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# Macro- and micronutrient intakes of adults with mood disorders and their association with mental function

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Having retired from the university, I am no longer a Principal Investigator of any project, but I continue to work as a co-investigator of some studies. But most of my time now is devoted to 2 things: 1) traveling to lecture about the importance of nutrition and mental health, and 2) raising money for the two charitable funds I established in 2015, to fund the many other scientists wanting to do research on nutrition and mental health. [View project](#)



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energy) lard/soy oil based diet for 12 weeks to induce obesity. Subsequently, a baseline control group was sacrificed and the remaining rats were randomized to 7 diets containing various levels of ALA and linoleic acid (LA) for 8 weeks. The groups and diets were as follows (g ALA/LA per 100 g oil): canola/flax mix (22/19), canola (11/21), soy (8/54), high-oleic canola/canola mix (7/21), high-oleic canola (3/20), lard/soy mix (1/9), and safflower (1/75). All dietary treatments resulted in similar levels of obesity (body and adipose mass). Early glomerulopathy was evidenced by the histological quantification of glomerular hypertrophy. A targeted lipidomics approach using HPLC-tandem mass spectrometry of 64 eicosanoids, docosanoids, and octadecanoids detected 33 renal metabolites. Of these, 19 were affected by diet. The 4 metabolites that were inversely correlated with glomerular volume ( $p < 0.05$ ;  $r = -0.3$ ) were derived from ALA, either directly (9- and 13-HOTRE), or indirectly after ALA conversion to eicosapentanoic acid (5-hydroxyeicosapentanoic acid) and docosahexanoic acid (4-hydroxydocosahexanoic acid). Consequently, glomerular hypertrophy was prevented in rats given the 3 diets with the highest levels of ALA: canola/flax mix, canola, and soy. Rats with the lowest dietary ALA experienced a 17%–25% increase in glomerular volume (hypertrophy). Renal HOTRE levels were influenced mostly by ALA and also notably by LA. Using logistic regression, for every nmol % increase in renal ALA and LA, HOTREs increased by 95 and 2 pmol/mg tissue, respectively. In conclusion, dietary ALA provides renoprotection in obesity-related glomerulopathy, possibly via novel renal metabolites derived from ALA, which can be manipulated through dietary ALA and LA. (Supported by CIHR, Government of Manitoba and Canola Council of Canada.)

### Relationship between dietary intakes and visfatin, TNF- $\alpha$ , or IL-6 concentrations among women with prior gestational diabetes mellitus

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Adipose tissue-derived cytokines might be involved in the development of obesity-related complications, such as diabetes and cardiovascular disease. Dietary factors may modulate adipose tissue function and affect circulating levels of cytokines. However, few data are available, especially in women with prior gestational diabetes mellitus (GDM). The aim of this study was to investigate the relationship between diet and the circulating cytokine profile in women with prior GDM. The study group included 205 women with a history of GDM between 2003 and 2010 based on diagnosis data from databanks provided by the Régie de l'assurance maladie du Québec (RAMQ) and for whom data on diet and cytokines were available. Nutritional information was obtained from a validated interviewer-administered food frequency questionnaire (FFQ). The cytokine profile (leptin, resistin, ghrelin, adiponectin, visfatin, IL-6, TNF- $\alpha$ , and PAI-1) was measured in fasting plasma by the xMAP technology using the Bio-Plex 200 system. Mean age and body mass index (BMI) was  $36.4 \pm 4.9$  years and  $27.8 \pm 6.7$  kg/m<sup>2</sup>, respectively. Time between delivery date and metabolic testing was  $4.1 \pm 1.7$  years on average. Dietary intakes of energy ( $r = -0.14$ ,  $p = 0.04$ ), total fat ( $r = -0.18$ ,  $p = 0.008$ ), monounsaturated fatty acids (MUFA) ( $r = -0.20$ ,  $p = 0.005$ ), polyunsaturated fatty acids (PUFA) ( $r = -0.21$ ,  $p = 0.003$ ), and omega-3 fatty acids ( $r = -0.19$ ,  $p = 0.006$ ) were negatively correlated with visfatin concentrations. Total fat ( $r = -0.14$ ,  $p = 0.05$  for both), MUFA ( $r = -0.15$ ,  $p = 0.04$  for both), PUFA ( $r = -0.16$ ,  $p = 0.03$  and  $r = -0.14$ ,  $p = 0.05$ , respectively), and

omega-3 intakes ( $r = -0.20$ ,  $p = 0.004$ ; and  $r = -0.18$ ,  $p = 0.01$ , respectively) were negatively correlated with TNF- $\alpha$  and IL-6 concentrations. In addition, there was a trend toward statistical significance between energy intakes and TNF- $\alpha$  or IL-6 concentrations ( $p < 0.09$  for both). Results were similar after adjustments for age and BMI. No association was observed between intakes of carbohydrates, proteins, or saturated fatty acids and visfatin, TNF- $\alpha$ , or IL-6 concentrations ( $p > 0.05$  for all). There was no association between all the studied dietary factors and leptin, resistin, ghrelin, adiponectin, or PAI-1 concentrations. These results suggest that visfatin, TNF- $\alpha$ , and IL-6 concentrations are associated with dietary fat intakes among women with prior GDM. (Supported by the Fond de la recherche en santé du Québec (FRSQ) and the Canadian Institutes of Health Research (CIHR).)

### Food perceptions among adults and dietitians: are they similar?

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Few studies have examined global food perceptions among adults. However, one study has addressed this issue among nutrition professionals. They observed wide ranges of perceptions among common foods, despite access to nutritional values (Scarborough et al. 2007, Public Health Nutr. 10(4): 346–353). Therefore, even among nutrition professionals, other factors than nutritional information influence food perceptions. The aim of this study was to determine how adults and registered dietitians spontaneously perceived common foods according to a food frequency continuum, and to assess the differences between these 2 groups. A sample of 1002 adults and 566 registered dietitians took part in this study. Participants had to associate 52 common foods with either “daily” food (1), “occasional” food (2), or “sometimes” food (3). Food groups were created according to (1) their inclusion in the Canadian Food Guide (CFG) foods (e.g., tomato, pastas, etc.;  $n = 22$ ), (2) sugar and fat content (high in sugar/high in fat (HSHF) foods) (e.g., apple pie, chips, etc.;  $n = 16$ ), and (3) meals that include foods from different groups (Meals) (e.g., burger, Caesar salad, etc.;  $n = 13$ ). Results show that 56.3% of participants perceived that CFG foods are daily foods while they perceived that HSHF foods (57.9%) and Meals (92.5%) are occasional foods. Although adults and registered dietitians perceived HFHS foods similarly ( $2.43 \pm 0.01$  vs.  $2.43 \pm 0.04$ ,  $p = 0.92$ ), significant differences were observed between perceptions of adults and registered dietitians for CFG foods ( $1.64 \pm 0.01$  vs.  $1.34 \pm 0.02$ ,  $p < 0.0001$ ) and Meals ( $2.02 \pm 0.01$  vs.  $1.75 \pm 0.02$ ,  $p < 0.0001$ ). While adults tend to be more severe in their food perceptions than registered dietitians, results from this study show that food perceptions among adults and registered dietitians are knowledgeable about actual nutritional guidelines. Results also suggest the presence of a popular knowledge about the value of food that is consistent with healthy eating. (Supported by the Health and Social services Minister of Quebec.)

### Selected food group and nutrient intakes rather than overall diet quality are associated with mental function in adults with mood disorders

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Intervention and epidemiological studies have linked intakes of nutrients from food or supplement sources with mental health. However,

to date, no investigations have simultaneously examined food, nutrient, and diet quality measurements in people with mental disorders and their association with psychiatric symptoms and function. The purpose of this study was to examine the relationships among different dietary intake measures with depression, mania, and overall psychological functioning in adults with mood disorders. A cross-sectional survey was conducted of food intakes recorded over 3 days, Global Assessment of Functioning (GAF) scores, and symptoms of depression and mania (Hamilton Depression Scale (Ham-D), Young Mania Rating Scale (YMRS)) in 97 community-based adults with confirmed diagnoses of mood disorders. Dietary measurements included the 4 food groups of Eating Well with Canada's Food Guide, energy (kilocalories), macro- and micronutrients (i.e., vitamins B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>9</sub>, B<sub>12</sub>, C, the major minerals, iron and zinc), and the Canadian Healthy Eating Index. Of all food groups, milk and alternates, and grain products ( $r = 0.25$ ,  $p < 0.05$ ) were associated with GAF and only grain products ( $r = -0.20$ ,  $p < 0.05$ ) were associated with Ham-D scores. Significant positive correlations were found between GAF scores and energy, carbohydrates, fibre, total fat, linoleic acid, vitamins B<sub>2</sub>, B<sub>3</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>9</sub>, B<sub>12</sub>, calcium, phosphorus, potassium, iron (all  $p < 0.05$ ), as well as magnesium ( $r = 0.41$ ,  $p < 0.0001$ ), and zinc ( $r = 0.35$ ,  $p < 0.001$ ). When supplement use was added to nutrient intakes from food, GAF scores remained positively correlated ( $p < 0.05$ ) with all dietary minerals; zinc was significantly correlated with YMRS ratings ( $r = -0.25$ ,  $p < 0.05$ ). This comprehensive analysis in a sample of adults with clinically diagnosed mood disorders appeared to show that mental function was more closely associated with individual food groups and specific nutrient intakes rather than measures of overall diet quality. This data suggests that nutrient intakes warrant further consideration in the treatment of those with mood disorders. (Supported by the Danone Research Institute Grant-In-Aid.)

### Dietary n-3 PUFA regulation of adipokines and inflammatory mediators in adipocyte-macrophage paracrine interactions

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In obesity, paracrine interactions between adipocytes and infiltrating macrophages in adipose tissue generate inflammation and related complications. Interestingly, the long chain n-3 polyunsaturated fatty acids (PUFA) eicosapentaenoic acid (20:5n-3, EPA) and docosahexaenoic acid (22:6n-3, DHA) are known to exert anti-inflammatory effects and thus may represent a strategy to reduce synthesis and secretion of pro-inflammatory adipokines, such as tumour necrosis factor (TNF $\alpha$ ), monocyte chemoattractant protein 1 (MCP-1), and interleukin 6 (IL-6) from obese adipose tissue. To address this, we developed an in vitro murine co-culture model that mimics the adipose tissue macrophage infiltration found in the *db/db* mouse model of obesity. Mature murine 3T3-L1 adipocytes were incubated with RAW 264.7 macrophages in direct contact, or separated by a trans-well membrane in the presence of 125  $\mu\text{mol/L}$  EPA, DHA, or palmitic acid (PA), all complexed to albumin, or albumin alone (control) for 12 h. After 12 h, IL-6 and MCP-1 secreted protein was markedly suppressed in DHA (74%, 58%, respectively) and EPA (33%, 49%, respectively) treated contact co-cultures, compared with PA and control ( $p < 0.05$ ). However, TNF $\alpha$  secretion was below the range of detection measured by Bio-Plex ( $<5.8$  pg/mL) in any treatment. Similar results were found in the trans-well system, although in all fatty acid groups, adipokine secretion was nearly 2-fold lower from the trans-well co-culture, emphasizing the importance of direct adipocyte-macrophage contact in paracrine interactions. The trans-well co-culture system allowed for isolation of adipocytes to measure mRNA expression of pro-inflammatory mediators. While PA increased ( $p < 0.05$ ) IL-6 mRNA expression in adipocytes relative

to control, DHA downregulated ( $p < 0.05$ ) the mRNA expression of TNF $\alpha$ , IL-6, toll-like receptor 4 (TLR-4) and nuclear factor- $\kappa\text{B}$  (NF $\kappa\text{B}$ ) compared with adipocytes treated with PA or control. Overall, these data demonstrate that long-chain n-3 PUFA can decrease pro-inflammatory adipokine secretion and mRNA expression of various pro-inflammatory mediators, and thus may provide a beneficial strategy to reduce inflammation in an obese state characterized by macrophage infiltration into adipose tissue. (Supported by NSERC.)

### Effects of 4 weight-loss diets differing in fat, protein, and carbohydrate on energy expenditure after weight loss: results from the POUNDS LOST trial

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Weight loss reduces energy expenditure, but these metabolic adaptations to different macronutrient profiles in free-living conditions have not been extensively measured. To determine if energy-reduced diets with varying levels of fat, protein, or carbohydrate differentially reduce total or resting energy expenditure. In a subset of participants ( $n = 55$ ) enrolled in a randomized trial of 4 energy-reduced weight loss diets, changes in body composition (by dual X-ray absorptiometry), and total (by doubly labeled water) and resting energy expenditure (by indirect calorimetry) were measured after 6 months. Comparisons were between assigned levels of protein (25% vs. 15%), fat (40% vs. 20%), and across 4 levels of carbohydrate (35% through 65%). Overall, total energy expenditure was reduced by  $128 \pm 46$  kcal/day (mean  $\pm$  SE) ( $-3.9\%$ ), and resting energy expenditure by  $113 \pm 17$  kcal/day ( $-6.8\%$ ) in all participants, with no statistically significant differences between levels of protein or fat or across the 4 levels of carbohydrate. Resting energy expenditure adjusted for lean and fat mass was significantly lower at 6 months (by  $45 \pm 17$  kcal/day;  $p = 0.01$ ) than predicted from changes in body composition, indicating a metabolic adaptation. The observed resting energy expenditure was significantly lower than predicted on the 15% protein diet ( $-67 \pm 18$  kcal/day;  $p = 0.01$ ), but not on the 25% protein diet ( $-22 \pm 29$  kcal/day;  $p = 0.45$ ); and  $52 \pm 20$  kcal/day lower than predicted on the 20% fat diet ( $p = 0.03$ ), but not on the 40% fat diet. For each 10% increase in assigned carbohydrate intake, the magnitude of metabolic adaptation decreased  $135 \pm 62$  kcal/day. Notwithstanding, weight loss was similar for all diets. After 6 months of weight loss, resting energy expenditure decreased. Changes in body composition were the major determinants of these changes, but resting energy expenditure decreased more than predicted on the low-fat and average-protein diets compared with high-fat and high-protein, and the degree of adaptation decreased with increasing carbohydrate intake. (Funding for this study was provided through grants from the National Heart, Lung, and Blood Institute (HL073286) and the General Clinical Research Center, National Institutes of Health (RR-02635). At the time this work was completed, RJdS was a doctoral student at the Harvard School of Public Health, and received the Irene and Frederick Stare Nutrition Education Scholarship. RJdS is currently supported by a Canadian Institutes of Health Research post-doctoral fellowship.)