet. Although there was no intervention during the habitual diet period, the diets were assessed. The intervention required subjects to incorporate almonds into their diet, thus this period will be referred to as the almond supplemented diet. The almond supplement was equivalent to fifteen percent of each subject's mean energy intake during the habitual diet period. Subjects had a choice of either the dry roasted or raw nuts, or both. All subjects were provided packaged daily portions of the almond supplement. No dietary advice was given, except to suggest simply that the almonds may be eaten with meals or as snacks, or added to desserts or salads. Thus subjects ate the almonds as they thought best.

Dietary assessment

In a previous publication, the intake of selected nutrients using two dietary assessment methods (24-hour dietary recalls and food diaries) was reported (Fraser *et al.*, 2002). Macronutrient intake data using the food diaries was related with large standard errors compared to the diet recalls. Therefore data collected from the diet recalls was used in this report. For each diet period, seven random order telephone 24-hour diet recalls (5 weekdays and each weekend day) were obtained by registered

dietitians using Nutrition Data System software package version 2.8 (The Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA, 1993). All recalls were unannounced and tape-recorded.

Compliance

Since almonds are rich in oleic acid, the oleic acid content of erythrocyte membranes was measured as an indicator of compliance. Blood samples to assess the oleic acid content of erythrocyte membranes were collected at four and six months during the habitual diet period, and at eight and twelve months during the intervention. Lipids were extracted from plasma using chloroform: methanol (2:1 v/v) (Folch *et al.*, 1957). Individual lipid classes were separated by preparative thin-layer chromatography (Watkins *et al.*, 2001). Fatty acid methyl esters were separated and quantified by capillary gas chromatography using a gas chromatograph (Hewlett-Packard model 6890, Wilmington, DE) equipped with a 30 m DB-225MS capillary column (J&W Scientific, Folsom, CA) and a flame-ionization detector (Watkins *et al.*, 2001).

Estimation of nutrient displacement

Let i be a nutrient. H_i is the intake of a nutrient during the habitual diet; S_i is the amount of that nutrient contained in the almond supplement; and A_i is the intake of that nutrient during the almond supplemented diet. Since the almond supplement methodologically was added to the habitual diet, the expected intake of that nutrient in the supplemented diet is $H_i + S_i$. Displacement of that nutrient (D_i) was estimated by subtracting the observed intake of that nutrient in the supplemented diet, A_i, from the

expected intake of that nutrient; thus, $D_i = (H_i + S_i) - A_i$. Percent displacement was calculated by $D_i/S*100_i$.

Statistical analysis

The arithmetic mean of the seven diet recalls from each diet period was calculated, and paired *t* test was used to compare results from the habitual and almond supplemented diets. Statistical significance was defined by $\alpha = 0.05$ (2-sided). Results are presented as means and standard deviations, or means and standard errors of the means. Paired *t* tests of Statistical Analysis System for Windows statistical software package version 8 (SAS Institute Inc., Cary, NC, USA, 1999) was used.

Ethical approval

Approval of the design and ethical conduct of this study was obtained from the Institutional Review Board of The Loma Linda University Human Subjects Committee before the study began.

Results

Subjects

Initially 100 subjects were enrolled, and 81 completed the study. Thirteen women and 6 men dropped out. The average age of these dropouts was 40.4 years. The average age of individuals who completed the study was slightly above 49 years for both males and females. Gender differences in BMI values were similar to those observed in the American population (Must *et al.*, 1991).

Compliance

Oleic acid as a portion of total membrane fat significantly increased ($p \leq 0.001$) from 11.53% during the control diet to 12.08% during the almond supplemented diet. This indicates that study participants adhered to the intervention.

Nutrient profile

Changes in the intake of selected nutrients between the habitual and almond supplemented diets comparing males and females are shown in figures 1 and 2. Since there were no significant gender differences in the intake of macronutrients and minerals, data for males and females were combined in succeeding analyses.

Changes in the intake of selected macronutrients and dietary fatty acids when subjects shifted from the habitual to the almond supplemented diets are shown in table 1. Average total energy intake increased significantly, but the total weight of food significantly decreased. On average, the diets during the almond supplemented diet compared to the habitual diet had higher total fiber content ($p = 0.0007$) and insoluble to soluble fiber ratio ($p < 0.0001$). The average carbohydrate and dietary cholesterol intake each was significantly reduced during the almond supplemented diet by 11%. Although total protein content did not change, proteins from animal sources dropped while proteins from vegetable sources rose significantly during the almond supplemented diet. The average lysine to arginine ratio also decreased ($p = 0.0001$) during the almond supplemented diet. Total fat intake increased by 24% during the almond supplemented diet ($p < 0.0001$), but there was a significant improvement in the fatty acid intake profile. During the almond supplemented diet, the intake of total

saturated fat (SFA) decreased by 2%; monounsaturated (MUFA) and polyunsaturated fatty acid (PUFA) increased by 52% and 23%, respectively. Specifically, dietary levels of stearic acid fell by 3%, linoleic acid increased by 26%, and oleic acid rose by 54% during the almond supplemented diet.

Changes in the relative intake of micronutrients comparing the habitual and almond supplemented diets are shown in table 2. The intakes of magnesium and phosphorus were significantly higher, and those of calcium and selenium significantly lower during the almond supplemented diet compared to the habitual diet. Sodium intake significantly dropped by 11% during the almond supplemented diet. Since potassium intake did not change significantly from the habitual to the almond supplemented diet, the concomitant increase in potassium to sodium ratio was proportionate to the change in sodium intake. On average, changes in the intake of copper, iron, zinc, and most of the vitamins were not significant.

Nutrient displacement

Estimates of percentage displacement of macro- and micronutrients and dietary fatty acids after six months supplementation with almonds are shown in table 3. The nutrient composition of the almond supplement is presented on the third column of table 3. On average, the almond supplement consumed by study participants was 52 g. Based on our calculations, percentage nutrient displacement by definition is an inverse measure of the degree to which the almond supplement induced a change in the content of a particular nutrient in the supplemented diet. For example, zero percent displacement means that the amount of a nutrient *i* present in almonds is totally added

to the supplemented diet. Displacement estimates of 100% mean that nutrient *i* from almonds replaced an equal amount of that nutrient in the supplemented diet by reducing the intake of nutrient *i* from foods other than almonds. A value between zero and 100, therefore, indicates partial displacement. A value of greater than 100% means nutrient *i* in almonds more than fully displaced that nutrient, and the overall supplemented diet now contains less of this nutrient. A negative percent displacement indicates that not only was there no displacement but that non-almond foods in the supplemented diet contained more of nutrient *i* than in the habitual diet period.

Macronutrients. In the almond supplemented diet, more than ½ of the total energy, over 1/3 the protein, and nearly ¼ of the fat present in almonds were displaced. Displaced dietary fatty acids in the almond supplemented diet were 75% of SFA, 16% of MUFA, and 25% of PUFA found in almonds. The estimated carbohydrate displacement in the almond supplemented diet was 260%. More than 1/3 of the total fiber content from almonds was displaced in the almond supplemented diet.

Micronutrients. Displacement estimates for magnesium, phosphorus, potassium, zinc, thiamin, and folic acid ranged from 23% to 99% in the almond supplemented diet. The micronutrients with displacement estimates of 100% or greater were calcium, iron, selenium, riboflavin, pantothenic acid, vitamins B_6, C and E, and α-tocopherol. Micronutrients with negative displacement estimates in the almond supplemented diet were copper and niacin.

Discussion

Our results indicate that simply adding a daily supplement of almonds (52 g) to an individual's habitual diet can induce favorable nutrient modifications. The nutrient profile of the almond supplemented diet was an overall improvement of the habitual diet: significant increases in the intake of MUFA, PUFA, fiber, magnesium, plant protein and potassium to sodium ratio, and significant reductions in SFA, animal protein, cholesterol, sodium, and lysine to arginine ratio. These nutrients, along with others which decreased from the habitual to the almond supplemented diet (calcium and selenium), as well as those which remained relatively unchanged (iron, zinc, copper and most of the vitamins) were either within or exceeded the dietary recommendations to prevent CVD and chronic diseases, or consistent with the Daily Reference Intakes (See Table 4 for summary) (Food and Nutrition Board & Medicine, 2000).

After six months of almond supplementation, total energy intake increased. Because of the evidence that associates high caloric intake with obesity and other chronic diseases, the dietary guidelines recommend a caloric intake that should not exceed that required to maintain a BMI of 25 or less (Shikany & White, 2000; Lauber & Sheard, 2001). In a previous publication, the authors found on average, no statistically or biologically significant changes in body weight between the habitual and the almond supplemented diets (Fraser *et al.*, 2002). This suggests perhaps that on average BMI was maintained throughout the study, in spite of the increased energy

intake. The almond supplemented diet, therefore, meets the dietary recommendations for energy intake.

The fiber content of the almond supplemented diet was within the dietary recommendations, and well above the population average. Although the insoluble to soluble fiber ratio of the almond supplemented diet was just below the dietary guidelines for chronic disease prevention (3:1), it was a significant improvement from the habitual diet. The cholesterol intake in the almond supplemented diet (absolute cholesterol intake = 191.3 mg/day) exceeds not only the guidelines for the general population (≤300 mg/day), but also the individualized recommendations (≤200 mg/day) for those at increased risk of developing CVD (individuals with diabetes, lipoprotein disorders, or pre-existing heart disease) (Lauber & Sheard, 2001).

In spite of the increased total fat intake in the almond supplemented diet, the changes in the dietary fatty acid profile were favorable. Additionally, when subjects crossed over to the almond supplemented diet, protein intake pattern shifted from animal to plant sources of protein, which is a strategy recommended by Shikany et al (2000) to reduce saturated fat intake. This observation suggests that the protein content in almonds possibly displaced animal sources of protein in the almond supplemented diet.

Although the average sodium intake during the almond supplemented diet was above the recommendation of ≤2400 mg, it was a significant reduction from the subjects' habitual diet. This decrease may have contributed to the significant improvement in the potassium to sodium ratio in the almond supplemented diet.

Observed intake levels for calcium, magnesium, folic acid, and vitamin D in the almond supplemented diet were within the dietary recommendation for the prevention of chronic diseases, or the current Dietary Reference Intake (DRI) (Trumbo *et al.*, 2001).

There were no significant changes in the antioxidant vitamins (as well as the B vitamins) between the two diets. The intake of these nutrients during the almond supplemented diet was within the DRI. In spite of the 13% decrease in selenium from the habitual to the almond supplemented diet, selenium in the almond supplemented diet was above the DRI.

During the intervention phase of our study, subjects incorporated an average of 52 g of almonds to their habitual diet each day. If the almond supplement simply was added to the habitual diet, one would expect the total weight of the almond supplemented diet to increase by 52 g, fat by 1083 kJ (259 kcal), and energy by 1318 kJ (315 kcal). This is not what occurred. Total weight of the almond supplemented diet dropped ~130 g, fat increased only 812 kJ, and energy increased 616 kJ. These findings suggest that the subjects' diets were more energy dense during the almond supplemented diet (2.97 kJ/g) compared to the habitual diet (2.66 kJ/g); in addition, they provide evidence that some displacement occurred.

Our calculations show that energy in the almond supplemented diet was partially displaced by almonds. Other investigators observed similar findings during free feeding with peanuts (Alper & Mattes, 2002). Displacement estimates show that almonds displaced macronutrients in the following order (from smallest to greatest

percentage displacement): fat < protein < carbohydrate. Interestingly, this displacement pattern is similar to that found in short-term satiety studies in which fats were shown to be slightly or much less satiating than carbohydrates (Foltin *et al.*, 1992; Green *et al.*, 1994; Rolls *et al.*, 1994), which means that fats were eaten more.

The displacement pattern of dietary fatty acids (MUFA < PUFA < SFA), combined with the observation that animal proteins were reduced in the almond supplemented diet suggests perhaps that almonds may have induced a natural change in the diet that led to a retention of its monounsaturated fats while displacing other fats by reducing the intake of foods high in saturated fats, such as meats, cheeses and other dairy products. Since the carbohydrate content from almonds is small, it is perhaps not surprising that all of it could be displaced. The 260% estimated carbohydrate displacement suggests that an additional 160% of carbohydrate from other sources were eliminated. Given that the fiber content in the almond supplemented diet was greater, it is possible that almonds induced a specific displacement pattern that reduced the intake of sugar-rich foods, or increased the intake of complex carbohydrates such as fruits and vegetables in the supplemented diet. Displacement estimates for vitamin E and calcium were just above 100%, which suggests that the entire amount of these nutrients from the almonds were retained while other sources of these nutrients in the supplemented diet were eliminated.

To summarize, when almonds were incorporated into the habitual self-selected diets of healthy individuals, total energy, total protein, total fat, dietary fatty acids, total fiber, magnesium, phosphorus, potassium, zinc, thiamin, and folic acid were

partially displaced in the supplemented diet. Total food weight, carbohydrate, and selenium were more than fully displaced, and the almond supplemented diet contained less of these nutrients. Nutrient displacement estimates in this study may be a potential indicator of the degree to which a particular nutrient from almonds is metabolized. More research is needed to evaluate the food displacement and eating patterns of individuals after supplementing their habitual diets with nuts. Results from such an investigation may reveal behavioral eating patterns that may be useful in dietary interventions and in teaching the larger population how to incorporate nuts into their habitual diets, as well as generate other hypotheses regarding the metabolism of nuts.

Acknowledgment

This paper was presented in part at the International Congress of Nutrition, Vienna, Austria, August 2001. The authors are grateful to the California Almond Board for a grant to support this work, and to Ingrid Hoffmann, PhD, for her critical comments on a previous draft of this manuscript.

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Figure 1. Comparison Between Males (n=43) and Females (n=38) of the Change (as Percent Difference) in the Intake of Selected Nutrients From Habitual to Almond Diets.

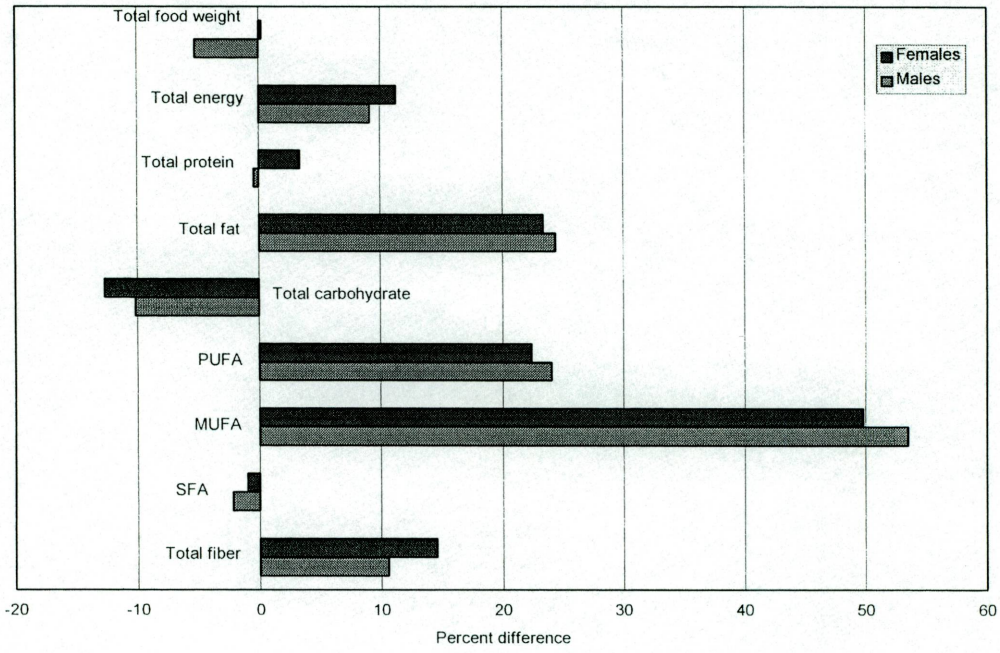

Figure 2. Comparison Between Males (n=43) and Females (n=38) of the Change (as Percent Difference) in the Intake of Minerals From Habitual to Almond Diets.

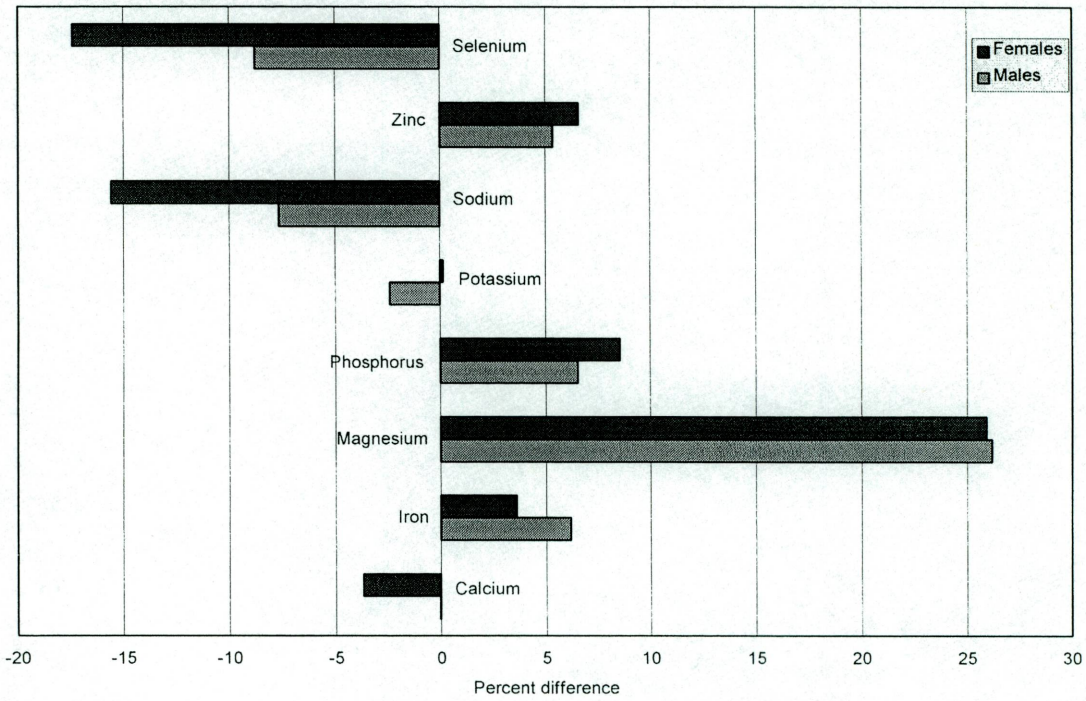

Table 1. Changes in the Intake of Selected Nutrients of 81 Subjects Assessed by Seven 24-Hour Recalls for Each Diet Period. (Dietary Intake as Means and Standard Deviations) (Percent Differences as Means and Standard Error of the Means)

	Dietary intake				Difference			
	Habitual diet h		Almond supplemented diet a		Absolute a-h		Percent[§] (a-h)/h*100	
Variable	Mean	SD	Mean	SD	Mean	$p^{\ddagger}$	Mean	SEM
Total food weight (g/d)	3204.2	795.7	3074.4	729.5	-129.8	0.01	-2.7	1.5
Total energy (kJ/d)	8522.3	2646.3	9138.3	2582.9	615.9	0.0005	10.1	2.3
Total protein (% of energy)	14.8	2.9	14.9	2.9	0.04	0.89	1.3	1.7
Animal protein (% of energy)	8.6	3.2	7.6	2.8	-1.0	<.0001	-9.4	2.4
Vegetable protein (% of energy)	6.2	2.4	7.2	2.9	1.1	<.0001	20.1	2.9
Total fat (% of energy)	32.3	6.0	39.2	5.2	6.9	<.0001	23.9	2.1
Total carbohydrate (% of energy)	54.6	7.5	48.2	6.9	-6.4	<.0001	-11.4	0.9
Total fiber (g/4184 kJ)[*]	11.3	3.2	12.3	2.8	1.0	0.0007	12.5	2.9
Soluble fiber (g/4184 kJ)	3.9	1.2	3.6	1.1	-0.3	0.003	-4.6	2.9
Insoluble fiber (g/4184 kJ)	7.3	2.1	8.6	1.9	1.3	<.0001	22.7	3.3
Insoluble-soluble fiber ratio	1.9	0.3	2.5	0.4	0.6	<.0001	32.2	2.9
Cholesterol (mg/4184 kJ)	104.9	49.6	87.6	38.7	-17.3	<.0001	-10.6	3.4
Water (g/d)[†]	2757.9	723.0	2614.5	667.9	-143.4	0.001	-3.8	1.7
Lysine-arginine ratio	1.1	0.1	1.0	0.1	-0.2	0.0001	-8.4	2.7
Fatty Acids								
Total SFA (% of energy)	10.5	2.6	10.1	2.2	-0.4	0.04	-1.7	2.1
Total MUFA (% of energy)	12.3	2.6	18.1	2.5	5.8	<.0001	51.8	3.5
Total PUFA (% of energy)	7.0	1.8	8.3	1.6	1.3	<.0001	23.3	2.6
16:0 (% of energy)	5.6	1.3	5.5	1.1	-0.1	0.48	0.7	1.8
18:0 (% of energy)	2.7	0.7	2.5	0.6	-0.2	0.006	-3.4	2.2
16:1*n*-7 (% of energy)	0.5	0.2	0.5	0.2	0.01	0.45	5.7	2.8
18:1*n*-9 (% of energy)	11.6	2.4	17.3	2.4	5.7	<.0001	54.3	3.7
18:2*n*-6 (% of energy)	6.2	1.6	7.5	1.4	1.3	<.0001	25.9	2.8
18:3*n*-3 (% of energy)	0.6	0.2	0.6	0.2	0.01	0.71	4.5	3.0

SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SD, standard deviation; SEM, standard error of the means. [*] 4184 kj = 1000 kcal.
[†] Including all fluids. [‡] *t* test comparing habitual and almond diets. [§] Mean of percent difference.

Table 2. Changes in the Micronutrient Intake of 81 Subjects Assessed by Seven 24-Hour Recalls for Each Diet Period (Dietary Intake as Means and Standard Deviations. Differences as Means and Standard Error of the Means)

	Dietary intake				Difference			
	Habitual diet h		Almond supplemented diet A		Absolute a-h		Percent‡ (a-h)/h*100	
Variable	Mean	SD	Mean	SD	Mean	$p^{\dagger}$	Mean	SEM
Calcium (mg/4184 kJ) *	569.5	242.1	529.8	210.8	-39.7	0.05	-1.7	3.3
Iron (mg/4184 kJ)	14.8	32.8	13.2	19.2	-1.6	0.30	5.0	3.6
Magnesium (mg/4184 kJ)	204.9	82.8	245.4	76.0	40.4	<.0001	26.1	3.2
Phosphorus (mg/4184 kJ)	661.6	132.7	698.4	108.7	36.8	0.002	7.5	1.8
Potassium (mg/4184 kJ)	1524.2	325.7	1475.0	269.5	-49.2	0.09	-1.2	2.0
Sodium (mg/4184 kJ)	1575.2	285.3	1363.2	280.5	-212.0	<.0001	-11.4	2.5
Zinc (mg/4184 kJ)	9.4	7.3	9.0	6.8	-0.3	0.59	6.0	5.3
Copper (mg/4184 kJ)	1.2	0.8	1.9	4.9	0.6	0.23	46.0	27.4
Selenium (mcg/4184 kJ)	69.5	38.0	59.0	37.1	-10.5	0.0005	-12.9	2.5
Potassium-sodium ratio	1.0	0.3	1.1	0.3	0.1	0.0002	17.2	3.7
Vitamin A (mcg RE/4184 kJ)	1171.6	1084.0	1016.2	793.8	-155.4	0.07	3.0	7.7
β-carotene (mcg/4184 kJ)	2739.1	2478.4	2334.2	2310.6	-404.9	0.16	9.4	12.5
Thiamin (mg/4184 kJ)	4.0	8.3	3.6	9.0	-0.3	0.44	5.0	9.7
Riboflavin (mg/4184 kJ)	3.3	6.0	3.0	5.9	-0.3	0.44	14.4	10.6
Niacin (mg/4184 kJ)	25.9	60.6	26.2	80.9	0.3	0.90	0.3	4.2
Pantothenic acid (mg/4184 kJ)	6.2	7.5	5.7	7.2	-0.6	0.21	0.4	5.2
Vitamin B-6 (mg/4184 kJ)	4.8	10.1	4.8	9.7	-0.1	0.94	42.5	23.8
Vitamin B-12 (mcg/4184 kJ)	18.5	72.3	18.0	50.5	-0.5	0.92	59.4	24.6
Vitamin C (mg/4184 kJ)	240.8	464.3	203.0	294.3	-37.9	0.24	4.0	8.7
Vitamin D (mcg/4184 kJ)	4.8	3.4	4.2	3.1	-0.5	0.01	-3.9	5.2
Folic acid (mcg/4184 kJ)	257.8	135.9	239.6	117.5	-18.3	0.05	-0.5	3.7
Total vitamin E (mcg/4184 kJ)	60.3	83.4	56.4	76.6	-3.9	0.40	29.9	12.3
α-tocopherol (mg/4184 kJ)	59.3	83.5	55.6	76.7	-3.8	0.42	38.4	15.4

RE, retinol equivalents; SD, standard deviation; SEM, standard error of the means. * 4184 kj = 1000 kcal. † *t* test comparing habitual and almond diets. ‡ Mean of percent difference.

Table 3. Displacement of Selected Nutrients After Six Months Supplementation With Almonds: Means of Seven 24-Hour Recalls for Each Diet Period (Percent Displacement as Mean Values and Standard Error of the Means)

	Dietary intake			Nutrient displacement		
	Habitual diet	Almond supplemented diet	Almond supplement	Absolute D	Percent‡	
	H	A	S*	S+H-A	D/S*100	SEM
Total food weight (g/d)	3204.2	3074.4	51.9	181.7	330.1	113.0
Total energy (kJ/d)	8522.3	9138.3	1317.8	701.8	53.6	17.5
Total protein (kJ/d)	1248.1	1342.3	167.5	73.3	39.8	22.8
Vegetable protein (kJ/d)	520.2	644.0	167.5	43.6	20.0	11.9
Total fat (kJ/d)	2759.2	3570.8	1083.0	271.3	24.5	9.3
Total carbohydrate (kJ/d)	4654.9	4423.2	161.9	393.5	259.8	78.0
Total dietary fiber (g/d)	22.6	26.3	5.8	2.0	34.0	12.1
Soluble fiber (g/d)	7.7	7.6	0.6	0.7	121.3	44.7
Insoluble fiber (g/d)	14.5	18.4	5.2	1.3	24.8	9.1
Water (g/d)†	2757.9	2614.5	1.9	145.3	6738.5	2662.1
SFA (kJ/d)	907.6	929.7	101.1	79.0	75.0	37.0
MUFA (kJ/d)	1054.7	1645.2	703.3	112.7	16.4	6.1
PUFA (kJ/d)	589.7	754.1	227.2	62.8	25.0	9.8
16:0 (kJ/d)	479.7	508.0	71.7	43.4	61.8	25.3
18:0 (kJ/d)	233.0	234.1	21.3	20.1	92.1	50.1
16:1*n*-7 (kJ/d)	41.9	46.1	6.3	2.2	35.3	25.5
18:1*n*-9 (kJ/d)	995.2	1576.1	690.3	109.5	16.2	5.8
18:2*n*-6 (kJ/d)	526.5	685.0	217.7	59.2	25.0	9.2
18:3*n*-3 (kJ/d)	51.9	56.1	7.7	3.4	27.5	32.0

Table 3. Displacement of Selected Nutrients After Six Months Supplementation With Almonds: Means of Seven 24-Hour Recalls for Each Diet Period (Continued) (Percent Displacement as Mean Values and Standard Error of the Means)

	Dietary intake			Nutrient displacement		
	Habitual diet	Almond supplemented diet	Almond supplement	Absolute D	Percent‡	
	H	A	S*	S+H-A	D/S*100	SEM
Calcium (mg/d)	1137.9	1137.1	110.4	111.2	107.9	39.2
Iron (mg/d)	26.2	26.5	2.5	2.2	108.0	85.6
Magnesium (mg/d)	406.5	520.8	151.3	37.0	22.9	8.9
Phosphorus (mg/d)	1347.2	1522.1	291.8	116.9	37.8	13.3
Potassium (mg/d)	3053.6	3169.5	364.9	249.1	68.0	24.7
Zinc (mg/d)	18.8	18.9	0.9	0.8	62.4	150.1
Copper (mg/d)	2.4	3.7	0.5	-0.8	-152.3	175.0
Selenium (mcg/d)	136.1	124.1	2.4	14.5	663.9	288.5
Thiamin (mg/d)	7.9	7.6	0.1	0.3	64.1	1271.5
Riboflavin (mg/d)	6.1	5.8	0.2	0.5	170.1	278.3
Niacin (mg/d)	42.9	47.1	2.0	-2.2	-120.2	333.1
Pantothenic acid (mg/d)	11.9	11.4	0.2	0.7	451.7	438.6
Vitamin B-6 (mg/d)	8.7	8.4	0.05	0.4	688.4	3050.1
Vitamin C (mg/d)	401.7	384.9	0.5	17.3	1205.7	8312.0
Folic acid (mcg/d)	509.6	508.0	32.3	33.9	99.0	60.1
Total vitamin E (mg/d)	109.4	109.4	4.3	4.4	108.4	170.3
α-tocopherol (mg/d)	107.5	107.6	4.3	4.2	106.8	173.8

* Almond supplement is the net difference in almond intake between the habitual and almond diets.
† Including all fluids.
‡ Mean of percent difference.

Table 4. Summary table comparing the almond supplemented diet to dietary recommendations.

Dietary recommendations	Does the almond supplemented diet meet recommendations?
Energy intake should not exceed what is required to maintain a BMI of 25 or less.[*]	Yes
Fat intake restricted to ≤30% of total calories[†‡§‖]	No
SFA intake, <10% of energy[*†‡§]	Yes
MUFA intake, 13% of energy[*]	Yes
PUFA intake, 10% of energy[*†]	Yes
Cholesterol intake limited to <300 mg/day[†‡]	Yes
Shift dietary emphasis from animal to plant sources of protein.[‡]	
Animal protein decreased	Yes
Plant protein increased	Yes
Fiber intake, 20-30 g/d[‖**]	Yes
Insoluble to soluble fiber ratio, 3:1[‡]	No
Sodium intake limited to 2400 mg/d or less [*†‡***]	No
Intake of antioxidant nutrients	
Vitamin A, 900 mcg/d (males) [***] 700 mcg/d (females) [***]	Yes
Vitamin C, 90 mg/d (males) [***] 75 mg/d (females) [***]	Yes
Vitamin E, 15 mg/d (both) [***]	Yes
Selenium, 55 mcg/d (both) [***]	Yes
Magnesium, 420 mg/d (males) [***] 320 mg/d (females) [***]	Yes
Calcium, 1000-1200 mg/d (both) [***]	Yes

[*] Dietary guidelines for chronic disease prevention (Shikany & White, 2000)

[†] Diet and health (Committee on Diet and Health et al., 1989)

[‡] The American Heart Association dietary guidelines (Lauber & Sheard, 2001)

[§] Nutrition objectives for Europe, Spain, Italy, and Malta (Serra-Majem, Ferro-Luzzi, Bellizzi, & Salleras, 1997)

[‖] Nutritional goals of the Norwegian National Nutrition Council (Norum, Johansson, Botten, Bjorneboe, & Oshaug, 1997)

[**] Dietary guidelines for weight control (U.S. Department of Health and Human Services, Health, & Institute, 1998)

[***] Dietary reference intakes (Food and Nutrition Board & Medicine, 2000)

CHAPTER 5

SECOND PUBLISHABLE PAPER

Long-Term Almond Supplementation Without Dietary Advice Affects Food Intake and Eating Patterns in Free- Living Healthy Individuals

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Short title: Effect of almond supplementation on eating patterns

Keywords: eating patterns, food group displacement, dietary assessment, meal skipping, almonds, nuts

To be submitted to *International Journal of Obesity and Related Disorders*

Abstract

OBJECTIVE: Describe and discuss the impact of supplementing a self-selected habitual diet with small daily portions of almonds for six months without dietary advice, on how individuals naturally incorporate almonds into their diets, the displacement of food groups, and the temporal distribution of energy and amount of food consumed throughout the day.

DESIGN: A 12-month intervention study of eating patterns without (1st six months) or with (2nd six months) almond supplementation.

SUBJECTS: 43 healthy males (BMI: 26.7±3.56 kg/m^2) and 48 healthy females (BMI: 25.9±5.54 kg/m^2) between ages 25-70 years.

MEASUREMENTS: Amount of foods and energy consumed/day, meal frequency, and number of times almonds were eaten in a day assessed by 7 24-hour diet recalls and 2 food diaries for each diet period.

RESULTS: Regardless of gender and snacking behavior, almonds generally were incorporated into habitual diets by eating the nuts as a single portion rather than snacking on the nuts. After adjusting for age, sex, and BMI, decreases in the amount of grains, dairy products, fats, sweets, and vegetables consumed in the overall diet were significantly associated with change in energy from almonds, $F(8, 72)=3.15$, $p<0.005$. There was an overall reduction in breakfast skipping among males ($p<.01$) with almond supplementation. The proportion of frequent and infrequent snackers in females according to BMI did not differ significantly. In lean males, 35% were frequent snackers, and 65% were infrequent snackers; in obese males (BMI>84th

percentile), 88% were frequent snackers, and 12% were infrequent snackers (χ^2=6.4, p<.05).

CONCLUSION: Regardless of gender and snacking behavior, almonds were usually incorporated into habitual diets by eating the nuts as a single portion rather than snacking on the nuts. Chronic almond consumption induced a displacement pattern that led to a reduction in the intake of grains, dairy products, fats, sweets, and vegetables in the overall diet, and prevented breakfast skipping among lean males. These findings are important, as they may have contributed to improved energy intake regulation in this population. In promoting regular consumption of high fat, high energy foods such as almonds, a comprehensive dietary assessment should record displacement of foods and changes in eating patterns, as long-term almond supplementation significantly impact food consumption and eating patterns in free-living healthy individuals.

Introduction

Promoting the addition of one food to a self-selected habitual diet may lead to an increased or decreased consumption of another food.[1] Long-term, successful incorporation of that food into the diet may displace other food groups and impact eating patterns that may result in an improvement or deterioration of the previous diet. Eating patterns can include the frequency of eating episodes in one day, the timing of meals and snacks, or a description of the temporal distribution of meal size, energy, and nutrients to meals and snacks throughout the day. These variables have been found to play a role in energy intake,[2] blood glucose levels,[3] and in some instances, impact body fatness[4] and body weight.[5] In spite of these findings, eating pattern analysis has been relegated to a minor role in the assessment of the overall diet.

Dietary interventions that use low calorie foods such as cereals or liquids as meal replacements typically limit the characterization of diet to energy and/or macronutrient intake.[6, 7] Using high fat, high calorie foods such as nuts, however, may require a more comprehensive assessment, as nuts may have greater impact on other aspects of the diet beyond macronutrients. In previous publications, the authors reported subsequent improvements in the intake of dietary fatty acids, fiber, vegetable protein, magnesium, and evidence of nutrient displacement following long-term supplementation with almonds.[8, 9] In spite of its high-calorie profile, large epidemiologic and several metabolic studies already have shown that regular nut consumption may protect against risks of heart disease and diabetes.[10-17] Because of

these findings, it is important to consider what effect adding nuts to a diet (with little or no nuts) will have on eating patterns and the consumption of other foods.

In this report, we examined the eating patterns of free-living, healthy individuals who participated in an intervention study designed to investigate the effect of a daily supplement of almonds for six months on body weight and nutrient displacement.[8] The goal of this report is to describe and discuss how individuals naturally incorporate almonds into their diets, displacement of food groups, changes in the temporal distribution of energy and meal size during meals and snacks, and changes in meal frequency following long-term supplementation with almonds without dietary advice.

Methods

Subjects

The Internal Review Board of Loma Linda University approved the protocol. Subjects were recruited by newspaper, radio, and bulletin board announcements. Forty-three healthy men (body mass index (BMI), 26.7±3.56 kg/m^2) and 38 healthy women (BMI, 25.9±5.54 kg/m^2) between the ages of 25 and 70 years completed the study. The average age of the subjects was 49 years; they had stable weight during the last six months, ate nuts less than 57 g (~2 oz) weekly, and had no allergy or aversion to nuts. In addition, they did not smoke, did not follow a rigorous exercise program, and did not have concurrent medical conditions that might affect body weight, drank no more than two glasses of alcoholic beverage per day, and did not consume a very atypical diet. Pregnant women were excluded from the study.

Protocol

Details of the randomization strategy used to enroll subjects into this study was previously reported.[8] Briefly, subjects were randomly allocated to four groups stratified by age, sex, and BMI. Subjects were entered into the study in staggered 3-month intervals, each period representing a particular season of the year to offset any seasonal effects on diet. In each quarter, equal numbers of subjects, with similar attributes, were enrolled.

All subjects were followed for 12 months. The first six months comprised the control diet period, where all subjects followed their habitual self-selected diet (HD). Although there was no intervention during the habitual diet period, diets were assessed. The intervention occurred during the second six months, which required subjects to eat a daily allowance of almonds; thus this period will be referred to as the almond supplemented diet (AD). The almond supplement was equivalent to fifteen percent of each subject's mean energy intake during the habitual diet period. Individuals whose energy intake was in the lowest tertile received 42 g, middle tertile 57 g, and the highest 71 g. On average, the almond supplement was ~52 g/day. Subjects had a choice of either the dry roasted or raw nuts, or both. All subjects were provided packaged daily portions of the almond supplement, labeled with a particular day of the week and the amount in ounces. No dietary advice was given, thus subjects were given liberty to eat the nuts as they so pleased. If subjects requested more instructions, only general suggestions that the almonds could be eaten with meals or as snacks, or added to desserts or salads were given.

Dietary recalls. During each six-month diet period, seven (one on each day of the week) random order telephone 24-hour diet recalls were obtained by trained dietitians using Nutrition Data System software package version 2.8.[18] All recalls were unannounced and tape-recorded.

Food diaries. During the 2nd month of the habitual diet period, subjects were given a 1-day (practice) food diary to record their food intakes. The diary was a booklet containing detailed instructions and photographs of different servings of foods. For each eating episode, subjects were asked to record in detail every item that they ate or drank, the time and location of the eating episode, and to define each eating episode as a meal (breakfast, lunch, dinner) or a snack. After completion of the 1-day practice diary, a nutritionist reviewed the diary, and subjects were instructed if any recording errors were noted. For each diet period, two food diaries (one Sunday, and one Wednesday) were obtained. Diaries were collected at months 4 and 6 during the habitual diet period, and at months 8 and 12 during the intervention period. After the completed diaries were submitted, one of the authors (KJS) reviewed the diaries and contacted the subjects by phone when data from the diaries were missing or needed clarification. Food diary data were entered and coded by a nutritionist using Nutrition Data System software package version 2.8.[18]

Compliance

Compliance was assessed by examining the congruence between the dietary recalls and food diaries in the reported amount of almonds consumed. In addition, since almonds are rich in oleic acid, the oleic acid content of erythrocyte membranes was

measured as an indicator of compliance. Blood samples to assess the oleic acid content of erythrocyte membranes were collected at four and six months during the habitual diet period, and at eight and twelve months during the intervention. Lipids were extracted from plasma using chloroform: methanol (2:1 v/v).[19] Individual lipid classes were separated by preparative thin-layer chromatography.[20]

Statistics

Displacement of foods

Dietary recalls from all 81 subjects were used to examine displacement of food groups. Complex food items were broken down into individual components. Individual foods/components were then aggregated into 12 separate categories using the food group scheme outlined in Table 1.[21, 22] Thus, snack foods such as potato chips first were broken down to potatoes, oil, and salt, then categorized into vegetables, fats, and other foods, respectively. The daily temporal distribution of the amount and energy of selected food groups consumed during breakfast, lunch, dinner, snacks, and in the overall diet was calculated by taking the arithmetic mean of the seven diet recalls from each diet period. To determine which food groups were displaced, changes (from the habitual to the almond supplemented diet) in the consumption of foods during breakfast, lunch dinner, snacks, and in the overall diet were calculated. Displacement occurs when there is a change in the contribution of food groups to daily intake. After careful evaluation of the amounts consumed from each of the 12 food groups, changes in the amount (in grams) of grains, dairy products, fats, sweets and vegetables consumed appeared to have linear relationships

with change in energy from almonds that deserved further examination. These food groups then were selected as independent variables with change in energy from almonds as the dependent variable in a regression analysis.

Eating pattern analysis

Two males each had a missing diary; therefore, diary data from only 79 subjects were included in the analyses of eating patterns. Subjects defined each eating episode as meals (breakfast, lunch, or dinner) or snacks (eating episodes outside those defined as meals), thereby eliminating investigator bias on predefined meals and snacks. It should be noted that subjects who consumed only a beverage at a particular eating event defined such events as "other" meals, which then were combined with the snack category. The average daily number of eating episodes was calculated. Frequency of eating episodes between the two separate days (Sunday and Wednesday) of each diet period did not differ significantly; therefore, both days were combined and then averaged. A chi-square test compared the snacking frequency between males and females. Meal skipping patterns were examined by calculating the average daily frequency of each meal (breakfast, lunch, and dinner) during each diet period. Subjects who had a mean daily value of less than 1 for a particular meal were considered meal skippers for that meal. McNemars Test for paired data was performed to compare the frequency of meal skippers between the habitual and almond supplemented diet periods. Descriptive analyses and chi-square tests were performed to describe how subjects incorporated almonds into their habitual diets. All

statistical were carried out using Statistical Analysis System for Windows software package version 8.[23]

Results

Compliance

During the almond supplemented diet, 567 24-hour diet recalls were obtained and 167 single food diaries were collected from subjects. Almonds were reported as eaten in 90.2% of the recalls, and 89.2% of the diaries. Oleic acid as a portion of total membrane fat significantly increased ($p<0.001$) from 11.53% during the habitual diet to 12.08% during the almond supplemented diet. These results suggest a high degree of compliance with the intervention among study participants.

Incorporation of almonds in the diet

Subjects incorporated the almonds into their diet by eating the nuts either as a single portion per day, or divided the nuts into smaller portions (snacked on nuts) throughout the day. This pattern of consumption was examined according to gender and snacking behavior (frequent or infrequent snacker) (Table 2). Among males, 76% of the frequent snackers ate the nuts as a single portion, and 24% snacked on the nuts. Among infrequent snackers, 85% ate the almonds as a single portion, and 15% snacked on the nuts ($\chi^2=.51, p>0.05$). Among females, 69% of frequent snackers incorporated the almonds into the diet by eating the nuts as a single portion, and 31% snacked on the nuts. Among infrequent snackers, 89% ate the entire portion of almonds once, and 11% snacked on the nuts ($\chi^2=1.4, p>0.05$).

Displacement of food groups

Displacement in meals and snacks. The means of the energy contribution of foods during the HD are shown in Table 3. Mean changes in the energy contribution of foods to breakfast, lunch, dinner and snacks during the almond supplemented diet are shown in Table 4. The largest change in the energy contribution from almonds occurred during snacks (865 kJ). Changes in the energy contribution from dairy products, sweets and desserts, nuts other than almonds, and other foods consistently dropped during breakfast, lunch, dinner and snacks, and ranged from -2 kJ to -57 kJ. The net change in energy was highest during snacks (705 kJ).

Mean changes in the amount of foods consumed at breakfast, lunch, dinner and snacks during the almond supplemented diet are shown in Table 5. The change in the amount of almonds consumed was highest during snacks (34 g), followed by breakfast (9 g), lunch (5 g), and then dinner (4 g). The amounts (g) consumed from grains, dairy products, and vegetables and legumes consistently dropped during breakfast, lunch, dinner, and snacks, and ranged from -1 g to -22 g. There was very little or no change in the intake of meat, fish and poultry. The net change in the amount of food consumed was highest during breakfast (-65 g), and snacks (-62 g).

Displacement in the overall diet. Mean changes in the energy contribution of foods consumed in the overall diet during the almond supplemented diet are shown in Table 4. There was a net increase of 617 kJ/day in energy in the overall diet. Consumption of dairy products, grains, sweets and desserts, and nuts other than almonds each decreased by over 100 kJ/day. Decreases in the consumption of fats and oils, fruits,

vegetables and legumes, and other foods ranged from –70 to –49 kJ/day. There was little change in the intake of meats and beverages. Mean changes in the amount of foods consumed in the overall diet during the almond supplemented diet are shown in Table 5. There was a reduction in the amount consumed from each food group, the largest coming from beverages (-63 g/day), followed by dairy products (-41 g/day), and vegetables and legumes (-29 g/day). Decreases in the consumption of fruits, grains, fats and oils, meats, sweets, and nuts other than almonds, and other foods were below 20 g/day. Overall, there was a net decrease of 129 g/day in the amount of foods consumed.

Results from regression analysis indicate that in the overall model, changes in the amount (in grams) of grains, dairy products, fats, sweets and vegetables consumed significantly were associated with change in energy (kJ) from almonds, $F(5, 75)=3.50$, $p<0.01$. In this model, the negative β coefficient for vegetables was significant ($p<0.01$) (Table 6). When age, sex, and BMI were added to the model ($F(8, 72)=3.15$, $p<0.01$), negative β coefficients were significant for vegetables ($p<0.01$) and for grains ($p<0.05$), as well as sex ($p<0.05$) (Table 7).

Meal skipping patterns. Meal skipping status during the habitual diet is shown in Table 7. During the almond supplemented diet, some of the skippers became nonskippers, and few of the original nonskippers became skippers. The change in meal skipping status among all subjects is illustrated in Figure 1a. Of the 19 original breakfast skippers, 10 became nonskippers. Of those who were original nonskippers, three became meal skippers. Overall, there was a reduction in breakfast skipping of 7

individuals. Since a McNemars test showed that change in meal skipping status nearly reached significance only for breakfast ($p>0.05$), results will be presented only for changes in breakfast skipping. Change in breakfast skipping pattern between males and females is shown in Figure 1b. There was no statistically significant change in breakfast skipping in females; however, breakfast skipping was significant among males ($p<0.01$). In males, of the 13 original skippers 7 became nonskippers; there was an overall reduction in breakfast skipping in males of 7 subjects. Change in breakfast skipping status among males according to BMI is shown in Figure 1c. Breakfast skipping was significant only among those with BMI<50th percentile ($p<0.05$). In this group, of the 7 original skippers, 4 became nonskippers. Overall, breakfast skipping in lean males was reduced by 4 subjects.

Snacking patterns. The daily average number of snacks did not differ between HD and AD according to sex and BMI. Chi-square analyses indicate that among the frequent snackers (snacks=2/day), 58% were females, 42% were males, and among the infrequent snackers (snacks<2/day), 69% were males, 31% were females ($\chi^2=5.3$, $p<0.05$). In lean males (BMI<50th percentile), 35% were frequent snackers, and 65% were infrequent snackers; in obese males (BMI>84th percentile), 88% were frequent snackers, and 12% were infrequent snackers ($\chi^2=6.4$, $p<0.05$). The proportion of frequent and infrequent snackers in females according to BMI did not differ significantly.

Discussion

Results from this study showed that regardless of gender or snacking behavior (frequent or infrequent snacker), subjects preferred to incorporate the almonds into their habitual diet by eating the entire portion of nuts once. An evaluation of the temporal distribution of the amount of foods and energy consumed showed that subjects ate the almonds primarily as snacks, and less frequently at breakfast. There was a small increase in energy intake at breakfast (24 kJ) and a large increase in energy during snacks (705 kJ). The increased contribution of snacks to energy is consistent with other studies that reported high energy intakes during snacks.[2, 24, 25] In this study it appears that subjects tried to compensate for the added calories by decreasing energy intake at lunch (-54 kJ) and at dinner (-58 kJ) (Table 4). In addition, subjects reduced the amount of foods from non-almond sources consumed during snacks (-62) and at breakfast (-65) (Table 5). The notion that the amount of almonds consumed and displacement of other foods may have a dose response relationship deserves further elucidation in future studies.

In examining changes in the overall diet, we found that the contribution to energy from dairy products, fats and oils, fruits, vegetables and legumes, sweets, beverages, and other nuts decreased during the almond supplemented diet (Table 4). Regression analysis revealed that the amounts of grains and vegetables consumed were significantly related to change in energy from almonds (Table 7). The significant negative β coefficients for grains and vegetables suggest that decreased intake of these food groups during the AD were associated with increased energy from

almonds during AD. The negative parameter for sex suggests that males had greater changes in energy from almonds compared to females. A decrease in the intake of grains and vegetables is an undesirable consequence;[26-28] however, in our analyses, complex foods first are broken down to individual ingredients and then aggregated into separate food groups. For example, snacks such as potato chips or popcorn become categorized as vegetables, fats, and other foods, while carrot cake or potpies become sweets, grains, fats, other foods, vegetables, and possibly meats (depending on individual ingredients). It is possible that our results reflect a reduction in the intake of complex snack foods such as chips, cakes or pies rather than decreased intake of vegetables or grains alone.

Based on findings associating more frequent meals with favorable lipid levels,[29, 30] body fatness,[4] and better accuracy in regulating energy intake,[3] one can infer that skipping of traditional meals can result in decreased meal frequency, which could have undesirable consequences. In this study, meal-skipping patterns were altered as a result of almond supplementation. The overall reduction in breakfast skipping of 7 individuals (Figure 1a) during the AD can be attributed to almond consumption. A separate analysis showed that among original breakfast skippers who became nonskippers, 60% consumed almonds during breakfast, which suggests that chronic supplementation of almonds prevented breakfast skipping in this study population. Breakfast skipping patterns among females did not differ according to BMI in our study. In another study comparing meal patterns between obese and non-obese women, the number of women consuming breakfast also did not differ between

the two groups.[24] By contrast, our results revealed that overall reduction in breakfast skipping was significant among lean males. This is an important observation, as consuming breakfast potentially may have prevented overeating at the next meal, and thereby resulted in better energy intake regulation in this population.

The average number of snacking events in one day did not differ between the diet periods. The proportion of frequent and infrequent snackers, however, differed between males and females. A greater proportion of females were frequent snackers than infrequent snackers. The opposite was observed in males. Furthermore, among lean males, 65% were infrequent snackers, whereas among obese males, 88% were frequent snackers. These findings imply that snacking patterns were influenced by gender and BMI, and were established before subjects entered the study.

Because of the evidence of the cardioprotective effects of nuts, it is possible that health practitioners already are encouraging regular consumption of nuts as a healthy food choice. Our findings confirm that using high fat, high calorie foods such as almonds as an intervention indeed requires a more comprehensive dietary assessment beyond macronutrients. The knowledge of how individuals preferentially incorporate nuts into their diet, what other foods are displaced, and what change in meal patterns occur can be valuable in assisting health practitioners to plan and/or improve heart-healthy diets. For example, the observation that almonds were consumed primarily as snacks suggests that nuts are a convenient whole food that can be easily incorporated into the diets of individuals with very busy schedules.

Conclusion

Regardless of gender and snacking behavior, almonds were incorporated into habitual diets by eating the nuts as a single portion rather than snacking on the nuts. Subjects ate the almonds primarily as snacks and less frequently at breakfast. Chronic almond consumption did not alter the frequency of snacks, however, it induced a displacement pattern that lead to a reduction in the intake of grains, dairy products, fats, sweets, and vegetables in the overall diet, and prevented breakfast skipping among lean males. These findings are important, as they may have contributed to improved energy intake regulation in this population. In promoting regular consumption of high fat, high energy foods such as almonds, a comprehensive dietary assessment should record changes in eating patterns, and displacement of other foods, as long-term almond supplementation significantly impact food consumption and eating patterns in free-living healthy individuals.

Acknowledgements

This paper was presented in part at the International Congress of Nutrition, Vienna, Austria, August 2001. The authors are grateful to the California Almond Board for a grant to support this work.

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Table 1. Food Group Scheme Used in Food Intake Analysis[1]

Food group	Description
Almonds	Raw, or roasted
Cereals and grain products	Breads, donuts, muffins, pancakes, cold and hot cereals, grains and flour, pasta and rice, snack chips, corn chips, popcorn, potato chips, pretzels, granola bars, crackers
Dairy products and eggs	Milk, cream, cheese, ice cream, ice milk, frozen desserts, milkshakes, milk and cheese recipes, eggs
Fats and oils	Margarine, table spreads, oil, shortening, salad dressings, butter, lard
Fruit	Fruit juices and drinks, fresh, dried and frozen fruit, fruit recipes, avocado
Meat, fish, poultry	Beef, lamb, pork, poultry, cold cuts, fish, shellfish, meat, poultry and fish recipes
Sweets and desserts	Cookies, cakes, frostings, fillings and toppings, pie crusts, pie fillings, pies, puddings, chocolate candy, non-chocolate candy, sugar, syrup, preserves and jelly
Vegetable and legumes	Raw, cooked, fresh, frozen and canned vegetables, vegetable meat substitutes and related products, vegetable juice, vegetable recipes, cooked and dried beans, cooked and dried lentils, bean soups

Table 1. Food Group Scheme Used in Food Intake Analysis (Continued)

Food group	Description
Beverages	Alcoholic and non-alcoholic beverages (includes soda and bottled water), tea, coffee, milk-, soy- and other-based meal replacement/supplement beverages
Nuts (other than almonds)	Nuts, nut butters, seeds
Other	Soups, gravies, dressings, spices, other ingredients

[1] Food group scheme modified from USDA and EPIC-East Anglia.[21, 22]

Table 2. Incorporation of Almonds Into the Diet According to Snacking Behavior

How nuts were incorporated	Males[1]		Females[2]	
	Frequent snacker[3] (%)	Infrequent snacker[4] (%)	Frequent snacker (%)	Infrequent snacker (%)
Ate nuts as a single portion	76	85	69	89
Snacked on nuts	24	15	31	11

[1]Males, n=41 (χ^2=0.51, p=0.48).
[2]Females, n=38 (χ^2=1.4, p=0.24).
[3]2 or more snacks per day.
[4]Less than 2 snacks per day.

Table 3. Mean Energy[1] Contribution of Foods During the Habitual Diet.

Food group	Breakfast	Lunch	Dinner	Snacks	Overall diet
Almonds	1 (0)	6 (1)	4 (1)	5 (1)	16 (4)
Grains and grain products	581 (139)	677 (162)	803 (192)	237 (57)	2297 (549)
Dairy products	285 (68)	317 (76)	440 (105)	315 (75)	1357 (324)
Fats and oils	129 (31)	310 (74)	430 (103)	145 (35)	1015 (242)
Fruits	293 (70)	171 (41)	115 (27)	203 (49)	782 (187)
Meat, fish and poultry	34 (8)	255 (61)	457 (109)	17 (4)	764 (182)
Vegetables and legumes	63 (15)	227 (54)	372 (89)	37 (9)	698 (167)
Sweets and desserts	137 (33)	115 (27)	121 (29)	295 (70)	668 (160)
Beverages	25 (6)	104 (25)	142 (34)	111 (27)	382 (91)
Nuts (other than almonds)	37 (9)	58 (14)	50 (12)	103 (25)	248 (59)
Other	34 (8)	81 (19)	121 (29)	47 (11)	284 (68)

[1]Values are in kJ(kcal).

Table 4. Mean Changes[1] in the Energy[2] Contribution of Foods During the Almond Supplemented Diet Compared to the Habitual Diet.

Food group	Breakfast	Lunch	Dinner	Snacks	Overall diet
Almonds	227 (54)	117 (28)	108 (26)	865 (207)	1317 (315)
Grains and grain products	-32 (-8)	-47 (-11)	-41 (-10)	7 (2)	-114 (-27)
Dairy products	-32 (-8)	-30 (-7)	-20 (-5)	-57 (-14)	-140 (-33)
Fats and oils	-25 (-6)	5 (1)	-25 (-6)	-25 (-6)	-70 (-17)
Fruits	-39 (-9)	-23 (-6)	15 (3)	-16 (-4)	-63 (-15)
Meat, fish and poultry	-4 (-1)	-16 (-4)	26 (6)	4 (1)	11 (3)
Vegetables and legumes	-2 (-1)	3 (1)	-45 (-11)	-6 (-1)	-51 (-12)
Sweets and desserts	-49 (-12)	-26 (-6)	-11 (-3)	-25 (-6)	-111 (-27)
Beverages	-4 (-1)	-3 (-1)	-10 (-2)	12 (3)	-5 (-1)
Nuts (other than almonds)	-2 (-1)	-24 (-6)	-31 (-7)	-52 (-12)	-108 (-26)
Other	-13 (-3)	-11 (-3)	-22 (-5)	-3 (-1)	-49 (-12)
Net change	**24 (4)**	**-54 (-14)**	**-58 (-14)**	**705 (169)**	**617 (148)**

[1]Change = almond supplemented diet - habitual diet.
[2]Values are in kJ(kcal).

Table 5. Mean Changes[1] in Food Consumption (g/day) During the Almond Supplemented Diet Compared to the Habitual Diet.

Food group	Breakfast	Lunch	Dinner	Snacks	Overall diet
Almonds	9	5	4	34	52
Grains and grain products	-5	-5	-1	-1	-11
Dairy products	-12	-14	-6	-9	-41
Fats and oils	-1	0	-1	-1	-2
Fruits	-16	-5	16	-13	-18
Meat, fish and poultry	0	-3	0	0	-2
Vegetables and legumes	-1	-5	-22	-1	-29
Sweets and desserts	-4	-1	0	-2	-7
Beverages	-32	21	18	-69	-63
Nuts (other than almonds)	0	-1	-1	-2	-4
Other	-3	2	-2	0	-3
Net change	**-65**	**-7**	**5**	**-62**	**-129**

[1]Change = almond supplemented diet - habitual diet.

Table 6. Parameter Estimates for the Relationship Between Change[1] in Energy From Almonds (kJ) and Amount of Foods Consumed in the Overall Diet.

Variable	Parameter estimate	t	Probability
Change[1] in the amount (g) of grains[2] in the overall diet	-1.06	-1.96	0.054
Change in the amount (g) of dairy products[2] in the overall diet	-0.27	-1.02	0.310
Change in the amount (g) of fats[2] in the overall diet	-1.14	-0.36	0.720
Change in the amount (g) of sweets[2] in the overall diet	-1.07	-0.85	0.400
Change in the amount (g) of vegetables[2] in the overall diet	-1.05	-2.80	0.006

[1] Change between almond and habitual diets.
[2] Complex food items were broken down into individual ingredients, which were then aggregated into separate food group categories. For example, complex snack foods such as potato chips were categorized as vegetables, fats, and other foods, while carrot cake became sweets, grains, dairy products, fats, other foods, and vegetables.

Table 7. Parameter Estimates for the Relationship Between Change[1] in Energy From Almonds (kJ) and Amount of Foods Consumed in the Overall Diet Adjusting for Sex, Age, and Body Mass Index.

Variable	Parameter estimate	t	Probability
Sex (Male =1; Female = 2)	-167.08	-2.10	0.039
Age	-4.50	-1.53	0.131
Body mass index	-4.81	-0.49	0.629
Change[1] in the amount (g) of grains[2] in the overall diet	-1.09	-2.06	0.042
Change in the amount (g) of dairy pr oducts[2] in the overall diet	-0.19	-0.73	0.470
Change in the amount (g) of fats[2] in the overall diet	-0.37	-0.12	0.907
Change in the amount (g) of sweets[2] in the overall diet	-1.68	-1.33	0.188
Change in the amount (g) of vegetables[2] in the overall diet	-1.03	-2.78	0.007

[1] Change between almond and habitual diets.
[2] Complex food items were broken down into individual ingredients, which were then aggregated into separate food group categories. For example, complex snack foods such as potato chips were categorized as vegetables, fats, and other foods, while carrot cake became sweets, grains, dairy products, fats, other foods, and vegetables.

Table 8. Meal Skipping Status During Habitual Diet.

Meal skipping behavior	Breakfast		Lunch		Dinner	
	n	(%)	n	(%)	n	(%)
Skipper	19	24	20	25	7	9
Non-skipper	60	76	59	75	72	91

a

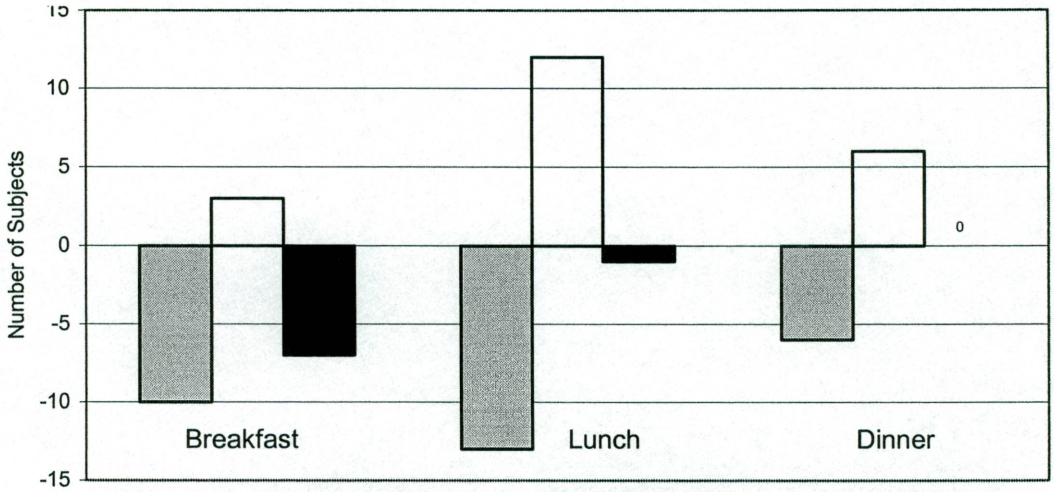


Figure 1a. Change in Meal Skipping Behavior of All Subjects (n=79). The gray box represents original skippers who became nonskippers; white box, original nonskippers who became skippers; black box, overall change. McNemars Test showed no statistically significant change in meal skipping for lunch and dinner, but breakfast skipping nearly reached significance (p=0.052).

b

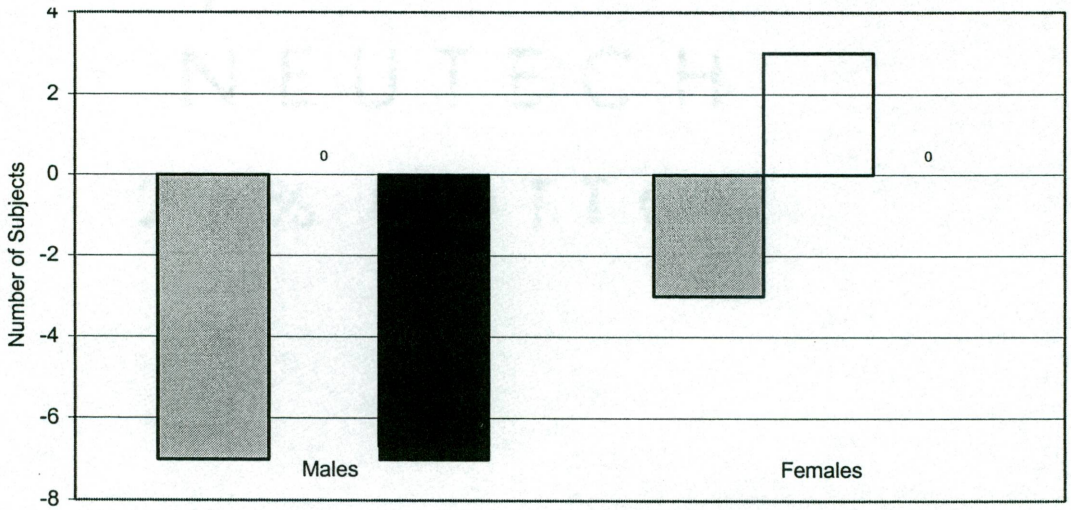


Figure 1b. Comparison of Breakfast Skipping Behavior Between Males (n = 41) and Females (n = 38). The gray box represents original skippers who became nonskippers; white box original nonskippers who became skippers; black box, overall change. McNemars Test showed that change in breakfast skipping was significant among males (p=0.008), but not females.

c

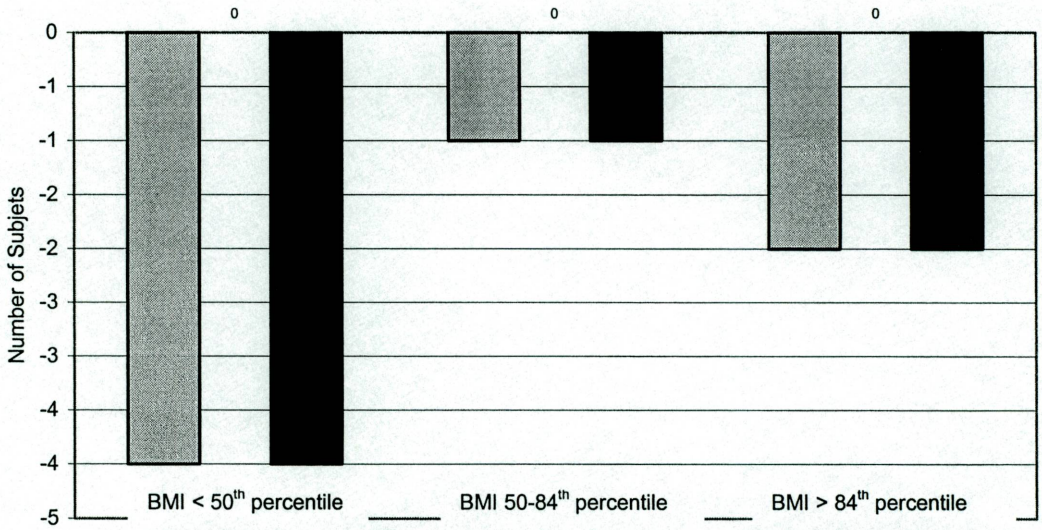


Figure 1c. Comparison of Breakfast Skipping Behavior Among Males (n = 41) According to BMI. The gray box represents original skippers who became nonskippers; white box, original nonskippers who became skippers; black box, overall change. McNemars Test showed no statistically significant change in breakfast skipping in medium or obese males, but breakfast skipping was significant among those with BMI<50th percentile (p=0.046).

CHAPTER 6

OTHER FINDINGS

A. The Effect of Almond Consumption on Caloric Intake of a Subsequent Meal

1. Calories Consumed at Lunch

An evaluation of the covariates - age, BMI, time since last meal, caloric intake at last meal, cumulative nut calories up to but not including lunch, cumulative non-nut calories up to but not including lunch, and proportion of nut calories over total number of calories consumed at a given meal - revealed no important collinearity among these variables (Table 1). Tolerance values ranged from 0.69 to 0.98.

Parameter estimates for the predictor variables are presented in Table 2. The factors influencing caloric intake at lunch were:

- Gender, $p = 0.0211$. Males consumed 110 kcal more at lunch than females.
- Age, $p = 0.0027$. Younger subjects consumed more calories at lunch than older subjects.
- At lunch, the average caloric intake was 545 kcal during the almond supplemented diet, and 597 kcal during the habitual diet ($p = 0.3010$).

2. Calories Consumed at Dinner

An evaluation of the covariates - age, BMI, time since last meal, caloric intake at last meal, cumulative nut calories up to but not including dinner, cumulative non-nut calories up to but not including dinner, and proportion of nut calories over total number of calories consumed at a given meal - revealed no important collinearity among these variables (Table 3). Tolerance values ranged from 0.56 to 0.96.

Parameter estimates for the predictor variables are presented in Table 4. The factors influencing caloric intake at dinner were:

- Gender, $p = 0.0003$. Males consumed 199 kcal more at dinner than females.
- At dinner, the mean caloric intake was 708 kcal during AD, and 633 kcal during HD ($p = 0.3181$).

The mean cumulative energy intake up to and including the last meal since the previous meal is illustrated in Figure 1. The proportion of non-nut calories consumed was 90.2% at breakfast, 91.7% at lunch, and 89% at the end of the day. The proportion of calories consumed from nuts was 9.8% at breakfast, 8.3% at lunch, and 11% by the last intake of the day.

B. The Effect of Almond Consumption on Time Interval Between the Previous Meal/Snack and the Current Meal

1. Time Since Last Meal/Snack at Lunch

An evaluation of the covariates – age, BMI, caloric intake at last meal, and proportion of nut calories over total number of calories consumed at a given meal – revealed no important collinearity among these variables (Table 5). Tolerance values ranged from 0.77 to 0.98.

Parameter estimates for the predictor variables are presented in Table 6. The factors influencing the time between the last meal/snack and lunch were:

- Amount of calories consumed at last meal/snack, $p < 0.0001$.

- Time until lunch was delayed by 17 minutes ($p = 0.2039$). The average time since last caloric intake until dinner was 180 minutes during AD, and 163 minutes during HD.

2. Time Since Last Meal/Snack at Dinner

An evaluation of the covariates – age, BMI, caloric intake at last meal, and proportion of nut calories over total number of calories consumed at a given meal – revealed no important collinearity among these variables (Table 7). Tolerance values ranged from 0.57 to 0.96.

Parameter estimates for the predictor variables are presented in Table 8. The factors influencing the time between the last meal/snack and dinner were:

- Amount of calories consumed at last meal/snack, $p < 0.0001$.
- The time until dinner was delayed by 37 minutes during AD compared to HD, ($p = 0.0655$). The average time since last caloric intake until dinner was 211 minutes during AD, and 174 minutes during HD.

A comparison between AD and HD of the median time to a meal since the previous meal is shown in Figure 2. The median time between lunch and dinner was longer during AD compared to HD.

C. Discussion

Findings from this study suggest that the important factors influencing caloric intake at lunch were gender and age (Table 2), and at dinner, gender (Table 4). As expected, males consumed more energy than females. Although not significant, the positive parameter for the proportion of cumulative nut calories relative to non-nut

calories at either lunch or dinner indicates that greater quantities of nut calories consumed during meals and/or snacks during the day are correlated with higher energy intake. Figure 1 shows that as the proportion of nut calories increased, the proportion of non-nut calories decreased. This suggests perhaps that almonds may have been more filling, thus subjects may have adjusted their energy intake of non-nut calories downwards due to the nuts. The displacement of energy and other nutrients reported in Chapter 4 confirm this observation.

The most important factor influencing time before lunch is energy consumed at the last meal or snack (Table 6). The positive parameter estimate implies that the more one consumes at a previous meal/snack, the longer time there is between meals. The negative parameter estimate for the proportion of cumulative nut calories relative to non-nut calories suggests that the proportion of calories from almonds relative to other foods is inversely correlated with time until lunch, which means that eating almonds did not delay the time until lunch.

Similarly, the most important factor influencing time before dinner is energy consumed at the last meal or snack (Table 8). However, the negative parameter estimate for almond consumption, which nearly reached significance, implies that eating almonds delayed the time until dinner by 37 minutes. Although not significant, the positive parameter estimate for the proportion of cumulative calories from almonds relative to other foods also suggests that eating almonds delayed the time until dinner. These findings suggest that perhaps the amount of calories consumed from almonds was not large enough to impact the time interval between intakes in this study.

Another possible reason for the different relation at lunch vs. dinner on mealtime delay from previous meal/snack is in the US culture, lunchtime is set by external circumstances, such as work hours, whereas dinner time depends on individual preferences.

D. Conclusions

There was no evidence that almonds lowered or raised overall caloric intake at lunch or dinner; however, almonds may delay time since the last meal or snack until dinner. Energy from small daily portions of almonds did not significantly alter satiety response in this population of healthy individuals. Future studies should examine other characteristics of almonds such as fiber, protein, and fatty acid content, and if larger portions of almonds will impact satiety.

Table 1. Collinearity Diagnostics for the Model Predicting Calories Consumed at Lunch.

Variable	DF	Parameter estimate	t	Probability	Tolerance
Gender	1	-107.1	-2.4	0.0185	0.89
Diet period	1	-52.3	-1.1	0.2817	0.77
Age	1	-5.2	-3.3	0.0012	0.98
BMI	1	5.7	1.0	0.3032	0.90
Time[1]	1	0.3	1.3	0.1790	0.71
Total energy at last intake[2]	1	-0.1	-1.6	0.1132	0.69
Nut calories : non-nut calories[3]	1	135.8	1.2	0.2	0.76

[1]Time (minutes) since last caloric intake.
[2]Total energy consumed at the last intake.
[3]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 2. Parameter Estimates for Predicting Calories Consumed at Lunch.

Variable	Parameter estimate	t	Probability
Gender	110.15	2.3	0.0211
Diet period	52.04	1.0	0.3010
Age	-5.13	-3.1	0.0027
BMI	5.32	0.9	0.3612
Time[1]	0.47	1.5	0.1270
Total energy at last intake[2]	-0.07	-0.4	0.6568
Total energy at last intake * time	-0.0003	-0.6	0.5577
Nut calories : non-nut calories[3]	139.2	1.3	0.2075

[1]Time (minutes) since last caloric intake.
[2]Total energy consumed at the last intake.
[3]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 3. Collinearity Diagnostics for the Model Predicting Calories Consumed at Dinner.

Variable	DF	Parameter estimate	t	Probability	Tolerance
Gender	1	-196.1	-3.9	< 0.0001	0.96
Diet period	1	76.8	1.2	0.2447	0.56
Age	1	-2.1	-1.1	0.2630	0.95
BMI	1	10.5	1.7	0.0897	0.95
Time[1]	1	-0.08	-0.3	0.7346	0.77
Total energy at last intake[2]	1	0.03	0.41	0.6851	0.75
Nut calories : non-nut calories[3]	1	113.7	0.54	0.5880	0.56

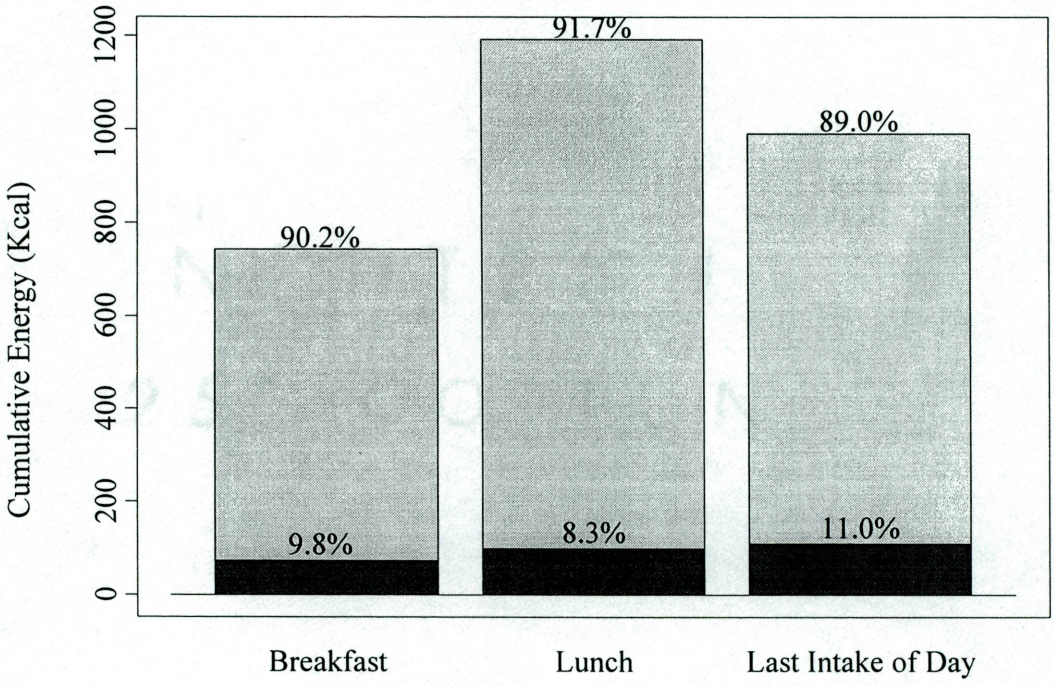
[1]Time (minutes) since last caloric intake.
[2]Total energy consumed at the last intake.
[3]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 4. Parameter Estimates for Predicting Calories Consumed at Dinner.

Variable	Parameter estimate	t	Probability
Gender	199.2	3.7	0.0003
Diet period	-75.0	-1.0	0.3181
Age	-2.4	-1.2	0.2404
BMI	10.3	1.6	0.1207
Time[1]	-0.3	-0.9	0.3631
Total energy at last intake[2]	-0.2	-0.9	0.3585
Total energy at last intake * time	0.0006	1.2	0.2423
Nut calories : non-nut calories[3]	133.6	0.6	0.5235

[1]Time (minutes) since last caloric intake.
[2]Total energy consumed at the last intake.
[3]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Figure 1. Mean Cumulative Energy Intake up to and Including That Meal Since the Previous Meal



The darker section is the cumulative nut calories and the lighter section is the cumulative non-nut calories. "Breakfast" intake is from the first intake of day to breakfast, "lunch" is cumulative energy intake from after breakfast to lunch, "Last Intake of Day" is cumulative energy intake from after breakfast until the last intake of the day.

Table 5. Collinearity Diagnostics for the Model Predicting Time Since Last Meal or Snack at Lunch

Variable	DF	Parameter estimate	t	Probability	Tolerance
Gender	1	-22.8	-1.9	0.0618	0.90
Diet period	1	17.0	1.3	0.2	0.77
BMI	1	-0.6	-0.4	0.7119	0.90
Age	1	0.02	0.1	0.9527	0.98
Total energy at last intake [1]	1	0.2	9.0	< 0.0001	0.90
Nut calories : non-nut calories[2]	1	-21.3	-0.7	0.4729	0.77

[1]Total energy consumed at the last intake.
[2]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 6. Parameter Estimates for Predicting Time Since Last Meal or Snack at Lunch

Variable	Parameter estimate	t	Probability
Gender	22.9	1.9	0.0641
Diet period	-16.8	-1.3	0.2039
BMI	-0.6	-0.4	0.7111
Age	0.02	0.05	0.9624
Total energy at last intake [1]	0.2	9.0	< 0.0001
Nut calories : non-nut calories[2]	-21.8	-0.7	0.4630

[1]Total energy consumed at the last intake.
[2]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 7. Collinearity Diagnostics for the Model Predicting Time Since Last Meal or Snack at Dinner

Variable	DF	Parameter estimate	t	Probability	Tolerance
Gender	1	-11.6	-0.9	0.3544	0.96
Diet period	1	41.5	2.5	0.0113	0.57
BMI	1	-1.6	-1.1	0.2847	0.95
Age	1	-0.2	-0.4	0.6980	0.95
Total energy at last intake [1]	1	0.2	8.9	< 0.0001	0.95
Nut calories : non-nut calories[2]	1	58.4	1.1	0.2650	0.57

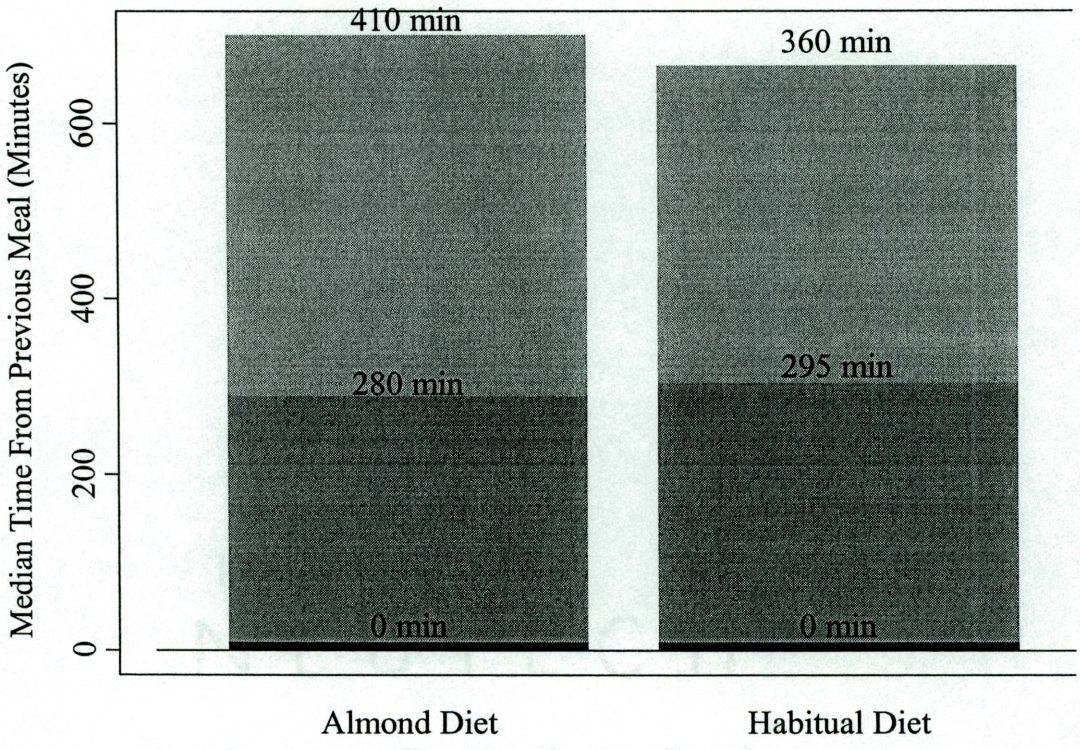
[1]Total energy consumed at the last intake.
[2]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Table 8. Parameter Estimates for Predicting Time Since Last Meal or Snack at Dinner

Variable	Parameter estimate	t	Probability
Gender	14.3	0.9	0.3293
Diet period	-37.0	-1.8	0.0655
BMI	-2.0	-1.1	0.2749
Age	-0.1	-0.3	0.7909
Total energy at last intake[1]	0.2	9.6	< 0.0001
Nut calories : non-nut calories[2]	34.6	0.7	0.4837

[1]Total energy consumed at the last intake.
[2]Proportion of cumulative nut calories relative to cumulative calories from other sources.

Figure 2. Comparison of the Median Time (Minutes) to Meal Since the Previous Meal Between Almond Supplemented Diet and Habitual Diet.



The bottom section is the time from the day's first intake to breakfast, the middle section is the time between breakfast until lunch, and the top section is the time between lunch until the last intake of the day.

CHAPTER 7

SUMMARY AND CONCLUSIONS

A. Summary and Implications of Findings

1. Effect of Long-Term Almond Supplementation on Nutrient Intake Patterns

Results from this study indicate that simply adding a daily supplement of almonds (52 g) to an individual's self-selected diet can induce favorable nutrient modifications. The almond supplemented diet compared to the habitual diet had significant increases in the intake of MUFA, PUFA, fiber, magnesium, plant protein and potassium to sodium ratio, and significant reductions in the intake of SFA, animal protein, cholesterol, sodium, and lysine to arginine ratio. These nutrients, along with others which decreased from the habitual to the almond supplemented diet (calcium and selenium), as well as those which remained relatively unchanged (iron, zinc, copper and most of the vitamins) met the dietary recommendations to prevent CVD and chronic diseases, or consistent with the Daily Reference Intakes.

Almond supplementation partially displaced total energy, total protein, total fat, dietary fatty acids, total fiber, magnesium, phosphorus, potassium, zinc, thiamin, and folic acid. Total food weight, carbohydrate, and selenium were more than fully displaced, and the almond supplemented diet contained less of these nutrients.

The favorable dietary modifications observed in this study imply that regular consumption of almonds can be recommended as a healthy food choice in preventing CVD and other chronic diseases. The partial displacement of energy, fat, and fiber

that occurred with almond supplementation suggests incomplete absorption of these nutrients, a mechanism thought to explain partially the lack of weight gain observed in a few nut studies. Nutrient displacement estimates in this study may be a potential indicator of the degree to which a particular nutrient from almonds is metabolized.

2. Effect of Long-Term Almond Supplementation on Food Consumption and Eating Patterns

Results from this study showed that regardless of gender or snacking behavior, subjects preferred to incorporate almonds into their habitual diet by eating the entire portion of nuts once. Subjects ate the almonds primarily as snacks, and less frequently at breakfast. Almond supplementation induced a displacement pattern that lead to a reduction in the intake of dairy products and fruits during snacks. In addition, chronic almond consumption prevented breakfast skipping among lean and possibly obese males.

The overall reduction in breakfast skipping is an important finding, as consuming breakfast potentially may have prevented overeating at the next meal, and thereby resulted in better energy intake regulation. Displacement of other foods consumed during snacks and breakfast also may have contributed to improved energy intake regulation in this population.

3. Effect of Long-Term Almond Supplementation on Satiety

Results from this study showed no evidence that almond consumption lowered or raised overall energy intake at a subsequent lunch or dinner; however, almonds may have delayed the time since the last meal or snack until dinner. Energy

from small daily portions of almonds did not significantly alter satiety response in this population of healthy individuals.

B. Conclusions

We found evidence of nutrient and food group displacement, subsequent improvement in the nutrient profile, and possible prevention of breakfast skipping among free-living healthy individuals after supplementing their self-selected habitual diets (containing little or no nuts) with almonds for six months. Findings from this study confirm that using high fat, high calorie foods such as nuts in dietary interventions requires comprehensive dietary assessment as nuts impact other aspects of the diet beyond macronutrients. The knowledge gained from such a comprehensive examination may be beneficial in improving dietary assessment methods, as well as developing health promotion, prevention and behavioral change programs.

C. Future Research Directions

More studies using free-living subjects, which compare differences between habitual diets (control) and diets free-feeding on nuts (intervention) are needed to assess the effects of nut consumption (using different nuts) on diet. These include studies that:

1. Examine nutrient and food displacement patterns.
2. Examine changes in dietary patterns.
3. Examine changes in meal skipping patterns.
4. Examine changes in snacking behavior.

5. Examine the effect of different amounts of nuts on the degree of food displacement. Results from such a study may help establish the amount of nuts considered "safe" for consumption, and standardize amounts used in future nut studies.
6. Examine whether larger portions of almonds will impact satiety response.

A great amount of data was collected in this study, much of which deserves further examination. These include:

1. Examine other characteristics of almonds such as fiber, protein, carbohydrate, fat, and fatty acid content that may impact satiety response.
2. Examine if the duration of a meal and/or the amount consumed during the meal impact satiation response.
3. Examine differences between AD and HD in the appetitive ratings before and after meals and snacks.
4. Examine the relationships between changes in serum lipid profile, and nutrient displacement, food displacement, frequency of eating episodes, and meal skipping patterns.
5. Examine the relationships between changes in body weight and nutrient displacement, food displacement, frequency of eating episodes, meal skipping patterns, and serum leptin.
6. Examine the validity of the diet questionnaire (Appendix J), which includes an eating patterns and a food frequency questionnaire, against dietary recalls and food diaries.

7. Compare nutrient and food displacement patterns between the food frequency questionnaire and dietary recalls.

D. Limitations

1. Study Population

Participants in this study were healthy individuals. Although on average the study population was borderline overweight, participants were chosen by design to reflect the US population. Results from this study, therefore, may not be applicable to a population of diseased individuals, those of ideal body weight, or those with age-gender-specific BMI > 95th percentile, as their response to energy and food intake regulation may be different.

2. Sources of Error in 24-Hour Recalls and Food Diaries

Reliable, self-reported dietary data depends greatly on the respondents' ability to communicate, awareness of food intake, memory, and motivation. Assessment of food intake in this study may have been affected by the day of the week, unwillingness of the subject to report accurately, learning effect, inaccurate estimation of portion size, distortion in memory of socially acceptable or unacceptable foods, age, sex, memory loss, fatigue, and underreporting of food intake among obese subjects. The process of collecting the data in and of itself also may have altered eating behavior.

3. Sources of Interviewer and Reviewer Error

Assessment of food intake may have been affected by the manner in which questions were asked, lack of standardization in probing and coding, failure to

probe, coding errors, the social status, attitudes and personal food habits of the interviewer or reviewer, and lack of rapport and biased attitude toward the respondent.

4. Nutrient Database Error

The nutrient database used in this study to derive nutrients from food intake may have been incomplete or inaccurate particularly for culture-specific foods, new foods, and new formulations.

5. Study Design

Although the study was designed to control for seasonal trends in body weight, the study design could not control for training effect and secular trends in the economy and the environment, which may affect dietary behaviors. In this study, all subjects started with the habitual diet, and then crossed over to the almond diet. The lack of randomization in the diet order may have resulted in either an over- or underestimation of the observed differences in the diet and eating patterns.

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APPENDIX A

INITIAL TELEPHONE SCRIPT AND SCREEN

ALMOND STUDY

Script for initial telephone screen

General information	We are doing the almond study to find out if eating almonds can help prevent heart disease.
Participant involvement	There is no special diet to follow. The study will last 9 months. During the first 3 months, you may eat as you would normally. However, in the 6 months after that you will be asked to also eat 2 ounces of almonds every day, which we will supply. During that time, you will be asked to come to the University clinic about 6 times to record your weight, receive your supply of almonds, and answer a few questions. On 3 of these visits, we will take blood samples. You also will be called by telephone 14 times during the 9-month period to report on your eating habits. These calls may take about 20 minutes each.
Qualifications for the study	You have to be between 25 and 70 years old, healthy, able to commit to the program for at least 9 months, and presently eat nuts no more than 2 times a week.
Benefits to the participant	First of all, you will receive a supply of almonds free for 6 months. At the completion of the study, you will receive a $100 honorarium, and a full report about your diet and cholesterol values.
Signing up for the study	I need to ask you a few questions, such as your height, weight, and your diet. We will review your responses to see if you may qualify, and then our research assistant will call you within a week to give you more instructions.
	Fill out screening form #1

Date: _____

ALMOND STUDY

INITIAL TELEPHONE SCREEN

For office use only

Name_____ ID#_____

Address_____

Do you have to drive >30 miles to come to LLU? **Y N** *If Y mark (+) here →* ____

Phone # (work)_____ (home)_____

Which number is the best one where we can reach you? **home work**

What is the best time to call?_____

Ethnicity_____ Gender **F M** Age_____ *If <25 or >70 mark (+) here →* ____

Self-reported weight_____lb ÷ 2.2 = _____ kg Approx. date_____

Height_____ft _____inches (_____inc. x 0.0254 = _____m)

BMI (kg/m^2)_____ *If ≥27.8 (male) or ≥27.3 (female) mark (+) here →* ____

Weight change during the past six months? **Y N** **Gain Loss**

Number of pounds_____ *If >20 lb in last 6 months mark (+) here →* ____

Are you vegetarian? **Y N** *If vegetarian mark (+) here →* ____

Do you eat nuts? **Y N**

*If **Yes** →* What type of nuts?_____

How many nuts per serving do you eat?_____

How many times per week do you eat these nuts?_____ *If >4 oz/week mark (+) here →* ____

Do you smoke cigarettes? **Y N** *If Y mark (+) here →* ____

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APPENDIX B

SECOND TELEPHONE SCREEN

Date:_____

ALMOND STUDY
SECOND TELEPHONE SCREEN

Comments

Name_____ ID#_____

Education_____ Occupation_____

Do you anticipate moving in the next 9-12 months? **Y N** If Y comment here → _____

Do you have allergies to almonds? **Y N** If Y comment here → _____

Do you follow an exercise regimen? **Y N**
Describe activities_____
_____
How often do you exercise? _____
How long per session? _____

A few questions about your medical history:

Medical condition		***Year diagnosed***	***Medical treatment***
diabetes	Y N	_____	_____
heart disease	Y N	_____	_____
malabsorption	Y N	_____	_____
thyroid disorder	Y N	_____	_____
cancer	Y N	_____	_____
stroke	Y N	_____	_____
psychiatric disorder	Y N	_____	_____
_____		_____	_____
_____		_____	_____

Are there any other medications/drugs that you take on a regular basis? **Y N**
Name of meds _____
_____
_____

Do you drink any alcoholic beverages? **Y N**
If ***Yes***→ How many drinks/wk?_____ If >14 drinks/wk comment here →

Appointment date_____

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APPENDIX C

FACE-TO-FACE SCREENING INTERVIEW QUESTIONNAIRE

ID # _____

Interviewer: _____

Protocol for the Almond Study
Screening Interview

The object of this interview is to evaluate a number of other less readily definable characteristics and questions that may make a subject more suitable for our study.

During the interview, as a minimum, the following topics should be covered:

a) Living Circumstances

i) married o Yes
o No

ii) Who else lives in the household?_____

b) Eating Patterns

i) Who does most of the cooking? _____

ii) Does the family usually eat the same food? _____

iii) At the same times? _____

c) Motivation for Enrolment

Why do you want to be part of this study? _____

_____

d) Usual Structure of the Week (Home/Work/Play, etc.)

	Morning	Afternoon	Evening
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

(Group days where appropriate)

e) Special Dietary Habits

i) Have you ever used diet pills?

- o No
- o Yes → When and for how long? _____

iii) Have you ever been on a weight reduction diet for at least several weeks?

- o No
- o Yes → When and for how long? _____

iv) If subject drinks alcohol, ask "Are there days where you may consume more than 3 drinks per day?" If so, obtain detail regarding frequency of such days and how many drinks on such days.

_____

_____

f) Travel and vacation

i) Vacation plans during the next one year

_____

_____

ii) Travel plans in the next one year

_____

_____

g) Exercise (Only for subjects who follow a vigorous exercise regimen at least 5 times each week)

i) How long have you followed this exercise routine?

_____

ii) If less than 6 months, have you previously had vigorous exercise programs that lasted a few months only? If so, when was the last time?

_____

h) Would you prefer the almonds raw or roasted?

- o raw
- o roasted

i) General comments by interviewer regarding likelihood of

	poor	fair	good	excellent
1) Reliability _____				
2) Contactability _____				
3) Unusual eating habits _____				
4) Interference from other family members/living companions _____ _____				

	Problem	No Problem
j) Weight reduction		
k) Alcohol		

APPENDIX D

DIETARY QUESTIONNAIRE USED DURING SCREENING

ID#_____

ALMOND STUDY
Dietary Questionnaire

1. Think about the meals you eat during the week. In the table below, indicate the number of meals (breakfast, lunch, dinner, or other meals) you eat per week for each category (prepared at home, fast food, cafeteria/take out, or restaurant).

B = Breakfast L = Lunch D = Dinner

Meal category	B	L	D	Other meals
Prepared at home				
Fast food				
Cafeteria/take out				
Restaurant				
Total				

2. When you eat meals NOT prepared at home (fast food, cafeteria/take out, restaurant), what type of food do you have a ***tendency*** to eat more of? **Check all that apply.**
   - [0] _____ fruit
   - [1] _____ vegetables
   - [2] _____ meats
   - [3] _____ sweets
   - [4] _____ breads/grains/pasta
   - [5] _____ other

3. Think about the time of day you have your meals and snacks. In the table below, give the approximate time when you have your meals and snacks.

Category	Time of day
Before breakfast/coffee snack(s)	
Breakfast	
Morning snack(s)	
Lunch	
Afternoon snack(s)	
Dinner	
Evening snack(s)	

4. How many snacks per day do you eat? _____

   What foods do you eat for snacks? _____
   _____

kbjaceldo/almond/dietpat6/031197

ID#_____

5. In the table below, indicate the number of drinks per day you consume.

Type of drink	# of drinks
Water	
Juice	
Fruit drink	
Soda	
Coffee/tea	
Other	

6. List any foods you avoid.

_____
_____
_____

7. List foods you eat most often.

_____
_____
_____

8. Think about ethnic foods you eat. In the table below, check the box which indicates the number of times per week you consume ethnic foods.

Frequency	Mexican	Asian				Mediterranean
		Chinese	Thai	Indian	Other	
Rarely or never						
1-2 times per week						
3-4 times per week						
5 or more times per week						

APPENDIX E

EXERCISE QUESTIONNAIRE USED DURING SCREENING

ID # _____

Date: _____

ALMOND STUDY
Exercise Questionnaire

1. a) Do you walk, run, or jog as part of a physical activity program? (include these same activities when they are performed on exercise machines
   [0] _____ No (go to Question 2)
   [1] _____ Yes (continue)

   b) How many of these "walk-run-jog" workouts do you do per week?
   [0] _____ Less than once/week
   [1] _____ 1 time per week
   [2] _____ 2 times per week
   [3] _____ 3 times per week
   [4] _____ 4 times per week
   [5] _____ 5 times per week
   [6] _____ 6 or more times per week

   c) How many miles do you average per ""walk-run-jog" workout? Please check the nearest category below.
   [0] _____ ¼ mile or less
   [1] _____ ½ mile
   [2] _____ 1 mile
   [3] _____ 1 ½ miles
   [4] _____ 2 miles
   [5] _____ 3 miles
   [6] _____ 4 or more miles

   d) What is your average time spent in each "walk-run-jog" exercise session (excluding rest stages)?
   [0] _____ 0-9 minutes
   [1] _____ 10-19 minutes
   [2] _____ 20-29 minutes
   [3] _____ 30-39 minutes
   [4] _____ 40-49 minutes
   [5] _____ 50-59 minutes
   [6] _____ 60 minutes or more

2. a) During an average day how much time is usually spent in **MODERATE PHYSICAL ACTIVITY** (active housework, vacuuming, light carpentry, regular walking, raking leaves, light gardening, leisurely cycling, etc.)?
   [0] _____ None
   [1] _____ Less than 1 hour
   [2] _____ 1-2 hours
   [3] _____ 2-4 hours
   [4] _____ 4-8 hours
   [5] _____ 8-16 hours

ID # _____

Date: _____

b) During an average day how much time is usually spent in **LIGHT ACTIVITY WHILE STANDING** (dishwashing, cooking, ironing, doing laundry, standing with little motion, etc.)?

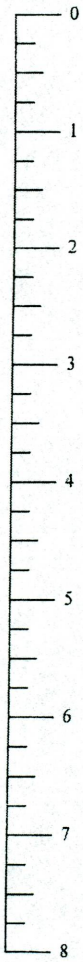
[0] _____ None
[1] _____ Less than 1 hour
[2] _____ 1-2 hours
[3] _____ 2-4 hours
[4] _____ 4-8 hours
[5] _____ 8-16 hours

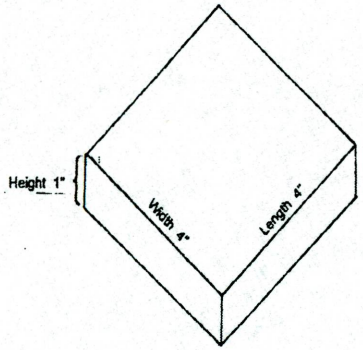
c) During an average day how much time is usually spent in **LIGHT OR SEDENTARY ACTIVITY WHILE SITTING OR RECLINING** (office work, personal care, sewing, eating, driving a car, watching TV, reading, lying down, etc.)?

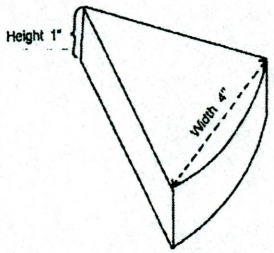
[0] _____ None
[1] _____ Less than 1 hour
[2] _____ 1-2 hours
[3] _____ 2-4 hours
[4] _____ 4-8 hours
[5] _____ 8-16 hours

APPENDIX F

FOOD DIARY







ID# _____

Loma Linda University
The Almond Study

Eating Diary

Name: _____

Date: _____

Day of the Week: _____

Clinic: 1 2 3 4 5 6 7

If this booklet is found, please contact Loma Linda University at (909) 824-4753

Instructions

This diary is to record **all** of the **food** and **drinks** consumed for one whole day. In addition, we need to record your **feelings** about eating **immediately** before and after each meal or snack. The diary is almost self-explanatory, but please especially note the following:

1. Please **carry the diary** with you throughout the day, and use it immediately **before** and **after** any meals and snacks. It will not work to simply record your feelings and eating by memory, at the end of the day.

2. Be sure to write in the **time** of each meal/snack in the space allotted. If you have more than one snack between meals there is room for two additional snacks at the end of this booklet.

3. Consult the 4 pages of sample foods (pages 3-6) to help with the units (e.g. teaspoons, tablespoons, cups) to record in the **amount** column. Find a similar food, even if your food is not exactly listed. Record brand names if relevant.

If you wish, use the measuring scale on the back of the booklet to record the width, length and height of say a serving of steak or pie. You can also indicate **amount** by picture number (pages 7-9).

4. An **example** of a page already completed is given below.

EXAMPLE

TIME: *12:00*

How hungry do you feel right now?
Not at all hungry ○○○○○○○○○●○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?
Extremely weak ○○○○○○○○○●○○○○○○○○ Extremely strong

How full do you feel right now?
Not at all full ○○●○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?
A large amount ○○○○○○○○○○○○○○●○○○○ Nothing at all

How thirsty do you feel right now?
Not at all thirsty ○●○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries __ Other (specify) __

TIME: *12:10* **RECORD FOODS EATEN FOR LUNCH**

Food/Drink	Description & Preparation	Amount
soup	*Campbell's condensed cream of mushroom, diluted half and half with water*	*2 cups*
bread	*Charthouse Squaw bread*	*2 med slices*
margarine	*Fleischman's reduced*	*1 tablespoon*
cheese	*Kraft's cheddar cheese*	*2 X 1.5"*
tomatoes	*fresh*	*1 medium*
yogurt	*Danon low fat, berry*	*6 oz*
tea	*iced, lemon and artificial sweetener*	*12 oz glass*
fruit	*peach, fresh*	*2 medium*
salad	*iceberg, cucumber, tomato*	*Picture 3b*
dressing	*Hidden Valley, Ranch, fat-free*	*1 tablespoon*

PLEASE FILL OUT IMMEDIATELY AFTER LUNCH

TIME: *12:45*

How pleasant was the meal you just consumed?
Extremely pleasant ○○○○○○○○○●○○○○○○○○ Not at all pleasant

How hungry do you feel right now?
Not at all hungry ○○●○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?
Extremely weak ○○○○○●○○○○○○○○○○○○ Extremely strong

How much food do you think you could eat right now?
A large amount ○○○○○○○○○○○○○○●○○○○ Nothing at all

How full do you feel right now?
Not at all full ○○○○○○○○○○○○○○●○○○ Extremely full

How thirsty do you feel right now?
Not at all thirsty ○●○○○○○○○○○○○○○○○○ Extremely thirsty

WHERE POSSIBLE, ALWAYS STATE WHAT SORT OF OIL OR FAT WAS USED FOR BAKING, FRYING ETC.		
Food/Drink	**Description & Preparation**	**Amount**
Bacon	lean or streaky; fried or grilled	number of slices
Beer	what kind; low alcohol, etc.	cans, bottles
Bread (also see sandwiches)	white or whole wheat, French, raisin, bagels, plain, raisin, etc., with cheese, etc.	dimensions, number of slices
Bread rolls	whole wheat, crusty or soft	diameter, number of pieces
Butter	added to food or spread on bread	pat, or spread thin, average, thick
Cake	what kind; with frosting/filling	number of pieces, (see ruler on back page for size, or pictures 10)
Candy	what kind: e.g. hard candy, Snickers bars, M&M, etc.	number
Cereal	type; brand name	cups or pictures 1
Cheese	type: cheddar, jack, Swiss, cream cheese, cottage cheese, specify low fat, low sodium	slice, cube (see ruler on back cover), oz
Chips	brand name; low fat; flavor	packed weight
Chocolate	what kind: Sees, Godiva, milk, semi sweet	diameter, number of pieces
Coffee	(ground, instant, decaffeinated) with milk/creamer	cups or mugs (oz)
Cold cuts or processed meats	what sort and brand; e.g. ham, bologna, turkey breast, hot dog (with or w/o bun)	number of slices
Condiments	salt or substitute	¼ or ½ teaspoon, pinch, etc.
Cookies	what kind: e.g. oatmeal, chocolate chip, peanut butter, wafers. Give brand name, if possible	number and size

WHERE POSSIBLE, ALWAYS STATE WHAT SORT OF OIL OR FAT WAS USED FOR BAKING, FRYING ETC.		
Food/Drink	**Description & Preparation**	**Amount**
Cooking oil	type; brand name	teaspoons, tablespoons
Cream	whipping, cool whip, sour	tablespoons
Dessert	fruit/cream pie: carrot cake; chocolate mousse;	dimensions, cups, or pictures 10
Egg	how was it cooked: boiled, fried, scrambled, poached, omelette, substitute, etc.	number of eggs (small, medium, large)
Fish	what sort: fried, grilled, boiled; microwaved, with batter or breadcrumbs; canned with oil or tomato sauce	3 oz or write dimensions (see ruler on back cover or pictures 6)
Fish sticks	what sort, fried or grilled	dimensions and number of pieces
Fruit - fresh	what sort and variety, e.g. Granny smith apple, with or without skin	number of pieces
Fruit - stewed or canned	what sort and variety, e.g. Dole pineapple; in light or heavy syrup	cups
Fruit juice	what sort; sweetened or unsweetened	glasses or cups (oz)
Gravy	thick or thin, instant or packet, meat based, etc.	tablespoons
Hamburgers	homemade, fast food, with cheese/bacon/pickles, etc.	number, size (eg. Quarter Pounder)
Herbs	type, fresh or dried	¼ or ½ teaspoon, pinch, etc.
Honey, jam	type, specify if low sugar	teaspoons
Ice cream	dairy or non-dairy, ice milk, sherbet, flavor or variety	scoops (small, medium, large)
Liquor	what kind: e.g. Scotch, gin, margarita	glasses
Margarine	hard, soft (tub), low fat; give brand name	thick, average or thin spread - tablespoons

WHERE POSSIBLE, ALWAYS STATE WHAT SORT OF OIL OR FAT WAS USED FOR BAKING, FRYING ETC.		
Mayonnaise	give brand name; state if low fat	teaspoons, tablespoons
Meats	beef, pork, cut used; lean or fatty; chicken (with or w/o skin) fried, microwaved, grilled, roasted, BBQ; well-done or rare, with or without gravy	dimensions (see ruler on back page or pictures 4)
Milk- for drinking or on cereal	full, low-fat, non-fat, flavored, soy, rice milk	glasses, cups
Nuts	what kind, raw, roasted, flavored, chocolate coated, etc.	cups, oz
Oatmeal	cooked with water or milk, from scratch or instant, sugar or honey added	cups
Pot pies	what sort; chicken, beef, turkey, fat used for pastry; home made or commercial	dimension and number of servings
Potatoes	baked, boiled, mashed, French fries	number of potatoes (e.g. 1 medium), cups
Pudding	what sort and brand: e.g. tapioca, chocolate	cups
Rice	brown or white, boiled or fried	cups
Salad	what kind; describe ingredients, with, w/o dressing; (e.g. oil and vinegar, ranch, honey mustard)	tablespoons or pictures 3
Salsa	with tomatoes, onions, cilantro	tablespoons
Sandwiches and rolls	what type of bread; whole wheat, white, pita, buns, Kaiser rolls, etc.)	size, number of slices or rolls
Sauce - hot	(for vegetables, meat or fish); savory or sweet; thick or thin (give recipe if possible)	tablespoons
Sauce - cold	what sort: e.g. tomato ketchup, steak sauce, soy sauce	tablespoons

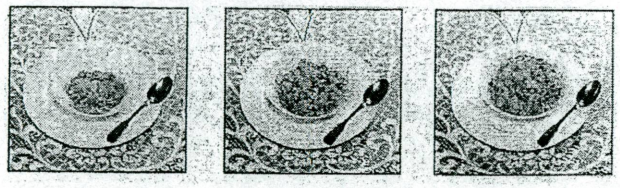
WHERE POSSIBLE, ALWAYS STATE WHAT SORT OF OIL OR FAT WAS USED FOR BAKING, FRYING ETC.		
Food/Drink	**Description & Preparation**	**Amount**
Sausages	what sort: e.g. pork, turkey; low fat; how cooked	number and dimensions
Snacks	what sort: e.g. pretzels, Doritos, popcorn (with or w/o butter, flavored), donuts	number, packet weight, cups
Soft drinks	sodas regular, diet, decaffeinated, give brand name	glasses (oz) or cans
Soup	what sort; canned, packet, instant or vending machine	fl oz, bowls
Spaghetti, other pasta	boiled, canned; white, whole wheat, spinach; in sauce	cups, or pictures 2
Spices	type	¼ or ½ teaspoon, pinch, etc.
Sugar	brown, white; added to cereals, coffee, tea, fruit, etc.	heaped or level teaspoons, tablespoons
Tea	hot or iced tea, with sugar or milk, herb; decaffeinated	cups, glasses
Vegetables	what sort and variey; fresh, frozen or canned; how prepared: e.g. cooked, fried, microwaved	cups, or pictures 5 or 9
Water	tap, filtered, bottled; carbonated, flavored	glasses, fl oz
Wine	white, red, dry, sweet, wine coolers	glasses, fl oz
Yogurt	plain, with fruit, low-fat, non-fat, brand name if possible	container size
Homemade dishes	please say what the dish is called and give recipe or ingredients if possible	serving size
TV dinners	what sort; e.g. pizza, lasagna, weight watchers, brand name if possible	serving size
Meals eaten away from home	Fast food, carry out, deli, restaurant	serving size

You may wish to use the pictures to help you to indicate the **amount** of the portion you have eaten. Write down the picture number and size nearest to your own serving, e.g. 1c, 4b, 7a, etc.

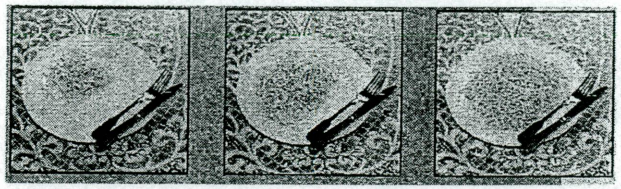
The pictures could also be used for foods not shown, e.g., fruit cobbler might be a similar portion to vegetable mix (5), peas similar to baked beans (8), etc.

Remember that the picture sizes are much smaller than life size. The foods in the pictures are placed on a 10" plate. Please note that cake is photographed on a dessert plate which is on top of a dinner plate.

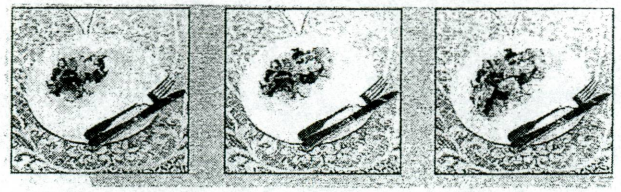
1a 1b CEREAL 1c



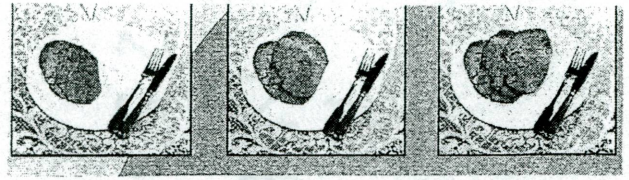
2a 2b SPAGHETTI 2c



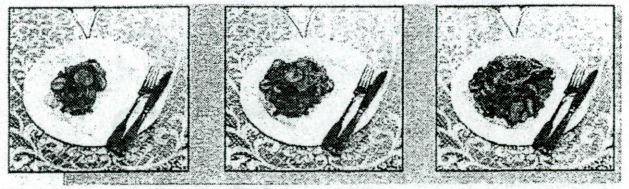
3a 3b MIXED SALAD 3c



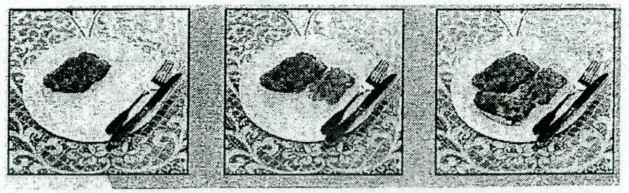
4a 4b SLICED MEAT 4c



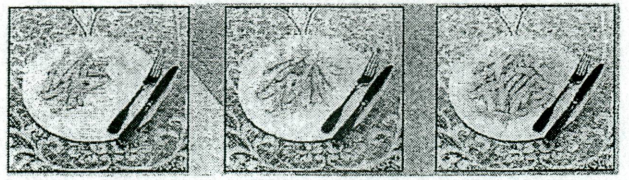
5a 5b MIXED VEGETABLES 5c



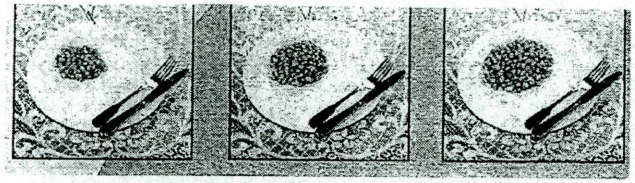
6a 6b FISH FILLETS 6c



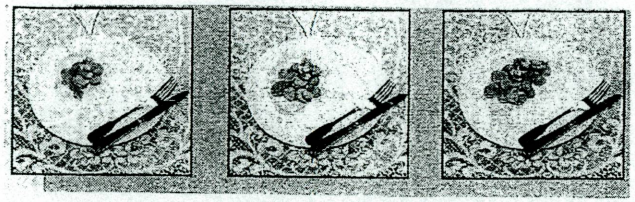
7a 7b FRENCH FRIES 7c



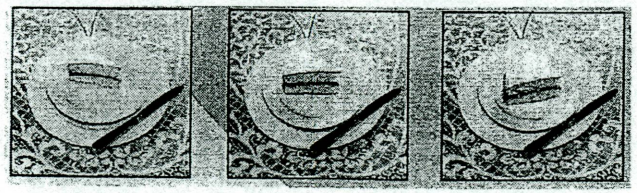
8a 8b BAKED BEANS 8c



9a 9b CARROTS 9c



10a 10b CAKE 10C



Please answer the following questions by filling in the circle according to how you truly feel. The scale is anchored by two opposing answers to the question so that you can "rate" your feelings to the question. Please fill this out immediately before eating.

SNACK BEFORE BREAKFAST

SECTION A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry ○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries __ Other (specify) _____

SECTION B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN AS SNACK BEFORE BREAKFAST**

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○ Not at all pleasant

PLEASE FILL OUT IMMEDIATELY BEFORE BREAKFAST

TIME: _____

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries ____ Other (specify) _____

TIME: _____ **RECORD FOODS EATEN FOR BREAKFAST**

Food/Drink	Description & Preparation	Amount

11

PLEASE FILL OUT IMMEDIATELY AFTER BREAKFAST

TIME: _____

How pleasant was the meal you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

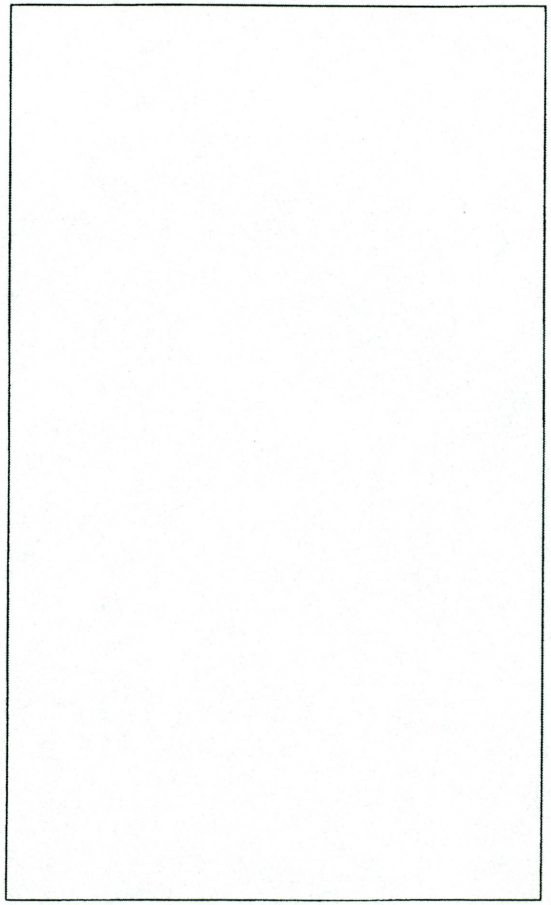
How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

12



13

PLEASE FILL OUT IMMEDIATELY BEFORE MID MORNING SNACK
(between breakfast time and lunch time)

SECTION A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry | ○○○○○○○○○○○○○○○○○○○○ | Extremely hungry

How strong is your desire to eat right now?

Extremely weak | ○○○○○○○○○○○○○○○○○○○○ | Extremely strong

How full do you feel right now?

Not at all full | ○○○○○○○○○○○○○○○○○○○○ | Extremely full

How much food do you think you could eat right now?

A large amount | ○○○○○○○○○○○○○○○○○○○○ | Nothing at all

How thirsty do you feel right now?

Not at all thirsty | ○○○○○○○○○○○○○○○○○○○○ | Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries ____ Other (specify) _____

SECTION B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN FOR MID-MORNING SNACK!**

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant | ○○○○○○○○○○○○○○○○○○○○ | Not at all pleasant

14

PLEASE FILL OUT IMMEDIATELY BEFORE LUNCH

TIME: _____

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries __ Other (specify) _____

TIME: _____ **RECORD FOODS EATEN FOR LUNCH !**

Food/Drink	Description and Preparation	Amount

PLEASE FILL OUT IMMEDIATELY AFTER LUNCH

TIME: _____

How pleasant was the meal you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How much food do you think you could eat right now?

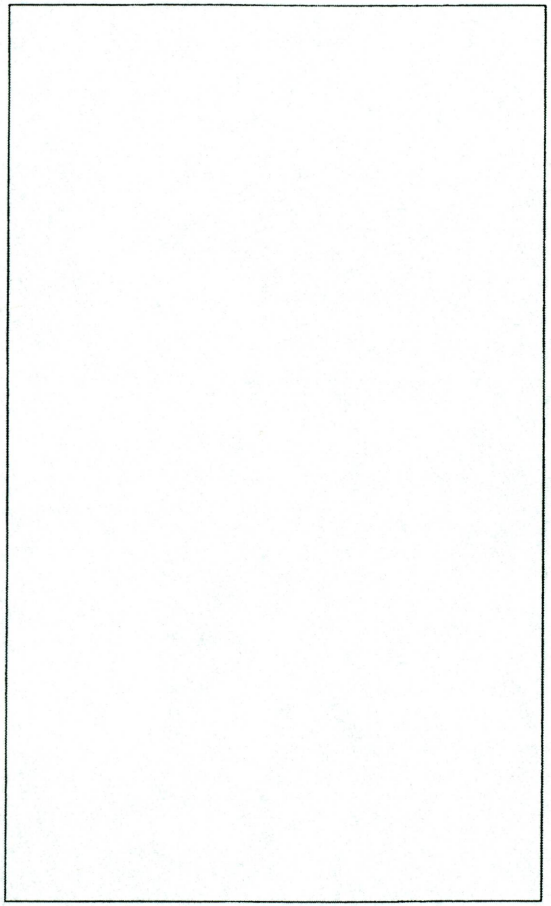
A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty



PLEASE FILL OUT IMMEDIATELY BEFORE MID AFTERNOON SNACK
(between lunch and dinner time)

SECTION A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin ___ pizza ___ burger ___ fruit ___ almonds ___ yogurt ___

cake ___ bread ___ French fries ___ Other (specify) _____

SECTION B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN FOR MID-AFTERNOON SNACK** 1

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant

PLEASE FILL OUT IMMEDIATELY BEFORE DINNER

TIME: _____

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries __ Other (specify) _____

TIME: _____ **RECORD FOODS EATEN FOR DINNER 1**

Food/Drink	Description and Preparation	Amount

19

PLEASE FILL OUT IMMEDIATELY AFTER DINNER

TIME: _____

How pleasant was the meal you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant

How hungry do you feel right now?

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

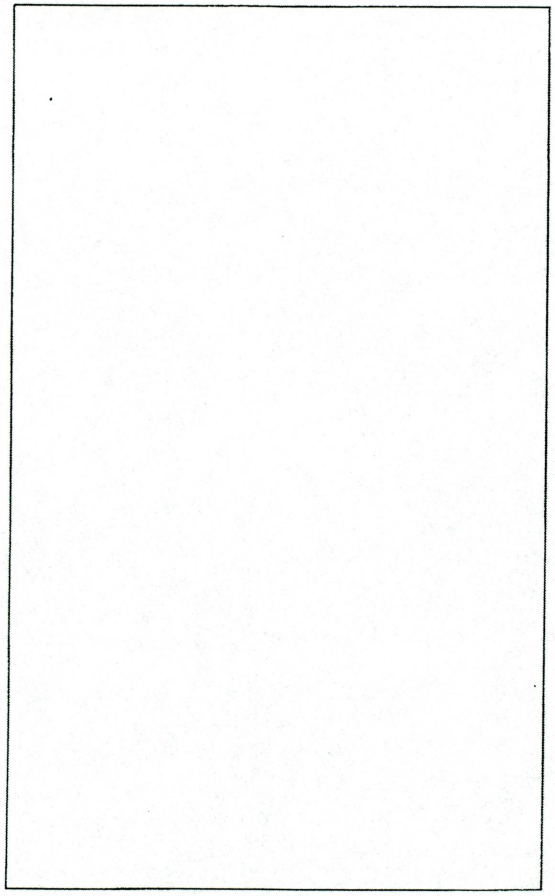
How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

20



PLEASE FILL OUT IMMEDIATELY BEFORE THE EVENING SNACK

SECTION A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry ○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin ___ pizza ___ burger ___ fruit ___ almonds ___ yogurt ___

cake ___ bread ___ French fries ___ Other (specify) _____

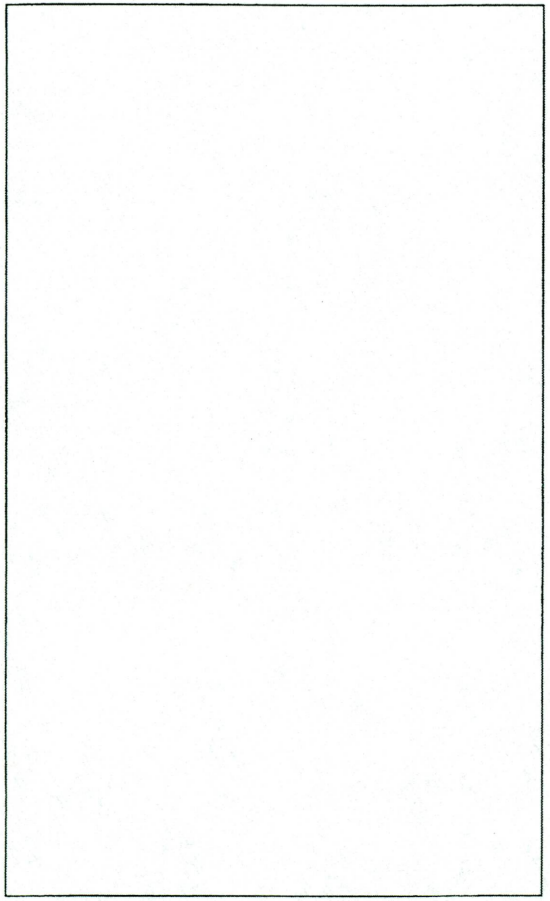
SECTION B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN FOR EVENING SNACK !**

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○ Not at all pleasant



ADDITIONAL SNACK #1

SECTION A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin __ pizza __ burger __ fruit __ almonds __ yogurt __

cake __ bread __ French fries ____ Other (specify) _____

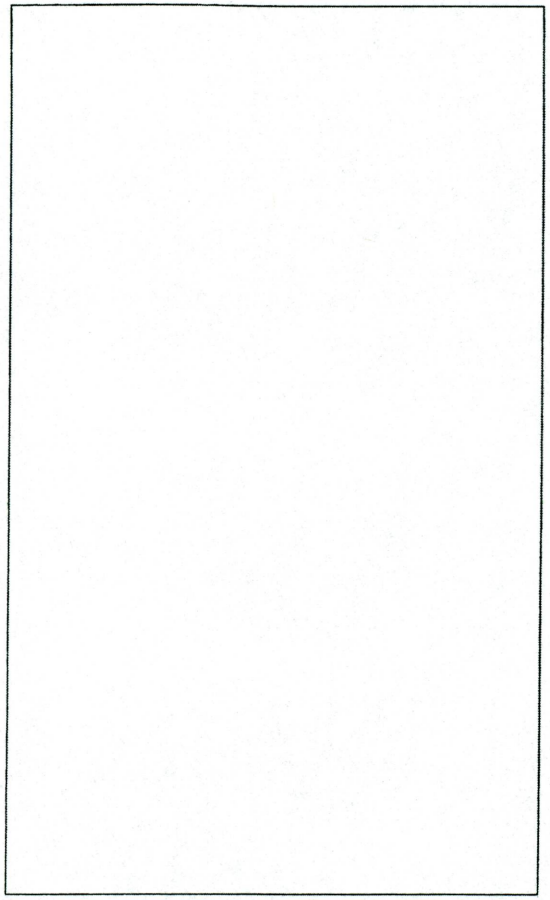
SECTION B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN AS SNACK BEFORE BREAKFAST 1**

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant



25

ADDITIONAL SNACK #2

Section A. Complete immediately **before** the snack.

TIME: _____ **How hungry do you feel right now?**

Not at all hungry ○○○○○○○○○○○○○○○○○○○○ Extremely hungry

How strong is your desire to eat right now?

Extremely weak ○○○○○○○○○○○○○○○○○○○○ Extremely strong

How full do you feel right now?

Not at all full ○○○○○○○○○○○○○○○○○○○○ Extremely full

How much food do you think you could eat right now?

A large amount ○○○○○○○○○○○○○○○○○○○○ Nothing at all

How thirsty do you feel right now?

Not at all thirsty ○○○○○○○○○○○○○○○○○○○○ Extremely thirsty

If you now feel like eating any of the food items listed, mark an X after the food:

muffin ___ pizza ___ burger ___ fruit ___ almonds ___ yogurt ___

cake ___ bread ___ French fries ____ Other (specify) ___

Section B. Complete immediately **after** the snack.

TIME: _____ **RECORD FOODS EATEN AS SNACK BEFORE BREAKFAST↓**

Food/Drink	Description & Preparation	Amount

How pleasant was the snack you just consumed?

Extremely pleasant ○○○○○○○○○○○○○○○○○○○○ Not at all pleasant

26

APPENDIX G

FOOD FREQUENCY QUESTIONNAIRE

Please do not write in this box→ | Date | ID No. | Group 1 2 3 4 | Phase 1 2

ALMOND STUDY

Section A. EATING PATTERNS

Think about your usual eating habits during the LAST SIX MONTHS as you answer the following questions. Please read the instructions carefully before answering. Items 1-6 relate to WHERE you usually eat.

1. How often do you **usually** eat BREAKFAST at **each** location? ***Do not leave any row unanswered.***	Never	Less than once per week	1 - 2 times per week	3 - 4 times per week	5 - 6 times per week	7 times per week	*For office use only*
Restaurant	O	O	O	O	O	O	1
Fast food	O	O	O	O	O	O	2
Cafeteria/take out	O	O	O	O	O	O	3
Prepared at home	O	O	O	O	O	O	4
2. How often do you skip breakfast? →	O	O	O	O	O	O	5

3. How often do you **usually** eat LUNCH at **each** location? ***Do not leave any row unanswered.***	Never	Less than once per week	1 - 2 times per week	3 - 4 times per week	5 - 6 times per week	7 times per week	
Restaurant	O	O	O	O	O	O	6
Fast food	O	O	O	O	O	O	7
Cafeteria/take out	O	O	O	O	O	O	8
Prepared at home	O	O	O	O	O	O	9
4. How often do you skip lunch? →	O	O	O	O	O	O	10

5. How often do you **usually** eat DINNER/SUPPER at **each** location? ***Do not leave any row unanswered.***	Never	Less than once per week	1 - 2 times per week	3 - 4 times per week	5 - 6 times per week	7 times per week	
Restaurant	O	O	O	O	O	O	11
Fast food	O	O	O	O	O	O	12
Cafeteria/take out	O	O	O	O	O	O	13
Prepared at home	O	O	O	O	O	O	14
6. How often do you skip dinner/supper? →	O	O	O	O	O	O	15

7. Which foods do you tend to eat more of when you eat out compared to when you eat at home?
Fill in all the circles that apply.

O Fruit O Vegetables O Poultry O Red meats O Other. ***Specify*** _____

O Fish O Desserts O Pasta O Breads/rice O None of the above

16-25

1

Items 8-11 relate to WHEN you eat, and the timing of your meals.
Mark the boxes which correspond to the time when you usually eat your meals and snacks using these symbols:

B = Breakfast **L** = Lunch **D** = Dinner **BR** = Brunch **S** = Snack

EXAMPLE

If you usually eat breakfast between 7:00-8:00 am, lunch between 12:30-2:00 pm, an afternoon snack between 4:00-5:00 pm, dinner between 8:00-10:00 pm, and a midnight snack between 12:00-1:00 am, you would mark the boxes as follows:

				B					L	L			S				D	D				S		
time	4am	5	6	7	8	9	10	11	12pm	1	2	3	4	5	6	7	8	9	10	11	12am	1	2	

8. Your eating pattern during **weekdays**

time	4am	5	6	7	8	9	10	11	12pm	1	2	3	4	5	6	7	8	9	10	11	12am	1	2	

9. Your eating pattern during **weekends**

time	4am	5	6	7	8	9	10	11	12pm	1	2	3	4	5	6	7	8	9	10	11	12am	1	2	

10. How long does it take you to eat your **breakfast, lunch, and dinner typically during *WEEKDAYS*.**	Never eat	Less than 15 min.	15 - 30 min.	30 - 60 min.	1 hr. or more	*For office use only*
Breakfast	O	O	O	O	O	26
Brunch	O	O	O	O	O	27
Lunch	O	O	O	O	O	28
Dinner	O	O	O	O	O	29

11. How long does it take you to eat your **breakfast, lunch, and dinner typically during *WEEKENDS*.**	Never eat	Less than 15 min.	15 - 30 min.	30 - 60 min.	1 hr. or more	
Breakfast	O	O	O	O	O	30
Brunch	O	O	O	O	O	31
Lunch	O	O	O	O	O	32
Dinner	O	O	O	O	O	33

12. Rank in numerical order foods you ***usually*** eat or drink as snacks. Start with number 1 as the most frequently used item, 2 as the next frequently used food, etc. Use zero (0) for items you do not use. (*Example: Most of the time, you alternate between apples and muffins equally, and you eat ice cream once in a while. Mark 1 for both fruit and muffins, and 2 for ice cream.*)

				34-51
___ almonds	___ popcorn	___ yogurt, ice cream	___ carrot or other vegetables	
___ other nuts	___ chips	___ bread, bagel, muffin	___ pie, cookies, cake, doughnut	
___ fruit	___ cereals	___ chocolate bar	___ Other. *Specify* _____	
___ crackers	___ hard candies	___ fruit juice	___ **Never eat snacks**	

\almond study\eating_3.wpd Revised 9/25/97

INSTRUCTIONS FOR SECTIONS B and C

When completing this questionnaire please keep in mind the following:

1. Average your intakes over the **PAST SIX MONTHS** (How often did you usually eat the food listed since you started in the study?)
2. Use **a No. 2 pencil** to fill in the circles.
3. Fill in the whole circle.
4. Should you wish to change a response, **erase the incorrect mark completely**.
5. Please keep write-in responses within the boxes provided. If you want to make comments, please write them on a separate piece of paper.
6. Please work through the examples on p. 4 before beginning each section.

You will find several columns in this questionnaire.

- The "FOOD ITEMS" column lists a number of food items with a ***standard size*** serving (in parenthesis).
- The "AVERAGE USE THE LAST SIX MONTHS" column contains nine frequency categories.
- Fill in the "PER DAY" columns for foods you used very often, and use the "PER WEEK" or "PER MONTH" columns for foods you ate less frequently.
- For each food item fill in **only one circle for average use**. You must fill in at least one circle for every food item. If you use a food less than once per month, fill in the "**Never or Rarely**" column.

Measurement Abbreviations

Tbsp = tablespoon
tsp = teaspoon
oz. = ounces
cup = 8 oz. cup
med. = medium
decaf. = decaffeinated
pcs. = pieces
pt. = pint

Please refer to these instructions as you complete the questionnaire. You may tear out this sheet to help you with your responses.

EXAMPLES Section B

Let us assume that over the past 6 months you ate the following:

1) In September you ate a banana every day but in the other months you ate no bananas. That would average out to about a banana a week over the six month period. In the banana row fill in the circle under 1 per week.
2) Every day you drank one (and sometimes two), 10 oz glasses of orange juice. Fill in the circle under 2 - 3 per day.
3) Over the past 6 months you ate white rice once a week sometimes twice. If you ate about 1 ¼ cup each time, you would fill in the circle under 2 - 4 per week .

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									For office use only
FRUIT	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Bananas (1 medium)	○	○	●	○	○	○	○	○	○	1
Orange juice, fresh or frozen (6 oz.)	○	○	○	○	○	○	●	○	○	2
Cooked white rice (¾ cup)	○	○	○	●	○	○	○	○	○	3

4) You ate cereal on average 2 - 4 times a week. You ate Kellogg's Raisin Bran for 5 months and Post Grape Nuts for 1 months out of the past six.

Write in Raisin Bran Kellogg's, then fill in the circle under 2 - 4 per week.

Then, write in Grape Nuts Post and fill in the circle under 1 - 3 per month

(3 per week x 4 weeks = 12 / 6 months = 2 per month).

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									For office use only
CEREALS	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
WRITE-IN: Raisin Bran (1cup) BRAND: Kellogg's	○	○	○	●	○	○	○	○	○	118
WRITE-IN: Grape Nuts (1cup) BRAND: Post	○	●	○	○	○	○	○	○	○	119

EXAMPLE Section C

5) You took no vitamin a in the last six months but you took 30,000 IU of Beta-Carotene about every other day. Fill in the circles for "No" under vitamin a and 13,000 - 22,000 per day for Beta-Carotene.

2. Not counting multi-vitamins reported above, do you take any of the following preparations?

Vitamin A ● No! ○ Yes, seasonal only ○ Yes, most months	Dose per day?	○ Less than 8,000 IU	○ 8,000 to 10,000 IU	○ 13,000 to 22,000 IU	○ 23,000 IU or more	○ Don't know
Beta-Carotene ○ No! ● Yes →	Dose per day?	○ Less than 8,000 IU	○ 8,000 to 10,000 IU	● 13,000 to 22,000 IU	○ 23,000 IU or more	○ Don't know

4

Please do not write in this box→ Date _____ ID No. _____ Group 1 2 3 4 Phase 1 2

Section B. FOOD INTAKE ASSESSMENT

When filling out the questionnaire, include ingredients used in mixed dishes (e.g. sandwiches, green salads) in the frequencies for individual foods below. Thus, if you use tomatoes on a sandwich, count the bread with the breads, and tomatoes under salads/raw vegetables, and margarine under dairy products. Please read the instructions carefully before filling out the questionnaire.

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									*For office use only*
FRUIT	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Fresh apples, pears (1 medium or ½ cup)	O	O	O	O	O	O	O	O	O	1
Cherries (½ cup or 10 pieces)	O	O	O	O	O	O	O	O	O	2
Oranges (1 medium)	O	O	O	O	O	O	O	O	O	3
Grapefruit (½ medium)	O	O	O	O	O	O	O	O	O	4
Bananas (1 medium)	O	O	O	O	O	O	O	O	O	5
Grapes (1 cup)	O	O	O	O	O	O	O	O	O	6
Peaches, nectarines (1 medium fresh or ½ cup canned)	O	O	O	O	O	O	O	O	O	7
Apricots (3 fresh or ¼ cup canned)	O	O	O	O	O	O	O	O	O	8
Cantaloupe (⅛ medium or 1 cup)	O	O	O	O	O	O	O	O	O	9
Strawberries, fresh or frozen (1 cup)	O	O	O	O	O	O	O	O	O	10
Blueberries, (½ cup)	O	O	O	O	O	O	O	O	O	11
Other berries (e.g. raspberries, blackberries, fresh or frozen) (½ cup)	O	O	O	O	O	O	O	O	O	12
Pineapple (4 oz fresh or ¼ cup canned)	O	O	O	O	O	O	O	O	O	13
Other fresh, or frozen fruit (1 medium or ½ cup)	O	O	O	O	O	O	O	O	O	14
Fruit cocktail, other canned fruit (¾ cup)	O	O	O	O	O	O	O	O	O	15
Applesauce (½ cup)	O	O	O	O	O	O	O	O	O	16
Dates (⅛ cup or 3 medium)	O	O	O	O	O	O	O	O	O	17
Prunes (4 pieces)	O	O	O	O	O	O	O	O	O	18
Raisins (½ cup)	O	O	O	O	O	O	O	O	O	19
All other dried fruit (4 pieces)	O	O	O	O	O	O	O	O	O	20
Orange juice, fresh or frozen (6 oz.)	O	O	O	O	O	O	O	O	O	21
Fruit punch or fruit flavored drinks (6 oz)	O	O	O	O	O	O	O	O	O	22
Other fruit juice or cider (6 oz.)	O	O	O	O	O	O	O	O	O	23

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									*For office use only*
VEGETABLES	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Tomatoes (1 medium fresh, 4 cherries, or ½ cup cooked or canned)	O	O	O	O	O	O	O	O	O	24
Cucumber or zucchini, raw (½ cup)	O	O	O	O	O	O	O	O	O	25
Celery (8" stalk or 1/3 cup)	O	O	O	O	O	O	O	O	O	26
Carrots (1 medium raw or ½ cup cooked)	O	O	O	O	O	O	O	O	O	27
Iceberg lettuce (1 cup)	O	O	O	O	O	O	O	O	O	28
Dark green lettuce, loose leaf (1 cup)	O	O	O	O	O	O	O	O	O	29
Spinach or chard (½ cup)	O	O	O	O	O	O	O	O	O	30
Cabbage or Mustard greens (½ cup)	O	O	O	O	O	O	O	O	O	31
Kale (½ cup)	O	O	O	O	O	O	O	O	O	32
Broccoli (½ cup)	O	O	O	O	O	O	O	O	O	33
Cauliflower (½ cup)	O	O	O	O	O	O	O	O	O	34
Peas (½ cup) or lima beans (⅓ cup)	O	O	O	O	O	O	O	O	O	35
Green or string beans (½ cup) & asparagus (4 spears)	O	O	O	O	O	O	O	O	O	36
Mushrooms (½ cup)	O	O	O	O	O	O	O	O	O	37
Onions (⅓ cup raw or ½ cup cooked)	O	O	O	O	O	O	O	O	O	38
Garlic (1 clove)	O	O	O	O	O	O	O	O	O	39
Corn, fresh or frozen (1 ear or ½ cup)	O	O	O	O	O	O	O	O	O	40
Peppers: green, red, jalapeno etc. (¼ cup)	O	O	O	O	O	O	O	O	O	41
Potato salad with mayonnaise (½ cup)	O	O	O	O	O	O	O	O	O	42
Avocado (⅛ med.), guacamole (2 Tbsp)	O	O	O	O	O	O	O	O	O	43
Other vegetables (½ cup)	O	O	O	O	O	O	O	O	O	44
Tomato or V-8 juice (6 oz.)	O	O	O	O	O	O	O	O	O	45
Other vegetable juices (6 oz.)	O	O	O	O	O	O	O	O	O	46

LEGUMES and NUTS	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Split peas, dried peas (½ cup)	O	O	O	O	O	O	O	O	O	47
Soybeans, tofu, tempeh (½ cup)	O	O	O	O	O	O	O	O	O	48

FOOD ITEMS **SWEETS, BAKED GOODS, MISCELLANEOUS** Continued	AVERAGE USE THE LAST SIX MONTHS (choose only one) NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	*For office use only*
Non dairy frozen desserts (½ cup)	O	O	O	O	O	O	O	O	O	72
Jam, jelly, preserves or honey on bread or other foods (1 Tbsp)	O	O	O	O	O	O	O	O	O	73
Syrup on foods (1 Tbsp)	O	O	O	O	O	O	O	O	O	74
Sugar (brown, white) at table, in coffee or tea (1 Tbsp)	O	O	O	O	O	O	O	O	O	75
Candy bar with nuts (1 medium)	O	O	O	O	O	O	O	O	O	76
Candy bar without nuts (1 medium)	O	O	O	O	O	O	O	O	O	77
Other candy: licorice, hard candy, gum drops, etc. (1- 2 piece)	O	O	O	O	O	O	O	O	O	78
Granola Bar (1 bar)	O	O	O	O	O	O	O	O	O	79
Energy Bar (e.g.. power bar) (1 bar)	O	O	O	O	O	O	O	O	O	80
Potato and other chips (15 chips or 1 oz)	O	O	O	O	O	O	O	O	O	81
Popcorn - low fat or non-fat (2 cups)	O	O	O	O	O	O	O	O	O	82
Popcorn with butter (2 cups)	O	O	O	O	O	O	O	O	O	83
Pepper (3 shakes)	O	O	O	O	O	O	O	O	O	84
Onion powder (3 shakes)	O	O	O	O	O	O	O	O	O	85
Garlic powder (3 shakes)	O	O	O	O	O	O	O	O	O	86
Soy sauce (1 Tbsp)	O	O	O	O	O	O	O	O	O	87
Salt (⅛ tsp)	O	O	O	O	O	O	O	O	O	88
Mayonnaise or miracle whip, *low calorie* (2 Tbsp)	O	O	O	O	O	O	O	O	O	89
Mayonnaise or miracle whip, *regular* (2 Tbsp)	O	O	O	O	O	O	O	O	O	90
Salad dressing, *low-calorie* (2 Tbsp)	O	O	O	O	O	O	O	O	O	91
Salad dressing, *regular*: French, Thousand Island, etc. (2 Tbsp)	O	O	O	O	O	O	O	O	O	92
Olive oil & vinegar dressing (2 Tbsp)	O	O	O	O	O	O	O	O	O	93
Other oil & vinegar dressing (2 Tbsp)	O	O	O	O	O	O	O	O	O	94
Catsup, red chili sauce or taco sauce (1 Tbsp)	O	O	O	O	O	O	O	O	O	95
Salsa (1 Tbsp)	O	O	O	O	O	O	O	O	O	96

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									For office use only
SWEETS, BAKED GOODS, MISCELLANEOUS Continued	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Tomato sauce used in pasta (½ cup)	O	O	O	O	O	O	O	O	O	97
Gravy, fat based (¼ cup)	O	O	O	O	O	O	O	O	O	98
Gravy, broth-based (¼ cup)	O	O	O	O	O	O	O	O	O	99
Tomato soup (1 cup)	O	O	O	O	O	O	O	O	O	100
Pea soup (1 cup)	O	O	O	O	O	O	O	O	O	101
Cream soups (1 cup)	O	O	O	O	O	O	O	O	O	102
Vegetable soup, minestrone (1 cup)	O	O	O	O	O	O	O	O	O	103
Other soups (1 cup)	O	O	O	O	O	O	O	O	O	104

BREADS, STARCHES, GRAINS, CEREALS	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Roll, english muffin, bagel or soft pretzel (1 medium)	O	O	O	O	O	O	O	O	O	105
Whole grain bread (2 slices)	O	O	O	O	O	O	O	O	O	106
White, French or Sourdough bread (2 slices)	O	O	O	O	O	O	O	O	O	107
Other breads (2 slices)	O	O	O	O	O	O	O	O	O	108
Biscuits, hamburger or hot dog buns (1 medium)	O	O	O	O	O	O	O	O	O	109
Muffin (1 medium)	O	O	O	O	O	O	O	O	O	110
Corn bread, corn tortilla - *include use in burritos, etc.* (2 medium pieces)	O	O	O	O	O	O	O	O	O	111
Flour tortilla, 6" (2 pieces)	O	O	O	O	O	O	O	O	O	112
Whole wheat crackers (4 pieces), wheat thins (8 pieces)	O	O	O	O	O	O	O	O	O	113
Graham crackers (4 whole crackers)	O	O	O	O	O	O	O	O	O	114
Other crackers (4 pieces)	O	O	O	O	O	O	O	O	O	115
Baked potato (1 medium)	O	O	O	O	O	O	O	O	O	116
Mashed potatoes (½ cup)	O	O	O	O	O	O	O	O	O	117
French fries, hash browns (¾ cup)	O	O	O	O	O	O	O	O	O	118
Pasta: spaghetti, macaroni etc. (1 cup)	O	O	O	O	O	O	O	O	O	119

9

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									For office use only
BREADS, STARCHES, GRAINS, CEREALS Continued	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Pizza, 8" pizza (2 slices, 4")	O	O	O	O	O	O	O	O	O	120
Pancakes, waffles, 6"x½" (2 pieces)	O	O	O	O	O	O	O	O	O	121
Oatmeal (1 cup)	O	O	O	O	O	O	O	O	O	122
Cream of Wheat (1 cup)	O	O	O	O	O	O	O	O	O	123
Cooked brown rice, millet (¾ cup)	O	O	O	O	O	O	O	O	O	124
Cooked white rice (¾ cup)	O	O	O	O	O	O	O	O	O	125
Other cooked grains: bulgar, couscous, kasha (¾ cup)	O	O	O	O	O	O	O	O	O	126
Pretzels (5 large twists or 1 oz)	O	O	O	O	O	O	O	O	O	127
COLD BREAKFAST CEREALS. If you do not use these, mark never or rarely and move on to the next section.										
WRITE-IN TYPE (AMOUNT): Raisin Bran (1 cup) BRAND: Kellogg's	O	O E	● X	O A	O M	O P	O L	O E	O	
WRITE-IN TYPE (AMOUNT): BRAND:	O	O	O	O	O	O	O	O	O	128
WRITE-IN TYPE (AMOUNT): BRAND:	O	O	O	O	O	O	O	O	O	129
WRITE-IN TYPE (AMOUNT): BRAND:	O	O	O	O	O	O	O	O	O	130
WRITE-IN TYPE (AMOUNT): BRAND:	O	O	O	O	O	O	O	O	O	131

EGGS, DAIRY PRODUCTS, OILS	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Eggs: fried, boiled, scrambled, egg salad (1 large egg, 2 halves)	O	O	O	O	O	O	O	O	O	132
Egg beaters (2-egg box) or egg whites (2 eggs)	O	O	O	O	O	O	O	O	O	133
Cottage cheese (½ cup)	O	O	O	O	O	O	O	O	O	134
Ricotta cheese or mozzarella (¼ cup)	O	O	O	O	O	O	O	O	O	135
Cream cheese, cheese spread (2 Tbsp)	O	O	O	O	O	O	O	O	O	136

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									For office use only
EGGS, DAIRY PRODUCTS, OILS Continued	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Low fat cheese, include in sandwiches and salads (2 slices)	O	O	O	O	O	O	O	O	O	137
Cheese: American, cheddar, include in sandwiches and salads (2 slices or 2 oz)	O	O	O	O	O	O	O	O	O	138
Low or non-fat margarine: soft, tub (1Tbsp, ½ oz.)	O	O	O	O	O	O	O	O	O	139
Low or non-fat margarine: hard, stick (1Tbsp, ½ oz.)	O	O	O	O	O	O	O	O	O	140
Regular margarine: soft, tub - added to foods or bread (1 Tbsp, ½ oz)	O	O	O	O	O	O	O	O	O	141
Regular margarine: hard, stick - added to foods or bread (1 Tbsp, ½ oz)	O	O	O	O	O	O	O	O	O	142
Butter, added to foods or bread (1 Tbsp)	O	O	O	O	O	O	O	O	O	143
Vegetable oil used in cooking (1 Tbsp)	O	O	O	O	O	O	O	O	O	144
Olive oil used in cooking (1 Tbsp)	O	O	O	O	O	O	O	O	O	145
Sour cream (2 Tbsp)	O	O	O	O	O	O	O	O	O	146
Milk-whole or 2% (8 oz glass)	O	O	O	O	O	O	O	O	O	147
Low fat milk - 1%, skim milk (8 oz)	O	O	O	O	O	O	O	O	O	148
Yogurt: flavored, plain, regular or low fat (8 oz cup)	O	O	O	O	O	O	O	O	O	149
Whipped cream (4 Tbsp or ¼ cup)	O	O	O	O	O	O	O	O	O	150

FISH and MEATS	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Fish cakes or sticks (1 medium or 4 sticks)	O	O	O	O	O	O	O	O	O	151
Fish fillet in sandwich (1 piece)	O	O	O	O	O	O	O	O	O	152
White fish - cod, sole, haddock or halibut, snapper, catfish (4 oz)	O	O	O	O	O	O	O	O	O	153
Salmon (4 oz)	O	O	O	O	O	O	O	O	O	154
Tuna, tuna salad, tuna casserole (4 oz)	O	O	O	O	O	O	O	O	O	155
Other fish (4 oz)	O	O	O	O	O	O	O	O	O	156

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									*For office use only*
FISH and MEATS Continued	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Processed meats: beef sausage, salami, bologna, hot dog (1 piece or 2 slices)	O	O	O	O	O	O	O	O	O	157
Hamburger, regular (1 patty, 3 oz)	O	O	O	O	O	O	O	O	O	158
Beef or lamb in sandwich (1 slice)	O	O	O	O	O	O	O	O	O	159
Beef or lamb as a main dish, e.g. steak, roast (3 oz)	O	O	O	O	O	O	O	O	O	160
Chicken or turkey *white meat,* baked, roasted or broiled (1 large piece or 3 oz)	O	O	O	O	O	O	O	O	O	161
Chicken or turkey *dark meat,* baked, roasted or broiled (2 small pcs. or 3 oz)	O	O	O	O	O	O	O	O	O	162
Chicken or turkey *white* meat, fried (1 large piece or 3 oz)	O	O	O	O	O	O	O	O	O	163
Chicken or turkey *dark meat,* fried (2 small pcs. or 3 oz)	O	O	O	O	O	O	O	O	O	164
Pork for breakfast or dinner, e.g. bacon, sausage, ham, chops, ribs, lunch meat (3 strips, 2 chops or 4 oz)	O	O	O	O	O	O	O	O	O	165
Meat analogues (3 oz)	O	O	O	O	O	O	O	O	O	166

BEVERAGES	NEVER OR RARELY	1-3 PER MO.	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Diet Soda- *no caffeine* (7-up, root beer, caffeine free cola, etc.) (12 oz)	O	O	O	O	O	O	O	O	O	167
Diet Soda- *with caffeine* (cola, Mt. Dew, etc.) (12 oz)	O	O	O	O	O	O	O	O	O	168
Regular Soda- *no caffeine* (7-up, root beer, caffeine free cola, etc.) (12 oz)	O	O	O	O	O	O	O	O	O	169
Regular Soda- *with caffeine* (cola, Mt. Dew, etc.) (12 oz)	O	O	O	O	O	O	O	O	O	170
Decaffeinated coffee (6 oz cup)	O	O	O	O	O	O	O	O	O	171
Coffee, regular (6 oz cup)	O	O	O	O	O	O	O	O	O	172
Herb or decaf. tea: hot or iced (6 oz cup)	O	O	O	O	O	O	O	O	O	173
Tea - hot or iced with caffeine (6 oz)	O	O	O	O	O	O	O	O	O	174
Hot chocolate (8 oz cup)	O	O	O	O	O	O	O	O	O	175

FOOD ITEMS	AVERAGE USE THE LAST SIX MONTHS (choose only one)									*For office use only*
BEVERAGES Continued	NEVER OR RARELY	1-3 PER MO	1 PER WEEK	2-4 PER WEEK	5-6 PER WEEK	1 PER DAY	2-3 PER DAY	4-5 PER DAY	6+ PER DAY	
Filtered bottled water (1 pt. or 16 oz.)	O	O	O	O	O	O	O	O	O	176
Tap water (8 oz glass)	O	O	O	O	O	O	O	O	O	177
Wine coolers (12 oz)	O	O	O	O	O	O	O	O	O	178
Beer (12 oz)	O	O	O	O	O	O	O	O	O	179
Wine (3½ oz)	O	O	O	O	O	O	O	O	O	180
Liquor (1 oz)	O	O	O	O	O	O	O	O	O	181

How much of the visible fat (or skin) on your chicken, beef, pork or lamb do you remove before eating? 182
O Don't eat meat O Remove all visible fat O Remove most fat
O Remove small part of fat O Remove none

What kind of fat is usually used for baking at home? (*Mark only one*) 183
O Real butter O Margarine O Vegetable oil O Vegetable shortening O Other

How often do you eat food fried, stir-fried, or sautéed at home? 184
O Never O Less than once a week O Once per week
O 2-4 times per week O 5-6 times per week O Daily

What kind of fat is usually used for frying and sautéing at home? (*Mark only one*) 185
O Real butter O Margarine O Vegetable oil O Lard
O "Pam" type spray O Vegetable shortening O Other

How often do you eat fried food away from home, excluding French fries (e.g., fried chicken, fish, shrimp, etc.)? 186
O Never O Less than once a week O Once per week
O 2-4 times per week O 5-6 times per week O Daily

Do you use cooking oil at home? (E.g., Wesson Corn Oil) 187-188
O No O Yes *Specify brand and type*→ _____

Please continue with Section C on the next page.

\almond study\ffq_4.wpd Revised 10/1/97

Please do not write in this box→ | Date | ID No. | Group 1 2 3 4 | Phase 1 2

Section C. VITAMINS, MINERALS, and DIETARY SUPPLEMENTS

Please *fill in the circles* that indicate the amount of vitamins, minerals, and other dietary supplements you use.

1. Do you currently take any **multi-vitamins** or **multiple vitamin/mineral supplements**?

			For office use only
○ No↓ ○ Yes →	What specific brand(s) do you use? Write in exact name and brand:	How many pills do you take per week? ○ 2 or less ○ 3 - 5 ○ 6 - 9 ○ 10 or more	1-3
	Write in exact name and brand:	How many pills do you take per week? ○ 2 or less ○ 3 - 5 ○ 6 - 9 ○ 10 or more	4-5
	Write in exact name and brand:	How many pills do you take per week? ○ 2 or less ○ 3 - 5 ○ 6 - 9 ○ 10 or more	6-7
	Write in exact name and brand:	How many pills do you take per week? ○ 2 or less ○ 3 - 5 ○ 6 - 9 ○ 10 or more	8-9

2. Not counting multi-vitamins reported above, do you take any of the following preparations?

Vitamin A ○ No↓ ○ Yes, seasonal only ○ Yes, most months	Dose per day?	○ Less than 8,000 IU	○ 8,000 to 10,000 IU	○ 13,000 to 22,000 IU	○ 23,000 IU or more	○ Don't know	10-11
Beta-Carotene ○ No↓ ○ Yes →	Dose per day?	○ Less than 8,000 IU	○ 8,000 to 10,000 IU	○ 13,000 to 22,000 IU	○ 23,000 IU or more	○ Don't know	12-13
Vitamin C ○ No↓ ○ Yes, seasonal only ○ Yes, most months	Dose per day?	○ Less than 400 mg	○ 400 to 700 mg	○ 750 to 1,250 mg	○ 1,300 mg or more	○ Don't know	14-15
Vitamin B_6 (Pyridoxine) ○ No↓ ○ Yes →	Dose per day?	○ Less than 10 mg	○ 10 to 39 mg	○ 40 to 79 mg	○ 80 mg or more	○ Don't know	16-17
Vitamin E ○ No↓ ○ Yes →	Dose per day?	○ Less than 100 IU	○ 100 to 250 IU	○ 300 to 500 IU	○ 600 IU or more	○ Don't know	18-19
Calcium (include Calcium in Dolomite and Tums, etc) ○ No↓ ○ Yes →	Dose per day?	○ Less than 400 mg	○ 400 to 900 mg	○ 901 to 1,300 mg	○ 1,301 mg or more	○ Don't know	20-21
Selenium ○ No↓ ○ Yes →	Dose per day?	○ Less than 80 mcg	○ 80 to 130 mcg	○ 140 to 250 mcg	○ 260 mcg or more	○ Don't know	22-23
Iron ○ No↓ ○ Yes →	Dose per day?	○ Less than 51 mg	○ 51 to 200 mg	○ 201 to 400 mg	○ 401 mg or more	○ Don't know	24-25
Zinc ○ No↓ ○ Yes →	Dose per day?	○ Less than 25 mg	○ 25 to 74 mg	○ 75 to 100 mg	○ 101 mg or more	○ Don't know	26-27
Fish Oil (Omega-3 fatty acids) ○ No↓ ○ Yes →	Dose per day?	○ Less than 2,500 mg	○ 2,500 to 4,999 mg	○ 5,000 to 9,999 mg	○ 10,000 mg or more	○ Don't know	28-29
Chromium picolinate ○ No↓ ○ Yes →	Dose per day?	○ Less than 100 mcg	○ 100 to 399 mcg	○ 400 to 599 mcg	○ 600 mcg or more	○ Don't know	30-31

Grapeseed extract O No↓ OYes →	Dose per day?	O Less than 99 mg	O 100 to 149 mg	O 150 to 299 mg	O 300 mg or more	O Don't know	32-33
Ginseng O No↓ OYes →	Dose per day?	O Less than 99 mg	O 100 to 149 mg	O 150 to 299 mg	O 300 mg or more	O Don't know	34-35
Gotu kola (tincture) O No↓ OYes →	Dose per day?	O Less than 9 ml	O 10 to 19 ml	O 20 to 29 ml	O 30 ml or more	O Don't know	36-37
Garlic pills O No↓ OYes →	Dose per day?	O Less than 2 g	O 2 to 3.9 g	O 4 to 5.9 g	O 6 g or more	O Don't know	38-39
Ephedra (Ma huang) O No↓ OYes →	Dose per day?	O Less than 250 mg	O 250 to 499 mg	O 500 to 624 mg	O 625 mg or more	O Don't know	40-41
Colloidal silver O No↓ OYes →	Dose per day?	O Less than 3 drops	O 4 to 8 drops	O 9 to 11 drops	O 12 drops or more	O Don't know	42-43
CoEnzyme Q10 O No↓ OYes →	Dose per day?	O Less than 60 mg	O 60 to 119 mg	O 120 to 179 mg	O 180 mg or more	O Don't know	44-45
Protein powder O No↓ OYes →	Dose per day?	O Less than 14 g	O 14 to 27 g	O 28 to 41 g	O 42 g or more	O Don't know	46-47
Echinacae O No↓ OYes →	Dose per day?	O Less than 99 mg	O 100 to 149 mg	O 150 to 299 mg	O 300 mg or more	O Don't know	48-49
Psyllium O No↓ OYes →	Dose per day?	O Less than 2 Tbsp	O 2 to 4 Tbsp	O 5 to 6 Tbsp	O 7 Tbsp or more	O Don't know	50-51
Valerian O No↓ OYes →	Dose per day?	O Less than 2 g	O 2 to 3.9 g	O 4 to 5.9 g	O 6 g or more	O Don't know	52-53
Acidophilus O No↓ OYes →	Dose per day?	O Less than 2 Tbsp	O 2 to 4 Tbsp	O 5 to 6 Tbsp	O 7 Tbsp or more	O Don't know	54-55
Brewer's yeast O No↓ OYes →	Dose per day?	O Less than 2 Tbsp	O 2 to 4 Tbsp	O 5 to 6 Tbsp	O 7 Tbsp or more	O Don't know	56-57
Do you take flaxseed, borage, or evening primrose oil? O No↓ OYes →	Dose per day?	O Less than 999 mg	O 1000 to 1999 mg	O 2000 to 2999 mg	O 3000 mg or more	O Don't know	58-59
Mark any OTHER supplements that you take on a regular basis. *(Mark all that apply)* →	O Cod liver oil O Folic acid O Vitamin D O Vitamin B12 O Niacin O Potassium O Magnesium O B-Complex vitamins (including injections) O Copper O Other (Please Specify): _____						60-69

THANK YOU

PLEASE REMEMBER TO MAIL THIS COMPLETED QUESTIONNAIRE WITHIN ONE WEEK

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15

APPENDIX H

BODY MEASUREMENTS PROTOCOL

ID#:_____

Date:_____

BODY MEASUREMENTS

INSTRUCTIONS

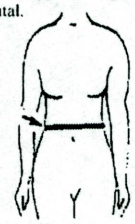
Clinic 2

TORSO

1. This measurement should be taken while the subject is standing (does not slouch) and breathing quietly, with the torso unclothed (a close-fitting slip can be worn). GIRDLE OR PANTYHOSE SHOULD NOT BE WORN during this measurement.

2. Measure the torso at a point **one inch above the navel ("belly button"), even if this is not the usual waistline.** Be sure the tape is applied snugly but not tight, and that it is horizontal.

Measure one inch above the navel even if this is not your waistline



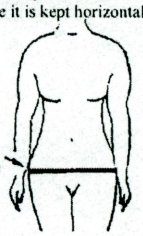
3. Record your first measurement to the nearest quarter inch. Release the tape measure and make a second remeasurement.

BUTTOCKS

1. The buttocks should be measured with subject standing either unclothed or wearing close fitting underwear. NO GIRDLE OR PANTYHOSE should be worn.

2. Slide the tape up and down until you find the **largest point between waist and thighs.** When sliding the tape to the correct spot be sure it is kept horizontal.

Measure the largest spot



3. Record measurements to the nearest quarter inch.

			Initials
Torso			
Buttocks			_____
Weight			
Height			_____

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APPENDIX I

PHYSICAL ACTIVITY QUESTIONNAIRE

ID # _____ Date: _____ 1

Your Physical Activity

Clinic 2

Instructions: Please answer the questions below concerning your usual physical activity over the **last twelve months.**

1. How many times per week do you engage in regular **vigorous** activities, such as brisk walking, jogging, bicycling, etc., long enough or with enough intensity to work up a **sweat**, get your **heart thumping** or get **out of breath**?

   O Never engage in activities this vigorous.
   O Less than once per week
   O 1 time per week
   O 2 times per week
   O 3 times per week
   O 4 times per week
   O 5 times per week
   O 6 or more times per week

2. a) Do you **walk, run, or jog** as part of a physical activity program? (include these same activities when they are performed on exercise machines)
   O Yes (continue)
   O No (Go to Question 3)

   b) How many of these "walk-run-jog" workouts do you do per week?
   O Less than once/week
   O 1 time per week
   O 2 times per week
   O 3 times per week
   O 4 times per week
   O 5 times per week
   O 6 or more times per week

   c) How many miles do you average per "walk-run-jog" workout? Please check the nearest category below.
   O ¼ mile or less
   O ½ mile
   O 1 mile
   O 1½ miles
   O 2 miles
   O 3 miles
   O 4 or more miles

   d) What is your average time spent in each "walk-run-jog" exercise session (excluding rest stages)?
   O 0-9 minutes
   O 10-19 minutes
   O 20-29 minutes
   O 30-39 minutes
   O 40-49 minutes
   O 50-59 minutes
   O 60 minutes or more

3. a) During an average day how much time is usually spent in **MODERATE PHYSICAL ACTIVITY** (active housework, vacuuming, light carpentry, regular walking, raking leaves, light gardening, leisurely cycling, etc.)?
   O None
   O Less than 1 hour
   O 1-2 hours
   O 2-4 hours
   O 4-8 hours
   O 8-16 hours

   b) During an average day how much time is usually spent in **LIGHT ACTIVITY WHILE STANDING** (dishwashing, cooking, ironing, office work while standing, etc.)?
   O None
   O Less than 1 hour
   O 1-2 hours
   O 2-4 hours
   O 4-8 hours
   O 8-16 hours

   c) During an average day how much time is usually spent in **LIGHT OR SEDENTARY ACTIVITY WHILE SITTING OR RECLINING** (office work while seated, personal care, eating, sewing, driving a car, watching TV, reading, etc.)?
   O None
   O Less than 1 hour
   O 1-2 hours
   O 2-4 hours
   O 4-8 hours
   O 8-16 hours

2

4. a) How many times per week does your usual program include the following **VIGOROUS** activities? (Please mark the **less than 1/wk column** for every exercise that you do **not** do.)

Please write-in up to two additional activities in the last two lines.

	Less than 1/wk	1/wk	2/wk	3/wk	4/wk	5/wk	6 or more per week
Vigorous walking or hiking	O	O	O	O	O	O	O
Running or jogging	O	O	O	O	O	O	O
Aerobics	O	O	O	O	O	O	O
Vigorous bicycling or stationary cycling	O	O	O	O	O	O	O
Lap-swimming	O	O	O	O	O	O	O
Tennis, racquet ball, other vigorous sports	O	O	O	O	O	O	O
Moderate or heavy labor during your employment	O	O	O	O	O	O	O
Vigorous yard work or gardening (such as spading, etc.)	O	O	O	O	O	O	O
Other vigorous exercise #1 (specify):_____	O	O	O	O	O	O	O
Other vigorous exercise #2 (specify):_____	O	O	O	O	O	O	O

b) How many MINUTES would you estimate you usually spend in **each** activity PER SESSION? (Note that the rows in this question correspond to those of question 4a. If you do not use a particular type of exercise, leave that row blank).

	1-9 min.	10-19 min.	20-29 min.	30-39 min.	40-49 min.	50-59 min.	60+ min.
Vigorous walking or hiking	O	O	O	O	O	O	O
Running or jogging	O	O	O	O	O	O	O
Aerobics	O	O	O	O	O	O	O
Vigorous bicycling or stationary cycling	O	O	O	O	O	O	O
Lap-swimming	O	O	O	O	O	O	O
Tennis, racquet ball, other vigorous sports	O	O	O	O	O	O	O
Moderate or heavy labor during your employment	O	O	O	O	O	O	O
Vigorous yard work or gardening (such as spading, etc.)	O	O	O	O	O	O	O
Other vigorous exercise #1 (specify):_____	O	O	O	O	O	O	O
Other vigorous exercise #2 (specify):_____	O	O	O	O	O	O	O

c) Do these vigorous activities make you work up a **sweat**, get your **heart thumping**, or get **out of breath**? Please check **yes** or **no.** (Note that the rows in this question correspond to those of question 4a. If you do not use a particular type of exercise, leave that row blank).

	No	Yes
Vigorous walking or hiking	O	O
Running or jogging	O	O
Aerobics	O	O
Vigorous bicycling or stationary cycling	O	O
Lap-swimming	O	O
Tennis, racquet ball, other vigorous sports	O	O
Moderate or heavy labor during your employment	O	O
Vigorous yard work or gardening (such as spading, etc.)	O	O
Other vigorous exercise #1 (specify):_____	O	O
Other vigorous exercise #2 (specify):_____	O	O

"I knew there'd be a catch to it ...You have to run 700 miles a day!"

APPENDIX J

CHANGE IN HEALTH STATUS QUESTIONNAIRE

Please do not write in this box→ **Date_____ ID No._____ Clinic 4 7**

ALMOND STUDY

Please answer the following questions below keeping in mind any changes that have occurred **since you enrolled in the study.**

Have you started smoking cigarettes? o No o Yes

Have you been diagnosed with any of these medical conditions?

Diabetes	o No	o Yes
Heart disease	o No	o Yes
Malabsorption	o No	o Yes
Thyroid disorder	o No	o Yes
Cancer	o No	o Yes
Stroke	o No	o Yes
Psychiatric disorder	o No	o Yes

3. Have you started any new mediations/drugs that you take on a regular basis?
o No o Yes →Please list the names and dose of each below.

_____

_____

4. ***For females only***
Are you pregnant? o No o Yes