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SWEET RESULTS FROM A SUGARLESS SNACK

Moderator: Swati Kalgaonkar (ABC)
Speakers: Rudy Ortiz (UC Merced),
Jaapna Dhillon (University of Missouri),
Jagmeet Madan (SVT College, Mumbai),
Soumik Kalita (FamPhy)

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Sweet Results from a Sugarless Snack

<u>Moderator</u>:
Swati Kalgaonkar, PhD
Associate Director, Nutrition Research Program

<u>Speakers</u>:
Rudy Ortiz, PhD
Professor, Molecular and Cell Biology
University of California, Merced

Jaapna Dhillon, PhD
Assistant Professor, Nutrition & Exercise Physiology
University of Missouri-Columbia

Jagmeet Madan (virtual)
Professor, Food Nutrition and Dietetics
SNDT Women's University, Mumbai, India

Soumik Kalita, MBBS, MMed, MPH, DHA
Founder, FamPhy

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Meet our esteemed guests

Dr. Rudy Ortiz
Professor, Molecular & Cell Biology
University of California, Merced

Dr. Jaapna Dhillon
Assistant Professor,
Nutrition & Exercise Physiology
University of Missouri-Columbia

Meet our esteemed guests

Dr. Jagmeet Madan

National President, Indian Dietetic Association, Principal & Professor, Department of Food Nutrition and Dietetics, Sir Vithaldas Thackersey College of Home Science (Autonomous) SNDT Women's University, Mumbai (India)

Dr. Soumik Kalita

MBBS, MMed, MPH, DHA,
Fellow of International Society of Cardiovascular Disease Epidemiology and Prevention,
Founder, FamPhy

Key Research Area:
Almonds & Blood Glucose

Almonds & Blood Glucose Regulation

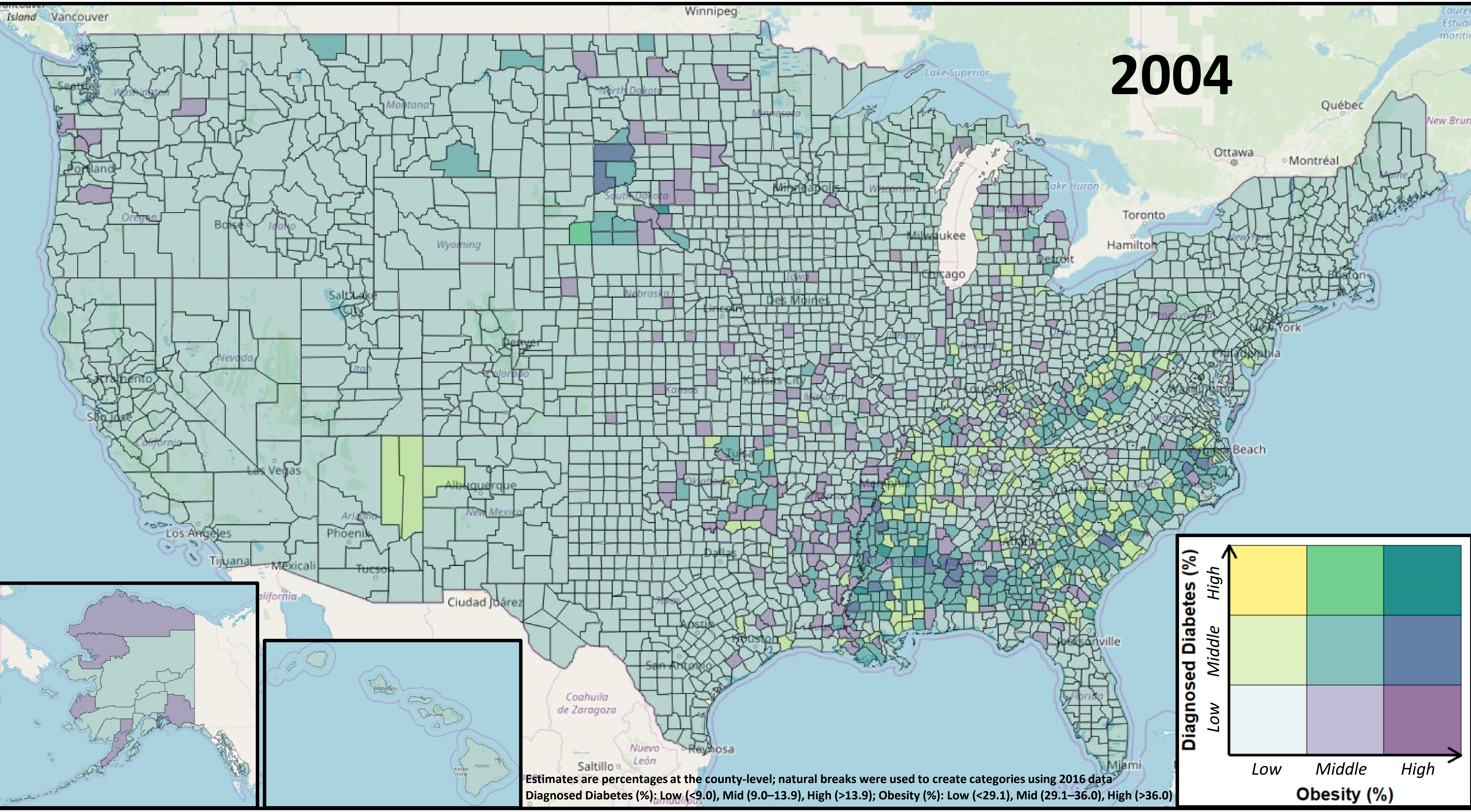
- Varied subject populations and outcomes studied.
- Several studies to date show almonds help reduce insulin resistance, and HbA1c.
- Additional studies underway.

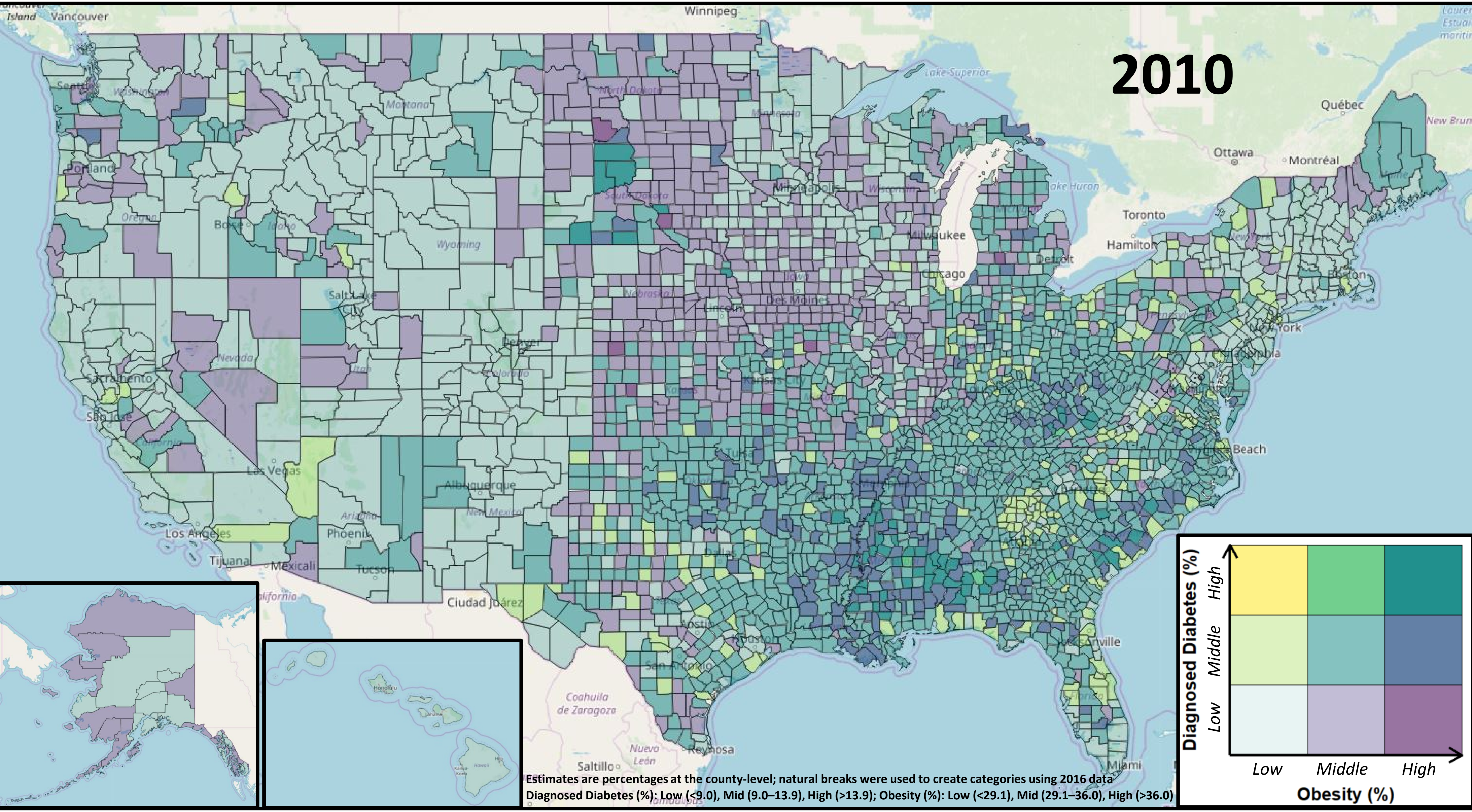
Sweet Results from a Sugarless Snack:

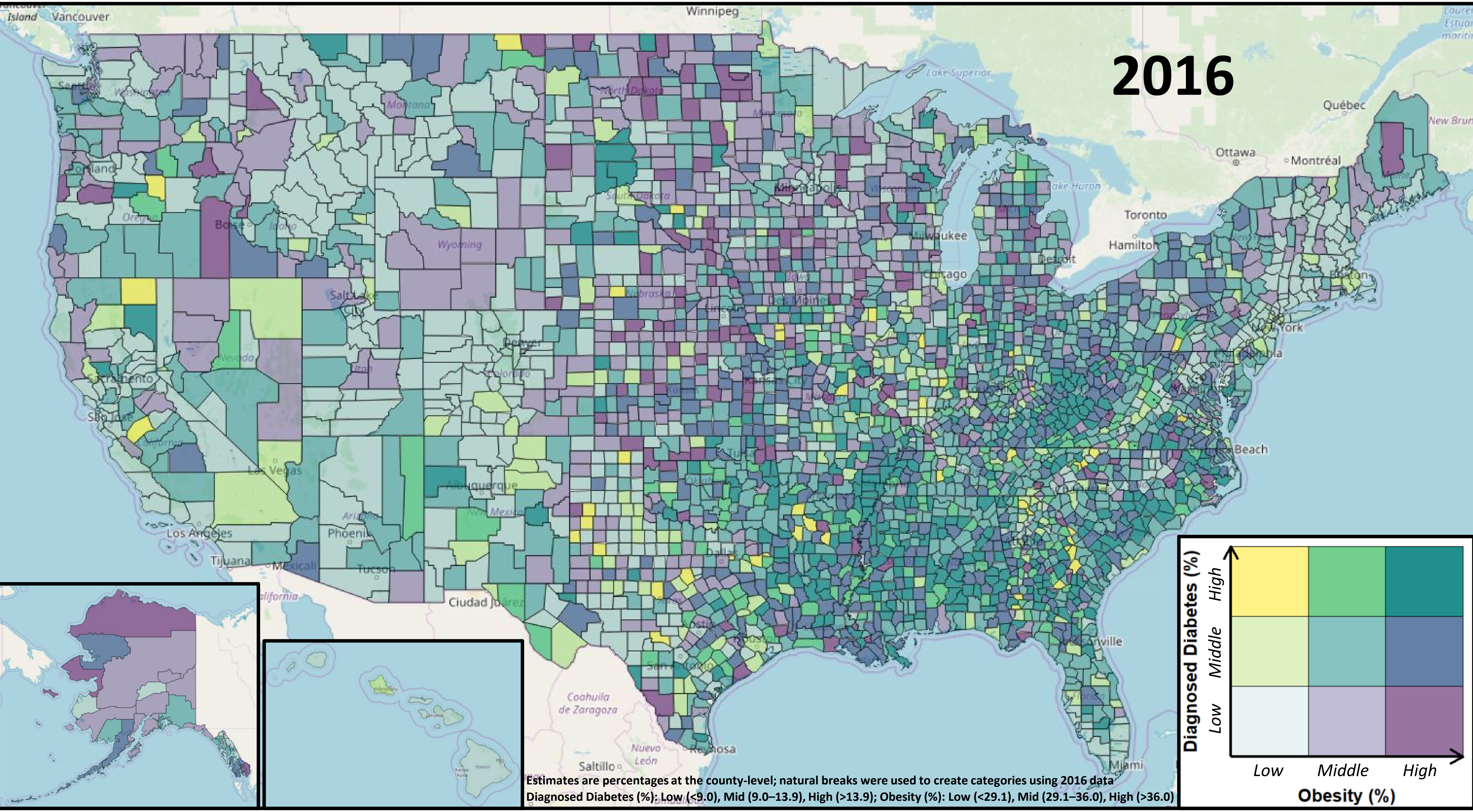
Brief Review and Implications of Current Results

Rudy M. Ortiz, PhD, FAPS, FAHA
Department of Molecular & Cell Biology
School of Natural Sciences
UC Merced

Almond Conf, 12.18.21


2004
Diagnosed Diabetes (%)
Low
Middle
High
Obesity (%)
Low
Middle
High
Estimates are percentages at the county-level; natural breaks were used to create categories using 2016 data
Diagnosed Diabetes (%): Low (<9.0), Mid (9.0–13.9), High (>13.9); Obesity (%): Low (<29.1), Mid (29.1–36.0), High (>36.0)


2010
Diagnosed Diabetes (%)
High
Middle
Low
Obesity (%)
Low
Middle
High
Estimates are percentages at the county-level; natural breaks were used to create categories using 2016 data
Diagnosed Diabetes (%): Low (<9.0), Mid (9.0–13.9), High (>13.9); Obesity (%): Low (<29.1), Mid (29.1–36.0), High (>36.0)


2016
Diagnosed Diabetes (%)
High
Middle
Low
Low
Middle
High
Obesity (%)
Estimates are percentages at the county-level; natural breaks were used to create categories using 2016 data
Diagnosed Diabetes (%): Low (<9.0), Mid (9.0–13.9), High (>13.9); Obesity (%): Low (<29.1), Mid (29.1–36.0), High (>36.0)

Benefits of Nuts on T2D Prevalence, Prevention Not Conclusive

A number of meta-analyses have calculated no or very minimal effects in prediabetic or T2D subjects

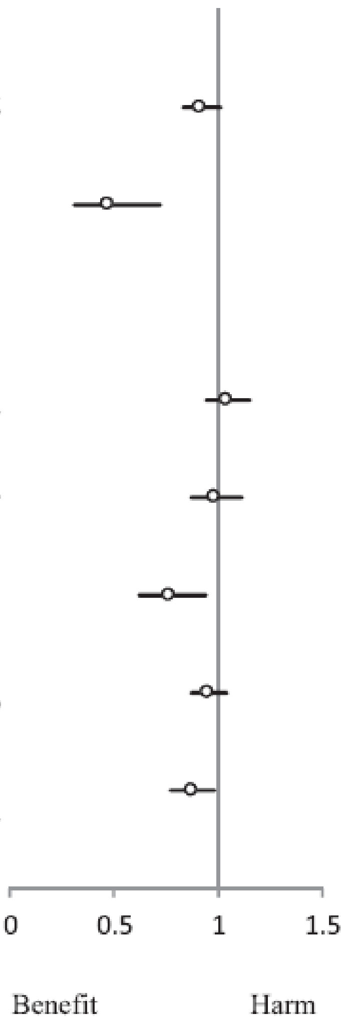
- *Kochar et al. 2010 Eur J Clin Nutri*; *Luo et al. 2014 Am J Clin Nutr*; *Viguiliouk et al. 2014 PLoS One*; *Wu et al. 2015 Nutr Rev; Muley et al. 2020 JBI Evid Synth*

Nut consumption in replacement of –CHO in T2D patients improved glycemic control (*Jenkins et al. 2018 Diabetalogia*)

Meta-analysis Suggests No Benefit of Nut Consumption on Prevalence of T2D

Subgroup	Studies	n	OR/RR [95% CI]	P value	Heterogeneity I^2, %	Heterogeneity P value	NutriGrade (Meta-evidence)
Cross-sectional studies							
Total nuts	3	72,559	0.91 [0.83, 1.01]	0.06	0	0.39	Very low
Walnuts	1	27,563	0.47 [0.31, 0.72]	—	—	—	Very low
Prospective cohorts							
Total nuts	4	194,168	1.04 [0.94, 1.15]	0.42	59.8	0.06	Very low
Total tree nuts	2	137,956	0.98 [0.87, 1.11]	0.77	0	0.65	Very low
Walnuts	1	137,956	0.76 [0.62, 0.94]	—	—	—	Very low
Peanuts	3	202,147	0.95 [0.87, 1.04]	0.29	72.4	0.03	Very low
peanut butter	2	119,806	0.87 [0.77, 0.98]	0.02	50.6	0.16	Very low

Pooled OR/RR [95% CI]



Becerra-Tomás et al. 2021 Am J Clin Nutr

Almond Consumption Independently Is Associated w/ Better Glycemia Metrics

Almond consumption (12 wks) had modest (4%) reduction in HbA1c (time effect but not group x time) in T2D adults but not healthy adults (*Cohen & Johnson 2011 Metab: Clin Exp*)

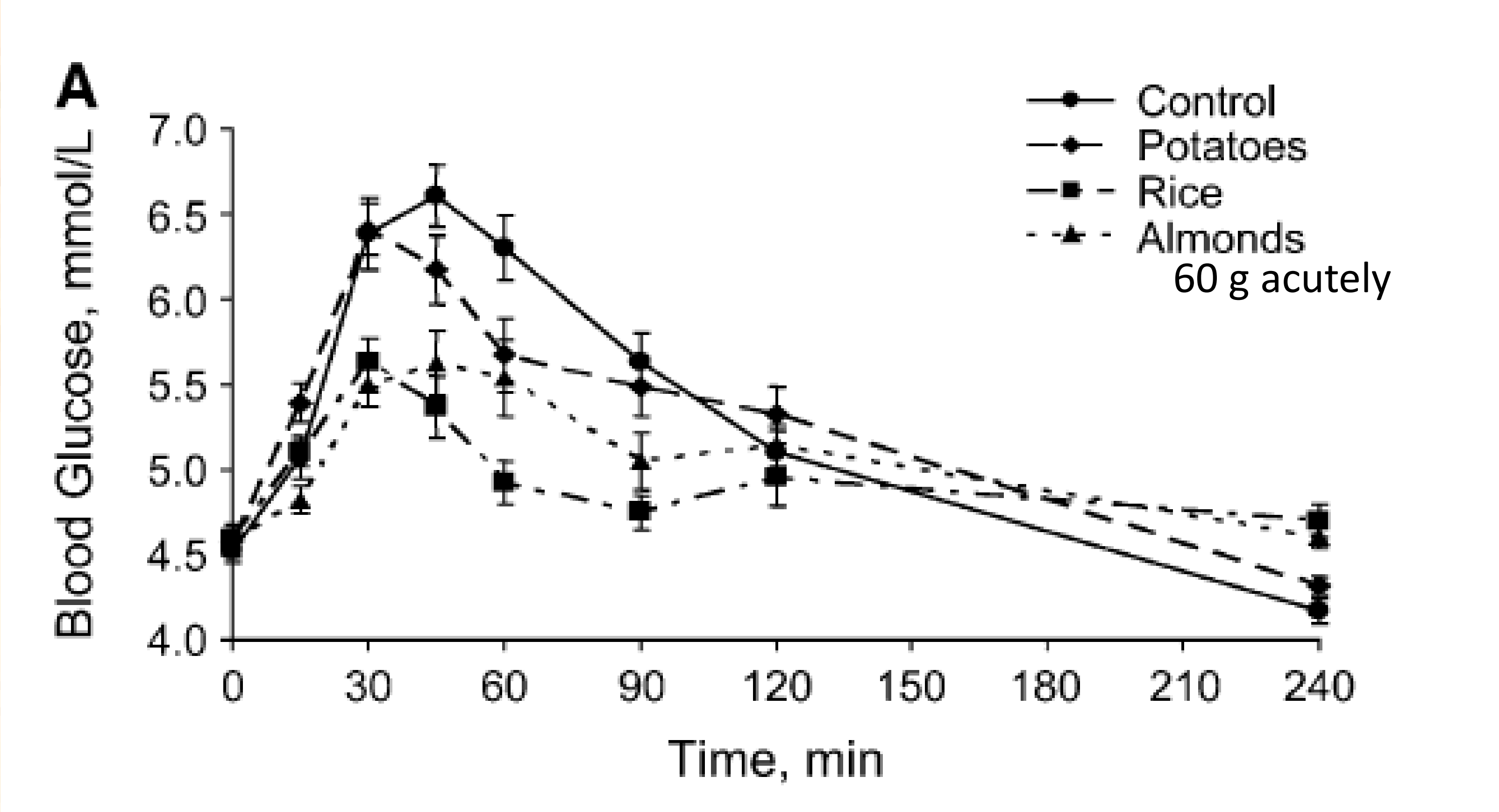
Almond consumption (4 wks) modestly improved FPG, FPI, HOMA-IR in T2D subjects (group effect only)(*Li et al. 2011 Metab: Clin Exp*)

Almond consumption (>4 d/wk x 3 mo) modestly improved HbA1c in T2D patients when included in LCD (*Ren et al. 2020 nutrients*)

However;
Almond consumption (43 g X 5-7x/wk X 12 wks) had no effect on glucoregulatory metrics in healthy/T2D subjects (*Sweazea et al. 2014 J Funct Foods*)

Other demonstrating no or very modest effects on glucose or associated metrics in pre-diabetics and/or T2D (Lovejoy et al. 2002 Am J Clin Nutr; *Wien et al. 2010 J Am Coll Nutr* [slight improvement FPI, HOMA-IR]; *Richmond et al. 2013 ISRN Nutr*; *Gulati et al. 2017 Metab Syn Rel Dis* [minimal effect on HbA1c]; *Hou et al. 2018 Nutrients*; *Bowen et al. 2019 Clin Nutr ESPEN*; *Palacios et al. 2020 J Am Coll Nutr*;

Almonds in Test Meal Improves Glucose Tolerance in Healthy Adults

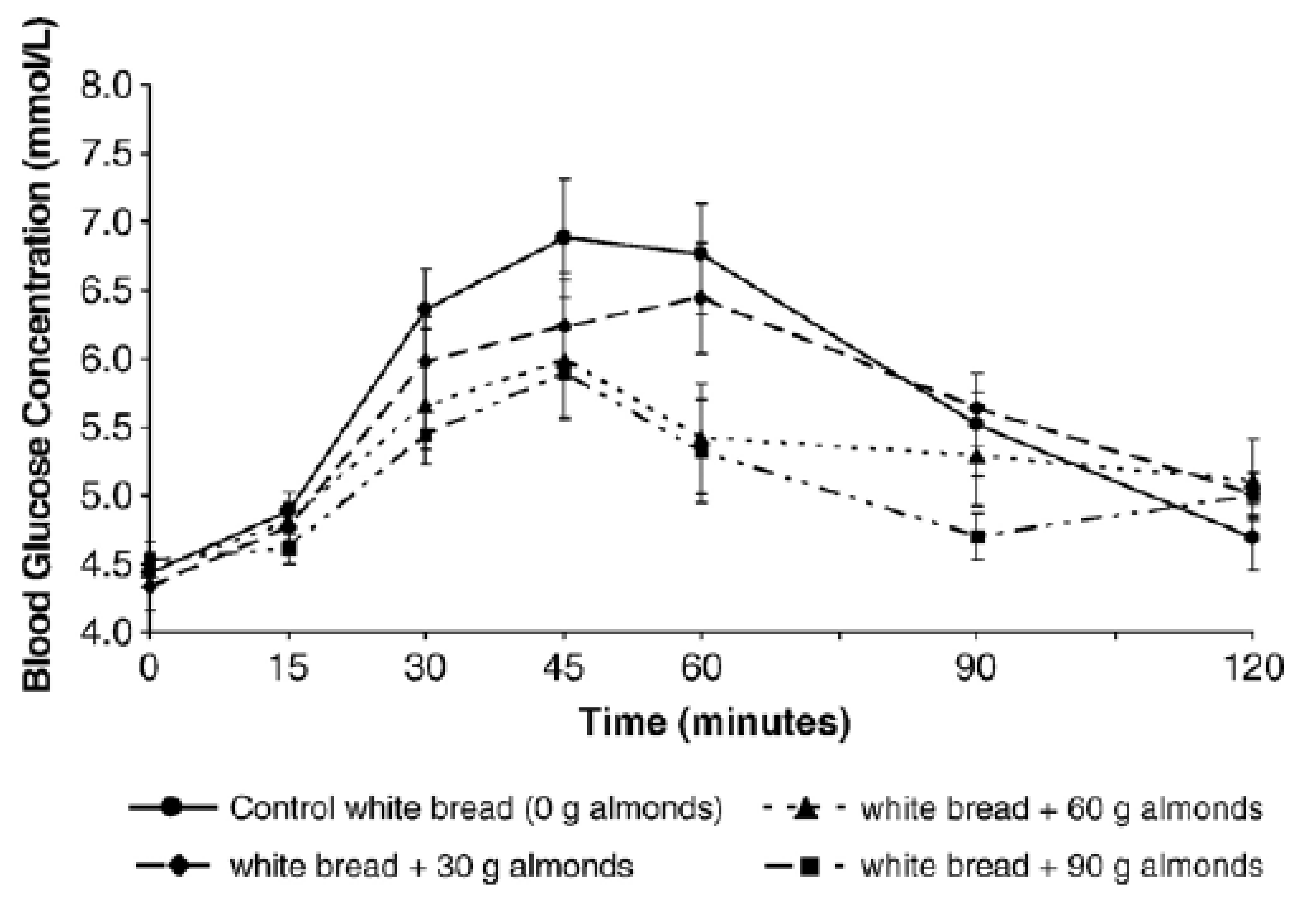


60 g acutely

Jenkins et al. 2006 J Nutr

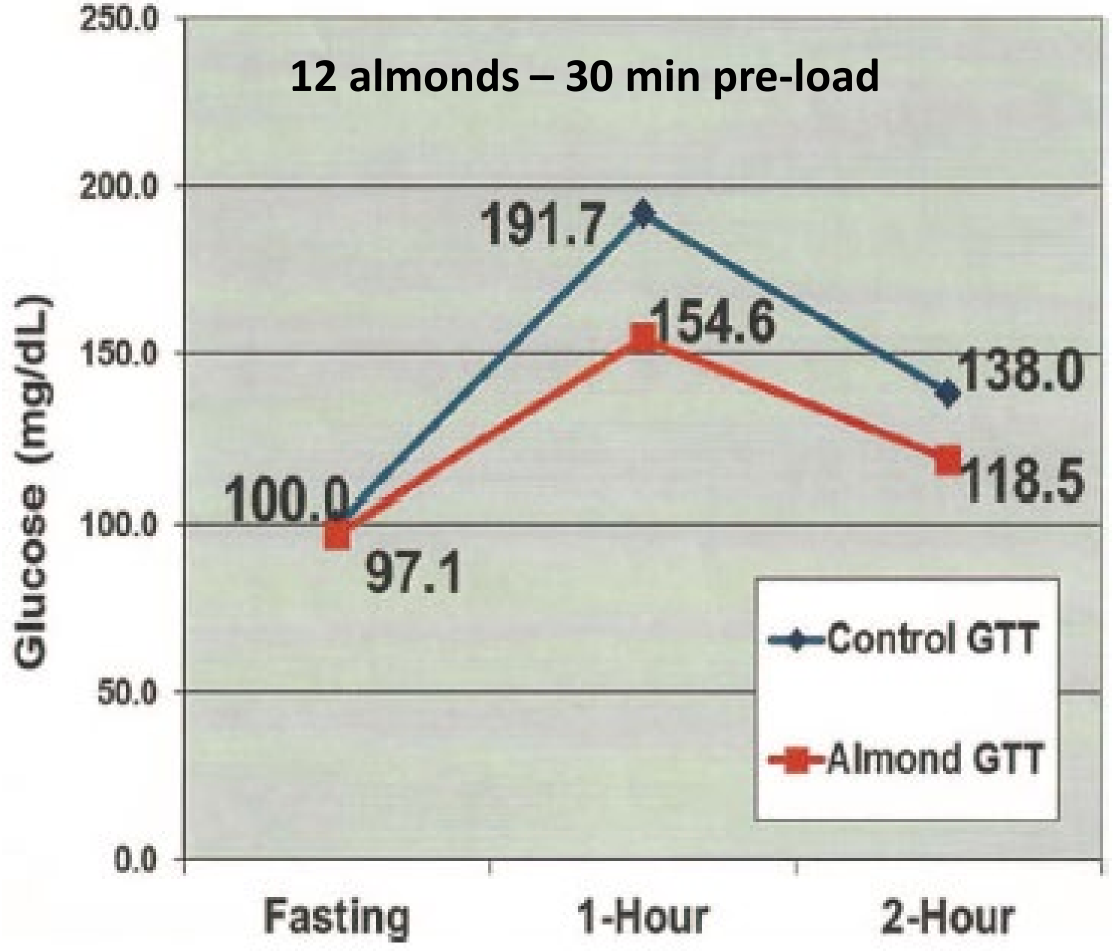
Single-serving Almonds Improves Glucose Tolerance in Relatively Young, Healthy Adults

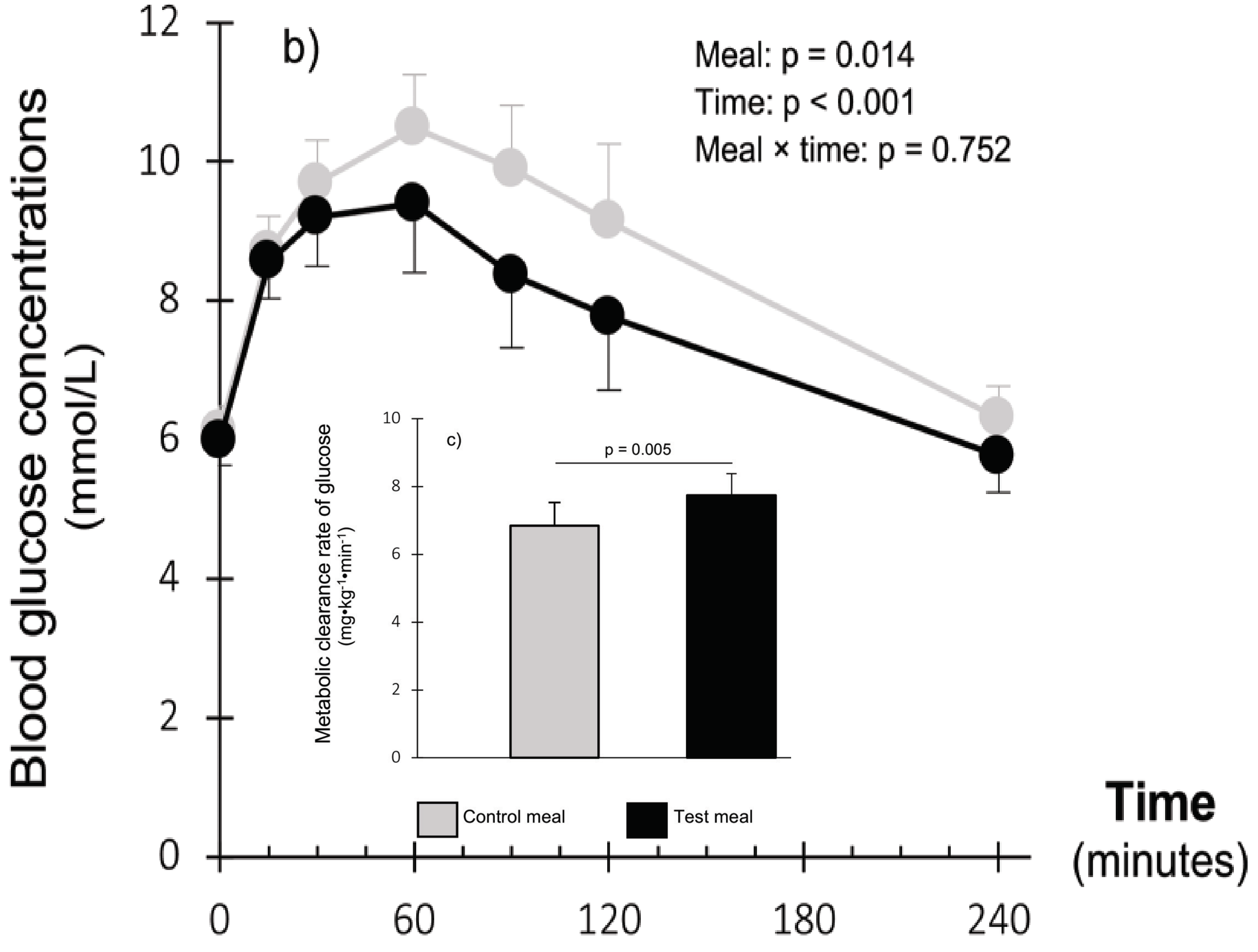
21-39 yrs



Josse et al. 2007 Metab: Clin Exp

Single-serving of Almonds Acutely Improves Glucose Tolerance in Pre-diabetic/IGT & T2D Subjects

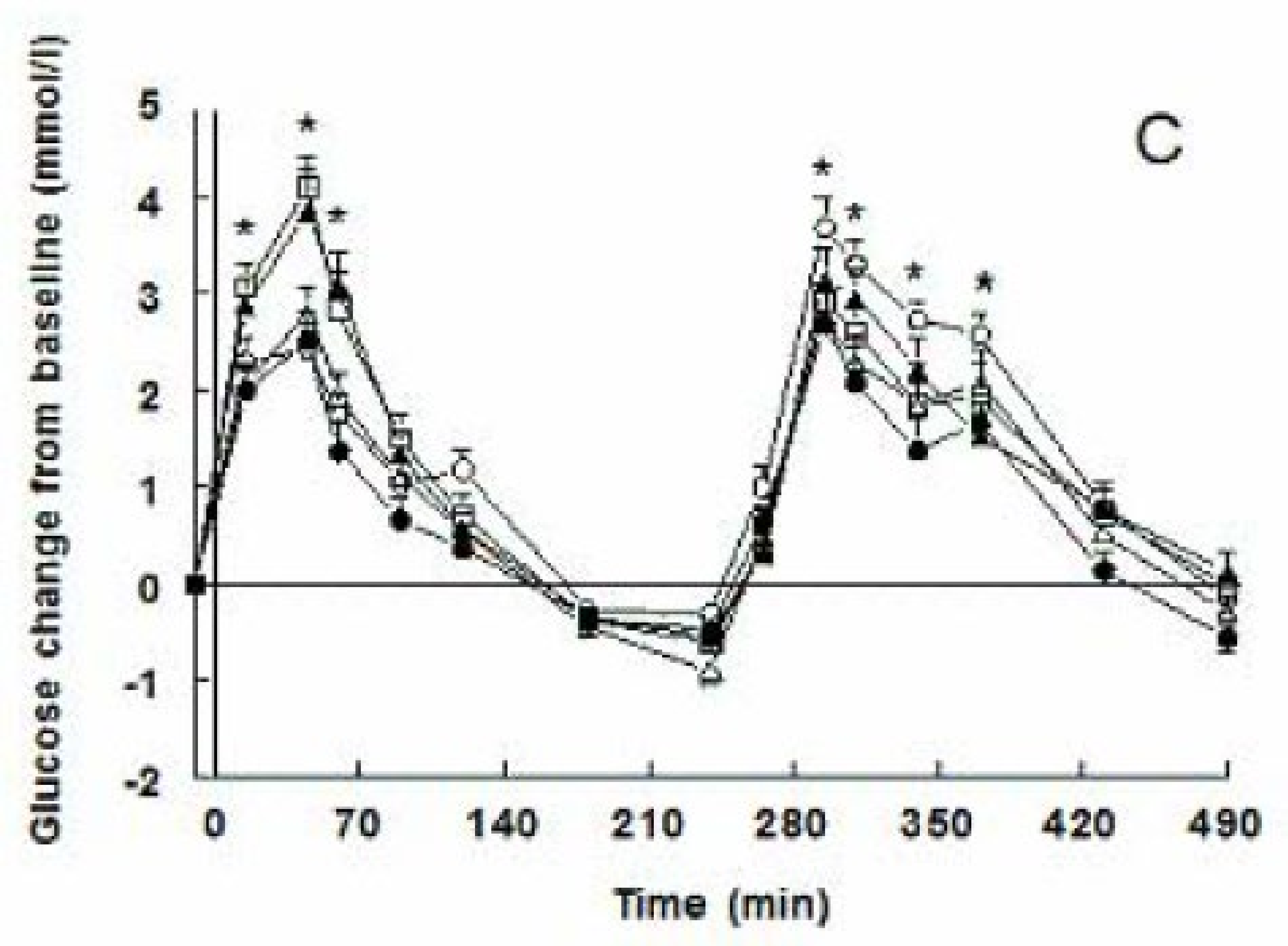




Crouch & Slater 2016 J Am Brd Fam Med

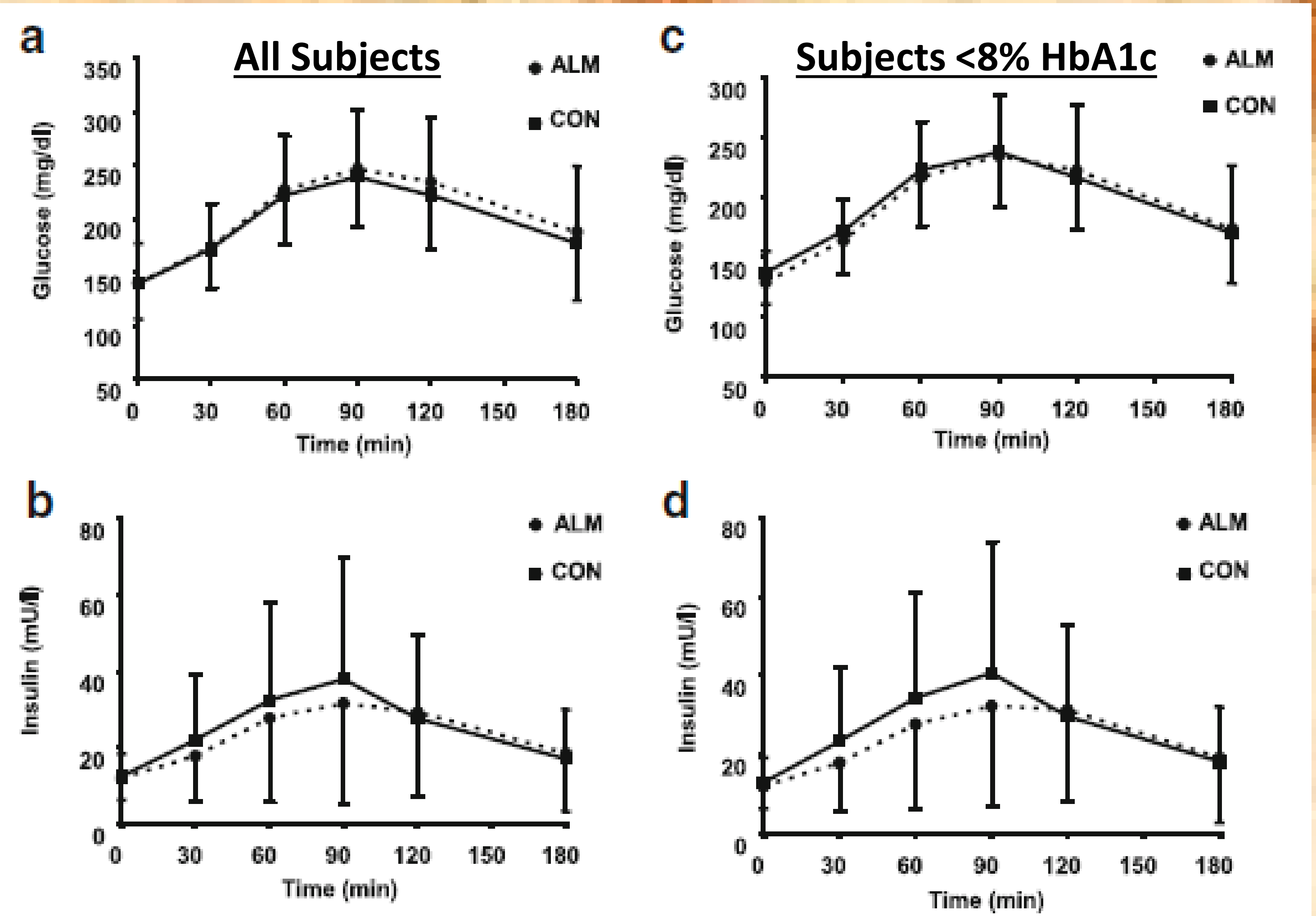
Bodnaruc et al. 2020 Appl Physiol Nutr Metab

Single-serving Almonds Improves Morning Meal Postprandial Glucose Excursion in IGT Adults



Mori et al. 2011 Nutr Metab

Almonds Did Not Change Glucose Tolerance or Insulin Resistance Index in T2D Subjects

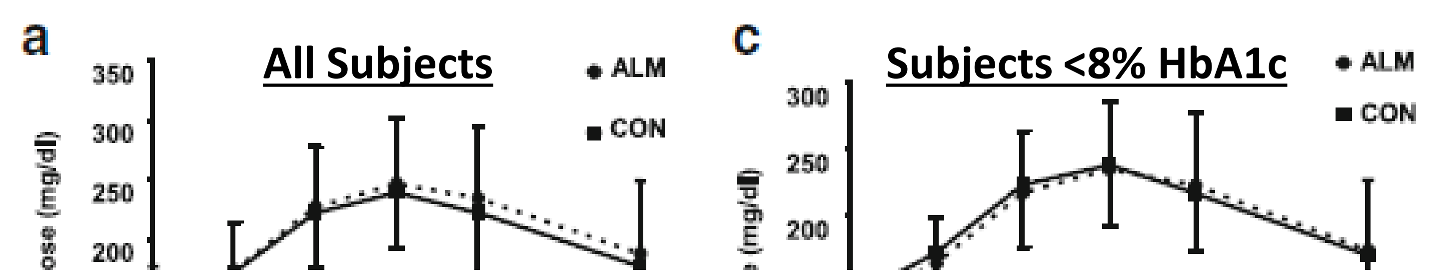


Details

- 40-70 yrs
- BMI: 25-35
- 12 wks, 60 g/d

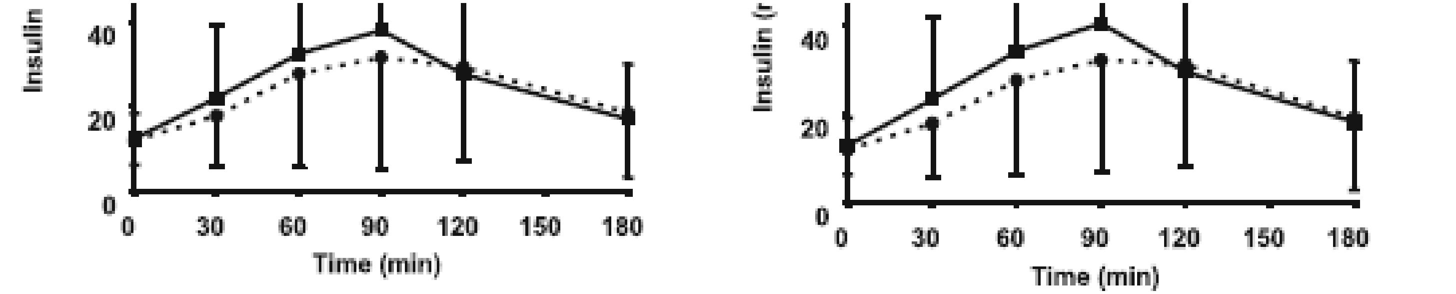
Chen et al. 2017 Nutr & Metab

Almonds Do Improve Long-term Glucose Control



Subjects with HbA1c ≤8 (n = 27)	Control		Almond		
HbA1c (%)	7.07 ± 0.58	7.23 ± 0.63	7.18 ± 0.64	7.01 ± 0.62	0.043
Fasting serum glucose (mg/dl)	134.3 ± 24.8	137.4 ± 26.7	132.8 ± 24.8	129.3 ± 25.6	0.011
Fasting serum insulin (mU/l)	11.2 ± 5.0	12.9 ± 6.4	10.8 ± 4.8	12.0 ± 5.7	0.660
HOMA-IR	3.73 ± 2.13	4.35 ± 2.92	3.56 ± 1.80	3.83 ± 2.05	0.416

- BMI: 25-35
- 12 wks, 60 g/d



Chen et al. 2017 Nutr & Metab

Parting Impressions

Chronic almond consumption can improve metrics of glycemic control such as HbA1c and FBG/FPG in T2D subjects or pre-diabetes but the benefits are not consistent across studies suggesting that certain study variables that are not sufficiently controlled across studies may mask the potential for almonds to impart more consistent benefits (ie, variability among populations characteristics, degree of the existing condition, etc.)

While chronic almond consumption may not be associated with consistent, sustained benefits (as assessed by end-of-study measurements), the improvements in postprandial glucose excursions are more consistent and indicative of significant, acute modifications in cellular glucose metabolism regardless of underlying diabetic condition

Almonds with breakfast does a body's glucoregulatory capability GOOD! When you eat almonds may be very important.

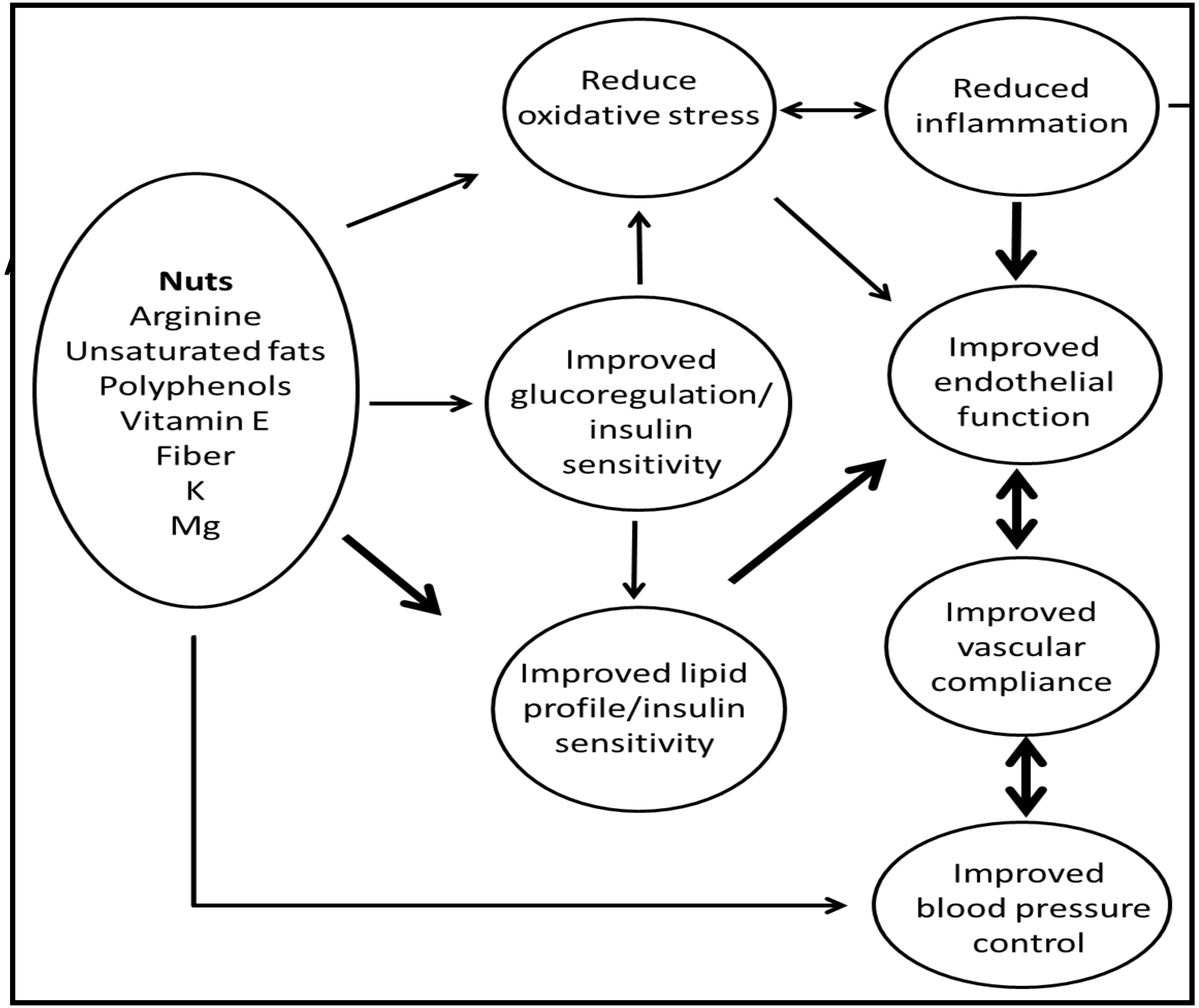
Effects of Almonds on Glucoregulatory Profiles in Young Adults

Jaapna Dhillon, PhD
Assistant Professor

Department of Nutrition and Exercise Physiology
University of Missouri - Columbia

December 09, 2021

Potential Mechanisms by Which Almonds Improve Metabolic Health



Adapted from Barbour et al. *Nutrition Research Reviews*. 2014; 27, 131–158.

Why Study College Freshmen?

- Nutritional independence
  - Weight gain
  - Increased risk of metabolic disease
  - Alterations in eating behaviors
    - Breakfast skipping
- Advantages
  - 18-19 years
    - Homogeneous population
  - Closely monitor food intake
  - Track compliance

Smith et al. *AJCN*. 2010; 92, 1316–1325.
Brevard et al. *JAND*. 1996; 96, 35–38.

Baseline Characteristics of Participants

Characteristics	Cracker (n = 35)	Almond [a] (n = 38)
Sex, n (%)		
Male	16 (45.7)	16 (42.1)
Female	19 (54.3)	22 (57.9)
Age, years (range)		
18	34 (97)	38 (100)
19	1 (3)	0 (0)
Race/Ethnicity, n (%)		
Hispanic	16 (45.7)	15 (39.5)
Asian/Pacific Islander	13 (37.1)	14 (36.8)
African American	2 (5.7)	5 (13.2)
Caucasian White	4 (11.4)	4 (10.5)
BMI, kg/m^2	25.3 ± 4.5	25.6 ± 5.0
BMI Category, n (%)		
Normal weight (5th–85th percentile)	22 (63)	28 (74)
Overweight (85th–95th percentile)	8 (23)	6 (16)
Obese (≥95th percentile)	5 (14)	4 (11) *

Dhillon et al. Nutrients. 2018;10:960.

Diet Quality of First-Year College Students Attending a Food Desert Campus

HEI-2015 Dietary Component	Males (n = 9)	Females (n = 11 *)
Total fruits (5)	1.2 ± 1.2	2.8 ± 1.8 **
Whole fruits (5)	1.3 ± 1.7	3.6 ± 1.5 **
Total vegetables (5)	3.3 ± 1.2	3.2 ± 1.3
Greens and beans (5)	3.1 ± 2.4	2.3 ± 2.3
Whole grains (10)	3.5 ± 2.4	3 ± 3.1
Dairy (10)	4.7 ± 2.4	4.4 ± 2.5
Total protein foods (5)	4.3 ± 1.7	4.2 ± 1.4
Seafood and Plant Proteins (5)	3 ± 2.5	4.1 ± 1.8
Fatty acids (10)	5.8 ± 3.3	6.8 ± 3.5
Refined grains (10)	4.1 ± 3.3	5.4 ± 3.4
Sodium (10)	1.8 ± 1.9	4.5 ± 2.7 **
Added sugars (10)	9.1 ± 0.9	7.7 ± 2.9
Saturated fats (10)	6.2 ± 2.3	5.6 ± 3.3
Total HEI 2015 score (100)	51.5 ± 10.9	57.6 ± 14.5

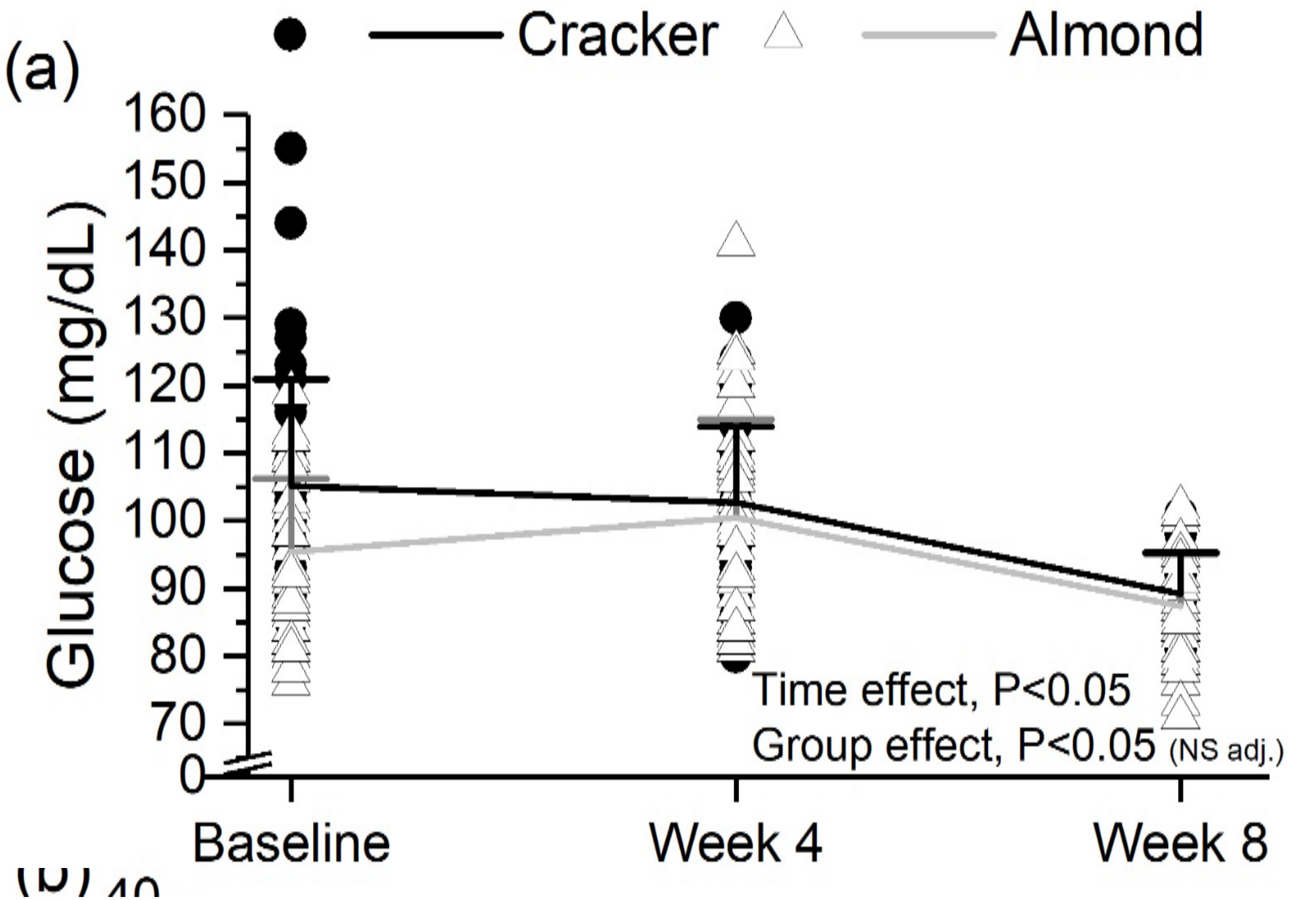
Dhillon et al. *Nutrients*. 2019;11:816.

Experimental Design

- Single-blinded, randomized, controlled, parallel-arm study
- 8-week study
- **2 Dietary interventions**

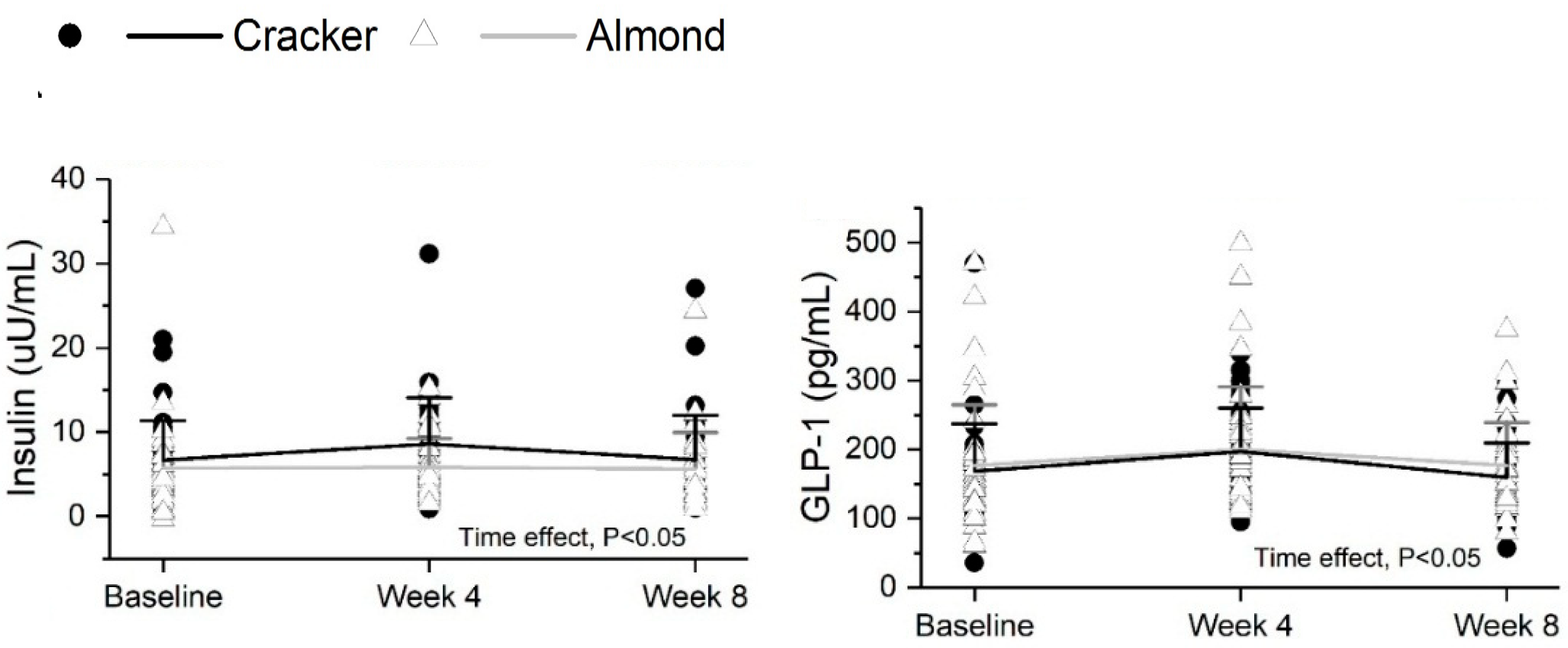
ALMOND	CONTROL
n=38	n=35
2 ounces (57 g, 325 kcal) whole unsalted almonds	Isocaloric graham crackers (5 sheets) No nuts or nut products
Consistent dietary patterns Consistent physical activity Consistent supplement use	

Almond and Cracker Snacking Led to Similar Decreases in Fasting Glucose Over 8 weeks



Dhillon et al. Nutrients. 2018;10:960.

Almond and Cracker Snacking Led to Similar Changes in Insulin and GLP-1 Over 8 weeks

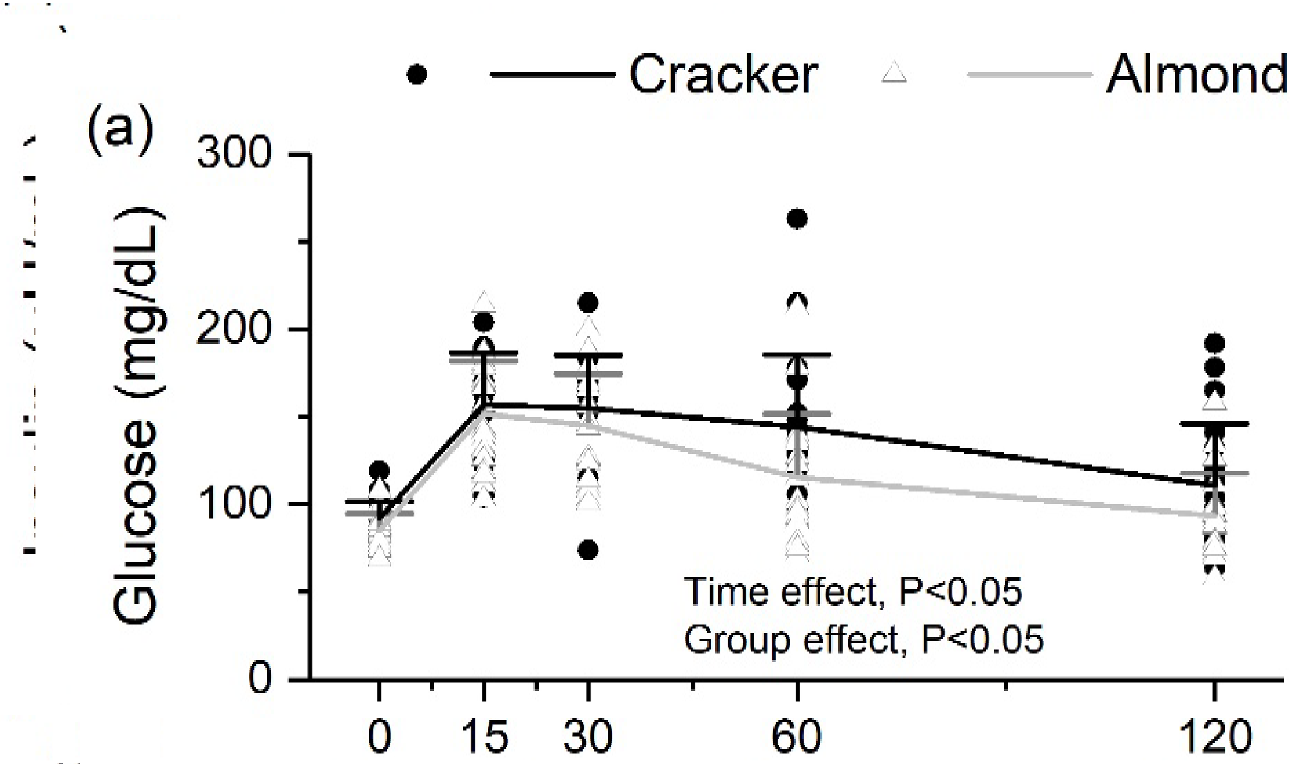


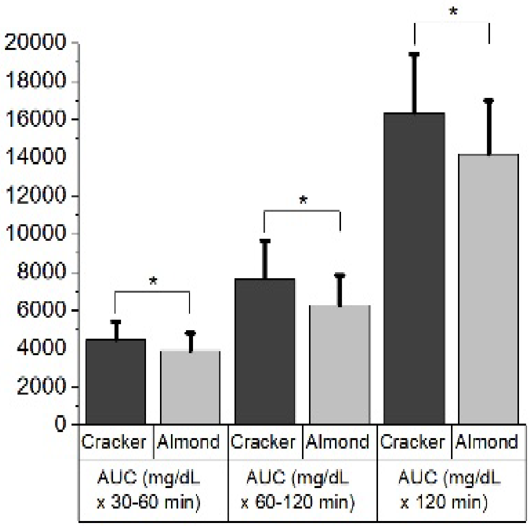
Dhillon et al. Nutrients. 2018;10:960.

Almond Consumption Prevented the Decline in HDL Cholesterol over 8 Weeks

OUTCOMES		
Total Cholesterol, LDL	 ↓	 ↓
HDL	 —	 ↓
Endothelial function	 —	 —

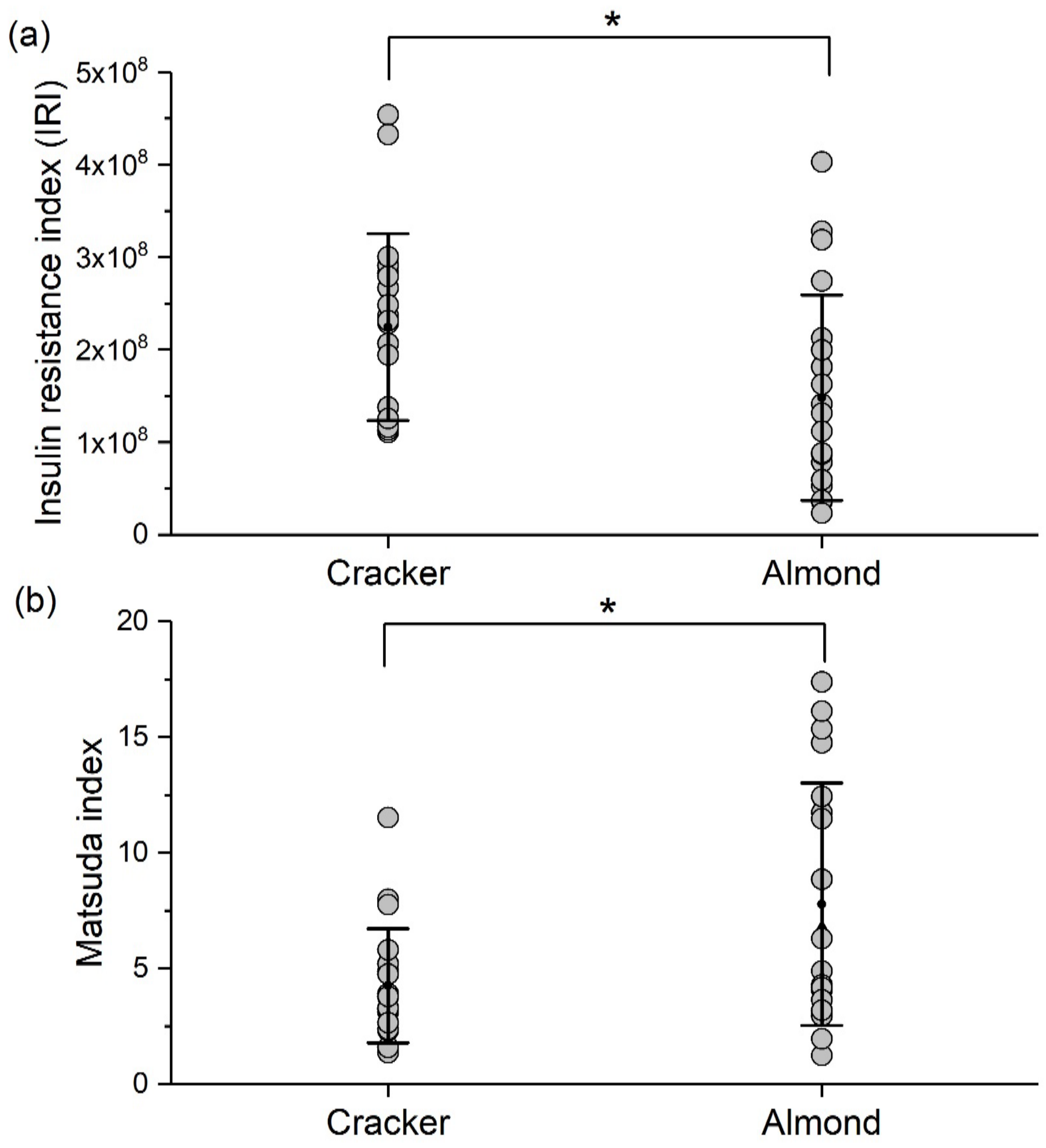
Almond Snacking Resulted In Lower Glucose, Insulin and C-peptide AUC Over 120 minutes of OGTT at 8 Weeks





Dhillon et al. Nutrients. 2018;10:960. OGTT-oral glucose tolerance test. AUC-area under the curve
*, P< 0.05

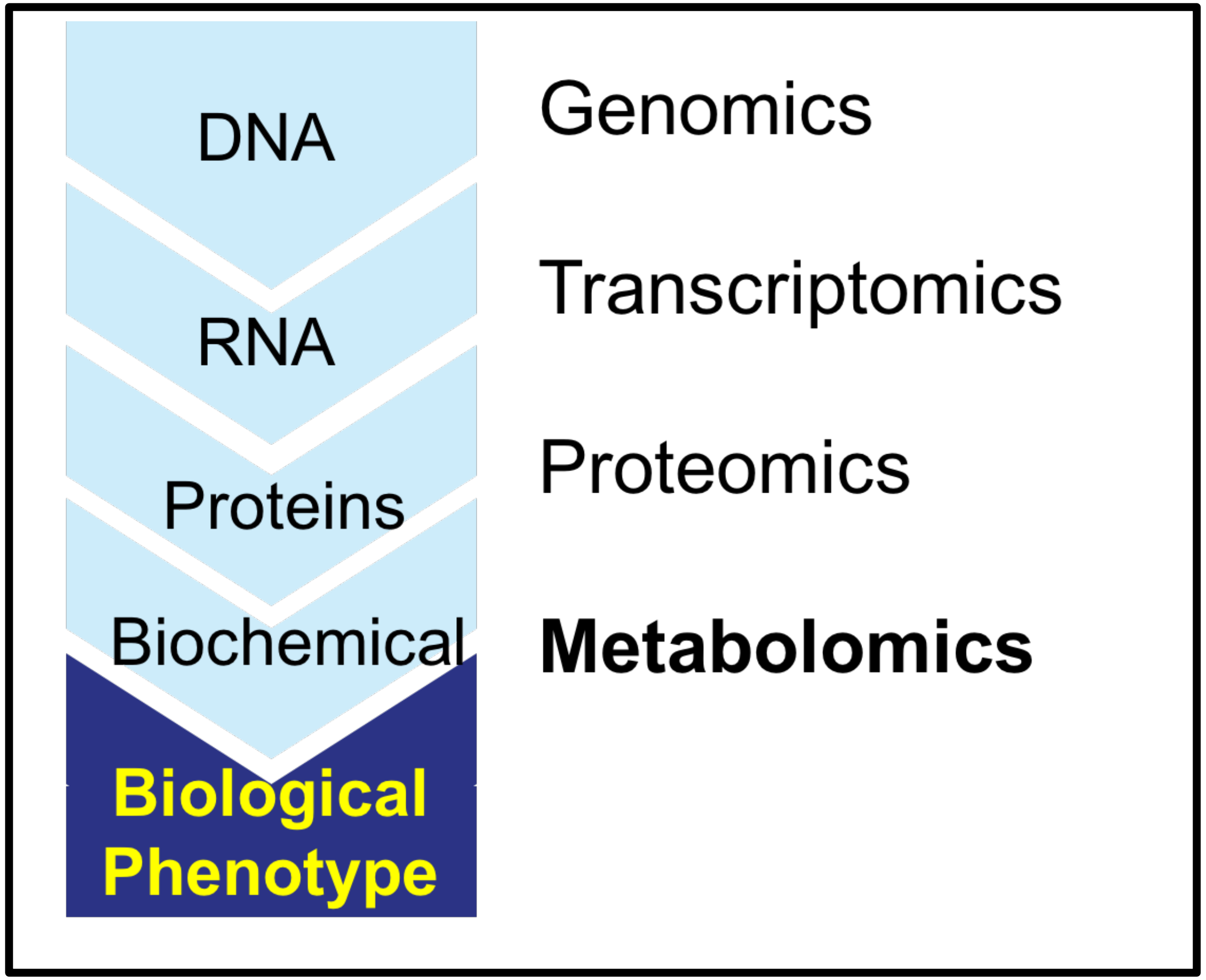
Almond Snacking Resulted In Greater Postprandial Insulin-Sensitivity at 8 Weeks



Dhillon et al.
Nutrients. 2018;10:960.

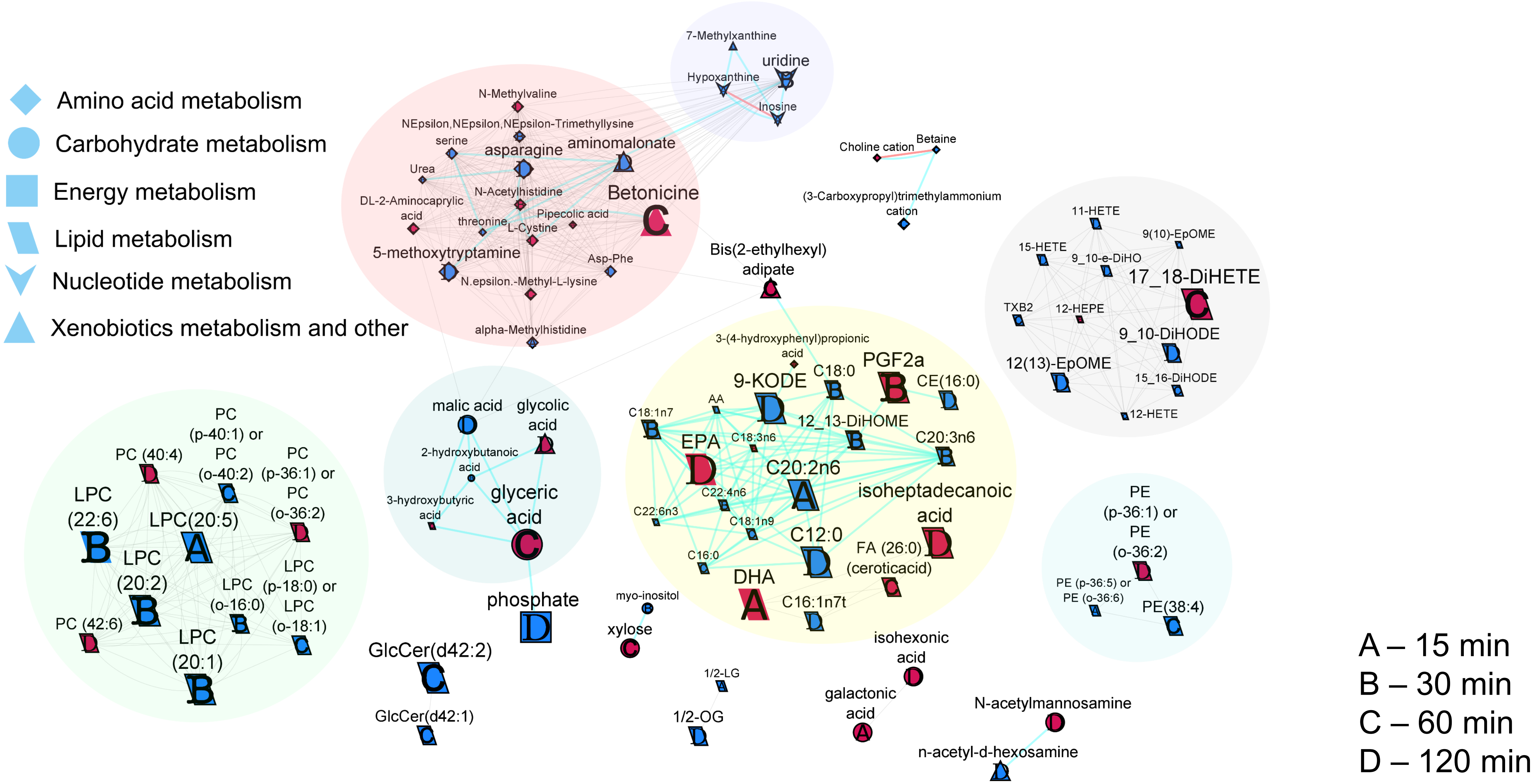
*, P< 0.05

Flow of Information from DNA to the Phenotype



Picture: https://en.wikipedia.org/wiki/Metabolomics

Biochemical Network Displaying Almond-Induced Changes in Metabolism after an OGTT



Almond and Glucoregulation Take-Aways

- Single time-point studies are not informative
- More profound changes in postprandial glucose metabolism vs. fasting
- Benefits can be seen in the short-term, but consistent consumption will lead to sustained beneficial effects.
- Consumption has to be maintained over the long term to maximize benefits.

Acknowledgments

Collaborators

- Dr. Rudy M. Ortiz
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- Quintin Kuse
- Emily Vu
- Syed Asad Asghar

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- NIH West Coast Metabolomics Center, UC Davis

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- Almond Board of California (Ortiz)

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“Effect of Almond Consumption on Glucose Metabolism, Hyperinsulinemia, Markers of Inflammation and Metabolic Risk Factors: A Randomized Controlled Trial in Adolescents and Young Adults in Mumbai, India”

WHY INDIA?

IDF DIABETES ATLAS

9th edition 2019

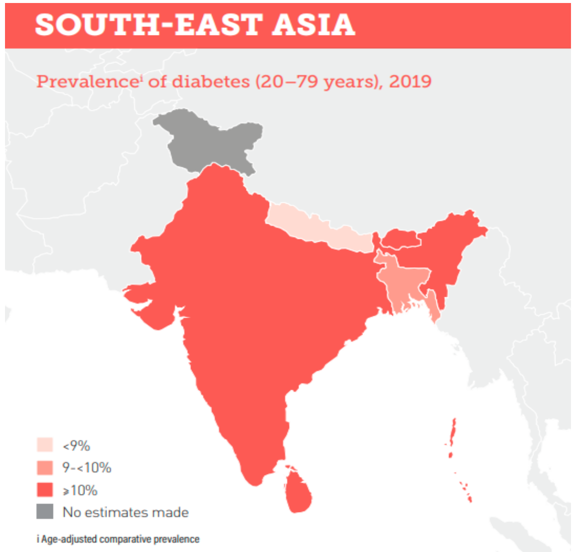
India has 2nd highest number of people with Diabetes

Table Top 10 countries or territories for number of adults (20–79 years) with diabetes

	2019		2030		2045	
Rank	Country or territory	No. of people w diabetes (millions)	Country or territory	No. of people w diabetes (millions)	Country or territory	No. of people w diabetes (millions)
1	China	116.4	China	140.5	China	147.2
2	India	77.0	India	101.0	India	134.2
3	United States of America	31.0	United States of America	34.4	Pakistan	37.1
4	Pakistan	19.4	Pakistan	26.2	United States of America	36.0
5	Brazil	16.8	Brazil	21.5	Brazil	26.0
6	Mexico	12.8	Mexico	17.2	Mexico	22.3
7	Indonesia	10.7	Indonesia	13.7	Egypt	16.9
8	Germany	9.5	Egypt	11.9	Indonesia	16.6
9	Egypt	8.9	Bangladesh	11.4	Bangladesh	15.0
10	Bangladesh	8.4	Germany	10.1	Turkey	10.4

Based on the Indian Council of Medical Research-INdiaDIABetes (ICMR-INDIAB) study conducted in 15 states

The overall prevalence **of prediabetes was 10.3%** & **diabetes was 7.3%** (Anjana RM, Deepa M et.al. 2017)



1 in 6 people with diabetes in the world come from India

Top five countries for number of people with diabetes (20–79 years), 2019

	Millions
India	77.0
Bangladesh	8.4
Sri Lanka	1.2
Nepal	0.7
Mauritius	0.2

Table 3.12 **Top 10 countries or territories for the number of adults (20–79 years) with undiagnosed diabetes in 2019**

Rank	Country or territory	Number of people with undiagnosed diabetes (millions)	Proportion undiagnosed (%)
1	China	65.2 (60.8–81.6) i	56.0
2	India	43.9 (35.5–54.9)	57.0
3	United States of America	11.8 (10.2–13.6)	38.1
4	Pakistan	8.5 (3.5–13.3)	43.8
5	Indonesia	7.9 (6.8–8.5)	73.7
6	Brazil	7.7 (6.9–8.6)	46.0
7	Mexico	4.9 (2.8–5.9)	38.6

- *IDF Diabetes Atlas 2019*
- Sinha, R., & Pati, S. (2017). Addressing the escalating burden of chronic diseases in India: Need for strengthening primary care, Journal of family medicine and primary care, 6(4), 701.
- Anjana RM, Deepa M, Pradeepa R, Mahanta J, Narain K, Das HK, et al.Prevalence of diabetes and prediabetes in 15 states of India: Resultsfrom the ICMR-INDIAB population-based cross-sectional study. Lancet Diabetes Endocrinol 2017; 5:585-96.

Thin-fat Indian phenotype

- Asian Indians in general have **greater insulin resistance than Caucasians** hence, are at greater risk of diabetes. It is therefore imperative that the high risk population is identified at an earlier age (Unnikrishnan et al., 2018; Dutta and Ghosh, 2019).

- Moreover, Indians in comparison to their Caucasian counterparts have higher body fat as well as visceral fat percentages at similar BMIs which is characterised by the **"thin-fat" Indian diabetes phenotype**. This particular phenotype may lead to an **early onset of diabetes mellitus and metabolic derangements** in Indians (Yajnik 2004; Kurpad A, Kiruba V, Aerbeli I 2011, Misra A, Vikram NK, 2009).

Snacking in India

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Snacking in India

- **60%** of **Indian** consumers **snack** more than **twice** a day,
- **15%** of them are **“super snackers”** who **snack** more than **four times** a day.
- The COVID-driven lifestyle adjustments would have further boosted these figures
- Based on a survey conducted, 89% of the study population was found to be consuming HFSS snacks

http://www.businessworld.in/article/Healthy-Snacking-Is-Changing-The-Face-Of-Snacking-In-India/11-12-2020-352536/

- SNDT Women's University Mumbai is the First Women's University of India and South East Asia.
- Sir Vithaldas Thackersey College of Home Science is the prestigious Autonomous College of State of Maharashtra with a coveted honor of College with Potential for Excellence and Accredited with NAAC- A Grade.
- The study was a collaboration of SVT Research Cell with Kasturba Health Research Society and Medical Research Centre, Mumbai. The collaboration brought together Reproductive Endocrinologists, Doyens of reverse pharmacology, Emeritus Professors, Eminent Nutritionists, Diabetic Educators and Medical practitioners.
- The study sites were educational institutions which catered to older adolescents and young adults. The willingness to participate was higher in girls as compared to boys.

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WHY ADOLESCENTS/YOUNG ADULTS?

Why Adolescents and Young Adults ?

- Adolescence is a “window of opportunity” for understanding and impacting health and development and they are the most vulnerable group in this era of nutrition transition (Dorn et al., 2019).

- There is a shift in trends from infectious to chronic lifestyle-related diseases, roots of which are behaviourally acquired and begin during adolescence (Jayawardena et al., 2017; Sharma et al.,2020).

- Over-nutrition in adolescence is seen mainly due to consumption of energy dense, HFSS foods. These unhealthy eating habits at a younger age remain for lifetime and pose a huge risk for the future (Ramachandran, 2019).

- Snacking patterns in adolescents and young adults can be a significant contributory factor towards early onset of obesity and other non-communicable diseases (Tripicchio et al., 2019).

- **Early identification of adolescents and young adults** with pre diabetes will aid in appropriate and timely management, thereby reducing both the progression to and incidence of diabetes, and related complications (Wang G,et al 2018; Al Amiri E, Abdulle A, et al, 2015).

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WHY ALMONDS?

Almonds are part of a healthy eating pattern

PROTEIN 6g
Building block of the body; helps build and preserve muscle, bone, skin and nails; helps keep you satisfied.

FIBER 4g • 13% DV
Helps promote fullness and digestive health; helps maintain healthy blood sugar levels.

MONOUNSATURATED FATS 9g
Heart-smart fats that help decrease LDL ("bad") cholesterol and increase HDL ("good") cholesterol.

VITAMIN E 7.3mg • 50% DV
Antioxidant that helps protect cells from damage and promotes healthy skin and hair.

POTASSIUM 210mg • 4% DV
Regulates blood pressure; important for heart health and muscle contraction.

CALCIUM 75mg • 6% DV
Helps build and maintain strong bones and teeth.

MAGNESIUM 76mg • 20% DV
Helps regulate muscle and nerve function, blood sugar levels and blood pressure.

RIBOFLAVIN 0.3mg • 25% DV
B vitamin that helps convert food into fuel; important for red blood cell production.

NIACIN 1mg • 6% DV
B vitamin that supports energy production.

PHOSPHOROUS 135mg • 10% DV
Helps build and maintain strong bones and teeth; plays a role in how the body uses and stores energy.

IRON 1mg • 6% DV
Carries oxygen to all body cells; plays a role in energy production.

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Why Almonds?

- To show that the adolescent "window of opportunity" can be used for teaching how to snack healthy.
- To help slow the spread of chronic lifestyle-related diseases in the younger age groups.
- Almonds make the 'green bar' and are recommended foods under FSSAI guidelines for the school canteen.
- Snacking patterns in adolescents and young adults can be a significant contributory factor towards early onset of obesity and other non-communicable diseases. Teaching this age group to 'snack healthy'.

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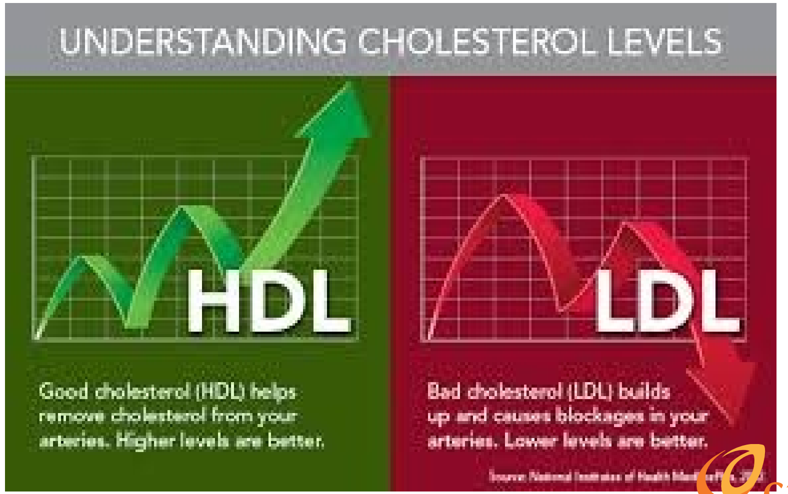
"Effect of Almond Consumption on Glucose Metabolism, Hyperinsulinemia, Markers of Inflammation and Metabolic Risk Factors: A Randomized Controlled Trial in Adolescents and Young Adults in Mumbai, India"

OBJECTIVES

To determine the effect of almond consumption on:

- ✓ Blood glucose levels
- ✓ Insulin levels
- ✓ Selected markers of inflammation
- ✓ Cardio metabolic risk factors

In adolescents and young adults (16-25 years) in Mumbai, India



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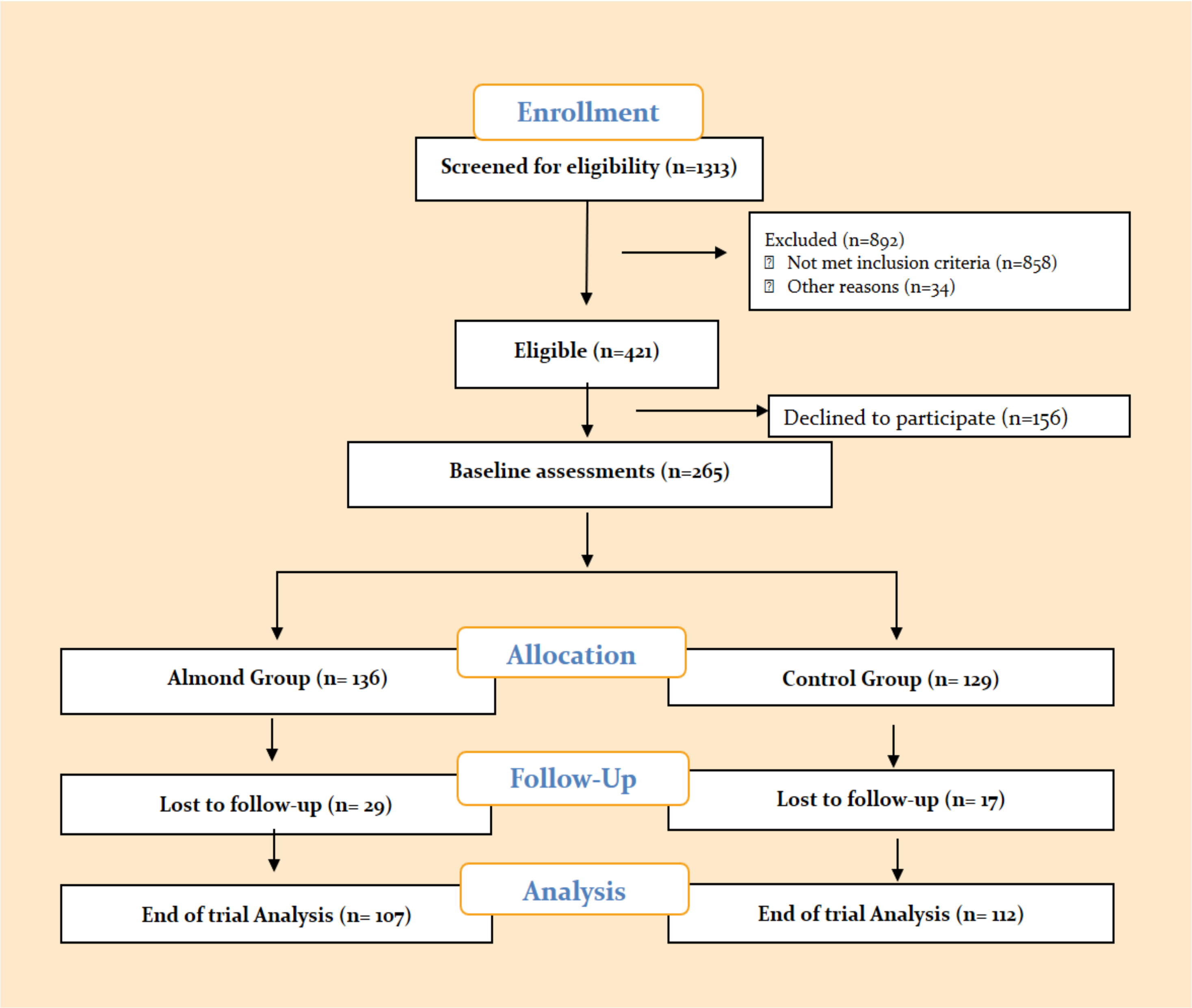
METHODS

Design: Cluster Randomized, open-label, parallel arm controlled trial.
Setting: Mumbai , India.
Participants: Adolescents and young adults (16-25 years).
Inclusion Criteria: Impaired fasting glucose (5.6-6.9mmol/L) and 2-h post-glucose (7.8-11.0 mmol/l) and/or fasting hyperinsulinemia(≥ 15 mIU /ml) or glucose challenge hyperinsulinemia (≥ 80mIU/ml)
Exclusion criteria: Presence of any chronic disease, known history of nut allergy, infections, pregnancy etc.
Ethics Approval and informed participant consent
Clinical Trial Number: CTRI 2018/02/011927
Intervention: Daily almonds consumption (56g) for 90 days.
Control: An iso-caloric snack for 90 days
Outcomes: Changes in fasting glucose and insulin, 2-h stimulated glucose and insulin, HbA1C, lipid profile, oxidized LDL, adiponectin, leptin, hs- CRP, TNF-α and IL-6.



- Of 1313 individuals screened, 421 met the inclusion criteria and were invited to participate in the trial.
- Of these, 275 provided consent to participate, and 219 (Almond Group *n* = 107 and Control Group *n* = 112) completed the trial.

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Pre-Screening Orientation

- 24 different institutions across Mumbai were approached to participate in the study
- 11 institutions agreed to allow for recruitment of participants
- Participants were explained the study protocol and **invited to participate** in the screening camps
- More than 30,000 people were approached to participate in the study

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Preliminary Activities

- **Training workshops** were conducted on 24 hour recall techniques and anthropometry measurements.
- **Development and standardization** of diet recall kit

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Biochemical Assessments

↑

Blood Investigations

Oral Glucose Load ⟶

Assessments

Anthropometry Assessment

Self Administered Dietary Questionnaires

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Standardization of Diet Recall Kit

Along with commonly consumed home-cooked snacks & meals, packaged and processed foods were also checked for their weight and macronutrients.

Baseline Characteristics

Characteristics	n (%)
Gender	
Males	457 (34.9)
Females	853 (65.1)
Age Categories	
16-19 years	724 (55.3)
20-22 years	492 (37.5)
23-25 years	94 (7.2)
Family history of diabetes	
First degree family member (parents/siblings)	287 (21.9)
Second degree family member (grandparents/ uncle/aunts)	554 (42.3)
Either first/ second degree family members	617 (47.1)
Medical history	
Known history of elevated blood pressure	19 (1.5)
Hormonal disorders (PCOS/ thyroid disorders)	58 (4.4)
Activity pattern	
Engages in physical activity > 2.5h/wk	685 (52.3)
Body weight status (n=1310)	
Underweight	310 (23.7)
Normal weight	535 (40.8)
Overweight	197 (15.0)
Obese	268 (20.5)
Central adiposity measures (n=1310)	
Waist to height ratio > 0.5	204 (15.6)

Table 1: Demographic and body weight status of adolescents and young adults (n=1313) in the study

- The mean age of the participants was 19.4 (1.8) years
- Among 1313 participants, 65.1% were females, 55.3% belonged to the age category,16-19 years and 47.1% had either first/second degree relatives with diabetes.
- The **prevalence of overweight and obesity** were 15.0% and 20.5% respectively.

Baseline Characteristics

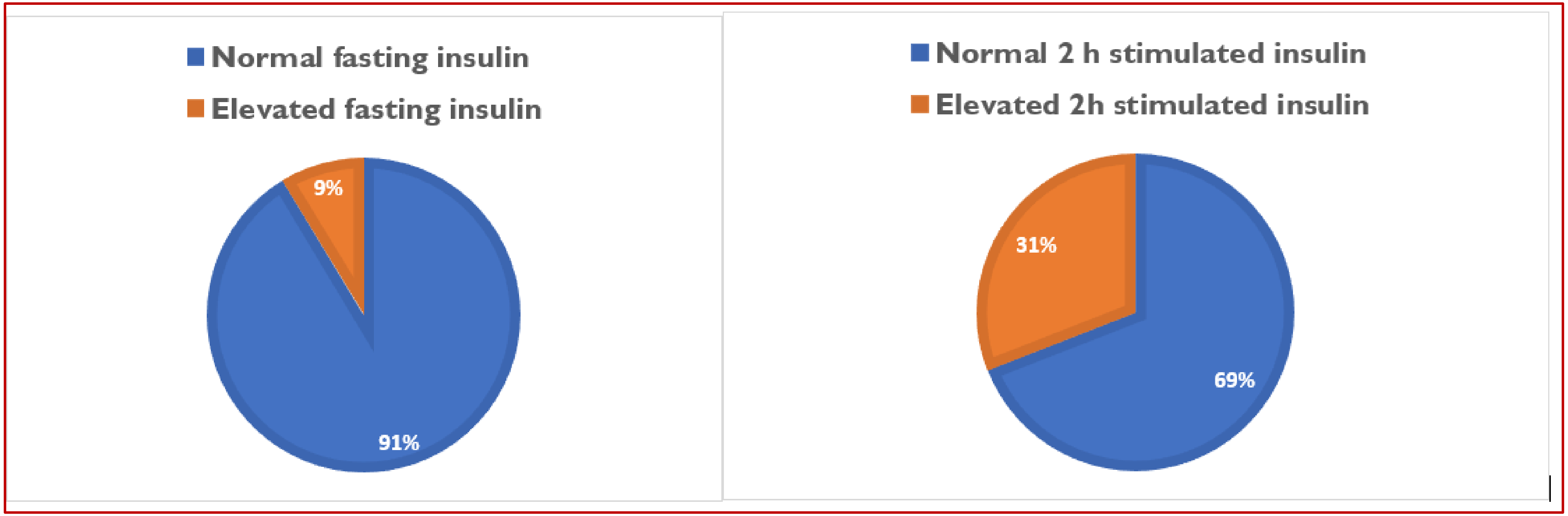

Figure 1: Proportion of participants with elevated fasting and 2h stimulated insulin levels

Among 1313 participants, 112 (8.7%) had elevated fasting insulin (≥15 mIU/ml), and 401(31.0%) had higher than normal 2 h stimulated insulin (≥80 mIU/ml)

Almonds and Blood Glucose

- Almonds helped reduce HbA1C which is a measure of the average blood glucose levels over the past 2-3 months
- HbA1C is the same as assessing fasting or post prandial blood glucose levels a hundred times which can be considered as a more reliable marker than either or both fasting and post prandial blood glucose levels

Almonds and Lipids

- Almonds helped reduce total Cholesterol levels significantly
- Almonds helped reduce LDL-C levels significantly . LDL-C is the most important component of lipid profile as it is risk factor for future heart disease

Almonds and Inflammatory Markers

- Interleukin-6 (IL-6) is a pro-inflammatory cytokine that decisively induces the development of insulin resistance and pathogenesis of type 2 diabetes mellitus (T2DM)

- This study showed that almonds helped reduce IL-6 levels in comparison to the control group although it did not achieve statistical significance (p=0.07)

Results

1. HbA1C reduced significantly in the Almond Group in comparison to the Control Group

2. Total cholesterol decreased in the Almond Group significantly in comparison to the Control Group

3. LDL-C decreased in the Almond Group significantly in comparison to the Control Group

4. A marked reduction in inflammatory marker- IL-6 was reduced in the Almond group in comparison to the Control Group although was not statistically significant

5. Post prandial (after food) Insulin reduced in the Almond group in comparison to the Control Group although was not statistically significant

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Results

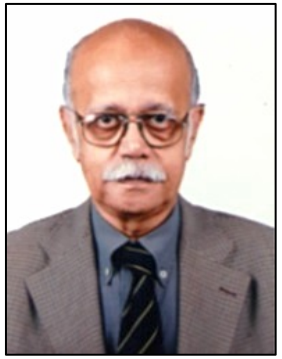
Biochemical Measurements	Almonds Group (n=107) Mean (SD) (95%CI)	Control Group (n=112) Mean (SD) (95%CI)	p value
HbA1C	↓ -0.04±0.44 (-0.12,0.04)	0.09±0.40 (0.01,0.16)	0.02*
CHOL (mg/dL)	↓ -5.70±24.63 (-10.42,-0.98)	13.35±94.74(4.38,31.09)	0.04*
LDL-C (mg/dL)	↓ -4.27±24.85 (-9.05,0.51)	5.93±21.26 (1.95,9.91)	0.01*
s2 hour insulin (mIU/L)	↓ -29.7±83.7 (-45.7,-13.6)	-20.3±78.3 (-35,-5.6)	0.39
IL-6 (pg/ml)	↓ -36.12±188.60 (-72.27,0.02)	-2.25±58.59 (-13.22,8.71)	0.07

CONCLUSION

- The strength of this study is that a **younger age group was studied indicating** the potential for preventing progression into further metabolic dysfunction.
- Further studies should assess the gender and socio economic differentials.
- The results of this study indicated a **high prevalence of insulin resistance and hyperinsulinemia** among adolescents and young adults, thus highlighting the need to identify at risk individuals and intervene at an early age to prevent diabetes.
- The findings that having **higher body fat percentage and body mass index significantly increased** the odds of hyperinsulinemia and hyperglycemia reiterate the importance of lifestyle interventions to manage both insulin resistance and obesity effectively.
- **Almonds have a** beneficial effect on **HbA1C, hyperinsulinemia, insulin resistance, lipid profile and inflammatory markers** at an early stage that even precedes prediabetes.
- **Inclusion of almonds as a part of a balanced diet has the potential to be a nutritional food based strategy** to prevent progression to further metabolic dysfunction ,pre-diabetes and further into Type 2 Diabetes Mellitus.

ACKNOWLEDGMENTS

Dr. Rama Vaidya



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Thank You

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