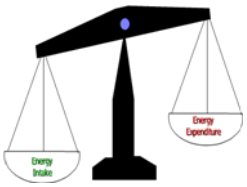


FIER LAB

Food Intake & Energy Regulation Laboratory

Behavior/ Metabolism Research

Mission

The mission of the Food Intake and Energy Regulation (FIER) Laboratory is to study metabolic, behavioral, and lifestyle factors that influence the dietary choices individuals make on a day to day basis over prolonged periods of time.

Approach

This lab will follow daily changes in biomarkers of energy balance, intake behavior in response to lifestyle influences that occur outside of the eating environment and social interaction and gustatory factors present in the eating environment. The ground breaking nature of this work will be the conduct of well-controlled nutrition studies, with precisely measured food intake and other outcome variables, over months and years. These studies will provide investigators the ability to look at both dietary and behavioral factors relative to precise measures of day-to-day food intake over periods of time not available in previous work or at other institutions. This work will capitalize on the extensive experience at BHNRC in conducting of large, outpatient feeding studies over prolonged periods of time and large cross-sectional studies that incorporate dietary and physical activity assessment of participants in unique modern facilities.

Why is FIER Laboratory Unique?

The proposed work is long term with minimal disruption of participant lifestyle yet will collect information using state-of-the-art methodologies. This is a departure from most current nutrition studies which either employ short-term feeding or epidemiological methodologies which provide data that is not easily translated to a free-living condition or only generalizable to populations of people, not individuals. The unique facilities, researcher expertise, and collaborations with the extensive research community that exists in the Baltimore-Washington corridor positions the FIER Lab and BHNRC capable of conducting ground breaking research that would be hard to sustain outside of a federal laboratory.

Physical Assets (Shared with FCHL)

- Calorimetry facilities
- Forty seat dining facility and controlled diet preparation kitchen for up to 100 subjects
- Exercise training and testing laboratory
- Body composition laboratory
- Food and biological sample processing facilities
- Phlebotomy/infusion with adjacent blood processing Laboratories
- Specimen (urine, fecal) collection, processing and storage facilities.
- Two conference rooms
- Three rooms for subject interviews
- Physician exam room
- Shower and lavatory facilities for subjects

Human Capital

- 5 research scientist positions (4 vacant)
- 0.5 secretarial position with 1 support clerk
- 1 support scientist position (vacant)
- 3 chemist/bio-lab tech positions (1 vacant)
- 2 Post-doc positions (vacant)

Current Food and Food Intake Research at Beltsville Human Nutrition Research Center (BHNRC)

What We Eat in America ://www.ars.usda.gov/Services/docs.htm?docid=7710

BHNRC's Food Survey and Research Group is responsible for the continuing survey of food and nutrient intake of Americans through it's "What We Eat in America" national food intake survey---the dietary assessment component of the National Health and Nutrition Examination Survey (NHANES), conducted yearly and administered by the CDC's National Center for Health Statistics.

National Nutrient Database ://www.ars.usda.gov/Services/docs.htm?docid=8964

BHNRC's Nutrient Data Laboratory is responsible for developing and maintaining the USDA National Nutrient Database (previously known as Handbook 8), a database of over140 nutrient and food components contained in over 7000 foods in the U.S. food supply, serving as the site of the national program for food composition and methods research.

Food Intake and Energy Regulation Laboratory (FIERL)

://www.ars.usda.gov/Main/docs.htm?docid=16056

FIERL conducts research on the dietary, lifestyle, psycho/social, genetic, and physiological characteristics of individuals that influence food self-selection and weight regulation.

Food Components and Health Laboratory (FCHL)

://www.ars.usda.gov/main/site_main.htm?modecode=12-35-20-00

FCHL conducts research on metabolic and physiologic responses of individuals to whole foods and dietary constituents including traditional nutrients, phytochemicals, and functional foods.

Diet, Genomics, and Immunology Laboratory (DGIL)

://www.ars.usda.gov/main/site_main.htm?modecode=12-35-25-00

DGIL conducts research on metabolic and physiologic responses to dietary intervention focusing on nutrients, chronic disease, immune function, probiotics, and genetic expression in animal models and humans.

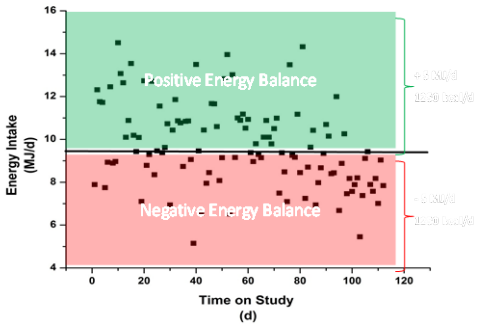
Human Studies Facility (HSF)

://www.ars.usda.gov/main/site_main.htm?modecode=12-35-35-00

The HSF is the largest nutrition intervention study facility in the U.S. It provides state-of-the-art voluntary or controlled diets daily for up 120 people per day, precise measures of energy expenditure, and biological outcomes -- from routine to molecular.

Recent FIER Lab Research

Food Intake Regulation



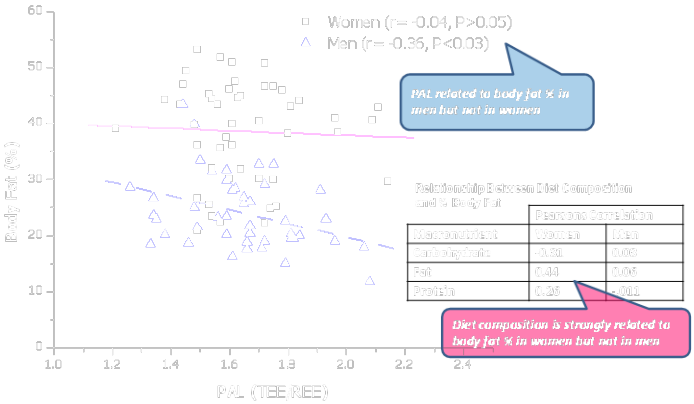
Variability in Daily Food Intake May Contribute to an Inability to Maintain a Healthy Weight and Lead to the Development of Obesity

Understanding how lifestyle and environmental influences affect dietary choices in individuals across a day is critical to understanding the increase in the number of overweight and obese individuals in the U.S.

Pumpler, M. K., Farmer, M., Stevens, D. R., and Paul, D. R., International journal of obesity (2010) 35 (5), 794 (2010).

It is likely that the food intake of all individuals is highly variable from day to day. This variation is due to a combination of factors that range from neuroendocrine regulators of satiety to social interaction at meal time. The significance of the variation in food intake to maintenance of a healthy body weight is unknown since only a few studies have been conducted which examine food intake over long periods of time. It is widely believed that individuals compensate for day-to-day fluctuations in food intake and generally match food intake with energy expenditure over extended periods of time. This is evidenced by the relative stability of body weight over months or years. However, the increasing incidence of obesity demonstrates that this compensation is imperfect in an increasing number of individuals. Data collected at BHNRC suggest that a day of over-eating is less likely to be followed by a day of under-eating than under-eating being followed by over-eating. This bias would ultimately lead to the observed increase in body fatness over time. One possible contributor to the increase in obesity observed in today's society is that food intake has become more variable from day-to-day.

Physical Activity, Gender, and Healthy Weight

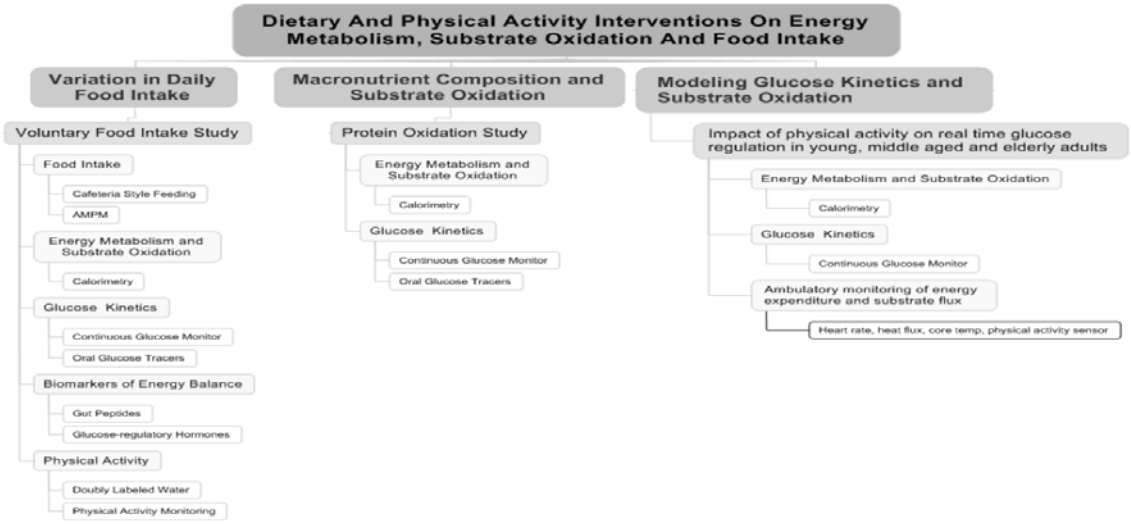


Gender Differences In How Males and Females Respond to Weight May Contribute Greater Incidence of Obesity in Females than in Males

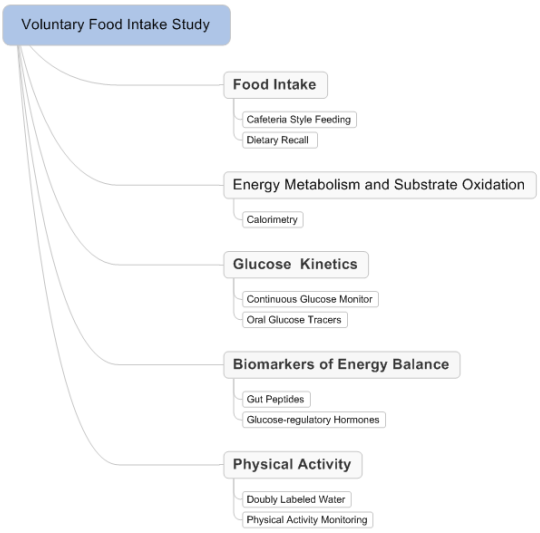
Understanding how physical activity and dietary choices influence weight maintenance is critical to understanding the increase in the number of overweight and obese individuals in the U.S. Paul, D. R., Moeller, J. A., and Pumpler, M. K., Am J Clin Nutr 79 (5), 825 (2004).

Despite the widely held notion that maintaining or reducing body weight or fat is facilitated by an increase in physical activity, the relation between physical activity level (PAL) and percentage body fat (Body Fat %) is not very strong. Work conducted at BHNRC suggests that the increasing incidence of excessive body fatness and obesity in America is not strictly a function of a sedentary lifestyle but a consequence of an inability to match calories consumed with those burned. It is becoming more apparent that simply increasing PAL is unlikely to result in a significant reduction in body fatness. Other studies have indicated that the %BF of active men is likely to be lower than that of less active men but the same relation was not observed in women.

Ongoing FIER Lab Research



Voluntary Food Intake Study

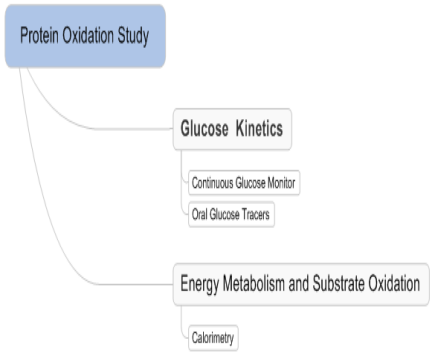


This study is a continuation of previous work [1] in which we measured the voluntary food intake in 12 healthy normal weight men (79.9 ± 8.3 kg, 39 ± 9 yrs, 24.1 ± 1.4 kg/m^2) over 4 months of continuous cafeteria style feeding. The data from this study has been used to examine the variability of daily intake [1], the relationship of metabolic and endocrine markers of satiety to daily food intake [2] and the extent and sources of error in 24 food intake reporting [3, 4] .

The current study is to determine the daily food intake of a sample of three additional populations of subjects: normal healthy women similar in age and BMI to the previous study in males and overweight male and female subjects exhibiting insulin insensitivity but not diabetes. The results from this work combined with the previous work will provide variance estimates for future studies as well as provide insight about the relationship of food intake to biomarkers of energy balance in both normal weight and overweight individuals. Daily food intake and food choice are followed for 4 months in each of three cohorts of 21 subjects (7 subjects from each of the 3 target populations in each cohort). In addition, total energy expenditure, biomarkers of energy balance and satiety and physical activity patterns are measured during the 4 month study period.

1. Rumpler, W.V., D.A. Rhodes, and D. Paul, R, *Covert manipulation of macronutrient intake has little impact on long term voluntary food intake and macronutrient selection in men.* 2003.
2. Paul, D.R., et al., *Preprandial ghrelin is not affected by macronutrient intake, energy intake or energy expenditure.* J Negat Results Biomed, 2005. **4**: p. 2.
3. Rumpler, W.V., et al., *Identifying sources of reporting error using measured food intake.* Eur J Clin Nutr, 2008. **62**(4): p. 544-52.
4. Paul, D.R., et al., *Validation of a food frequency questionnaire by direct measurement of habitual ad libitum food intake.* Am J Epidemiol, 2005. **162**(8): p. 806-14.

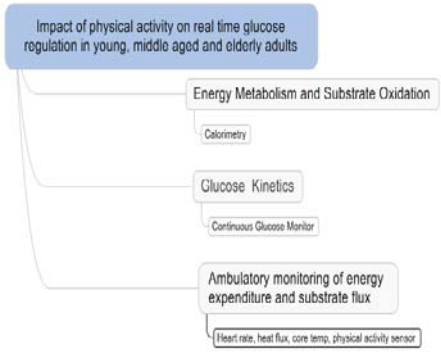
Protein Oxidation Study



A clinical study, using a randomized, double-blind design to test whether consumption of a supplement containing whey protein alters fat balance, improves glucoregulatory status, and suppresses food intake will be conducted in overweight and moderately obese men (BMI 25 to < 30) when compared to a soy protein-based supplement or a carbohydrate control.

Three experimental periods, 7 days in length, separated by at least 10 days, are utilized to examine three test treatments, each consisting of 250 kcal/day (half given twice each day): 1) a whey protein-based supplement, 2) a soy protein-based supplement with carbohydrate and mineral content similar to the whey treatment, and 3) a carbohydrate supplement (control; isocaloric and similar in mineral content to the other two treatments). Calorimetry measures along with oral glucose tolerance testing (OGTT) provide data on substrate oxidation and response curves for OGTT. These data are used for interpretation of levels of carbohydrate uptake, oxidation, and circulating levels of substrates, hormones, and other endocrine markers in light of the treatments imposed.

Impact of Physical Activity on Real-time Glucose Regulation through the Lifespan



This study examines the extent to which different exercise/physical activity protocols impact post-prandial and 24-h glycemic control in active, inactive, young, middle-aged, and elderly adults at risk for type 2 diabetes. The principal outcome measures of this study are:

- Real-time blood glucose levels, as estimated from implanted continuous glucose monitors
- whole body substrate oxidation, as estimated from continuous respiratory calorimetry
- core temperature, skin temperature, heart rate, heat flux, and physical activity, as determined by the Hidalgo Equivital I monitoring system

These data will be recorded continuously in human volunteers, residing in our whole body calorimeters, over the course of several two-day blocks. Study volunteers will represent three age groups: adults aged 25-35 y, 45 – 55y, and elderly aged 65 – 85 y. These groups will be evaluated for aerobic fitness level and will participate in a prescribed exercise routine which represents 65% of VO_2 max for the younger group and 50% of VO_2max for the elderly group. Three activity patterns will be used to meet the prescribed physical activity to test the short-term effectiveness of three different exercise conditions on glucose and substrate regulation. These data contribute to an ongoing project to develop a mathematical model relating ingestion, uptake, and oxidation of carbohydrate, fat, and protein to real-time measures of blood glucose, heat flux, physical activity, and energy expenditure.